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NAVIGATOR - TASKS AND TRAINING

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ORIGINAL ARTICLE

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Emergency medical teams interventions for cardiac reasons in the first year of the pandemic caused by SARS-CoV-2 virus in Poland

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ABSTRACT

Aim: To assess the impact of the Covid-19 pandemic on the frequency of EMTs interventions for cardiac reasons in 2020 compared to 2019.
Material and methods: The frequency of EMTs interventions for chest pain, dyspnea, fainting, sudden cardiac arrest (SCA), paralysis/slurred speech and cardiac problems between 01.03 - 31.12.2020 were analysed. The results were compared for the same period in 2019. The data obtained were analysed by month and territorial distribution.
Results: The frequency of EMTs interventions to patients with cardiac problems in 2020 accounted for 40% out of 2483280 calls, and in 2019 for 37% out of 2777291. The most common reason for call was dyspnea (24.56-29.94%). Compared to 2019, the proportion of interventions due to dyspnea (24.56-29.94%), paralysis/slurred speech (8.43-9.54%) and SCA (2.51-3.18%) increased. There was a decrease of call due to fainting (24.02-19.21%), cardiac problems (19.82-18.67%) and chest pain (20.66-19.46%). The highest number of call was observed in November 2020 (12.80%), in March 2019 (10.68%), in the Mazowieckie Voivodeship (13%). In contrast, the fewest calls were shown in April 2020 (7.97%), in September 2019 (9.34%) and in the Opolskie Voivodeship (2%).
Conclusions: 1. The frequency of EMTs interventions among patients with cardiac problems in the first year of the Covid-19 pandemic duration decreased. 2. Dyspnea was the main cause of calls regardless of the season. 3. It is recommended to monitor and increase the availability of Primary Health Care Clinics and Cardiology Outpatient Clinics during the initial period of the Covid-19 pandemic and the greatest increase in the number of cases.

KEYWORDS

Covid-19 pandemic, cardiac reasons, EMTs

INTRODUCTION

The first case of SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) infection causing Covid-19 (Coronavirus disease) was reported in Poland on March 4th, 2020. In order to limit the number of infections, a state of epidemiological emergency and an epidemic state was introduced, resulting in a number of restrictions [1, 2]. The increasing number of Covid-19 cases has forced the reorganization of health care facilities and emergency services [3-9]. The quarantine, other restrictions and the direct impact of SARS-CoV-2 virus infection on the human body may have affected the health status of patients with cardiac problems and the frequency of EMTs calls [3-17].

The impact of the Covid-19 pandemic on the frequency and profile of EMTs interventions in Poland has still not been thoroughly examined. [8, 10, 13-16]. Therefore, it was considered reasonable for public health and organizers of the National Emergency Medical Service system to conduct an analysis in this area, with particular emphasis on calls for cardiological reasons.

AIM

The purpose of this study was to assess the impact of the Covid-19 pandemic on the frequency of EMTs interventions for cardiac reasons in 2020 compared to the corresponding period in 2019.

MATERIAL AND METHODS

The study material consisted of data on the frequency of EMTs interventions in Poland to patients with cardiac

problems in the period 01.03-31.12.2020 and 2019. The data were obtained from the National Monitoring Center for Emergency Medical Services. The frequency of EMTs interventions due to chest pain, shortness of breath, fainting, cardiac problems (hypertension, arrhythmia, etc.), sudden cardiac arrest (SCA) and paralysis/slurred speech was analysed. The obtained material was considered in distribution by cause, seasonality and territorially. The results were analysed using descriptive statistics by evaluating percentages (%), arithmetic mean (M) and median (Me). Statistical analysis was performed using MS Excel 2010.

RESULTS

During the time period considered, EMTs calls among patients with cardiac problems accounted for 40.09% of all calls in 2020 (995,610 out of 2,483,280) and 36.96% in 2019 (1,026,464 out of 2,777,291).

Most commonly, patients reported shortness of breath (24.56% - 29.94%), chest pain (19.46% - 20.66%) and fainting (19.21% - 24.02%).

Compared to 2019, the number of interventions due to shortness of breath, paralysis/slurred speech and SCA was increased. The number of calls due to fainting, chest pain and cardiac problems was decreased (Fig. 1).

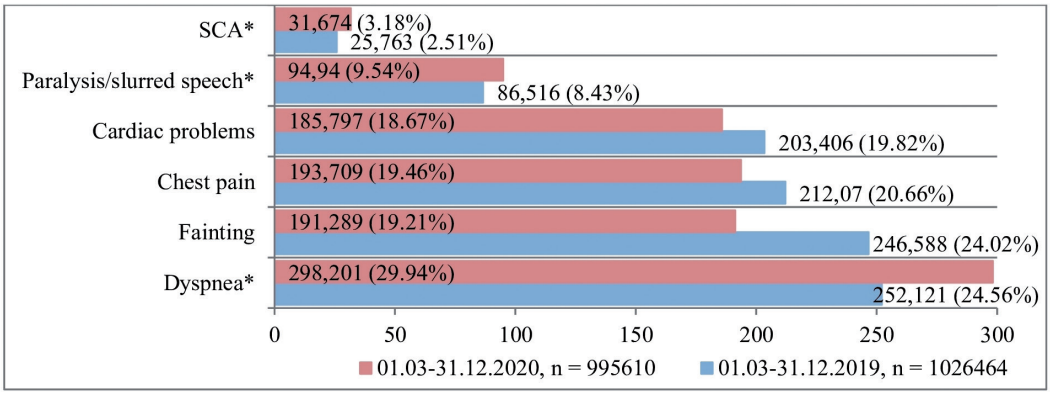
Analysis of interventions in the monthly distribution showed, compared to 2019, a lower percentage of calls from March to July and in September 2020. A higher percentage of calls was recorded in August and from October to December 2020. The M and Me for the number of calls per month were 99,561 and 93,070, respectively, in 2020 and were lower than those shown in 2019 (M=102,646, Me=103,002).

The highest number of calls was shown in November 2020 (127,401, 12.80%) and in March 2019 (109,623, 10.68%). The lowest number of calls in 2020 were reported in April (79,383, 7.97%) and in September 2019 (95,878, 9.34%) (Fig. 2).

Observation of the frequency of interventions in the territorial distribution showed the highest number of notifications in the Mazovian voivodeship and the least in the Opolskie. Compared to 2019, the number of interventions slightly decreased in Greater Poland, Świętokrzyskie, Pomeranian, Mazovian, Lesser Poland, Lubelskie, Silesian, Subcarpatia, Łódź, Kuyavian-Pomeranian, Lower Silesian Voivodeships. An increase in the number of EMTs calls was recorded in the other voivodeships: Opolskie, Warmian-Mazurian, Lubuskie and Podlaskie. The M and Me for the number of calls in all voivodeships were 62,225 and 53,913 in 2020, respectively, and were lower than those shown in 2019 (M=64,153, Me=56,100) (Fig. 3).

The variability of the causes of interventions in the monthly distribution, compared to 2019, is presented in Figure 4. The changes observed in 2020 concerned the months with the highest and lowest number of calls. Therefore, the most calls in 2020 were observed due to:

– SCA in November (14.11%), while in December 2019



*SCA - Sudden Cardiac Arrest, * increase in 2020 year in relation to 2019*

Fig. 1. EMTs intervention (in thous.) due to cardiac reasons

Source: Own materials

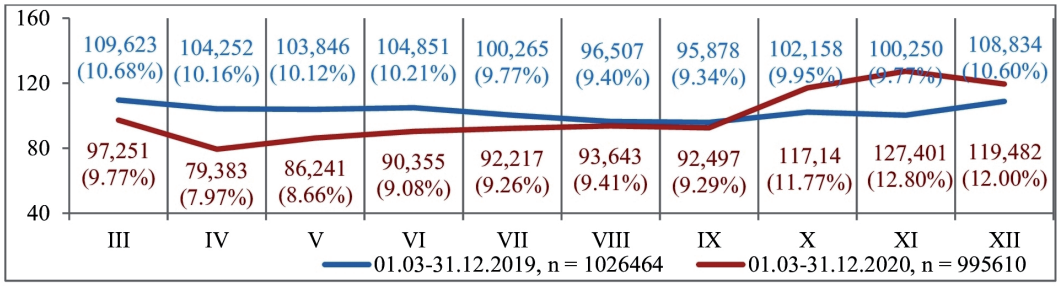


Fig. 2. EMTs interventions depending on the analysed causes in individual months

Source: Own materials

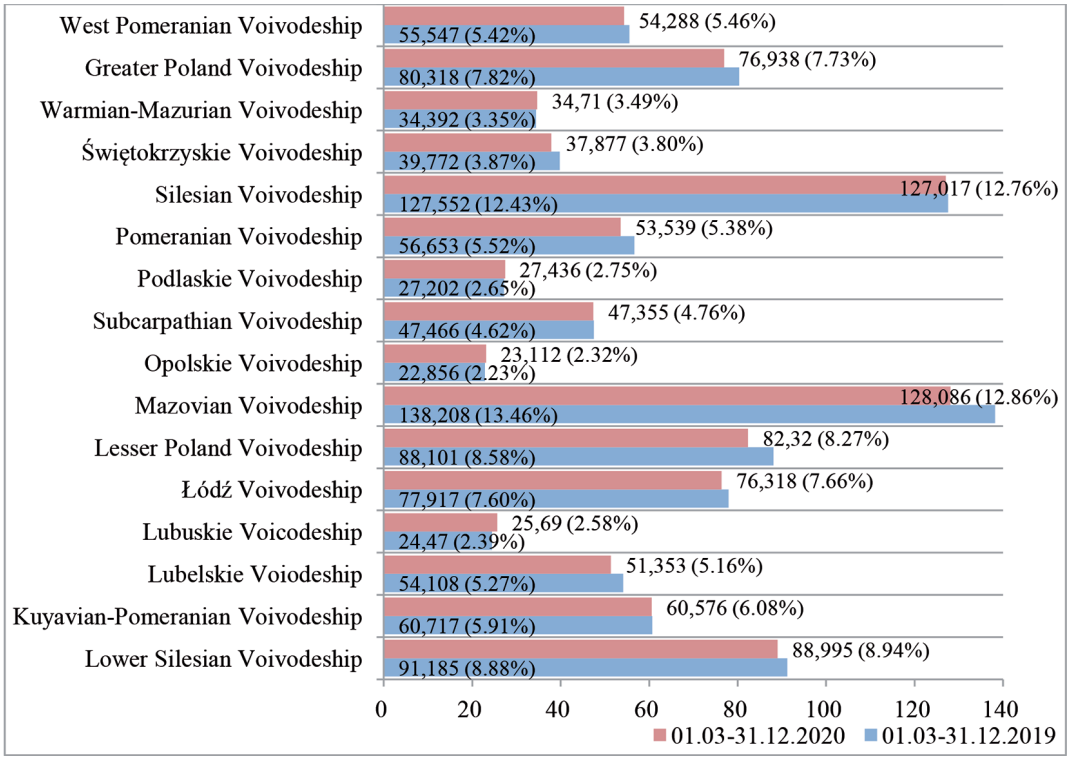


Fig. 3. EMTs interventions (in thous.) due to cardiac reasons in the voivodeships

Source: Own materials

(11.83%) (Fig. 4a);
- paralysis/slurred speech in October (11.07%), in December 2019 (10.70%) (Fig. 4b);
- cardiac problems in December (11.23%), in March 2019 (11.14%) (Fig. 4c);
- chest pain in December (11.14%), in March 2019 (10.76%) (Fig. 4d);
- fainting in October (11.67%), and in June 2019. (12.70%) (Fig. 4e);
- shortness of breath in November (18.26%), in March 2019 (11.46%) (Fig. 4f).

The lowest percentage of interventions in 2020 was shown due to:
- SCA in June (8.39%), and in August 2019 (9.23%) (Figure 4a);
- paralysis/slurred speech in April (8.81%), and in September 2019 (9.53%) (Fig. 4b);
- cardiac problems in November (9.32%), in June 2019 (8.64%) (Fig. 4c);
- chest pain in April (9.06%), and in September 2019 (9.28%) (Fig. 4d);
- fainting in April (6.75%), while in September 2019 (9.07%) (Figure 4e);
- shortness of breath in April (18.26%), and in August 2019 (8.83%) (Fig. 4f).

DISCUSSION

The announcement of the pandemic caused by the SARS-CoV-2 virus initiated a reorganization of social life, the functioning of healthcare facilities, and emergency services. Remote provision of medical services, quarantine, chronic stress, and the direct impact of Covid-19 on the human body may have affected the health of patients, especially those burdened with cardiovascular diseases. These factors may also have influenced the frequency of interventions by EMTs for patients with cardiological problems [3-17].

Studies on the impact of the Covid-19 pandemic in Poland on patients' decisions are general and concern the selected period of 2020 (15.03-15.05 and 1.01-14.04) [14-16]. Therefore, it has been deemed necessary for public health, the organization of the healthcare system, and emergency medical services to conduct an analysis of the impact of the Covid-19 pandemic on EMTs interventions for cardiological reasons in the first year of its duration.

Cardiovascular diseases are the first cause of death in Poland. In 2019-2020, they accounted for 37-39% of deaths [18, 19]. In the analysed material, it was shown that the most common reasons for the intervention of EMTs to patients with cardiac problems in each voivodeship did not change significantly.

Among the three most common reasons for intervention, dyspnea, chest pain and fainting dominated. Calls for other causes remained at similar levels (Fig. 1). The highest number of calls in the Mazovian voivodeship and the lowest in the Opolskie voivodeship corresponded with the population in those areas (Fig. 2).

Observation of interventions by cause in a monthly and territorial distribution in the study period of 2020, compared to the same period of 2019, showed a decrease

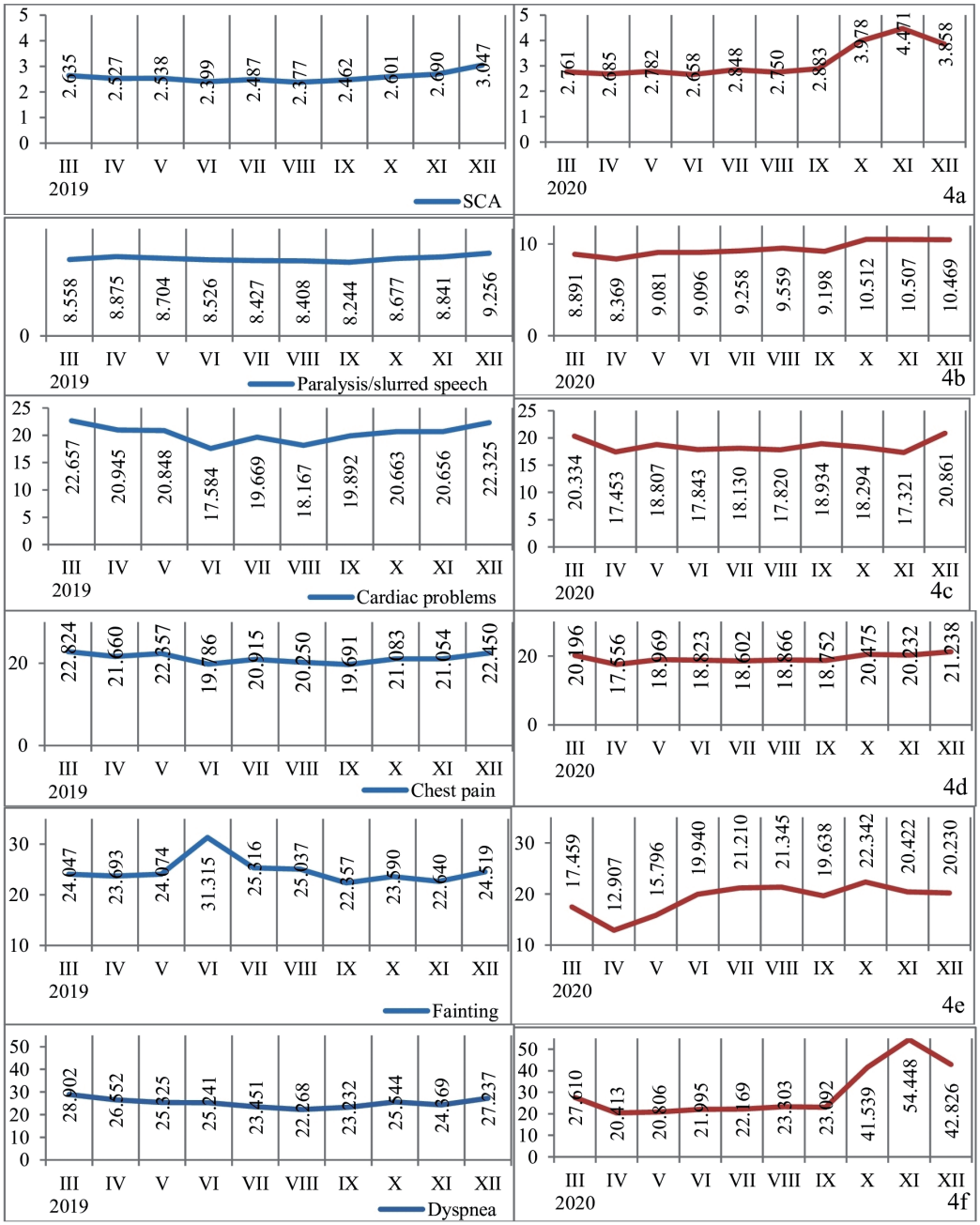


Fig. 4. EMTs interventions (in thous.) due to cardiac reasons in the monthly distribution

Source: Own materials

in the number of calls, including those for fainting (55,299), chest pain (18,361) and cardiac problems (17,609). The decline in the percentage of calls from March to July and September 2020 was insignificant, at 0.91%, 2.19%, 1.46%, 1.13%, 0.51%, 0.05%, respectively (Fig. 1 and Fig. 2).

The fewest calls in 2020 due to paralysis/slurred speech, fainting, shortness of breath and chest pain were shown in April (in August and September 2019), due to SCA in June (in August 2019), and due to cardiac problems in November (in June 2019).

The decrease in the number of calls in 2020 in 12 voivodeships, compared to 2019, was insignificant, ranging from 0.09% to 0.60%, and was within the statistical error.

The reasons for the decrease in the frequency of interventions due to fainting, chest pain and cardiac problems during the period of the so-called first wave of Covid-19 cases should be attributed to various patient concerns; these included calling the EMTs, getting infected, being diagnosed with SARS-CoV-2 infection or being sent to quarantine. These behaviors may have been indicative of the public's low awareness of the facts that fainting, chest pain and other cardiac problems (hypertension, arrhythmia) require urgent diagnosis and may indicate a medical emergency.

The reported increase in the number of interventions in 2020 due to shortness of breath, paralysis/slurred speech and SCA, as well as calls in the Lubuskie, Opolskie, Warmian-Mazurian and Podlaskie Voivodeship were insignificant, ranging from 0.67% to 5.38%. In contrast, there was a decrease in the number of calls due to fainting, chest pain and cardiac problems (Fig. 2).

The increase in the number of interventions for paralysis/slurred speech in October, shortness of breath and SCA in November (during the peak incidence period) shown from March to December 2020 (Fig. 4) could be due to the impact of Covid-19 infection on the immune response of the respiratory and cardiovascular systems, as well as exacerbations of chronic conditions. In Poland, the first increase in SARS-CoV-2 cases was observed in the second and fourth quarters of 2020 [2, 8, 9]. The results are in line with reports by other authors, who showed an increase in SCA cases in the first months of the Covid-19 pandemic in 2020 and a decrease in the number of hospitalizations of people with cardiac conditions and acute coronary syndrome [15, 20, 21].

An increase in emergency department interventions for cardiovascular causes has also been noted by other study authors. Jasne et al. observed an increase in stroke patients with hypertension from 62% to 72%, hyperlipidemia from 49% to 62% and coronary artery disease from 17% to 26% and those presenting with weakness and neurological disorders in 2020 in three hospitals in Connecticut (USA) [22]. The results again indicate the possible impact of the Covid-19 pandemic on patients' concerns and abandonment of calling the EMTs. Kucap et al. showed from March to April 2020 in Poland a decrease of 6%-14% the number of EMTs calls compared to the same period in 2016-2019 [14].

The demonstrated decrease in the number of EMTs calls in the first months of the Covid-19 pandemic and their increase in the last quarter of 2020 could be due to the impact of SARS-CoV-2 infection, other respiratory conditions dependent on systematic treatment or weather conditions [23-26]. Kuchcik et al. showed in Poland between 1975 and 2014 an increase in deaths from cardiovascular and respiratory causes during the winter season [23]. Kozminski et al. noted the effect of high atmospheric pressure and the autumn-winter season on an increase in calls of EMTs for dyspnea and hypertension, among other reasons, between 2008 and 2011 [24]. Other authors further confirmed the adverse effect of low temperature on increased mortality, including among patients with cardiac conditions [25-28].

Research on the impact of the Covid-19 pandemic on EMTs interventions due to cardiovascular reasons indicated potential changes in the healthcare system in Poland. During the peak of any pandemic, it is essential to promote knowledge of first aid and the necessity of direct contact with healthcare facilities among the public, as well as to ensure their efficient operation.

CONCLUSIONS

The frequency of EMTs interventions among patients with cardiac problems in the first year of the Covid-19 pandemic duration decreased.

Dyspnea was the main cause of calls regardless of the season.

It is recommended to monitor and increase the availability of Primary Health Care Clinics and Cardiology Outpatient Clinics during the initial period of the Covid-19 pandemic and the greatest increase in the number of cases.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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Preparedness of EMS teams for rescue operations during mass casualty incidents and incidents involving hazardous materials and explosive devices in the Masovian region: a comparative analysis for 2019 and 2025

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ABSTRACT

Aim: To assess, based on subjective self-assessment, the preparedness of emergency medical service (EMS) teams for multiple and mass casualty incidents (MCI) and chemical, biological, radiological, nuclear and explosive (CBRNE) events, and to analyse changes between 2019 and 2025 as well as differences in opinions by length of service.

Material and methods: A two-stage repeated cross-sectional study was conducted among EMS personnel in the operational areas of the Masovian region. In 2019, 337 and in 2025, 341 fully completed anonymous questionnaires (22 items) were analysed. Variables included participation in exercises, experience with triage and acting as Medical Incident Commander (MIC), assessment of interagency cooperation, and knowledge of procedures for CBRNE incidents.

Results: In 2025, respondents more often reported participation in exercises, involvement in triage and experience in the MIC role, and they rated cooperation between the national EMS system and other agencies in incidents involving hazardous substances more favourably ($P<0.001$). Declared knowledge of cooperation principles with counterterrorism services increased, whereas practical experience in CBRNE incidents, in the use of isolation chambers and in explosive-related threats remained limited.

Conclusions: Between 2019 and 2025, an improvement was observed in declared preparedness of EMS teams and in the assessment of interagency cooperation, while deficits in practical experience during CBRNE incidents persisted. There is a need to further develop realistic simulation-based exercises and intersectoral training adapted to the needs of staff with different lengths of service.

KEY WORDS

national emergency medical services system, emergency medical service team, CBRNE, EMS, multiple casualty incident, medical triage.

INTRODUCTION

Contemporary challenges faced by emergency medical services (EMS) personnel, arising from civilization-related threats, result from their diversity, scale, intensity, unpredictability and dynamic course. This situation requires continuous professional development and the acquisition of new knowledge and skills in the management of medical care, especially in the context of mass casualty incidents or events involving hazardous and explosive materials [1]. Skills related to saving the health and life of an individual patient are acquired and refined at all stages of academic education in the medical professions, as well as during training courses, workshops and continuing education for practicing paramedics, physicians and nurses. Knowledge and skills related to managing medical care for a large number of casualties represent a difficult area and are often insufficiently addressed in training programs [2]. Management of casualties in the context of mass casualty incidents (MCI) is a challenge for emergency services at the scene, for hospitals receiving the injured, and for other authorities responsible for security and emergency response [3].

Entities within the national EMS system collaborate with other services during multiple and mass casualty incidents. The content of the call to the emergency number 999 and the reported number of casualties determine the number of EMS teams dispatched by the medical

dispatcher. In addition, the nature of mass incidents requires the participation of the State Fire Service (SFS), which has the necessary equipment and personal protective measures. The direct hazard zone for rescue operations is designated by the incident commander. Only rescuers equipped with appropriate tools and protective gear may enter this zone. After evacuating casualties to the safe zone, firefighters usually hand them over to EMS personnel [4, 5].

In a mass casualty incident there is a marked imbalance between the number of casualties and the available emergency resources. During medical rescue operations in such incidents, the use of triage of casualties is very helpful. The individual preparedness of paramedics for rescue operations in multiple or mass casualty incidents has been the subject of scientific analyses and specialist training within mandatory continuing professional development for paramedics [6].

Effective response in a crisis situation, such as a mass casualty incident, requires a comprehensive approach and cooperation between many stakeholders, based on legal and organizational frameworks, planning, financing and staff training. Efficient functioning of coordinated services during a crisis also depends on appropriate response, communication, adequate personal protective equipment and effective management [7, 8].

AIM

The main aim of the study was to assess, based on subjective evaluation, the experience of EMS personnel, their knowledge of principles and procedures, and their cooperation with other rescue entities in the context of multiple and mass casualty incidents. Additional aims were: (1) to explore opinions related to the organization of practical exercises and the issues that should be included in the training system; (2) to analyse changes between 2019 and 2025 in self-assessed preparedness and cooperation with other services in the context of multiple or mass casualty incidents and Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) incidents.

MATERIAL AND METHODS

RESEARCH DESIGN

The analysis was carried out among personnel of mobile units of the national EMS system in the Masovian Voivodeship, using a two-stage repeated cross-sectional study design. It included two independent measurement phases conducted in 2019 and 2025 in the same population of EMS teams and with the use of the same author-developed questionnaire. In both stages, a random sample was drawn from medical personnel employed in EMS teams, assuming equal probability of inclusion for every member of the population. This approach enabled not only a cross-sectional description but also a comparison of changes in the preparedness of EMS personnel over a six-year period, while maintaining methodological comparability between the two measurements.

RESEARCH SETTING

The study included EMS teams operating in the operational areas of the Masovian Voivodeship. In both stages, data were collected using the same author-developed questionnaire consisting of 22 questions, including:

- a demographic section with 3 questions concerning medical profession, sex and length of employment in EMS teams,
- 15 closed-ended questions,
- 4 open-ended questions.

STAGE I – 2019 SURVEY

In the first phase of the study, conducted in 2019, paper questionnaires were distributed to EMS staff via ambulance stations in the following operational areas: Warsaw, Siedlce, Ostrołęka, Radom and Grodzisk Mazowiecki. For analysis, 337 fully completed questionnaires were included, meeting the criterion of full completion of the demographic section and all closed-ended questions.

STAGE II – 2025 SURVEY

The second phase of the study was conducted from 1 July 2025 to 1 October 2025, using the same procedure and the same research instrument. The study involved 347 individuals providing medical services in EMS teams in the operational areas of Warsaw, Siedlce and Radom. After verification of completeness, 341 questionnaires that were fully completed in the demographic section and closed-ended questions were included in the analysis.

Both datasets, from 2019 and 2025, were then subjected to comparative analysis aimed at assessing changes in the level of preparedness of EMS personnel for operations during mass casualty incidents and incidents involving hazardous and explosive materials.

ETHICAL CONSIDERATIONS

The questionnaire was designed as a fully anonymous tool and participation in the survey was voluntary, which was clearly communicated to all respondents. The analysis was carried out in accordance with the principles of the Declaration of Helsinki and did not require approval from a bioethics committee.

CHARACTERISTICS OF THE RESEARCH AREA

Based on correspondence with the Masovian branch of the National Health Fund (NHF), it was assumed that as of 30 June 2019 medical staff in the Masovian Voivodeship numbered 2,220 persons, including 509 system physicians, 221 system nurses and 1,490 paramedics. As of 30 June 2025 the staff numbered 2,594 persons, including 169 system physicians, 171 system nurses and 2,254 paramedics [9]. The sample size calculation assumed a confidence level of 95% and a maximum error of 5%.

STATISTICAL ANALYSIS

Qualitative variables were presented as quantity (n) and percentage values of the whole group (%), while proportions in groups were assessed with a Chi-squared test. Statistica 13 software (StatSoft Inc., Tulsa, OK) was used in the statistical analysis. $P<0.05$ was adopted as the significance level.

RESULTS

COMPARATIVE ANALYSIS 2019 *VS* 2025

In 2025, compared with 2019, the proportion of paramedics among respondents clearly increased (from 67% to 90%; p<0.001), with a simultaneous decrease in the share of physicians (from 10% to 3%) and nurses (from 23% to 7%). In parallel, the gender structure also changed, with the proportion of women decreasing from 28% to 16% (p<0.001). In the area of preparedness for multiple and mass casualty incidents, a clearly favourable trend was observed. In 2025, significantly more respondents reported participation in practical exercises on mass casualty incidents (Q1: an increase from 56% to 67%; p=0.004), acting as the person in charge of medical operations (Q2: from 31% to 46%; p<0.001) and involvement in medical triage of casualties (Q3: from 50% to 65%; p<0.001). Significant changes were also noted in the assessment of cooperation between EMS units and other rescue entities. For mass casualty incidents (Q5), the percentage of "good" ratings increased from 30% to 53%, with a simultaneous decrease in "poor" ratings (from 27% to 16%) and complete disappearance of the "very poor" category in 2025 (from 3% to 0%; p<0.001). A similar, but even more pronounced, pattern was observed for cooperation in incidents involving hazardous substances (Q13). The proportion of "good" ratings increased from 17% to 38%, while the combined share of "poor" and "very poor" ratings decreased from 18% + 3% to 6% + 0% (p<0.001). Cooperation with counterterrorism units also deserves particular attention. In 2025, the proportion of respondents declaring knowledge of the principles of cooperation between EMS units and counterterrorism services almost doubled, from 29% to 55% (Q17; p<0.001) (Table 1).

ANALYSIS OF 2025 RESULTS BY LENGTH OF SERVICE

With regard to participation in practical exercises for multiple and mass casualty incidents, most respondents, regardless of length of service, declared that they had taken part in such activities (on average 67%). A similar pattern was observed for acting as the person in charge of medical operations and for participation in medical triage of casualties. In both cases affirmative answers predominated and differences between groups were not statistically significant. The only area in which a

Table 1. Comparative analysis of survey results from 2019 *vs* 2025

Question	Response	2019	2025	P
1. In the past few years, have you participated in practical exercises for multiple or mass casualty incidents?	no	149 (44%)	113 (33%)	0.004
	yes	188 (56%)	228 (67%)	
2. During practical exercises or EMS team callouts to multiple or mass casualty incidents, have you ever acted as the Medical Incident Commander (MIC)?	no	232 (69%)	183 (54%)	<0.001
	yes	104 (31%)	158 (46%)	
3. During practical exercises or EMS team callouts to multiple or mass casualty incidents, have you ever taken part in medical triage of casualties?	no	166 (50%)	120 (35%)	<0.001
	yes	168 (50%)	221 (65%)	
5. How do you assess cooperation between units of the national Emergency Medical Services (EMS) system and other rescue entities during multiple or mass casualty incidents?	very good	53 (16%)	41 (12%)	<0.001
	good	102 (30%)	180 (53%)	
	neutral	80 (24%)	65 (19%)	
	poor	91 (27%)	55 (16%)	
	very poor	10 (3%)	0 (%)	
6. During practical exercises or EMS team callouts to multiple or mass casualty incidents, have you ever encountered coordination of operations by crisis management authorities?	no	259 (77%)	249 (73%)	0.257
	yes	77 (23%)	92 (27%)	
7. If yes, how do you assess the effectiveness of these operations?	very poor	19 (6%)	6 (2%)	<0.001
	good	63 (19%)	85 (25%)	
	neutral	130 (39%)	224 (66%)	
	poor	40 (12%)	26 (8%)	
8. Do operations aimed at mitigating the consequences of multiple or mass casualty incidents require improvement?	no	150 (47%)	181 (53%)	0.150
	yes	169 (53%)	160 (47%)	
9. How do you assess the current "Procedures for multiple or mass casualty incidents" in the national EMS system?	no opinion	124 (37%)	41 (12%)	<0.001
	not useful	32 (10%)	64 (19%)	
	useful	179 (53%)	234 (69%)	
10. In the past few years, have you participated in practical exercises or EMS team callouts involving hazardous substances (chemical, biological, radiological) posing a direct threat to human life and health?	no	275 (82%)	287 (84%)	0.483
	yes	61 (18%)	54 (16%)	

Table 1. Cont.

12. Do operations aimed at mitigating the consequences of incidents involving hazardous substances require improvement?	no	174 (57%)	255 (75%)	<0.001
	yes	129 (43%)	86 (25%)	
13. How do you assess cooperation between EMS units and other rescue entities during incidents involving hazardous substances?	very good	47 (15%)	29 (9%)	<0.001
	good	55 (17%)	130 (38%)	
	neutral	164 (51%)	160 (47%)	
	poor	47 (15%)	22 (6%)	
	very poor	10 (3%)	0 (0%)	
14. Are you familiar with the principles of initial and full decontamination (removal of contamination or infection)?	no	128 (39%)	118 (35%)	0.311
	yes	203 (61%)	223 (65%)	
15. In the past few years, have you participated in practical exercises or EMS team callouts using an isolation chamber (Bio-Bag) for transport or short term isolation of a patient with suspected or confirmed particularly dangerous, highly contagious disease?	no	263 (78%)	250 (73%)	0.179
	yes	74 (22%)	91 (27%)	
16. In the past few years, have you participated in practical exercises or EMS team callouts related to a bomb threat or explosive devices?	no	240 (71%)	252 (74%)	0.486
	yes	97 (29%)	89 (26%)	
17. Are you familiar with the principles of cooperation between EMS units and counterterrorism services?	no	236 (71%)	154 (45%)	<0.001
	yes	98 (29%)	187 (55%)	
20. Respondent's profession	paramedic	225 (67%)	308 (90%)	<0.001
	physician	35 (10%)	10 (3%)	
	nurse	77 (23%)	23 (7%)	
21. Sex	female	90 (28%)	53 (16%)	<0.001
	male	232 (72%)	288 (84%)	

statistically significant difference was found was the assessment of procedures in the EMS system for multiple or mass casualty incidents (Q9, p=0.006). In this part of the survey, clear differences in the perceived usefulness of procedures emerged. In the group with five years of service, positive opinions prevailed. As many as 76% of respondents considered the procedures useful. Respondents with longer experience expressed a different view. In the groups with 6 years and more than 10 years of service, answers indicating that procedures were "not useful" appeared more often (24% and 23% respectively) and the percentage of positive assessments was lower (65–67%). This result can be interpreted as an effect of professional experience. Staff with longer service, who have had more contact with real mass casualty incidents, more often see procedural gaps and the need for updates. In contrast, younger groups, including those with around five years of experience, may show greater trust in the existing solutions, which may result from more limited exposure to real crisis situations.

Analysis of the demographic questions confirmed that the distribution of medical professions did not differ significantly between length of service groups. Paramedics accounted for about 90% of respondents, with a small share of physicians and nurses. Statistically significant differences were observed in gender structure (Q21, p=0.001). In groups with shorter service (<1 and 5 years), the proportion of women was clearly higher (25–27%), while among respondents with longer experience (6 and >10 years) the share of women decreased to 12% and 8% respectively. At the same time, the proportion of men in these older groups increased to more than 90% (Table 2).

ANALYSIS OF RESPONSES TO OPEN-ENDED QUESTIONS FROM 2025

The questionnaire included 4 open-ended questions that allowed respondents to provide free-form answers based on their professional experience. These results were not subjected to statistical testing due to selective responses provided by participants. The findings are presented in Tables 3-6.

The most frequently reported variants in the category "OTHER" were: lack of cooperation between several EMS teams, errors in triage (overtriage and undertriage), long distance to trauma centres, absence of emergency lanes for approaching emergency services, and limited training on multiple or mass casualty incidents.

The most frequently reported variants in the category "OTHER" were: employer and expert team.

The most frequently reported variants in the category "OTHER" were: active shooter, confidentiality of exercises (scenario and timing), increased frequency of exercises, financial remuneration for participants, mass casualty incident in a water environment, professional debriefing, and lack of appropriate personal protective equipment (PPE) in EMS teams.

Table 2. Comparative analysis of 2025 survey results by length of service

Question	Response	<1	5	6-10	>10	Total	P
1. In the past few years, have you participated in practical exercises for multiple or mass casualty incidents?	no	8 (33%)	37 (39%)	29 (29%)	39 (32%)	113 (33%)	
	yes	16 (67%)	57 (61%)	72 (71%)	83 (68%)	228 (67%)	0.455
2. During practical exercises or EMS team callouts to multiple or mass casualty incidents, have you ever acted as the Medical Incident Commander (MIC)?	no	12 (50%)	53 (56%)	46 (46%)	72 (59%)	183 (54%)	
	yes	12 (50%)	41 (44%)	55 (54%)	50 (41%)	158 (46%)	0.213
3. During practical exercises or EMS team callouts to multiple or mass casualty incidents, have you ever taken part in medical triage of casualties?	no	6 (25%)	38 (40%)	32 (32%)	44 (36%)	120 (35%)	
	yes	18 (75%)	56 (60%)	69 (68%)	78 (64%)	221 (65%)	0.422
5. How do you assess cooperation between units of the national Emergency Medical Services (EMS) system and other rescue entities during multiple or mass casualty incidents?	very good	3 (12%)	10 (11%)	12 (12%)	16 (13%)	41 (12%)	
	good	10 (42%)	56 (60%)	54 (53%)	60 (49%)	180 (53%)	
	neutral	8 (33%)	10 (11%)	19 (19%)	28 (23%)	65 (19%)	
	poor	3 (12%)	18 (19%)	16 (16%)	18 (15%)	55 (16%)	0.360
6. During practical exercises or EMS team callouts to multiple or mass casualty incidents, have you ever encountered coordination of operations by crisis management authorities?	no	18 (75%)	71 (76%)	70 (69%)	90 (74%)	249 (73%)	
	yes	6 (25%)	23 (24%)	31 (31%)	32 (26%)	92 (27%)	0.779
7. If yes, how do you assess the effectiveness of these operations?	very poor	0 (0%)	0 (0%)	4 (4%)	2 (2%)	6 (2%)	
	good	6 (25%)	26 (28%)	25 (25%)	28 (23%)	85 (25%)	
	neutral	16 (67%)	59 (63%)	67 (66%)	82 (67%)	224 (66%)	
	poor	2 (8%)	9 (10%)	5 (5%)	10 (8%)	26 (8%)	0.637
8. Do operations aimed at mitigating the consequences of multiple or mass casualty incidents require improvement?	no	12 (50%)	53 (56%)	54 (53%)	62 (51%)	181 (53%)	
	yes	12 (50%)	41 (44%)	47 (47%)	60 (49%)	160 (47%)	
9. How do you assess the current "Procedures for multiple or mass casualty incidents" in the national EMS system?	no opinion	6 (25%)	13 (14%)	11 (11%)	11 (9%)	41 (12%)	
	not useful	2 (8%)	10 (11%)	24 (24%)	28 (23%)	64 (19%)	
	useful	15 (62%)	71 (76%)	66 (65%)	82 (67%)	234 (69%)	0.859
10. In the past few years, have you participated in practical exercises or EMS team callouts involving hazardous substances (chemical, biological, radiological) posing a direct threat to human life and health?	no	21 (88%)	77 (82%)	84 (83%)	105 (86%)	287 (84%)	
	yes	3 (12%)	17 (18%)	17 (17%)	17 (14%)	54 (16%)	0.810
12. Do operations aimed at mitigating the consequences of incidents involving hazardous substances require improvement?	no	22 (92%)	65 (69%)	78 (77%)	90 (74%)	255 (75%)	
	yes	2 (8%)	29 (31%)	23 (23%)	32 (26%)	86 (25%)	0.133
13. How do you assess cooperation between EMS units and other rescue entities during incidents involving hazardous substances?	very good	1 (4%)	6 (6%)	10 (10%)	12 (10%)	29 (9%)	
	good	11 (46%)	41 (44%)	35 (35%)	43 (35%)	130 (38%)	
	neutral	11 (46%)	38 (40%)	51 (50%)	60 (49%)	160 (47%)	
	poor	1 (4%)	9 (10%)	5 (5%)	7 (6%)	22 (6%)	0.685
14. Are you familiar with the principles of initial and full decontamination (removal of contamination or infection)?	no	10 (42%)	34 (36%)	29 (29%)	45 (37%)	118 (35%)	
	yes	14 (58%)	60 (64%)	72 (71%)	77 (63%)	223 (65%)	0.482
15. In the past few years, have you participated in practical exercises or EMS team callouts using an isolation chamber (Bio-Bag) for transport or short term isolation of a patient with suspected or confirmed particularly dangerous, highly contagious disease?	no	18 (75%)	66 (70%)	74 (73%)	92 (75%)	250 (73%)	
	yes	6 (25%)	28 (30%)	27 (27%)	30 (25%)	91 (27%)	0.856

Table 2. Cont.

16. In the past few years, have you participated in practical exercises or EMS team callouts related to a bomb threat or explosive devices?	no	18 (75%)	71 (76%)	69 (68%)	94 (77%)	252 (74%)	
	yes	6 (25%)	23 (24%)	32 (32%)	28 (23%)	89 (26%)	0.493
17. Are you familiar with the principles of cooperation between EMS units and counterterrorism services?	no	9 (38%)	42 (45%)	49 (49%)	54 (44%)	154 (45%)	
	yes	15 (62%)	52 (55%)	52 (51%)	68 (56%)	187 (55%)	0.783
20. Respondent's profession	paramedic	22 (92%)	89 (95%)	90 (89%)	107 (88%)	308 (90%)	
	physician	2 (8%)	0 (0%)	4 (4%)	4 (3%)	10 (3%)	
	nurse	0 (0%)	5 (5%)	7 (7%)	11 (9%)	23 (7%)	0.191
21. Sex	female	6 (25%)	25 (27%)	12 (12%)	10 (8%)	53 (16%)	
	male	18 (75%)	69 (73%)	89 (88%)	112 (92%)	288 (84%)	0.001

Table 3. Open-ended responses to Question 4 from the 2025 survey – Please indicate difficulties or organizational problems during multiple or mass casualty incidents

Response	Number – total - 194 (56.8%)
Chaos	56
Communication problems	42
Errors in communication	38
Lack of coordination between services	23
Lack of logistical support	11
Stress	6
Other	18

Table 4. Open-ended responses to Question 11 from the 2025 survey – Which procedures regulating cooperation between units of the national EMS system and other rescue entities during incidents involving hazardous substances are you familiar with?

Response	Number of respondents – total - 38 (11.1%)
CBRNE	8
Provincial rescue plans	6
Regulation on the National Rescue and Firefighting System	6
Decontamination	5
Patient treatment zones	4
Act on the State Fire Service	4
Other	5

Table 5. Open-ended responses to Question 18 from the 2025 survey – Who should be the main organizer of practical exercises related to crisis management?

Response	Number of respondents – total - 177 (51.9%)
State Fire Service	49
Emergency medical services (EMS)	43
Crisis management authorities	31
Ministry of Interior and Administration	16
Armed Forces	14
Local authorities	9
Other	15

Table 6. Open-ended responses to Question 19 from the 2025 survey – Which issues should receive particular attention in the preparation of future practical exercises?

Response	Number of respondents – total - 170 (49.8%)
Improvement of communication and radio links	52
Realism of operations	49
Command of large operational forces	20
Division of competences	16
Medical support for casualties	9
Mass casualty incident following terrorist actions	7
Other	17

DISCUSSION

Due to the lack of studies of this type in the national context, the discussion refers to research that is most similar in scope to our analysis. Our study focused on the subjective assessment, by practitioners on duty in mobile units of the national EMS system, of the preparedness of EMS teams for operations during mass casualty incidents and incidents involving hazardous and explosive materials. In addition, we evaluated knowledge over a five year interval, corresponding to the continuing education period defined by the Ministry of Health, with regard to the organization of rescue operations and practical exercises on these topics. Wilk et al. [10] point to an insufficient level of experience among EMS personnel in this area. Their results clearly show that 28% of respondents had not participated in a mass casualty incident during their work in EMS, 37% had taken part only once, 24% had participated up to five times and only 10% reported participation in such incidents more than five times.

In the national EMS system, according to the Simple Triage and Rapid Treatment (START) system, the main criteria used to assess the condition of a casualty in multiple or mass casualty incidents include: ability to walk independently, airway patency, respiratory rate as an indicator of respiratory function, capillary refill time to assess the risk of shock and, in difficult weather conditions and poor lighting, peripheral pulse and skin appearance, as well as the ability to follow simple commands. Since START is also used by trained first aid rescuers and firefighters in the National Rescue and Firefighting System, experience in triage should not be a major problem for a professional and well educated medical workforce [11].

The most frequently reported issue in our open-ended questions, namely chaos, also appears in other publications. The term is used to describe disorganized conduct of operations, usually resulting from incorrect recognition of actual needs and therefore remaining ineffective despite significant effort. Proper coordination of medical rescue operations at the scene of a mass casualty incident is crucial for success. It is noteworthy that the most highly qualified medical staff, that is system physicians, most often listed poor cooperation and confusion, followed by chaos and problems with the transmission of current information [12, 13].

According to Kłosiewicz [14], staff working in EMS teams do not have sufficient knowledge about medical rescue activities undertaken by rescuers in the National Rescue and Firefighting System. This should prompt institutions responsible for education of medical personnel to take measures aimed at increasing awareness of these issues among clinicians.

An important area of the survey concerned CBRNE threats in the practice of medical rescue entities. Mass casualty incidents that are particularly dangerous, such as chemical, radiological or biological events requiring decontamination of a large number of casualties, pose major organizational challenges. As indicated in the previous part of this paper on the organization and conduct of rescue operations, there is currently no unified rescue procedure in the civilian rescue system. The State Fire Service and other specialist units subordinate to or supervised by the Minister of Interior and Administration and the Minister of National Defence have procedures and technical capabilities that can be used for mass decontamination. The key problem, however, is the lack of a clearly defined role and position for EMS medical personnel in the process of mass decontamination of casualties [15, 16].

Knowledge of how to use transport isolators, such as Bio-Bag type devices, is also important for EMS personnel. These devices provide protection against pathogens transmitted by the respiratory route, such as Ebola virus, and offer the highest possible protection against infection. The ability to use them is crucial in situations with direct contact with blood, secretions or excretions of an infected person. In addition, the use of such devices significantly reduces the consequences of possible human error in the use of PPE and substantially limits the scope of necessary decontamination of the ambulance, which shortens the time required to prepare the team for subsequent missions [17].

Another area addressed in our questionnaire was the specificity of injuries caused by explosions and the feasibility of effective rescue procedures while maintaining staff safety. EMS team members may never take part in rescue operations in such specific conditions, but this does not

release them from the obligation to possess the relevant knowledge. At the scene, key elements of their conduct include understanding the pattern of blast related injuries in casualties, awareness of risks for EMS personnel and the ability to cooperate with counterterrorism services and units. This is particularly important because regulations and procedures for the organization of operations during such incidents are widely available. The Act on the national EMS system describes the entities and services that cooperate with EMS units. Other legal acts define which service has the lead role depending on the type and characteristics of the incident. During multiple and mass casualty incidents with CBRNE, explosive or terrorist threats, EMS teams, despite the large number of casualties and the need to implement procedures for medical rescue operations coordination, must follow the lead service [18–20].

Current educational and training opportunities for medical students, based on medical simulation and virtual reality (VR) technology, make it possible to reproduce real conditions. The most impressive and at the same time most demanding form of training in mass casualty incidents is full scale field simulation. Such training requires substantial engagement of EMS resources, simulation props, moulage and a large group of people acting as casualties in order to reproduce the atmosphere of a real incident. It is the best method for training practical skills, teamwork and performance in demanding environmental conditions, because all actions and decisions are taken in circumstances that closely resemble reality. Simulation can evoke emotions and feelings such as stress, anxiety and fear that are experienced by EMS personnel and casualties in real incidents. It makes training more realistic and elicits characteristic behaviours in participants, which allows assessment of decision making under high emotional load [22, 23].

LIMITATIONS

It should be emphasized that in 2019 and 2025 two different samples were studied, both drawn from the same population of employees of the national EMS system in the Masovian Voivodeship. The observed differences in responses may therefore reflect not only real changes in preparedness for multiple and mass casualty incidents and Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) events, but also staffing changes in the EMS system, including a different distribution of professional groups and gender structure in the two samples. The applied repeated cross-sectional design does not allow tracking of changes at the individual level or drawing causal conclusions. The study was based on an author-developed questionnaire and self-reported assessments, which involves a risk of systematic errors, including social desirability and selection bias. In addition, the analysis was mainly univariate and did not take into account all potential confounding factors. The results come from a single voivodeship, so any generalization to the entire country should be made with caution.

CONCLUSIONS

Comparison of results from 2019 and 2025 shows a clear favourable trend in the preparedness of EMS personnel for multiple and mass casualty incidents. In 2025 more respondents reported participation in practical exercises, acting as the person in charge of medical operations and involvement in triage, which indicates a real increase in operational experience. At the same time, assessments of cooperation between units of the national EMS system and other services improved, both for classical multiple casualty incidents and for incidents involving hazardous substances, with a decrease in the proportion of strongly negative responses. The proportion of respondents who considered procedures for multiple casualty incidents to be useful also increased, and fewer respondents remained undecided, which suggests better familiarity with these procedures and more frequent use in practice.

At the same time, declared knowledge of cooperation principles, including cooperation with counterterrorism services, increased significantly, although a discrepancy remains between declared knowledge and actual experience in the field of CBRNE threats. It should be emphasized that these changes occur against the background of a transformation in the structure of the study population. In 2025 paramedics predominated, while the share of physicians, nurses and women was lower, which requires caution when generalizing conclusions to all professional groups. Despite the observed improvement, it remains crucial to further develop systematic, practical simulation based training and interagency exercises, particularly in the area of CBRNE, operational coordination and cooperation with entities responsible for internal security.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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Assessment of cooperation in the using telemedicine between emergency medical teams and cardiology centers in the Silesian Voivodeship in 2023

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ABSTRACT

Aim: The aim of the study was to determine what the cooperation between Emergency Medical Teams and cardiology centers looks like during the transfer of a patient to a medical facility and to learn the opinions of respondents on what such cooperation should look like.

Material and methods: In 2023, a retrospective study was conducted on the collaboration between Emergency Medical Services and cardiology centers in the Silesian Voivodeship. Ninety-nine response sheets were collected, which served as research material.

Results: 96% of Emergency Medical Team members send Lifenet to hospitals with invasive cardiology departments in cases of acute coronary syndrome. 29% of paramedics do not perform teletransmission for patients with chest pain without ECG changes. In only 8% of cases of refusal in the cardiology emergency room with hemodynamics, the physician examines the patient in the emergency room; almost half of these cases are not examined.

Conclusions: Nearly 95% of respondents believe that national guidelines should be established for patient transport to hemodynamic centers. It is appropriate to introduce advanced training in the use of ultrasound machines and image interpretation for Emergency Medical Services personnel. Live streaming will significantly improve the quality of cooperation between Emergency Medical Teams and cardiology centers.

KEY WORDS

telemedicine, medical rescue, emergency medicine, acute coronary syndrome, pre-hospital care, live streaming

INTRODUCTION

Telemedicine is one of the most dynamically developing healthcare sectors. Constant technological development in medicine focuses on improving diagnostics and treating patients by proper proceeding with specific cardiovascular diseases. There are also new medical technologies created which aim at making communication and advanced medical procedures more efficient. Emergency medicine and medical rescue are among the medical branches benefiting from modern technologies. Telemedicine also means remote clinical care with the use of audio- or visual broadcast provided to given facility by other hospitals or private companies [1]. Since a dozen or so years ago telemedicine has been developed within research projects – formerly as Health telematics, currently as eHealth. Software provided by eHealth are with no doubt very popular among European scientific research projects. Research provides prognostics for future implementation and possible clinical use. Over the course of recent years European and Polish network of IT and mobile phone network has been greatly developed. This fully allows virtually anyone to transmit basic medical data and signs, such as ECS. This allows for constant development of services, therein cardiological telemonitorig [2]. In case of EMS teams the use of telemedicine for pre-hospital care means mainly the option to transmit data to invasive cardiology centers, broadcasting USG imaging and gradually implemented live streaming – transmitting electrocardiogram and other patient's vital signs in real time. Ambulances are equipped with defibrillators with cardio-monitor function, capable of transmitting data to cardiology departments, assigned to given ambulance team's region of operation. Patients with acute coronary syndrome or heavy arrhythmia diagnosed by ambulance team have their ECG transmitted to cardiology department. Then, after tele-consultation between ambulance team leader and physician in target facility, patients are transported there to undergo advanced diagnostics and be qualified for operation if indicated.

The technological solution of data transmission makes action easier especially for ambulance teams operating in remote, extra-urban regions. In order to „buy time" for the patient and shorten transport to target facility, they also use the Helicopter Emergency Medical Service support.

There are many more medical specialties, apart from tele-cardiology, where remote healthcare provision is possible – tele-dermatology, tele-ophthalmology, tele-psychiatry, tele-audiology, tele-rehabilitation [3].

Legal regulations regarding telemedicine in Poland are based only on general definition in enactment regarding healthcare from the year 2011 (Ustawa o działalności leczniczej z 2011 roku) [4]. According to it, providing healthcare is based on healthcare services which can be provided with the use of information and communication technology systems (source: art. 3 par. 1 of the given act).

According to art. 41 par. 3 of State Emergency Rescue System Act (Ustawa o Państwowym Ratownictwie Medycznym), the individual in command of medical action should stay in constant contact with medical dispatcher, using the telemedical system while undertaking medical rescue action [5].

Cardiovascular diseases remain the leading cause of mortality worldwide. Among these the acute coronary syndrome is dominant. The average patient suffering from non ST-segment elevation myocardial infarction in 2004 was 66.8 years old, in 2014 – 69. In case of ST-segment elevation myocardial infarction the age was 63 and nearly 66 respectively. Individuals aged under 50 are 8,9% of all hospitalized patients diagnosed with ACS, while patients aged 50-74 are 65% of population suffering from STEMI and NSTEMI. Group aged over 75 constitutes 26,1% of patients hospitalized due to ACS [6, 7]. GRACE (Global Registry of Acute Coronary Events) research has proven that the percentage of patients with ACS aged under 75 was 32%. In the CRUSADE registry (regarding only non ST-segment elevation ACS) the number was 35%. STEMI dominates among patients of younger age groups, NSTEMI – among elder ones [8].

Ambulance team action regarding patients with stenocardial pain focuses on following the guidelines of the European Society of Cardiology. These focus on diagnosing STEMI-ACS or suspecting NSTEMI-ACS with the use of data transmission to cardiology department, making tele-consultation with physician, administering pharmacological therapy and organizing fast transport to dedicated facility.

Drugs used on pre-hospital level, depending on indications and patient's condition, are administered following the HAKT-ONOB acronym (H – Heparin; unfractionated 5000 units intravenously, A – Aspirin 300 mg orally, K – Klopidogrel (Plavix) 600 mg orally or Tikagrelor (Brilique) 180 mg orally, O – Opioids, such as Morphine or Fentanyl in fractionated doses, N – Nitroglycerin sublingual aerosol 0.4 mg, O – Oxygen titrated whenever saturation is <90%, B – Benzodiazepines – Diazepam, Midazolam, Clonazepam – depending on increasing anxiety).

Clinical group of symptoms developing in the course of single disease process is divided into: unstable angina pectoris, non ST-segment elevation myocardial infarction ans ST-segment elevation myocardial infarction [9].

AIM

The research aims at determining how does the cooperation between ambulance teams and cardiology facilities look upon transferring patients, based on the opinions of paramedics from Silesia who have answered the survey.

MATERIAL AND METHODS

Retrospective research regarding cooperation between ambulance teams and Silesian cardiology centers had been conducted in 2023. 99 answer sheets have been collected, which served as research material. Detailed questions regarded the frequency of data transmission used, proceeding in case of cardiology center refusing to admit the patient, the frequency of USG use and meaningfulness of live streaming implementation.

Survey was dedicated to ambulance team members who provide pre-hospital treatment. Over 70% of respondents were male. Nearly 95% were paramedics, the rest being nurses. Among respondents there were no physicians working within the ambulance teams.

Over 60% of respondents had over 10 year professional experience and the majority of them were ambulance team leaders.

RESULTS

Characteristics of the group are presented in Table 1. The majority of respondents were male (71%) and paramedics (95%). Only 5% of respondents were emergency medical system nurses. The majority of respondents (61.6%) have a dozen or so years of experience in work as a paramedic or nurse. More than a half works as ambulance team leader or ambulance team leader-driver (56.6% and 35.4% respectively).

Nearly all respondents work in a region with access to cardiology department with hemodynamics laboratory.

Nearly all respondents (96%) confirmed that in case of ACS confirmed by ECG (STEMI) they transport patients to hospitals with hemodynamics laboratory (Fig. 1A).

Practice regarding transmitting ECG in case of patient with suspected ACS, but with no ACS-specific pathology in electrocardiogram varies. 28% of respondents always or nearly always send ECG live stream to physician on duty, while 29% never (5.1%) or nearly never (24.2%) do so (Fig. 1B).

When asked about transporting patient with chest pain but with no ischemia-specific ECG pathology to hemodynamics laboratory, the majority (56%) responded that they do it rarely or never (Fig 1C). Over half the respondents (51%) are never or nearly never handed written admission denial after bringing in patient with chest pain with no ECG ACS confirmation (Fig. 1D).

In case when cardiology center physician denies patient admission, he or she does not examine the patient, neither in admissions chamber (according to 41% respondents – Fig. 2A), nor in an ambulance (according to 65% respondents – Fig. 2B). 64% of respondents treat admission denial on the phone authoritatively, indisputably (Fig. 2C), therefore they do not treat denial as suggestion or proposal. 67% never, despite denial on the phone, transport patients to facility with hemodynamics laboratory (Fig. 2D).

Only 5% of paramedics surveyed do contact cardiology to inform that they have patient requiring cardiovascular intervention (Fig. 3A). Such information is not a request to admit patient. 96% do not inquire to be handed written admission denial from interventional cardiology department (Fig. 3B.). The vast majority (80.8%) claim that transmission is not intended only to patients with chest pain (Fig. 3C). In case of denial to admit patient to center with hemodynamics laboratory, only 23% of respondents always contact the

Table 1. Characteristics of study group

Feature		Number (%)
Gender	males	N (70.7%)
	females	N (29.3%)
Profession	paramedics	N (94.9)
	nurses	N (5.1%)
Work experience	< 1 year	N (3.1%)
	1 to 5 years	N (21.2%)
	5 to 10 years	N (14.1%)
	> 10 years	N (61.6%)
Ambulance team working position	team leader	N (56.6%)
	team leader – driver	N (35.4%)
	team member	N (0.9%)
	team member – driver	N (7.1%)

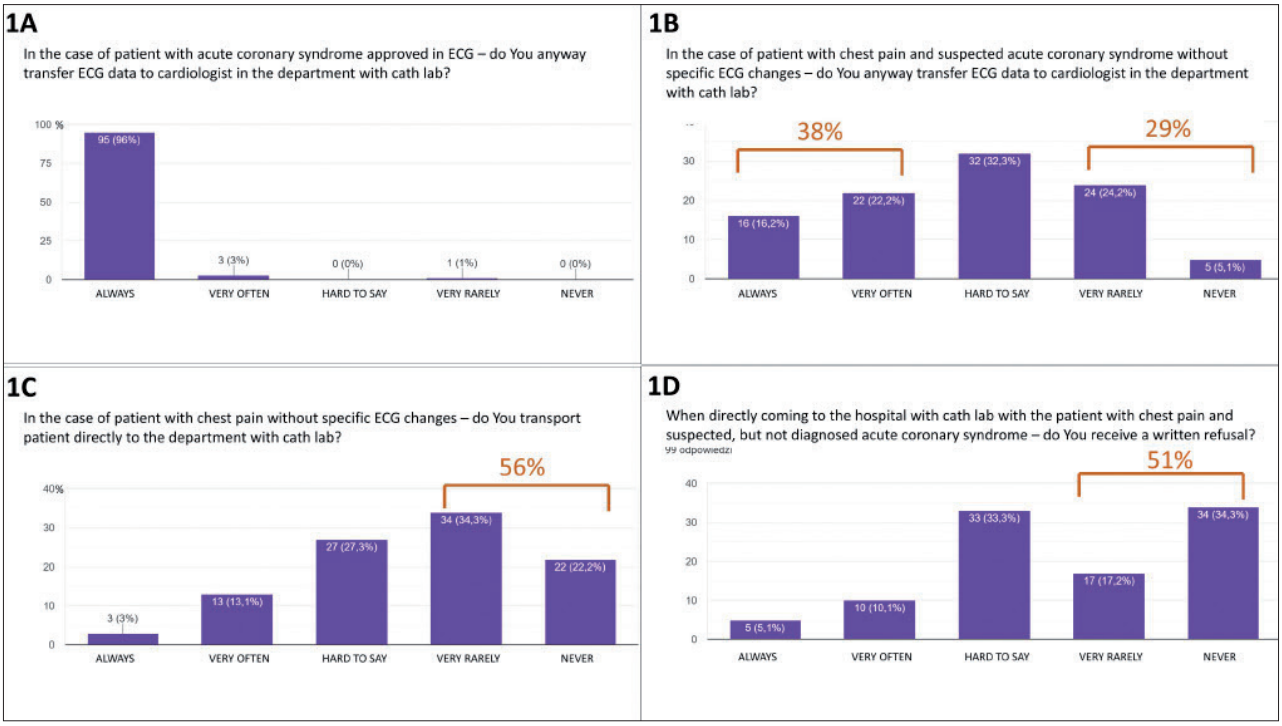

Fig. 1A. Transfer ECG data to cardiologist in the department with acute coronary syndrome; **1B** Transfer ECG data to cardiologist in the department with chest pain and acute coronary syndrome; **1C** Transport patient directly to the department with chest pain without specific ECG changes; **1D** Written refusal

Source: Own materials

Medical Rescue Coordinator of the Voivodeship (Wojewódzki Koordynator Ratownictwa Medycznego) (Fig. 3D).

The vast majority do not use ultrasound in case of patient with chest pain (66% never, 13% very rarely, 2% always and 9% very frequently).

Moreover the survey also contained questions regarding specific diseases: atrial fibrillation, lung edema, pulmonary embolism and heart tamponade.

64% of respondents would rather not direct a de novo atrial fibrillation case to cardiology. 1 in 10 respondents always direct patients with first ever atrial fibrillation case to cardiology center (Fig. 4A). About half of respondents (51.5%) decide to transport patient with hemodynamically unstable atrial fibrillation to cardiology facility (Fig. 4B).

62% of respondents would rather not direct patient with lung edema and no ACS symptoms to cardiology with hemodynamics. 6% would always direct such patient to cardiology center (Fig. 5).

When it comes to pulmonary embolism, nearly 87% of respondents claim that patient with such diagnosis should be admitted to emergency room of cardiology department with hemodynamics laboratory (Fig. 6A).

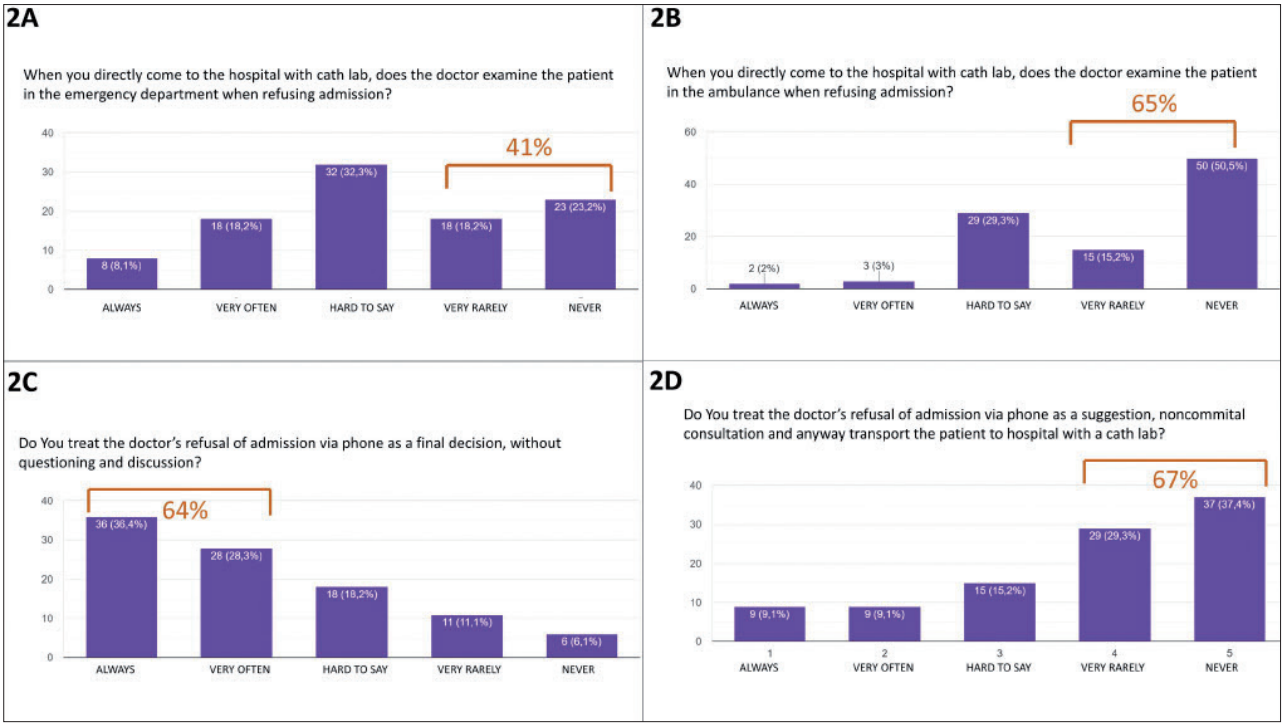

Fig. 2A. Examine the patient in emergency department by the doctor; **2B** Examine the patient in ambulanse by the doctor; **2C** Admission via phone as a final decision; **2D** Admission via phone as a suggestion, noncommital consultation

Source: Own materials

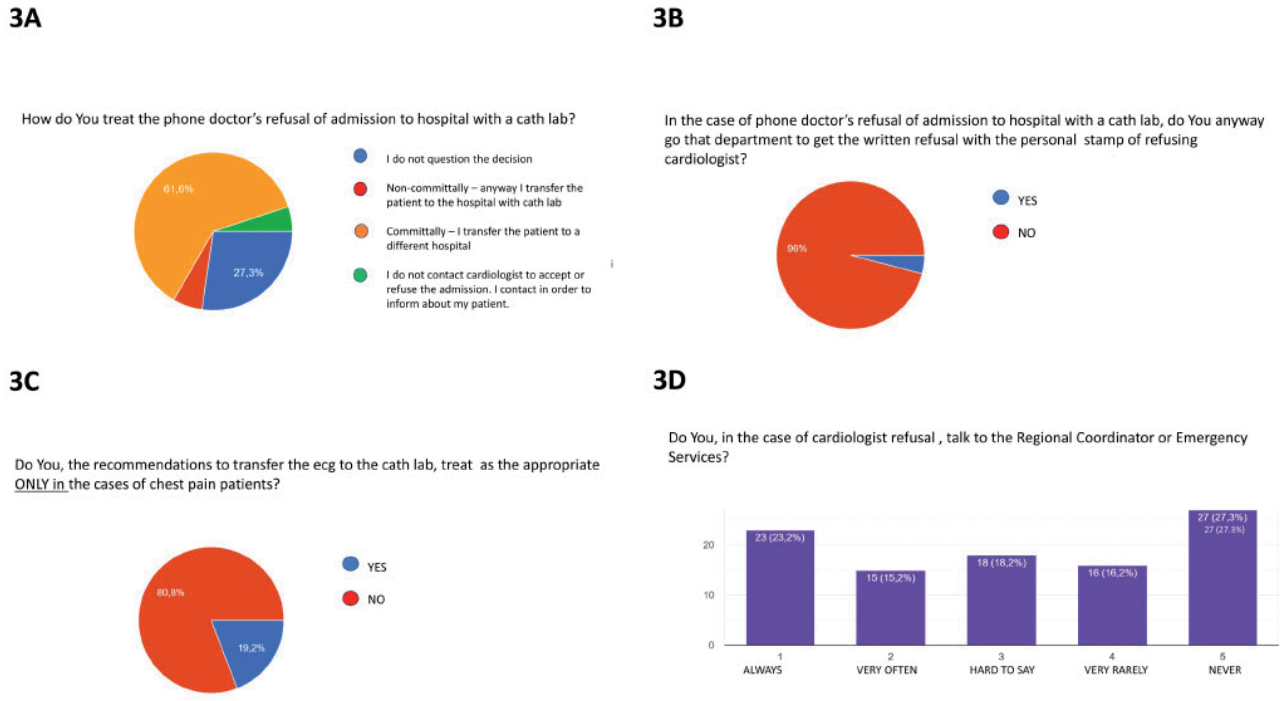

Fig. 3A. Decision after the doctor refused admission; **3B** Obtaining a written refusal of admission from the doctor.; **3C** Patient with chest pain.; **3D** Contact the Regional Coordinator of Emergency Services

Source: Own materials

One in three paramedics (37%) claim that patient with pulmonary embolism should be admitted to cardiology department, but only after initial heart and lung USG imaging performed by paramedic (Fig. 6B). Essentially similar results regard heart tamponade: 87% claim that patient with suspected tamponade should be admitted to cardiology department (fig. 6C), 41% agree, but would treat heart USG made by ambulance team crucial (Fig. 6D).

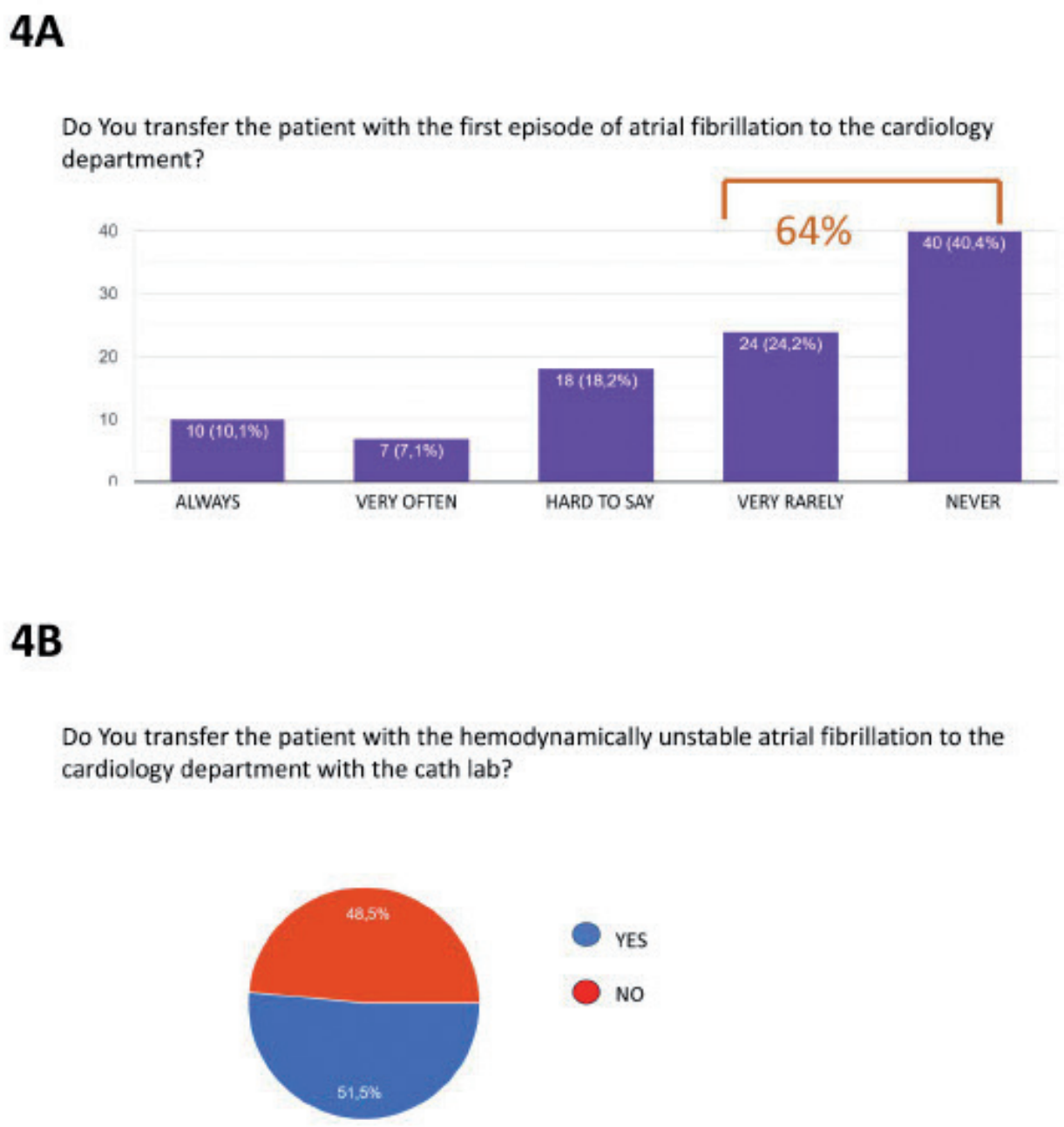

Fig. 4A. Transport patient with atrial fibrillation to the cardiology department; **4B** Transport patient with unstable atrial fibrillation to the cardiology department

Source: Own materials

84% of paramedics claim that it is meaningful to implement live streaming to communicate between ambulance and hospital (Fig. 7A), while 78% claim that live streaming with USG broadcast would also be a good solution (Fig. 7B).

Paramedics agree (95%) that it is required to publish guidelines that would recommend which patients (apart from ACS) should be directed to cardiology reference facility (Fig. 8).

RESEARCH OVERVIEW

The surveyed paramedics most frequently communicate on the phone with cardiologists after transmitting ECG of patient with chest pain. They treat admission denial on the phone as indisputable and very rarely inquire to be handed written denial in the admissions chamber.

According to responses gathered not only STEMI ACS is an indication to direct patient to specialist cardiology facility. Low percentage also direct to cardiology the first episode of atrial fibrillation or lung edema with no ECG pathology. The majority – also hemodynamically unstable atrial fibrillation.

Respondents claim that suspicion of acute pulmonary embolism and heart tamponade should be admitted directly to cardiology, with the minority agreeing to decide so after USG imaging.

The greatest compliance regards the acceptance of live streaming (including USG) in communication on cardiologist-

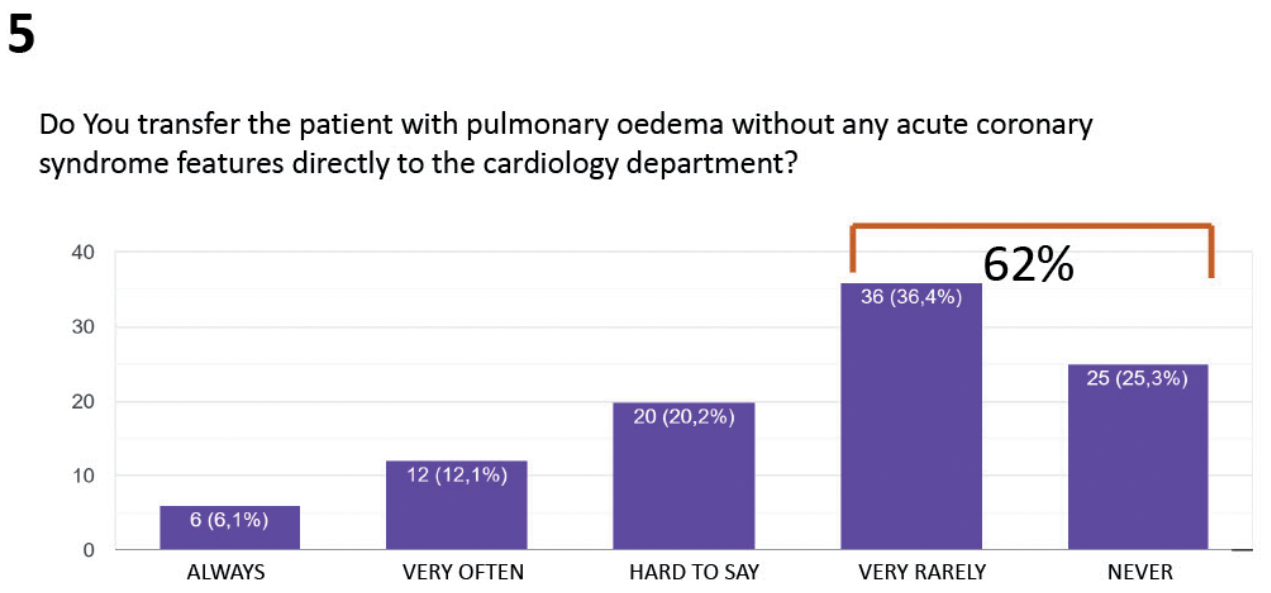

Fig. 5. Transport patient with pulmonary oedema to the cardiology department

Source: Own materials

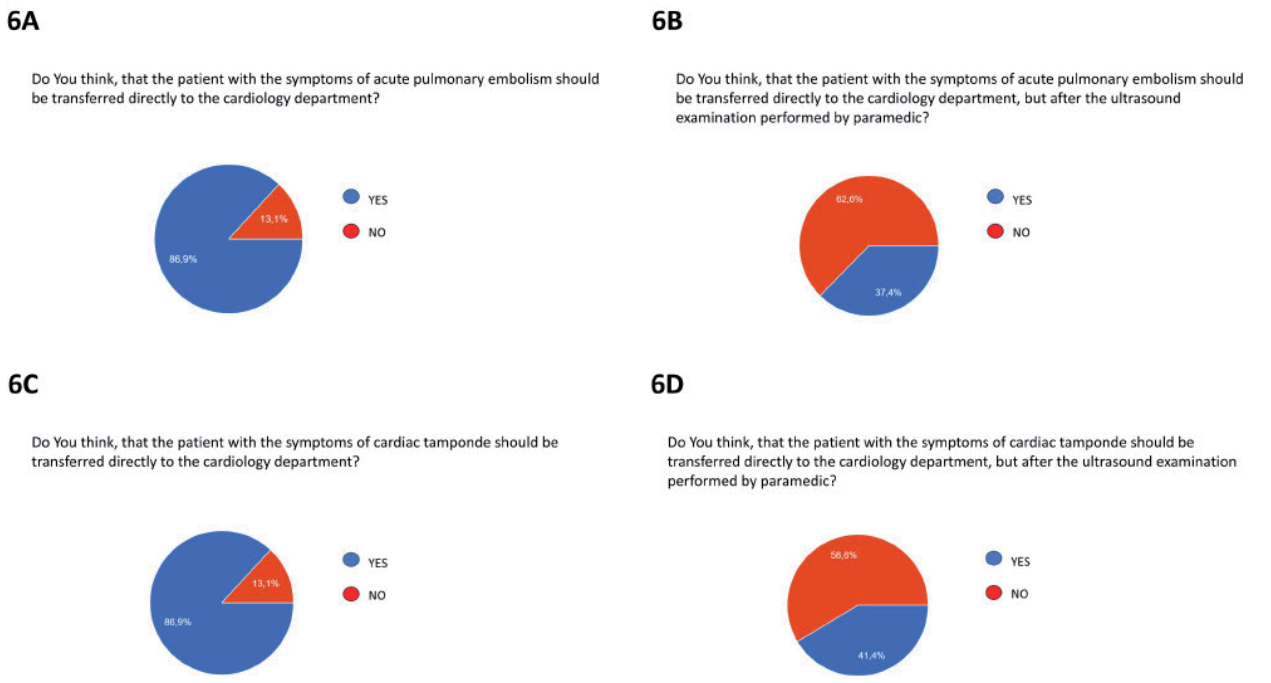

Fig. 6A. Transport patient with pulmonary embolism to the cardiology department; **6B** Transport patient with acute pulmonary embolism to the cardiology department after ultrasound; **6C** Transport patient with cardiac tamponade to the cardiology department; **6D** Transport patient with cardiac tamponade to the cardiology department after ultrasound.

Source: Own materials

paramedic line, and the need to create clear guidelines regarding which symptoms should make patients be directed to specialist cardiology facility.

DISCUSSION

Cooperation between pre-hospital medical rescue and specialist hospital care based on ambulance team (both land and airborne) and emergency department is a key factor leading to balance between action and possibilities. Such action should take scientific and clinical challenges into account, while possibilities should be generated by medical reports and guidelines.

The integration of electrocardiography (ECG) and ultrasonography (USG) in telecommunication during the management of cardiovascular emergencies has significantly enhanced diagnostic and therapeutic approaches. These

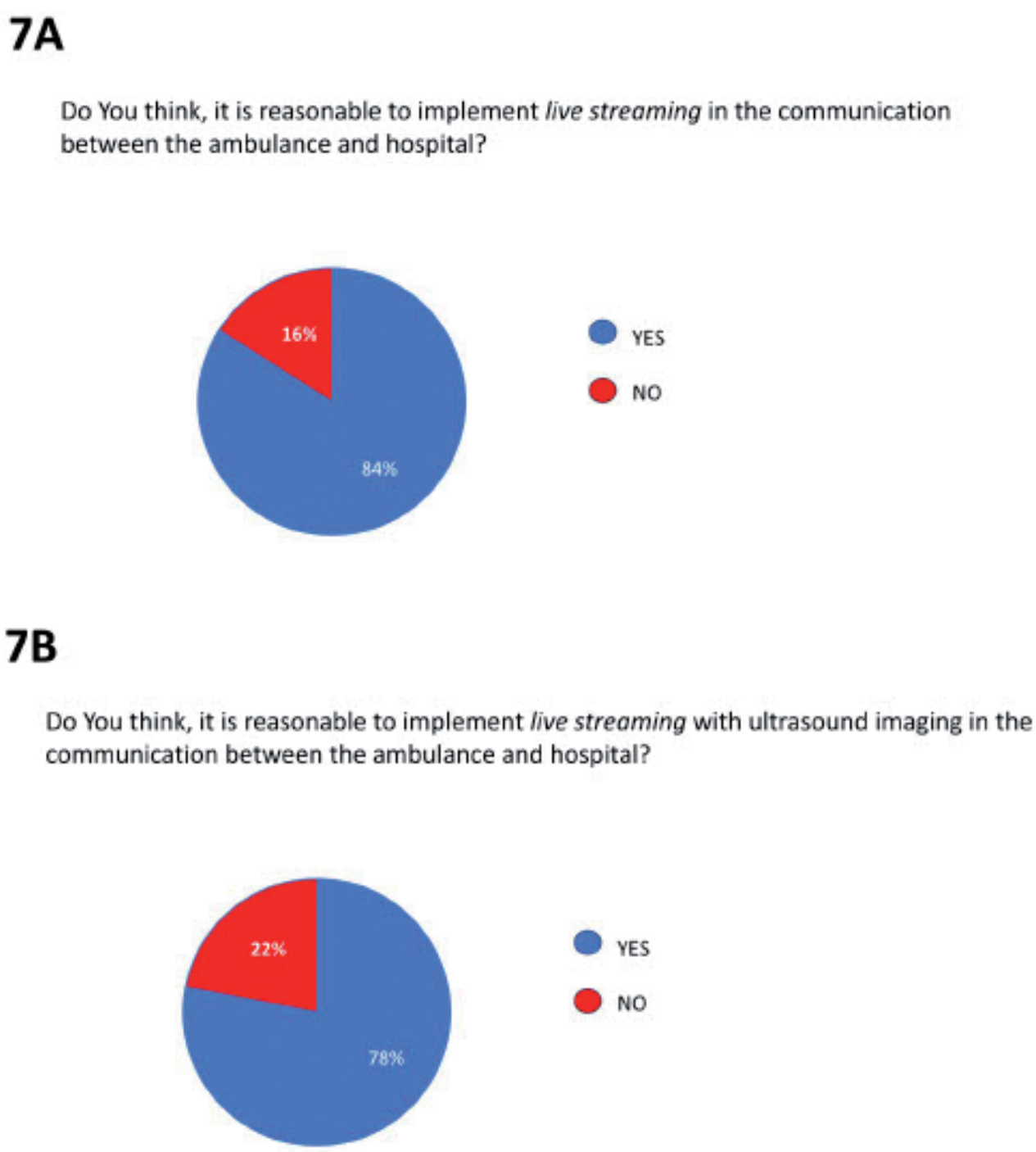

Fig. 7A. Live streaming in the communication; **7B** Live streaming in the communication with ultrasound

Source: Own materials

modalities provide crucial, real-time data, enabling prompt clinical decision-making, especially in settings requiring coordination with cardiologists, paramedics, and catheterization laboratories (cath labs) or cardiology emergency departments.

DOCTOR-PARAMEDIC INTERACTION IN EMERGENCY CARDIOVASCULAR CARE

The interaction between doctors and paramedics is crucial for optimal pre-hospital and in-hospital management of cardiovascular emergencies. Paramedics often serve as the first point of contact in acute events, utilizing ECG and sometimes ultrasound to assess the patient's condition on-site. Rapid transmission of ECG data to receiving hospitals allows for early activation of cath labs and preparation for PCI, reducing time-to-treatment. Furthermore, direct communication between paramedics and doctors ensures a seamless transfer of critical clinical information, improving patient outcomes.

In 2021 in St. Vincent's University Hospital in Dublin a group of scientists published results of research regarding pre-

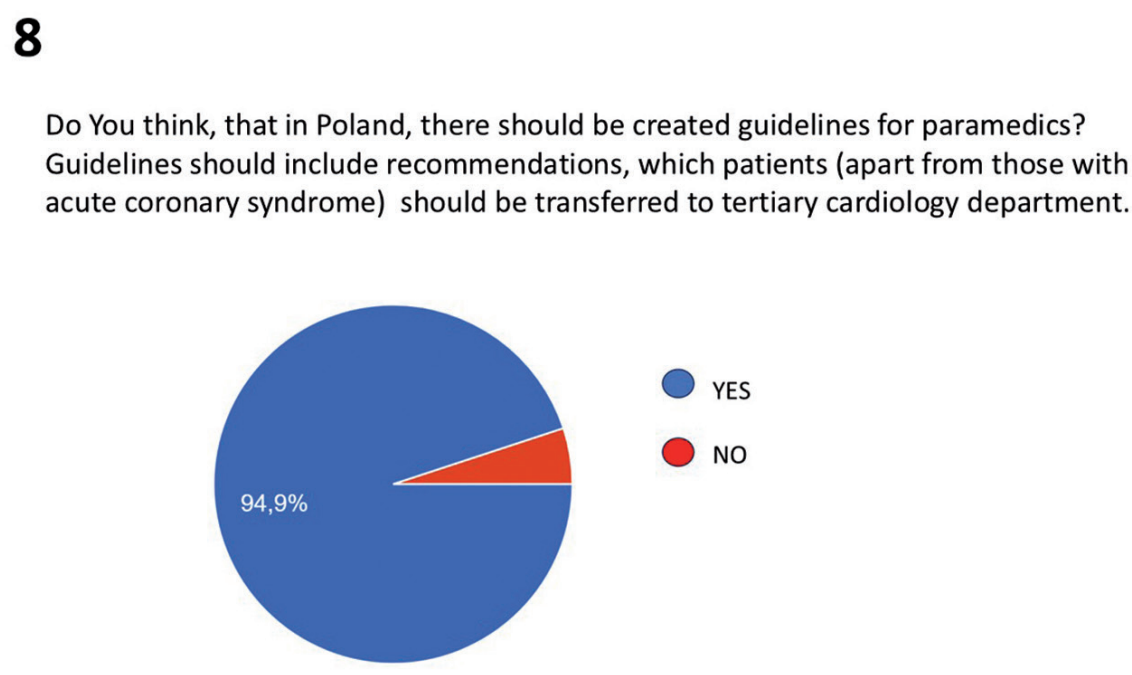

Fig. 8. Guidelines for paramedics

Source: Own materials

hospital treatment of patients with acute decompensated heart failure (ADHF). It was emphasized in the results, that it is necessary to enhance care both on basic and specialist level. The first aspect of this is data transmission and access to current information about the patient for all healthcare sectors [10]. This shows how important telemedicine is for patients with acute heart failure. Thanks to it, the early introduction of pre-hospital medical interventions (basic healthcare and ambulance team) inhibits ADHF onset and helps prevent hospitalization. On ambulance team level the solution is the transmission of ECG, then phone consultation with physician, implementing on-scene medical treatment and transporting patient to hospital. Results of this research confirm consent – however not unanimous – among paramedics regarding the use of live streaming.

In case of basic healthcare the general practitioner may conduct tele-consultation with cardiologist and implement on-scene treatment or direct the patient to hospital. Acute heart failure (AHF) has become a global burden for public health, mainly due to related high morbidity, mortality and financial cost [11].

In the course of acute heart muscle ischemia (non ST-segment elevation myocardial infarction and ST-segment elevation myocardial infarction) conditions such as lung edema, heart tamponade, pulmonary embolism, tachy-arrhythmia and brady-arrhythmia, conduction disorders, mechanical complications of heart attack, aortic aneurysm may lead to cardiogenic shock within ambulance team practice. The above-mentioned conditions in many cases require ambulance team to tele-consult physician in invasive cardiology center. Cooperation on this level allows for introducing optimal live-saving treatment on pre-hospital level and achieve early readiness of clinical team to admit the patient. It seems that USG image live streaming (heart tamponade, acute pulmonary embolism) could make the initiation of dedicated treatment significantly faster – as confirmed by the survey presented in this paper. Moreover it is worth noticing that live streaming in rural areas may be particularly useful, as poor communications infrastructure and extensive transport times occur there [12].

Heart damage leading to severe impairment of its function may be acute, resulting from heart muscle damage (acute heart attack, myocarditis) or may have chronic character, like among patients with acute decompensated heart failure [13]. Ambulance team should not delay transferring patient to proper hospital. Broadened randomized research in the field would provide more data regarding treatment and target transport facility [14].

The above indicates that cooperation between ambulance team/helicopter emergency medical team and invasive cardiology facility should be published in the form of guidelines. Also the survey respondents share this view.

This would make a chance to avoid many controversial situations, when patients await specialist hospital care for too long, and ambulance teams would have clear guidelines regarding patients of given category in life and health distress. Pre-hospital action in many situations and countries is based on algorithms and procedures which enhance the functioning of local and state patient care systems [15]. Constant contact between ambulance teams with specialist facility is possible thanks to live streaming connection.

In 2020 research conducted in ambulance teams and hospitals in Sweden has shown that among patients whose main symptom was dyspnea the three most frequent etiologies were: chronic obstructive pulmonary disease (20,4%), lung infection (17,1%) and heart failure (15%). More than half of the research group, aged 73 and more, have called an ambulance. Over 200 out of 400 patients who have been treated by a nurse were in critical condition due to dyspnea and required transport to specialist hospital unit. One of the factors verifying life distress condition, which indicated transporting patient to cardiology department, was diagnosing the following pathologies in electrocardiogram: atrial fibrillation or flutter, ST-segment elevation, ST-segment depression, mirrored T-wave inversion, left branch bundle block. Other symptoms were: I, II or III degree atrioventricular block, ectopic vestibular rhythm/ tachycardia and ventricular tachycardia [16].

Ultrasound imaging is of great importance in diagnosing cardiac issues, both on pre-hospital and hospital level. Increasing mobility, quality and decreasing price of USG devices make them more available and useful in pre-hospital environment. Numerous protocols which allow basic and advanced heart function assessment are known as Point-of-care ultrasound (PoCUS) and Pre-hospital point-of-care ultrasound (PHUS). Additionally, pulmonary ultrasound aids in differentiating cardiac from non-cardiac causes of dyspnea, such as acute pulmonary edema versus chronic obstructive pulmonary disease exacerbation [17-19].

Thanks to enhancing data communication technology, tele-medicine is a promising technique of remote assessment of USG images recorded by operators – qualified paramedics. In such situation they may be even live prompted and supported by remote operation of USG device settings under certain scenarios. In the year 2016 Kirkpatrick had demonstrated the possibility of conducting remote tele-mentoring for soldiers not familiarized with USG, as they have performed post-trauma FAST USG in order to detect free fluid on phantom [20]. Kolbe introduced a program of PoCUS teaching for a single-room medical clinic in Nicaraguan village. Despite limited resources, after initial introduction USG, instructors used telemedicine for remote viewing of USG images in real time. Remote tele-mentored USG was practicable for training inexperienced nurse practitioners in diagnosing pneumothorax directly after the removal of thoracotomic tube [21]. Rubin has proven feasibility of remote viewing and interpreting data and ultrasonographic image of carotid arteries among healthy volunteers, which was called the „tele-neurosonology" [22]. Survey respondents also expressed their positive opinion regarding USG live streaming in an ambulance. Moreover, the majority confirmed that whenever acute pulmonary embolism or heart tamponade is suspected, it is only after USG that transferring the patient to specialist facility is reasonable.

Decision to perform ultrasonography depends on personnel competence, experience and available time. One has to bear in mind, that taking time is not always cost-effective, and diagnosis precision is not ideal. Advantages of pre-hospital ultrasound are above all improved decisions regarding treatment, notifying the hospital before arrival, better chosen transport type and target facility.

LIMITATIONS AND FUTURE DIRECTIONS

Research was limited by low survey respondent number and their operation location in only one region of Poland. This is to be a pilot research – its development may be a confirmation of initial conclusion with the use of larger group and wider area.

Conclusion may serve as baseline for preparing guidelines for paramedics regarding cooperation with specialist cardiology facilities in the field of acute cardiological emergencies.

CONCLUSIONS

The complementary use of ECG and USG is pivotal in the timely management of cardiovascular conditions and facilitates effective communication with paramedics, cardiologists, and cath labs. Enhancing training, fostering collaboration, and integrating novel technologies are essential steps toward optimizing pre-hospital patient care. Practices in communication with cardiology department, highly differ among paramedics – what was proven by this study. Standardization in the paramedic – cardiology cooperation is needed.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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The search and rescue team navigator – their task and training (part I)

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ABSTRACT

In recent years, Poland has seen the dynamic development of Search and Rescue Groups, whose aim is to search for missing persons. A well-developed network of Volunteer Fire Brigades encourages rescuers to specialise not only in first aid, but also in searching for missing persons. Civil search and rescue groups are being formed to carry out a wide range of activities. Specialised equipment and devices are being purchased. Training, courses, exercises and manoeuvres are being organised to utilise the equipment, skills and improve rescue tactics.

The author characterised one of the key roles in the functioning of such a group – the navigator. The important tasks assigned to the navigator and the special role they can play during search and rescue operations or during the organisation of exercises were discussed. Two courses were proposed from scratch: map reading and compass use, and GPS receiver operation and use in search and rescue operations. The subsequent stages of navigator training were presented in accordance with the principles of increasing difficulty.

KEY WORDS

disappearance, missing person, search, navigator, search and rescue group

INTRODUCTION

Recently in Poland, civilians and specialised search and rescue teams should be involved in the search for missing persons by the services to a greater extent than before [1]. The author's own experience shows that the police are interested in cooperating with people who are often more experienced in search activities and better equipped with specialised equipment (drones, quads, rescue dogs and others) than the state services. The natural desire to help and get involved in the search for a missing person has become a passion for many people, where together with a specialised group they can improve their skills, technique, tactics and use of equipment to provide professional assistance. One of the important people who make up a Search and Rescue Group is the navigator.

It should be noted that search and rescue operations in Poland are managed by the police criminal division. In life-threatening situations, often at the initial stages of operations, the search is carried out on the part of the services by the National Fire Service, Mountain Volunteer Rescue Service, Tatra Mountains Volunteer Rescue Service or Water Volunteer Rescue Service. Modern tools and equipment used in the search for missing persons require familiarisation and practice among rescuers [2]. The interaction of services, as well as the involvement of other actors in rescue operations, requires specific coordination and often prior joint exercises. Acting ‚on your own' or ‚rushing in' can significantly hamper the work of the professional services.

Those wishing to become involved in assisting in the search for missing persons as a navigator should familiarise themselves with the specific tasks assigned to this function. To find an organisation dealing with this subject, the first steps can be directed to the criminal division of the police, the State or volunteer fire brigade or units of the Mountain Volunteer Rescue Service. These services often cooperate with local groups. Organisations and associations most often bring together volunteers to act in search and rescue groups. Members of these groups are eager to join in the search for missing persons, and these groups provide them with the opportunity to operate with modern equipment, participate in interesting training courses and take part in interesting projects.

AIM

The aim of the study is to present the role of the navigator in search and rescue operations and to discuss the key elements of their training, including terrain navigation, compass and GPS receiver operation, as well as practical methods of improvement within the rescue team.

MATERIAL AND METHODS

The material consisted of applicable instructions and materials concerning search tactics [3], publications and guides on navigator work and terrain navigation, as well as technical documentation for GPS receivers [4]. The method of work was a review of the literature and an analysis of

practical training procedures used in search and rescue groups. The author's observations of various Search and Rescue Groups (SRG) and his experience of participating in numerous exercises, manoeuvres and training meetings resulted in the development of his own navigator training programme.

REVIEW AND DISCUSSION

Search organisations in Poland and related groups conduct formal training courses for people whose activities include navigation (using maps, compasses, GPS), search area planning, documentation and practical exercises. The courses end with a theoretical and practical examination [5, 6].

In practice, Volunteer Fire Brigades (VFB) or GPR organise meetings with more experienced navigators from other services to obtain the necessary information on how to improve their qualifications in the field of rescue search (equipment, formation, training, examinations) [7, 8].

National PSP regulations provide for cooperation with local GPRs, but also include training in the organisation of exercises and rescue techniques in the activities of Specialised Search and Rescue Groups (SGPR) [9].

Among the current structures dealing with search and rescue, increasingly centralised forms of action are emerging, aimed at standardising procedures, training and examinations. Interest is so great that the forms of examination previously used by the State Fire Service for the certification of dog handler teams specialising in terrain search and rescue are undergoing a thorough reorganisation, as they are unable to keep up with demand. In September 2025, the Association of Civil Search and Rescue Groups of the Republic of Poland was registered, which aims to unify activities, standardise training and certify rescue dogs [10].

THE ROLE OF THE NAVIGATOR IN SEARCH AND RESCUE OPERATIONS

Navigation is the activity of getting to a specific destination. The role of the navigator is not only to know how to orient himself in the terrain in order to carry out the set plan to search a sector, but also to have a broad knowledge of the use of equipment, communication, the application of search tactics and more. Depending on the specialisation of the group, he or she may take on varied tasks.

ORIENTATION IN THE FIELD

Orientation is the most basic function of a navigator. Hence, the ability to read a map, use compasses and GPS – should be mastered to the highest degree. This is especially true since search operations are often conducted at night. Modern equipment for determining one's own location and advanced terrain imaging capabilities (electronic map bases) can p12rove useless when they stop working or are affected by large errors. Awareness of such situations necessitates responsible preparation and the acquisition of much broader knowledge and skills than the mere operation of a smartphone app or even perfect use of a GPS receiver.

Depending on the search area, the navigator must be able to familiarise himself with the topography of the terrain. In a mountain area, it is particularly important to know the trails, the ridge ranges of the mountains, the valleys, rivers, streams, individual peaks and passes, the location of which in relation to each other allows orientation. Given that search and rescue operations are often carried out at night or in difficult weather conditions – these factors definitely make it difficult to determine one's position. In addition, in the mountains there is the danger of sudden and changeable weather conditions (fog, snowstorm, gloom, others). Skills in skiing, rope work or other specialised training may become essential for a candidate navigator.

Wetlands, standing water, deep ravines, rocky outcrops – are not only difficulties during the search being carried out and obstacles limiting the ability to navigate the terrain, but also important landmarks for the navigator.

Locally, each area has its own characteristic landmarks (towers, hills, buildings, roads, points of interest) in relation to which, residents often identify potential areas to search. The navigator should understand the map of the area sufficiently to correctly infer from conversations with locals which places are indicated by the local community as relevant to the search. It should be stressed that not every person will be able to pinpoint specific characteristic points on the map. Therefore, care should be taken not to be tempted to ask locals or witnesses to point out places on a map when we are not sure that these people can interpret it correctly.

During search operations, the navigator should mark places to be checked with specialised equipment (e.g. wells, ponds) or other places excluded from the search (e.g. inaccessible behind fences).

A rather unusual task for the navigator may be to orientate in a building that is being searched by a team with a dog. This is when the navigator concentrates on guiding the handler to successive rooms and memorising their location in order to guide the team through all floors and not miss any of the rooms. The dog handler is then able to focus his attention on the work of the animal and direct it to areas that are difficult to access.

Another task of the navigator attached to the mantrailing dog handler is to ensure the safety of the team (e.g. that they do not step in front of an oncoming vehicle) or to document the dog's trail of work, together with marking the locations to which the dog handler draws attention.

LEADING THE TEAM

The navigator is often the team leader who has the knowledge of what tactics to adopt and which way to go in order to achieve a specific objective. He or she leads the other team members, ensures that the planned route is followed correctly, and coordinates the tasks of others. In a stressful situation (which is what we are dealing with when saving life and limb), the team leader must show composure, concern for the team, communication skills and decisiveness.

When leading a Rapid Search Triage, he is in the middle of the three-person team. Based on the detection range, he determines the distance of the people on either side of him and keeps an eye on the correct pace of movement. The navigator manages turnarounds or changes in moving tactics [3].

When driving a quad using the SPD (Detailed Road Search) method, the navigator marks characteristic places on the GPS device (junctions, end of the road, etc.) creating a road network diagram on the fly and marking the progress in searching the designated sector [11].

When working with a field dog handler, the navigator moves behind him in order not to interfere with the dog's observation and control of the animal. He communicates by voice the direction of the handler's march, specifying it in degrees or clock hours and stating the direction to turn. In doing so, the navigator avoids reference to landmarks so as not to distract the handler from observing the dog. When the team stops, the navigator positions himself facing the direction of the march, signalling with his posture the further direction of movement. Based on the map and knowledge of his own position, the navigator informs the handler of approaching dangers (e.g. road, cliff) or sector boundaries. After unsuccessfully searching the designated sector, the navigator directs the team to the area of a substituted posse to verify the dog's work [12].

ENSURING COMMUNICATION

Communicating one's location may require radio skills. Communication with the command centre is an important part of the team's safety, but it is also an opportunity to communicate vital information regarding the search and rescue operation, for example finding the missing person or their belongings. The way in which the location is communicated must not be in doubt, hence knowledge of the different formats of GPS coordinates, map legend and world directions seems extremely important. Being able to communicate with another search and rescue team often makes it possible to establish important issues concerning the search of common sector boundaries or the transmission of important messages (e.g. the appearance of another team's rescue dog).

During radio correspondence, it is useful to remind the navigator to say the addressee of the correspondence twice in his/her call message, followed by his/her own call. For example: „Base, base report to Zork". Messages should be given slowly, clearly, concisely and specifically – to limit transmission time. Any receipt of a message should be acknowledged by the addressee (e.g. „Understood"). Communications already in progress shall not be interrupted.

It is becoming increasingly common to find smartphone apps, or locators, that continuously track a team's location, making it easier for staff to deploy teams and speed up decision-making. However, in difficult terrain and poor weather conditions, these tools can misidentify people's location and confirming this through communication with the team becomes crucial. Another thing to note here is that the determination of own position should be done with reference to directions relative to the north. It can be incorrect to understand the sender's position through the terms: „to the right", „at the top", „behind me", etc., and should not be used.

PRE-MEDICAL FIRST AID

Many times it is the team with the navigator that finds the missing person. It is then necessary to immediately assess the psychological and physical state of the person and provide possible pre-medical first aid. The aim is therefore often to train the navigator in first aid and equip him/her with a first aid kit.

OTHER TASKS OF THE NAVIGATOR

It is impossible to describe all the roles that a navigator may perform, but more advanced tasks are to be expected as experience is gained. It should be emphasised that during a search and rescue operation, additional activities should always be carried out in consultation with the search commander. Being aware of the collection of search-relevant information about the missing person and traces of the missing person can contribute to the success of the search operation. The navigator's training in missing person profiling – there may be value in briefly interviewing randomly met witnesses and asking them questions relevant to the search. When the navigator performs his or her primary roles automatically, he or she can focus his or her attention on finding likely traces of the missing person (shoe print, clothing, etc.). Traces documented and consulted with staff – can also prove valuable to the work of rescuers.

Experience and skills in the use of GPS equipment and map reading, can help in the organisation and coordination of search and rescue exercises. In such an aspect, the role of the navigator focuses on setting sector boundaries for the work of the search teams, deploying the posse in the planned sectors, dividing and assigning tasks to the search teams, up to coordinating their activities and constructively discussing the exercise with the participants.

When exercising with rescue dogs, the way the dog works should be taken into account in order to adequately hinder or facilitate the animal's ability to find the posse in the field. The navigator should familiarise themselves with the theory of scent propagation and the specifics of how the dog works on a trail. When working with a field dog, wind plays an important role in carrying the scent molecules of the positor over long distances. When the wind direction is constant and there are no obstacles in the field, it can be assumed that the scent of the positor spreads from the positor in a cone shape. It is reasonable to move successively perpendicular to the wind direction and upwind when determining sector search tactics with the field dog.

A dog that moves with the team, crossing the scent cone, will have the chance, from a considerable distance, to locate the poser. The poser that is in the sector also leaves its scent trail in the field. This scent trail can be an important aid to the working dog – so the navigator, who plans the exercise, should know the route of the posers into the sector. For

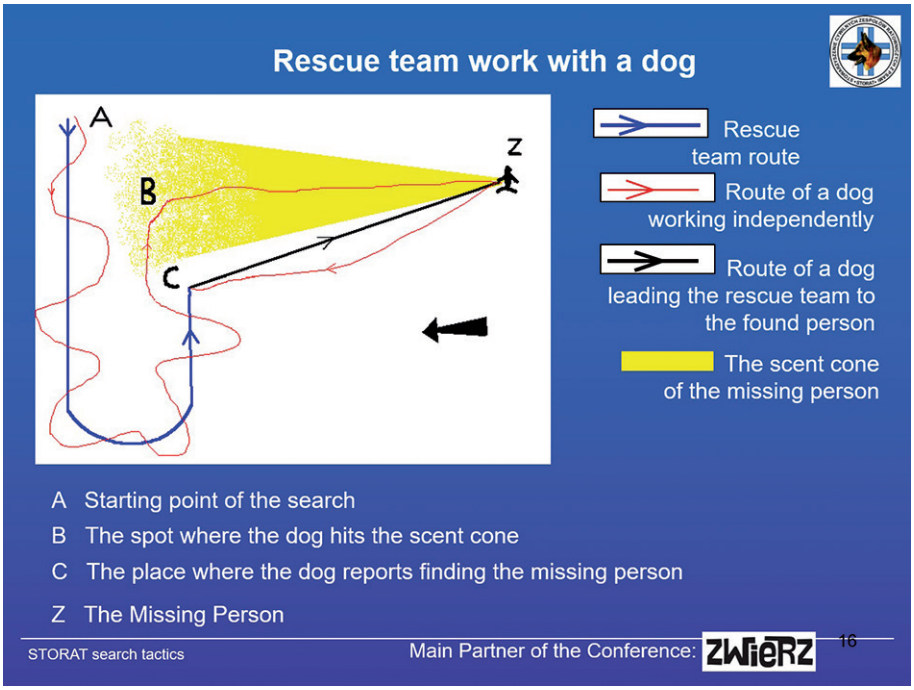

Fig. 1. Scent cone from a poser and team work with a field dog [12]

tracking dogs, there are many more important considerations. The timing of the trail placement and weather conditions can contribute to the disappearance of the poser's scent. But also the way the poser moves (number of turns) and the substrate on which he leaves his trace are important. In addition, the scents (footprints) of other people or animals can effectively impede the dog. The navigator who organises exercises for handlers with tracking dogs must therefore discuss a number of factors with the handlers in order to adequately meet the objectives set for the team.

A COURSE IN MAP READING AND COMPASS USE IN THE FIELD

The author has undertaken to develop the necessary content and skills to act as a search team navigator. Mastering the many ways to determine directions of the world can help you spot equipment malfunctions or avoid your own mistakes when navigating. The methods presented for learning to read a map or use a compass will enable the reader to attempt practical exercises. The order of the proposed exercises has been arranged according to the principle of graded difficulty.

DETERMINING WORLD DIRECTIONS

In order to determine one's position in the field, it is necessary to refer to other points which are located in space. With reference to the sun, as well as other celestial bodies, it is relatively simple to determine the direction of north and then the other main directions of the world (Fig. 2). Only when the Sun is at zenith above the Earth's horizon will the direction of north coincide with the shadow line [13].

At other times of the day, an analogue watch can be used to determine the direction of midnight. By setting the watch horizontally and with the small hand towards the sun, the direction of south will be determined by the bisector of the angle between 12 o'clock and the small hand. North will be directed behind the observer. If the observation is carried out in the afternoon then the angle is also divided in half between the small hand pointing towards the sun and 12.00, where midnight is also behind the observer [14].

A gnomon can be used to determine the directions of the world at different times of the sunny day. On a flat surface of the ground, stick a straight stick vertically and mark the end of the cast shadow on the ground. After waiting several minutes, mark the end of the shadow cast by the stick on the ground again. The combination of the

Fig. 2. Determining the main directions of the world from the sun at zenith [13]

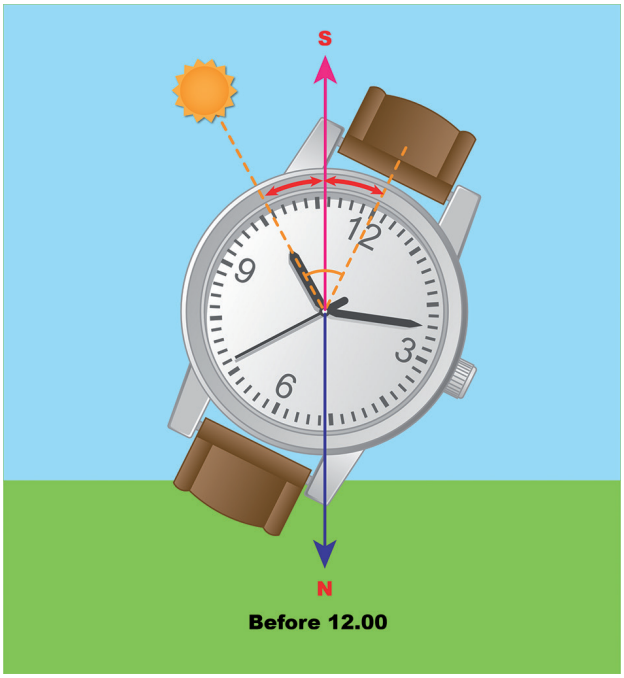

Fig. 3. Determining the direction of midnight from a watch [14]

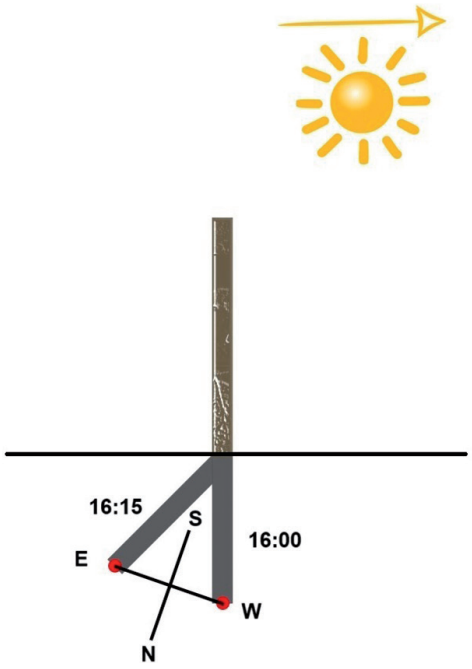

Fig. 4. Determining the main directions of the world using a gnomon [15]

two marked points on the ground will determine an east-west line, while a north-south line runs in the middle of this section and perpendicular to it – with north being at the extension of the shadow (Fig. 4).

North direction at night is most conveniently determined from the position of the Pole Star (which is located at a distance of five times the distance between the rear wheels of the Great Cart). North is in the direction of the shortest line drawn from the Polar Star to the horizon (Fig. 5).

Knowing the direction of north is insufficient to reach a specific destination. It is also necessary to relate one's position in the field to other landmarks or to have the ability to read a map. For an understanding of topography and, in a broader sense, terrain science, the author encourages the reader to consult the study by Piotr Wozniak [16]. However, without delving into the complex possibilities of mapping terrain on a map, the author believes that the first focus should be on learning to read a map.

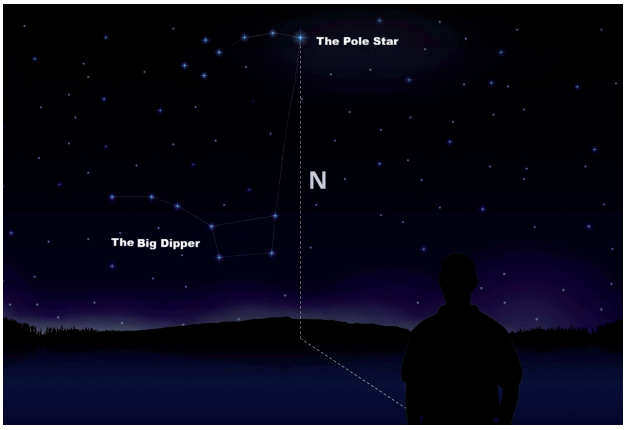

Fig. 5. Determination of the direction of north from the Polar Star [14]

READING A MAP

The content of a map consists of various topographical symbols. These conventional signs are explained in the map legend, which is placed on the map sheet. Map marks are divided into [17]:

Contour (surface) – describing field objects. The marks consist of an outline inside which a symbol, colour, pattern is placed (e.g. forests, meadows, lakes).

Punctual – describing objects that are too small to be represented to scale (e.g. monument, shrine, petrol station). The centre of the base of the sign corresponds to the actual location of the object.

Linear – describing objects that cannot be faithfully represented in terms of width (e.g. roads, rivers, power lines). The axis of the sign corresponds to the actual location of the object.

Explanatory – occurring in conjunction with others, as a complement to them (e.g. a blue arrow on a river indicates the direction of a current; a brown number indicates the height above sea level).

For the ordering of topographic signs, be aware that their colour is not random. Blue stands for hydrography (waters, rivers); green for vegetation (forests, meadows); brown for relief (landforms); black for human activities and descriptions (e.g. roads, summit heights). An important element of the map, and one that is difficult to interpret, are the terrain mapping markings – contour lines. Contour lines (horizons) – are brown lines connecting the same points of height above sea level on the map. Depending on the scale of the map, baseline lines can be drawn every

Fig. 6. Contour lines and slope index

Source: Own materials

5, 10, 20 or even 50 metres. Bold is every tenth or fifth line. The variation in altitude and terrain are important reference points for the navigator. In order to orientate yourself among the contours on the map as to which is higher and which is lower, pay attention to the markings: the brown numbers on the contours, the peaks with a specific height, the course of watercourses – which will start at the source and merge into increasingly larger streams, the slope lines – marked by a short perpendicular line to the contour (Fig. 6).

The first step towards map reading should be to obtain paper hiking (topographic) maps showing the immediate vicinity of one's home at a scale of at least 1:50,000. Then one should roam the area and match the markings on the map (legend) to the objects observed (roads, buildings, bridges, power lines, forests, rivers, relief, etc.). Such an activity will stimulate interest in both the objects in the field and their recording as cartographic signs on the map. Identifying field objects and landforms with markings on a map is known as topographical orientation. The next stage may be studying a map to develop a route plan for the excursion and then implementing it in the field together with reading the map and paying attention to the numerous terrain objects and cartographic marks on the map. According to the author, the form of planning the route and then moving according to the plan – is the best way to remember the map legend.

An extremely important issue when reading a map is to be aware of the magnitude of the reduction in reality, i.e. the scale of the map. On paper copies, the scale can be represented as a denominated form (e.g. 1 cm – 0.5 km), a linear scale or a numerical scale (fraction). A map scale of 1:50000 means that 1 centimetre on the map corresponds to 50000 centimetres in reality. For a simpler interpretation, it is sufficient to delete the last two zeros of the denominator. The number then obtained corresponds to the number of metres in relation to one centimetre on the map, i.e. a distance of 1 centimetre on the map corresponds to 500 metres in the field. On electronic maps, the scale is usually represented by a segment described by a number in specific units, which corresponds to the distance in the field.

USING A COMPASS

A compass is a device in which a magnetic needle points to the Earth's magnetic pole (direction of north). Care should be taken not to store the compass in close proximity to sources of magnetic field (e.g. radio stations) as this risks permanent damage to the equipment (demagnetisation of the needle). When using the compass, care must be taken to ensure that metal objects, a high voltage line, a watch or a smartphone do not interfere with the reading of the magnetic needle. The compass is a more sophisticated measuring tool than a compass, whose magnetic needle only determines the north direction. The movable ring in the compass allows for easy measurement and reading of angles (Fig. 7).

When using the compass in the field, it should be held properly in the hand. Positioning should be horizontal to the ground so that the magnetic needle can rotate freely and is not blocked by the bottom or top of the compass box. The course line should face in front of the user and the string should be closer to the user (possibility of hanging around the neck). Care should be taken to ensure that the compass held in the hand is pointing with the course line perpendicular to the user's shoulder line. When repositioning the compass course line, rotate with it around its vertical axis, changing the position of the feet. Turning the compass ring so that 0 degrees or „N" is on the course line – means that an azimuth has been set on the compass. Azimuth is the angle between the north direction and the direction of march, measured in degrees clockwise (to the right). The term route is used to describe the direction of the march according to the chosen azimuth. When plotting a route on a map, the direction of movement should be marked and described with a fraction, with the azimuth in the numerator and the distance (in metres, paces or steps) in the denominator, and possibly the walking time. The practice of using a compass and marching to azimuth boils down to marking out a short section of march using the compass to a characteristic point in the terrain. Once you have reached a characteristic point in the terrain, use the compass again and take a new lookout point (characteristic point).

Distinguish between the north indicated by the compass needle and the north marked on the map. North on the map is so-called geographical north, indicating the geographical pole of the Earth, the place where all the meridians converge. Geographical north is otherwise known as true north. If the north direction is not marked on the map, maps are usually oriented so that the edge of the map is the north-south direction, while place names are written along an east-west line. The north magnetic

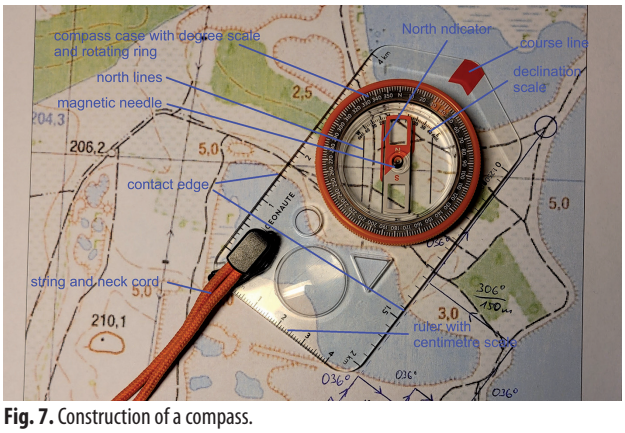

Fig. 7. Construction of a compass.

Source: Own materials

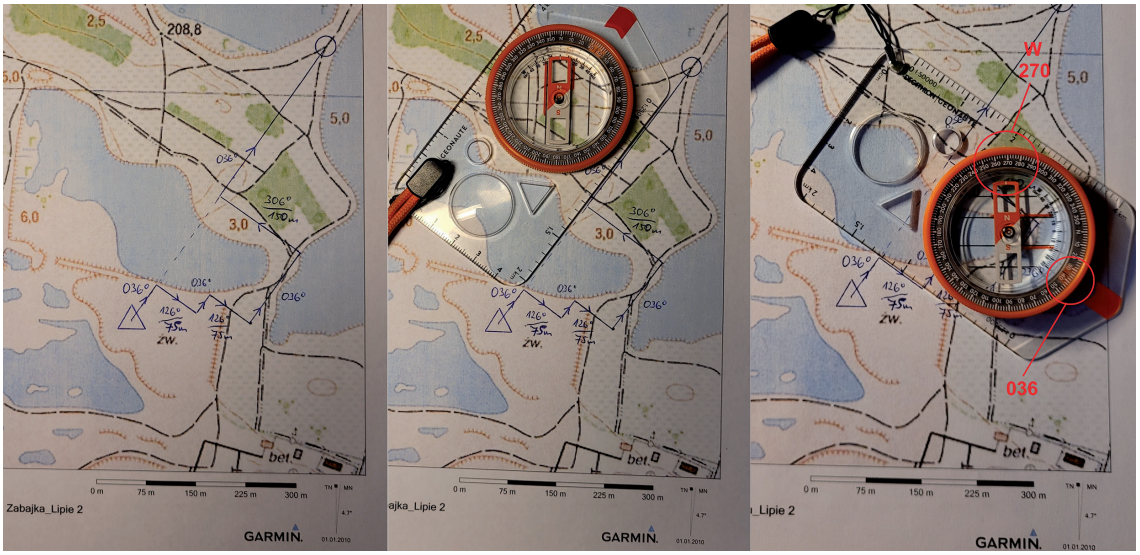

Fig. 8. Avoiding an obstacle and turning right with a compass

Source: Own materials

pole changes its position and does not coincide with the geographic pole. The magnetic declination is the angle between the magnetic meridian and the geographical meridian. The value of this angle is positive to the east and negative to the west of the geographical meridian. If the declination is less than 3 degrees, it can be ignored in practice. If, on the other hand, the declination value is not indicated on the map, it can be estimated using a geomagnetic calculator for a given location on Earth (https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml#declination). To take the declination into account when using the compass, it can be set on the device. Simply adjust the declination scale by a certain value (Figure 7. Construction of a compass.). When determining the direction of north on the map, care must be taken not to confuse it with the map's topographic grid lines, which run parallel to each other by a certain distance. These geodetic north lines (grid lines) do not correctly show the geographical north direction [17].

Calculating distances in the field using steps takes practice and practice. It is important to remember that step length decreases in overgrown or uphill terrain. In contrast, it increases when walking on hard ground or downhill. In order not to make a mistake when counting your steps, you can note down dozens of them. Another way may be to break a stick into the appropriate number of tenths of steps and then put them from one pocket to another until the first pocket is empty. A good practice for measuring distances is to compare the distances of the distances: the one that has just been walked with the one that, according to the map, is to be walked (e.g. similar length or half as long or twice as long, etc.).

During the course of the route, you may encounter obstacles that prevent you from moving along the set azimuth. When circumnavigating an obstacle (e.g. pond, swamp), the easiest way is to turn perpendicularly to the right (or left). In practice, when a specific azimuth is set on the compass, it is sufficient to make a 90-degree turn to the right. The magnetic needle will then point west (or east if turning right) and the direction line will indicate the new walking direction. Then measure the distance away from the original azimuth until you can return to the original azimuth (turning to the right so that the magnetic needle shows the direction of north). After passing the obstacle, turn perpendicularly to the left, i.e. the opposite of the original course (or to the right, if bypassing turned left) and necessarily count the distance measured when deviating from the original course. After covering an equivalent distance, return to the original azimuth (Fig. 8).

A COURSE IN USING A GPS RECEIVER

A GPS receiver is a sophisticated device used to determine one's own location, but also to record a trace of a change in position or to delineate a search area. It is now widely used in search operations. An essential element of the receiver is the map background displayed on the screen. Up-to-date and detailed topographic maps supported by orthophotomap overlays or three-dimensional lidar maps allow for easier orientation in the field and planning of the marching route. For exploration, push-button receivers without a touchscreen, which can complicate use in severe weather conditions, are best suited. It should be stressed that, as with a compass, a GPS receiver is only a device to help determine one's position, which is subject to error. Being in a deep ravine or under wet tree leaves – the signal from the satellite is significantly attenuated and makes locating difficult – so you cannot rely on the device alone. In practice, the GPS accurately locates your position as you move because it takes into account an additional variable – your last position. When you stop, you can see on the device (especially if you zoom in on the map) how your own location, calculated on the fly, changes. For this reason, it is best to use a compass or simply move in order to find the correct walking direction.

Fig. 9. GPS receiver

Source: Own materials

GPS RECEIVER DESIGN AND PRINCIPLE OF OPERATION

The author's own observations show that the most commonly used GPS receiver in search operations is the Garmin 62 GPS model and newer, therefore the basic use of the device in search and rescue operations will be discussed on their example (Fig. 9).

According to the manufacturer's recommendations, after changing the power source, a significant change in temperature or travelling a significant distance (more than 100 km) with the receiver switched off, it is recommended to carry out a calibration [4]. To do this, scroll the screen to Compass, select Calibrate from the Menu and follow the messages that appear. Note – GPS rotation should be done slowly (4-5 seconds per rotation). Only after the device has tracked the satellites will the flashing question mark displayed in place of the Current own position disappear from the screen. If the device has difficulty in determining its own location, it may display the message: „Unable to find satellites. Continue searching?" Note: If „No" is selected in response to the message – the question mark will disappear and the unit will enter Demo mode, which means that displayed maps and on-screen values, will refer to the last position memorised by the receiver. In Demo mode, it is also possible to move the Current own position. To do this, after confirming a point on the map (e.g. indicated by the Map Cursor) and selecting Go, confirm Go to position. Please remember to switch off the demo mode before using the GPS receiver in the field!

The GPS satellites deployed around the earth send out a signal, where the most important aspect is the time of day the signal is transmitted. The GPS receiver compares the time the signal was sent with the time it was received and calculates the signal's travel time. Knowing the travel time and the speed of the signal, the device calculates the distance to the satellite. It is necessary to connect to at least three satellites to determine its position.

GPS RECEIVER OPERATION

Using a GPS receiver for searching involves adjusting its settings. Depending on the service, the navigator may receive coordinates in different formats, hence the need for the ability to change the position format. It is imperative that the co-ordinates given by the radio receiver are written down on a piece of paper and then entered into the GPS receiver. This will avoid the error of recording the position, if it would be given in a different format than the one set in the GPS (Main menu – Configuration – Position format). The most commonly used position formats are:

- hddd° mm'ss.ss" (DNS – degrees, minutes, seconds – 51°06'38.6 „N 17°01'56.5 „E);
- hddd° mm,mmmm' (DMM – decimal degrees and minutes – 51 6.6433333333 17 1.9416666667);
- hddd.dddddd° (DD – decimal degrees – 51.110735, 17.032366);
- 34U EV 78783 56379 (MGRS – UTM zone 100 km easting [m] northing [m]).

The display of the north direction (Configuration – Direction – Display – Numerical degrees) and north reference (Configuration – North reference – Actual) must also be configured. As the sector to be searched can be based on waypoints, care should also be taken in the settings to enable the option of directly linking points (Configuration – Routing – Activity – Direct routing). Otherwise, the device will attempt to merge waypoints by navigating on the roads and paths of the map, completely distorting the boundaries of the prepared sector.

When the map is displayed on the screen, you can call up the change of map settings via Menu. When using the GPS receiver in the field, it is convenient to enable the option to rotate the map according to the direction of travel (Menu – Map Configuration – Orientation – Direction at the top). Note then that on the map Direction north will follow the north direction as the GPS receiver rotates. In the Map Configuration, also disable the automatic zooming option (Map Configuration – Advanced map settings – Adjust zoom range – Automatic zoom – Disable). When the map is displayed on the GPS receiver's screen, you can measure the distance and take a bearing. To do this, select any of the four function keys once to make the arrow (Map cursor) appear, then use the function keys to move the map cursor to the corresponding point on the map. Two values will be displayed at the top of the screen: distance in metres and bearing in degrees (see Fig. 9.)

USING THE GPS RECEIVER DURING SEARCH AND RESCUE OPERATIONS

One of the first actions upon arriving at the search site should be to mark the base location on the GPS receiver. To do this, select the Mark button – a screen will appear with the coordinates of the current position and the number of the point to be created. Instead of a consecutive number, a unique point name can be entered and the changes confirmed.

The receiver automatically records its trace. To facilitate the work of the planners and the transparency of the recorded data, it is advisable to clear the current trace before proceeding (Trace Manager – Current trace – Clear

current trace). On the other hand, after completing the fieldwork it is recommended to save the current trace under a name compatible with the format: date and team name (e.g. 2025-02-28 Zorka).

To delineate a search sector, traces are most often used whose connected points form the shape of a sector. Less commonly, a sector is created as a planned route, where the connected points of the route form the outline of the search area. The track or sector route data can be copied to the GPS device from a PC or transferred between GPS receivers via Bluetooth (Main menu – Send wirelessly – Receive). Only one planned route can be displayed on the GPS device (Route planning – Route 001 – Show map – Drive) and multiple traces at the same time (Trace manager – 2025-02-15 STP2 – Show on map).

CONCLUSIONS

The author hopes that the description of the navigator's role and tasks will help emerging search and rescue teams to organise training and improve the skills of their members. Perhaps they will also encourage the reader to undertake training so that they can then assist in search operations. The courses described: map reading, compass use and GPS receiver use are just the beginning of the journey to fulfilling the important and responsible role of navigator in a search and rescue team.

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CONFLICT OF INTEREST

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REVIEW ARTICLE

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Efficacy of diagnostic and therapeutic methods for post-traumatic stress disorder (PTSD) with special consideration for health care workers as a risk group

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ABSTRACT

Post-Traumatic Stress Disorder (PTSD) is a complex condition caused by exposure to a threatening or horrific event. Its recognition as a major health problem rises, especially among risk groups like healthcare workers. This narrative review compares diagnostic tools commonly used to diagnose PTSD: Clinician-Administered PTSD Scale for DSM-5 (CAPS-5), PTSD Checklist for DSM-5 (PCL-5), Structured Clinical Interview for DSM-5 (SCID-5), and International Trauma Questionnaire (ITQ) in terms of their psychometric properties and practical utility across different clinical settings. Furthermore, the review analyses evidence-based therapeutic approaches for PTSD, including Prolonged Exposure (PE), Cognitive Processing Therapy (CPT), Eye Movement Desensitization and Reprocessing (EMDR), Narrative Exposure Therapy (NET), and pharmacotherapy. Findings indicate that CAPS-5 remains the diagnostic gold standard, offering excellent psychometric properties but is limited by its time-consuming nature and the lack of a Polish adaptation. Self-report instruments such as PCL-5 and ITQ show high reliability and strong screening potential but require careful interpretation due to the risk of self-report bias. Among therapeutic methods, PE, CPT, and EMDR demonstrate the highest efficacy. However, only PE and CPT are included in first-line treatment recommendations of American Psychological Association (APA). The review emphasizes the urgent need to adapt and standardize diagnostic tools based on the International Classification of Diseases 11th Revision (ICD-11), as well as Polish adaptation for already existing, efficient tools. It also highlights the necessity of further research on the effectiveness of PTSD therapies among Polish healthcare workers.

KEY WORDS

PTSD, diagnosis, psychotherapy, healthcare workers

INTRODUCTION

According to the International Classification of Diseases, 11th Revision (ICD-11), Post-Traumatic Stress Disorder (PTSD) comprises three main symptom clusters: re-experiencing, avoidance and a persistent sense of threat. The disorder is triggered by exposure to an exceptionally threatening or horrifying event or series of events, which may be experienced directly or, in some cases, indirectly [1].

PTSD is a prevalent mental disorder, although its global incidence is difficult to determine precisely. On average, the estimated prevalence of PTSD in the general population is 3.9%, while among trauma-exposed individuals, it is 5.6% [2]. However, a meta-analysis of the Polish population indicates a PTSD prevalence ranging from 22% to 41%, with wide confidence intervals influenced by the sociodemographic structure of the groups and the severity and diversity of traumatic events [3].

Naturally, the primary factor differentiating occupational groups is the degree of exposure to traumatic events, with military veterans traditionally considered the highest-risk group. This is associated with the harsh conditions experienced during armed conflicts and the very origins of the PTSD concept, which trace back to the American Civil War („Soldier's Heart") and World War I („Shell Shock") [4]. However, healthcare workers (HCWs), such as nurses, paramedics, and physicians, also belong to a high-risk group for developing PTSD, especially during health crises like the COVID-19 pandemic, when the overall prevalence reached 13.52% [5]. Even in countries with a relatively low spread of COVID-19, such as the Republic of Cyprus, the number of HCWs reporting PTSD symptoms was elevated [6]. In Poland, studies indicate that the prevalence of PTSD among paramedics can be as high as 37% [3]. Furthermore, all HCWs are at risk, as PTSD can develop not only from direct threats but also from witnessing the suffering of others and the consequences of traumatic events [7].

Over the years, numerous diagnostic tools based on various criteria (including Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-4), Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), and ICD-11) have been developed and validated. Due to the prevalence of PTSD across all societal groups, appropriate

treatment is as crucial as an accurate diagnosis. Currently, various methods of psychotherapy and pharmacotherapy are employed [8]. Effectively mitigating the problem of PTSD fundamentally depends on the accurate diagnosis of the disorder, which presents a significant diagnostic challenge. It requires the use of a reliable diagnostic tool, yet no single universal instrument exists. This also makes it impossible to accurately estimate the scale of the problem and, consequently, to plan preventive and therapeutic actions. This article aims to present the most important diagnostic methods and forms of assistance, which will translate into a more adequate and informed selection of them for specific situations and tasks.

AIM

The aim of this review is to analyse and compare the most commonly used diagnostic tools for identifying PTSD based on DSM-5 and ICD-11 criteria. The study intends to evaluate their psychometric properties, practical utility, and scope of application in various clinical contexts, with a particular focus on the Polish population. An additional goal is to review and discuss current, evidence-based therapeutic methods used in the treatment of PTSD, including Cognitive Behavioural Therapy for Trauma (CBT-T), Eye Movement Desensitization and Reprocessing (EMDR) therapy, and pharmacotherapy. The review aims to identify the advantages and limitations of individual diagnostic and therapeutic methods and to formulate practical conclusions regarding their selection based on the diagnostic purpose, clinical context, and available resources, while also considering healthcare workers as a risk group.

MATERIAL AND METHODS

This article is a narrative literature review. The analysis included selected diagnostic tools used in the diagnosis of PTSD: the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5), the PTSD Checklist for DSM-5 (PCL-5), the Structured Clinical Interview for DSM-5 (SCID-5), and the International Trauma Questionnaire (ITQ), as well as aforementioned methods for treating PTSD. The diagnostic tools were compared in terms of their diagnostic value, including psychometric parameters, practical features, and alignment with the latest criteria (DSM-5 or ICD-11). Therapeutic methods were selected purposefully, based on current international guidelines for PTSD treatment. The literature analysis was conducted using the electronic databases PubMed and Taylor & Francis Online, covering the years 2010-2025, as well as recommendations from national and international authoritative institutions. Validation studies, meta-analyses, and, where possible, publications concerning Polish adaptations of diagnostic tools and therapeutic methods were included.

REVIEW

DIAGNOSTIC TOOLS

The CAPS-5 is a structured, 30-item clinical interview based on DSM-5, recognized as the gold standard for the clinical diagnosis of PTSD [9]. According to Weathers et al., the CAPS-5 demonstrates excellent psychometric properties, including high reliability (κ=0.78-1.00), good test-retest stability (ICC=0.78), high internal consistency (α=0.88), and convergent validity with previous versions of the scale (r=0.83 with CAPS-4). A low correlation with measures of anxiety and depression (r=0.02-0.54) confirms its discriminant validity. The interview's structure allows the clinician to expand the assessment with additional questions and minimizes errors arising from self-presentation, which can occur with self-report questionnaires. It enables a formal diagnosis of PTSD. Wojujutari et al. also confirmed the test's flexibility and consistency across different cultural contexts and language versions. It also serves as a benchmark for the validation of other tools [10].

The PCL-5, like the CAPS-5, is based on DSM-5 criteria. It is a 20-item self-report questionnaire. The PCL-5 is widely used in clinical practice and scientific research for screening for PTSD, assessing symptom severity, and monitoring treatment progress [11]. Its Polish version is characterized by satisfactory psychometric properties. High internal consistency (α=0.95) and test-retest reliability (overall coefficient rtt=0.81) were established. High theoretical validity was also confirmed [12]. Other studies show that the PCL-5 accurately reflects universal, culturally independent indicators of PTSD, but in cross-cultural research, it is necessary to verify measurement equivalence in the analysed populations each time to confirm the scalar equivalence of the tool [13]. According to a meta-analysis examining the questionnaire's accuracy, an optimal cutoff score of 36 was determined, with a sensitivity of 82% and a specificity of 76%, although it was noted that for some patient groups (e.g., veterans), this needs to be adjusted [14].

The SCID-5 is one of the most frequently used clinical tool for diagnosing mental disorders. It consists of multiple modules that assess individual nosological units based on DSM-5 criteria. According to Osório et al., who studied the psychometric properties of its clinical version, the interview for diagnosing PTSD is characterized by high validity (sensitivity=100%, specificity=96%, and κ=0.8) and reliability (0.84) [15]. It also has significant internal consistency (α > 0.89) [16]. A Polish adaptation is in preparation, so its previous version, based on DSM-4, is still in use, which also features high validity and reliability as well as higher specificity than self-report questionnaires [17].

The ITQ is a self-report, 18-item tool for assessing PTSD or complex PTSD (cPTSD) – a condition newly introduced in ICD-11. The questionnaire is based on ICD-11 and assesses its three symptom clusters: re-experiencing, avoidance, and a persistent sense of threat, as well as disturbances in self-organization (DSO), which include difficulties in emotion regulation, difficulties in relationships, and a negative self-concept [1]. Numerous studies validated its clinical utility and satisfactory psychometric parameters, and its Polish version has achieved good internal consistency (α=0.887) and confirmed convergent and discriminant validity [18, 19, 20].

The data presented in Table 1 indicates that all compared diagnostic tools for PTSD demonstrate high internal consistency (Cronbach's α ≥0.88). Tools based on the DSM-

Table 1. Comparison of Diagnostic Tools for PTSD

Diagnostic Tool	Based on criteria	Tool Type	Internal consistency (Cronbach's α)	Polish adaptation
CAPS-5	DSM-5	Clinical Interview	$\alpha = 0.88$	NO
PCL-5	DSM-5	Self-report Questionnaire	$\alpha = 0.95$	YES
SCID-5	DSM-5	Clinical Interview	$\alpha > 0.89$	NO
ITQ	ICD-11	Self-report Questionnaire	$\alpha = 0.887$	YES

Table created by the authors based on conducted research and information from cited articles [9, 12, 16, 20]

5 criteria (CAPS-5, PCL-5, and SCID-5) remain dominant in clinical and research practice, while the ITQ represents the only instrument aligned with the ICD-11 classification, allowing for the diagnosis of both PTSD and complex PTSD. Self-report questionnaires (PCL-5 and ITQ) show greater accessibility due to existing Polish adaptations, whereas clinician-administered interviews (CAPS-5 and SCID-5) lack validated Polish versions.

THERAPEUTIC METHODS

Meta-analyses indicate that the strongest evidence of efficacy has been obtained for therapies classified as CBT-T and EMDR. There are various types of CBT-T; the best results were achieved for Prolonged Exposure (PE), Cognitive Processing Therapy (CPT), and Cognitive Therapy (CT), with weaker but still significant results for Narrative Exposure Therapy (NET) and Cognitive-Behavioural Therapy (CBT) without a trauma focus. However, there is insufficient evidence to confirm the effectiveness of psychodynamic therapy, which is one of the most popular psychotherapy modalities in Poland [21].

PROLONGED EXPOSURE (PE)

This method typically involves 12 weekly sessions [22]. In a safe environment, the patient works with the trauma imaginatively (during sessions) and in vivo (desensitization through confrontation with anxiety-provoking stimuli outside of therapy). Through psychoeducation and breathing techniques, the patient gradually learns to stop avoiding stimuli reminiscent of the trauma. The method aims to make the patient realize that the emerging emotions are not a real threat [23].

COGNITIVE PROCESSING THERAPY (CPT)

It usually consists of 12 sessions and lasts 6-17 weeks [22]. It serves to reduce PTSD symptoms by teaching the patient to notice and modify maladaptive beliefs about the trauma. It includes psychoeducation about PTSD, working with traumatic experiences to break the pattern of avoiding thoughts and feelings related to the trauma, and learning to evaluate and modify beliefs about the traumatic event [24].

EYE MOVEMENT DESENSITIZATION AND REPROCESSING (EMDR)

It typically includes 6-12 sessions, held once a week [22]. During the session, the patient mentally returns to the traumatic experiences and the accompanying fear and tension. Simultaneously, they follow the therapist's moving fingers or a moving point of light with their eyes. This serves to gradually reduce the intensity of emotional reactions associated with the trauma [25].

NARRATIVE EXPOSURE THERAPY (NET)

It consists of 4-10 sessions and lasts from 3 to 17 weeks [22]. It aims to develop an autobiographical story in which the trauma is a coherent part but does not play a central, dominant role. The creation of a chronological narrative of one's life focuses on traumatic experiences but does not omit positive life moments. This allows for considering events in a broader context. The method is particularly used for individuals with complex and repeated trauma [26].

PHARMACOTHERAPY

The American Psychological Association (APA) recommends pharmacotherapy only as a second-line treatment. The drugs with the most documented efficacy are selective serotonin reuptake inhibitors (SSRIs): sertraline, paroxetine, and fluoxetine, and selective serotonin and norepinephrine reuptake inhibitors (SNRIs) – venlafaxine [8]. However, only sertraline and paroxetine have been approved by the Food and Drug Administration (FDA) for the treatment of PTSD [27].

The duration, number of sessions, and recommendation levels according to the APA for each therapeutic approach are summarized in Table 2.

DISCUSSION

This review indicates that despite their high psychometric values, none of the diagnostic tools for PTSD are without limitations, and none represents an ideal solution. The CAPS-5 is the diagnostic gold standard, which, thanks to the ability to expand the interview with additional questions from the specialist conducting the test, can thoroughly assess the patient [9]. A broad systematic review comparing 24 different diagnostic tools based on psychometric parameters, including CAPS-5, PCL-5, and ITQ, recommended CAPS-5 as the preferred tool [28]. At the same time, conducting the assessment is very time-consuming, potentially taking a clinician up to an hour, which is problematic given the limited number of mental health specialists [29, 30]. The need for training to administer the test also reduces its potential for widespread use. A fundamental problem is the current lack of a Polish adaptation of the test.

Table 2. Comparison of therapeutic methods for PTSD

Treatment Method	Number of sessions	Treatment duration	APA Recommendations
Prolonged Exposure (PE)	1-30	1-30 weeks	First-line recommendation
Cognitive Processing Therapy (CPT)	12-17	6-17 weeks	First-line recommendation
Eye Movement Desensitization and Reprocessing (EMDR)	3-18	3-8 weeks	Second-line recommendation
Narrative Exposure Therapy (NET)	4-17	3-17 weeks	Second-line recommendation
Pharmacotherapy	-	1-24 weeks	Second-line recommendation

Table created by the authors based on conducted research and information from cited articles [8, 22]

The PCL-5, also based on DSM-5, can be a faster alternative to the CAPS-5. It does not require a clinician and takes the patient up to 10 minutes to complete. A clear advantage is the existence of a Polish adaptation. However, over-reliance on the PCL-5 for diagnosing PTSD can be risky. As a self-report tool, the PCL-5 is susceptible to misinterpretation and patient bias [31]. Furthermore, it requires adjusting the cutoff score depending on the group being studied. Therefore, it may be better suited as a screening tool, for example, for regular mental health assessments of at-risk groups, whether immediately after a trauma (disaster victims) or for those chronically exposed to such factors e.g healthcare workers or uniformed services.

The SCID-5, with its modular structure covering other nosological units, can be very useful in assessing co-occurring mental disorders. However, like the CAPS-5, it requires additional resources in the form of a significant amount of time and trained personnel. The lack of a Polish adaptation is also a limitation.

The ITQ is the only tool described here that is based on ICD-11, not DSM-5, which also reflects a significant shortage of questionnaires based on the WHO classification. This is a major problem, considering that it is the ICD classification, not the DSM, that is legally binding in Poland and Europe, even though the American classification is widely known among Polish mental health specialists. At the same time, this is a unique advantage of the ITQ, which is further enhanced by the existence of its Polish adaptation [20]. The ability to assess DSO symptoms is a very valuable aid in the differential diagnosis of PTSD and cPTSD. However, Foster et al. point to the unnecessary emphasis on trauma at the beginning of the form, which may cause bias, and note the problem of dichotomizing symptoms, which may be significant in subclinical or non-clinical populations - potential subjects for screening studies [32]. These and other problems arising from the very structure of a self-report questionnaire mean that the ITQ should not be a universal clinical tool [33].

PE, CPT, and EMDR appear to have the best therapeutic efficacy. Initially, EMDR therapy raised some controversy and doubts, but numerous studies have confirmed its effectiveness in treating PTSD, which has led to the development of this method. NET and CBT without a trauma focus are important alternatives if a person who has experienced a traumatic event cannot access APA-recommended therapies or if there are contraindications to their use [8, 21]. The epidemiology of PTSD among healthcare workers indicates that it is very important to increase awareness of factors that prevent the development of PTSD and, if it occurs, knowledge of available help options [3, 26]. It is also worth noting that NET is used to work with people who have experienced traumatic events multiple times. NET may be important in working with healthcare workers who are exposed to direct and indirect traumatization daily [26]. Moreover, therapies differ in duration. It might be advisable to use PE, as it can show effectiveness from the very first session [22].

LIMITATIONS

The primary limitations of this work stem from its methodology as a narrative review, which, unlike a systematic review or meta-analysis, carries a risk of selection bias and does not include a formal quality assessment of the cited studies. A major practical constraint arises from the analysis of key diagnostic tools: considered the „gold standard" – CAPS-5 as well as SCID-5 which are based on the DSM-5 classification. These tools lack official Polish validation and are fundamentally misaligned with the legally binding ICD-11 system used in Poland and across Europe. This discrepancy creates a significant gap between international scientific knowledge and local clinical practice, rendering recommendations for their use in Poland largely theoretical. Additionally, while healthcare workers are identified as a key risk group, the recommendations are largely extrapolated from general population data rather than specific research on this cohort. Consequently, this review should be regarded as a general overview of the topic, not an exhaustive analysis covering all variables such as comorbidities or the full complexity of trauma-related disorders.

CONCLUSIONS

In summary, diagnostic tools should be selected based on the diagnostic purpose. Self-report questionnaires like the PCL-5 and ITQ are better suited for screening, with the choice between them potentially depending on whether the researcher wants to rely on DSM-5 or ICD-11 criteria. For making a formal diagnosis, however, interviews conducted by a clinician are recommended, where the tool will be used

in the context of the specialist's knowledge and experience. The current lack of Polish adaptations is a serious problem, so that the most effective, evidence-based diagnostic tools can be used, their Polish adaptations must be developed urgently. A temporary solution may be the Polish version of the SCID-I based on DSM-4, which, despite its older criteria, has been successfully used in diagnosing PTSD [17]. It is also worth noting that the classification binding in Europe is ICD-11, which means that most diagnostic tools based on DSM-5 do not have a direct translation to the system integrated with most local healthcare systems. Therefore, it is in the best interest of all countries using ICD-11 to develop new tools that are integrated with their existing systems.

As research and international and national recommendations show, there is no single technique for working with people with PTSD. The choice of therapy is highly dependent on the patient's individual preferences and the availability of specific therapy methods in their place of residence. This review suggests that further research is necessary to determine the effectiveness of therapies in different occupational groups under Polish conditions.

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CONFLICT OF INTERTEST

The Authors declare no conflict of interest

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REVIEW ARTICLE

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Changes in ALS ERC 2025 Guidelines – possibilities of implementation in the Polish Emergency Medical Services System

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ABSTRACT

The ERC 2025 Guidelines aim to advance resuscitation practices across Europe, with this article examining their impact on the Polish pre-hospital system. Key updates emphasize „effective" two-person ventilation, encourage the I-gel over the laryngeal tube, and specifying mechanical ventilation settings (Vt 6-8ml/kg, RR 10/min). For defibrillation, while dual sequential defibrillation (DSD) is not routinely recommended, altering electrode placement for refractory VF is stressed. Adrenaline and amiodarone timing is clarified, particularly after the 5th shock in multi-shock protocols. ETCO2 is paramount for confirming endotracheal tube placement and monitoring CPR quality. Point-of-care ultrasound (POCUS) during CPR is advised only for highly experienced clinicians. Mechanical chest compression devices are for specific situations, not routine use. Critically, the guidelines highlight the inadequacy of two-person EMS teams for Advanced Life Support (ALS), advocating for three-person crews. Arrhythmia management updates include immediate cardioversion for post-ROSC hemodynamic instability, addressing underlying causes of sinus tachycardia, and a refined approach to asystole with P waves (CPR first, then pacing if immediately effective). Overall, despite new diagnostic and therapeutic considerations, the ERC 2025 Guidelines underscore the paramount importance of consistently high-quality basic resuscitation interventions.

KEY WORDS

The ERC 2025 Guidelines, advanced life support, resuscitation

INTRODUCTION

The European Resuscitation Council (ERC) Guidelines aim to present the latest scientific evidence related to cardiopulmonary resuscitation (CPR) and to improve the conduct of resuscitation procedures throughout Europe. The guidelines focus not only on treatment but also on preventing the occurrence of sudden cardiac arrest (SCA) both in-hospital (IHCA) and out-of-hospital (OHCA). The guidelines are updated every 5 years. This update also seeks to present the most recent findings from registries and statistical analyses [1].

According to the guidelines published on October 22, 2025, the incidence of out-of-hospital cardiac arrest (OHCA) varies by country, ranging from 31 to 243 events per 100,000 inhabitants. Resuscitation efforts conducted by trained Emergency Medical Services (EMS) teams are undertaken in an average of 55 cases per 100,000 inhabitants, and the average survival to hospital discharge is 7.5%. [2] Despite an increase in OHCA case reporting, the true number of incidents cannot be accurately estimated due to a lack of comprehensive registries in many countries [2, 3]. It should be noted that in a study conducted in 2019, Poland maintained a registry covering some parts of the country. However, in 2024, Poland did not report participation in OHCA case reporting. Furthermore, compared to 2019, there was an increase in ambulance response time in urban areas, exceeding 10 minutes [4].

Early recognition and timely initiation of resuscitation are crucial for improving survival [5]. The ERC guidelines place significant emphasis on enhancing public awareness of basic life support (BLS). Experts highlight that as many as 91% of OHCA cases had a medical etiology, with circulatory problems being the predominant cause [3]. In individuals under 50 years of age experiencing an SCA episode, up to 25% of cases may stem from genetic defects [6]. This underscores that only through a standardized management protocol focused on thorough patient assessment can appropriate therapeutic actions be effectively implemented.

An initial shockable rhythm occurs in 20% of OHCA cases and is one of the most important prognostic factors for both short- and long-term survival [3, 7]. It should be emphasized that the incidence of a shockable rhythm

and its duration are directly related to the time elapsed until the first rhythm analysis and the resuscitation efforts undertaken by bystanders [8]. This demonstrates the immense importance of public education in BLS.

The aforementioned data clearly illustrate the scale of the OHCA problem and its associated low survival rates. European countries exhibit differences in SCA incidence, the competencies of EMS personnel, and their scope of practice. ERC Guidelines updates facilitate the improvement of advanced life support (ALS) skills and a deeper understanding of the etiologies of cardiac arrest. However, efforts should be made to standardize management strategies in accordance with the latest medical knowledge and applicable legal frameworks in individual countries.

AIM

The purpose of this article is to present changes in the ERC 2025 Guidelines with specific reference to the Polish Emergency Medical Services system in pre-hospital settings. The scope of the discussed topic pertains to Advanced Life Support (ALS) procedures. This work has been divided into subchapters covering proper ventilation, airway management, resuscitation interventions, and cardiac arrhythmias.

REVIEW AND DISCUSSION

AIRWAY PATENCY AND VENTILATION

Maintaining airway patency and ensuring adequate ventilation are indispensable elements of effectively conducted cardiopulmonary resuscitation. This has been an obvious and undisputed fact for many years. The latest ERC Guidelines place strong emphasis on the correct execution of basic life support procedures. As the analysis of recent studies indicates, the effectiveness of bag-mask ventilation is often insufficient [9]. In 60% of patients who underwent resuscitation using the 30:2 compression-to-ventilation ratio, it was observed that more than half of the ventilation attempts were ineffective, which was associated with worse neurological outcomes [9]. For this reason, increased emphasis has been placed on providing „effective" ventilation from the very beginning of resuscitation. The role of the two-person ventilation technique has been highlighted, where one rescuer uses both hands to maintain a tight seal with the face mask [10]. Referring this to the Polish reality, where a significant portion of Emergency Medical Services (EMS) teams consists of two-person crews, greater attention should be paid to training medical personnel on the quality of proper ventilation performed by both single and two-person teams.

The ERC maintains the position that tracheal intubation should only be performed by experienced clinicians [11, 12]. It has been emphasized once again that there is no difference in the incidence of sustained Return of Spontaneous Circulation (ROSC) when comparing the I-Gel and endotracheal intubation [13]. Supraglottic airway devices (SAD), which are a common and recommended method for securing airway patency, were also evaluated for effectiveness. According to the cited studies, the percentage of successfully secured airways and survival to hospital discharge was higher in the group of patients in whom the I-Gel was used compared to the laryngeal tube (LT) [14]. In Poland, three types of SAD devices are generally available: the LT, the laryngeal mask airway (LMA), and the I-Gel. Service providers should conduct training and update recommendations to increase the awareness of emergency personnel in this area.

New ERC guidelines provide an explicit recommendation regarding mechanical ventilation in patients experiencing cardiac arrest. Initial ventilator settings should include Tidal Volume (TV): 6-8 ml/kg predicted body weight, Fraction of Inspired Oxygen (FiO2): 1.0, Respiratory Rate (RR): 10/min, Inspiratory Time (IT): 1-1.5s, Positive End-Expiratory Pressure (PEEP): 0-5 cm H2O, Peak Inspiratory Pressure (PIP): 60-70 cmH2O [15]. There is a significant disparity in the capabilities of mechanical ventilation devices with which Polish EMS teams are equipped. Some of these devices do not allow for the application of the standard recommended by the ERC. Each time, it is necessary to familiarize oneself with the available equipment and understand its application. In case of inadequate mechanical ventilation, one should revert to manual ventilation. Currently, there is a lack of scientific evidence determining which type of ventilation (manual or mechanical) is superior.

RESUSCITATION

It is widely known that only 4% of the energy released during defibrillation reaches the myocardium [16]. Based on this information, it seems logical that defibrillation of a critical mass of myocardium, targeting the largest possible area of fibrillating ventricles, will be a key factor influencing the success of the intervention[17, 18]. Due to differences across individual European countries, the authors of scientific publications cited in the ERC 2025 Guidelines mention the possibility of using manual paddles during defibrillation. However, it should be emphasized that the advantages of self-adhesive pads have been clearly highlighted. The ERC Guidelines distinctly indicate that the correct application of electrodes can be challenging. The preferred position remains anterolateral, with particular attention to the accurate placement of the apical electrode [19]. This electrode should be located in the left mid-axillary line, below the axilla, at the level of lead V6. This position is more straightforward to implement than alternative positions and minimizes interruptions in chest compressions. To achieve the aforementioned defibrillation of a critical myocardial area, it is important to place the electrodes in an anteroposterior configuration [20].

The period of several months leading up to the release of the latest Guidelines was filled with numerous discussions regarding the dual sequential defibrillation (DSD) strategy, its potential applications, and benefits for patients. In 2021, this strategy was described as being in the testing phase, and many hoped for its inclusion in the latest recommendations. DSD involves the use of two devices that deliver two electrical shocks almost simultaneously. One set of electrodes is placed in the standard anterolateral position, while the second set is applied in an alternative anteroposterior

configuration. Expert consensus does not recommend the routine application of this strategy. This is due to the fact that studies on this topic were terminated prematurely, failing to enroll the required number of participants. The application of this strategy in pre-hospital settings requires the use of two independent defibrillators, necessitating the presence of two Emergency Medical Services (EMS) teams during resuscitation. In some parts of Europe, this is very difficult to achieve or is associated with a significant time delay. Manufacturers' analyses of defibrillators indicate that the clinical implementation of the DSD strategy may result in device damage [21]. Currently, two large studies concerning the mentioned strategy are ongoing. Only after the results of these studies are obtained will final recommendations regarding the use of the DSD strategy be issued.

Refractory ventricular fibrillation (rIVF) is defined as a persistent shockable rhythm despite three electrical defibrillation attempts. While the Dual Sequential Defibrillation (DSD) strategy is not routinely recommended in this scenario, the guideline authors have increased emphasis on considering an alternative electrode placement. If standard defibrillation does not lead to rhythm conversion, altering the energy vector should be considered. This can be achieved by changing the electrode placement from an anterolateral to an anteroposterior position. The anterior electrode should be positioned on the left side of the chest, between the sternum and the nipple, with careful attention to avoid overlapping breast tissue in females. The posterior electrode should be placed on the left side of the spine, just below the scapula.

When performing resuscitation using an Automated External Defibrillator (AED), ERC 2025 recommends adhering to the device's prompts. Within the first resuscitation cycle, specifically the first two minutes from arrival at the patient's side, the monitoring mode should be switched to manual [22].

The varying levels of knowledge and skills among pre-hospital clinicians prompted experts to emphasize the importance of training in both resuscitation procedures and interventions, as well as the recognition of cardiac arrest etiologies. This is crucial because the peri-defibrillation pause for rhythm assessment should not exceed 5 seconds. When, during heart rhythm assessment in Advanced Life Support (ALS), doubts arise as to whether the cardiac arrest mechanism is asystole or fine ventricular fibrillation, it is recommended to always perform electrical defibrillation.

In the event of cardiac arrest in a monitored patient, if the observed rhythm is a shockable rhythm, the guidelines recommend performing 3 defibrillations in quick interwals. After each shock, it should be checked whether the SCA mechanism has converted to a perfusing rhythm, and if so, it is the duty of the ALS team to verify this. After 3 unsuccessful shocks, chest compressions and standard ALS procedures should be initiated as soon as possible. For the administration of both adrenaline and amiodarone, a sequence of 3 shocks should be considered as a single shock for timing purposes. This implies that when employing a strategy of three consecutive defibrillations, drug administration begins after the 5th shock. For non-shockable rhythms, the standard remains the same, and adrenaline should be administered without delay.

An exceptional situation that may occur during CPR is the partial return of consciousness in a patient without the return of spontaneous circulation. The incidence of such a phenomenon is rare, ranging from 0.23% to 0.90%. The 2025 Guidelines highlight that patients experiencing the aforementioned episode have a higher chance of a successful outcome from the interventions performed. Furthermore, they suggest considering the administration of low-dose sedatives and/or analgesics. An optimal treatment regimen has not been defined; local protocols should be followed [23]. Among the drugs mentioned in the guidelines and available within the reality of basic EMS in Poland, fentanyl and midazolam can be used.

The strategies for administration and dosages of adrenaline and amiodarone remain consistent with previous guidelines. In non-shockable rhythms, 1 mg of intravenous (IV) adrenaline should be administered without delay. In shockable rhythms, after 3 shocks, 1 mg of IV adrenaline and 300 mg of amiodarone should be administered. Adrenaline should be given every 3-5 minutes until the end of resuscitation (literally every 4 minutes, meaning every two resuscitation cycles, immediately after confirming a non-shockable cardiac arrest rhythm). Amiodarone, at a dose of 150 mg, should be repeated after the 5th shock. The guidelines permit the use of lidocaine instead of amiodarone if amiodarone is unavailable or contraindicated. Lidocaine is dosed at 100 mg after the third defibrillation and potentially 50 mg after the fifth defibrillation. Currently, there is no scientific evidence prioritizing intraosseous access over intravenous access. However, it has been clearly stated that two attempts to establish intravenous access should be made first, and if these are unsuccessful, intraosseous access should then be utilized [24].

DEVICES ASSISTING DURING CPR AND PATIENT TRANSPORT

ETCO2 (END-TIDAL CARBON DIOXIDE)

For several years, the end-tidal carbon dioxide (ETCO2) sensor has been standard equipment for every Emergency Medical Services (EMS) team in Poland. The ERC 2025 Guidelines emphasize the crucial role of measuring this parameter in Sudden Cardiac Arrest (SCA). Firstly, it is the only effective and reliable method to confirm the correct placement of the endotracheal tube. Auscultation and other elements of the patient's physical examination should not be prioritized over ETCO2 readings [25]. ETCO2 measurement reflects cardiac output, tissue perfusion, pulmonary blood flow, and the adequacy of patient ventilation. Therefore, this parameter allows for monitoring the quality of chest compressions. The ETCO2 value is primarily related to the depth, not the rate, of chest compressions. A decrease in ETCO2 values during resuscitation may indicate fatigue of the person performing chest compressions. The guidelines emphasize that ETCO2 measurement trends hold significantly

greater diagnostic value than a single reading. In predicting the likelihood of Return of Spontaneous Circulation (ROSC), one cannot rely solely on ETCO2 measurements but rather on the comprehensive clinical picture of the patient.

USG (ULTRASOUND) / POCUS (POINT-OF-CARE ULTRASOUND)

For several years, we have observed an upward trend in the use of point-of-care ultrasound (POCUS) during SCA. A review of the latest research unequivocally indicates significant discrepancies and heterogeneity in study findings. Heterogeneity of results was observed for decisions regarding ALS termination and in identifying potentially reversible causes of SCA. The guidelines highlight the challenges of misinterpreting examination results and obtaining optimal imaging within the brief 10-second pause for rhythm assessment [26,27,28]. According to the ERC 2025 recommendation, only clinicians highly experienced in POCUS should attempt this examination during ongoing CPR. To successfully utilize this device in pre-hospital care in Poland, emphasis must be intensified on clinical training in this area and on acquiring and refining experience. A single course without the opportunity for development and improvement of skills will not benefit patients, but will instead prolong the intervals between chest compressions

MECHANICAL CHEST COMPRESSION DEVICES

The ERC 2025 Guidelines reiterated recommendations from the previous edition. These devices do not enhance survival compared to manual chest compressions and should not be routinely employed [29-31]. Indications for their use include situations hazardous to personnel (e.g., patient transport) and when high-quality manual CPR is not feasible. Attention was, however, drawn to proper ventilation when these devices are utilized. This ventilation can be challenging due to mechanical forces that lead to reduced lung volumes, and the optimal ventilation method has not been determined. It was emphasized that the use of chest compression devices should be reserved for trained individuals to avoid resulting in prolonged periods without compressions.

EXTRACORPOREAL CARDIOPULMONARY RESUSCITATION (ECPR)

Despite uncertainty surrounding the evidence and their limited applicability – (only 10% of SCA patients typically qualify for this type of intervention) – ECPR is becoming increasingly popular [32]. Due to time constraints and the time-consuming nature of initiating this procedure, it is crucial for medical personnel to rapidly identify patients who could potentially benefit from this therapy. The guidelines present general criteria for patient qualification for ECPR, based on criteria established by major clinical centers worldwide. In the Polish context, there are several centers capable of performing this procedure. EMS teams whose arrival time to a facility potentially allows for considering such a procedure should be systematically trained in patient qualification and collaboration with dispatchers and the ECPR team.

NUMBER OF EMS TEAM MEMBERS

The ERC 2025 Guidelines explicitly state that the efficacy of ALS cardiopulmonary resuscitation performed by two-person teams is suboptimal. According to expert consensus, there is no evidence supporting an optimal adaptation of the management protocol to the working conditions of a two-person EMS team [33]. It has been emphasized that patient survival with a favorable neurological outcome is associated with the presence of a minimum of 3-person crews. Relating this provision to Polish realities should prompt service providers to increase EMS staffing levels, as permitted by statutory regulations, or to increase the number of 3-person EMS teams. After diagnosing SCA over the phone, the medical dispatcher should always send at least two two-person teams if a three-person team is not available.

CARDIAC ARRHYTHMIAS

The ERC 2025 Guidelines indicate changes concerning the management of tachyarrhythmias and bradyarrhythmias. The definition of hemodynamic instability in patients has also been expanded. The ERC 2025 Guidelines state that every patient immediately after Return of Spontaneous Circulation (ROSC) should be treated as hemodynamically unstable. The recommended standard of care for such patients is immediate electrical cardioversion or transcutaneous pacing.

The role of a thorough ABCDE assessment has been significantly emphasized, drawing attention to investigating the underlying causes of sinus tachycardia. Attempts to reduce heart rate through pharmacological interventions or electrical cardioversion in such a scenario may exacerbate the patient's condition. A rapid heart rate in patients, for example, with septic shock or hypovolemia, are compensatory mechanisms aimed at enhancing tissue and organ perfusion. Treatment for such a patient should focus on addressing the underlying cause rather than merely controlling the heart rate.

A properly conducted ABCDE assessment, including a 12-lead ECG, and a comprehensive patient history facilitate determining the correct treatment method for tachyarrhythmias. Compared to the previous edition, the ERC 2025 Guidelines have been expanded with new diagnostic and therapeutic modalities and present a more comprehensive approach to tachycardia management. Each time, before deciding on a treatment strategy (both determining cardioversion energy and potential pharmacotherapy), if available, the patient's baseline resting ECG record should be analyzed. QRS widening may result, for example, from conduction abnormalities such as bundle branch blocks or the presence of an accessory pathway. In such a situation, the patient should be treated according to the supraventricular tachycardia (SVT) protocol. As mentioned earlier, QRS widening in supraventricular rhythms can also result from coexisting pre-excitation syndrome. Adenosine administration in these types of arrhythmias may lead to physiological pathway blockade and enhanced conduction via accessory pathways, resulting in accelerated heart

rate, worsened hemodynamic performance, or SCA. The expanded management strategy may lead to uncertainty regarding the optimal therapeutic decision and should prompt EMS personnel to enhance their knowledge in electrocardiography. The ERC 2025 guidelines emphasize that in any situation where the decision is ambiguous, consultation with a specialist is warranted.

The changed management strategy also applies to patients with monomorphic VT where, based on history or medical records, EMS clinicians suspect structural heart disease or are uncertain about myocardial function prior to VT onset. In such patients, there is a high risk of acute deterioration, so even if they do not exhibit overt signs of hemodynamic instability, electrical cardioversion should still be performed. If the use of analgosedation may lead to a reduction in arterial pressure and a decline in patient performance, pharmacotherapy is the recommended treatment of choice [34].

In the presence of polymorphic tachycardia (Torsades de Pointes, TdP) with wide QRS complexes, ERC 2025 recommends the administration of 2g of magnesium sulfate and a potassium chloride infusion. Basic Emergency Medical Services teams lack the competency to administer potassium chloride, which prevents the full implementation of this recommendation in clinical practice. In situations where a patient has a prolonged QT syndrome, applicable strategies include isoprenaline administration (which is not feasible for Polish EMS teams as this drug is not routinely available in Poland) or transcutaneous pacing in overdrive mode. This type of pacing involves overriding the dominant ectopic focus by applying pacing at a rate higher than the patient's intrinsic heart rate. Such management reduces the likelihood of TdP degenerating into ventricular fibrillation (VF) [35].

The ERC Guidelines recommend initiating anticoagulation therapy in patients with atrial fibrillation after 24 hours, rather than the previously indicated 48 hours.

The energy levels for the initial cardioversion remain consistent with prior recommendations, specifically:

- Supraventricular Tachycardias (SVT) – 70-120 J
- Ventricular Tachycardias (VT) – 120-150 J
- Atrial Fibrillation (AF) – maximum Energy.

During therapy, the principle of energy escalation up to the third cardioversion, which should be delivered at maximum energy, still applies.

The management of bradyarrhythmias has not undergone substantial revisions. It has been more clearly emphasized that atropine may be ineffective and could paradoxically worsen the patient's condition in the presence of a high-grade atrioventricular block with a wide QRS complex. In the context of a basic EMS team in Poland, the second-line drug remains adrenaline at a dose of 2-10 mcg/min [36]. It should be remembered that adrenaline at this dosage can only be administered using an infusion pump, which is mandatory equipment for an ambulance. Training on the correct operation of infusion pumps in pre-hospital settings should be conducted.

The statement concerning asystole with P waves has been rephrased with much greater clarity, leaving no room for discussion.

ERC 2021 Guidelines: „Whenever a diagnosis of asystole is made, check the ECG carefully for the presence of P waves because this will likely respond to cardiac pacing."

ERC 2025 guidelines: „Whenever a diagnosis of asystole is made start CPR, and when chest compressions are paused for a rhythm check look at the ECG carefully for the presence of P waves because this may respond to cardiac pacing. If there is no immediate electrical and mechanical capture with pacing restart CPR."

The 2025 Guidelines clearly define the course of action. When assessing the rhythm during cardiac arrest and diagnosing asystole with P waves, chest compressions should be initiated immediately, and 1mg of adrenaline administered. During the 2-minute CPR cycle, preparation for potential cardiac pacing should be made. If, during the subsequent rhythm assessment, the presence of asystole with P waves is confirmed, and pacing can be performed without delay, its application should be considered. If hemodynamically effective cardiac output cannot be achieved through pacing, chest compressions should be resumed as quickly as possible. The clarification of this statement explicitly indicates that ventricular asystole represents a non-shockable cardiac arrest rhythm, and initially, resuscitation efforts should be conducted according to the ALS protocol.

CONCLUSIONS

The role of the European Resuscitation Council Guidelines is to refine and advance the care of patients in life-threatening conditions throughout Europe. While the changes introduced in 2025 may seem minor, they significantly impact the reality of clinical practice and thus can influence the prognosis for critically ill patients. The expert recommendations are based on continually updated and evolving scientific evidence. Despite continuous changes and the introduction of new diagnostic methods, the ERC 2025 Guidelines suggest placing greater emphasis on the quality of performed interventions, such as effective ventilation, high-quality chest compressions, and optimal placement of defibrillation electrodes.

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CONFLICT OF INTEREST

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REVIEW ARTICLE

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The role of point-of-care ultrasound in emergency medicine: A contemporary narrative review

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ABSTRACT

Point-of-care ultrasound (POCUS) has become a key diagnostic and decision-support modality in emergency medicine, providing rapid bedside imaging that improves early evaluation of time-sensitive conditions. This narrative review summarizes contemporary evidence on the use of POCUS for major emergency department (ED) presentations, including shock, acute dyspnea, chest pain, abdominal pain and trauma. A structured search of PubMed, Scopus and Google Scholar (2015-2025) identified systematic reviews, randomized trials, meta-analyses and key professional guidelines.

Across clinical domains, POCUS consistently enhances diagnostic accuracy and expedites management. In undifferentiated shock, multi-organ protocols markedly increase correct etiologic classification, particularly for obstructive and cardiogenic shock. In patients with dyspnea or chest pain, lung and focused cardiac ultrasound accurately differentiate cardiogenic from non-cardiogenic causes of respiratory failure, support early therapeutic decisions and reduce reliance on radiography and computed tomography. In acute abdominal pain, POCUS demonstrates high accuracy for biliary pathology, hydronephrosis, bowel obstruction and abdominal aortic aneurysm, enabling faster, radiation-sparing diagnostic pathways. In trauma, eFAST reliably identifies pneumothorax, hemothorax, pericardial effusion and intraperitoneal fluid, outperforming chest radiography in acute assessment.

Although POCUS does not replace comprehensive imaging or established diagnostic algorithms, evidence supports its role as a powerful adjunct that strengthens bedside assessment and improves process-of-care metrics in the ED. Its effectiveness remains strongly dependent on operator training, structured protocols and integration into clinical workflows.

KEY WORDS

point-of-care ultrasound, emergency medicine, shock, respiratory distress, abdominal pain

INTRODUCTION

Emergency departments (EDs) are increasingly affected by crowding, diagnostic delays and limited access to advanced imaging, while the case-mix of patients becomes older and more comorbid. In this context, tools that provide rapid, bedside physiological information without ionizing radiation are of particular value. Point-of-care ultrasound (POCUS), defined as an ultrasound examination performed and interpreted by the treating clinician in real time to answer focused clinical questions, has evolved over the last three decades into a core component of emergency medicine practice [1, 2].

Early emergency ultrasound was largely limited to trauma (FAST examination) and selected abdominal or aortic indications. Contemporary POCUS is used across the full spectrum of emergency care – from prehospital medicine through resuscitation bays to observation units – and includes cardiac, lung, abdominal, vascular, musculoskeletal, ocular and procedural applications. Recent narrative reviews emphasize that emergency physicians now routinely use POCUS to augment physical examination, refine differential diagnosis, guide time-critical interventions and monitor response to therapy at the bedside [1-3].

Professional societies have formally recognized this role. The American College of Emergency Physicians (ACEP) ultrasound guidelines define emergency ultrasound as an extension of the clinical examination and list core applications grouped into resuscitation, diagnostic, symptom-based, procedural guidance and therapeutic monitoring categories. These guidelines also outline training requirements, quality assurance processes and credentialing frameworks for emergency medicine POCUS [2, 4]. International recommendations similarly advocate structured curricula and integration of multiorgan POCUS into emergency and critical care practice [2].

Accumulating evidence supports the clinical impact of POCUS in several high-risk emergency presentations. In acute dyspnea, a recent systematic review and meta-analysis demonstrated that POCUS-integrated pathways improve key clinical outcomes compared with standard diagnostic strategies, including more accurate etiologic diagnosis and shorter time to appropriate therapy [5]. In undifferentiated

shock, a systematic review of emergency department patients showed that adding structured multiorgan POCUS to usual care increased overall diagnostic accuracy of shock type and final diagnosis from approximately 45-60% to 80-89% [6], underscoring its value as a diagnostic rather than purely therapeutic tool.

For non-traumatic abdominal pain, which remains one of the most common reasons for ED presentation, the evidence is more heterogeneous. A recent randomized, bicentric trial of adult patients with acute abdominal pain found that emergency-physician-performed POCUS did not significantly change the rate of exact diagnosis, use of laboratory tests or CT imaging, nor ED length of stay, although the examinations were feasible, rapid (median duration ~8 minutes) and safe [7]. Other studies suggest that in selected etiologies (e.g., biliary disease, renal colic, bowel obstruction), POCUS may narrow the differential diagnosis and reduce downstream imaging, but results depend heavily on operator training and clinical integration [2, 7].

Given the expansion of POCUS indications, the proliferation of handheld devices and ongoing changes in ED organization, there is a need for an up-to-date, clinically oriented review focused specifically on the role of ultrasound in the emergency department. The present article summarizes current evidence on emergency ultrasound across major symptom domains (shock and hemodynamic instability, acute dyspnea, chest pain, abdominal pain, trauma), with particular attention to diagnostic accuracy, impact on clinical decision-making and patient-relevant outcomes, as well as practical aspects of training and implementation in the ED setting.

AIM

The aim of this narrative review is to summarize contemporary evidence on the use of point-of-care ultrasound (POCUS) in the emergency department, with particular emphasis on: (1) core clinical applications in adult patients presenting with shock or hemodynamic instability, acute dyspnea, chest pain, abdominal pain and trauma; (2) the diagnostic accuracy and impact of POCUS on clinical decision-making and patient-relevant outcomes; and (3) practical aspects of implementation, including training, credentialing and quality assurance for emergency physicians and emergency medical services.

MATERIAL AND METHODS

This article is a narrative review based on a structured search of the PubMed/MEDLINE database. The search was conducted in November 2025 using the terms „point-of-care ultrasound", „POCUS", „emergency department", „emergency medicine", „shock", „dyspnea", „chest pain", „abdominal pain", and „trauma", combined with Medical Subject Headings (MeSH). Only human studies published in English from 2015 onwards were considered.

Eligible publications included randomized controlled trials, prospective and retrospective cohort studies, diagnostic accuracy studies, systematic reviews, and major professional guidelines relevant to emergency ultrasound. Articles focusing exclusively on pediatric populations or on radiology-performed ultrasound without involvement of emergency clinicians were excluded.

Reference lists of key systematic and narrative reviews were additionally screened to identify studies not captured in the initial search. Given the heterogeneity of study designs and outcomes, results were synthesized qualitatively and grouped by major clinical presentations (shock, dyspnea/chest pain, abdominal pain, trauma). This approach follows recommended methodology for narrative reviews in clinical medicine.

REVIEW AND DISCUSSION

POINT-OF-CARE ULTRASOUND IN UNDIFFERENTIATED SHOCK AND HEMODYNAMIC INSTABILITY IN THE EMERGENCY DEPARTMENT

Early identification of the underlying type of shock is crucial, as distributive, cardiogenic, hypovolemic, and obstructive shock require different therapeutic strategies and delays in appropriate treatment are associated with increased mortality. Recent systematic reviews confirm that multi-organ POCUS performed at the bedside substantially improves etiologic diagnosis in patients with undifferentiated shock in the emergency department (ED). In a PRISMA-guided systematic review including six ED studies and adult patients with non-traumatic undifferentiated shock, Berg et al. demonstrated that multi-organ POCUS increased overall diagnostic accuracy from approximately 45-60% with standard care to 80-89% when integrated with clinical information, without significantly changing the amount of fluids or vasopressors administered in the ED [6]. This suggests that the main added value of POCUS in this setting is improving early diagnostic certainty rather than directly changing initial resuscitation volumes.

A more recent systematic review focused specifically on undifferentiated shock in the ED (761 patients, 7 studies, 2018-2023) confirmed high sensitivity and favourable likelihood ratios of POCUS for identifying shock etiology, particularly obstructive shock [8]. The studies included in this review used multi-organ protocols combining focused echocardiography, lung ultrasound, inferior vena cava (IVC) assessment and, in some cases, additional abdominal or venous scans. In an Indian cohort of patients with non-traumatic undifferentiated hypotension, Patil et al. showed that adding a structured POCUS assessment to routine ED evaluation improved the accuracy of identifying the underlying cause of hypotension to 89%, compared with substantially lower accuracy of clinical assessment alone (around 45-47%) [8]. Similarly, Elbaih et al. reported that a RUSH-based multi-organ POCUS protocol in unstable polytrauma patients achieved a sensitivity of 94.2% and overall diagnostic accuracy of 95.2% for the underlying cause of circulatory instability when compared with the final clinical diagnosis [8].These data support the concept that protocolised, multi-organ ultrasound provides a rapid, structured framework for differentiating between major categories of shock in the ED.

The performance of POCUS in real-life ED environments has also been evaluated in prospective observational studies. In

a resource-limited emergency department, Rahulkumar et al. examined the utility of multi-organ POCUS for differentiating shock etiologies and found substantial agreement between POCUS-based and final clinical diagnoses, with a kappa index of 0.86 and an average examination time of 12 minutes [8]. POCUS showed good effectiveness in distinguishing obstructive, hypovolemic, and cardiogenic shock, while performance was less robust for distributive shock, where overlapping hemodynamic patterns and mixed etiologies are common. [8] In another study included in the same review, Ramadan et al. evaluated echocardiographic and ultrasound parameters used in an ED shock protocol and confirmed that integrating simple functional parameters (such as left ventricular function and right ventricular size) with IVC and lung findings improves identification of the primary shock mechanism and guides tailored therapy [8].

The impact of protocolised POCUS on diagnostic processes and time to treatment has been explored beyond the ED as well. In a prospective controlled study of rapid response team calls for acute respiratory and/or circulatory failure on hospital wards, Zieleskiewicz et al. implemented a handheld POCUS-guided management strategy. Adequate immediate diagnosis (compared with the final hospital diagnosis) was achieved in 94% of patients in the POCUS group versus 80% in the control group, and time to first treatment or intervention was significantly shorter (median 15 vs. 34 minutes) [9]. In-hospital mortality was lower in the unadjusted analysis but this difference did not persist after propensity score adjustment, suggesting that while POCUS clearly improves diagnostic accuracy and process-of-care metrics, its independent effect on survival remains uncertain [9]. Although this study was conducted on general wards rather than in the ED, it illustrates how a structured multi-organ POCUS approach can accelerate appropriate treatment in patients with acute circulatory failure.

Randomized and quasi-experimental data raise important nuances about the relationship between POCUS and hard outcomes. In the SHOC-ED randomized trial, a protocolised multi-organ POCUS assessment for undifferentiated hypotension and shock improved early diagnostic confidence but did not significantly change overall diagnostic accuracy compared with standard care (both arms achieved accuracy around 94%) and did not reduce mortality [10]. This suggests that in well-resourced EDs with experienced clinicians, POCUS may confirm and refine diagnoses rather than dramatically change them. Even more cautionary, Mosier et al. reported in a large retrospective cohort of 5,441 hemodynamically unstable non-traumatic ED patients that POCUS performed before any key intervention (fluid bolus or vasoactive therapy) was associated with higher in-hospital mortality (adjusted odds ratio 1.41; 95% CI 1.12-1.76) compared with patients who did not undergo POCUS, whereas POCUS performed after the first intervention had a more neutral association [11]. The authors interpreted this as a signal that extensive ultrasound evaluation before initiating basic resuscitation may introduce harmful delays, especially if scans are performed or interpreted by less experienced operators.

Taken together, contemporary evidence indicates that multi-organ POCUS in undifferentiated shock should be viewed as a powerful diagnostic adjunct rather than a stand-alone solution or a substitute for immediate resuscitation. Systematic reviews and cohort studies show that multi-organ protocols (RUSH and similar approaches) clearly improve etiologic diagnostic accuracy and frequently shorten time to targeted treatment, particularly for obstructive and cardiogenic shock [6, 8, 9].At the same time, randomized data and large observational cohorts emphasise that POCUS must not delay simple, high-yield interventions such as early fluid resuscitation, vasopressor initiation, and airway management, and that its effect on mortality is at best indirect and dependent on context, operator training, and integration with clinical judgment [10, 11]. For emergency departments and SOR-type services, this implies that ultrasound should be embedded in structured shock algorithms, performed by adequately trained clinicians as soon as life-saving measures have been initiated, and interpreted within the broader clinical picture rather than in isolation.

POINT-OF-CARE ULTRASOUND IN ACUTE DYSPNEA AND CHEST PAIN

Acute dyspnea and chest pain are among the most frequent reasons for emergency department (ED) visits and are associated with a broad spectrum of life-threatening conditions, including acute heart failure, acute coronary syndromes, pulmonary embolism, pneumothorax, pneumonia and acute respiratory distress syndrome (ARDS). Differentiating these entities based on history, physical examination, electrocardiography and basic laboratory tests is often challenging, particularly in elderly, multimorbid patients. Contemporary narrative and scoping reviews consistently describe multi-organ point-of-care ultrasound (POCUS), combining lung ultrasound (LUS), focused cardiac ultrasound and basic vascular scans, as a key tool for the rapid, bedside assessment of patients with dyspnea or chest pain in the ED [1, 12-14]. Piccioni et al. specifically summarized the potential role of POCUS in patients presenting with chest pain or dyspnea, highlighting its usefulness in differentiating cardiogenic versus non-cardiogenic causes of respiratory failure, identifying pneumothorax and pleural effusion, and detecting indirect signs of pulmonary embolism (PE) or acute coronary syndromes [12].

LUNG ULTRASOUND FOR ACUTE HEART FAILURE AND PULMONARY CONGESTION

Lung ultrasound has become central to the evaluation of suspected acute heart failure (AHF) in the ED. A recent comprehensive meta-analysis of LUS in AHF, pooling emergency and acute care studies, reported excellent overall diagnostic performance, with pooled sensitivity and specificity both above 90% for B-line-based protocols when applied in patients with acute dyspnea [15]. Earlier multicentre ED studies demonstrated that adding LUS to clinical assessment and natriuretic peptides significantly improves diagnostic accuracy in patients with diagnostic uncertainty. Buessler et al. showed that six- or eight-zone

LUS on top of the Brest clinical score increased accuracy for AHF compared with clinical assessment alone, particularly in cases where the initial diagnosis was equivocal [16]. In a German ED cohort, Glöckner et al. observed that a simplified eight-point LUS protocol, focusing on B-lines, had very high specificity (≈98%) but only moderate sensitivity for AHF overall; however, sensitivity improved when diuretic-pretreated patients were excluded, underlining how prior therapy can affect ultrasound findings [17].

Smaller prospective ED studies corroborate these findings. Yahia et al. reported that an eight-zone LUS protocol had a sensitivity of 91.9% and specificity of 100% for AHF, comparable or superior to NT-proBNP while providing answers much faster than biomarker testing and chest radiography [18]. More recently, Russell et al. extended this concept to the prehospital setting in a systematic review and meta-analysis, demonstrating that paramedic- or physician-performed LUS for suspected AHF had diagnostic characteristics similar to ED-performed LUS and facilitated earlier initiation of heart failure–directed therapy before hospital arrival [19, 20] .

Beyond single diseases, several ED-based studies and reviews emphasise that the combination of LUS with focused echocardiography and inferior vena cava (IVC) assessment is particularly powerful in undifferentiated dyspnea. The recent meta-analysis and critical appraisal of POCUS by Ceriani et al. concluded that, for dyspneic patients, a multiorgan approach (heart-lung-IVC) consistently provides higher diagnostic accuracy than isolated tests and allows for rapid risk stratification in both AHF and PE [14].

UNDIFFERENTIATED DYSPNEA: DIAGNOSTIC AND OUTCOME IMPACT

While diagnostic accuracy is crucial, contemporary literature increasingly focuses on whether POCUS actually improves clinical outcomes in patients with acute dyspnea. The systematic review and meta-analysis by Szabó et al., including randomized and quasi-experimental studies of POCUS-guided management versus conventional care, demonstrated that the use of multi-organ POCUS in acute dyspnea was associated with a significantly higher likelihood of appropriate therapy (odds ratio ≈2.3) and reduced need for additional diagnostic imaging, but did not significantly reduce in-hospital or 30-day mortality [5]. This aligns with the interpretation that POCUS primarily improves diagnostic precision and process-of-care metrics, with mortality being influenced by many downstream factors.

In a more recent pragmatic trial conducted in the ED, Ovesen et al. compared a POCUS-driven diagnostic strategy (focused lung and cardiac ultrasound) with standard evaluation in adults presenting with acute dyspnea. Integrating POCUS into the initial emergency physician assessment significantly shortened time to etiologic diagnosis without compromising diagnostic accuracy, although the study did not demonstrate a clear mortality benefit [13, 21]. Similarly, an ED observational study from a high-volume centre reported that adding point-of-care LUS to routine assessment of dyspneic patients resulted in high diagnostic performance and substantially shorter time to final diagnosis compared with usual care, confirming the feasibility of POCUS even in crowded emergency environments [22].

Overall, current data suggest that in undifferentiated dyspnea, multi-organ POCUS improves diagnostic confidence, accelerates decision-making and tends to reduce reliance on additional radiologic imaging, while its effect on hard outcomes such as mortality remains uncertain and likely context-dependent [1, 14].

PNEUMOTHORAX, PNEUMONIA AND ARDS IN ACUTE RESPIRATORY FAILURE

POCUS also plays a central role in the identification of pneumothorax and parenchymal lung disease in acute respiratory failure. A 2025 systematic review and meta-analysis by Bouillon-Minois et al., including 15 ED studies and more than 3,000 patients, compared chest ultrasound performed by emergency healthcare workers with chest radiography for pneumothorax diagnosis using computed tomography as reference. Bedside ultrasound had markedly higher pooled sensitivity (≈79%) than chest X-ray (≈48%), with similar very high specificity (≈99–100%) for both modalities, and superior negative predictive value [23]. These data confirm that, when performed by trained ED staff, chest ultrasound is more reliable than supine radiography for ruling out pneumothorax in acutely dyspneic or traumatized patients.

For parenchymal lung disease, LUS has proven useful in distinguishing acute pulmonary edema, pneumonia and ARDS. Lichtenstein's original work and subsequent validation studies underpin the BLUE protocol, a standardized LUS algorithm for acute respiratory failure that can differentiate common causes such as cardiogenic pulmonary edema, pneumonia, COPD/asthma exacerbations, PE and pneumothorax with overall diagnostic accuracy often reported above 90% [22, 24]. A recent narrative review by Sartini et al. summarised contemporary evidence indicating very high accuracy of BLUE-based approaches, with individual disease accuracies in the range of 93–100% for key entities such as pulmonary edema, pneumothorax and pneumonia in appropriately selected ED and ICU populations [25]. Furthermore, Boumans et al. conducted a 2024 systematic review and meta-analysis on the use of LUS for ARDS diagnosis and found that LUS is a reliable method for identifying ARDS in adult patients, supporting its integration into ED and ICU diagnostic pathways for severe respiratory failure [26] .

PULMONARY EMBOLISM AND OTHER CAUSES OF CHEST PAIN

In patients presenting with chest pain and dyspnea, suspected pulmonary embolism is a frequent concern. The PRIME randomized controlled trial evaluated a bespoke multi-organ ultrasound protocol (combining LUS, focused cardiac ultrasound and compression ultrasonography of leg veins) integrated into the diagnostic work-up of suspected PE. Falster et al. reported that this ultrasound-based strategy substantially reduced referrals for advanced diagnostic

imaging (such as CT pulmonary angiography) compared with standard care, but at the cost of an „unacceptable" failure rate (missed or delayed PE diagnoses), highlighting the risk of using ultrasound as a stand-alone gatekeeper in this context [27], Recent reviews suggest that multi-organ POCUS can meaningfully support PE risk stratification (e.g. detecting right ventricular strain, pleural-based infarcts or DVT), yet emphasise that it should complement and not replace validated clinical prediction rules and D-dimer/CT-based algorithms [14, 27, 28]

Regarding acute coronary syndromes, emerging data indicate that POCUS can help in early risk stratification by identifying regional wall motion abnormalities, left ventricular dysfunction and pulmonary congestion. A contemporary review by Wainstein et al. on POCUS in ST-elevation myocardial infarction (STEMI) patients stressed that focused echocardiography and LUS provide valuable information on hemodynamics and complications, but remain adjunctive to ECG and coronary angiography and should not delay reperfusion [14, 29].

POCUS IN NON-TRAUMATIC ABDOMINAL PAIN

Acute non-traumatic abdominal pain is another frequent and diagnostically challenging ED presentation. POCUS offers a rapid, bedside assessment of biliary, urinary, intestinal and vascular pathology without exposing the patient to radiation or contrast agents. A comprehensive review by Radonjić et al. summarised that abdominal POCUS has high sensitivity and specificity for many common conditions (e.g. cholelithiasis, cholecystitis, hydronephrosis, abdominal aortic aneurysm), and can reliably differentiate patients requiring further imaging or admission from those suitable for discharge [30].

High-quality trial data are emerging. In a prospective randomised bicentric trial, Brau et al. compared systematic emergency physician-performed POCUS plus standard care vs. standard care alone in adults with acute abdominal pain. POCUS was feasible and frequently contributed diagnostic information, but did not significantly increase the proportion of exact ED diagnoses or reduce ED length of stay overall, suggesting that a „POCUS-for-all" strategy may not be efficient in unselected abdominal pain [7]. Observational data, however, indicate that targeted POCUS – especially in patients with suspected biliary disease, renal colic, bowel obstruction or abdominal aortic aneurysm – is associated with shorter time to diagnosis, reduced use of CT and lower ED costs, with no signal of harm [31, 32].

In biliary and renal pathology, emergency physician POCUS repeatedly demonstrates diagnostic performance comparable to radiology-department ultrasound, particularly when positive findings are present. For suspected appendicitis, POCUS yields moderate sensitivity but high specificity; when combined with clinical scores and, if necessary, second-line CT or MRI, it enables radiation-sparing diagnostic strategies, especially in younger patients[30-32]. Abdominal POCUS is also an established first-line tool in suspected abdominal aortic aneurysm or rupture, where systematic reviews report pooled sensitivities and specificities above 95%, enabling rapid life-saving decisions in unstable patients [30, 31].

Overall, the literature supports a nuanced approach: POCUS should be used as a focused extension of the physical examination in patients with a high pre-test probability of ultrasound-accessible conditions, rather than as a universal screening test for all abdominal pain.

POCUS IN TRAUMA AND RESUSCITATION

Trauma care was historically the entry point for POCUS in emergency medicine, with the focused assessment with sonography for trauma (FAST) and its extension (eFAST) now widely integrated into ATLS-based resuscitation. Recent reviews confirm that eFAST has high diagnostic accuracy for detecting free intraperitoneal fluid, haemoperitoneum, pericardial effusion and pneumothorax. Bella et al. summarised that eFAST is a reliable, rapid tool in blunt and penetrating trauma, with particular strengths in ruling in life-threatening thoracic and intra-abdominal injuries during primary survey [33].

Newer studies have evaluated eFAST performance when performed by trainees or non-expert operators. Buyurgan et al. found that eFAST carried out by emergency medicine residents after focused training achieved sensitivities around 70% and specificities around 95% compared with CT, with most missed injuries being small or clinically less relevant, underlining the importance of structured education and supervision [34, 35]. Samson et al. reported even higher pooled sensitivity (~98%) and specificity (~99%) for hemothorax and pneumothorax in blunt chest trauma, with eFAST outperforming chest X-ray and physical examination [36].

Outside trauma, POCUS is increasingly used during cardiopulmonary resuscitation to identify reversible causes of cardiac arrest (e.g. tamponade, massive PE, severe hypovolaemia). A systematic review by Reynolds et al. found that intra-arrest POCUS can identify some underlying etiologies but also carries a risk of prolonged interruptions in chest compressions if not performed within strict time limits, leading professional societies to recommend cautious, protocolised use [37].

TRAINING, IMPLEMENTATION AND LIMITATIONS

Across all indications, the evidence is consistent on one key point: POCUS is highly operator dependent. Diagnostic accuracy and clinical impact are tightly linked to the quality of training, frequency of use and local quality assurance. Recent guidance documents stress the need for structured curricula, supervised scanning, image archiving and periodic competency assessment for emergency physicians [14, 38] Studies of eFAST and abdominal POCUS performed by residents or students show that high specificity is achievable after relatively short training, but sensitivity and image quality may lag without ongoing practice and feedback [34, 35, 39].

Another challenge is the integration of POCUS into workflow without delaying time-critical interventions. Evidence from shock, dyspnea and trauma suggests that POCUS is most beneficial when it is embedded into early care, but not allowed to prolong decision-making or interrupt resuscitation [5, 37].Finally, most studies are single-centre,

with heterogeneous protocols and outcomes, which limits the ability to perform robust meta-analyses and to translate findings directly into universal algorithms.

Despite these limitations, the overall picture from contemporary literature and guidelines is coherent: POCUS is a powerful, bedside extension of clinical examination that, when used appropriately, improves diagnostic precision and process-of-care measures in the ED. The focus of future research is shifting from pure diagnostic accuracy towards patient-centred outcomes, cost-effectiveness and implementation strategies at the system level [14, 40]

CONCLUSIONS

Point-of-care ultrasound (POCUS) has evolved into a fundamental diagnostic and decision-support tool in emergency medicine. Evidence across major clinical domains demonstrates that POCUS enhances early diagnostic accuracy, increases diagnostic confidence and accelerates time-critical management, particularly in shock, acute dyspnea, chest pain, abdominal pain and trauma. Although POCUS does not replace comprehensive imaging or established diagnostic pathways, it consistently improves bedside assessment and supports more efficient resource allocation in the emergency department. Its effectiveness remains closely linked to operator training, structured protocols and appropriate clinical integration. Continued development of standardized curricula, quality assurance systems and emerging technologies- such as AI-assisted image acquisition- will further strengthen the role of POCUS in emergency care. Overall, POCUS should be regarded as an essential adjunct that enhances the safety, precision and timeliness of emergency department decision-making.

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CONFLICT OF INTEREST

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Model for integrating battlefield medicine with the civil security and health system

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ABSTRACT

The aim of this article is to present a conceptual model for integrating battlefield medicine into the national civil security and healthcare system in the context of contemporary challenges arising from the experience of armed conflicts, including the war in Ukraine. The analysis covers organisational, doctrinal and technological solutions enabling the effective use of military potential in the system of response to mass and crisis events and its adaptation to rescue operations in a civilian environment. Based on a review of the literature, NATO and EU normative documents, and medical practices observed during the conflict in Ukraine, an integration model based on three pillars was proposed: interoperability of structures, standardisation of procedures, and a common system of training and certification of medical personnel. The research findings indicate the need to update national standards for pre-hospital and hospital medicine based on experience in military medicine, especially in the field of mass casualty management, the use of conventional weapons and improvised explosive devices, and operating in conditions of limited resources. The proposed model involves incorporating combat medicine experience into the emergency medical services system and civil defence plans, which will increase the effectiveness of responses to emergencies, optimise the use of resources and strengthen health security. The article proposes a concept for civil-military cooperation in the field of health security medicine and emergency management.

KEY WORDS

battlefield medicine, civil security system, civil-military integration, interoperability

INTRODUCTION

Contemporary military and non-military threats reveal the need for close integration of battlefield medicine with the civilian security and health care system. Effective cooperation between these structures is one of the key elements in building a state's resilience to emergencies and mass medical incidents. Experience gained from warfare, rescue operations and mass events confirms that the boundaries between the civilian and military environments are gradually blurring. The integration of these areas is essential to ensure consistency of action, standardisation of procedures, effective use of available resources and continuity of care for the injured – from the scene of the incident, through evacuation, to specialist treatment. In the face of contemporary challenges such as armed conflicts, hybrid operations, terrorist attacks, technical disasters and natural disasters, the traditional division between 'military' and 'civilian' systems is becoming obsolete. The response to this process should be the creation of integrated emergency management models, in which the medical component capable of operating in extreme conditions plays a key role.

In this context, combat medicine (tactical emergency medicine) appears not only as a tool dedicated to the armed forces, but also as an important element strengthening the social and health resilience of the state. Its experience in dealing with casualties in combat conditions, organising the chain of care, patient care, medical evacuation, triage and medical logistics can form the basis for improving civilian response systems.

AIM

The aim of this study is to present a proposal for a conceptual model for integrating battlefield medicine with the civilian health and safety system, covering organisational, training and practical aspects. The author proposes solutions enabling effective cooperation between military and civilian structures in the field of emergency medicine and the identification of barriers and good practices that can form the basis for improving the medical response system in emergency and mass casualty situations.

MATERIAL AND METHODS

The analysis covers organisational, doctrinal and technological solutions enabling the effective use of military potential in the system of response to mass and crisis events and its adaptation to rescue operations in a civilian environment. Based on a review of the literature, NATO and EU normative documents, and medical practices observed during the conflict in Ukraine, an integration model based on three pillars was proposed: interoperability of structures, organization of procedures, and a common system of training and certification of medical personnel.

REVIEW AND DISCUSSION

CIVIL SAFETY AND HEALTH PROTECTION SYSTEM IN POLAND

The civil security and health protection system in Poland is a multi-layered organisational structure whose primary objective is to ensure the continuity of state operations, protect the population and respond effectively to all types of threats – whether natural, technological or man-made. Its functioning is based on the cooperation of many institutions, services and entities operating within separate but interrelated systems of medical rescue, internal security, crisis management and public health protection. [1-5].

COOPERATION BETWEEN SERVICES AND SYSTEMIC CHALLENGES

Cooperation between military and civilian systems in the field of battlefield medicine and health security requires an integrated approach based on consistent procedures, technological interoperability and mutual understanding of the specific nature of operations.

Initiatives that break down barriers to cooperation between the military, uniformed services and civilian services are becoming increasingly common. These include joint exercises involving uniformed services, workshops on TCCC and TEC, and the creation of health care training centres at military and civilian medical universities.

Despite the existing legal and organisational foundations, cooperation between civilian and military services in Poland still faces numerous deficits and challenges [7].

The most frequently mentioned ones include:

– ack of unified standards for training and certification in Tactical Combat Casualty Care (TCCC) and Tactical Emergency Casualty Care (TECC)
  Although both concepts form the basis of modern pre-hospital medicine in tactical situations, they are implemented in an inconsistent manner – different training programmes operate within the structures of the Polish Armed Forces, the Police, the State Fire Service and the State Medical Rescue System (PRM).
  Differences in the methodology of competence assessment result in limited interchangeability of personnel and hinder cooperation during real events;
– limited exchange of information and experience between ministries;
  There is a lack of permanent platforms for knowledge exchange, shared databases of tactical and medical events, and standardised reporting procedures. In practice, this hinders the analysis of the effectiveness of actions and the implementation of conclusions into the training and operational planning system. To this end, many NATO countries have introduced integrated Joint Medical Training and Simulation Centres (JMTC), which bring together military and civilian personnel in high-fidelity simulation-based exercises. Poland is only just beginning to develop such solutions. including through the creation of teaching centres at military or civilian universities with a medical profile;
– differences in command structures and communication systems;
  Research and analyses following joint exercises such as Kraj-Rescue, Anakonda, Patriot and Dragon indicate limited compatibility of communication systems, differences in decision-making structures and insufficient mechanisms for joint planning of medical evacuation and triage of casualties.
– insufficient preparation of some civilian rescue teams to operate in combat or mass casualty situations:
  • Standardisation of training and certification of competences within a uniform, inter-ministerial programme;
  • Creation of a common medical response doctrine, including interoperable TCCC/TECC procedures, medical evacuation (MEDEVAC) and medical support for combat and crisis operations;
  • Development of a common training and simulation infrastructure using modern VR/AR technologies and scenarios based on real events;
  • Implementation of data exchange and after-action review mechanisms for continuous improvement of procedures;

Increasing the resilience of the PRM system to military and hybrid situations through appropriate training, equipment and integration of communication channels.

In strategic terms, the integration of military and civilian medical structures should be a key component of building national resilience within the framework of the Total Defence concept and the National Security Strategy of the Republic of Poland. Only a coherent, integrated system will allow for effective action in multidimensional threats, such as hybrid conflicts, mass disasters or terrorist attacks.

THE ROLE OF THE HEALTHCARE SYSTEM

The healthcare system in Poland plays a key role in ensuring continuity of patient care at all stages – from first aid, through medical transport, to specialist treatment in high-level referral facilities. In the context of integration with battlefield medicine, the importance of the healthcare system becomes even more complex and multidimensional. It is not only about standard care, but also about the ability to respond in crisis situations that require rapid adaptation of infrastructure, personnel and medical procedures.

Preparing hospitals to receive trauma patients involves both logistical and operational planning. An important aspect is ensuring an adequate number of beds, operating theatres and life-saving equipment, while maintaining the safety of patients and medical staff. Triage procedures are also crucial, as they allow patients to be effectively sorted according to the urgency of their medical needs, which in situations of mass influx of casualties becomes an essential tool for effective resource management. The integration of the healthcare system with battlefield medicine also requires the development of mechanisms for cooperation between different levels of medical care and emergency and public safety services. This includes medical transport (both ground and, where possible, air), coordination with emergency services, and specialist support in trauma surgery, anaesthesiology and intensive care.

The ability to operate in conditions of limited availability of personnel and equipment is also particularly important,

requiring flexible organisational models and emergency procedures.

In practice, this means that the healthcare system does not operate in isolation from the civil security environment. Its role goes beyond standard medical care and becomes part of the state's strategic resilience to mass threats, including conflict and catastrophic crisis situations. In this context, staff training, crisis simulations and the development of medical infrastructure adapted to battlefield scenarios become essential elements of an effective system for integrating civil and military medicine.

THE IMPORTANCE OF INTEGRATION IN THE CONTEXT OF HEALTH SECURITY

The integrated functioning of the civil security and health protection system is one of the pillars of the state's resilience to threats [9].

The COVID-19 pandemic has highlighted the importance of coordination between ministries, public institutions, non-governmental organisations and the private sector. The lack of consistent procedures and communication channels in the early stages of the crisis contributed to delays in response and insufficient use of available resources. In turn, the experience of the war in Ukraine has highlighted the crucial importance of readiness for the flexible and integrated use of military and civilian resources within a single response model.

Joint planning, information exchange and interoperability of rescue and medical structures reduce response times and increase the effectiveness of operations [11-12]. Integration in the area of security means creating a common system of values, procedures and standards of operation that enables cooperation between different entities regardless of their institutional affiliation. In practice, this means not only formal organisational links, but also joint training, exercises and exchange of experience. Only cooperation based on trust, common procedures and mutual understanding can ensure the effectiveness of rescue operations in the face of contemporary challenges and threats [12-13].

SYSTEMIC ASSUMPTIONS OF INTEGRATION

The integration model should be based on several fundamental assumptions:

- Sharing competences and resources between military and civilian structures in the field of rescue and pre-hospital care;
- Recognising battlefield medicine as part of emergency medicine, not just military medicine;
- Preparing civilian medics and emergency services personnel to operate in combat or quasi-combat conditions (e.g. terrorist activity zones, technical disaster sites, mass incidents);
- Developing interoperable procedures and organisational structures enabling rapid response to irregular events;
- Training and certifying civilian personnel in TCCC/TECC standards and implementing these standards in national procedures.

LEVELS OF INTEGRATION: FROM STRATEGY TO OPERATIONAL ACTION

The proposed model assumes the integration of activities in three key dimensions:

A. Strategic level – policies and framework documents

At this level, it is necessary to:

- Inclusion of battlefield medicine as a component in national security policy documents (e.g. National Security Strategy of the Republic of Poland, Health Policy in Emergency Situations);
- Establishing advisory bodies and inter-ministerial working groups for the implementation of tactical medicine elements in the civilian sector;
- Including the issue in the defence plans of the Republic of Poland and the planning documents of the Government Security Centre.

B. Operational level – institutions and civil-military cooperation

At the operational level, the model predicts:

- Creation of joint training teams (civil-military centres of excellence in tactical medicine);
- Sharing of resources, including equipment, medical transport, simulators and trauma laboratories;
- Regular inter-institutional exercises, e.g. between the emergency medical services, Territorial Defence Force, fire brigade, police, emergency departments and military units;
- Standardisation of medical and communication procedures for crisis situations.

C. Local level – social resilience and field practice

At the local level, the model assumes:

- Training civilians in providing assistance in accordance with TECC standards;
- Introducing modules on the basics of tactical medicine to schools, universities and workplaces;
- Development of rapid response teams (e.g. volunteer fire brigade rescuers, trained volunteers, evacuation coordinators) with access to tactical medicine equipment;
- Creation of local medical response plans taking into account combat scenarios (e.g. explosion, mass casualties, active shooter attack).

COMPONENTS OF THE MODEL

Education and training

Integration of TCCC/TECC elements into the curricula of medical emergency services colleges and secondary schools with uniformed services profiles:

- Mandatory initial and periodic training for uniformed services and civil rescue services;
- State or ministry certification in tactical medicine;
- Cascade training model for local communities ('train the trainers')

Logistics and resources

- Standardisation of equipment in accordance with NATO and CoTCCC recommendations (e.g. CAT tourniquets, haemostatic agents, evacuation stretchers, not only rigid but also canvas);

- Purchase and deployment of IFAK kits and RTF (Rescue Task Force) backpacks in civilian units;
- Integration of evacuation systems (civilian and military MEDEVAC and possibly CASEVAC);
- Creation of mobile medical points capable of operating in dangerous areas.

Sharing information and procedures

- Uniform communication platform (e.g. based on SWD system solutions);
- Common triage and evacuation protocols;
- Procedures for cooperation at the scene of an incident (e.g. the 'clean–warm–hot zone' model)

Legal and institutional framework

- Amendment to the Act on Public Administration, on the state of emergency and martial law;
- Amendments to the Medical Professions Act regarding emergency response in combat conditions;
- Introduction of a formal framework for civil-military cooperation in the healthcare system.

AN EXAMPLE OPERATIONAL MODEL OF INTEGRATION (AUTHOR'S PROPOSAL)

As part of the proposed operational model, the author suggests creating:

- National Centre for Combat and Crisis Medicine Coordination (KCMK) – operating at the Government Security Centre, responsible for training, certification, developing guidelines, analysing resource needs and coordinating activities during crisis situations;
- Regional Competence Centres (RCC) – at medical universities, military academies and PSP/WOT headquarters, conducting training, simulations and personnel preparation;
- Local Tactical Rescue Teams (LZRT) – operating at OSP units, WOT, district hospitals and rescue services, constituting a real tool for initial response to mass threats using components of battlefield medicine.

CONCLUSIONS

The proposed model for integrating battlefield medicine with the civil security system involves moving away from the traditional separate treatment of military and civil services in favour of a joint front for medical operations in crisis situations. Tactical medicine can – and should – be integrated into the architecture of national resilience, both through institutional measures and through education and public awareness-raising. In this context, it is necessary to systematically integrate battlefield medicine into the national healthcare system, which will allow for the harmonisation of procedures, better use of resources and more effective response in emergency situations.

A key element of integration is the development of common procedures, training standards and a certification system for medical personnel, which will enable interoperability between civil and military structures. The development of interoperable response structures allows for the rapid mobilisation of medical resources and the effective management of trauma patients, even in conditions of limited availability of personnel and equipment. At the same time, building public awareness and health resilience based on military experience helps prepare citizens for crisis situations and raises the overall level of health security in the country.

In practice, specific institutional solutions may be considered, such as the establishment of a National Crisis Medicine Centre at the Government Security Centre or the implementation of a national TCCC/TECC training programme for civilian and military personnel. Such measures would not only enable the standardisation of procedures, but also the continuous improvement of medical staff competencies and the readiness of the healthcare system to respond to situations involving a mass influx of casualties.Implementing such a model requires constant monitoring, updating of procedures and investment in the development of medical personnel's competences, which allows for flexible adaptation of the system to changing threats and, in the long term, significantly increases the resilience of the state and the safety of its citizens.

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CONFLICT OF INTEREST

The Author declares no conflict of interest.

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CASE STUDY

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Meningitis in the course of *Neisseria meningitidis* infection in EMS team pre-hospital care – case study

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ABSTRACT

Aim: The aim of this paper was to present the issue of bacterial infections caused by Neisseria meningitidis from the perspective of the Emergency Medical Services (EMS) in pre-hospital care. The case of a 47-year-old patient to whom the primary emergency medical services (EMS) were dispatched due to chest pain and difficulty breathing was analyzed. Based on this, final conclusions were drawn.

Material and methods: Case report based on the Medical Rescue Card of the Basic Medical Rescue Team. During EMS team intervention he was differential-diagnosed toward intracranial hemorrhage or laryngological disorder due to increasing hearing impairment. Final in-hospital diagnosis was meningitis in the course of Neissera meningitidis. The case presents how insidious a neuroinfection can prove.

Conclusions: Early recognition of changes along with symptomatic treatment, also on EMS team level, allows preventing severe complications of bacterial meningitis.

KEY WORDS

infection, medical rescue, meningitis, pre-hospital care, *Neissera meningitidis*

INTRODUCTION

Infections are common ailments. In advanced stage they require intensive care in-hospital treatment and antibiotic therapy. Neisseria meningitidis (meningococcus) is an example of bacterial infection. It causes severe infection of sterile tissues and organs. Infection is usually in the course of purulent meningitis or sepsis, sometimes also pneumonia. In fewer cases meningoccoci cause conjunctivitis, otitis media, laryngitis, arthritis, endocarditis, pericarditis, urethritis and cervicitis. Thromboembolic issues, multiple organ dysfunction syndrome and sepsis are severe complications of invasive meningococcal disease.

AIM

The aim of this study was to present the issue of bacterial infections associated with Neisseria Meningitidis from the perspective of emergency medical services (EMS) in pre-hospital care. To this end the study analyzed the case of a 47-year-old patient.

CASE REPORT

Emergency Medical System rescue team (paramedics) has been dispatched early during the day to 47 year old male worker of city sanitation company who was suffering from acute chest pain and shortness of breath. The man was moaning, grunting, shivering, feeling aching behind the sternum since he woke up and pain for about half and hour.

Upon arrival on scene paramedics got hold of obese man sitting in dressing-room, sweating, pale, anxious, with tachypnoe.

SAMPLE interview was as follows:

S – chest pain (creasing and pressure) in the morning, now much smaller, creasing in upper-abdomen, difficulty breathing, sweating, impaired left ear hearing
A – none
M – formerly 5 mg Prestarium, currently none
P – blood hypertension
L – breakfast at home, about 5:00 am
E – worried by hearing impairment, increasing during work.

Patient denied recent injuries, infections and loss of consciousness. He smokes cigarettes and drinks alcohol on weekends. Reported cases of hypertension among his relatives.

Vital signs have been assessed according to ABCDE scheme (A – airway patency, B – breath rate, C – circulation. D – level of awareness, E – exposition) and physical examination has been performed.

A – clear
B – 20/min
C – 122 BPM, steady, CRT (Capillary Refill Time) < 2 s.
D – AVPU (A), Glasgow Coma Scale (GCS) 14 points – patient confused at times
E – pale skin, sweating, obesity, anxiety at times, no injuries, no peripheral edema, no lower-leg varicose veins, left side impaired hearing.

Normal respiratory sounds in auscultation, correct pupil dilation and response to light, blood pressure 190/100 mmHg. Stomach was distended and tense, peristalsis present. Heart sounds loud and clear. No paresis or paralysis. Smell from the mouth normal.

Glycemia: 347 mg%. Body temperature 36 Degrees Centigrade. Saturation 99%.

In 12-lead ECG: sinus rhythm, sinus tachycardia, no signs of arrhythmia, no ST segment abnormalities.

In neurological examination; patient confused, pupils dilation normal and even, with correct response to light. Meningism negative. Muscle tension and strength correct, sensation to touch correct, no paresis or paralysis. Babinski reflex negative, Kernig's sign negative, Romberg's test positive with deviation to the left. dizziness. Patient had slight nystagmus.

Patient had been secured, with two # 18G intravenous lines and constant ECG and pulsoxymetry monitoring.

Medication: 25 mg Captopril sublingual, 20 mh Hydroxizine orally, 300mg ASA (Polopiryna S) orally, 500 ml Plasmalyte intravenous, 2 g Magnesium sulfate intravenous.

Patient was transferred to an ambulance in seated position, on board he was placed in semi-seated position on the stretcher.

Before initiating transport patient had been reassessed.

A – clear, B – 16/min, with no breathing difficulty, C – 100 BPM, steady, CRT <2 sec., blood pressure 140/85 mmHg, D – at times confused, increasing hearing impairment, E – stopped sweating.

Patient was taken to hospital admissions room, with indication to be consulted neurologically as there was risk of intracerebral hemorrhage. Transport with lights and sirens took 10 minutes.

Before handing patient over in the admissions room, he was once again reassessed:

A – clear, B – 14/min, C – 95 BPM, steady, CRT <2 s., blood pressure 170/95 mmHg, D – confused, bilateral hearing impairment, E – none.

Table 1. summarizes the patient's vital signs during the initial assessment, before transport and before hospital transfer.

Patient was handed over to neurologist.

In the admissions room patient was examined physically and neurologically, with vital signs control. There was persistent hypertension, bilateral hearing impairment, nystagmus and slightly positive Babinski reflex on the right side.

In head computer tomography scan: intracerebral and pericerebral hemorrhage was excluded. Cerebrum CT scan image within norm, which did not exclude the early stage of acute ischemic changes.

Chest X-Ray: increased lung vascularity, single collagen cords in lower fields of both lungs, heart enlarged, degenerative and proliferative changes of thoracic spine.

Abdomen USG: no free air under hemidiaphragm, no level of free fluid in the abdomen.

Laboratory blood tests proven increased inflammatory reaction parameters – CRP 258,65 mg/l and Procalcytonin 1.07 ng/ml. Blood gas test results were within norm. Full blood morphology, ionogram and heart muscle damage markers were also within norm.

Patient had been transferred to laryngology admission room for consultation regarding acute hearing impairment.

After examination, laryngologist ordered a lumbar puncture. Fluid was cloudy and yellowish. Material was sent to laboratory for general analysis and multiplex (multiplex technique – nervous system infection panel allows detecting genetic material of 18 pathogens most frequently responsible for meningitis, therein viruses and bacteria, within the cerebrospinal fluid). The result indicated Neisseria meningitidis.

Final diagnosis was the bacterial meningitis. Hydration, antibiotic therapy (2 g of Ceftriakson intravenously), glucocortycosteroid (Dexamethasone every 6 hours intravenously), antipyretic medication and pain killer (Metamizole 2,5 g intravenously) were implemented.

Patient has been transferred to hospital with infectious disease department.

Table 1. Patient's vital signs

	A	B	C	D	E
Examination at first contact	clear	20/min.	122/min, regular, CRT< 2 s., BP 190/100 mmHg	AVPU – A, GCS: 14 points, sometimes tangled	pale skin, sweaty, obesity, periodically, anxious, no trauma or injuries, no peripheral edema, no varicose veins of the lower legs, hearing loss in the left ear
Examination before transport	clear	16/min, no difficulty breathing	100/min, CRT< 2 s., BP 145/85 mmHg	periodically confused, worsening hearing loss	the sweats stopped
Examination before transfer to the admissions room	clear	14/min.	95/min, regular, CRT < 2 s., BP 179/95 mmHg	confused, bilateral hearing loss	lack

Own source

CRT: capillary refill time, AVPU: alert, verbal, pain, unreaction, GCS: Glasgow Coma Scale, BP: blood pleasure

Personnel of the admission room, where the patient was initially treated, underwent antibacterial procedure. Also other patients and EMS team paramedics received preventive dose of antibiotic.

Co-workers and family of the patient have been informed.

DISCUSSION

EPIDEMIOLOGY

Bacterial meningitis concerns all ages within the population. Onset of meningococcal disease is acute, and death may occur within several hours. There are 500 000 cases of meningococcal illness reported each year. It is estimated that 50 000 of those patients die – especially children and young individuals. Mortality rate in case of invasive meningococcal illness is between 10 and 15%. Mortality depends on type and severity of invasive illness. People suffering meningococcemia, fulminant sepsis and shock die most frequently (50-60%), followed by meningitis and sepsis (up to 25%). Patients with meningitis without sepsis present the lowest mortality rate (less than 5%) [2]. Infectivity is an important aspect of infectious diseases. High concentration of people make disease transmission easier. Meningococcal disease research in Maryland (1992-1997) has shown that students living in campus were exposed to at least three times higher risk of becoming infected with meningococcus than students from outside the campus. Another state-wide research (1998-1999) regarding state medical faculties and university medical centers has shown that the frequency of meningococcal disease among 1st year students living in dormitories was 5,1 out of 100 000 compared to 0,7 out of 100 000 among students of all three years combined and 1,4 out of 100 000 among people aged 18-23 [3].

Research in England and Wales has shown the increase in the number of meningitis cases among adults in 2004-2011 period – the increase was about 3% per year among patients aged over 65. Morbidity rate among adults was estimated at 1,05 case per 100 000 citizens (between 2004 and 2011), with the highest morbidity in group aged 45-64 (1,21 per 100 000). Mortality rate in case of out-of-hospital bacterial meningitis increases with age and remains high – about 20% regardless of case, and up to 30% in pneumococcal meningitis [4, 5].

Polish research from 2019 covered 2239 cases of meningitis and encephalitis. This means decrease by about 19,9% compared to the year 2018. In viral infection group decrease was by 14% (from 1533 to 1318 cases). In 31% of all cases with bacterial etiology the etiological factor was one of the following three: Neisseria meningitidis, Streptococcus pneumoniae and Haemophilus influenzae [6].

PATIENT EXAMINATION

EMS team practice while responding emergency is based on implementing guidelines applicable for trauma, non-trauma patients, either adults or children. Reliable interview from the patient or distress witness is very important element of rescue action. Using SAMPLE interview scheme we can gather information or determine facts regarding illness and the mechanism of disease entity [7].

S – symptoms
A – allergies
M – medication
P – past medical history
L – last oral intake
E – (prior) events

On-scene neurological examination comprises AVPU awareness assessment (A – alert, V – responsive to voice, P – responsive to pain, U – unresponsive) which determines awareness regarding location, time and oneself. It is followed by the use of Glasgow Coma Scale.

Glasgow Scale classifies consciousness level as follows:
GCS 13–15 – minor
GCS 9–12 – moderate
GCS 6–8 – unconscious
GCS 5 – decortication
GCS 4 – decerebration
GCS 3 – brain-dead [8].

Physical examination starts by head assessment – search for bleeding, fractures, pain. Shape and symmetry of the skull is assessed. Then eyeballs (eye orientation, exophtathalmos, enophthalmos). Eyelid crevices and eyeball movement are assessed. During eye examination also reaction to light is checked. It is at best done by illuminating pupil with diagnostic flashlight or by covering and uncovering patient's eyes one by one. The condition where one pupil turns out to be dilated more than the other is called anisocoria. Single side dilation occurs, among other, in case of post-traumatic subdural haematoma wedging, brain tumor, syphilis, alcoholism, diabetes. Face examination should be limited to assessing mimicry by frowning, eyelid clenching and grinning. In case of paresis, the affected side will be indicated by the lack of grin and sloping corner of mouth. Patient also has tongue examined, specifically the XII sublingual nerve. Trace of bleeding or tongue having been bitten may indicate past episode of seizure. Further neurological assessment covers meningeal symptoms. One of the major is neck stiffness: during passive movement of patient's head forward neck muscles resist, making it unable for the chin to touch the sternum. This may lead to initial suspicion of sub-arachnoidal hemorrhage or meningitis, which frequently occurs after the interview is completed and the following symptoms are confirmed: fever, hypersensitivity to touch and acoustic stimuli, photophobia, nausea and vomiting. Meningeal symptoms also occur after post-trauma brain damage and sometimes in case of intracranial tumors. While examining meningeal symptoms we can also use the Kernig's sign, applicable in initial diagnosis of meningitis. Two Kernig's sign types are discerned:

- lower – leaning upper body of the seated patient forward elicits flexing the knees and hips.
- upper – positive if flexing the hip, elicits flexing the knee.

Further symptom is positive Brudziński's sign, which (similar to the latter) is observed in about 5% of meningitis cases. This sign has the following types:

- Brudziński's neck sign – forced flexion of the neck forward elicits flexion of hips and knees.

– Brudziński's cheek sign – pressure on the cheek, usually below the zygomatic bone, elicits forearm raising and flexing,
– Brudziński's symphyseal sign – strong pressure on pubic symphysis elicits flexing the knees and hips.

Flataua sign – this may be positive in case of increased intracranial pressure and meningitis. Two types can be observed:
– upper Flataua sign (neck-mydriatic) – forced flexing of the neck forward elicits pupil dilation,
– lower Flataua sign (erective, regarding infant male patients) – multiple forward upper body flexions elicit penile erection. This is more frequently observed in case of tuberculous meningitis.

There is also Brdlik sign, known as the „knee kissing". It is impossible for the child to bend in order to touch the knee with head without simultaneous flexion of knees and hips [9].

Table 2. presents a summary of meningeal symptoms.

Further stage of neurological examination performed by EMS team is examination of the motion system. This can be initially assessed by visual examination of the limbs. All changes such as edema, bruising, dislocations, rotations and wounds need to be noticed. Passive movement and muscle tension may enable detecting limited movement and tonus impairment caused by local changes within joints and muscles. Active movement and muscular strength is also assessed. Limited movement or reduced strength is known as paresis, complete lack of movement is known as paralysis or plegia. In practice we will diagnose paresis whenever there is a deficit in muscular strength, but the patient is capable of active movement; we will diagnose paralysis whenever muscular strength is reduced to zero during the examination [11]. While examining pathological reflexes we assess the Babiński sign. It is positive if the big toe is dorsiflexed after running the instrument up the lateral platar side of the foot. Under the age of 2 this reflex is physiological, at later age it is pathological and may indicate damage to corticospinal tract [12]. During the initial phase, aside physical examination, general health condition and patient's biological age need to be determined. Close relation of patient's general and neurological condition calls for general assessment to be completed before neurological assessment [13].

Medical rescue procedures, apart from the interview and physical examination, are also based on symptomatic pharmacology (pain-killing, anti-inflammatory, antipyretic, antiemetic and intravenous hydration). In case of patients with neurological disorders related to encephalitis, rapid antibiotic administration is very important. The latter is not possible in EMS team pre-hospital treatment. EMS team has the possibility of consulting a specialist and selecting destination of patient transfer. Emergency conditions related to encephalitis are: neuropathy, miopathy, encephalitis, meningitis, Creutzfeldt-Jacob disease, neuroboreliosis.

In most cases of encephalitis, the following symptoms are present: limb numbness, dizziness, vomiting, paresis and paralysis, impaired hearing and vision, difficulty in swallowing saliva, fever, incontinence, hyperesthesia. urinary bladder disorders, dysaesthesia, neck stiffness, imbalance and aphasia, qualitative and quantitative awareness disorders. There are also numerous research-based cases where patients with neuroinfection presented non-neurological symptoms.

Between January 2017 and December 2021, Escola et al. conducted research in Essen university Hospital in Germany. Specific and non-specific symptoms among patients over the age of 18, transferred to neurology department by EMS

Table 2. Types of meningeal symptoms

Kernig's sign	lower - by bending the trunk of a sitting patient forward, the examiner observes reflex flexion of the lower limbs in the knee and hip joints; upper - during passive flexion of the lower limb in the hip joint, forced flexion occurs in the knee joint.	5% of patients with meningitis
Brudzinski's sign	nuchal – when the head is passively bent towards the chest, the lower limbs flex at the knee and hip joints; buccal – pressure on the cheek below the zygomatic bone causes the forearms to rise and flex; pubic – firm pressure on the pubic symphysis causes flexion of the lower limbs at the knee and hip joints.	5% of patients with meningitis
Flatau's sign	upper (nuchal-mydriatic) – when the head is passively tilted forward, the pupils dilate; lower (erectile) – in young boys, when the torso is tilted forward several times, penile erection occurs.	This symptom may be positive with increased intracranial pressure and meningitis. It is observed more frequently in tuberculous meningitis.
Brdlik's sign – the knee-kissing symptom	It consists in the inability of the child to bend deeply enough to touch the knee with the head without simultaneously bending the lower limbs in the knee and hip joints	

teams have been assessed. EMS teams have brought in 2242 patients with initial diagnosis of possible brain stroke. 2167 have been qualified for further diagnostics. 1504 (64,8%) had either ischemic brain stroke, TIA (transient ischemic attack) or intracranial hemorrhage diagnosed. 762 (35,2%) had stroke-imitating symptoms. 369 (48,4%) patients were diagnosed with non-neurological issues, in case of 393 (51,6%) patients the etiology was neurological. The most frequent non-neurological diagnoses were: infections (14,7%), cardiovascular diseases (11,3%) and dry skin (8,1%). The most frequent brain stroke-imitating diagnoses were: seizures (23,2%), peripheral neuropathy (5,6%) and migraine (4,6%) [14].

PRE-HOSPITAL TREATMENT

Guidelines dedicated to bacterial meningitis and meningeal sepsis in pre-hospital care focus on the following recommendations:

1. all patients with meningitis or meningococcal disease should be brought in to hospital with suspected sepsis within the given society in order to perform further diagnosis and consider lumbar puncture.
2. transfer from ambulance to the hospital should be organized in such matter, that laboratory tests are complete within one hour from calling the EMS team.
3. occurrence (or lack thereof) of the following symptoms has to be documented: headache, altered mental condition, neck stiffness, fever, any kind of rash, seizures and any symptoms of shock (hypotension, prolonged capillary refill time)
4. one should not rely on Kernig's and Brudziński's signs in making diagnosis [15].

Guidelines strictly underline that it is crucial for in-hospital diagnosis to perform physical examination, laboratory tests (therein lumbar puncture and cerebrospinal fluid testing), diagnostic imaging, antibiotic therapy, fluid therapy and fighting septic shock.

Elements of this procedure have to be implemented already on pre-hospital stage. These are: physical and neurological examination, fluid therapy, symptomatic pharmacotherapy, fighting septic shock and medical rescue procedures adequate to patient's condition (oxygenation, maintaining airway patency, ECG monitoring and other).

The first medics coming in touch with many patients who manifest septic symptoms (of various mechanisms) are EMS team members. It does happen in common everyday practice of EMS teams that at this stage clinical symptoms may be overlooked or misinterpreted. Many screening test tools have been used for detecting sepsis, among those: SIRS (systemic inflammatory response syndrome) or the SOFA score (sequential organ failure assessment score). Results of both scales are based on patient's blood sample laboratory test parameters. This makes them impossible to be used on pre-hospital stage, especially in case of rescue action performed by an EMS team. The Third International Consensus Conference regarding sepsis (Sepsis-3) was held in 2016. The only three basic parameters were recommended for use in case when more advanced measures (such as blood testing, biomarkers or diagnostic imaging) are inaccessible, timing is critical or tests are underway. These are:

- impaired consciousness
- systolic blood pressure ≤100 mmHg
- respiratory rate ≥22/min [16].

These vitals signs may be identified by the EMS team, which is the first to stabilize the patient on stage. This allows for rapid diagnose of direct infection-related life threat.

Antibiotic therapy

Implementing antibiotics is a very important criterion on early neuroinfection treatment stage. Success after antibiotic therapy on pre-hospital stage depends on particular meningococcus type and reference of hospital, which will eventually treat the patient. Indications for the use of antibiotics in case of Neisseria meningitidis infection, are as follows:

1. antibiotics are to be administered to patients with symptoms of meningococcal disease, such as rash along with meningism or severe sepsis.
2. antibiotics are to be administered to patients with symptoms of severe sepsis shock, such as: hypotension, long capillary refill time, altered mental state.
3. patients with meningitis symptoms, who have been transferred to hospital with delay longer than 1 hour, are to be given antibiotics.
4. the recommended antibiotics are: Benzylopenicillin 1200 mg intramuscular or intravenous, or third generation cephalosporins – Cephotaxime (2 g) or Ceftriaxone (2 g) intramuscular or intravenous
5. in case of anaphylactic reaction to penictllin-derived medication or cephalosporins antibiotics should not be administered until final admission to hospital.
6. antibiotics should not be administered parenterally; transport to hospital should not be delayed [17-19].

In 2022, research team from Medical University of Warsaw, conducted research in Warsaw Infectious Hospital regarding intestinal microbiota and its influence on immunity in correlation with neuroinfections. 47 patients with clinical diagnose of neuroinfection were included in research. 26 suffered viral meningitis or encephalitis, 8 suffered bacterial meningitis. 20 patients acted as control group. Research aimed at determining if patients with neuroinfection manifest any changes to intestinal microflora compared to healthy individuals and if this influences etiology (viral or bacterial) and changes to intestinal microbiome.

Results presented have proven that some particular bacterial taxa (Clostridium, Anaerostipes, Lachnobacterium, Lachnospira and Roseburia) have been decreased among patients with neuroinfection compared to control group. Reasons of these changes are not clear and may result from inflammatory process coexisting with disease. However one can not rule out the influence of diet modification or hospitalization itself. In case of short-term (1-3 days) antibiotic therapy no significant change to intestinal microbiota was observed [20].

Neuroinfections remain an important cause of mortality and morbidity of people throughout the world [21].

The above-mentioned research shows that disorders of microbiota-intestine-brain route influence the functioning of central nervous system.

Apart from infection influencing nervous system, infection also has negative influence on other organs and systems within human organism. Urinary infection, pericarditis, myocarditis, pneumonia, purulent skin infection can all serve as examples.

IN-HOSPITAL MEDICAL TREATMENT

Medical rescue action comprises procedures undertaken by physicians, nurses and paramedics treating patient in medical distress or life threatening condition. According to current guidelines, the following medical procedures need to be implemented in case of Neisseria meningitidis neuroinfection:

1. securing airway, respiration and circulation
2. decision regarding advanced physical examination, laboratory tests, imaging diagnostics or admission to intensive care unit should be made on the first day
3. level of consciousness should be documented with the use of Glasgow Coma Scale
4. blood culture should be made as quickly as possible – within 1 hour since admission to hospital
5. patients with meningitis symptoms (with no signs of shock or sepsis) need to have lumbar punction performed within 1 hour since reaching hospital, as long as it is safe. Treatment has to be initiated immediately after lumbar punction, within the first hour. If there is no possibility of lumbar punction within 1 hour, treatment has to be initiated immediately after taking blood for blood culture testing.
6. patients with dominant sepsis or rapidly developing rash need to be given antibiotics immediately. Fluid resuscitation has to be initiated at once, with initial bolus of 500 ml crystaloid.
7. all clinicians treating patients discussed should complete post-graduate training regarding initial treatment of acute bacterial meningitis and meningococcal sepsis.
8. patients with meningitis and meningococcal sepsis should be treated by specialists [22-24].

Death risk factors during meningococcal disease

Sepsis – direct life threatening condition – is a consequence of meningococcal disease.

Between 1974 and 2007 there have been 5924 cases of meningococcal disease recorded in Denmark. Analysis of lethal meningococcal disease risk factors confirmed that the major contributing factors were sepsis and age over 50 [25]. According to The UK joint specialist societies guideline on the diagnosis and management of acute meningitis and meningococcal sepsis in immunocompetent adults, the following are death risk factors in meningococcal disease:

1. rapid developing rash
2. coma
3. hypotension and shock
4. lactates >4 mmol/l
5. low/normal white peripheral blood cell count
6. low acute phase reactants (acute phase proteins)
7. low blood platelet count
8. coagulopathy
9. lack of meningitis [26].

CONCLUSIONS

Meningococcal infections are major problem for the population which had contact with infected individuals. Meningitis in the course of Neisseria meningitidis infection very frequently has dynamic course and presents high degree of infectivity. Early pre-hospital identification of symptoms

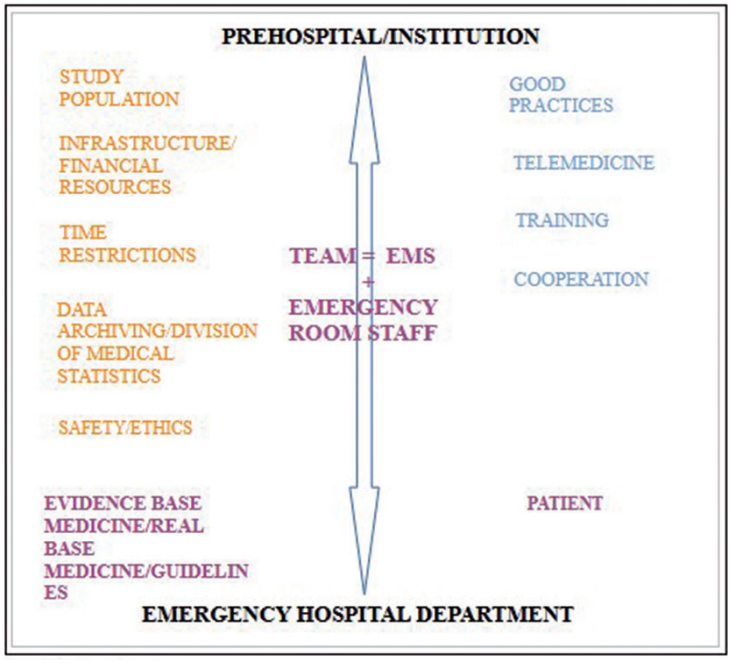

Fig. 1. Scheme of research regarding pre-hospital Emergency Medical Services care and in-hospital care presenting dependency between challenges (orange) and capabilities (blue)
Own source

and advanced in-hospital broad-spectrum antibiotic therapy can alleviate patients' infection and save lives. On EMS team stage it is important to gather detailed interview from patient or his/her family, perform proper physical and neurological examination and differentiate patient's condition with other disease entities. Currently recommended pharmacotherapy should be symptomatic. Number of patients treated by EMS teams, who are later diagnosed with meningococcal infections, is not definitely specified. Taking into consideration the guidelines of treating patients with meningitis in the course of Neisseria meningitidis infection it may be reasonable to equip EMS teams with group of antibiotics dedicated for treating patients with specific infection signs. This should correlate with earlier EMS personnel training in the use of antibiotics.

Figure 1 presents dependency between scientific criteria based action on pre-hospital and in-hospital stage, considering challenges for science and medicine and capabilities generated by medical publications – analyses databases, statistics, guidelines. These are patient-oriented and aim at effective stabilization and treatment. Orange color indicates challenges, blue indicates capabilities. Purple color marks units strategic in researching the effectiveness of medical care based on advanced evidence-based scientific reports, effects of EMS-ED cooperation and the success of this complex mechanism which is patient's well-being. In the field of bacterial meningitis there is still a need of detailed research and publications, making it possible to work-out the ideal scheme of treating the patient both on pre-hospital and in-hospital stage, achieving the intended benefits.

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CONFLICT OF INTEREST

The Author declare no conflict of interest

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CASE REPORT

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Blunt thoracic aortic injury complicated by multi-organ failure and carbapenem-resistant *Acinetobacter baumanii* pneumonia – a case report

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ABSTRACT

Aim: This case report aims to present the diagnostic and therapeutic challenges associated with managing blunt thoracic aortic injury (BTAI) in a polytrauma patient who developed overlapping hemorrhagic, infectious, and suspected thromboembolic complications.

Material and methods: The case was described in accordance with the CARE Guidelines. Clinical data and imaging were reviewed retrospectively, focusing on diagnostic approach, therapeutic management, and patient outcomes. We report the case of a 29-year-old male who sustained multiple injuries following a high-energy motorcycle collision.

Conclusions: This case illustrates how the co-existence of hemorrhagic, infectious, and possible thromboembolic complications can delay recognition of clinical deterioration in trauma patients. It addresses the need for individualized stent graft sizing in hypovolemic trauma patients and emphasizes the critical role of local antimicrobial resistance surveillance in deciding on empiric therapy for ICU-acquired infections.

KEY WORDS

pulmonary embolism, ventilator-associated pneumonia, carbapenem-resistant *Acinetobacter baumannii*, thoracic endovascular aortic repair, blunt thoracic aortic injury

INTRODUCTION

Blunt thoracic aortic injury (BTAI) is a high-risk vascular emergency typically caused by blunt trauma to the chest or back [1]. It most frequently affects the descending aorta and the isthmus [2, 3]. Motor vehicle collisions account for over 70% of cases, and other common causes include pedestrian accidents or falls from significant heights [1, 2, 4]. Prehospital mortality is extremely high, reaching 75-80% at the scene [3, 4]. Among the patients who survive to get to the Emergency Department, many present with multiple associated injuries, and 30-50% of them succumb within the first 24 hours [4-6]. BTAI may be initially asymptomatic, often presenting as a pseudoaneurysm or contained rupture, causing a misdiagnosis rate of 30-60% [4]. However, the silent phase is only temporary, as the injury often progresses to an uncontained rupture requiring urgent intervention [4]. Treatment options for unstable BTAI patients include open surgical repair and thoracic endovascular aortic repair (TEVAR) [1, 2, 4]. TEVAR has become the preferred therapeutic approach due to lower perioperative complications and mortality compared to open surgical repair [3, 4, 7-9]. However, current guidelines for TEVAR in trauma remain evolving, especially regarding stent sizing in hypovolemic patients and thromboembolic prophylaxis [1, 3, 10].

Critically ill trauma patients are at high risk of ventilator-associated pneumonia (VAP), particularly during prolonged Intensive Care Unit (ICU) stays. Acinetobacter baumannii, a non-fermenting Gram-negative rod, is increasingly recognized as a predominant pathogen in VAP among mechanically ventilated patients in trauma centers. The rise of carbapenem-resistant Acinetobacter baumannii (CRAB) strains complicates treatment, as many isolates retain susceptibility only to last-resort agents such as colistin, tigecycline, or high-dose sulbactam. Inadequate empiric antibiotic coverage in such cases can lead to rapid clinical deterioration and poor outcomes [11-13].

While each of these complications is individually challenging, their overlap generates diagnostic and therapeutic dilemmas unique to the polytrauma ICU population. This report highlights a rarely documented, simultaneous occurrence of hemorrhagic, infectious, and suspected thromboembolic complications in BTAI. This manuscript is prepared following the CARE Guidelines checklist.

AIM

This report illustrates the complex diagnostic and therapeutic challenges encountered during the management of blunt thoracic aortic injury (BTAI) in a polytraumatic patient complicated by simultaneous hemorrhagic, infectious, and suspected thromboembolic events.

MATERIAL AND METHODS

The article was prepared following the CARE Guidelines checklist. Clinical data, imaging results, and laboratory parameters were retrospectively analyzed. The management strategy included emergency thoracic endovascular aortic repair (TEVAR) and intensive care monitoring with hemodynamic, respiratory, and biochemical assessments. Empiric and targeted antimicrobial regimens were reviewed in relation to microbiological findings and patient outcomes.

CASE REPORT

A 29-year-old male was brought to the Emergency Department via Helicopter Emergency Medical Service following a high-energy motorcycle collision with another vehicle. On arrival, he was unconscious, hypotensive, and in acute respiratory failure. The patient had no significant medical or family history and was not taking any medications prior to the accident. Initial management included airway protection with a laryngeal mask and pelvic stabilization using an external fixation device.

Laboratory test results revealed anemia, leukocytosis, elevated creatinine, hyperglycemia, and hypofibrinogenemia. Trauma-focused computed tomography scan identified a descending aortic pseudoaneurysm with active hemorrhage, extensive right-sided pulmonary contusion with pneumatocele, right pneumothorax, posterior mediastinal hematoma, and multiple fractures of the vertebrae, pelvis, ribs, right scapula, and sternum. Fluid accumulation was detected in the perisplenic and perirenal spaces bilaterally. The clinical and laboratory findings indicated severe hypovolemic shock and early multi-organ dysfunction.

The patient underwent endotracheal intubation and urinary catheterization, followed by analgesia and sedation with propofol and fentanyl. A chest drain was inserted to manage the pneumothorax. Resuscitative management included isotonic fluids, red blood cell transfusion (four units), and intravenous vasopressors (norepinephrine and epinephrine) to stabilize the circulatory system prior to definitive intervention. Empirical antimicrobial therapy with ceftriaxone and tetanus prophylaxis were initiated. After initial stabilization, he was transferred to the Vascular Surgery Department for TEVAR. The stent graft sizing was based on the initial computed tomography measurements, with an oversizing of 20% in accordance with the clinical guidelines at the time.

Following the procedure, the patient was admitted to the ICU in critical condition. Multi-organ failure developed, including acute kidney injury (AKI), metabolic acidosis, and myocardial injury. Continuous venovenous hemodiafiltration (CVVHF) was initiated, along with low-molecular-weight heparin (LMWH) for thromboprophylaxis, and enforced diuresis with furosemide. Additionally, pantoprazole for stress ulcer prevention was implemented. Laboratory results showed elevated troponin I and creatine kinase-myocardial band levels, confirming myocardial injury, and increased inflammatory markers, prompting empiric antimicrobial therapy with meropenem and vancomycin. However, bacteriemia was later excluded following negative blood cultures.

Initial ICU therapy led to gradual hemodynamic stabilization. Follow-up imaging confirmed correct stent graft positioning with no evidence of endoleak and revealed no new abnormalities. Despite early stabilization, the patient's condition rapidly deteriorated on the seventh day of hospitalization. He developed respiratory acidosis and hyperkalemia, along with a significant increase in inflammatory markers. Transthoracic echocardiography identified acute right ventricular (RV) strain, raising suspicion of pulmonary embolism (PE). Differential diagnosis included acute respiratory distress syndrome and cardiogenic shock. However, the combination of the acute RV strain and rapid clinical deterioration were most suggestive of acute PE. Confirmatory computed tomography pulmonary angiography (CTPA) could not be performed due to persistent hemodynamic instability, and concerns about the safety of the patient's transport, therefore PE could not be directly verified. Despite maximal mechanical ventilation support, oxygen saturation remained consistently below 80%, and the patient died on the eighth day of hospitalization. Post-mortem bronchial cultures identified Acinetobacter baumannii complex with OXA-40 carbapenemase, resistant to all antibiotics except colistin, confirming the presence of VAP.

Table 1 and Figure 1 provide a visualization of the major clinical events, illustrating the rapid evolution from initial stabilization after TEVAR to the onset of multi-organ dysfunction and the need for escalating therapeutic interventions. Figure 2 depicts serial measurements of key laboratory parameters. Fluctuations in hemoglobin concentration resulted from the ongoing bleeding and transfusions. Rising C-reactive protein (CRP) levels, accompanied by increasing creatinine and transient changes in leukocyte count, reflect the development of systemic inflammation and AKI, which preceded the patient's decline.

DISCUSSION

Due to the polytraumatic nature of most BTAI cases, patients are frequently subject to both hemorrhagic and thromboembolic complications, posing a significant diagnostic and therapeutic challenge [3, 10]. The patient initially stabilized after TEVAR but later deteriorated due to overlapping complications, including VAP and suspected PE.

A particular challenge in this case was the sizing of the aortic stent graft in a severely hypovolemic patient, where vasoconstriction may have led to underestimation of the true aortic diameter [6, 14]. Although early imaging confirmed correct stent graft placement with no endoleak, the possibility of delayed graft-related complications cannot be fully excluded in the absence of serial imaging. At the

Table 1. Selected laboratory parameters at key clinical timepoints

Day of Hospitalization	Hb (g/dL)	WBC (10^3/µL)	PLT (10^3/µL)	Creatinine (umol/L)	CRP (mg/L)	PCT (ng/mL)	INR	D-dimer (µg/mL)	Na (mmol/L)	K (mmol/L)	Troponin I (ng/mL)	pH	PO_2 (kPa)	Clinical Notes
Admission (11.09.2023)	8.8	18.8	254	120	N/A	N/A	1.30	N/A	142	4.81	NA	N/A	N/A	Hypovolemic shock, pre-TEVAR
Post-TEVAR (12.09.2023)	10.5 / 9.1	17.5 / 13.8	124 / 98	261 / 297	77.5	82.43	1.22 / 1.32	31.34 / 26.05	142	6.25 / 5.08	1308 / 814	7.28 / 7.43	14.90 / 18.90	Post-procedural stabilization
Onset of multi-organ failure (13.09.2023)	7.6 / 8.8	13.6 / 13.8	95 / 189	358 / 427	166.1	97.30	1.35 / 1.25	20.89 / 16.12	142	4.46 / 4.52	469 / 377	7.48 / 7.44 / 7.30	19.40 / 16.80 / 19.30 / 16.50	ICU, AKI, rising inflammation
Deterioration (17.09.2023)	8.4 / 10.3	9.0 / 8.9	102 / 99	236	165.6	10.62	1.03	2.04	144	3.03 / 4.12	44	7.39 / 7.38	17.00 / 12.00 / 4.94	Rapid clinical and respiratory decompensation
Pre-terminal (18.09.2023)	10.7 / 11.3	14.8 / 22.0	168 / 242	253	213.2	7.00	1.03	2.36	145	4.68 / 5.82	104	7.23 / 7.30	8.29 / 10.40	Terminal phase, pre-mortem

time of treatment (2023), the approach was consistent with the 2017 ESVS guidelines, which advised caution regarding excessive oversizing (>20%) due to the risk of graft collapse [9]. However, the updated ESVS 2025 guidelines now specifically recommend up to 30% oversizing in hypovolemic patients to account for the potential underestimation of the true aortic diameter due to vasoconstriction [3, 6, 14]. This update represents a more individualized approach aimed at reducing the risk of endoleak or stent migration once physiological blood volume is restored. However, there is still a need for prospective research to establish specific recommendations for stent graft sizing depending on the severity of hypovolemic shock.

PE, which was suspected in the patient, is the second leading cause of trauma-related death, and frequently mimics other acute complications in polytrauma patients [10]. Its clinical presentation - including chest pain, dyspnea, hypoxia, and hemodynamic instability - often overlaps with other conditions seen in critically injured trauma patients, including BTAI [15, 16]. Moreover, the utility of D-dimers and conventional clinical prediction scores for PE, such as the Wells and Revised Geneva criteria, is limited in trauma patients [10, 17]. This diagnostic uncertainty addresses the need for rapid CTPA when PE is suspected, which remains the gold standard in PE diagnosis, and unfortunately, was not done in time in the case of the patient [17]. Systematic use of CTPA may be difficult in case of hemodynamically unstable patients, but, where feasible, should be prioritized given the high mortality of PE in this group. Although thromboprophylaxis with low-molecular-weight heparin (LMWH) was initiated per trauma guidelines, anti-Xa monitoring was not performed [18]. Current literature strongly supports individualized LMWH dosing based on anti-Xa levels in high-risk trauma patients to reduce the risk of under-anticoagulation and fatal PE [10, 18].

This case also illustrates the critical role of CRAB-associated VAP in ICU-acquired infections. VAP is a significant complication in trauma patients, associated with higher mortality, prolonged ICU stays, and infection with multidrug-resistant (MDR) pathogens [11, 12, 19]. Considering these risks, adherence to VAP prevention bundles is crucial. Recent guidelines by Society for Healthcare Epidemiology of America (SHEA) advise minimizing sedation using benzodiazepines, avoiding unnecessary intubation in favour of non-invasive ventilation, and prioritizng early enteral nutrition. However, the application of these recommendations is often limited in polytrauma patients. In this case, the severe respiratory failure required prolonged endotracheal intubation, precluding the use of non-invasive strategies. Similarly, the multiple sustained injuries and hemodynamic instability necessitated parenteral nutrition. Consequently, prophylactic measures were focused on maintaining endotracheal tube cuff pressure and elevating the head of the bed by 30-45°. Regarding oral hygiene, subglottic secretion drainage was implemented, as recommended for patients ventilated for over 48 hours [20]. Nevertheless, the patient developed VAP.

Ultimately, VAP was confirmed post-mortem, with isolation of a CRAB strain expressing OXA-40 carbapenemase,

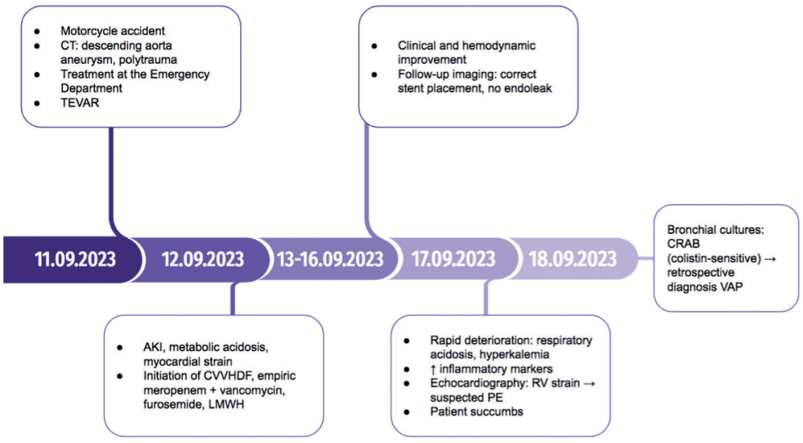

Fig. 1. Timeline of key clinical events, interventions, and outcomes during hospitalization

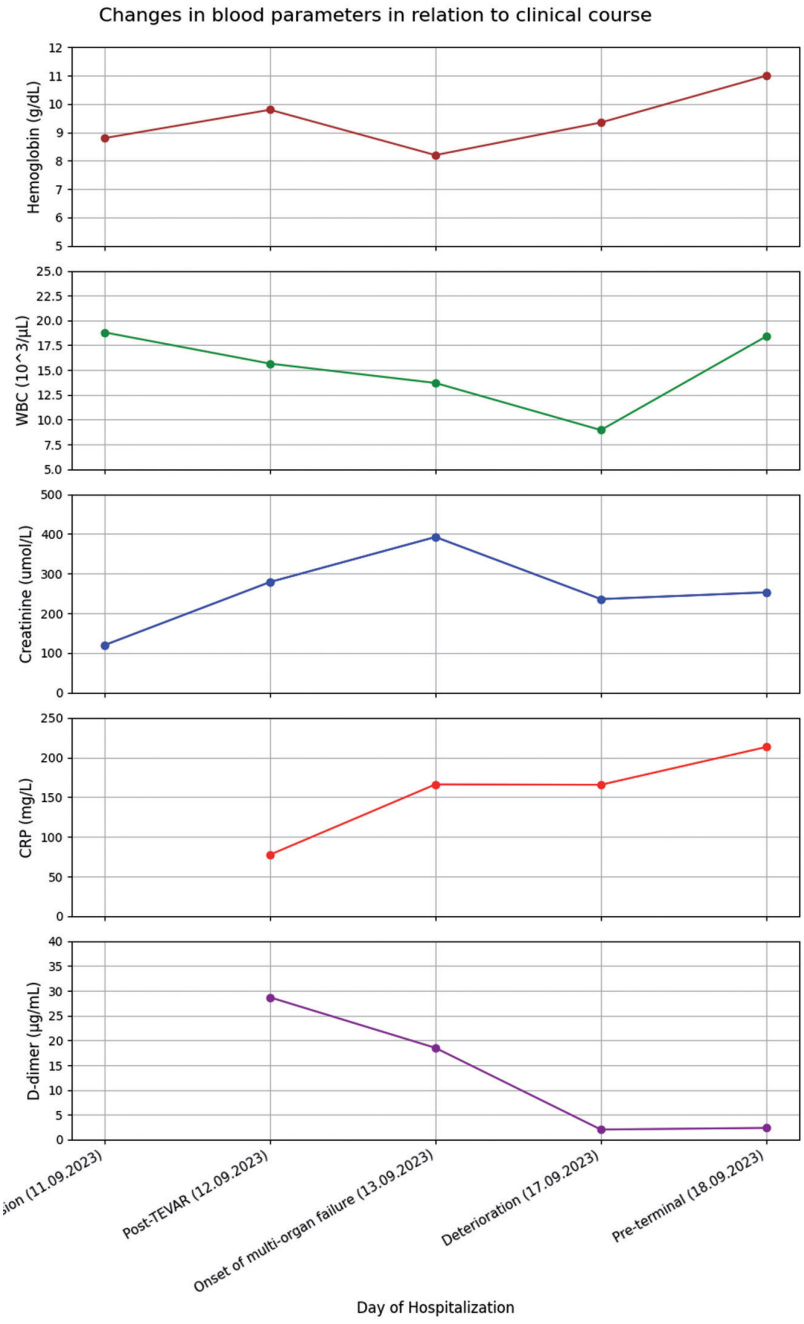

Fig. 2. Changes in key blood parameters in relation to the cli-

which was susceptible only to colistin. Despite empirical treatment with carbapenems, the therapy was ineffective against the identified strain. This underscores that in high-risk ICU environments with known CRAB prevalence, earlier use of colistin, sulbactam, or tigecycline may be warranted to ensure appropriate coverage for CRAB, especially in unstable patients where culture results may be delayed [13]. Adjustment of empiric regimens based on local MDR surveillance should be considered in trauma ICUs.

This case report has several strengths. It provides a detailed description of a rare and complex clinical scenario characterized by overlapping hemorrhagic, infectious, and suspected thromboembolic complications following BTAI. Addressing the protocol challenges offers practical insights into trauma and ICU management. The discussion highlights current gaps in clinical standards, emphasizing the importance of individualized strategies and multidisciplinary collaboration in similar cases.

However, this case has several limitations:

- The diagnosis of PE was presumptive, as confirmatory CTPA could not be performed due to persistent hemodynamic instability.
- The diagnosis of VAP was retrospective, based on post-mortem cultures, and may not accurately differentiate between community- and hospital-acquired colonization, or true infection.
- Routine anti-Xa monitoring for LMWH efficacy was not performed, following current standard protocols for trauma patients, but this precluded precise assessment of the adequacy of thromboprophylaxis in this patient.
- Serial imaging follow-up of the stent graft was limited due to the patient's clinical deterioration, preventing assessment of potential delayed complications.

CONCLUSIONS

This case demonstrates how simultaneous hemorrhagic, infectious, and suspected thromboembolic complications can create diagnostic uncertainty and delay the diagnosis of emerging threats in BTAI patients. Optimal care must be based on individualized intervention strategies, as reflected in the updated ESVS 2025 recommendation to increase stent graft oversizing up to 30% in hypovolemic trauma patients. Delayed complications such as endoleak, PE, and VAP may mask each others' clinical presentations and pose diagnostic dilemmas. While standard VAP prevention bundles should be implemented where feasible, severe trauma often makes it difficult to adhere to some protocols, such as providing non-invasive ventilation or early enteral nutrition. Furthermore, the emergence of CRAB addresses the need for adjusting empiric antimicrobial therapy to up-to-date local resistance patterns. Further prospective, multicenter studies are needed to establish guidelines for stent graft sizing stratified by the severity of hypovolemic shock in trauma patients.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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