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Assessment of pain at the peripheral intravenous cannulation site during intravenous propofol administration for induction of general anesthesia: A prospective observational study

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ABSTRACT

Aim: To assess the intensity of pain at the site of peripheral venous access during propofol injection and to analyze the relationship between pain severity and selected clinical factors.

Materials and Methods: A prospective single-center observational study included 100 adult patients (ASA I-III) undergoing elective surgery under general anesthesia. Propofol was administered intravenously at a dose of 1.5-3 mg/kg without prophylactic lidocaine. Pain intensity was assessed immediately after the start of propofol injection, before loss of consciousness, using the Numeric Rating Scale (NRS, 0-10). Non-parametric statistical tests and multivariable logistic regression analysis were applied.

Results: The mean pain intensity was 4.6 ± 1.9 (median 5). Clinically significant pain (NRS ≥ 4) was reported by 68% of patients. The highest pain scores were observed during cannulation on the dorsum of the hand, whereas the lowest scores occurred with antecubital fossa access ($p < 0.001$). Women reported higher pain intensity than men ($p < 0.001$). In multivariable analysis, cannulation on the dorsum of the hand and the use of a 22G cannula were associated with an increased risk of clinically significant pain, while male sex and age above 70 years were associated with a lower risk.

Conclusions: Pain during propofol injection is common and frequently reaches clinically significant intensity. The site of venous cannulation appears to be the strongest modifiable factor influencing pain severity. Whenever possible, more proximal venous access sites should be preferred.

KEYWORDS

general anesthesia, Numeric Rating Scale, propofol, injection pain, peripheral venous cannulation

INTRODUCTION

Propofol is currently the primary intravenous agent used for the induction of general anesthesia and is considered the gold standard in anesthesiology practice [3]. Its rapid onset of action, the ability to precisely control the depth of anesthesia, and smooth recovery profile make it the drug of choice in routine operating room practice.

Despite these advantages, pain at the injection site remains one of the most common and well-documented adverse effects associated with propofol administration [2, 3]. Although this discomfort is typically short-lived, it often represents the first conscious stimulus experienced by the patient at the onset of anesthesia induction. For some patients, it becomes the most distinct and memorable element of the entire induction process [4].

The reported incidence of propofol injection pain ranges from 28% to 90%, depending on factors such as the injection technique, the site of venous access, and the use of preventive strategies [1, 5, 7]. In everyday clinical practice, particularly

when pharmacological prophylaxis is not routinely used, a considerable proportion of patients report pain of varying intensity, often described as moderate or severe.

The exact mechanism responsible for this phenomenon has not been fully elucidated. It is believed that pain results from the direct irritative effect of the free aqueous fraction of propofol on the vascular endothelium and from the activation of inflammatory mediators, including the kallikrein-kinin system [2, 6]. The site of venous cannulation also appears to play an important role. Smaller, more peripheral veins are associated with slower blood flow and prolonged contact between the drug and the vessel wall, which may contribute to increased pain perception.

Although this pain is transient and usually subsides as consciousness decreases, it represents a real component of the patient's perioperative experience. In the context of modern perioperative care, which increasingly emphasizes not only patient safety but also comfort and quality of care, effective pain assessment and management remain

essential components of clinical practice. Despite numerous studies investigating pharmacological methods for reducing propofol injection pain, data regarding the influence of clinical factors related to venous access under routine clinical conditions remain limited.

AIM

The aim of this study was to assess the frequency and intensity of pain during intravenous propofol injection in adult patients undergoing induction of general anesthesia for elective surgical procedures, and to identify clinical factors associated with the occurrence of clinically significant pain ($\text{NRS} \geq 4$).

MATERIALS AND METHODS

Study design and setting

This study was designed as a prospective, single-center observational study. It was conducted between mid-January and the end of February 2026 in the operating theatre of the Masovian Provincial Hospital in Siedlce, Poland. Clinical management followed the standard anesthetic protocols routinely used at the institution.

PARTICIPANTS

The study included 100 consecutive adult patients (≥ 18 years) scheduled for elective surgical procedures under general anesthesia.

Inclusion criteria were: American Society of Anesthesiologists (ASA) physical status I-III and absence of contraindications to propofol administration.

Exclusion criteria included inability to establish verbal communication, impaired consciousness, refusal to participate in the study, and administration of midazolam prior to induction of anesthesia due to its potential influence on pain perception.

All participants were informed about the voluntary and anonymous nature of the study.

ANESTHESIA PROTOCOL

Induction of general anesthesia was performed according to the standard clinical practice of the institution. As part of the induction protocol, atropine and fentanyl were administered intravenously in doses individually determined by the attending anesthesiologist. Propofol was subsequently administered intravenously at a dose of 1.5-3 mg/kg body weight.

No prophylactic lidocaine was administered prior to propofol injection. Patency of the intravenous access was confirmed in each case by flushing the cannula with 0.9% sodium chloride solution.

OUTCOME ASSESSMENT

Pain intensity was assessed immediately after the initiation of propofol injection and before loss of consciousness. Pain was evaluated using the Numeric Rating Scale (NRS) ranging from 0 to 10, where 0 indicates no pain and 10 represents the worst pain imaginable.

Clinically significant pain was defined as $\text{NRS} \geq 4$ and was used as the dependent variable in the multivariable analysis.

The following clinical variables were recorded: site of venous cannulation (dorsum of the hand, wrist, forearm, antecubital fossa), cannula size (18G, 20G, 22G), age group, and sex.

Pain assessment was performed by a single investigator in order to reduce inter-observer variability.

No formal sample size calculation was performed; the study included a convenience sample of consecutive patients.

ETHICAL CONSIDERATIONS

The study had an observational design and did not involve modification of standard clinical management or the use of additional medical procedures. Data were collected anonymously without interference with the treatment process. All participants were informed about the voluntary nature of participation in the study.

The study protocol was approved by the Management Board of the Masovian Provincial Hospital in Siedlce. The study was conducted in accordance with the principles of the Declaration of Helsinki.

STATISTICAL ANALYSIS

Statistical analysis was performed due to the ordinal nature of the data obtained using the Numeric Rating Scale (NRS); therefore, non-parametric statistical methods were applied. Quantitative variables were presented as the median and, for descriptive purposes, also as the mean $\pm$ standard deviation (SD). Qualitative variables were expressed as counts and percentages.

Comparisons between two groups were performed using the Mann-Whitney U test, whereas comparisons among more than two groups were conducted using the Kruskal-Wallis test. When statistically significant differences were detected, post-hoc analysis with Bonferroni correction was applied.

To identify independent factors associated with the occurrence of clinically significant pain ($\text{NRS} \geq 4$), multivariable logistic regression analysis was performed. The dependent variable in the model was the presence of clinically significant pain ($\text{NRS} \geq 4$). Variables that were statistically significant in the univariable analysis were included in the multivariable model. The results were presented as odds ratios (OR) with 95% confidence intervals (CI).

A p -value < 0.05 was considered statistically significant. All statistical analyses were performed using the R statistical environment (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

STUDY POPULATION

A total of 100 patients undergoing elective surgical procedures under general anesthesia were included in the study. The characteristics of the study population are presented in Table 1.

OVERALL PAIN INTENSITY

The mean pain intensity during propofol injection was 4.6 ± 1.9 points on the Numeric Rating Scale (NRS), with a median value of 5. Clinically significant pain ($\text{NRS} \geq 4$) was reported by 68 patients (68%).

Table 1. Characteristics of the study population (n = 100)

Variable	n	[%]
Women	54	54%
Men	46	46%
Age (years)		
18-30	24	24%
31-50	38	38%
51-70	28	28%
>70	10	10%
Cannulation site		
Dorsum of the hand	28	28%
Wrist	22	22%
Forearm	30	30%
Antecubital fossa	20	20%
Cannula size		
18G	27	27%
20G	52	52%
22G	21	21%

Source: Own materials

EFFECT OF CANNULATION SITE

Pain intensity differed significantly depending on the site of venous cannulation ($p < 0.001$). The highest NRS scores were recorded for cannulation on the dorsum of the hand, whereas the lowest values were observed for cannulation in the antecubital fossa.

Cannulation in the wrist and forearm was associated with intermediate NRS values. Detailed results are presented in Table 2 and Figure 1.

SEX, AGE AND CANNULA SIZE

Women reported significantly higher pain intensity compared with men (5.5 ± 1.5 vs 3.6 ± 1.4 ; Mann-Whitney U test, $p < 0.001$).

Differences between age groups were also statistically significant ($p = 0.001$). Higher NRS values were observed in younger patients, whereas the lowest pain scores were recorded in patients aged over 70 years.

Significant differences in pain intensity were also observed depending on the cannula size ($p = 0.0006$). The highest NRS values were recorded in patients with 20G cannulas. Detailed data are presented in Table 2.

MULTIVARIABLE ANALYSIS

In the multivariable logistic regression analysis, including variables that were significant in the univariable analysis, male sex was associated with a lower risk of clinically significant pain.

A similar association was observed for patients aged over 70 years, who also demonstrated a lower risk of clinically significant pain.

Independent factors associated with an increased risk of clinically significant pain ($\text{NRS} \geq 4$) included cannulation

on the dorsum of the hand, wrist, and forearm, compared with the antecubital fossa.

A statistically significant association with the occurrence of clinically significant pain was also observed for the use of a 22G cannula.

Detailed results of the multivariable analysis are presented in Table 3.

DISCUSSION

In the present study, pain during intravenous administration of propofol reached clinically significant intensity in 68% of patients, with a mean NRS score of 4.62. These findings are consistent with previously published data, which indicate that the incidence of pain during propofol injection remains high, particularly in routine clinical practice and in the absence of pharmacological prophylaxis [1, 5]. The results of this study confirm that pain associated with propofol administration is not a marginal clinical issue but rather a common phenomenon affecting a substantial proportion of patients undergoing standard induction of general anesthesia.

Among the analyzed variables, the most pronounced differences in pain intensity were related to the site of venous cannulation. The mean NRS score for cannulation on the dorsum of the hand was 6.43, while for the antecubital fossa it was 2.43 (see Table 3). This difference was both statistically and clinically significant. This observation is consistent with the mechanism of propofol injection pain described in the literature and with general principles of pain assessment and management [11]. In smaller and more peripheral veins, slower blood flow may prolong the contact of the drug with the vascular endothelium and

Table 2. Pain intensity on the Numeric Rating Scale (NRS) according to the analyzed variables

Variable	Mean $\pm$ SD (NRS)	Median	p
Cannulation site			<0.001
Dorsum of the hand	6.43 $\pm$ 1.2	6.5	
Wrist	5.36 $\pm$ 1.4	6	
Forearm	3.90 $\pm$ 1.6	4	
Antecubital fossa	2.43 $\pm$ 1.3	3	
Sex			<0.001
Women	5.52 $\pm$ 1.5	6	
Men	3.57 $\pm$ 1.4	3	
Cannula size			0.001
18G	3.59 $\pm$ 1.3	3	
20G	5.31 $\pm$ 1.5	6	
22G	4.24 $\pm$ 1.4	4	
Age (years)			0.001
18-30	5.63 $\pm$ 1.6	6	
31-50	4.89 $\pm$ 1.7	5	
51-70	4.00 $\pm$ 1.5	4	
>70	3.00 $\pm$ 1.2	3	

Source: Own materials

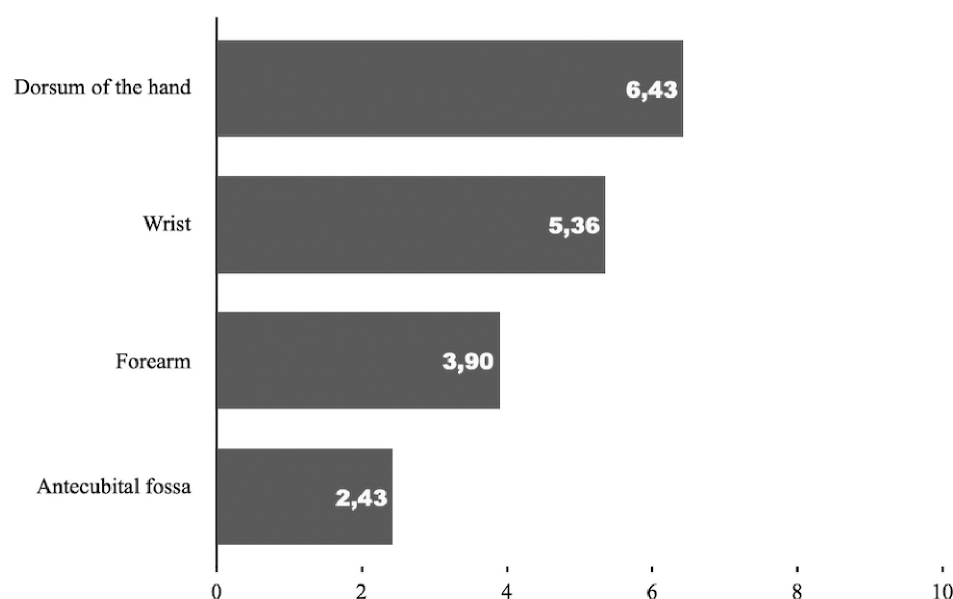


Fig. 1. Mean pain intensity on the Numeric Rating Scale (NRS) according to the site of peripheral venous cannulation.

Source: Own materials

enhance the activation of pain mediators [2, 6]. From a practical perspective, these findings suggest that, whenever anatomical conditions allow, more proximal venous access sites such as the antecubital fossa or forearm should be preferred, while cannulation of veins on the dorsum of the hand should be avoided when possible.

Women reported significantly higher pain intensity compared with men. This finding is consistent with observations described in the literature on procedural pain

[3] and may be explained by both biological and psychosocial factors related to pain perception and expression. In the multivariable analysis, male sex was associated with a lower risk of clinically significant pain, indicating that this relationship persisted even after adjustment for other clinical variables.

Statistically significant differences were also observed between age groups. Higher NRS values were reported among younger patients, whereas lower pain scores were

Table 3. Results of multivariable logistic regression analysis evaluating factors associated with clinically significant pain (NRS ≥ 4)

Variable	OR (95% CI)	p
Men	0.16 (0.03-0.88)	0.033
Age 31-50 years	0.84 (0.18-3.92)	0.82
Age 51-70 years	0.52 (0.10-2.63)	0.43
Age >70 years	0.03 (0.001-0.76)	0.028
Dorsum of the hand	310.4 (18.7-5146.2)	<0.001
Wrist	190.2 (9.6-3763.5)	0.002
Forearm	18.4 (2.1-162.8)	0.007
20G cannula	1.9 (0.4-8.7)	0.41
22G cannula	12.8 (1.4-118.6)	0.023

Reference categories were: female sex, age 18-30 years, antecubital fossa cannulation, and 18G cannula.

Source: Own materials

observed in older individuals. In the multivariable model, age above 70 years was associated with a lower risk of clinically significant pain. This pattern is consistent with findings from other studies on procedural pain and may reflect differences in pain perception as well as age-related changes in the reactivity of the nervous system [7].

It should also be emphasized that psychological factors such as preoperative anxiety, stress, and previous medical experiences were not assessed in this study. These variables are known to significantly influence pain perception and may act as potential confounders.

This study also demonstrated an association between cannula size and pain intensity [8]. In the univariable analysis, the highest NRS values were observed in the 20G cannula group; however, in the multivariable model, a statistically significant association with clinically significant pain was observed only for the use of a 22G cannula. The non-linear nature of this relationship suggests the possible influence of additional clinical factors, such as the site of cannulation or anatomical characteristics of the vein, which should be taken into account when interpreting this finding.

It is also noteworthy that all patients received fentanyl prior to induction, in accordance with the standard protocol of the department. However, the dose of fentanyl was not analyzed as a continuous variable and may have varied between patients, which could have influenced pain perception, as opioids are known to modulate nociceptive responses. Therefore, the potential confounding effect of fentanyl dosing should be considered when interpreting the results. Despite the administration of an opioid, 68% of patients reported pain with NRS ≥ 4 , suggesting that routine peri-induction analgesic management may reduce but does not completely eliminate discomfort associated with propofol injection.

Previous clinical studies have demonstrated the effectiveness of several pharmacological methods in reducing propofol injection pain, including the use of lidocaine, opioids, and other adjunctive agents [1, 9, 10]. In recent years, both pharmacological and technical strategies

aimed at reducing pain during propofol administration have continued to be investigated, including alternative anesthetic agents and modified drug formulations [12-17].

Clinically, the findings of this study suggest that patient comfort during anesthesia induction may be improved through careful selection of the venous cannulation site. In situations where multiple venous access options are available, preference for more proximal venous sites may represent a simple and easily implementable strategy to reduce pain associated with propofol administration.

LIMITATIONS OF THE STUDY

The single-center design of the study limits the generalizability of the results to populations with different demographic characteristics or to institutions with different operating room practices.

The dose of fentanyl was not analyzed as a continuous variable, and its variability between patients may have acted as an uncontrolled confounding factor influencing the assessment of pain intensity.

The study also did not account for psychological variables such as the level of preoperative anxiety or previous experiences with anesthesia, although these factors are recognized as important modulators of pain perception.

The lack of randomization and blinding of the assessor results from the observational design of the study.

Despite these limitations, the study reflects real-world clinical practice and includes a relatively homogeneous population of elective surgical patients, which increases the practical applicability of the findings.

CONCLUSIONS

Pain during propofol injection is common and reaches clinically significant intensity in the majority of patients undergoing induction of general anesthesia without lidocaine prophylaxis.

The site of venous cannulation appears to be the strongest modifiable factor influencing pain during propofol injection. Cannulation on the dorsum of the hand is associated with a significantly higher risk of pain compared with cannulation

in the antecubital fossa and, whenever possible, should be limited in favor of more proximal venous access sites.

Female sex and younger age were associated with a higher risk of clinically significant pain, whereas age above 70 years was associated with a lower risk. In the multivariable

analysis, a significant association with pain occurrence was also observed for the use of a 22G cannula.

Considering these factors may facilitate the identification of patients who could benefit from additional preventive measures prior to anesthesia induction.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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Assessment of knowledge, skills, and readiness to provide first aid before the arrival of emergency services: A survey study

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ABSTRACT

Aim: To assess respondents' opinions on the need to learn first aid principles and to analyze the level of knowledge, skills, and readiness to undertake rescue actions.

Materials and Methods: The study was conducted using a diagnostic survey method with an original online questionnaire. Data analysis was descriptive in nature. The study included participants with diverse demographic profiles, predominantly individuals associated with the medical field.

Results: Most respondents declared a high level of knowledge and skills in first aid; however, their sense of confidence in life-threatening situations was moderate. The most frequently indicated barrier was fear of making a mistake. Practical training was assessed as more effective than theoretical instruction. Respondents emphasized the need for regular knowledge renewal and the widespread availability of training, supporting its mandatory nature.

Conclusions: Despite the high level of declared knowledge, there is a need to strengthen practical competencies and confidence in emergency situations. The results highlight the importance of regular practical training and broad public education. Further studies using larger samples and statistical analyses are necessary.

KEYWORDS:

first aid, medical education, prehospital care, emergency situations, first responder

INTRODUCTION

The quality and timeliness of first aid provided before the arrival of emergency services play a crucial role in the survival of injured individuals, as the effectiveness of prehospital emergency management largely depends on the skills and competencies of the first responder present at the scene [1, 2]. Early medical intervention and minimizing delays in initiating initial rescue actions are key factors determining positive treatment outcomes in life-threatening situations [2, 3]. Data indicate that the vast majority of trauma-related deaths occur in the prehospital environment, before victims gain access to professional medical care [4-6]. This problem is particularly pronounced in low- and middle-income countries, where up to 90% of trauma-related deaths occur in the absence of well-developed prehospital emergency systems [5-7]. In such conditions, individuals present at the scene – including citizens, volunteers, police officers, and other non-professional responders – play a crucial role by undertaking rescue actions independently or in cooperation with others [7-9]. Disaster research clearly shows that “ordinary citizens”

are most often the ones who save lives in the initial phase of an incident, and assistance provided within the first hour may determine whether a victim survives or dies [9, 10]. The importance of the first minutes following an incident is particularly evident in cases of sudden cardiac arrest, where resuscitation must be initiated as quickly as possible to restore spontaneous circulation within the first four minutes [11, 2]. It has been demonstrated that earlier use of an AED by bystanders significantly reduces time to defibrillation and is associated with higher 30-day survival compared to defibrillation performed after the arrival of emergency medical teams [11, 2].

Despite clear evidence of the effectiveness of early intervention, fewer than 30% of out-of-hospital resuscitation attempts are initiated by bystanders, indicating a weak or absent first link in the chain of survival [8, 11]. At the same time, it has been shown that basic life-saving interventions performed by minimally trained bystanders within minutes of an incident can significantly reduce mortality and morbidity [5, 2]. One of the key barriers limiting the effectiveness of first responders is the rapid

decline in knowledge and skills after completing first aid training, which may occur as early as 30 days after training and reach unacceptable levels before recertification [12, 13]. At the same time, individuals who renew their first aid certification or training achieve better outcomes than those who completed training only once [4, 12].

Studies also show that a high level of theoretical knowledge does not always translate into confidence and readiness to act, as training participants often report low perceived competence in performing cardiopulmonary resuscitation and using an AED [1, 13]. Lack of confidence and emotional concerns significantly limit readiness to undertake rescue actions in real-life emergencies [13, 14]. Another factor influencing the effectiveness of first aid is access to information and situational awareness among responders at the scene, particularly in conditions of chaos and information overload [15, 16]. It has been shown that lack of information, failure to share it, or excessive cognitive load on responders may lead to loss of life and increased material damage [15]. In emergency situations, victims are often in shock, which makes obtaining information difficult, prolongs response time, and results in an incomplete situational picture; therefore, reducing time spent searching for information and focusing on rescue actions is crucial for effective assistance [3, 15]. Improving the situational awareness of first responders enables better understanding of event dynamics and more effective decision-making [15].

Numerous studies confirm that well-designed training programs increase knowledge levels, perceived competence, and readiness to provide first aid, with effects lasting at least six months after training [4, 5, 7]. Participants in such programs report fewer knowledge-related barriers and greater confidence in providing first aid [4, 7]. In the context of mass casualty incidents and disasters, it is emphasized that traditional emergency services cannot remain the sole group responsible for saving lives, and local communities are often best prepared to undertake immediate actions [8, 10]. Authors indicate that widespread public education in first aid may increase the number of lives saved and citizens' willingness to help [10, 16, 17].

AIM

The aim of the study was to explore respondents' opinions on the need to learn first aid principles prior to the arrival of emergency services and to assess the level of knowledge, skills, and perceived readiness to undertake rescue actions in life-threatening situations. The study also aimed to identify factors influencing readiness to provide first aid, such as prior participation in training, educational or work environment (medical vs. non-medical), emotional concerns, and fear of legal liability.

An additional objective was to determine the perceived effectiveness of different forms of first aid education (theoretical vs. practical) and to examine respondents' opinions regarding training frequency, accessibility, and the justification for introducing mandatory courses in schools and workplaces. The obtained results allow for

an assessment of the current level of public awareness of first aid and the identification of areas requiring intensified educational efforts.

MATERIALS AND METHODS

The study was conducted using a diagnostic survey method with an online questionnaire technique. The research tool was an original questionnaire developed specifically for this study. The survey was distributed electronically via the Internet to 472 respondents, enabling access to individuals diverse in age, education, and educational/work environments.

The questionnaire consisted of 35 closed-ended questions covering demographic data (age, gender, university, field of study, work environment), assessment of knowledge and skills in first aid, experience in providing assistance, as well as opinions on training, barriers to undertaking rescue actions, and the role of prehospital education in society.

Participation in the study was voluntary and anonymous. Respondents were informed about the purpose of the study, the principles of anonymity, and the possibility of withdrawing at any stage of completing the questionnaire. The collected data were used solely for scientific purposes, and the analysis was descriptive and comparative in nature, allowing interpretation of the results in the context of the need for first aid education prior to the arrival of emergency services.

RESULTS

The study group was dominated by young individuals aged 20-35 years (76.3%). Smaller proportions included respondents under 20 years of age (10.7%), aged 36-45 (8.4%), and 46-60 (4.6%). Women predominated (76.3%), while men accounted for 23.7% of participants.

Respondents were associated with the medical environment. The largest group consisted of medical students (55.0%), followed by nursing students (13.7%) and students of other medical fields. Overall, 67.2% were medical students, and 32.8% were individuals working in medical professions.

PARTICIPATION IN TRAINING AND LEVEL OF KNOWLEDGE

The vast majority of respondents had participated in first aid training. As many as 71.8% had attended multiple times, and 19.8% at least once. Only a small proportion had never participated, although most of them expressed willingness to do so. Participants' responses are presented in Figure 1.

The most commonly reported time since the last training was 1 to 3 years (45.8%), while 36.6% had participated within the past year.

Respondents rated their knowledge of first aid highly - 44.3% described it as rather good, and 34.4% as very good. Only a small proportion considered it poor. The vast majority declared familiarity with basic first aid principles (68.7% definitely yes; 28.2% rather yes).

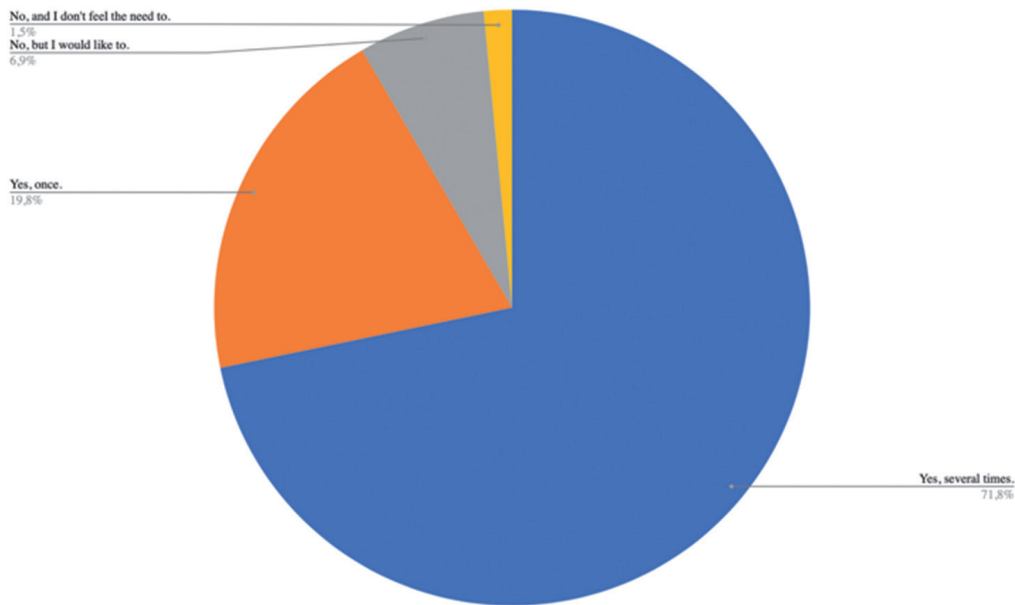


Fig. 1. "Have you participated in a first aid training or course?"

Source: Own materials

PRACTICAL SKILLS IN FIRST AID

Most respondents declared high practical competence. As many as 82.4% were able to recognize an unconscious person without difficulty, and 73.3% declared the ability to correctly perform cardiopulmonary resuscitation in adults.

Knowledge of AED use was also high – 86.3% indicated that they knew how to use it and were able to do so. Additionally, 79.4% declared the ability to provide first aid in common emergencies such as choking, burns, fractures, or hemorrhage.

Almost all respondents knew the emergency number applicable in Poland (97.7%).

EXPERIENCE AND READINESS TO PROVIDE ASSISTANCE

More than half of respondents (51.1%) had witnessed a situation requiring first aid. Among them, 38.9% actually provided assistance, while in some cases intervention was undertaken by another person.

The most frequently indicated barrier to providing assistance was fear of making a mistake (48.1%). At the same time, more than one-third of respondents (35.9%) declared that nothing would prevent them from providing assistance. Responses are presented in Figure 2.

Most respondents did not fear legal liability (71.0% combined "no" and "rather no"), although a significant group

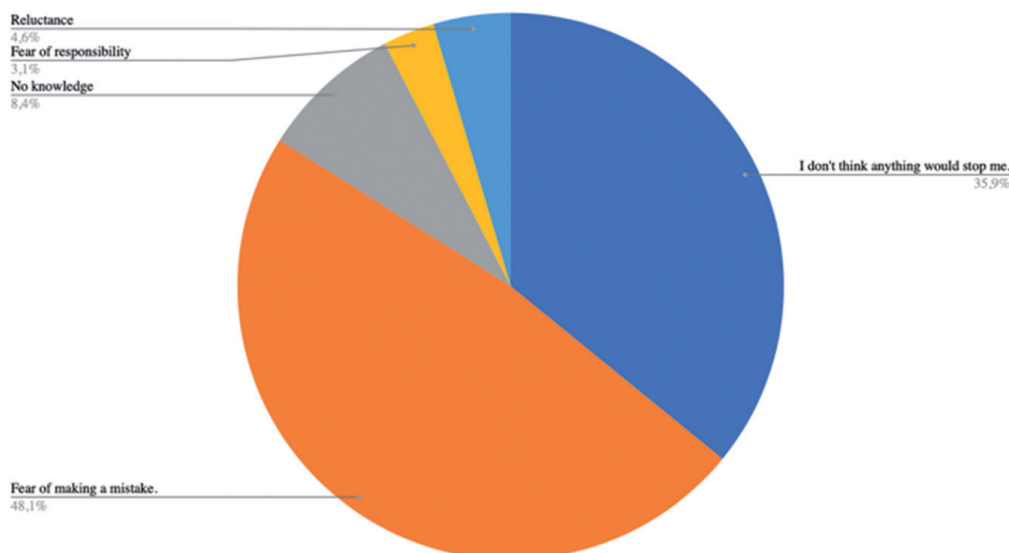


Fig. 2. "The greatest obstacle to providing assistance would be for me: ..."

Source: Own materials

still had such concerns. In terms of emotions, moderate stress predominated – 59.5% declared feeling tension but believed they could cope.

PERCEPTION OF COMPETENCE AND SOCIAL BEHAVIOR

The vast majority of respondents believed that people are afraid to provide first aid (96.9% “definitely yes” and “rather yes”). At the same time, their own confidence in life-threatening situations was moderate – only 26.0% felt confident, while a substantial proportion reported uncertainty.

Respondents assessed the level of public knowledge about first aid as insufficient. Approximately 43.5% rated it as low and 6.9% as very low. Additionally, most believed that the media do not sufficiently promote this topic (80.2% negative responses).

EVALUATION OF EDUCATIONAL FORMS AND TRAINING NEEDS

Respondents rated practical learning significantly higher than theoretical instruction. As many as 71.0% considered practical sessions very effective, whereas lectures were most often rated as moderately effective (55.0%). Distribution of responses is presented in Figure 3.

The most preferred form of learning was practical sessions with an instructor (86.3%). The most frequently indicated optimal frequency of knowledge refreshment was once a year (57.3%).

The main motivation for participating in training was awareness of its usefulness (44.3%), followed by obtaining certification (24.4%) and access to free courses (18.3%).

ATTITUDES TOWARD FIRST AID EDUCATION

Respondents showed very high agreement regarding the need for widespread first aid education. As many as

90.1% believed training should be mandatory in schools, and the same proportion supported its introduction in workplaces.

Moreover, the vast majority (97.0%) supported free and universally accessible training.

IMPORTANCE OF FIRST AID IN EMERGENCY SITUATIONS

Respondents almost unanimously emphasized the crucial importance of first aid – 87.0% rated it as very high, and an additional 9.9% as high.

At the same time, 97.8% believed that lack of public knowledge in this area may increase the number of deaths before emergency services arrive, highlighting the importance of prehospital education. Responses are presented in Figure 4.

DISCUSSION

The obtained results confirm the crucial role of bystanders in providing first aid, consistent with literature indicating that actions undertaken by laypersons are significant and may reduce injury severity [18]. Consequently, response time is of particular importance, especially in cases of sudden cardiac arrest, where immediate initiation of cardiopulmonary resuscitation may double or even triple patient survival [19]. At the same time, each minute of delay in defibrillation leads to a 10-12% decrease in survival, further emphasizing the importance of rapid and decisive action by bystanders [19]. Thus, the role of bystander-initiated resuscitation becomes particularly important, as current evidence clearly demonstrates its impact on improving survival in sudden cardiac arrest [20, 21]. Moreover, it is recommended that every witness of an incident initiate chest compressions in a person experiencing cardiac arrest, which constitutes a fundamental life-saving intervention [20, 21]. Despite these clear recommendations, the results

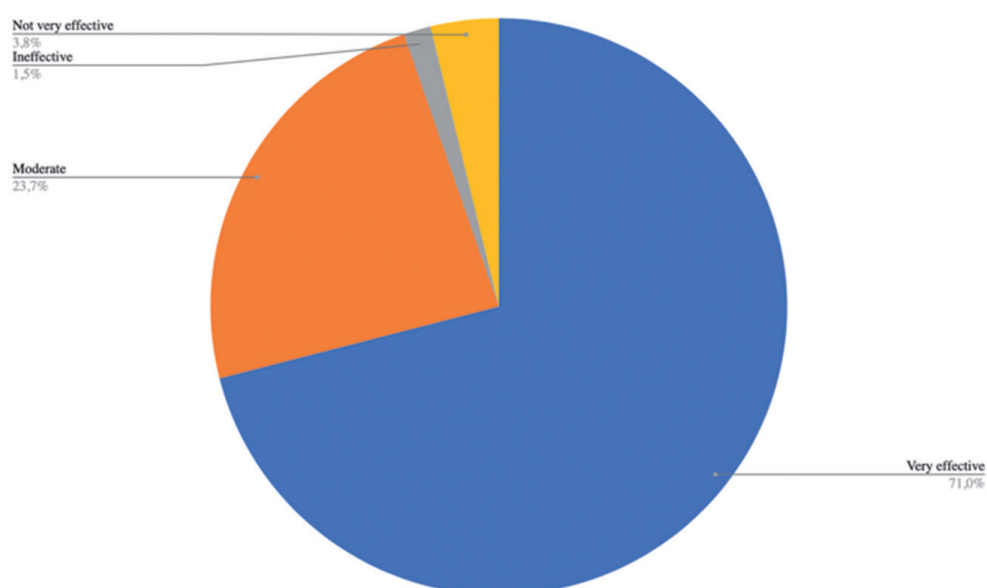


Fig. 3. “How do you assess the effectiveness of practical learning (exercises/simulations)?”

Source: Own materials

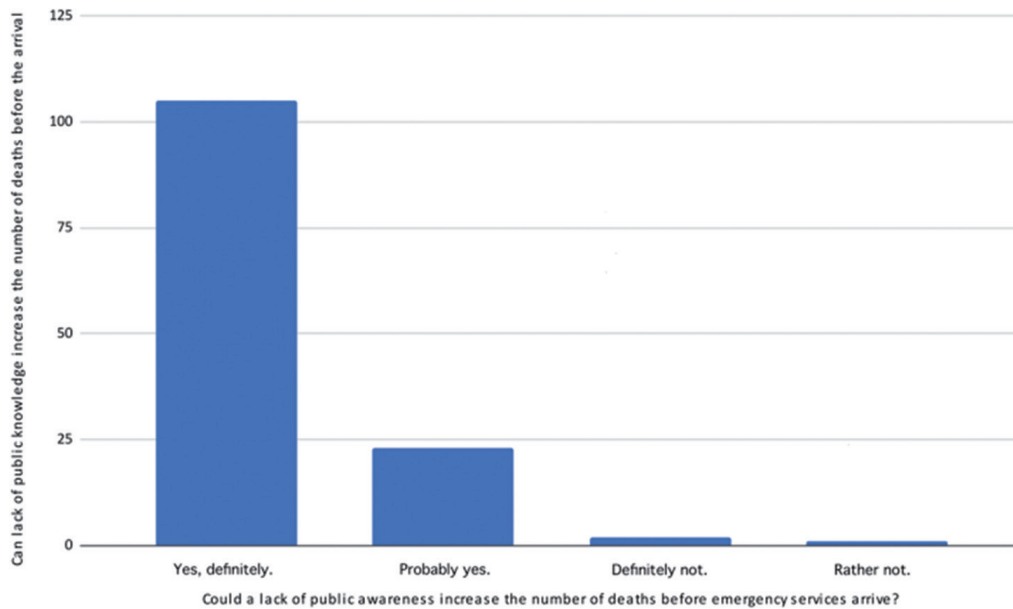


Fig. 4. “Can lack of public knowledge increase the number of deaths before emergency services arrive?”
Source: Own materials

of this study indicate a persistent gap between declared knowledge and readiness to act, consistent with the widely described phenomenon of discrepancy between scientific evidence and clinical practice [20, 21]. This phenomenon is among the most commonly observed issues in health systems research, indicating difficulties in implementing knowledge in real-world situations [20, 21]. At the same time, the need for further research to identify barriers to the implementation of effective interventions is emphasized, which may contribute to improving their application in practice [21].

One of the key factors limiting readiness to act, also confirmed in this study, is fear of making a mistake and concern about negative outcomes of rescue actions [22]. Studies on volunteer participation in emergency systems show that only a small proportion of individuals choose to become actively involved, with the main reasons for withdrawal being perceived insufficient competence and fear of unsuccessful resuscitation [22]. Additionally, the very prospect of confronting a life-threatening situation, including the possibility of ineffective intervention, may constitute a significant psychological barrier for potential responders [22]. In response to these challenges, appropriately designed education is crucial, with particular emphasis on integrating theoretical and practical training [18]. The findings of this study, indicating higher ratings of practical sessions, are consistent with reports that combining practical and didactic components facilitates more effective acquisition and retention of knowledge [18]. The importance of education in simple life-saving interventions is particularly evident in resource-limited settings, where training communities in basic actions such as airway management or hemorrhage control may significantly reduce mortality [23].

At the same time, in crisis situations and disasters, volunteers play an important role by providing immediate assistance

and support to affected communities [24]. Emergency organizations recognize the benefits of their involvement, including improved operational efficiency and the use of local knowledge [24]. However, the effectiveness of these actions largely depends on the quality of communication, which is crucial in complex situations such as trauma resuscitation [25]. Inadequate communication may lead to errors, highlighting the need to develop not only technical but also interpersonal competencies [25, 26].

The importance of communication is also reflected in patient experiences, where its effectiveness contributes to reducing anxiety and improving overall perception of healthcare. Therefore, it is emphasized that medical personnel should act as leaders, addressing both medical and social needs of patients. At the same time, the moderate level of confidence observed among respondents may be related to limitations of traditional training, which does not always cover all aspects of care, leading to ambivalence and discomfort in clinical decision-making [26].

At the system level, emergency care plays a key role in reducing mortality and morbidity, serving as the first point of contact between patients and the healthcare system [27]. It also provides access to further services, including preventive and specialized care [27]. Emergency departments often serve as the main access point to healthcare for vulnerable populations, further emphasizing the importance of their efficient functioning [28]. In such conditions, rapid access to information and ease of its processing are crucial for making appropriate medical decisions [28].

It is noteworthy that the study group consisted mainly of individuals associated with the medical environment, which may explain the high level of declared knowledge and skills. At the same time, even within this group, moderate confidence in action was observed, indicating that knowledge alone is not sufficient to undertake effective interventions

in emergency situations. In comparison with literature data, this highlights the need for further strengthening of practical competencies, reduction of psychological barriers, and improvement of knowledge implementation in practice to increase readiness to provide first aid across the population.

CONCLUSIONS

The obtained results indicate that despite a high level of declared knowledge and skills in first aid among individuals representing the medical environment, the sense of confidence in life-threatening situations remains moderate, suggesting a significant gap between theoretical

preparation and readiness to act. The most important barrier to undertaking rescue actions is fear of making a mistake, while concerns related to legal liability are of lesser importance. Respondents clearly indicate higher effectiveness of practical learning compared to theoretical instruction, emphasizing the need for regular, cyclical training based on exercises and simulations. At the same time, participants demonstrate high awareness of the importance of first aid and strong support for the introduction of mandatory, widely accessible education in this field. The results suggest the need to intensify educational efforts focused not only on knowledge transfer but also on building confidence and readiness to provide assistance in emergency situations.

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CONFLICT OF INTEREST:

The Authors declare no conflict of interest

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Optimization of state medical rescue procedures – project for amending the direct coercion card

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ABSTRACT

Aim: The authors of this publication, as long-time practitioners, academic lecturers, and employees of the State Medical Rescue System, have attempted to optimize the content of the Direct Coercion Card along with a proposal for original structural changes to the mentioned documentation in order to streamline the process of Direct Coercion in the conditions of the State Medical Rescue.

Materials and Methods: In the process of creating the Direct Coercion Card project for a person assisted by the Medical Rescue Team, the authors used original concepts based on their own experience, opinions of active paramedics, and analysis of empirical observations from attempts to apply direct coercion in the work of the State Medical Rescue.

Results: Creating modification of the Direct Coercion Card so that its form more closely resembles other documents used in Medical Rescue Teams, such as the Medical Rescue Activities Card included in the SWD PRM program.

Conclusions: The project of the Direct Coercion Application Card for a person assisted by the Medical Rescue Team, presented in the publication, was showcased during the VI Emergency Medicine Days in October 2024. As mentioned, interventions by the State Medical Rescue related to mental disorders and the potential necessity of applying direct coercion are among the most challenging and carry a high degree of responsibility. The creators are convinced that the acceptance of the project by the Ministry of Health, and its implementation in both standard and electronic versions of the proposed change, will certainly facilitate the work of paramedics.

KEYWORDS:

mental disorders, aggressive patient, direct coercion, Medical Rescue Team, State Medical Rescue, Hospital Emergency Department, admission, direct coercive measures

INTRODUCTION

The Act of September 8, 2006, on State Medical Rescue regulates many issues related to the operation of broadly understood emergency assistance. It comprehensively specifies the scope of competencies, procedures, and activities conducted by medical personnel. Article 1 states that the EMS system was established „to fulfill the state's tasks of providing assistance to any person in a state of sudden health threat.” The term „sudden health threat” also applies to mentally ill patients who, due to their illness, pose a threat to their own life and health or that of others around them, public property, or seriously disrupt or threaten the operation of a hospital unit [1]. This may involve the necessity of applying direct coercion by the medical rescue team (MRT) intervening with individuals with mental disorders, as well as by personnel of EMS system units such as the Hospital Emergency Department or Admission Rooms. The Act of August 19, 1994, on the protection of mental health, which regulates the legal basis for healthcare concerning the mentally ill, guarantees the implementation of principles respecting civil rights and freedoms and ensures the use of the least traumatic means possible for the patients [2].

PRACTICAL PROBLEMS OF APPLYING DIRECT COERCION

Direct coercion is a controversial topic and is approached with caution in the environment of Medical Rescuers. They are aware that direct coercion is a forceful intervention, which somewhat contradicts the professional ethos. Moreover, they very often encounter circumstances that do not fully exhaust the provisions of the Mental Health Protection Act in the part concerning the premises for applying direct coercion [3]. In fact, the Act itself, in the opinion of System employees, also requires amendments in several issues. This state of affairs causes direct coercion in the Emergency Medical Teams (EMT) to be applied very reluctantly, and a factor that exacerbates this is the obligation to fill out documentation that is absolutely not suited to the specifics of EMT work [4]. In teams that are very often two-person, there is simply no time for this – the paramedic driver operates the vehicle, and one medic has to take care of the patient and medical documentation. Mazur in his study indicates that only about 30% of paramedics employed in EMS fulfill this obligation [5]. Of course, maintaining documentation describing the reasons and course of applying direct coercion is entirely justified, but it is also

necessary to create one that is more practical from the point of view of EMS employees, who are responsible for maintaining medical records, monitoring the patient's condition, and updating entries every 15 minutes [6].

AIM

The authors of this publication, as long-time practitioners, academic lecturers, and employees of the State Medical Rescue System, have attempted to optimize the content of the Direct Coercion Card along with a proposal for original structural changes to the mentioned documentation in order to streamline the process of Direct Coercion in the conditions of the State Medical Rescue, enhance the transparency of documentation, improve patient safety, and ensure the repeatability of the procedure.

MATERIALS AND METHODS

In the process of creating the draft Direct Coercion Card for individuals assisted by the Emergency Medical Services Team, the authors utilized an original concept based on their own experience, opinions, and consultations with active paramedics working in the Emergency Medical Services system, as well as with the Emergency Departments of Opole hospitals with psychiatric departments. Analysis

and numerous empirical observations of direct coercion attempts were conducted, along with comments from ambulance team members. The current direct coercion documentation was evaluated and verified, and based on this and the checklists used, an original graphic design was created. A scientific search of available publications was conducted to assess their substantive merits. The starting point was a SWOT synthesis of the current coercion card, along with a proposed conceptual design for the new documentation, in a single table, which highlighted the shortcomings of the current one alongside the advantages of the project. The acronym stands for Strengths, Weaknesses, Opportunities, and Threats (Table 1). Thanks to this, the external and internal factors of the KPB were realistically assessed, as well as the minimum risk and standards of conduct towards the patient against whom direct coercion was applied [7].

RESULTS

In the currently applicable Direct Coercion Application Card presented in Figure 1, attention is drawn to the necessity of filling out individual points in writing. Meanwhile, for reasons mentioned above, in Medical Rescue Teams, it is preferred to „check off“ individual information in a checklist system.

Table 1. SWOT Analysis of the Direct Coercion Charter

SWOT ANALYSIS OF THE DIRECT COERCION CARD	
Strengths (S): The current card is uniform throughout the system, enabling a comprehensive and qualitative assessment of all cases. Correctly completed documentation provides legal protection for both the patient and staff. It has the basic function and assumptions for analyzing the validity of establishing a PB and is a monitoring tool. Supports the continuity of MCR and patient care. Provides the legal basis for establishing a PB.	Weaknesses (W) The current chart is too formal The documentation used cannot always describe the situational context The method of completing the KPB presents many difficulties in prehospital medicine Limited descriptive detail It lacks the medical implications of the patient's clinical condition High risk of schematic entries and completing it for the sake of the procedure It is not designed as a checklist – risk of erroneous entries Administrative burden on staff in its current form Low analytical usefulness of the current documentation Lack of transparency in the current chart format – which is often continued as an extension of the ŠPB
Opportunities (O) Implementing the draft KPB amendment may impact the quality and quantity of data. The new draft may remind patients to assess and reassess their condition in a factual and reliable manner. The new PB Card may improve aggregate analysis, e.g., which situations most often lead to coercion, etc. It may be expanded to include de-escalation elements for patients, which will certainly improve the protection of patient rights. Case analysis in real-life incidents as part of staff training based on the draft card. Implementation of the project after research trials into the PRM system – electronic documentation as an attachment in the PRM SWD. Better management of the PB procedure and quality policy thanks to the new card. Improvement and reduction of abuse of the current card – eliminating PB as a routine practice.	Threats (T) The current card becomes a mandatory administrative attachment Lack of consistency with the patient's actual condition - requires supplementation in the Emergency Medical Procedures Card Lack of legal and substantive updates to the current documentation to reflect the actual situation There is currently a high risk of errors or omissions in the documentation The new design requires clinical testing and a validation period The current card and its lack of clarity may lead to situations in which staff are focused on self-protection rather than an objective description of the event Low value of the current medical documentation

Source: Own materials

Fig. 1. Project of the Card for the application of direct coercion against a person assisted by a medical rescue team, page 1

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

10. Assessment of the justification for the use of direct coercion made by the head of the healthcare facility / authorized physician*:

1) I hereby establish the existence of a legal and factual basis for the use of direct coercion resulting from*:

a) Art. 18 sec. 1 point 1 – a person commits an attack against: – letter a – his or her own life or health or that of another person, – letter b – public safety,

b) Art. 18 sec. 1 point 2 – a person violently destroys or damages objects in his or her surroundings,

c) Art. 18 sec. 1 point 3 – a person seriously disrupts or makes impossible the functioning of a healthcare facility or social welfare organizational unit,

d) Art. 34, first sentence – it is necessary to perform the necessary therapeutic activities referred to in Art. 33,

e) Art. 34, second sentence – in order to prevent a person admitted without his or her consent from leaving a psychiatric hospital without his or her consent,

f) Art. 40 sec. 3 – in order to prevent a person from leaving a social welfare home in the event of behaviour that poses a threat to their life or health, or the life or health of other persons

– the Act of 19 August 1994 on the Protection of Mental Health (Journal of Laws of 2020, item 685, as amended);

2) I find that there is no legal basis for the use of direct coercion (please provide justification):

3) justification of the direct coercion measure used: (type/types* of coercive measure used) I confirm / I do not confirm* (please justify in the absence of confirmation):

4) correctness of application of the procedure for a given type of direct coercion and its conduct in accordance with the relevant requirements referred to in Art. 18–18f of the Act of 19 August 1994 on the Protection of Mental Health: I confirm the correctness / I do not confirm the correctness* (please justify in the absence of confirmation):

5) assessment of the course of action in a situation where the patient's life or health is at risk (if applicable):

6) documentation of the use of direct coercion in accordance with the requirements referred to in Art. 18–18f of the Act of 19 August 1994 on the protection of mental health: correct/incorrect* (please provide justification in the case of irregularities):

(place, date) (designation of the entity carrying out the assessment of the justification for the use of direct coercion)

* Delete where not applicable.

Fig. 2. Project of the Card for the application of direct coercion against a person assisted by a medical rescue team, page 2: Assessment of the justification for the application of direct coercion (...) fragment of Annex No. 2 of the Regulation of the Minister of Health of May 16, 2022, amending the regulation on the application of direct coercion against a person with mental disorders

Source: <https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20220001135>

This applies to both standard and electronic documentation. For this reason, the Polish Society of Medical Rescuers (PTRM) came up with the idea to propose a modification of the Direct Coercion Card so that its form more closely resembles other documents used in Medical Rescue Teams, such as the Medical Rescue Activities Card included in the SWD PRM program [8]. The card project (Fig. 1-2) includes all the essential information that, according to the law, should be included.

LIMITATIONS

In developing this publication, the authors used methods unrelated to the conducted research. The limitations of the article include the lack of validation and evaluation of the proposed Direct Coercion Card, the lack of a control group, and preliminary results. At this initial stage, the adopted hypothesis and design may not fully address the problem and the issue of optimizing this medical record. Furthermore, the limitations resulting from the lack of clinical data on the use of the new card may contribute to the discussion and serve as a prelude to initiating a testing phase in an appropriate location and consultations with paramedics, lawyers, and psychiatrists.

EXPLANATION OF THE DRAFT DIRECT COERCION CARD

Modules 1 and 2 (Fig. 3-4) of the Card Project contain data regarding the composition of the Medical Rescue Team, the locality where the intervention took place, the date and order number, as well as patient data including the fact of their possible incapacitation along with providing the details (name and surname and phone number of the legal guardian).

Modules 3, 4, and 5 (Fig. 5-7) of the Charter Project describe the patient's behavior with an indication of behaviors that constitute grounds for the application of direct coercion. At this point, it seems appropriate to mention the Project

of the Scale of violence used by the patient against the Medical Rescue Team (in preparation), which indicates situations justifying the application of coercion.

The further part of the project concerns the compulsion itself: time frames, possible police assistance, including a breathalyzer test along with the result (module 6, Fig. 8), as well as information on whether the patient was informed about the decision to apply direct compulsion against them, and the justification for any possible waiver of providing the aforementioned information (module 7, Fig. 9).

In modules 8 and 9 (Fig. 10-11), information is provided regarding the type of direct coercion used, including any pharmacotherapy along with the name of the drug, its dosage, and route of administration (module 8), as well as a list of vital signs that were monitored during the application of coercion (with an indication of the patient's parameters' compliance with the values marked in the Medical Emergency Procedures card) – module 9

The last part of the Project contains information about the possible extension of the use of direct coercion (module 10, Fig. 12) and about the transfer of the patient to a specialized center: data of the person to whom the patient was transferred, with an indication of the attached documentation and the time of the patient's transfer (modules 11 and 12, Fig. 13-14). The transfer and acceptance of the patient must be confirmed by the signature and stamp of the transferring and receiving person.

DISCUSSION

The use of direct coercion in EMS conditions is a controversial procedure, fraught with a high degree of risk and requiring detailed analysis tailored to the individual aspect of the situation. There is an increased number of EMS interventions, including life and health-threatening situations involving the use of coercive measures. Along

KZW:

Composition of the EMT:

Head(name and surname):paramedic/ ☐

nurse ☐

Driver's (name and surname).....paramedic ☐

nurse ☐

Team member (name and surname).....paramedic ☐

Nurse ☐

Fig. 3. Project of the Card for the application of direct coercion against a person assisted by a medical rescue team, module 1
Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

Town	Date	Order number
.....		
Patient's name and surname	Personal Number ID	
.....		
Patient under guardianship		
Partially	☐	
Completely	☐	
Carer (name and surname)	phone number	
.....		

Fig. 4. Project of the Card for the application of direct coercion against a person assisted by a medical rescue team, module 2

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

Patient's behavior:	
Calm	
Sleep	☐
Struggles	☐
Strikes	☐
Scream	☐
Crying	☐
Laughing	☐
Sings	☐
Mumble	☐
Spits	☐
Throw things	☐
Destroys	☐

Fig. 5. Project of the Card for the application of direct coercion against a person assisted by a medical rescue team, module 3. Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

Aggressive patient :	
towards himself	
towards his surroundings	☐
towards the EMS team	☐
towards his family	☐

Fig. 6. Project of the Card for the application of direct coercion against a person assisted by a medical rescue team, module 4

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

<u>The patient poses a threat:</u>	
to their own health/life	☐
to bystanders	☐
to public property	☐
to the environment	☐

Fig. 7. Project of the Card for the application of direct coercion against a person assisted by a medical rescue team, module 5

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

with structural changes in the composition of emergency teams, i.e., a reduced number of specialist ambulances (with a doctor) in favor of basic teams, where the team leader is a paramedic or system nurse. This necessitates making decisions about the use of direct coercion without the involvement of a doctor. Difficult working conditions and increased exposure to aggression from patients or

their surroundings lead not only to reduced work comfort but also to rapid response, use of coercive measures, high risk of error, and adequate and correct documentation [9]. An element subject to rational modification is the

Direct coercion

Beginning

Time:.....

End

Time:.....

Dispatcher notified

Police escort

Breathalyzer test

Result.....

Coercion applied:

At the scene of the incident

During transport

Fig. 8. Design of the Card for the application of direct coercion against a person assisted by the medical rescue team, module 6

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

optimization of the structure of Coercion Cards. According to the authors, this will enable increased monitoring of the patient’s condition, quicker detection of changes in critical parameters, or the appearance of alarming symptoms. Patients under direct coercion are often burdened with comorbidities, have multiple diseases, or their diagnosis is not complete. In the work of Pawłowski and Baranowski, the authors emphasized this fact. In the course of their research analysis, they determined that the most commonly used restraint was immobilization, which posed a significant risk of thromboembolic complications and required constant monitoring of the patient. Additionally, the use of anxiolytic

Was the patient informed of the use of coercive measures?

YES

NO

Reason for not informing the patient of the use of coercive measures:

.....

.....

.....

Fig. 9. Design of the Card for the application of direct coercion against a person assisted by the medical rescue team, module 7

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

drugs exacerbated the already high danger [10]. When discussing the topic of the use of direct coercion, it is worth mentioning the initiative undertaken by the Parliamentary Assembly of the Council of Europe. Work is ongoing on the urgent abolition of direct coercion in the mental health care systems of member states. The resolution is an expression of the Assembly’s concern for the appropriate level of protection of human rights and the dignity of people with mental health issues [11]. Attempts to change the policy and procedures for the use of direct coercion can be observed in Denmark, the Netherlands, and the United Kingdom. In these countries, special psychiatric intervention ambulance programs are being developed and implemented, in which direct coercion is used. It is interesting to note that the most commonly used measure is sedation, which involves increased supervision of the patient and appropriately selected medical documentation. This documentation clearly and transparently allows for rational completion and thus does not limit the staff’s ability to monitor the patient [12]. It is obvious that the use of direct coercion should be limited to the necessary minimum, keeping in mind the well-being of the patient, the safety of the

Type of restraint used

Immobilization : restraint: belts:

Pharmacotherapy

Medicine		Medicine		Medicine	
Dose		Dose		Dose	
supply route		supply route		supply route	
IV		IV		IV	
IM		IM		IM	
Oral		Oral		Oral	
SL/ BUC.		SL/ BUC.		SL/ BUC.	
Time of administration		Time of administration		Time of administration	

Fig. 10. Design of the Card for the application of direct coercion against a person assisted by the medical rescue team, module 8

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

During the application of direct restraint:	
SpO2 measurement:	☐
NIBP measurement	☐
ECG monitoring	☐
Oxygen therapy	☐
Position changes every 30 minutes	☐
Other:.....	
Patient parameters consistent with the attached MCR card:	☐
EMS leader's comments:.....	
.....	
.....	
.....	

Fig. 11. Design of the Card for the application of direct coercion against a person assisted by the medical rescue team, module 9

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

Extension of the use of direct coercion:	☐
Reason:	
no improvement	☐
prolonged transport	☐
The exact time of commencement of the direct coercion period	
TIME:.....	
.....	

Fig. 12. Design of the Card for the application of direct coercion against a person assisted by the medical rescue team, module 10

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

Patient Transfer	
Name and Surname:.....	
Function:.....	
Documentation:	
Emergency Medical Services Card	☐
Patient Medical Records	☐

Fig. 13. Design of the Card for the application of direct coercion against a person assisted by the medical rescue team, module 11

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

Patient transfer time	
TIME:.....	
Duration of direct coercion	
TIME:.....	
Stamp and name of the person taking over the patient:.....	
.....	
.....	
Stamp and signature of the EMS manager:.....	
.....	

Fig. 14. Design of the Card for the application of direct coercion against a person assisted by the medical rescue team, module 12

Source: Idea: Ireneusz Barziej, Dawid Jakóbczak, Kamil Saweczka; graphic design: Ireneusz Barziej

environment, and medical staff [13]. In a publication in Germany, an attempt was made to analyze coercion in a 24-hour context combined with out-of-hospital and early hospitalization. The available medical documentation was correlated and evaluated. This was made possible by a uniform, transparent, and properly completed structure of medical materials [14]. The introduction of it in Poland will facilitate the process of reassessment, analysis of the justification for the use of coercion, and will have a significant impact on the early hospital phase of a patient under direct coercion. Coercion itself is also traumatizing for medical personnel. In Norway, 28 studies were analyzed, revealing that the procedure of coercion, even when used relatively rarely, is significantly burdensome for medical professionals [15]. Currently, there are no such studies in Poland, which is why, according to the authors of this publication, considering the well-being of EMS workers, the procedure for medical documentation of a patient under coercion should be simplified as much as possible, thereby relieving the staff by using the proposed Card. An identical view is presented by Paul Doedens and others in their systematic review. They depict coercion as a negative measure, but often necessary to ensure the safety of staff and the environment and to maintain continuity of care for the patient, which is highly traumatizing for both medical professionals and the patient. They suggest focusing on analyzing and improving the safety of the procedure, changing its constructs, and reducing the risk [16]. The authors of this article also wish to draw attention to these facts and propose a change to the Direct Coercion Card in the conditions of Medical Rescue in Poland.

CONCLUSIONS

The draft Charter for the Use of Direct Coercion against a Person Assisted by an Emergency Medical Service Team, presented in this publication, was presented during the 6th Emergency Medicine Days in October 2024, where it generated significant interest and acceptance among

participants of a scientific conference chaired by the Polish Society of Paramedics. As mentioned, State Emergency Medical Service interventions related to mental disorders and the possible need to use direct coercion are among the most difficult and burdensome. The authors of the publication propose implementing the project in broader clinical trials, along with the possibility of validating its usefulness directly

in the realities and medical events of Emergency Medical Service operations. This will certainly enable a favorable evaluation of the new Charter for the Use of Direct Coercion and, perhaps in the future, its full implementation into the system and structures of the State Emergency Medical Service. Furthermore, the authors encourage open discussion regarding the proposed medical documentation.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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Workplace violence against healthcare professionals in Poland: A nationwide cross-sectional study of prevalence, predictors and consequences

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ABSTRACT

Aim: Violence against healthcare professionals is a major occupational hazard, particularly in emergency clinical settings. This cross-sectional study aimed to assess the prevalence, forms, predictors, and emotional and professional consequences of patient aggression toward healthcare workers in Poland.

Materials and Methods: An anonymous nationwide online survey based on an original questionnaire was conducted among healthcare professionals. A total of 1,255 respondents participated, including physicians, nurses, paramedics, midwives, and other medical staff from hospitals, emergency medical services, outpatient clinics, and long-term care facilities. The questionnaire collected sociodemographic data, exposure to verbal, physical, psychological, and sexual violence, emotional reactions, professional consequences, reporting behaviors, and the availability of workplace safety procedures. Descriptive statistics and inferential analyses were applied.

Results: Overall, 88.7% of respondents experienced at least one form of patient-initiated violence. Verbal aggression was the most prevalent (94.2%), followed by physical (70.9%), psychological (61.0%), and sexual violence (19.3%). Exposure differed significantly by workplace, profession, and years of experience, with the highest prevalence among emergency medical service personnel and hospital staff. More than 64% of respondents experienced multiple forms of violence. Fear and anger were the most common emotional responses, nearly all respondents reported reduced work quality, and one-third considered leaving the profession.

Conclusions: Workplace violence against healthcare professionals in Poland is widespread and recurrent. The findings indicate an urgent need for safety protocols, training, improved reporting mechanisms, and strengthened legal protection.

KEYWORDS:

workplace violence, aggression, violence, emergency medical services, healthcare professionals

INTRODUCTION

Violence against healthcare workers constitutes one of the most serious and rapidly escalating threats within health systems worldwide [1-3]. This issue is particularly pronounced in emergency care settings – Emergency Departments (EDs) and Emergency Medical Services (EMS) – which, according to numerous studies, are among the environments most exposed to aggression from patients and their relatives [4-7]. Both Polish and international research indicate that 70-90% of personnel working in these settings experience some form of violence at least once a year, with many facilities reporting even higher rates [8-10].

In Poland, verbal aggression is reported by more than 90% of ED personnel and paramedics, while physical violence affects 60-80% of these professionals [5, 11]. Similar findings are presented in international meta-analyses demonstrating that emergency department employees are several times more likely to encounter violence compared to staff working in other hospital units [1, 12]. The most commonly cited

factors contributing to violent incidents include long waiting times, stress, patient agitation, intoxication with alcohol or narcotics, psychiatric disorders, and staff overload [13-16]. Clinical and review studies consistently show that patient intoxication and agitation are among the strongest predictors of aggressive behavior [1, 10].

The consequences of violence against healthcare workers are substantial and encompass both psychological effects (fear, anger, stress, sense of threat) and professional outcomes (reduced work quality, interpersonal conflicts, absenteeism, and even consideration of leaving the profession) [21-23]. Existing evidence indicates that workplace violence is one of the major risk factors for burnout among healthcare professionals [10, 24]. Many authors emphasize that chronic exposure to aggression leads to long-term deterioration of psychological well-being and an increase in workforce turnover [12, 22].

Given the continuously rising prevalence of violent incidents, there is an urgent need for a comprehensive understanding of risk factors, consequences, and the

effectiveness of existing safety procedures. The findings of the present study may serve as a foundation for developing effective organizational interventions, implementing training programs, and establishing uniform standards aimed at improving the safety of healthcare personnel.

AIM

The aim of this study was to assess the scale and nature of patient violence against healthcare professionals, to identify the most common forms of violence and the circumstances of its occurrence, to evaluate the emotional and professional consequences for healthcare workers, and to assess the effectiveness of existing prevention procedures.

The research addressed the following questions:

1. How often do healthcare professionals experience violence from patients or their relatives?
2. What forms of violence are most frequently experienced?
3. Does the occurrence of violence depend on workplace, profession, years of experience, or gender?
4. What are the emotional and professional consequences of violence for staff?
5. Are workplace safety procedures in place and applied in practice?
6. What actions, according to respondents, may reduce violence?
7. How does staff react to violent incidents, and are such events reported to supervisors?

The assumed results included determining the scale of violence against healthcare professionals, identifying risk factors (e.g., workplace type, patient intoxication), evaluating preventive measures and training needs, and formulating recommendations for healthcare institutions to improve staff safety.

The practical significance of this research is to provide evidence that may serve as a basis for the implementation of workplace violence response procedures, planning of training programs on aggression prevention, and raising awareness of this issue among healthcare managers and decision-makers.

MATERIALS AND METHODS

STUDY DESIGN

The questionnaire was an author-developed tool designed based on a literature review regarding patient violence against healthcare professionals. The tool consisted of 30 questions, including closed-ended, semi-open, and open-ended questions.

The questionnaire covered the following thematic areas:

1. Sociodemographic data – gender, age, education, profession, work experience, and workplace.
2. Experience of violence – exposure to different forms of patient violence and frequency of occurrence.
3. Consequences of violence – perceived impact on work quality and relationships with other patients.
4. Coping and reporting – reactions to violent incidents and whether they were reported to supervisors.
5. Prevention strategies – assessment of existing safety procedures and suggestions for reducing workplace violence.

Prior to the main study, a pilot was conducted on a group of 10 healthcare professionals to evaluate the clarity of the questions. No statistical analyses were performed at the pilot stage; however, feedback was incorporated before launching the online survey.

No formal psychometric validation or reliability testing was performed, as the questionnaire was descriptive in nature and consisted primarily of categorical questions rather than psychometric scales.

DATA COLLECTION

The survey was distributed online, and responses were collected over a one-month period. Participation was voluntary and anonymous. The study group consisted of healthcare professionals, including physicians, nurses, paramedics, midwives, and other healthcare workers, representing various types of facilities (hospitals, outpatient clinics, emergency medical services).

DATA PROCESSING AND SAMPLE CHARACTERISTICS

A total of 1255 valid responses were included in the analysis. The study group consisted of healthcare professionals (82, 5% women, 17, 5% men). The respondents represented different levels of education (e.g., secondary medical, bachelor's, master's) and professional backgrounds (e.g., nurses, paramedics, physicians). Detailed characteristics of the study population are presented in Table 1.

All responses were reviewed prior to statistical analysis. Data were checked for entry errors and categorized. Missing data were presented in descriptive analyses (tables and figures) as a separate category („No answer” / NA). The primary analytical variable regarding the experience of patient violence contained no missing data. For some analyses, selected variables were recoded into binary (0-1) format to facilitate statistical testing.

STATISTICAL ANALYSIS

Data were analyzed using Microsoft Excel and the R programming language, version 4.4.3 (2023-04-21), within the RStudio environment, version 2025.05.1+513 „Mariposa Orchid”.

Descriptive statistics (frequencies, percentages) were calculated to summarize the study sample and responses. Associations between categorical variables were assessed using the chi-square test of independence, with Fisher's exact test applied where expected cell counts were low. Heatmaps were generated to visualize relationships between selected variables.

To examine the relationship between emotional intensity and the likelihood of considering leaving, a logistic regression analysis was conducted. Odds ratios (ORs) and 95% confidence intervals (CIs) were computed to assess the strength and direction of the association.

Statistical tests included the following variables: experience of violence, age, gender, profession, work experience (seniority), workplace, and selected variables regarding workplace safety procedures. Missing data affected two auxiliary variables: „workplace” (110 missing responses out of 1255 respondents) and „participation in safety training, which had a high rate of missing values.

Table 1. Characteristics of the study population.

Characteristic	n	%
Sex		
– Female	1035	82.5%
– Male	220	17.5%
Age (years)		
– <25	140	11.2%
– 25–34	675	53.8%
– 35–44	325	25.9%
– >45	115	9.2%
Level of education		
– Secondary medical	75	6.0%
– In progress (currently studying)	15	1.2%
– Bachelor's degree	395	31.5%
– Master's degree	765	61.0%
– Doctorate	5	0.4%
Profession		
– Nurse	630	50.2%
– Paramedic	255	20.3%
– Physician	250	19.9%
– Medical imaging technologist	30	2.4%
– Midwife	30	2.4%
– Other medical specialists	30	2.4%
– Support staff	20	1.6%
– Student	10	0.8%
Work experience (years)		
– <1 year	100	8.0%
– 1–5 years	460	36.7%
– 6–10 years	370	29.5%
– 11–20 years	230	18.3%
– >20 years	95	7.6%
Total	1255	100%

Source: Own materials

In analyses involving the 'workplace' variable, the 'no answer' category was treated as a distinct category and included in statistical tests. Due to small sample sizes in some contingency table cells, Fisher's exact test was applied.

In analyses regarding workplace safety procedures, missing data exclusively concerned the 'participation in training' variable. Due to the high rate of missing values for this variable, observations with no response were excluded from inferential analyses, and the Chi-square test was applied only where sample size assumptions were met.

The differentiated approach to missing data handling and the selection of statistical tests resulted from the nature of the variables and the sample sizes within the analyzed categories."

RESEARCH QUESTIONS

HOW OFTEN DO HEALTHCARE PROFESSIONALS EXPERIENCE VIOLENCE FROM PATIENTS OR THEIR RELATIVES?

The analysis demonstrates that incidents of violence against medical personnel by patients or their families are reported with considerable frequency. The largest proportion of respondents (n=450) indicated experiencing such events on more than ten occasions. A further 295 respondents reported between four and seven incidents, while 255 respondents experienced one to three incidents. A smaller group, 115 individuals, reported experiencing violence between seven and ten times. Additionally, 140 responses were categorized as missing data (Fig. 1).

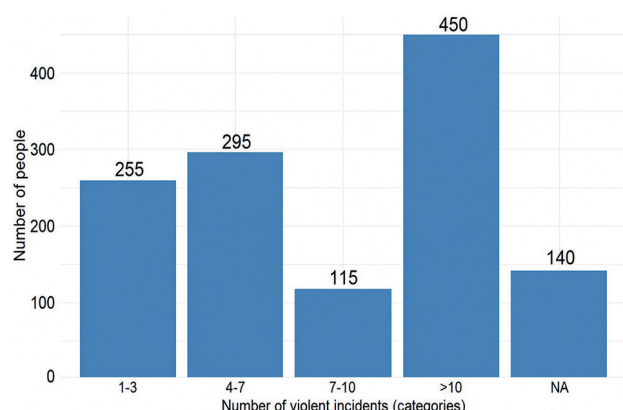


Fig. 1. Frequency of violent incidents experienced by medical staff.

Source: Own materials

These findings suggest that violent incidents are not isolated occurrences but rather recurrent experiences for a substantial proportion of healthcare workers. Notably, the predominance of respondents reporting more than ten incidents underscores the chronic and persistent nature of this issue within the healthcare setting.

WHAT FORMS OF VIOLENCE ARE MOST FREQUENTLY EXPERIENCED?

Among the surveyed healthcare professionals, verbal violence was the most prevalent form of aggression, reported by 94.2% of respondents. Physical violence was experienced by 70.9%, psychological violence by 61.0%, and sexual violence by 19.3% of participants (Fig. 2).

When analyzed by gender, verbal violence was reported by nearly all respondents (94% of women and 95% of men). Sexual violence was reported more frequently by women (22%) compared to men (8%), while men were more likely to report experiences of physical (85% vs. 68%) and psychological violence (67% vs. 60%) (Fig. 3).

Overall, verbal abuse emerged as the most widespread form of violence across both genders, while gender differences were most evident

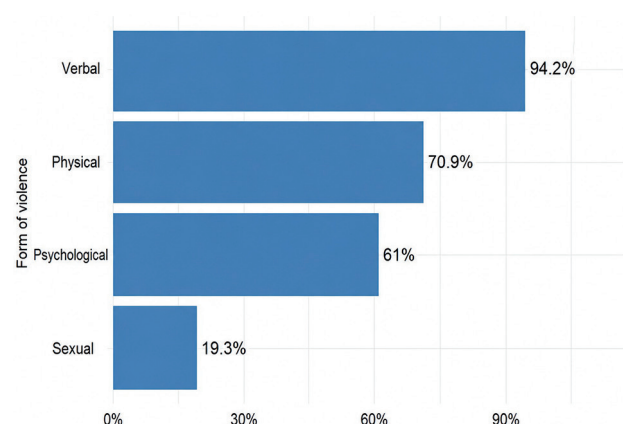


Fig. 2. Forms of violence most frequently experienced by medical staff from patients.

Source: Own materials

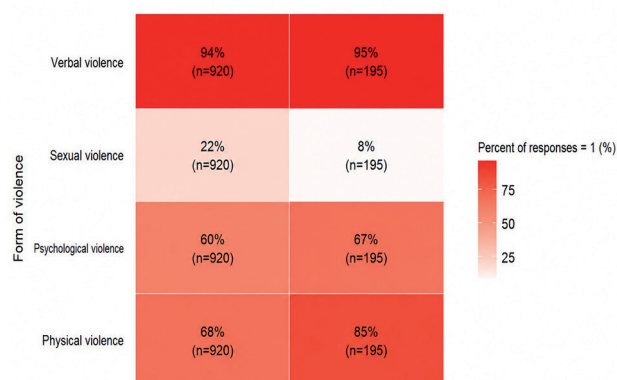


Fig. 3. Forms of violence experienced by medical staff from patients by gender.

Source: Own materials

in experiences of sexual and physical violence. Verbal violence was almost universal in all age groups (91-100%). Sexual violence was reported more often by younger respondents (<25 years, 30%) and less frequently with increasing age. Psychological and physical violence were reported by over half of participants across all age groups, with the highest prevalence of physical violence among respondents aged 25-34 years (78%). The findings may indicate that younger healthcare workers, particularly those early in their careers, are more likely to encounter or perceive sexual harassment, while mid-aged professionals experience more physical aggression (Fig.4).

The findings indicate that verbal violence is by far the most frequently experienced form of violence across all educational groups, with prevalence rates ranging from 92% to 100%. Psychological violence was also commonly reported, affecting between 50% and 100% of respondents depending on education level. Physical violence was less frequent overall, though still reported by a substantial proportion, ranging from 46% among respondents with secondary medical education to 100% among those with doctoral degrees. Sexual violence was the least commonly

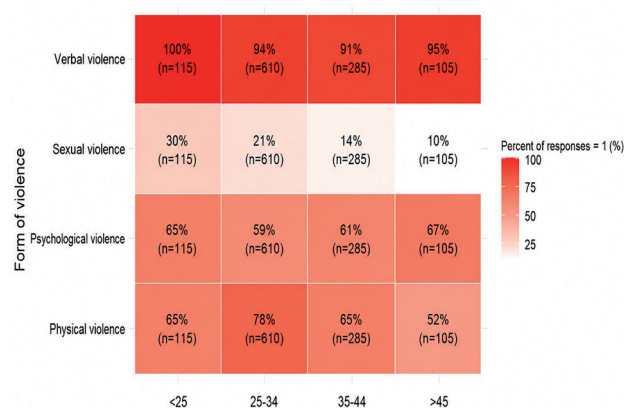


Fig. 4. Forms of violence experienced by medical staff from patients by age.

Source: Own materials

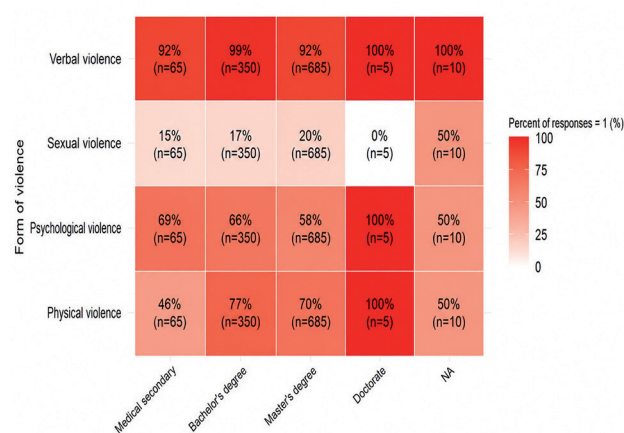


Fig. 5. Forms of violence experienced by medical staff from patients by education.

Source: Own materials

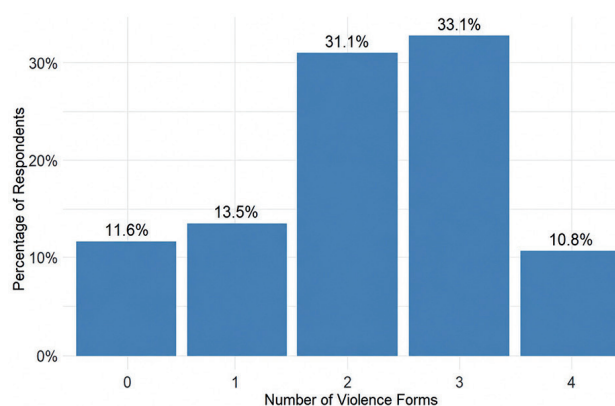


Fig. 6. Number of violence forms experienced by medical staff.

Source: Own materials

Table 2. Distribution of respondents by number of forms of violence experienced by medical staff.

Numbers of forms of violence	Numbers of people	Percent
0	145	11.6%
1	170	13.5%
2	390	31.1%
3	415	33.1%
4	135	10.8%

Source: Own materials

experienced form, reported by 15-20% of respondents with secondary, bachelor's, or master's education, while no doctoral-level respondents reported it.

Overall, the results clearly demonstrate that verbal and psychological violence are the predominant forms of aggression encountered by medical personnel, whereas physical and sexual violence, though less frequent, still represent significant occupational risks (Fig. 5).

More than half of the respondents reported experiencing multiple forms of violence simultaneously. Specifically, 64.2% of healthcare personnel (n=805) experienced at least two types of violence. Among them, 31.1% were exposed to two forms, while 33.1% experienced three different forms of violence.

These findings highlight the complex and overlapping nature of workplace aggression in healthcare settings, where staff are often subjected to multiple types of abuse rather than isolated incidents (Fig. 6, Table 2).

DOES THE OCCURRENCE OF VIOLENCE DEPEND ON WORKPLACE, PROFESSION, YEARS OF EXPERIENCE, OR GENDER?

Tables 3-6 show the distribution of respondents who experienced workplace violence (yes/no) according to gender, workplace, profession, and years of experience.

No significant difference in the occurrence of workplace violence between women and men ($\chi^2(1)=2.44 \times 10^{-29}$, $p=1$).

In contrast, the analysis revealed significant disparities related to the work environment. Relationships regarding workplace and profession were analyzed using Fisher's exact test with Monte Carlo simulation (10,000 replications) due to the large dimensions of the contingency tables. A statistically significant association was found between the workplace and the experience of violence ($p<0.001$), with a moderate effect size (Cramér's $V=0.28$). Hospitals and emergency medical services showed the highest prevalence of aggressive incidents.

Significant differences were also observed among professional groups (Fisher's exact test with Monte Carlo simulation, $p<0.001$).

However, the strength of this relationship was weak (Cramér's $V=0.16$). Nurses, paramedics, and students reported higher rates of violence exposure compared to other groups. Longer experience was associated with higher exposure ($\chi^2(4)=26.92$, $p<0.0001$). Respondents with 6-10 years of experience reported the highest prevalence.

Overall, workplace, profession, and years of experience were significantly associated with experiencing violence, whereas gender was not.

WHAT ARE THE EMOTIONAL AND PROFESSIONAL CONSEQUENCES OF VIOLENCE FOR STAFF?

Emotional intensity was defined as the cumulative number of experienced emotional reactions, including fear, anger, sadness, indifference, shame, and helplessness. Each emotion was coded binarily (0 – absent, 1 – present) and then summed,

Table 3. Distribution of violence by gender ($\chi^2(1)=2.44 \times 10^{-29}$, $p=1$).

Gender	Did not experience violence (n, %)	Experienced violence (n, %)
Woman	115 (11.1%)	920 (88.9%)
Man	25 (11.4%)	195 (88.6%)

Source: Own materials

Table 4. Distribution of violence by workplace (Fisher's exact test, $p < 0.001$).

Workplace	Did not experience violence (n, %)	Experienced violence (n, %)
No information	10 (9.1%)	100 (90.9%)
Senior center	5 (100%)	0 (0%)
Dental office	0 (0%)	5 (100%)
Emergency medical service	0 (0%)	55 (100%)
Outpatient clinic	5 (10%)	45 (90%)
Psychiatric Social Care Home	0 (0%)	5 (100%)
Hospital	120 (11.8%)	900 (88.2%)
Nursing home / Long-term care facility	0 (0%)	5 (100%)

Source: Own materials

Table 5. Distribution of violence by profession (Fisher's exact test, $p < 0.001$).

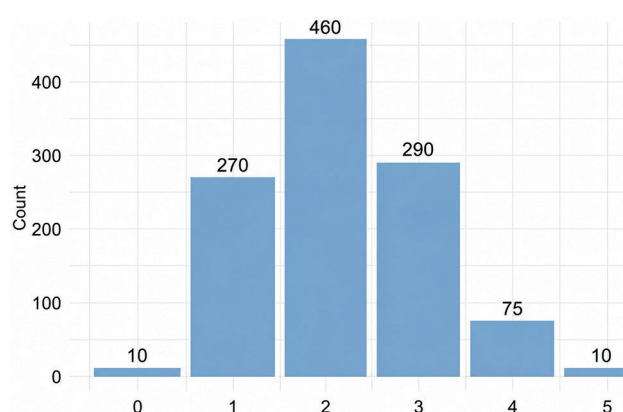
Profession	Did not experience violence (n, %)	Experienced violence (n, %)
Electroradiologist	5 (16.7%)	25 (83.3%)
Doctor	25 (10%)	225 (90%)
Auxiliary staff	5 (25%)	15 (75%)
Nurse	80 (12.7%)	550 (87.3%)
Midwife	0 (0%)	30 (100%)
Other medical specialists	0 (0%)	30 (100%)
Paramedic	20 (7.8%)	235 (92.2%)
Student	5 (50%)	5 (50%)

Source: Own materials

Table 6. Distribution of violence by years of experience ($\chi^2(4) = 26.92$, $p = 2.07 \times 10^{-5}$).

Years of experience	Did not experience violence (n, %)	Experienced violence (n, %)
<1 year	25 (25%)	75 (75%)
1–5 years	55 (12%)	405 (88%)
6–10 years	25 (6.8%)	345 (93.2%)
11–20 years	25 (10.9%)	205 (89.1%)
>20 years	10 (10.5%)	85 (89.5%)

Source: Own materials

**Fig. 7.** Distribution of emotional responses.

Source: Own materials

resulting in a score ranging from 0 to 6, where higher values indicated a greater cumulative emotional burden. Respondents who had not experienced patient violence did not report any of the monitored emotional responses. In contrast, those who experienced violence reported between 1 and 5 emotions simultaneously, indicating a clear association between exposure to violence and emotional impact. The majority of exposed respondents reported 1–3 emotions, suggesting that workplace violence commonly induces a multifaceted emotional burden. Only a small number reported either no emotional reaction (0 emotions) or all five monitored emotions, indicating variability in individual emotional responses (Fig. 7).

Among respondents who experienced patient violence, the most commonly reported emotions were anger (77.6%)

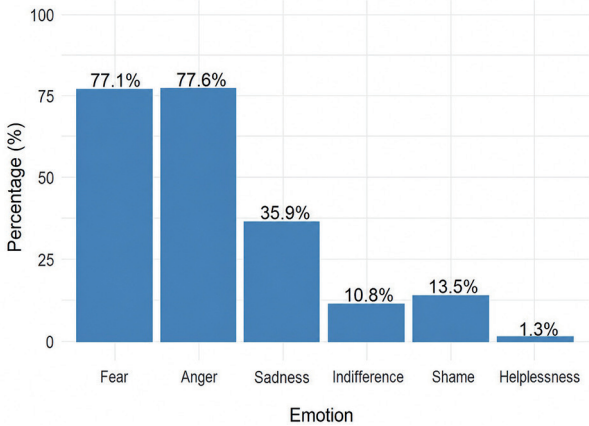


Fig. 8. Proportion of respondents reporting each emotion.

Source: Own materials

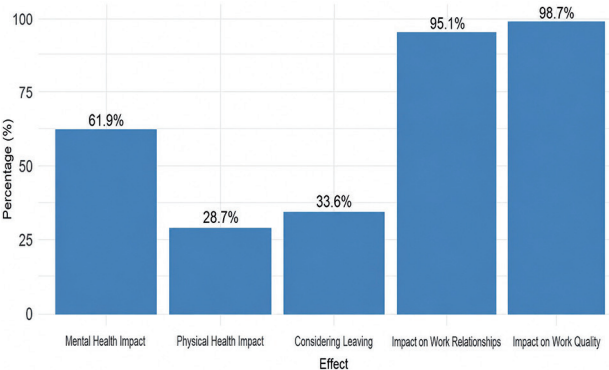


Fig. 9. Proportion of work-related effects among violence-exposed staff.

Source: Own materials

and fear (77.1%), indicating that these are the primary emotional reactions to violent incidents. Sadness was reported by 35.9% of respondents, while shame (13.5%) and indifference (10.8%) were less frequent. Helplessness was rarely reported (1.3%) (Fig. 8).

These findings suggest that workplace violence predominantly triggers high-arousal negative emotions, such as fear and anger, highlighting the immediate psychological impact of exposure. Less frequent emotions, like shame and helplessness, may reflect individual coping strategies or situational factors.

Among respondents exposed to patient violence, the most commonly reported professional impacts were decreased work quality (98.7%) and strained work relationships (95.1%). Mental health impact was reported by 61.9% of respondents, whereas physical health impact affected 28.7%. Notably, one-third of respondents (33.6%) considered leaving their profession as a result of violent experiences.

These results indicate that workplace violence has a profound effect on professional functioning, affecting not only psychological and physical well-being but also interpersonal relationships and overall work performance. The data underline the potential for staff turnover due to exposure to violence (Fig. 9).

We examined correlations between emotional responses reported by staff exposed to patient violence. The strongest associations were observed between fear and indifference ($r = -0.26$) and fear and sadness ($r = 0.23$) (Fig. 10).

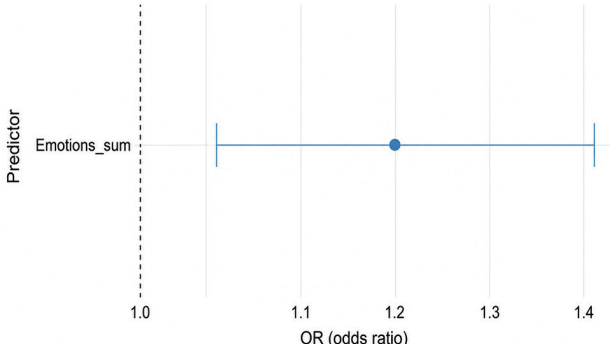


Fig. 11. Effect of emotional intensity on considering leaving.

Source: Own materials

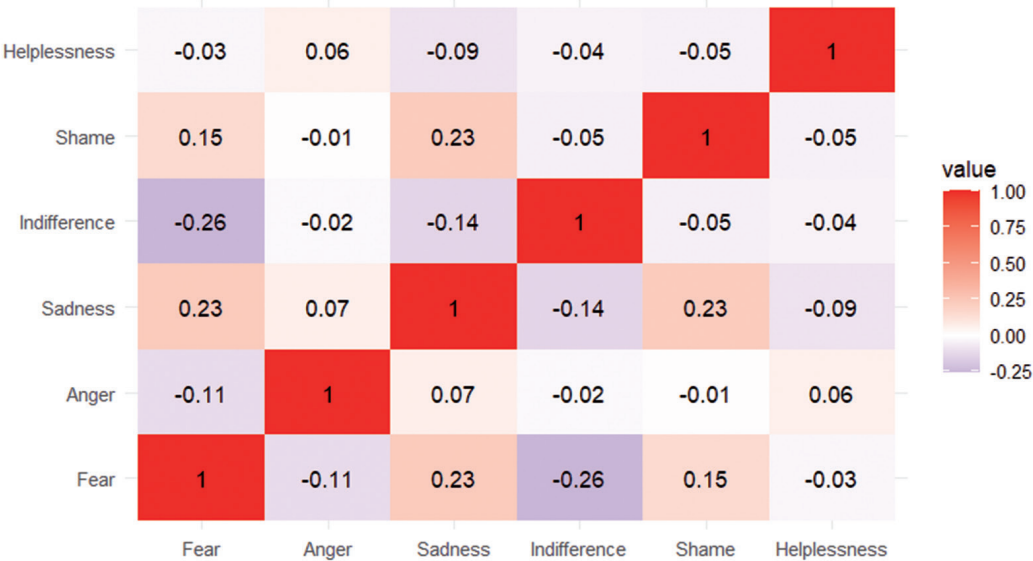


Fig. 10. Correlation Matrix between emotions.

Source: Own materials

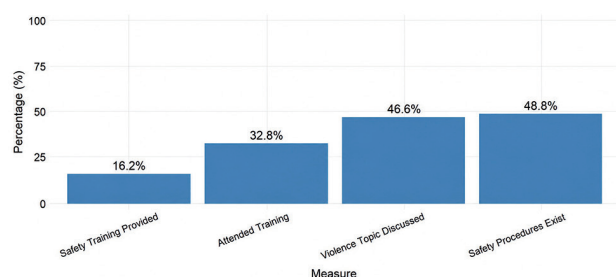


Fig. 12. Safety procedures and training in the workplace reported by medical staff.

Source: Own materials

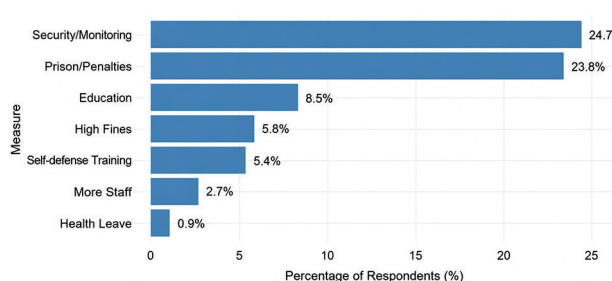


Fig. 13. Perceived measures to reduce workplace violence.

Source: Own materials

Table 7. Association between workplace safety procedures and staff experience of workplace violence (χ^2 tests).

Variable	Test	Statistic	p-value	p-value adj Bonferroni	p-value adj FDR
Safety Training Provided	Chi-squared	1.76	0.184	0.736	0.245
Attended Training	Chi-squared	0.445	0.505	1	0.505
Violence Topic Discussed	Chi-squared	2.76	0.0967	0.387	0.245
Safety Procedures Exist	Chi-squared	1.97	0.160	0.642	0.245

Source: Own materials

The negative correlation between fear and indifference suggests that respondents experiencing higher levels of fear were less likely to report indifference. Conversely, the positive correlation between fear and sadness indicates that fear often co-occurred with feelings of sadness.

These findings suggest that emotional responses to patient violence are multifaceted, with some emotions co-occurring (e.g., fear and sadness) and others inversely related (e.g., fear and indifference), highlighting the diversity of staff reactions. In the logistic regression analysis, considering leaving the profession' was the dependent variable, with 'emotional intensity' as the sole predictor. The model revealed a significant association (OR = 1.20, 95% CI: ~1.05-1.38), indicating that each unit increase in emotional intensity raises the likelihood of considering departure by approximately 20% (Fig. 11).

ARE WORKPLACE SAFETY PROCEDURES IN PLACE AND APPLIED IN PRACTICE?

The survey results indicate that less than half of the respondents reported the existence of workplace safety procedures (48.8%) or discussions on violence-related topics (46.6%). Only 16.2% of respondents indicated that safety training was provided, while 32.8% reported actually attending such training (Fig. 12).

Chi-squared tests revealed no statistically significant differences in the availability or application of safety measures between staff who had experienced workplace violence and those who had not (p-values >0.05, with Bonferroni and FDR corrections). This suggests that safety procedures and training are applied broadly, regardless of individual exposure to violence, or that the implementation of these measures is not directly linked to actual experiences of violence (Table 7).



Fig. 14. Reporting of violence incidents.

Source: Own materials

Overall, these results highlight a gap between organizational safety policies and their practical effectiveness, emphasizing the need for broader implementation, regular training, and targeted measures to ensure that all staff are adequately protected and prepared to respond to violent incidents.

WHAT ACTIONS, ACCORDING TO RESPONDENTS, MAY REDUCE VIOLENCE?

Respondents were asked which actions they consider most effective in reducing workplace violence. The most frequently indicated measures were security measures and monitoring (24.7%) and strict legal penalties for perpetrators (23.8%). Only 8.5% of respondents suggested education or public awareness campaigns as an effective strategy (Fig. 13).

These findings suggest that healthcare staff prioritize direct protective measures and legal accountability over educational or preventive campaigns. This highlights the perceived urgency for immediate interventions to safeguard staff and deter violence in healthcare settings.

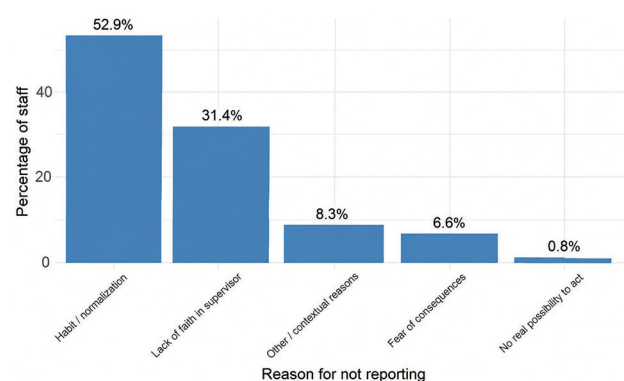


Fig. 15. Reasons for not reporting workplace violence.

Source: Own materials

HOW DOES STAFF REACT TO VIOLENT INCIDENTS, AND ARE SUCH EVENTS REPORTED TO SUPERVISORS?

A total of 58.1% of respondents ($n = 645$) reported incidents of workplace violence to their supervisors, while 41.9% ($n = 465$) did not report such events (Fig. 14).

Among staff who did not report incidents of workplace violence, the most frequently cited reason was habit or normalization of violence (52.9%), indicating that many respondents perceive certain violent behaviors as part of routine work. Lack of faith in supervisors' response was reported by 31.4% of respondents, reflecting limited trust in the reporting system. Fear of consequences was mentioned by 6.6% of staff, while no real possibility to act was reported by only 0.8%. Additional contextual reasons, such as patient-related factors or suggestions from colleagues, were cited by 8.3% of respondents (Fig. 15).

These findings highlight the need for changing workplace culture, improving supervisor responsiveness, and raising awareness that reporting is important and effective, to encourage staff to report all incidents of violence.

DISCUSSION

The findings of this study confirm that violence against healthcare workers in Poland is a widespread and critical occupational hazard. With 88.7% of respondents reporting at least one form of aggression, our results align with the high prevalence rates observed in national and international research, particularly in emergency medicine settings [1-7, 10]. Verbal aggression was the most dominant form (94.2%), consistent with global literature [1, 3, 13], yet the high rate of physical violence (70.9%) exceeds figures often reported in general healthcare studies [1, 3], reflecting the specific risks associated with Emergency Departments (ED) and Emergency Medical Services (EMS) [5-7, 14]. Importantly, nearly two-thirds of personnel experienced multiple forms of violence simultaneously, a pattern characteristic of acute care environments where staff are exposed to cumulative aggression [13, 14].

Significant disparities in exposure were evident across workplaces and professions. The highest prevalence among EMS personnel, hospital staff, and specifically paramedics, nurses, and physicians reinforces the consensus that unpredictable, high-stress environments carry the greatest

risk [4, 6, 10, 17]. Interestingly, while some literature suggests inexperienced staff are most vulnerable [19, 20], our study noted increased exposure among professionals with 6–10 years of experience. This likely correlates with their greater responsibility in independent decision-making and high-risk interventions during this career stage.

The study highlights the severe emotional and professional toll of workplace violence. The dominance of fear and anger among respondents corresponds with findings by Neukirch et al. [19] and Kafle et al. [2]. Crucially, our analysis revealed a direct link between emotional intensity and the intention to leave the profession, supporting global data on violence-induced burnout and turnover [10, 22-24]. The reported decline in work quality (98.7%) and deterioration of workplace relationships (95.1%) further underscore that violence compromises not only staff well-being but also patient safety and care quality [1, 10, 23].

A critical finding that warrants immediate attention is the systemic failure in prevention and reporting. Our results expose a substantial gap between safety requirements and reality: only 16.2% of respondents had access to training, and merely one-third had participated in it. This insufficiency is a known driver of aggression escalation [3, 10, 15]. Furthermore, the fact that nearly half of the incidents remain unreported due to the normalization of violence and lack of trust in managerial support [2, 3, 19] represents a major barrier to safety.

PRACTICAL RECOMMENDATIONS

Based on these findings, tackling underreporting and improving training availability must be the priority for healthcare management. Interventions should focus on

1. Mandatory, regular training in de-escalation techniques, which is currently inconsistent or absent [17, 18].
2. Simplifying reporting procedures to move away from „blame culture“ towards a supportive institutional response, thereby breaking the cycle of silence.
3. Implementing tangible security measures, such as improved monitoring and legal support for affected staff, as expected by the workforce and recommended in recent meta-analyses [1, 3, 8, 17].

CONCLUSIONS

Violence against healthcare personnel is a widespread and persistent problem affecting the vast majority of medical professionals. In this study, 88.7% of participants reported experiencing at least one form of aggression, confirming the high level of occupational exposure described in national and international literature.

Verbal aggression was the most prevalent form of violence, reported by over 94% of respondents. The high prevalence of physical (70.9%) and psychological violence further demonstrates that healthcare workers routinely face diverse and overlapping forms of aggression. More than 64% of respondents experienced multiple types of violence concurrently, highlighting the complex nature of the phenomenon.

Exposure to violence was significantly associated with workplace type, profession, and years of experience. The highest

rates of aggression occurred in emergency medical services, emergency departments, and among nurses, paramedics, and physicians. Employees with 6–10 years of experience reported the highest frequency of incidents, possibly reflecting greater involvement in high-risk clinical situations.

Violence had considerable emotional and professional consequences. The most frequently reported emotional reactions were fear and anger, while nearly 99% of respondents observed a decline in their work quality. Additionally, 33.6% considered leaving the profession, reflecting the serious psychological and occupational burden associated with repeated exposure to aggression.

Safety procedures were insufficiently implemented across medical facilities. Fewer than half of respondents indicated that such procedures existed in their workplace, and training on aggression management was offered only sporadically. This gap between formal guidelines and practical implementation is consistent with international research.

A substantial proportion of healthcare workers did not report violent incidents, primarily due to normalization of violence and lack of trust in managerial response. This underreporting perpetuates a cycle of inadequate data, ineffective interventions, and continued escalation of violence.

The findings confirm an urgent need for systemic interventions, including effective safety procedures, regular training, psychological support, and strengthened legal accountability for perpetrators. Healthcare institutions must recognize violence as a serious threat to both employee well-being and patient care quality.

The development of evidence-based prevention strategies should rely on empirical data, such as those presented in this study, and incorporate best international practices. Only comprehensive and coordinated efforts can reduce the prevalence of violence and improve workplace safety for healthcare professionals.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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Predictive value of cardiac contractile activity on point-of-care ultrasound for return of spontaneous circulation in pulseless electrical activity cardiac arrest – a retrospective study

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ABSTRACT

Aim: To assess the relationship between the presence of myocardial contractility on POCUS and the achievement of ROSC in patients with cardiac arrest due to PEA.

Materials and Methods: This retrospective study included 33 patients with sudden cardiac arrest due to PEA admitted to the First University Clinical Hospital of the Pomeranian Medical University in Szczecin. Clinical data, duration of cardiopulmonary resuscitation, EtCO₂ values, causes of cardiac arrest, and the presence of myocardial contractility assessed in the PLAX, PSAX, 4JP, and 4JK views using the Butterfly iQ3 ultrasound system were analyzed.

Results: Myocardial contractility was observed in 21 patients (63.6%), while it was absent in 12 patients (36.4%). Patients with preserved contractility were younger (median 69.3 vs. 84.0 years; $p < 0.001$), had higher EtCO₂ values (19.52 vs 13.67 mmHg; $p < 0.001$), and a shorter resuscitation time (15 vs 24 min; $p = 0.046$). ROSC was achieved in 15 patients (71.43%) with preserved systolic function, whereas in the group without systolic function, ROSC was not achieved in any case ($p < 0.001$).

Conclusions: The presence of myocardial systolic function assessed by POCUS is a significant predictor of achieving ROSC in patients with cardiac arrest due to PEA. The integration of POCUS with EtCO₂ monitoring and clinical analysis in accordance with the current 2025 European Resuscitation Council guidelines may increase the effectiveness of resuscitation management [4, 7].

KEYWORDS:

POCUS; PEA; ROSC; EtCO₂; ultrasound; cardiopulmonary resuscitation

INTRODUCTION

Sudden cardiac arrest (SCA) remains one of the most serious challenges in modern emergency medicine. Despite significant progress in resuscitation education, improvements in the quality of cardiopulmonary resuscitation, and increased access to defibrillation, mortality rates among patients who have suffered SCA remain very high. Current European data indicate that survival after out-of-hospital cardiac arrest remains low, and in-hospital treatment outcomes, despite improved access to advanced procedures, remain unsatisfactory [7]. In the mechanism of sudden cardiac arrest, shockable rhythms, ventricular fibrillation (VF) and pulseless ventricular tachycardia (pVT), and non-shockable rhythms, including asystole and pulseless electrical activity (PEA), are distinguished. PEA remains a particularly significant clinical problem; it currently accounts for a substantial proportion of SCA cases and is characterized by the presence of organized cardiac electrical activity without effective mechanical function or peripheral perfusion. The prognosis

in this patient group remains poor, and the rate of return of spontaneous circulation (ROSC) is significantly lower than in shockable rhythms [1, 3].

In recent years, the use of point-of-care ultrasound (POCUS) as a tool to support diagnostic and therapeutic decisions in emergency medicine has grown rapidly. During cardiopulmonary resuscitation, ultrasound allows for the assessment of the presence or absence of cardiac function, the identification of potentially reversible causes of cardiac arrest, and the evaluation of the effectiveness of the resuscitation efforts [4,6].

A study conducted by Romolo J. Gaspari et al. showed that the presence of mechanical cardiac activity on POCUS during cardiac arrest is one of the strongest predictors of ROSC. In patients with preserved cardiac mechanical activity, the ROSC rate was significantly higher than in patients with complete cardiac standstill [1]. Similar observations were reported by Justin M. Schoenberger et al., demonstrating a clear association between the presence of cardiac activity

and short-term survival [2]. A meta-analysis conducted by Chao Wu and Zheng Z confirmed the high prognostic value of the presence of myocardial mechanical activity during resuscitation [3]. In response to the growing role of ultrasound, structured protocols for examination during cardiac arrest have been developed, such as SHoC, CASA, and FEEL. The SHoC consensus described by Paul R. Atkinson et al. organizes the ultrasound assessment of a patient with cardiac arrest, focusing on structures that directly influence therapeutic decisions [4]. The CASA protocol described by Michael Clattenburg et al. enables a systematic assessment of reversible causes of cardiac arrest [5], while FEEL, developed by Rudiger Breitzkreutz et al., remains one of the most commonly used models for integrating echocardiography with ALS [6]. In its 2025 guidelines, the European Resuscitation Council emphasizes that ultrasound examinations may only be performed by appropriately trained operators and must not prolong interruptions in chest compressions [7]. At the same time, the International Liaison Committee on Resuscitation highlights the growing role of POCUS as a tool to support the differential diagnosis of PEA and prognosis assessment [8].

In recent years, the integration of ultrasound examination with capnographic monitoring has become particularly important. A systematic review by Christopher Atwood et al. indicates that combining POCUS with EtCO₂ analysis enhances the prognostic value of resuscitation assessment [9]. Similar observations were presented by Peter Meaney et al., who emphasized the importance of physiological monitoring of CPR effectiveness [10]. Additionally, Louis Lamhaut et al. demonstrated the practical feasibility of integrating ultrasound with advanced resuscitation procedures without compromising the quality of chest compressions [11].

The introduction of POCUS into the Advanced Life Support (ALS) algorithm has opened a new dimension in diagnostics during CPR. An ultrasound examination allows, within seconds, the differentiation between situations where mechanical cardiac activity is present (pseudo-PEA) and cases of complete myocardial stillness (true PEA). This distinction is crucial for therapeutic decisions - both regarding the continuation of CPR and the search for reversible causes of cardiac arrest.

AIM

The aim of this study was to evaluate the relationship between the presence of myocardial contractility assessed by point-of-care ultrasound (POCUS) and the occurrence of return of spontaneous circulation (ROSC) in patients with sudden cardiac arrest due to pulseless electrical activity (PEA). It was hypothesized that the presence of mechanical myocardial function observed during cardiopulmonary resuscitation on ultrasound is a significant predictor of a positive resuscitation outcome, whereas its absence is associated with resuscitation failure and the lack of ROSC [1-3].

MATERIALS AND METHODS

This is a single center retrospective study, conducted at the First University Clinical Hospital of the Pomeranian Medical University in Szczecin between January 2024 and

June 2025. The analysis included all hospitalized patients who experienced sudden cardiac arrest (SCA) due to pulseless electrical activity (PEA) during their stay and underwent point-of-care ultrasound (POCUS) during cardiopulmonary resuscitation. The study was conducted in accordance with the Declaration of Helsinki and applicable ethical standards. The project received approval from the Bioethics Committee of the Pomeranian Medical University in Szczecin (approval no. KB.008.101.2026). Patient data were anonymized and analyzed in a manner that prevented the identification of study participants.

INCLUSION AND EXCLUSION CRITERIA

The analysis included patients who met the following criteria: a diagnosis of cardiac arrest with PEA confirmed by ECG monitoring, a POCUS examination performed during cardiopulmonary resuscitation, availability of complete clinical and resuscitation data (CPR duration, rhythm, EtCO₂, resuscitation outcome), the ability to review archived ultrasound recordings, achievement of ROSC lasting >20 minutes, or complete documentation of a case that ended without ROSC.

The following patients were excluded from the study: with cardiac arrest in shockable rhythms (VF/pVT), who did not undergo an ultrasound examination or whose ultrasound recording was illegible, for whom POCUS was performed after resuscitation had been completed, or with incomplete medical records that precluded statistical analysis.

CARDIOPULMONARY RESUSCITATION

Cardiopulmonary resuscitation (CPR) was performed according to the current guidelines of the European Resuscitation Council applicable during the years 2021-2025 [7]. All cases of SCA occurred in an inpatient setting and included both surgical and non-surgical wards. Advanced Life Support (ALS) was provided by the hospital rapid response team (RRT) after the cardiac arrest has been identified and the ward team has initiated basic life support (BLS) or intermediate life support (ILS).

The following monitoring techniques were used in all patients: real-time ECG monitoring, capnographic monitoring of EtCO₂, peripheral or central intravenous access, and ventilation with a self-inflating bag following airway clearance using supraglottic methods or following endotracheal intubation.

The following variables were analyzed for each patient: age, sex, diagnosis on admission, type of ward (surgical/non-surgical), potentially reversible causes of cardiac arrest (hypovolemia, hypoxia, embolism, metabolic disorders, others), duration of resuscitation (from start to completion of CPR), EtCO₂ value during CPR [mmHg], primary cardiac arrest rhythm (PEA/asystole), presence or absence of myocardial contractility on POCUS, resuscitation outcome (ROSC: yes/no).

TECHNICAL ASPECTS OF THE ULTRASOUND EXAMINATION

The ultrasound examination was performed using a portable, chip-based ultrasound probe Butterfly iQ3 (Butterfly

Network, USA) integrated with mobile application Butterfly iQ App. Cardiac preset was used with frequency range of 2-5 MHz. The ultrasound examination was performed according to the FEEL/FEER protocol, during scheduled 10-second pauses in chest compressions for rhythm analysis [6]. The following cardiac views were obtained: parasternal long axis (PLAX), parasternal short axis (PSAX), apical four-chamber (A4CH) and subcostal four-chamber (S4CH).

Systolic myocardial activity was defined as a presence of any organized mechanical cardiac activity visualized on POCUS examination and including movement of heart walls and valves. Absence of myocardial activity was defined as a complete lack of movement of cardiac structures while electrical activity was preserved on the ECG. In cases of uncertainty, the images were independently assessed by two investigators in accordance with the FEEL/FEER protocol [4, 6]. The degree of inter-rater agreement was analyzed using Cohen's κ coefficient, with a value >0.8 considered very good agreement.

STATISTICAL ANALYSIS

Statistical analysis was performed using the licensed software Statistica 13.0 (StatSoft Inc., Tulsa, OK, USA). Descriptive statistics were used to characterize the study group, including means $\pm$ standard deviation, medians and quartiles, as well as counts and percentages. The normality of data distribution was assessed using the Shapiro-Wilk test. Differences between two groups were analyzed using the Student's t-test or the non-parametric Mann-Whitney U test.

Categorical variables were analyzed using the chi-square (χ^2) test, with Yates' correction applied when subgroup counts were low. Relationships between selected variables were evaluated using Spearman's rank correlation coefficient. A p-value of <0.05 was considered statistically significant.

RESULTS

STUDY POPULATION CHARACTERISTICS

Characteristics of the study population were summarized in table 1. The study population consisted of 33 patients with sudden cardiac arrest (SCA) in the mechanism of pulseless electrical activity (PEA). In 21 patients (63.6%), echocardiography revealed the presence of myocardial contractility, whereas in 12 patients (36.4%), no cardiac mechanical activity was observed.

The median age of the entire population was 74.0 years (Q1-Q3: 66.0-83.0). Patients with preserved systolic function were significantly younger than patients without mechanical cardiac function (69.3 vs. 84.0 years; $p<0.001$). No significant differences in gender distribution were observed between the groups (women: 42.9% vs. 50%; $p=0.486$).

The most common diagnosis on admission was sepsis, which was more frequent in the group with preserved systolic function (52.4% vs. 16.7%; $p=0.028$). In the analysis of potentially reversible causes of SCD, hypovolemia predominated, observed significantly more frequently in patients with preserved cardiac mechanical function (71.4% vs. 16.7%; $p=0.027$).

Table 1. Characteristics of the study population depending on myocardial systolic activity

		No systolic function (n=12)	Preserved systolic function (n=21)	p
Sex, n (%)	female	6 (50%)	9 (42.86%)	0.486
	male	6 (50%)	12 (57.14%)	
Age [years], Me(Q1-Q3)		84.0 (81.5-86.0)	69.3 (63.0-78.0)	<0.001
Diagnosis on hospital admission, n (%)	sepsis	2 (16.67%)	11 (52.38%)	0.028
	trauma	0 (0%)	3 (14.29%)	
	pulmonary embolism	1 (8.33%)	1 (4.76%)	
	Pulmonary edema	1 (8.33%)	3 (14.29%)	
	Other concomitant disorders	8 (66.67%)	3 (14.29%)	
ILS, n (%)	yes	8 (66.67%)	15 (71.43%)	0.914
	no	4 (33.33%)	6 (28.57%)	
Ward, n (%)	surgical	7 (58.33%)	12 (57.14%)	0.764
	non-surgical	5 (41.67%)	9 (42.86%)	
Reversible cause of SCA, n (%)	Hypovolaemia	2 (16.67%)	15 (71.43%)	0.027
	Hypoxia	5 (41.67%)	2 (9.52%)	
	Embolism	1 (8.33%)	1 (4.76%)	
	Electrolyte imbalances	1 (8.33%)	2 (9.52%)	
	Other	3 (25.0%)	1 (4.76%)	

Abbreviations: Me – median; Q1 – first quartile; Q3 – third quartile; C+SCA – sudden cardiac arrest; ILS – intermediate life support

Source: Own materials

In the group of patients with preserved systolic function, PEA was the predominant rhythm (95.2%), whereas in the group without mechanical function, asystole was the most common (66.7%), a difference that was statistically significant ($p < 0.001$). No significant differences in image quality were found between the ultrasound views; however, the best diagnostic image was most often obtained in the PLAX view.

RESUSCITATION PARAMETERS

Selected resuscitation parameters were analyzed in a group of patients with preserved myocardial contractility

and in a group without myocardial contractility (Table 2). Patients with preserved myocardial contractility were characterized by a shorter duration of resuscitation and higher EtCO_2 values during CPR. The median duration of resuscitation was 15.0 min (Q1-Q3: 6.0-25.0) in the group with preserved systolic function and 24.0 min (Q1-Q3: 21.0-25.0) in the group without mechanical cardiac function ($p = 0.046$) (Fig. 1). The mean EtCO_2 value was significantly higher in patients with preserved systolic function (19.52 ± 4.00 mmHg) than in the group without mechanical cardiac activity (13.67 ± 2.23 mmHg; $p < 0.001$) (Fig. 2).

Table 2. Resuscitation parameters depending on systolic myocardial activity

Variable	No systolic function (n=12)	Preserved systolic function (n=21)	p
CPR duration [min], Me (Q1–Q3)	24.0 (21.0–25.0)	15.0 (6.0–25.0)	0.046
EtCO_2 [mmHg], mean $\pm$ SD	13.67 ± 2.23	19.52 ± 4.00	< 0.001
ROSC, n (%)	0 (0%)	15 (71.4%)	< 0.001

Abbreviations: CPR – cardiopulmonary resuscitation; EtCO_2 – end-tidal carbon dioxide; ROSC – return of spontaneous circulation

Source: Own materials

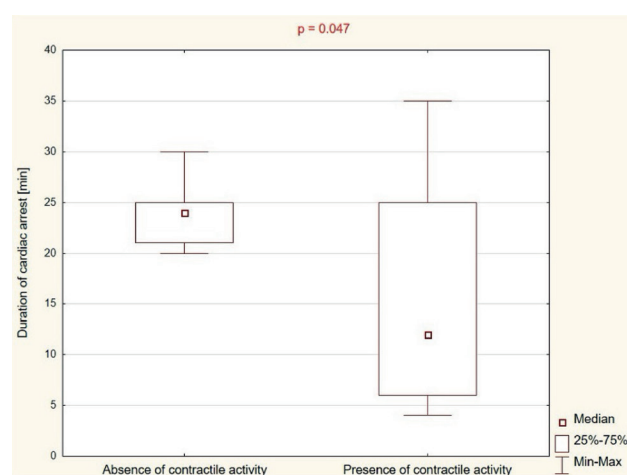


Fig. 1. CPR duration depending on systolic myocardial activity

Source: Own materials

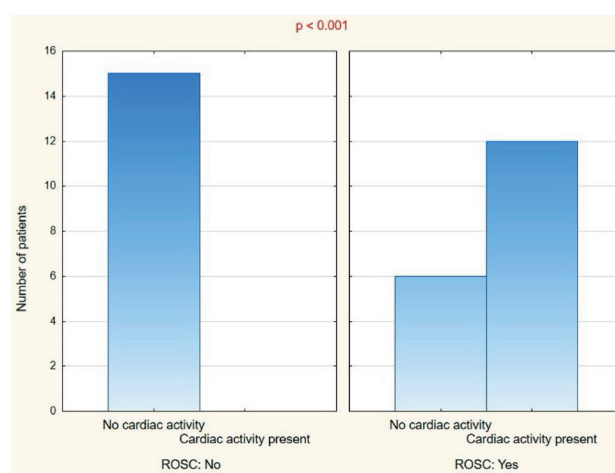


Fig. 3. The prevalence of ROSC depending of systolic myocardial activity

Source: Own materials

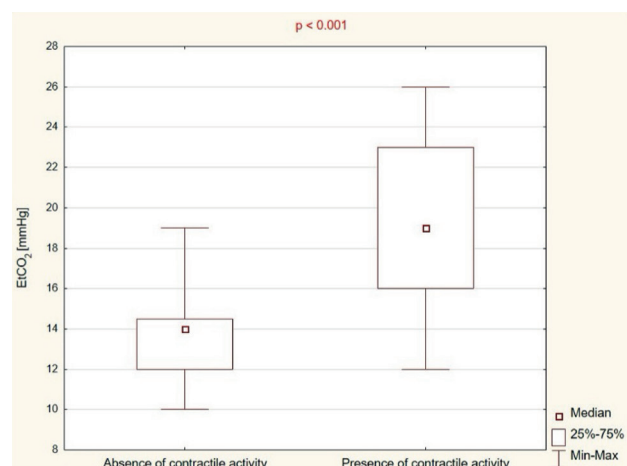


Fig. 2. EtCO_2 level during CPR depending on systolic myocardial activity

Source: Own materials

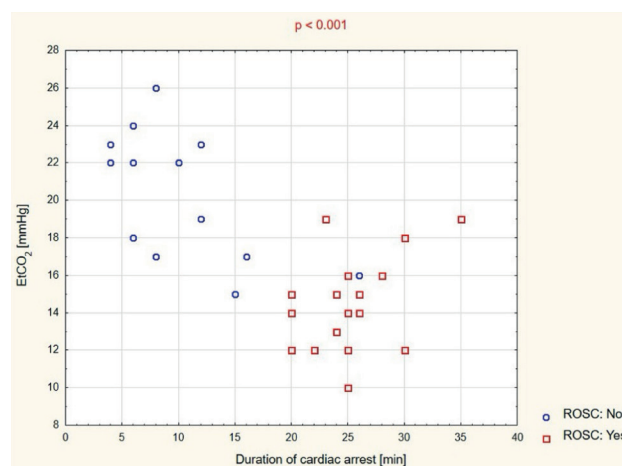


Fig. 4. The relationship between EtCO_2 in ROSC and duration of CPR

Source: Own materials

Spontaneous circulation was restored in 15 patients (45.5%) of the entire study population (Fig. 3). All cases of ROSC occurred exclusively in the group of patients with preserved myocardial contractility. No cases of ROSC were observed in the group without cardiac mechanical activity ($p < 0.001$). The presence of cardiac mechanical activity increased the likelihood of achieving ROSC (OR=6.37; 95% CI: 2.3-17.4).

A positive correlation was found between EtCO₂ levels and the presence of myocardial systolic function ($p = 0.74$; $p < 0.001$) (Fig. 4). A negative correlation was also demonstrated between the duration of resuscitation and EtCO₂ levels ($p = -0.68$; $p < 0.01$). In patients who achieved ROSC, the median EtCO₂ was 22.0 mmHg (Q1-Q3: 17.0-24.0), whereas in patients without ROSC it was 13.5 mmHg (Q1-Q3: 11.0-16.0), which was also statistically significant ($p < 0.001$).

DISCUSSION

The results of this study confirm that the presence of myocardial contractility, as assessed by POCUS during sudden cardiac arrest with pulseless electrical activity, is one of the strongest bedside prognostic indicators of resuscitation success [1-3]. In the analyzed patient group, return of spontaneous circulation was achieved exclusively in patients in whom mechanical cardiac activity was visualized on ultrasound, whereas the absence of systolic function was associated with a complete lack of ROSC. This finding indicates a very high negative predictive value of this parameter in our own data.

The results obtained are consistent with the REASON study conducted by Romolo J. Gaspari et al., involving 793 patients with PEA and asystole, which demonstrated that the presence of mechanical cardiac activity increased the likelihood of ROSC to 51%, while in the group with complete cardiac standstill, ROSC was achieved in only 14.3% of patients [1]. In our own data, this relationship appears even stronger, as ROSC occurred exclusively in the group with preserved systolic function. The ROSC rate observed in our own data was higher than that reported in the REASON study, which may be due to the homogeneity of the in-hospital population, a shorter time to the first ultrasound examination, and the standardization of resuscitation protocols.

An important interpretive factor is the high proportion of patients with pseudo-PEA. In the REASON study, more than half of the patients with an electrical PEA pattern exhibited preserved mechanical cardiac activity [1]. This confirms that the classic diagnosis of PEA, based solely on ECG monitoring, does not accurately reflect the patient's actual hemodynamic status. Our own results indicate that some patients may have been in a state of pseudo-PEA, i.e., with preserved minimal cardiac output that was not detectable by palpation but was visible on ultrasound. Distinguishing pseudo-PEA from true PEA is of significant clinical importance, as it determines the intensity of further causal treatment [2, 3].

Our study also demonstrated a strong association between the presence of systolic function and higher EtCO₂ values. The higher capnographic values observed in patients with

mechanical cardiac activity indicate that both parameters describe a common physiological component – the actual effectiveness of perfusion during resuscitation [10, 12]. EtCO₂ remains an indirect indicator of cardiac output during CPR; however, on its own, it does not allow one to determine whether an increase in values results from improved compression quality, partial restoration of mechanical cardiac activity, or a reversible cause of cardiac arrest. The advantage of POCUS lies in the direct visualization of the myocardial response to ongoing resuscitation efforts [9, 10].

Of particular interest is the shorter duration of resuscitation in patients with preserved systolic function. This may indicate that the presence of mechanical activity is associated with earlier achievement of ROSC or faster confirmation of treatment efficacy. At the same time, it suggests a potential role for POCUS as a tool for dynamic prognosis assessment during ALS [11, 12].

In the context of diagnosing reversible causes, the predominance of hypovolemia in the group with preserved systolic function is of particular significance. Ultrasonography enables rapid diagnosis of potentially reversible conditions, such as cardiac tamponade, right ventricular overload suggestive of pulmonary embolism, or features of severe hypovolemia [4, 5]. It is precisely this aspect that currently constitutes one of the main arguments in favor of routinely incorporating POCUS into ALS algorithms [4].

In recent years, there has been a shift from the simple use of ultrasound as a tool to assess the presence or absence of cardiac mechanical function to the application of structured protocols specifically designed for cardiac arrest. Three approaches are currently of the greatest importance: SHoC, CASA, and FEEL [4-6]. The SHoC protocol limits the examination to structures that directly influence immediate therapeutic decisions and remains consistent with the principle of minimizing interruptions in chest compressions. CASA organizes the assessment according to a sequence of reversible causes of cardiac arrest. FEEL remains the most practical implementation model for clinical teams, as it combines ease of execution with high reproducibility in image interpretation.

In our own study, the FEEL/FEER protocol most closely resembled the model used, as operators performed assessments in the PLAX, PSAX, and four-chamber subxiphoid views, interpreting the presence or absence of systolic function in accordance with the principles of simplified resuscitation echocardiography [6]. In the practice of Polish hospitals, the FEEL model extended with SHoC elements appears to be the most useful, as it enables rapid identification of reversible causes without prolonging interruptions in chest compressions [4, 6].

The European Resuscitation Council explicitly emphasizes in its 2025 guidelines that POCUS must not prolong interruptions in chest compressions [7]. However, our own results indicate that an examination performed during scheduled rhythm analysis windows by operators trained in accordance with FEEL/FEER can be effectively integrated into ALS without compromising the quality of CPR [6, 7]. This is of particular importance for the organization of ER/RR teams.

The results of this study have direct implications for the organization of work within Polish ER/RR teams. Incorporating bedside ultrasound into the standard equipment of these teams may improve the accuracy of distinguishing pseudo-PEA from true PEA, accelerate the identification of reversible causes, and aid in prognosis assessment during resuscitation. Of particular importance is the use of the Butterfly iQ3 mobile ultrasound system, which allows for examination without the need for stationary echocardiography equipment [11].

The absence of cardiac contractility on POCUS should be considered one of the strongest adverse prognostic factors; however, it should not be treated as a standalone criterion for terminating resuscitation. Both the International Liaison Committee on Resuscitation and the ERC emphasize that no single sonographic finding can serve as the sole basis for discontinuing CPR [7, 8]. This is because, despite the very high negative predictive value of cardiac standstill, isolated cases of survival have been reported. In the REASON study, survival to discharge in the group without cardiac activity was 0.6%, indicating an extremely poor prognosis, but not zero [1].

Despite the high clinical value of the results obtained, the study's limitations must be taken into account. Its retrospective, single-center design and small sample size limit the ability to fully extrapolate the results. At the same time, the clinical homogeneity of the study group, the uniform model of ZWIT activation, the use of the same ultrasound technology, and the comparable experience of the operators enhance the internal consistency of the data.

Finally, it should be emphasized that POCUS is not merely an imaging tool, but an element of a dynamic resuscitation model integrating etiological diagnosis, assessment of CPR efficacy, and clinical prognosis. The obtained results align with the current trend in the development of physiologically guided resuscitation, in which bedside ultrasound is becoming a tool supporting therapeutic decisions by resuscitation teams and ERT/RR [7, 11].

STUDY LIMITATIONS

This study is retrospective and single-center, which limits the generalizability of the results. The small

sample size (n=33) increases the risk of a Type II error. Furthermore, the quality of chest compressions and detailed hemodynamic parameters (e.g., blood pressure during CPR) were not analyzed. Moreover, although all operators were FEEL/FEER certified, individual differences in scanning technique may have influenced image interpretation (operator bias).

CONCLUSIONS

The presence of myocardial contractility on POCUS is one of the strongest prognostic factors for return of spontaneous circulation (ROSC) in patients with sudden cardiac arrest due to pulseless electrical activity (PEA). The absence of mechanical cardiac activity is associated with a very low probability of successful resuscitation. Higher EtCO₂ values during resuscitation remain significantly associated with the presence of myocardial contractility and the achievement of ROSC, confirming their importance as a noninvasive indicator of perfusion and resuscitation efficacy. The shorter duration of resuscitation observed in patients with preserved cardiac mechanical function may reflect greater hemodynamic potential and faster achievement of effective cardiac output.

The integration of POCUS, EtCO₂ monitoring, and clinical assessment should be part of the standard management of cardiac arrest with PEA, in accordance with the current 2025 recommendations of the European Resuscitation Council. This approach enables a more precise prognosis assessment, earlier identification of patients with the potential for ROSC, and more rational management of resuscitation efforts. The implementation of bedside ultrasound into daily clinical practice requires systematic training of medical personnel, particularly within the FEEL/FEER protocols, and standardization of ultrasound image interpretation during ALS. Further prospective studies involving larger patient populations and multicenter analysis are necessary to validate the combination of POCUS parameters, EtCO₂, and duration of resuscitation as a composite prognostic model for the effectiveness of resuscitation therapy.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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Practice of providing assistance to combat-experienced police officers in working with psychological trauma

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ABSTRACT

Aim: To identify effective approaches to providing qualified assistance to combat-experienced police officers in counteracting the development of psychological trauma.

Materials and Methods: The research methods were selected taking into account the set aim, as well as the need for a comprehensive study of the means of providing qualified assistance to law enforcement officers in dealing with psychological trauma (bibliosemantic, analysis, generalization). Clarifying the etymology of combatants' psychological trauma and the mechanisms for reducing its impact made it possible to identify approaches to providing psychological assistance to police officers after their deployment in tense and stressful war conditions.

Conclusions: It has been argued that one key indicator of stress is the combatant's attitude toward the crisis and toward themselves in it. Providing psychotherapeutic assistance involves changing pessimistic assessments and memories of trauma to interrupt patterns of behavior and/or thinking that interfere with the combatant's daily life. Psychological practice involves helping combatants create a sense of personal safety. It has been established that the specific strategy used to treat psychological trauma varies depending on the characteristics of the patient and the duration of the traumatic experience.

KEYWORDS:

psychological assistance, combat-experienced police officers, psychological trauma, combat stress, mental health

INTRODUCTION

In everyday understanding, the concept of "trauma" primarily refers to physical injuries, violations of the integrity of the body, etc. [1]. According to the laws of homeostasis, anything that disrupts the body's balance and integrity triggers a response aimed at restoring a stable state. The body's reflex response to any pain is alienation, avoidance, and deprivation. But the main function of pain is to provide information; it signals the presence of trauma and triggers the body's healing and recovery mechanisms. However, psychological trauma can have a greater impact on the individual because, unlike physical trauma, it is invisible and is objectified through indirect signs, primarily psychological discomfort [2]. Psychological discomfort usually triggers the activation of defense mechanisms, especially mechanisms of distraction and inhibition or corresponding reactions [3]. There is always a corresponding reaction to traumatic shock, and the more intense the trauma, the more intense the external influences or internal experiences. Appropriate reactions can include resistance, apathy, psychomotor agitation, fighting, feelings of helplessness, and even crying.

Trauma is associated with certain traumatic situations [4, 5]. This situation, in turn, is an event that, to a greater or lesser extent, can lead or does lead to the destruction of a person's established way of life and damage to their mental health. In other words, trauma manifests itself to

varying degrees through different situations in the life or professional path of a particular person. A traumatic situation is characterized by a sudden and intense emotional impact on the individual; it may also include states of self-doubt, emotional lability, and reduced critical assessment of the environment [6].

The modern professional reality of police officers is an inexhaustible source of psycho-traumatic situations, which are understood as extreme critical events, threatening situations that have a powerful and negative impact on the individual and require extraordinary efforts to overcome the consequences of this impact [7, 8]. They can take the form of unusual circumstances or events that expose professionals to extreme, intense, and extraordinary influences that threaten their lives or the health of their loved ones, and that fundamentally undermine their sense of security. Traumatic events in police officers' professional activities are stressors with strong negative potential [9]. Such events lead to traumatic stress experiences for police officers, the psychological consequences of which are diverse and unpredictable. For some, the very fact of experiencing traumatic stress becomes the cause of future psychological trauma.

Scientists have proven [10, 11] that crises in the service activities of police officers can provoke mental disorders, which in turn affect their daily lives and work performance.

There is a view that the main factor leading to psycho-traumatic consequences is the awareness of danger to life and health, namely, the perception by the psyche of the likelihood of injury or even death [12, 13]. Hence, it can be argued that it is not objective circumstances that determine whether an event is traumatic, but the subjective emotional experience of the event. That is why law enforcement officers who have experienced a traumatic event usually show signs of narrowed consciousness, which is focused on specific events, and also feel an acute need to talk about their experience. In the absence of adequate support, victims may exhibit aggression, malice, and other maladaptive manifestations of social and psychological deformation, which are considered to be the consequences of psychological trauma. This confirms the advisability of using modern approaches when working with law enforcement officers under constant stress in their professional activities.

AIM

The aim is to identify effective approaches to providing qualified assistance to combat-experienced police officers in counteracting the development of psychological trauma.

MATERIALS AND METHODS

The research was conducted at the Department of Legal Psychology of the National Academy of Internal Affairs (NAIA, Kyiv, Ukraine) in 2025-2026. The research involved 114 combat-experienced police officers with signs of psychological trauma.

The research methods were selected taking into account the set aim, as well as the need for a comprehensive study of the means of providing psychological assistance to combat-experienced police officers who are (were) in extreme (crisis) situations of war:

- 1) the bibliosemantic method was used to conduct an analytical review of scientific sources on the outlined range of problems;
- 2) the analysis method allowed us to understand the etymology and mechanisms of cognitive coping strategies of police officers in the presence of psychological trauma;
- 3) the generalization method was used to formulate research conclusions and practical recommendations for organizing the practice of providing psychological assistance to combat-experienced police officers.

The procedure for organizing the study and the topic of the article were previously agreed with the Committee on compliance with Academic Integrity and Ethics of the NAIA. Also, this study followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all cadets who took part in this study.

FRAMEWORK

This scientific article was carried out according to the plan of the research work of the National Academy of Internal Affairs for 2020-2026, «Psychological, pedagogical and sociological support of law enforcement officers» (state registration number 0113U008196).

REVIEW

The specificity of traumatic combat stress significantly changes the dynamics of psychological trauma, which is associated with several factors: the intensity and excessiveness of traumatic influences, insufficient time for the formation of psychological defense mechanisms, “depersonalized” ways of responding, a complex semantic load, and the severity of somatic and vegetative components of the stress response. Hence, correct diagnosis and selection of psychological correction strategies can only be ensured if the stage of trauma development is taken into account. The stages of psycho-trauma development can vary significantly in duration and intensity depending on the nature of the psycho-traumatic conditions.

According to scientists [6, 14, 15], stress disorder from any psycho-traumatic event is associated with complex semantic load and cognitive processing of trauma by the psyche itself. Hence, we propose to distinguish the following stages of development of psychological trauma in combat-experienced police officers. Understanding these stages influences the nature and content of the qualified assistance provided to individuals who have experienced combat stress.

MOBILIZATION STAGE

This stage arises in the process of law enforcement officers adapting to extreme and crisis situations (combat engagement and bombing, death of comrades, injuries, civilian casualties, etc.). Behavior goes beyond normal life experience, and a corresponding psychological change occurs in the individual: the activation of the autonomic nervous system mobilizes the body's defenses.

FIXATION STAGE

It occurs after exposure to extreme situations, when psycho-traumatic conditions no longer require the mobilization of all the mental and physical forces of the law enforcement officer. At the same time, changes in mental activity may occur at this stage that differ from those in the previous stage. First of all, it is worth talking about psychological numbness or the denial of trauma. Psychological numbness is characterized by a slowdown in psychophysiological reactions, delays, and emotional disturbances in mental processes, which often leads to a temporary loss of the ability to perform service combat missions. Denial of psychological trauma is accompanied by denial of its role in shaping personality changes. It is this manifestation that causes symptoms of post-traumatic stress disorder (PTSD). At this stage, the law enforcement officer tries to erase all events related to the traumatic experience from his life (“reset”), and he develops a psychologically protective selective reaction.

STAGE OF AGGRESSION

At this stage, irritability and aggressiveness, and anxiety among law enforcement officers may be characteristic; increasingly, and often irrationally, demands are made on the environment, various fears and nightmares are felt, and sometimes outbursts of anger are observed, directed

at the immediate professional or domestic environment or at oneself.

STAGE OF DEPRESSIVE REACTION

At this stage, the tendency toward aggression is replaced by depression, low mood, feelings of helplessness, powerlessness, various psychosomatic disorders, etc.

STAGE OF RECOVERY

At this stage, the law enforcement officer's personality is freed from psychological trauma under the influence of various external and internal factors. If this stage does not occur, a chronic process of cyclical repetition of the previous stages is observed, leading to disordered forms of personality disorders – acute stress reaction (ASR) and PTSD.

DISCUSSION

Therefore, given the dynamics of the formation of psychological trauma in a combat environment, it is possible to identify a fundamental difference between “classical” psychogenesis and “combat trauma.” Combat stress has a latent phase characterized by a weakening of the effects of combat environment factors. Recovery from combat stress, which is considered a generally accepted criterion for “classical” psychological trauma, is not a prerequisite. The initial stage of psychological trauma formation in crises is characterized by adaptive psychological reactions at the physiological level, which usually end in recovery and do not reach the level of distress. That is why psychological assistance should be provided at this stage, because moving on to the next stage creates “painful material” for other psychological changes.

It should be noted that psychological trauma can manifest itself significantly through a person's conscious attitude toward psychologically traumatic events. One key indicator of experiencing a stressful situation is one's attitude toward the crisis and oneself in it. Psychological assistance should usually begin with education about PTSD, thoughts, and emotions. The patient begins to understand the connection between thoughts and emotions better, and also begins to identify “automatic thoughts” that may support PTSD symptoms. The patient describes in detail their current understanding of why the traumatic event occurred and the impact it had on their beliefs about themselves, others, and related matters. In light of this, the initial communication process with the combatant after the event becomes relevant. The impact of recounting the psychological trauma, as well as reminders of it or emotions, is often used to help the patient reduce the risk of avoidance or the emergence of maladaptive associations with the trauma. The goal of such measures is to restore the patient's sense of control, self-confidence, and predictability, as well as to prevent escape behavior and the likelihood of distancing themselves from their surroundings (professional, domestic). At the same time, this process should be accompanied by cognitive-behavioral therapy. A significant number of contemporary researchers emphasize its usefulness in such cases [16-19]. It focuses on the relationship between thoughts, feelings,

and behavior and outlines how changes in any one domain can improve functioning in other domains [20]. For example, changing the unhelpful thinking of a combat-experienced police officer can lead to healthier behavior and improved emotion regulation. This practice should be combined with control of emotional information processing. In particular, the surrounding reality (news, extreme situations, specific people) can elicit associations with a traumatic event, thereby triggering accompanying emotional reactions (fear, numbness, etc.). That is why a specialist working with combatants' psychological trauma must take into account the need to change these associations, which lead to unhealthy mental functioning.

In our opinion, it may be useful in working with combat-experienced police officers' psychological trauma to encourage patients to reevaluate their thinking patterns and assumptions to identify unhelpful patterns (often referred to as “distortions”) in their thoughts, such as overgeneralization of bad outcomes, negative thinking that downplays positive thinking, and constantly expecting catastrophic outcomes, to more balanced and effective thinking patterns. Hence, it can be argued that the goal of such practice is to help the patient rethink their understanding of the traumatic experience they have gone through, as well as their understanding of themselves and their ability to cope with it. Finally, once the patient has developed the skills to identify and address unhelpful thinking, they should be encouraged to continue to evaluate and change beliefs related to traumatic events. At this stage, the psychotherapist or psychologist helps the patient develop the ability to use these adaptive strategies outside of treatment to improve overall functioning and quality of life. Professionals may particularly focus the combatant's attention on safety, trust, power, control, respect, and intimacy, as all of these areas can be significantly affected by traumatic experiences.

Therefore, providing psychotherapeutic assistance involves changing pessimistic assessments and memories of trauma to interrupt patterns of behavior and/or thinking that interfere with the combatant's daily life. This practice should be conducted in weekly sessions over three months, either individually or in groups. The specialist works with the patient or group to identify the relevant assessments, memories, and trauma triggers that support specific symptoms of PTSD or ASR. It is understood that strategies for working with psychological trauma vary depending on the characteristics of the patient and the duration of the traumatic experience, namely: short-term (hours to days) psychological trauma from participation in combat operations; prolonged psycho-traumatic impact on the personality of extreme factors (serving at temporary deployment points, checkpoints, strongholds, etc.); service and combat operations involving complex and prolonged psycho-traumatic factors of varying intensity (transition from isolation and blockade operations to special operations to eliminate armed groups and illegal formations). Given the intensity of psychophysical stress, the approach of a psychotherapist or psychologist should still be based on

the combatant creating a new assessment of reality, which is then integrated with their traumatic memory or signals. This can be achieved by embedding the new reality into the further imaginary experience of the traumatic experience. The combat-experienced police officer must ultimately understand the meaning of traumatic memories and how they are currently assessed and recognize that an overly pessimistic assessment of trauma or its consequences may exaggerate the current sense of threat. In contemporary psychotherapeutic practice, the Socratic questioning strategy [21-23] is often used to help the patient form a favorable assessment of the phenomena of reality that the patient finds convincing. The therapist also guides the patient in creating a meaningful narrative, a story that begins before the trauma occurred and ends with the patient feeling safe again. This can be achieved, in particular, by writing a comprehensive description of the traumatic event, by imagining it, or by revisiting the place where the traumatic event occurred. Sometimes this involves an element of "exposure," the goal of which is to identify idiosyncratic memory points that elicit strong reactions and to use cognitive restructuring during work on the psychological trauma. Such refinement of autobiographical memory helps to reduce re-experiencing and prevents the development of problematic thinking associated with trauma. Finally, the specialist should help the combatant reduce the feeling of current threat and, in the long term, actually prevent the recurrence of PTSD symptoms. The psychotherapist (psychologist), in interaction with the patient, focuses on behavior that primarily involves the search for safety and the suppression of obsessive thoughts. We believe that this practice will reduce the persistence of PTSD symptoms. Therefore, the presence of psychological trauma in a combat-experienced police officer does not always lead to the development of post-traumatic stress disorder symptoms. Employees who have experienced a traumatic event from participating in combat operations face many problems even in peacetime that can contribute to the destruction of basic life assumptions (security, justice, trust, etc.). Therefore, qualified assistance should be provided at any stage of the development of psychological trauma in combat-experienced police officers, as they have suffered traumatic losses in war, experienced a combination of grief and trauma symptoms, and are therefore at risk.

According to contemporary researchers [8, 11, 24], stress becomes traumatic when the action of a stressor leads to mental disorders similar to physical disorders. Traumatic events are stressors - extreme crises with strong negative potential that threaten an individual's life and health. Such events fundamentally violate a person's sense of security, leading to traumatic stress, the psychological consequences of which are diverse and quite unpredictable. For some, the very fact of experiencing traumatic stress causes PTSD. Similar situations require urgent psychotherapeutic help, as significant delays increase the risk of adverse personality changes that significantly affect a person's overall functioning. In particular, while initial reactions to trauma may include exhaustion, confusion, sadness, anxiety, agitation, numbness,

physical agitation, etc., indicators of more serious reactions include continuous distress without periods of relative calm or rest, severe symptoms of dissociation, and intense intrusive memories that persist despite returning to a safe place.

To date, no generally accepted concept explains the mechanisms of combat trauma development [7, 12, 25]. The risk factors for post-traumatic stress disorder are diverse, ranging from personality characteristics (character traits and temperament, nervous system strength, dependent behavior, physical illness, etc.) to the duration and content of the traumatic experience. Several fundamental positions should also be considered. First, the experience of participating in combat operations, in one way or another, disturbs the combatant's mental activity, generally affecting the course of their behavior and life activities. In view of this, there is a position [26, 27] that the main factor in the emergence of combat trauma is the danger to life and health associated with the perception of death and injury by those around them. As our analysis shows, it is necessary to help combatants build a sense of security and promote the restoration of basic life assumptions (such as belief in justice and manifestations of trust). Secondly, in police officers who have participated in combat operations, psychological trauma develops over a relatively long period of time under the influence of less obvious but constantly acting factors [6]. In this case, combatants accumulate psychological stress continuously and unconsciously. As a result, they may withdraw into themselves, distance themselves from their immediate (professional and personal) environment, and exhibit aggression towards colleagues, family members, etc. Therefore, it is important to understand that any traumatic events and situations are a kind of signal that one needs to return to oneself, to one's "Self." At the same time, to overcome trauma or reduce the risk of its development, combatants must have the desire and strength to restore their mental health and fill the void in their personal integrity. With this in mind, we have proven that in modern work with the psychological trauma of police combatants, it is advisable to encourage patients to change their own thinking patterns, primarily to identify various types of "distorted" thoughts. This also applies to the need for qualified correction of the combatant's emotional manifestations. As we noted in our research, the goal of psychological assistance is to help clients learn to regulate their emotions without the use of substances or other deviant behavior. Naturally, this requires new coping skills and the strength to endure anxious emotions. The results of previous studies on this range of problems confirm our standpoints. [2, 9, 14, 28-30].

CONCLUSIONS

Psychological trauma can manifest itself significantly through a person's conscious attitude toward psychologically traumatic events. Combat-experienced police officers often exhibit signs of narrowed consciousness, focused on specific events. Even in peacetime, they face many problems that can undermine their basic life positions. One key indicator

of experiencing a stressful situation is one's attitude toward the crisis and toward oneself in it. There is an urgent need to talk about and share the traumatic experience.

Providing psychotherapeutic assistance involves changing pessimistic assessments and memories of trauma to interrupt patterns of behavior and/or thinking that interfere with the combatant's daily life. At the same time, it is necessary to help the combatant feel safe. The specific strategy for working with psychological trauma varies depending on the characteristics of the patient and the duration of the

traumatic experience. In the absence of adequate psychological support, patients exhibit aggression, a desire to distance themselves from their immediate environment, and other maladaptive manifestations of social deformation, which are considered to be the consequences of psychological trauma.

PROSPECTS FOR FURTHER RESEARCH

Prospects for further research include examining potential changes in police officers' personalities while performing their service duties during a state of martial law.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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Microcirculation monitoring in perioperative care: Methods and clinical significance

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ABSTRACT

Aim: To analyze current methods of microcirculatory monitoring and evaluate their clinical significance in perioperative care.

Materials and Methods: A systematic search of the PubMed database was conducted for studies published between January 2020 and February 2026. The search strategy included combinations of relevant Medical Subject Headings related to microcirculation and hemodynamic monitoring. Studies were screened for relevance, and those meeting the inclusion criteria were included in the qualitative analysis.

Various techniques for microcirculatory assessment were identified, including handheld vital microscopy, laser Doppler flowmetry, near-infrared spectroscopy, hyperspectral imaging, and vascular occlusion test. These methods enable real-time evaluation of tissue perfusion and oxygenation. Several studies demonstrated that microcirculatory alterations may occur despite normal macrocirculatory parameters. Some evidence suggests that microcirculatory-guided strategies may improve perioperative tissue perfusion and potentially clinical outcomes; however, results remain inconsistent.

Conclusions: Microcirculatory monitoring represents a promising adjunct to standard hemodynamic assessment. Although current evidence highlights its potential clinical value, further studies are required to determine its role in routine perioperative practice and its impact on long-term outcomes.

KEYWORDS

microcirculation, hemodynamic monitoring, perioperative care, general anesthesia

INTRODUCTION

Contemporary anesthesiology and intensive care medicine largely focus on the assessment and management of hemodynamic disturbances based on macrocirculatory parameters, such as arterial blood pressure and heart rate [1]. However, an increasing body of evidence suggests that traditional macrocirculatory monitoring may be insufficient for a comprehensive evaluation of the surgical patient.

Despite normalization of macrohemodynamic parameters, some patients continue to develop postoperative complications resulting from microcirculatory disturbances. Impairments at the microcirculatory level may lead to tissue hypoxia even in the presence of normal macrocirculatory values. Therefore, direct assessment of the microcirculation has emerged as an important adjunct to conventional hemodynamic monitoring.

Currently, several techniques are available for microcirculatory assessment, including handheld vital microscopy (HVM), vascular occlusion test (VOT), and laser Doppler flowmetry (LDF). However, none of these methods has yet been fully implemented in routine clinical practice [2, 3]. A combined evaluation of macro- and microcirculation appears essential for optimizing perioperative management and ensuring adequate tissue perfusion and oxygenation.

MATERIALS AND METHODS

A systematic search of the PubMed database was conducted, covering articles published between January

2020 and February 2026. The review process was performed independently by two reviewers, and any disagreements were resolved through discussion and consensus.

The search strategy included combinations of relevant keywords and Medical Subject Headings (MeSH), such as "microcirculation" AND "hemodynamic monitoring" AND "perioperative care" OR "general anesthesia." Only studies published in English were included.

As this study was a literature review and did not involve human or animal participants, ethical approval was not required. A total of 52 records were initially identified, of which 36 had full-text availability. After screening, 2 studies involving pediatric populations, 2 ongoing clinical trials without available results, and 12 studies not relevant to the topic were excluded. Ultimately, 20 studies met the inclusion criteria and were included in the qualitative synthesis.

AI-assisted tools (e.g., ChatGPT) were used for language editing. The authors take full responsibility for the content of the manuscript.

AIM

The aim of this study was to provide a comprehensive review of current methods of microcirculatory monitoring and to evaluate their clinical significance in perioperative care, with particular emphasis on their potential role in improving tissue perfusion assessment and guiding hemodynamic management.

REVIEW

METHODS OF MICROCIRCULATORY ASSESSMENT

Assessment of the microcirculation enables evaluation of tissue perfusion at a local level, representing a significant advantage over macrocirculatory monitoring. This allows for a more precise analysis of blood flow within specific tissue regions. However, an important limitation remains the difficulty in extrapolating these findings to the whole organism. For instance, it is unclear whether sublingual microcirculation accurately reflects perfusion of internal organs [2].

In addition to HVM, VOT, and LDF, other techniques used for microcirculatory assessment include:

- near-infrared spectroscopy (NIRS),
- hyperspectral imaging (HSI),
- tissue partial pressure of CO₂ measurements,
- indices such as gastric pH and indocyanine green plasma disappearance rate [3].

LASER DOPPLER FLOWMETRY (LDF)

Laser Doppler flowmetry is a noninvasive method for assessing microcirculation, enabling continuous measurement of microvascular blood flow without disrupting tissue integrity. Studies suggest that combining LDF with impedance analysis allows for a more accurate representation of microcirculatory dynamics, which may be particularly useful in monitoring perfusion during cardiac surgery [4].

LDF has also been applied in gastrointestinal surgery, where it facilitates the assessment of tissue perfusion and identification of areas at risk of ischemia, for example at the site of gastrointestinal anastomosis [5].

Another important application of LDF is in neurosurgery, where it serves not only as a tool for microcirculatory assessment but also as a navigation aid in stereotactic procedures, such as deep brain stimulation implantation and brain tumor biopsies. [6] Studies have shown that LDF enables identification of regions with increased blood flow and generates characteristic signal profiles ("barcodes") corresponding to different tissue types. This allows differentiation between gray and white matter along the probe trajectory and precise localization of deep brain structures.

The measurement is based on direct assessment of microvascular flow at the probe tip, enabling intraoperative monitoring of perfusion changes. The procedure is relatively rapid (approximately 7 minutes) and may reduce the risk of complications, including intraoperative hemorrhage [7].

NEAR-INFRARED SPECTROSCOPY (NIRS)

Near-infrared spectroscopy enables noninvasive measurement of tissue oxygenation (StO₂). Clinical studies have demonstrated that lower regional oxygen saturation (rSO₂) values are associated with neurological deterioration in patients with subarachnoid hemorrhage, suggesting potential utility in neurosurgical monitoring [8].

Furthermore, the combination of NIRS with VOT may have prognostic value in predicting acute kidney injury following cardiac surgery [9].

HYPERSPSPECTRAL IMAGING (HSI)

Hyperspectral imaging (HSI) enables noninvasive assessment of tissue oxygenation, perfusion, and chemical composition, providing information on parameters such as oxygen saturation (StO₂), near-infrared perfusion index (NIR), hemoglobin index (HbI), and tissue water index (TWI) [10]. In a 2021 observational pilot study, HSI was used for the first time to visualize tissue oxygenation and water content in patients undergoing pancreatic surgery. The results suggested that this technique may represent a promising tool for intraoperative microcirculatory assessment [11]. In the same year, HSI was shown to be a feasible and useful method for assessing tissue oxygenation prior to esophageal anastomosis, potentially reducing the risk of anastomotic failure in gastrointestinal surgery [12].

Subsequent studies confirmed the utility of HSI in transplantation. Sucher et al. demonstrated its applicability for real-time monitoring of pancreatic grafts following reperfusion [10]. Further studies indicated its usefulness in kidney transplant recipients, where HSI-derived parameters enabled early prediction of delayed graft function (DGF). Analysis of oxygenation, perfusion, hemoglobin concentration, and tissue water content allows assessment of graft viability, including the kidney and ureter.

Importantly, intraoperative measurements may provide predictive information before the onset of clinical signs of graft dysfunction [13].

Overall, available data suggest that HSI is a promising method for intraoperative microcirculatory monitoring, enabling real-time assessment of tissue perfusion and hydration. It also holds potential for improving surgical outcomes through more precise evaluation of tissue viability and better personalization of therapeutic strategies.

MICROCIRCULATION IN CLINICAL STUDIES

The CUSTOM study did not demonstrate significant changes in sublingual microcirculation regardless of the hemodynamic strategy applied. However, strategies targeting cardiac output optimization resulted in increased oxygen delivery in the perioperative period [14]. In contrast, a randomized clinical trial involving patients undergoing major abdominal surgery demonstrated that the use of decision-support systems for fluid therapy improved microcirculatory parameters compared to standard care [15].

These findings highlight the potential role of microcirculatory monitoring in evaluating the effectiveness of perioperative therapies.

MICROCIRCULATION IN ANESTHESIOLOGY

During general anesthesia, hemodynamic monitoring is primarily based on macrocirculatory parameters such as arterial blood pressure and heart rate. However, growing evidence suggests that this approach may be insufficient for a comprehensive assessment of tissue perfusion.

Induction of general anesthesia alone may affect the microcirculation, leading to alterations in capillary blood flow and redistribution of perfusion. These changes may occur independently of macrohemodynamic parameters, highlighting the limitations of standard monitoring.

The clinical application of microcirculatory assessment remains controversial. A major limitation is the lack of clear evidence as to whether regional measurements - such as sublingual microcirculation - accurately reflect perfusion of critical organs, including the brain and kidneys [16]. Nevertheless, increasing evidence suggests that a comprehensive hemodynamic assessment should include not only macrocirculatory parameters but also microcirculatory and metabolic indicators, such as lactate levels, pH, and tissue oxygen saturation. This multidimensional approach allows for a more accurate evaluation of the balance between oxygen delivery and consumption [17].

From a physiological perspective, the microcirculation - particularly the capillary network - represents the final stage of oxygen and nutrient delivery to cells. Therefore, optimization of macrocirculatory parameters does not necessarily translate into adequate tissue perfusion, potentially leading to so-called "occult hypoperfusion" [1].

A prospective observational study conducted in 2025 in patients undergoing major abdominal surgery demonstrated that monitoring sublingual microcirculation may support intraoperative hemodynamic optimization. However, its value as a surrogate marker of organ perfusion remains uncertain and requires further investigation [18].

Important insights are also provided by studies using COMET technology, which enables measurement of mitochondrial oxygen tension (mitoPO₂). These studies demonstrated a significant decrease in mitoPO₂ during general anesthesia, which did not directly correlate with macrohemodynamic parameters, suggesting a functional dissociation between macro- and microcirculatory regulation [19].

This phenomenon has been further confirmed in proof-of-concept studies, indicating that microcirculatory disturbances may occur despite normal global hemodynamics. This dissociation may result from changes in blood rheology, endothelial dysfunction, iatrogenic factors, or inflammatory processes, including sepsis and shock. [20]

DISCUSSION

Despite growing interest in microcirculatory monitoring, its role in routine perioperative care remains unclear. The available evidence consistently demonstrates that microcirculatory disturbances may occur independently of macrocirculatory parameters, highlighting a potential limitation of standard hemodynamic monitoring. [19, 20]

However, several important challenges limit its clinical implementation. First, there is significant heterogeneity among available studies in terms of patient populations, surgical procedures, and monitoring techniques. Second, most methods assess regional microcirculation (e.g., sublingual), and their ability to reflect perfusion of vital organs such as the brain or kidneys remains uncertain. [2, 16, 18]

Moreover, although some studies suggest that microcirculatory-guided therapy may improve tissue perfusion [14, 15], robust evidence demonstrating a direct impact on clinically relevant outcomes - such as mortality or postoperative complications - is still lacking.

Technological limitations, cost, and the need for specialized training further restrict widespread use. Nevertheless, emerging techniques, including hyperspectral imaging and mitochondrial oxygen tension monitoring, offer new insights into tissue-level perfusion and may play an important role in future personalized perioperative management. [10-13, 19]

Overall, integration of microcirculatory assessment with macrocirculatory and metabolic parameters appears to be a promising direction, but requires further validation in large, well-designed clinical trials.

CONCLUSIONS

Microcirculatory monitoring reveals clinically relevant perfusion disturbances that may not be detected by conventional hemodynamic parameters. While it holds promise for improving perioperative assessment and guiding individualized therapy, its routine clinical application remains limited and requires further high-quality evidence.

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CONFLICT OF INTEREST

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Traumatic shock as a life-threatening condition for the wounded on the battlefield that requires emergency medical care

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ABSTRACT

Aim is to examine the causes, phases, degrees, and signs of traumatic shock in a wounded persons to provide them with emergency medical care.

Materials and Methods: Research methods: analysis and generalization of scientific and educational literature and data from the Internet; study and generalization of combat experience during the Russian-Ukrainian war; and knowledge of the armies of leading NATO countries in providing emergency medical care to the wounded on the battlefield during traumatic shock.

The causes, phases, degrees, and signs of traumatic shock in a battlefield casualty have been identified. It has been found that the primary causes of traumatic shock are rapid loss of a large volume of blood in the casualty and severe pain. It has been established that traumatic shock progresses through two phases: the erectile phase, in which the victim experiences pain and signals it by all means available to them, and the torpid phase, in which the wounded is lethargic, apathetic and depressed. It has been established that, there are four degrees of manifestation of the shock: first-degree shock – mild shock; second-degree – moderate; third-degree – severe; and fourth-degree – pre-agony or agony. Without providing emergency medical care to the wounded, traumatic shock of third and fourth degrees usually results in death.

Conclusions: Thus, traumatic shock is a severe pathological condition that threatens the life of the wounded and occurs in cases of severe trauma and injuries. Timely detection of signs of shock in the wounded is a prerequisite for providing them with emergency medical care on the battlefield.

KEYWORDS

traumatic shock, emergency medical care, wounded person, battlefield

INTRODUCTION

Modern warfare statistics show that a wounded person's chances of survival often depend on the ability of those nearby to provide necessary first aid: over 90% of those killed by wounds die before the wounded person is transported to a hospital; 80% of those killed by wounds die within the first 30 minutes after being wounded; 99% of preventable deaths (those deaths from which the wounded were saved on the battlefield) had a window of 1 to 10 minutes for rescue, but the wounded were accompanied by knowledgeable and skilled companion in arms who managed to save them [1, 2].

According to experts [3-5], the most dangerous factors threatening the life of a wounded person on the battlefield due to wounds and injuries are massive bleeding, acute respiratory failure, and the development of traumatic shock. Each of these factors, individually and in combination with others, disrupts vital organ and system functions, poses a threat to human life, and requires immediate emergency care to eliminate or mitigate the effects.

Scientists note that shock is a circulatory-metabolic syndrome in which the blood's oxygen supply fails to meet the body's metabolic needs [6]. It is accompanied

by a sharp disruption of the nervous regulation of vital organs and systems (circulation, respiration, metabolism, etc.) and threatens the victim's life [7].

Experts [8-10] distinguish various clinical forms of shock; however, in battlefield injuries, traumatic shock is most commonly observed – a severe pathological condition arising from gunshot wounds and other severe injuries, such as pelvic fractures, traumatic brain injuries, internal organ injuries, and massive blood loss. Understanding its main causes and the specifics of providing emergency care is a critical task for a combat rescuer-medic during wartime.

AIM

The aim is to examine the causes, phases, degrees, and signs of traumatic shock in a wounded persons to provide them with emergency medical care.

MATERIALS AND METHODS

The results were processed and analyzed at the Department of Special Physical Training and Survival of the S. P. Koroliov Zhytomyr Military Institute (Zhytomyr, Ukraine, ZMI) in 2025-2026.

Research methods: analysis and generalization of scientific and educational literature and data from the Internet (21 sources on the topic of the article from the scientometric databases PubMed, Scopus, Web of Science Core Collection were analyzed); study and generalization of combat experience during the Russian-Ukrainian war in 2022-2026; and knowledge of the armies of leading NATO countries in providing emergency medical care to the wounded on the battlefield during traumatic shock.

The research was performed according to the requirements of the Regulations on Academic Honesty at the S. P. Koroliov Zhytomyr Military Institute, which were developed on the basis of Ukrainian and world experience of ethical rulemaking. According to its provisions, the members of the scientific community are guided by the rules of ethical conduct and professional communication; respect the principles, values, norms, rules, and conditions of academic honesty in their activities.

REVIEW

According to statistical data, in cases involving a combination of bone and abdominal organ injuries, traumatic shock develops in 80-100 % of the wounded. However, traumatic shock cannot be considered purely hypovolemic, caused by rapid loss of a significant amount of blood (hemorrhagic) or fluid (dehydration), leading to a drop in blood pressure (BP), impaired tissue perfusion, and organ hypoxia. Significant pain and extensive tissue damage from the injury also play a major role, triggering a corresponding protective response from the body. Key signs include pallor, cold skin, a rapid pulse, low blood pressure, and confusion.

Severe pain and neuropsychological stress caused by the injury significantly exacerbate the severity of the shock state. Excessive pain stimuli from injuries trigger numerous nerve impulses that reach the brain and rapidly deplete its cortex. This dangerous phenomenon is counteracted by an inhibitory protective process, which disrupts the cortex's regulation of the deeper brain regions associated with it. This disrupts the body's basic physiological functions, manifesting as impaired blood circulation, decreased blood volume, insufficient oxidative processes, blood pooling, and so on.

Another primary cause of traumatic shock is the rapid loss of a large volume of blood or plasma. Such loss does not necessarily take the form of external or internal bleeding – a state of shock can also be caused by massive exudation (the leakage of the liquid component of blood through the vessel walls) of plasma through the burned skin surface in cases of burns (burn shock). In the development of traumatic shock, it is not so much the absolute amount of blood loss as the rate of blood loss that is important. With rapid blood loss, the body has less time to adjust, making shock more likely. Therefore, shock is more commonly observed in cases of injury to large arteries with massive bleeding.

Factors that lead to the development of traumatic shock or exacerbate it also include injuries involving damage

to particularly sensitive areas (perineum, neck) and vital organs. In such cases, the severity of shock is determined by the amount of blood loss, the intensity of pain, the nature of the injury, and the degree of preservation of vital organ function.

Rapid and massive blood or plasma loss leads to a sharp decrease in the circulating blood volume in the victim's body. As a result, the victim's blood pressure drops rapidly and significantly, the supply of oxygen and nutrients to tissues deteriorates, and tissue hypoxia develops. Due to the lack of oxygen in the tissues, toxic, under-oxidized metabolic byproducts accumulate, metabolic acidosis develops, and intoxication increases. The lack of glucose and other nutrients in the tissues leads to their transition to "self-sufficiency" – lipolysis (fat breakdown) and protein catabolism (protein breakdown) intensify.

In an attempt to cope with blood loss and stabilize blood pressure, the body responds by releasing vasoconstrictors – catecholamines (including epinephrine, norepinephrine, dopamine, and cortisol) – into the bloodstream and by causing peripheral vasospasm. Blood flow becomes centralized – first and foremost, blood is directed to the brain, heart, and lungs, while the skin, muscles, and abdominal organs receive insufficient blood. This may temporarily stabilize blood pressure at a relatively satisfactory level, but at the same time, it further worsens the supply of oxygen and nutrients to peripheral tissues. Consequently, metabolic acidosis, intoxication, and catabolic processes in the tissues are further exacerbated.

Reduced blood flow to the kidneys leads to decreased urine filtration and impaired renal excretory function. The body's attempts to cope with pain by increasing the secretion of endorphins (endogenous opioid analogs) lead to a further drop in blood pressure and to the development of lethargy, apathy, and anergy – the loss of the ability to resist pathogenic environmental influences. The response to decreased blood pressure and elevated catecholamine levels is tachycardia (rapid heartbeat). At the same time, due to the circulating blood volume (CBV) insufficiency, cardiac output is reduced, and pulse volume is diminished (to the point of a thread-like or indistinct pulse in the peripheral arteries).

Traumatic shock progresses through two phases in its development – the erectile and the torpid phases. In the erectile phase of traumatic shock, the victim experiences pain and signals it by all means available to them: screaming, complaints, crying, moaning, words, facial expressions, and gestures. They are agitated, frightened, anxious, and aggressive; they may resist examination or attempts to help, and demand analgesics. In the erectile phase, the body's compensatory capabilities have not yet been exhausted, and blood pressure is often even elevated (as a reaction to pain and stress). At the same time, there is a vasospasm of the skin – It feels cold and appears pale, a condition that worsens as bleeding continues. There is a rapid heartbeat (tachycardia), rapid breathing, fear of death, cold, clammy sweat (odorless), tremors, or fine muscle twitching. The pupils are dilated (a reaction to pain), and the eyes are

shiny. The gaze is restless, unfocused. Body temperature may be slightly elevated due to stress, catecholamine release, and increased basal metabolism. The pulse retains satisfactory fullness and rhythm.

In the torpid phase of traumatic shock, the injured person, in most cases, stops screaming, moaning, crying, or thrashing about in pain; they ask for nothing and make no demands. They are sluggish, lethargic, apathetic, drowsy, and depressed; they may lie in a state of complete prostration or lose consciousness. Sometimes the victim may emit only a faint moan. At the same time, the wounded person's pain sensations do not diminish. There is marked tachycardia; blood pressure drops, sometimes to critically low levels, or cannot be detected at all when measured in peripheral vessels. Pain sensitivity is absent or sharply reduced – they do not react to any manipulation of the wound. They either do not respond to questions or respond barely audibly. Seizures may occur. In particularly severe cases, generalized convulsions develop (involuntary muscle contractions affecting the vast majority of different muscle groups). Involuntary urination and defecation often occur.

The skin of a wounded person in the torpid phase of shock is cold and dry (there is no longer any perspiration – the patient cannot sweat due to significant fluid loss from bleeding), and tissue turgor is reduced. Facial features appear more pronounced, and the nasolabial folds are smoothed out. The subcutaneous veins are dilated. The pulse is thready, over 120 beats per minute. The more frequent and weaker the pulse, the more severe the traumatic shock. The injured person's eyes become dull, lose their luster, appear sunken, and shadows appear under the eyes. The pupils are dilated, and the gaze is fixed at a distance. Body temperature may be normal, elevated (due to wound infection), or slightly reduced. Chills are present even in warm weather, along with marked pallor of the skin and cyanosis of the lips and other mucous membranes. "Shock kidney" syndrome develops – despite thirst and generous fluid intake, the wounded person produces little urine (anuria), and it is highly concentrated and dark. In severe shock, there may be no urine at all. "Shock lung" syndrome is also present – despite rapid breathing and intense lung activity, oxygen delivery to tissues remains inadequate due to vasospasm and low blood hemoglobin levels.

The erectile phase of shock is brief (up to 30 minutes), less commonly lasting several hours. The torpid phase of shock can last from several hours to a day or longer. In wounded with low compensatory capacity, the erectile phase of shock may be absent or very brief (minutes). Shock begins to develop immediately from the torpid phase, for example, in cases of very severe trauma or wounds accompanied by blood loss and soft tissue laceration (traumatic avulsions and lacerations of the limbs at the thigh level, penetrating wounds of the abdominal and thoracic cavities with injury to internal organs). Such injuries usually lead to extreme shock. In this case, the person immediately loses consciousness due to an excessively severe pain syndrome, which the brain is unable to cope with and effectively "shuts down."

Depending on the severity of the shock, four degrees of its manifestations are distinguished:

First-degree shock (mild). The condition of the wounded person is relatively satisfactory; the functions of the body's systems are preserved. The injured person is pale, conscious, sometimes exhibits mild lethargy, and has diminished reflexes. The pulse is rapid – 90-100 beats per minute – and systolic blood pressure is at least 100 mm Hg.

Second-degree shock (moderate severity). Vital functions are impaired; the casualty's reactions are sluggish, and they are lethargic. The skin is pale and moist; breathing is rapid and shallow. The pupils are dilated; the pulse is 120-140 beats per minute; systolic blood pressure is 80-70 mm Hg.

Third-degree shock (severe). The casualty's condition is severe; they are severely lethargic, consciousness is preserved, but they do not recognize those around them, do not respond to questions, or respond with a single word, and do not react to pain stimuli. The skin is earthy gray due to impaired microcirculatory blood flow, covered with cold, clammy sweat; there is marked cyanosis of the lips, nose, and fingertips. The pulse is thread-like, detectable only in the central vessels (carotid and femoral arteries), with a rate of 150-160 beats per minute; blood pressure drops to 70 mm Hg or below. Breathing is shallow, rapid, and sometimes slowed. Vomiting, involuntary urination, and defecation may occur.

Fourth-degree shock (pre-agony or agony). The wounded person is unconscious; conventional methods cannot detect the pulse or blood pressure; heart sounds are muffled. Breathing is shallow, agonal, resembling gasping for air. Blue spots appear on the skin in areas of venous blood pooling, resembling postmortem lividity. Reflexes, including pain reflexes, are absent; the eyes are fixed, and the pupils are dilated. The prognosis for recovery in this case is extremely poor.

Without providing emergency medical care to the injured person, traumatic shock of third-fourth degrees usually results in death. In cases of mild or moderate shock, spontaneous recovery is possible: at some stage, the progression of shock may halt, and subsequently the condition stabilizes, the body adapts, and recovery begins. However, one cannot rely on this, as the development of a shock state of any degree in itself indicates a breakdown of adaptation, and the severity of the injury has exceeded the body's compensatory capabilities.

Shock can be primary (early), occurring immediately after an injury and representing the body's immediate reaction. Secondary (late) shock occurs 4-24 hours after the injury and even later, often as a result of additional trauma to the injured person (during transport, hypothermia, renewed bleeding, tourniquet application, careless handling, etc.).

DISCUSSION

According to researchers [8-10], the most common clinical forms of shock are: hypovolemic shock, which results from a loss of circulating blood volume (CBV) due to bleeding (hemorrhagic shock), trauma (traumatic shock), dehydration (due to illness), burns (burn shock), etc.; cardiogenic shock,

which occurs due to a decrease in the heart's pumping function in cases of heart disease (myocardial infarction, tamponade, etc.); and redistributive shock, which occurs in cases of relative mismatch between CBV and vascular bed capacity. Its subtypes include septic shock (characterized by a significant decrease in peripheral vascular resistance and increased permeability of the vessel walls), anaphylactic shock (developing as an allergic reaction in response to intravenous exposure to an allergenic substance (medications, insect venom, certain foods, etc.) with the release of a hormone into the blood that causes vasodilation and is accompanied by a decrease in blood pressure; and obstructive shock (in the presence of extracardiac obstacles to normal blood flow, such as cardiac tamponade, pneumothorax with mediastinal organ displacement, etc.) [11]. At the same time, the most common form of shock in battlefield casualties is traumatic shock [12].

As experts note [13], traumatic shock is a life-threatening pathological condition resulting from severe trauma, massive blood loss, or intense pain. It is characterized by a sudden disruption of the function of vital organs (heart, lungs, brain), a critical reduction in blood circulation, and tissue hypoxia. Our research identified the causes, phases, degrees, and signs of traumatic shock in battlefield casualties. The main signs (symptoms) of traumatic shock in a wounded person are pale, cold, and clammy skin, rapid pulse, low blood pressure, weakness, restlessness, confusion, and thirst.

As recommended by experts [14-17], emergency medical care provided by a combat rescuer-medic to a casualty experiencing traumatic shock on the battlefield includes: stopping bleeding (applying a tourniquet or bandage); ensuring airway patency; warming the casualty (covering

with a blanket); ensuring rest and evacuating the casualty to a safe location (to provide qualified medical care or transport to a hospital). The results of our research confirm the conclusions of many researchers [2, 3, 18-21].

CONCLUSIONS

The causes, phases, degrees, and signs of traumatic shock in a battlefield casualty have been identified. It has been found that the primary causes of traumatic shock are rapid loss of a large volume of blood or plasma in the casualty and severe pain. It has been established that traumatic shock progresses through two phases: the erectile phase, in which the victim experiences pain and signals it by all means available to them, and the torpid phase, in which the wounded person is lethargic, sluggish, apathetic, drowsy, and depressed. It has been established that, depending on the severity of the shock, there are four degrees of its manifestation: first-degree shock – mild shock; second-degree – moderate; third-degree – severe; and fourth-degree – pre-agony or agony. Without providing emergency medical care to the wounded, traumatic shock of third and fourth degrees usually results in death.

Thus, traumatic shock is a severe pathological condition that threatens the life of the wounded and occurs in cases of severe trauma and injuries. Timely detection of signs of shock in the wounded is a prerequisite for providing them with emergency medical care on the battlefield.

PROSPECTS FOR FURTHER RESEARCH

Prospects for further research include studying and developing an algorithm to provide medical care to the wounded on the battlefield during the control of massive bleeding.

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Hypertrophic cardiomyopathy as an important cause of sudden cardiac death: a clinical review from the perspective of emergency medicine

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ABSTRACT

Aim: The aim of this paper is to present the current state of knowledge on hypertrophic cardiomyopathy as an important cause of sudden cardiac death, with particular emphasis on pathophysiology, diagnosis, risk stratification, prevention and contemporary treatment options that are also relevant from the perspective of emergency medicine.

Materials and Methods: A clinical review was prepared on the basis of purposefully selected scientific literature, current guidelines, expert statements and selected publications indexed in biomedical databases. The review primarily included documents of the American Heart Association/American College of Cardiology and the European Society of Cardiology, as well as recent studies on the genetics of cardiomyopathies, arrhythmic risk, cardiac myosin inhibitors and septal reduction therapy.

Hypertrophic cardiomyopathy is a heterogeneous myocardial disease in which left ventricular hypertrophy may coexist with dynamic left ventricular outflow tract obstruction, systolic anterior motion of the mitral valve leaflet, diastolic dysfunction, microvascular ischemia, myocardial fibrosis and supraventricular or ventricular arrhythmias. Diagnosis requires the integration of clinical, electrocardiographic, echocardiographic and cardiac magnetic resonance findings, as well as genetic testing in selected patients and families. Identifying patients at risk of sudden cardiac death and selecting candidates for implantable cardioverter-defibrillator therapy are of particular clinical importance.

Conclusions: Modern care for patients with hypertrophic cardiomyopathy should be multidisciplinary. In emergency medicine, it is important to recognize warning symptoms, avoid interventions that may worsen left ventricular outflow tract obstruction and rapidly identify patients who require urgent cardiological assessment.

KEYWORDS

cardiomyopathy, hypertrophic, death, ventricular outflow obstruction; defibrillators, myosins

INTRODUCTION

Hypertrophic cardiomyopathy (HCM) is a myocardial disease characterized by thickening of the left ventricular wall that cannot be explained solely by abnormal loading conditions. It is a clinically and genetically heterogeneous entity. Its clinical spectrum may range from asymptomatic carriage of a pathogenic variant to a severe phenotype with left ventricular outflow tract obstruction, heart failure, arrhythmias and the risk of sudden cardiac death (SCD) [1-4].

The prevalence of phenotypic HCM has classically been estimated at approximately 1:500. However, when genotype-positive/phenotype-negative individuals and the broader use of genetic and imaging tests are considered, the true prevalence of disease-related variants may be higher. The contemporary approach to HCM has moved beyond treating it only as a disease of interventricular septal hypertrophy. Increasing importance is now attached to comprehensive phenotypic assessment, family screening, cardiac magnetic resonance imaging, evaluation of myocardial fibrosis and treatment directed at sarcomere mechanics [1-4].

From the perspective of emergency medicine, HCM is particularly relevant because it may present with syncope, chest pain, dyspnea, palpitations, acute heart failure, ventricular arrhythmias or sudden cardiac arrest. At the same time, some interventions commonly used in patients with chest pain, hypotension or dyspnea may worsen hemodynamics in patients with obstructive HCM if they reduce preload, increase tachycardia or enhance myocardial contractility [1, 2].

AIM

The aim of this paper is to present the current state of knowledge on HCM as an important cause of SCD, with particular emphasis on the definition of the disease, genetic background, pathophysiology, clinical presentation, diagnosis, risk stratification, prevention of SCD and contemporary treatment options. An additional aim is to identify practical aspects that are important for emergency medical personnel when managing a patient with known or suspected HCM.

MATERIALS AND METHODS

This paper is a clinical review based on purposefully selected scientific literature, current guidelines and expert documents on HCM and cardiomyopathies. No systematic review or meta-analysis was performed. The analysis was also based on selected scientific publications concerning genetics, diagnostic imaging, SCD risk stratification, cardiac myosin inhibitors and septal reduction therapy. Particular emphasis was placed on documents published between 2023 and 2026 and on publications from the last year that expand current knowledge on treatment and arrhythmic risk in HCM.

The literature search was targeted and primarily included PubMed/MEDLINE and the websites of scientific journal publishers. The following search terms and their combinations were used: hypertrophic cardiomyopathy, sudden cardiac death, left ventricular outflow tract obstruction, cardiac myosin inhibitors, mavacamten, aficamten, septal reduction therapy, alcohol septal ablation, septal myectomy, cardiac magnetic resonance and genetic testing. Clinically relevant and up-to-date publications that could be verified in scientific databases or on regulatory institution websites were included.

The clinical figures used in this manuscript have been anonymized. The photographic material was used with the informed consent of the patient.

Artificial intelligence tools were used as auxiliary editorial support, particularly to organize the manuscript structure.

REVIEW

DEFINITION AND GENETIC BACKGROUND

HCM is defined as thickening of the left ventricular (LV) wall that cannot be explained solely by pressure or volume overload, such as arterial hypertension, significant valvular disease, storage disease or training-related adaptation. In adults, the most commonly accepted criterion for phenotypic diagnosis is a maximum LV wall thickness of ≥ 15 mm in one or more segments. In first-degree relatives or in individuals with a confirmed pathogenic variant, lower thresholds may be relevant and require interpretation in the clinical context [1, 2].

HCM is most commonly inherited in an autosomal dominant pattern with incomplete and age-dependent penetrance. Pathogenic variants mainly involve genes encoding sarcomeric proteins, especially MYBPC3 and MYH7. In some patients, however, genetic testing remains negative or identifies a variant of uncertain significance (VUS). Therefore, genetic testing should be combined with genetic counseling, pedigree analysis and periodic assessment of first-degree relatives [3].

In clinical practice, it is important to distinguish genotype-positive/phenotype-negative individuals from patients with overt HCM. This classification influences follow-up intervals, decisions regarding physical activity, family diagnostics and risk assessment over subsequent years of life. A negative genetic test does not exclude HCM, and a variant of uncertain significance should not be used as the sole basis for diagnosing the disease in relatives without phenotypic features [1-3].

PATHOPHYSIOLOGY AND LEFT VENTRICULAR OUTFLOW TRACT OBSTRUCTION

HCM most often involves asymmetric hypertrophy of the interventricular septum (IVS), although hypertrophy may also affect the lateral wall or the left ventricular apex, or may be more concentric. An important hemodynamic mechanism is dynamic left ventricular outflow tract obstruction (LVOTO), which may be present at rest or may become apparent only after provocation, for example during the Valsalva maneuver, after exercise or when preload is reduced [1, 2, 4].

LVOTO is often accompanied by systolic anterior motion (SAM) of the mitral valve leaflet, which may increase the left ventricular outflow tract gradient and cause secondary mitral regurgitation. Pathophysiologically, this results in a variable, dynamic gradient that depends on myocardial contractility, heart rate, intravascular volume and peripheral vascular resistance. For this reason, dehydration, fever, tachycardia, alcohol, vasodilation or positive inotropic drugs may markedly worsen symptoms in some patients (Fig. 1) [1, 2, 4].

The course of the disease is also influenced by impaired left ventricular relaxation, increased filling pressures, microvascular ischemia, an abnormal response to changes in preload and afterload, and myocardial fibrosis. The presence and extent of late gadolinium enhancement (LGE) on cardiac magnetic resonance imaging are associated with a greater arrhythmic burden and may be relevant in supplementary SCD risk assessment [1, 2, 4].

CLINICAL PRESENTATION AND DIAGNOSIS

The clinical presentation of HCM is highly variable. Some patients remain asymptomatic, and the diagnosis is made incidentally during family screening or evaluation of an abnormal electrocardiogram. In symptomatic patients, the dominant manifestations are related to limited exercise reserve, increased left ventricular filling pressure, LVOTO, microvascular ischemia and arrhythmias [1, 2, 4].

The most common symptoms include exertional dyspnea, chest pain, exercise intolerance, palpitations, dizziness, presyncope and syncope. Symptoms may worsen during dehydration, exposure to high temperatures, after alcohol intake, with tachycardia, after an abrupt reduction in preload or after the use of vasodilating drugs. Syncope, especially when unexplained, exertional or associated with palpitations, should be treated as a warning symptom requiring urgent diagnostic assessment [1, 2, 6-8].

The diagnostic evaluation of HCM should begin with a detailed history, including family history of HCM, SCD, syncope and implantable cardioverter-defibrillator (ICD) implantation, physical examination, 12-lead electrocardiography and transthoracic echocardiography. Cardiac magnetic resonance (CMR) does not replace first-line echocardiography but is a very important complementary test, particularly in equivocal echocardiographic findings, suspected apical HCM, assessment of LV apical aneurysm, differentiation of HCM phenocopies and evaluation of LGE [1, 2, 4].

No electrocardiographic pattern is pathognomonic for HCM; however, the 12-lead electrocardiogram is abnormal in most patients. Common abnormalities include features

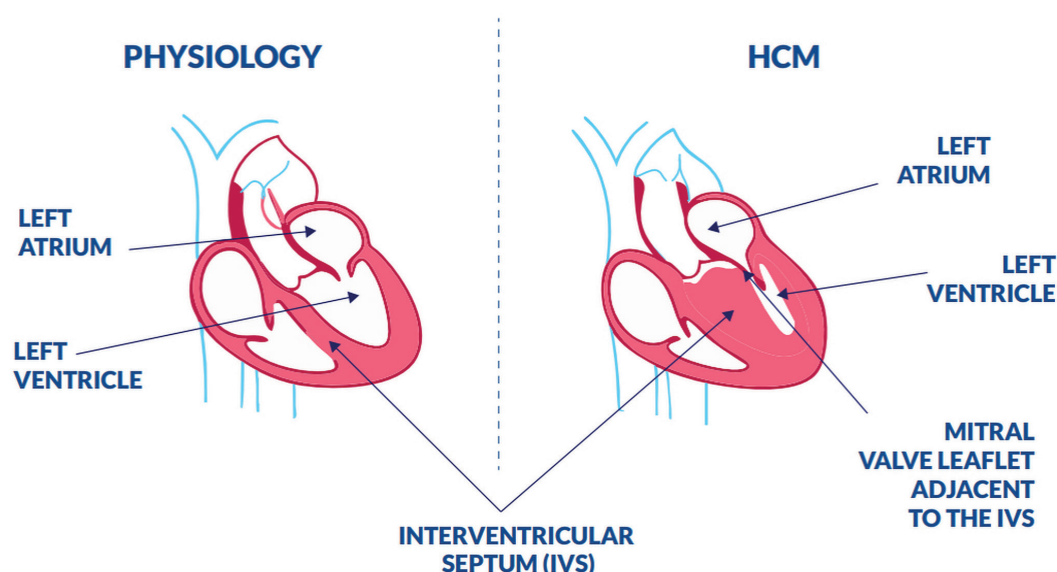


Fig. 1. Schematic comparison of a normal heart and a heart affected by hypertrophic cardiomyopathy, showing interventricular septal hypertrophy and systolic anterior motion of the mitral valve leaflet
Source: Authors' own material

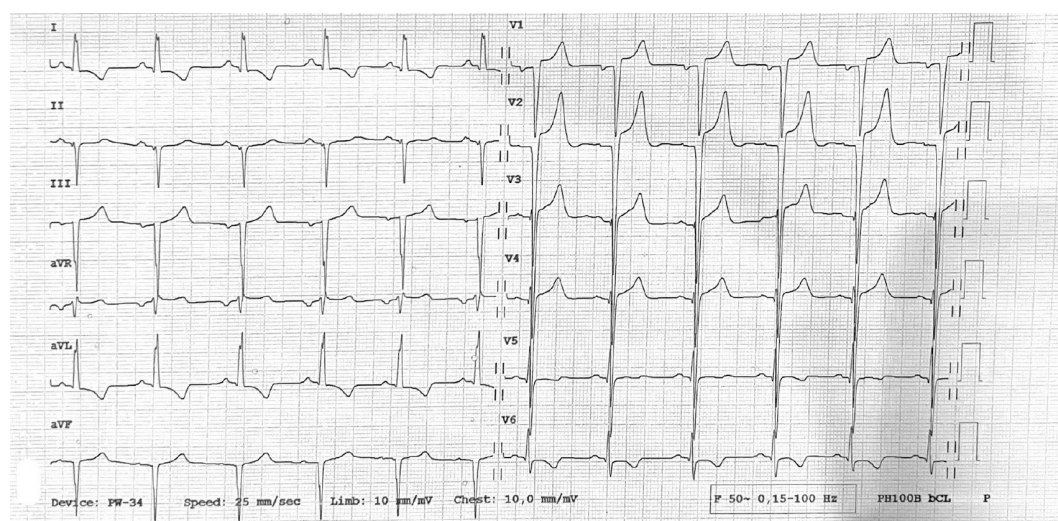


Fig. 2. Representative 12-lead electrocardiogram in a patient with hypertrophic cardiomyopathy. Anonymized material
Source: Author's own material

of left ventricular hypertrophy, ST-T segment changes with T-wave inversion, features of left atrial enlargement, deep and narrow Q waves, intraventricular conduction disturbances and repolarization abnormalities that may mimic ischemia (Fig. 2) [5].

Echocardiographic assessment should include the location and extent of hypertrophy, chamber size, systolic and diastolic function, the presence of SAM, the degree of mitral regurgitation and the LVOT gradient at rest and after provocation. LVOTO is diagnosed when the gradient is ≥ 30 mmHg, whereas a gradient of ≥ 50 mmHg is considered clinically significant and relevant when qualifying patients for septal reduction therapy [1, 2, 4].

Current recommendations emphasize the need to differentiate HCM from phenocopies, such as Fabry disease, cardiac amyloidosis, mitochondrial diseases, RASopathies, arterial hypertension and advanced kidney disease. This

differential diagnosis is important because identifying a phenocopy may completely change prognosis, family counseling and treatment [1-3].

RISK AND PREVENTION OF SUDDEN CARDIAC DEATH

The risk of SCD in HCM remains one of the major clinical challenges because it may also affect young individuals and patients with only mild previous symptoms. Contemporary care, regular follow-up, imaging, rhythm monitoring and appropriate selection for ICD implantation have significantly reduced disease-related mortality. However, SCD should not be restricted only to adolescents and individuals under 30 years of age, because risk persists throughout life, although its profile changes with age and disease phenotype [1, 2, 6-8].

The most important SCD risk factors and markers include a history of cardiac arrest, sustained ventricular tachycardia

or ventricular fibrillation, a family history of SCD in a patient with HCM, unexplained syncope, recurrent episodes of non-sustained ventricular tachycardia (nsVT) on Holter ECG monitoring, massive left ventricular hypertrophy, LV apical aneurysm, reduced left ventricular ejection fraction below 50% and extensive LGE on CMR [1, 2, 6-8].

After cardiac arrest, sustained ventricular tachycardia or ventricular fibrillation, ICD implantation is the standard approach for secondary prevention. In primary prevention, the decision requires individualized risk assessment, discussion with the patient and consideration of both European Society of Cardiology risk calculators and the markers emphasized in the American Heart Association/American College of Cardiology guidelines [1, 2, 6-8].

The decision to implant an ICD should account not only for the potential reduction in SCD risk, but also for the possible burden for the patient, including the risk of inappropriate therapies, lead-related complications, occupational limitations, fear of device shocks and effects on daily functioning. For this reason, shared decision-making is recommended, particularly in primary prevention [1, 2].

TREATMENT AND PRECAUTIONS

Physical activity recommendations in patients with HCM should be individualized. Current guidelines do not reduce recommendations to a complete prohibition of exercise; rather, they emphasize the benefits of regular, moderate recreational activity after cardiological assessment and discussion of risk. Particular caution is required in relation to competitive and very intense exercise, dehydration, exposure to high temperatures, tachycardia and situations that abruptly reduce preload [1, 2].

In obstructive HCM, caution is required with drugs that may reduce preload or afterload and increase the LVOT gradient, including nitrates, potent vasodilators, dihydropyridine calcium channel blockers, high-dose diuretics and phosphodiesterase type 5 inhibitors. This does not mean that each of these drug classes is absolutely contraindicated in all patients with HCM; the decision should depend on the phenotype, presence of LVOTO, comorbidities and hemodynamic tolerance [1, 2].

Treatment of symptomatic obstructive HCM is based primarily on drugs that reduce heart rate and myocardial contractility. First-line therapy consists of beta-blockers without vasodilating properties, administered at the maximum tolerated dose. In patients with intolerance or contraindications, non-dihydropyridine calcium channel blockers, especially verapamil, may be an alternative, although caution is required in severe obstruction, hypotension or advanced heart failure. Disopyramide may be considered as add-on therapy in patients with a persistent gradient [1, 2, 4].

Cardiac myosin inhibitors, including mavacamten and aficamten, are becoming an increasingly important therapeutic group. These agents reduce excessive actin-myosin cross-bridge activity, decrease the LVOT gradient and improve New York Heart Association functional class and exercise parameters in selected adult patients with symptomatic obstructive HCM [9-13]. Aficamten has also been approved by

the Food and Drug Administration for the treatment of adults with symptomatic obstructive HCM to improve functional capacity and symptoms, which requires consideration of local regulatory status and safety monitoring requirements [14].

In patients with symptomatic obstructive HCM who continue to have a significant LVOT gradient, most commonly ≥ 50 mmHg, and symptoms usually corresponding to New York Heart Association class III-IV despite optimal pharmacological therapy, or persistent marked exercise intolerance, septal reduction therapy (SRT) should be considered. The decision between septal myectomy and alcohol septal ablation should be made in an HCM-experienced center after analysis of septal anatomy, the mitral apparatus, septal vessels, age, comorbidities and patient preferences [1, 2, 15-17].

Alcohol septal ablation consists of percutaneous administration of a small volume of alcohol into a selected septal branch of a coronary artery in order to induce controlled necrosis of the limited septal segment responsible for obstruction. The consequence is remodeling and reduction in the mass of the hypertrophied segment, which may decrease the LVOT gradient. Important complications include atrioventricular block requiring pacing, and the hemodynamic effect may continue to develop over subsequent months [16, 17].

Septal myectomy, classically referred to as the Morrow procedure, involves surgical removal of part of the hypertrophied septum in the left ventricular outflow tract. In some patients, simultaneous correction of abnormalities of the mitral apparatus, papillary muscles or subvalvular structures is required. Available data indicate that both SRT methods can effectively reduce the gradient and symptoms. However, procedure selection should depend on the patient profile and the experience of the center rather than on arbitrary preference for one technique in all patients (Fig. 3) [15-17].

In acute hypotension or hemodynamic deterioration in a patient with obstructive HCM, it is crucial to avoid interventions that may increase the LVOT gradient: excessive vasodilation, dehydration, tachycardia and strongly positive inotropic drugs. Management should focus on maintaining adequate intravascular filling, controlling rhythm and heart rate, and obtaining urgent cardiological consultation. In an unstable patient with suspected ventricular arrhythmia, sustained ventricular tachycardia or ventricular fibrillation, management should follow resuscitation and electrical therapy algorithms while simultaneously taking into account the specific features of HCM [1, 2].

DISCUSSION

Hypertrophic cardiomyopathy remains a disease with substantial clinical variability. In some patients it remains asymptomatic for many years, whereas in others it causes significant limitation of exercise capacity, recurrent syncope, atrial fibrillation, heart failure or malignant ventricular arrhythmias. A particular clinical challenge is that the risk of SCD is not always proportional to subjectively perceived symptoms; therefore, patient assessment cannot be limited to current exercise tolerance [1, 2, 6-8].

From the perspective of emergency medicine, three practical consequences are of key importance. First, unexplained

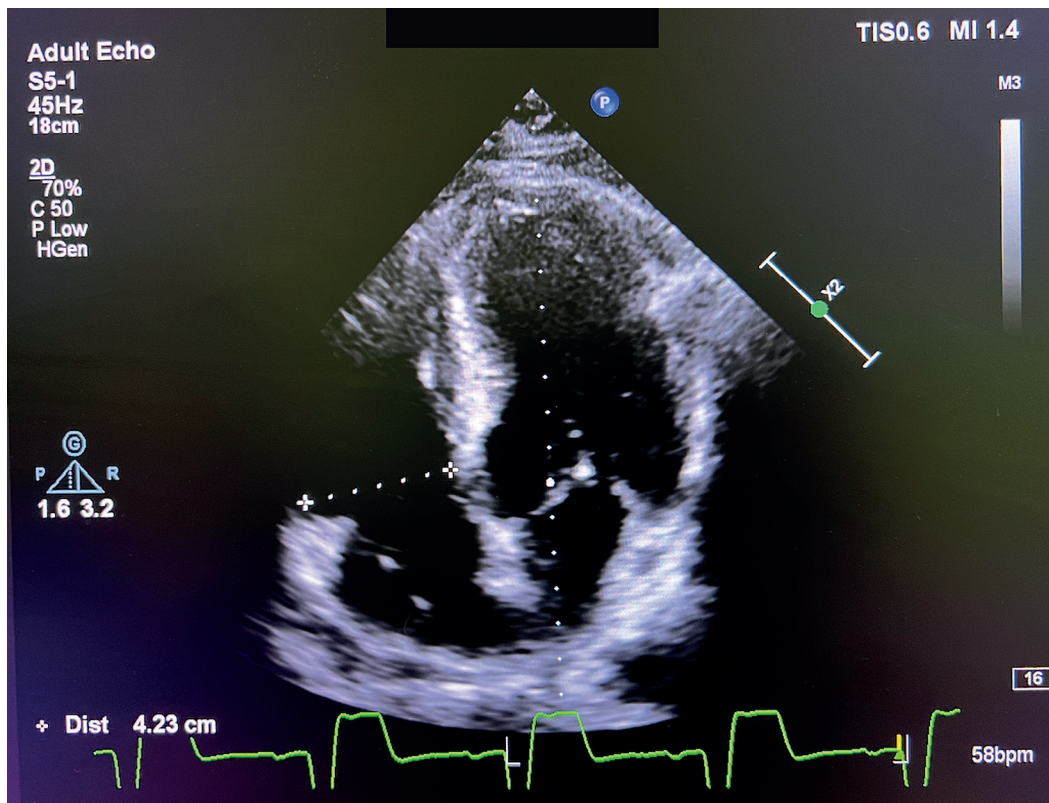


Fig. 3. Echocardiographic image after interventricular septal myectomy in a patient with hypertrophic cardiomyopathy. Anonymized material; patient/author consent obtained for use of the figure

Source: Author's own material

syncope, especially exertional syncope or syncope preceded by palpitations, should trigger diagnostic evaluation for structural heart disease. Second, in a patient with known or suspected obstructive HCM, drugs that reduce preload or afterload should be used cautiously because they may increase the LVOT gradient and worsen the patient's condition. Third, the ECG may suggest hypertrophy, overload or ischemia, but it cannot independently confirm or exclude HCM [1, 2, 5].

An important development in recent years has been the emergence of mechanistic treatment. Cardiac myosin inhibitors represent an attempt to treat the pathophysiological cause of excessive contractility and dynamic obstruction rather than only the symptoms of the disease. Studies of mavacamten and aficamten indicate improvement in symptoms, reduction of the LVOT gradient and improvement in functional capacity in appropriately selected patients. This therapy, however, requires appropriate qualification, monitoring of left ventricular ejection fraction and consideration of drug availability and regulatory status [9-14].

A second key area is septal reduction therapy. Both myectomy and alcohol septal ablation can effectively reduce the gradient and improve quality of life, but they should be performed in centers experienced in HCM. Data on the association between procedural volume, costs and outcomes strengthen the principle of referring patients to specialized teams that can provide comprehensive anatomical, imaging, cardiological and cardiac surgical assessment [15-17].

CONCLUSIONS

1. HCM is a heterogeneous myocardial disease that may be asymptomatic, but may also lead to heart failure, ventricular arrhythmias and SCD.
2. The diagnosis of HCM requires integration of clinical data, ECG, echocardiography, CMR and, in selected patients and families, genetic testing.
3. SCD risk stratification should be a repeated process over time and should include not only classical risk factors, but also CMR findings, the presence of an LV apical aneurysm, ejection fraction and arrhythmic burden.
4. In emergency medicine, recognizing warning symptoms of HCM is important, particularly syncope, palpitations, chest pain, dyspnea and ventricular arrhythmias in young and active individuals.
5. In obstructive HCM, interventions that may worsen LVOTO should be avoided, especially excessive vasodilation, dehydration, tachycardia and strongly positive inotropic drugs.
6. Treatment of HCM should be individualized and should include pharmacotherapy, cardiac myosin inhibitors, ICD therapy and septal reduction therapy in centers experienced in the management of this disease.

Consent for use of clinical material: The clinical figures used in this manuscript have been anonymized. The photographic material was used with the informed consent of the patient.

Artificial intelligence disclosure

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CONFLICT OF INTEREST

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