



Polish State Fire Service (SFS) response to out-of-hospital cardiac arrest (OHCA): a retrospective study.

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ABSTRACT

INTRODUCTION: Out-of-hospital cardiac arrest (OHCA) is one of the leading causes of death in developed countries, which is a leading public health problem. Saving endangered human life is a priority task for emergency services around the world. The aim of study was to analysis of OHCA cases for which the Fire Rescue Units (FRU) teams were ordered in situations that meet the criteria of the isolated emergency medical incidents (IEMI).

MATERIAL AND METHODS: The study included a retrospective analysis of calls by Polish FRU to local medical threats over a period of 5 years. The data come from the Decision Support System for Fire Service. Quantitative data were described using classical measures: arithmetic means (M), standard deviations (SD), median (Me) and interquartile ranges (IQR).

RESULTS: The total number of OHCA cases included was 94. The mean time between receipt of the IEMI call and arrival on scene was 6 minutes and 22 seconds (IQR = 4). ROSC occurred in 21 patients, which is 22.34% of all cases. An Automated External Defibrillator (AED) was used in 64 cases (68.09%). The analyzed victims were mostly men (76.59%). The mean age of the victims was 63.06 years (Me = 62 years).

CONCLUSIONS: The results of the research are in line with global trends and show the role of early cardiopulmonary resuscitation. Sending FRU to OHCA in the case of non-availability of the EMT in the initial phase of the intervention is justified.

KEY WORDS: Sudden cardiac arrest, OHCA, state fire service, medical incidents.

INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) is one of the leading causes of death in developed countries challenging public health care systems [1,2]. There are approximately 275,000 OHCA in Europe each year [3]. Despite strategies focusing on the rapid provision of resuscitation care and defibrillation as links in the rescue chain, the survival rate in OHCA remains low and ranges from 5-38% [4]. Optimization of care for OHCA victims, related to the early arrival of emergency services at the scene, is associated with increased survival of the victims [5-8].

Saving endangered human life is a priority task for emergency services around the world. The implementation of medical interventions has also become a part of the activities of fire rescue units (FRU) in Poland. Pursuant to the Act on the National Emergency Medical Service (NEMS) [9], units cooperating with the NEMS system include statutory services to help people in a state of emergency health, in particular organizational units of the State Fire Service (SFS) and fire protection units included in National Firefighting Rescue System (NFRS). In addition to performing their statutory tasks, i.e. organizing and conducting rescue operations during fires, natural disasters or the elimination of local threats, Polish firefighters are increasingly available to the so-called isolated emergency medical incidents (IEMI) [10].

IEMI is an event that remains or is within the properties of NEMS, during which FRU rescuers carry out medical interventions until the responsibility for the victim is taken over by the Emergency Medical Service (EMS), including Helicopter Emergency Medical Service (HEMS) in the following situations:

- when the forces and resources of the NFRS, at the request of the medical dispatcher, arrive prior to the EMS units (EMS / HEMS) to provide assistance to people who are in a state of sudden health threat;
- when the implementation of medical interventions was undertaken in people in a state of sudden health emergency at the request of third parties (e.g. after reporting the state of sudden health emergency to command post (CP) SFS);
- when the MDR implementation was undertaken during the movement of FRU forces and resources (eg during the return from events, during the return from exercises).

The aim of the study was to analyze OHCA cases to which FRU teams were called in situations meeting the criteria of IEMI, in particular involving return of spontaneous circulation (ROSC). According to the authors' knowledge, this is the first OHCA study in the activities of FRU in Poland.

MATERIAL AND METHODS

The study included a retrospective analysis of trips by Polish FRU's to local medical threats over a period of 5 years (date of reporting to the emergency service between January 1, 2015 and December 31, 2019). The study included cases in which the FRU was sent to an OHCA incident in the IEMI (in accordance

with the rationale for the order, Table 1). Cases that did not bear the hallmarks of IEMI and were incorrectly recorded were excluded from further analysis.

Table 1. Exemplary content of the FRU instruction to IEMI.

- **Flag** – isolated emergency medical incident - **Description** – the rescue crowd on the way back from the exercises noticed the hit pedestrian.
- **Flag** – isolated emergency medical incident - **Description** – EMS inaccessible, request for medical protection of the victim.
- **Flag** – isolated emergency medical incident - **Description** – securing of the victim until EMS arrival, no free EMS.

The data comes from the EWID event recording program and the Decision Support System for State Fire Service (DSS PSP), made available upon request by the National Centre for Rescue Coordination and Civil Protection (NCRCCP) at the National Headquarters of the State Fire Service (NH SFS).

Statistical analysis

The database was prepared in Microsoft Excel using the MS Office 2016 suite for Windows 10. The statistical analysis of the results was performed using STATISTICA 12 (StatSoft Polska). Spatial analysis was performed using Quantum GIS (QGIS) v.3.12, under the GNU GPL license. With the use of QGIS, the places of OHCA occurrence were identified and visualized, and the average distance between the stations of the State Fire Service Rescue and Firefighting Units (SFS Unit) and OHCA was calculated.

Quantitative data were described using classical measures: arithmetic means (M), standard deviations (SD), median (Me) and interquartile ranges (IQR). Statistical comparison between the groups was performed using the Student's t-or Mann-Whitney U test for quantitative variables and the chi-square test for qualitative variables. Correlations and differences at a significance level of $p < 0.05$ were considered statistically significant.

RESULTS

In the analyzed period, Polish firefighters intervened 2,471,171 times, including 128,653 incidents defined as local medical threats - in which medical intervention was necessary. CPR was conducted 7,026 times in these activities. After applying the exclusion criteria, the total number of OHCA cases included was 94. Of the 94 victims who received CPR by FRU or EMS, 21 of them had ROSC, which is 22.34% of all analyzed cases. In this group of casualties, ROSC was achieved before the arrival of the EMS at the scene in 5 cases (23.81%) and after the arrival of the EMS in 16 cases (76.19%). An Automated External Defibrillator (AED) was used in 64 cases (68.09%) (Figure 1). The analyzed victims were mostly men (76.59%). The mean age of the victims was 63.06 years (Me = 62 years). OHCA was most common in casualties aged 60-69 (31.91%) (Table 2).

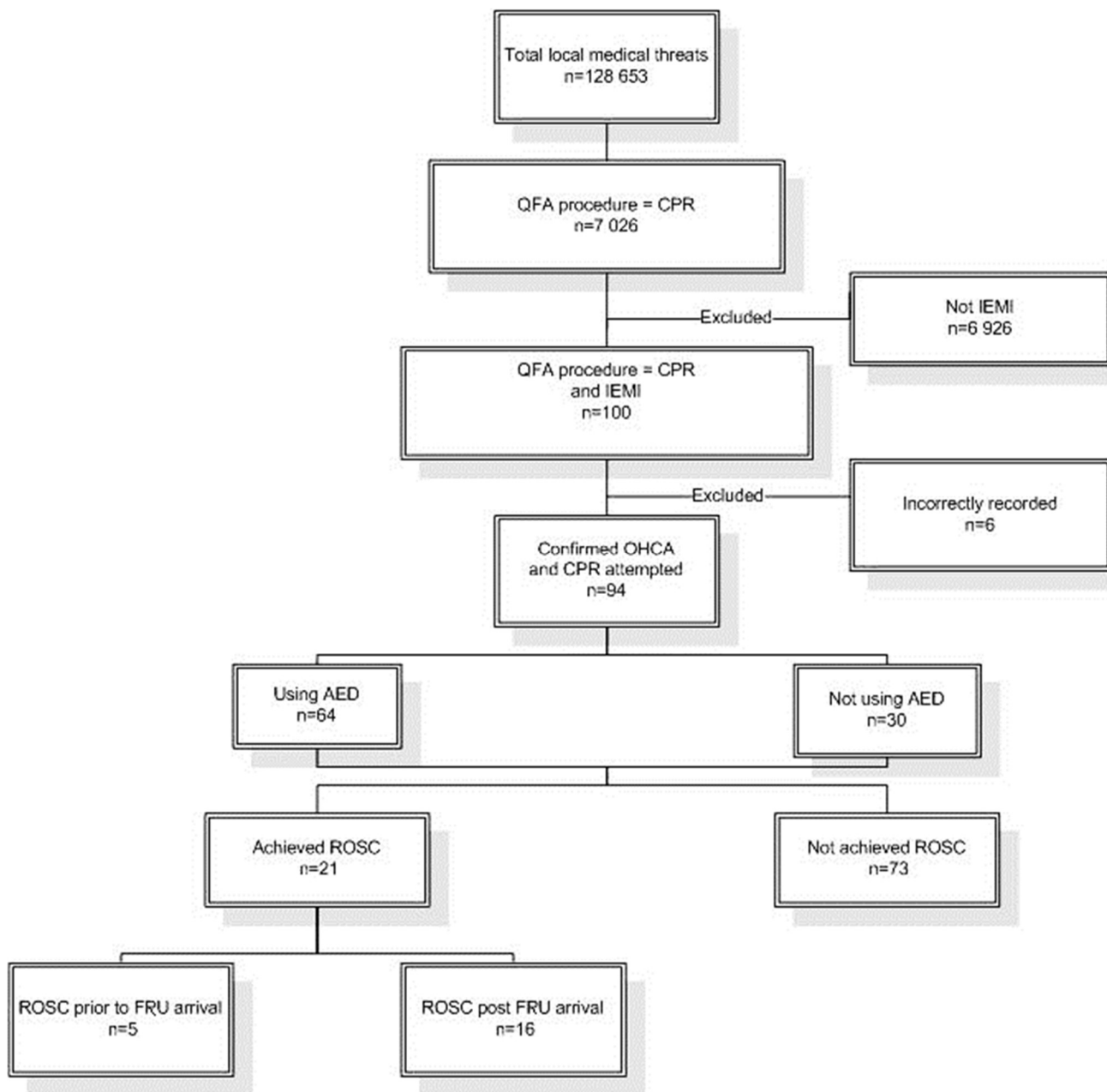


Figure 1. Summary of a FRU mission in case of OHCA during IEMI.

Statistical analyzes showed that in the study group, ROSC was not correlated with sex ($p > 0.05$) or with the use of AED ($p > 0.05$). The size of the sample also does not allow for the conclusion that ROSC was statistically significantly influenced by the age of the victims. The analyzes encourage the authors to study this phenomenon more broadly on a larger study group.

The mean time between receipt of the IEMI call and arrival on scene was 6 minutes and 22 seconds (IQR = 4). The mean duration of activities on scene (until completion of operations by FRU) was 59 minutes and 14 seconds (IQR = 36.75). The mean distance that FRU traveled from the place of their stationing to the scene was 6.46 km (IQR = 9).

Table 2. Characteristics of the victims.

	N (%)	ROSC (%)	Statistical analysis
Gender			
Woman	22 (23.40)	18.18	X ² =0.286 p=0.592
Man	72 (76.59)	23.61	
	M (SD)	ROSC (%)	
Age (years)			
Mean	63.06 (13.97)	22.34	Z=1.212 p=0.226
	N (%)	ROSC (%)	
Age (years)			
<40	4 (4.26)	50.00	p>0.05
40-49	11 (11.70)	9.11	
50-59	21 (22.34)	9.52	
60-69	30 (31.91)	23.33	
70-79	16 (17.03)	37.50	
80-89	9 (9.57)	22.22	
> 90	3 (3.19)	33.33	
Using AED			
YES	64 (68.09)	23.44	X ² =0.139 p=0.709

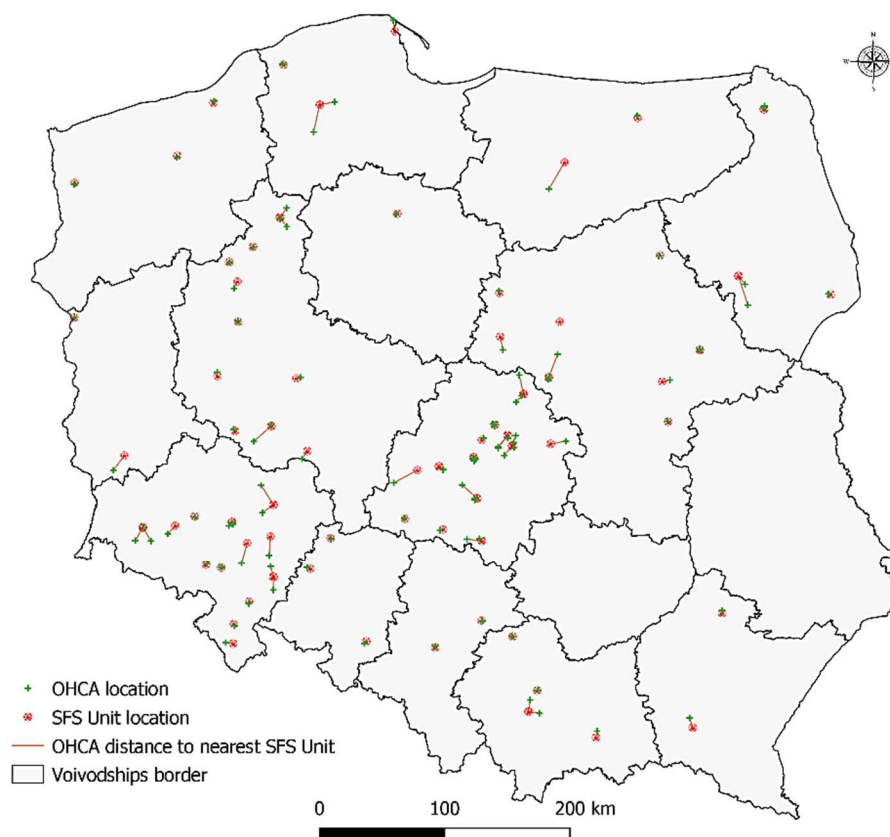


Figure 2. Distances between the locations of the SFS Unit and OHCA.

Table 3. OHCA mission details.

	M	SD	min.-max.	Me	Q1	Q3
Time between FRU call and arrival on scene ¹	6.37	3.60	1 – 20	5	4	8
Time of activities on scene ¹	59.23	46.63	13 – 387	48	32.25	70
Total time of incident ¹	65	47.60	16 – 398	54	39	77
Distance FRU to scene ²	6.46	6.88	0.14 – 28.57	27.40	1.28	10.28

1-time [min]; 2- distance [km]

DISCUSSION

Due to the lack of OHCA research in the activity of FRU in Poland, the authors compared the obtained results of their own analysis to the results related to OHCA and ROSC in the activity of NEMS and the current guidelines. The inability to compare ROSC indicators with other studies was a limitation of the study.

In the face of an out-of-hospital cardiac arrest, even the best-equipped medical teams and densely located FRU units will not be able to improve the prognosis of the injured person if an eyewitness activity is limited to calling emergency services. The time it takes for the emergency services to arrive and for the services to continue the chain of survival must be used optimally. Bystanders should conduct CPR, with particular emphasis on high-quality chest compressions. Similar observations to the presented own research were made in 2011 by Krzysztof Pstrągowski et al. [11] describing the sequence of activities key to the prognosis of a patient with OHCA as a chain of survival. Its links include: quick diagnosis of life-threatening conditions and calling for medical assistance, immediate initiation of basic life support procedures, early defibrillation and implementation of specialist life support procedures. At the same time, the authors pay attention to the statistics. OCHA has a very high mortality rate. In modern registries, in-hospital mortality in adults who have managed to restore spontaneous circulation ranges between 67% and 71% [11]. In addition to the work discussed above, observations on the participation of witnesses in OHCA were carried out by K. Nadolny et al. [12] in a study from 2016. An important factor contributing to the improvement of survival in out-of-hospital cardiac arrest is the interaction between the medical dispatcher, the witness performing CPR and the rapid use of AED. In another publication of 2014, the authors R. Gałązkowski et al. [13] noted that the immediate commencement of first aid by a witness of an emergency or the implementation of activities in the field of QFA by units cooperating with the system before the arrival of the emergency medical team may beyond doubt contribute to the improvement of the effectiveness of medical rescue operations, provided to a person in a state of emergency. Moreover, as the authors add, due to the importance of implementing CPR in people with sudden cardiac arrest (SCA), it is worth considering the results in terms of CPRG units undertaking cardiopulmonary resuscitation [13].

The literature on the subject includes another publication from 2015 describing the necessity to take action and the contribution of the witnesses of the event to further prognosis after SCA. The authors S. Pilip et al. [14] noticed that the activation of the chain of survival by the witnesses of the incident, including, if necessary, the involvement of units providing QFA and finally properly implemented ALS constitute an inseparable whole that conditions the success of resuscitation. The implementation of BLS ensures a small but sufficient blood flow for the brain and heart, thus increasing the likelihood of successful defibrillation and return of the heart rhythm. People who undergo immediate resuscitation measures have a chance to recover and function independently in everyday life [14]. The same research team mentions the time that has elapsed since the onset of SCA. We only have 4 minutes from cardiac arrest for CPR to become an effective resuscitation. Therefore, in a state of emergency, the time of diagnosis and providing effective help plays a key role. It is a difficult or even impossible task to reach a patient with symptoms of cardiac arrest within 3-4 minutes by qualified personnel competent to provide advanced life support (ALS), especially in an outpatient setting. Therefore, the system of the State Medical Rescue cooperates with other units [14]. These data are consistent with the observations of the authors of the own analysis.

The participation of FRU in OCHA is important, and due to the dense distribution of FRU entities in the Volunteer Fire Department (VFD) units equipped with AED, the share of firefighters will be increasing. In addition to the favorable location of FRU, there is an excessive use of NEMS units. Many authors point to the equipment and skills of firefighters that can be used during IEMI. Wójcik et al. [15] in their work from 2017 describe that one of the key skills required from firefighters to perform CPR in a patient with cardiac arrest. This skill is so important because it is often the firefighters who may have the first contact with the casualty and carry out life-saving actions and continue them until medical assistance arrives.

As the authors of the analysis on the activity of FRU at OHCA, we agree with the results of the study from 2016 by T. Kłosiewicz. The author noted that the critical situation was to accept the report of sudden cardiac arrest. In this case, only quick chest compressions and the provision of defibrillation increase the chance of survival. The guidelines of the European Resuscitation Council place particular emphasis on rapid defibrillation, performed before the arrival of the ambulance service. A properly functioning program of universal access to defibrillation, which significantly improves the survival of SCA victims, requires the cooperation of medical services with units cooperating with the system [16].

CONCLUSIONS

Research results in the field of ROSC are in line with global trends and show the role of early cardiopulmonary resuscitation. At the same time, they encourage a broader analysis of the discussed topic, especially in the study group of FRU rescuers. The study also shows that sending the FRU to OHCA in the case of non-availability of the EMS in the initial phase of the intervention is justified. Further studies on the suitability of disposing of FRU in Poland to typically medical events are also justified.

LIST OF SHORTCUTS

ALS	advanced life support
BLS	basic life support
CP	command post
DSS	decision support system
EMS	emergency medical service
FRU	fire rescue units
HEMS	helicopter emergency medical service
IEMI	isolated emergency medical incidents
MRO	medical rescue operations
MRT	medical rescue team
NCRCCP	National Centre for Rescue Coordination and Civil Protection
NEMS	National Emergency Medical Service
NFRS	National Firefighting Rescue SystemNational Fire and Rescue System
NH	National Headquarter
SCA	sudden cardiac arrest
SFS	State Fire Service
QFA	qualified first aid
VFD	Volunteer Fire Department

SUPPLEMENTARY INFORMATION

Funding: This research received no external funding.

Institutional Review Statement: The study was conducted according to the guidelines of the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

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