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# Does the position of the body impact the return of spontaneous circulation and hospital survival in sudden cardiac arrest patients?

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## ABSTRACT

**Introduction:** Out-of-hospital cardiac arrest (OHCA) is a big medical problem.

**Material and methods:** The aim of this study was to assess the occurrence of sitting position in victims of OHCA at the arrival of Emergency Medical Services (EMS) and examine whether maintaining a supine position until ambulance arrival impacts the return of spontaneous circulation (ROSC) and survival until hospital admission and discharge. The documentation of patients in the OHCA registry of part of Silesian Voivodeship 1–06.2018 was accessed and yielded 634 cases for analysis.

**Results:** The sitting position was found in 41 (6.5%) patients. These patients were more frequently female: 46.3% vs 30.6%, and older: 74.0 (57.9–82.0) vs 67.7 (54.9–75.8) and less frequently received cardiopulmonary resuscitation (CPR) from bystanders: 7.3% vs 63.6%, while ROSC was found with similar frequency: 34.2% vs 34.1%, survival until hospital admission in ROSC subgroups was lower in those in a sitting position than in a lying position: 50% vs 75.5%. None patients who were found in the sitting position survived until hospital discharge, while 33 (6.1%) patients out of those found in the lying positions survived. The univariable analysis showed that the sitting position was associated with female sex, older age, previously implanted implantable cardioverter-defibrillator (ICD) before OHCA. The multivariable logistic revealed that the sitting position was independently associated with chest pain and the presence of ICD.

**Conclusions:** Patients found in a sitting position at the arrival of EMS constituted 6.5% of patients with OHCA in whom resuscitation attempts were undertaken and were at higher risk of unfavorable outcomes.

**Key words:** cardiac arrest, cardiopulmonary resuscitation, sitting position

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## Introduction

Cardiac arrest is a cessation of cardiac mechanical function leading to loss of consciousness, apnoea or stertorous breathing, and impalpable large arterial pulse [1]. Depending on how out-of-hospital cardiac arrest (OHCA)

is defined, the condition is diagnosed in Europe with the incidence of 38/100,000 inhabitants per year [2, 3], in the United States — 76/100,000 inhabitants per year [4], and in Poland — 69.7–95.0/100 000 inhabitants per year [5, 6].

The majority of cardiac arrest victims are in a lying position, in which they may be at the onset of cardiac

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arrest or which they assume as a result of falling due to a decrease in postural muscle tone [7, 8]. Patients who are initially in a seated position usually fall down unless supported by people or objects in the environment or if they have a low center of gravity [9, 10].

The position of a patient's body during cardiac arrest may delay the correct diagnosis and resuscitation by witnesses or even the members of medical services [10, 11].

The importance of a maintained sitting position during a cardiac arrest for the recognition of the condition and its prognosis is unknown. The sitting position may be accidental or caused by the adoption of this position before the arrest due to premonitory symptoms. However, it cannot be ruled out that sitting may be associated with activities involved in the cause of cardiac arrest, such as passing urine or stool [12]. Delay in assuming a horizontal position is likely to extend the duration of loss of consciousness (LOC) and potentially lead to permanent cardiac arrest [13]. Moreover, the defibrillation threshold is likely to be rising at this time leading to ineffective shocks [14].

The aim of this study was to assess the occurrence of sitting position in victims of OHCA at the arrival of Emergency Medical Services and examine whether maintaining a supine position until ambulance arrival impacts the return of spontaneous circulation (ROSC) and survival until hospital admission and discharge in patients who received cardiopulmonary resuscitation (CPR).

## Material and methods

The study group and methods were described elsewhere [15]. A brief questionnaire regarding cardiac arrest data and circumstances was completed by Emergency Medical Services (EMS) personnel in upper region Poland. In Poland, EMS can perform endotracheal intubation and administer drugs according to the guidelines for resuscitation or defibrillation manual, etc. The Silesian Registry of Out-of-Hospital Cardiac Arrest (SIL-OHCA; Clinical Trials. Gov Identifier: NCT03654859) provided the study material. From a total of 853 questionnaires compiled between January and June 2018, the following questionnaires were excluded: 162 cases where the cardiac arrest occurred after EMS arrival, one questionnaire concerning a patient referred to Helicopter Emergency Medical Services (HEMS), 42 questionnaires covering the same patients completed by first responders and specialist EMS personnel, and 14 questionnaires concerning patients in whom the position of the body at EMS arrival was classified as other than sitting or lying, or was not assessed, yielding 634 cases qualifying for inclusion in the study.

The following data were gathered based on the questionnaire: sex, age, place of incident, assessment

of the mechanism of cardiac arrest as traumatic or non-traumatic, presence of witnesses of the event, bystander CPR consisting of automated external defibrillation (AED) or chest compressions, symptoms before cardiac arrest (chest pain, dyspnoea, weakness), comorbidities (previous myocardial infarction, diabetes, previous stroke, coronary artery bypass graft [CABG]/percutaneous coronary interventions [PCI], pacemaker [PM], implantable cardioverter-defibrillator [ICD]) if available to bystanders, duration between the call and EMS arrival, body position at EMS arrival, first recorded rhythm, defibrillation, the airways management, and vascular access, prehospital ROSC, and survival until hospital admission and discharge.

The data on in-hospital mortality rates were provided by the National Health Fund (NHF), the sole public provider of healthcare services in Poland; the data were available for 580 patients.

The number and percentage of patients with missing data on characteristics, the event setting, performed procedures, and outcomes are shown in the supplementary materials (Tab. S1).

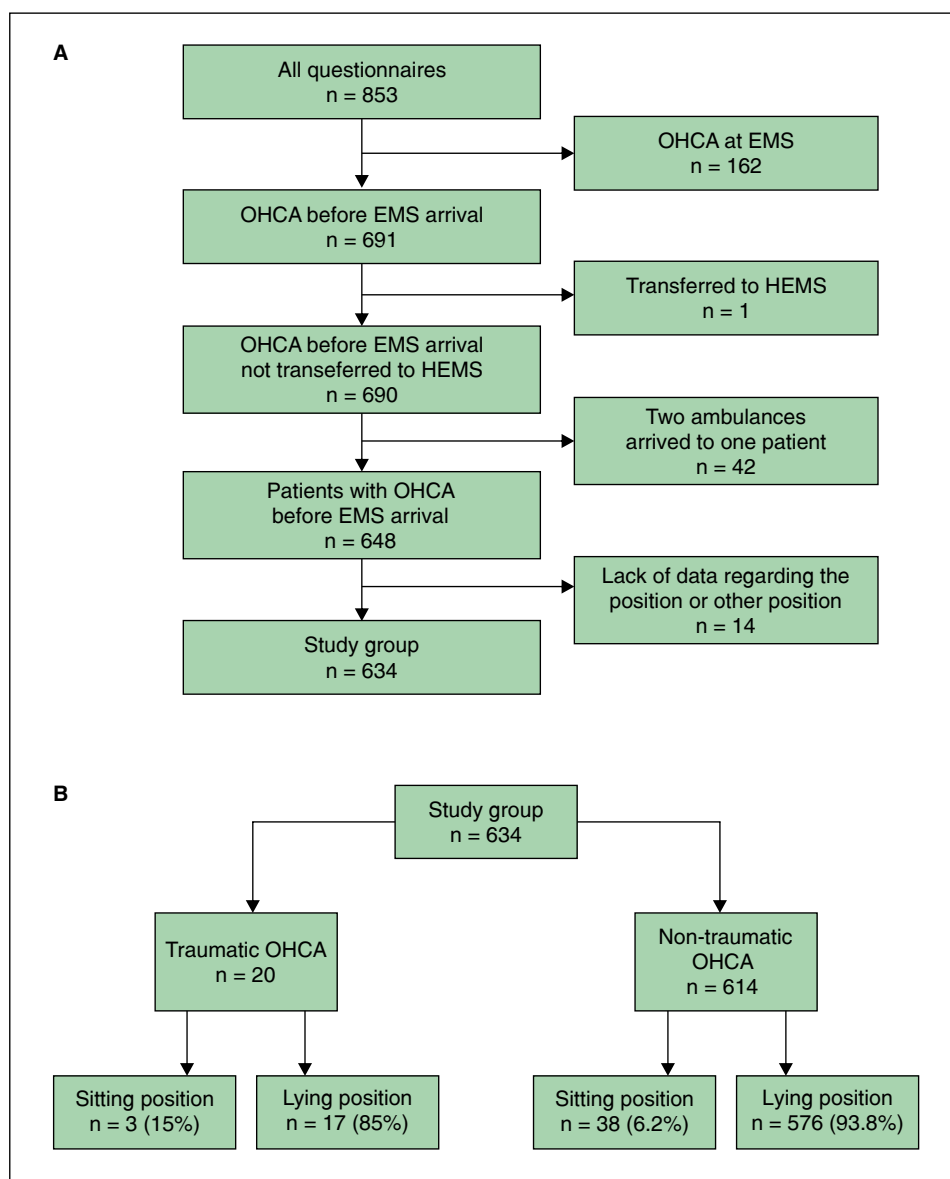
ROSC was defined as any documented return of adequate circulation achieved during the prehospital phase during the event. Survival until hospital admission was defined as a transfer of care to the medical staff at the receiving hospital, independent of the patient's ROSC status (with sustained ROSC or during ongoing CPR).

The Bioethical Commission of Silesian Medical Chamber assessed that an opinion of the Bioethical Commission is not necessary for collecting data from The Silesian Registry of Out-of-Hospital Cardiac Arrest.

## Statistical analysis

Continuous data are presented as the median and interquartile range (IQR) and compared using a Mann-Whitney U test or numbers and percentages and compared using a  $\chi^2$  test.

Univariable and multivariable logistic regression analyses were performed to find factors associated with the sitting position and survival until hospital admission, which was the study's primary endpoint. The univariable analysis of factors associated with sitting position included sex, age, OHCA aetiology, arrest location, witnesses of the event, previous myocardial infarction, previous stroke, a previous pacemaker, or implantable cardioverter-defibrillator, dyspnoea or chest pain before cardiac arrest, and shockable rhythm. The univariable model regarding survival until hospital admission additionally encompassed the following factors: sitting position, adrenaline administration, and endotracheal intubation. All variables significantly associated with the outcome in the univariable analysis were included in the multivariable model.



**Figure 1. A.** Flow chart. Study group construction; **B.** Patients with traumatic and non-traumatic cardiac arrest found in a sitting position

The Bioethical Commission of Silesian Medical Chamber decided that an opinion of the Bioethical Commission is not necessary for collecting data from The Silesian Registry of Out-of-Hospital Cardiac Arrest. The present study was performed on the basis of the above Registry. The study follows the principles of the Declaration of Helsinki.  $P < 0.05$  was considered significant. Statistica version 13.3 (TIBCO Software, CA, USA) was applied for all computational analyses.

## Results

The flow chart representing the study group construction is presented in Figure 1A.

The sitting position was found in 41 (6.5%) victims of cardiac arrest at EMS arrival. Among 20 patients with traumatic cardiac arrest, three (15%) were sitting at EMS arrival, while among the rest of 614 patients, 38 (6.2%) were sitting ( $p = 0.12$ ) — Figure 1B.

The demographics, OHCA circumstances, and clinical data are presented in Table 1 and Table 2.

Patients found in a sitting position in comparison with those found lying were more frequently women: 46.3% vs. 30.6%  $p = 0.036$ , older: 74.0 (57.9–82.0) vs. 67.7 (54.9–75.8)  $p = 0.007$ , less frequently given CPR by bystanders: 7.3% vs. 63.6%  $p < 0.001$ , the ROSC was found with similar frequency: 34.2% vs. 34.1%  $p = 0.99$ . Survival until hospital admission in the subgroup of prehospital ROSC patients earlier

**Table 1.** Demographics and cardiac arrest circumstances

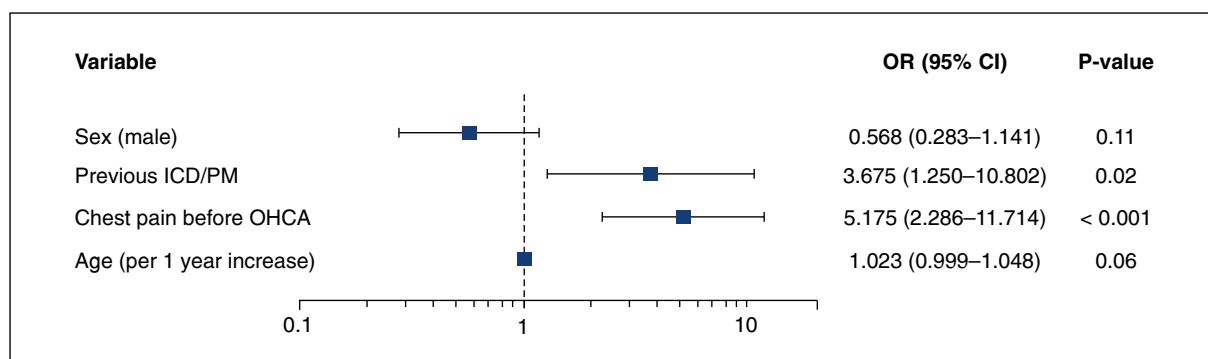
	<b>Lying position n = 593</b>	<b>Sitting position n = 41</b>	<b>P-value</b>
Males n (%)	410 (69.4)	22 (53.7)	0.036
Age (years) — median (interquartile range)	67.7 (54.9–75.8)	74.0 (57.9–82.0)	0.007
Aetiology n (%)			
Medical	502 (86.3)	34 (82.9)	0.26
Traumatic	17 (2.8)	3 (7.3)	
Other	64 (11.0)	4 (9.8)	
Place n (%)			
Home	424 (71.7)	30 (73.2)	0.67
Public place	105 (17.8)	7 (17.1)	
Street/highway	23 (3.9)	3 (7.3)	
Workplace	19 (3.2)	0 (0)	
Outpatient clinic	6 (1.0)	0 (0)	
Other	14 (2.4)	1 (2.4)	
Witnessed n (%)	543 (92.2)	35 (87.5)	0.29
Bystander CPR n (%)	376 (63.6)	3 (7.3)	< 0.001

CPR — cardiopulmonary resuscitation

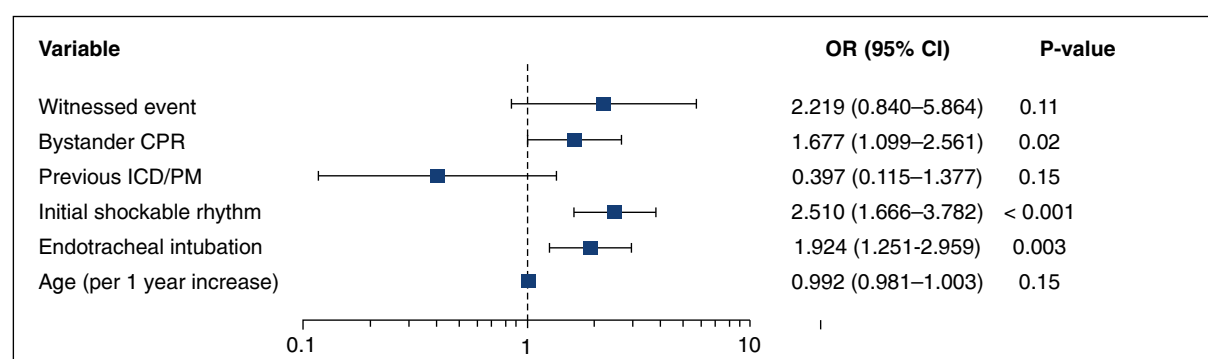
**Table 2.** Clinical and cardiac arrest description data

	<b>Lying position n = 593</b>	<b>Sitting position n = 41</b>	<b>P-value</b>
Symptoms before CA n (%)	318 (57.4)	33 (84.6)	< 0.001
Dyspnoea n (%)	104 (17.5)	11 (26.8)	0.14
Chest pain n (%)	46 (7.8)	10 (24.4)	0.001
Weakness n (%)	70 (11.8)	9 (22.0)	0.057
Previous myocardial infarction n (%)	64 (10.8)	4 (9.4)	0.84
Diabetes n (%)	85 (14.3)	10 (24.4)	0.08
Stroke n (%)	26 (4.4)	1 (2.4)	0.55
CABG/PCI n(%)	30 (5.1)	1 (2.4)	0.45
PM/ICD n (%)	25(4.2)	6(14.6)	0.002
Time from emergency call to EMS arrival (min)	8 (8–11)	8 (8–9)	0.50
First recorded rhythm			
VF/PVT	128 (21.5)	7 (17.0)	0.30
PEA	62 (10.4)	21 (51.2)	
Asystole	347 (58.5)	8 (19.5)	
Unknown	56 (9.6)	5 (12.3)	
Defibrillation n (%)	204 (34.9)	17 (41.5)	0.40
Epinephrine use n (%)	492 (83%)	36 (87.8)	0.42
Oropharyngeal tube n (%)	43 (7.3)	3 (7.3)	0.87
Airway mask n (%)	116 (19.6)	8 (19.5)	
Intubation n (%)	351 (59.2)	26 (63.4)	
Other or no data n (%)	83 (14.0)	4 (9.8)	
Venous access n (%)	511 (86.2)	36 (87.8)	0.99
Intraosseus access only n (%)	3 (0.51)	0(0)	
No data n (%)	79 (13.3)	5 (12.2)	
ROSC n (%)	200 (34.1)	14 (34.2)	0.99
Survival until hospital admission n (%)	151 (25.4)	7 (17.1)	0.23
Survival until hospital admission in ROSC group (%)	75.5	50.0	0.036
Survival until discharge n (%)	33 (6.1)	0 (0)	0.11

CA — cardiac arrest; CABG/PCI — coronary artery bypass graft/percutaneous coronary intervention; PEA — pulseless electrical activity; PM/ICD — pacemaker/implantable cardioverter defibrillator; ROSC — return of spontaneous circulation; VF/PVT — ventricular fibrillation/pulseless ventricular tachycardia



**Figure 2.** Independent factors associated with the sitting position of patients with OHCA on EMS arrival. Results of multivariable analysis. CI — confidence interval; ICD/PM — implantable cardioverter-defibrillator/pacemaker; OHCA — out-of-hospital cardiac arrest; OR — odds ratio; P-value — probability value



**Figure 3.** Independent predictors of the survival until hospital admission after OHCA. Results of multivariable analysis. CI — confidence interval; CPR — cardiopulmonary resuscitation; ICD/PM — implantable cardioverter-defibrillator/pacemaker; P-value — probability value

found by EMS personnel in a sitting position was lower than those found in a lying position: 50% vs 75.5%  $p = 0.036$ . None of the victims found arrested in a sitting position by EMS survived until hospital discharge, while survival until hospital discharge was found in 33 (6.1%) victims found in a lying position:  $p = 0.11$ .

The multivariable logistic regression analysis revealed that the sitting position was independently associated with chest pain before cardiac arrest and the presence of ICD or PM but not with sex or age (Fig. 2).

The univariable analysis showed that the sitting position was associated with female sex, older age, previously implanted ICD or PM, and chest pain before OHCA (Supplementary Materials, Table S2).

The independent predictors of survival until hospital admission included bystander CPR, shockable rhythm, and endotracheal intubation (Fig. 3). The witnesses of the event, ICD or PM, and age were not significantly or independently related to the transfer to the hospital with or without sustained ROSC.

The survival until hospital admission after OHCA was associated with the following factors in univari-

able analysis: younger age, witnesses of the event, bystander CPR, initial shockable rhythm, endotracheal intubation, and borderline significantly with the lack of ICD or PM.

### Discussion

The main finding of the study is that 6.5% of patients with OHCA were found in a sitting position at the arrival of Emergency Medical Services. The reason for maintaining the sitting position at EMS arrival was the lack of spontaneous fall of the victim and the lack of changing the victim's position by bystanders. No spontaneous fall may be related to the fastened seat belt in a vehicle or limited space around a victim that prevents adoption of a lower position or falling [16]. In fact, the sitting position occurred in 15% of patients with traumatic cardiac arrest where these factors frequently occur. Nonetheless, the traumatic injury as the cause of cardiac arrest concerned less than 10% of patients found by EMS in a sitting position.

Reports regarding body position at EMS arrival to the arrested patient in the literature are scarce, and this was not the primary consideration of the available publications [11, 12, 16]. The victim's body position at EMS arrival was not included in the Utstein style reporting of cardiac arrest; therefore, the data were not systematically collected. However, some information is available from papers regarding the occurrence of cardiac arrest in toilets or circumstances of OHCA recorded on video [16].

Kiyohara et al. [12] reported that 4.6% of OHCA in Japan occurred in a toilet. The outcome of these events was poor, mainly because of delayed recognition. Hayashi et al. compared the percentage of cardiac arrests preceded by a given daily life activity with the estimated percentage of time spent performing it. Three kinds of activities were related to higher than expected incidence of OHCA, namely using a bath, which may be a special consideration in Japan due to the practice of taking very hot baths and their relationship to vasovagal syncope (VVS), using a toilet, walking or cycling for sport or strenuous work [17, 18]. Abe et al. [18] reported an increased incidence of OHCA due to drowning during bathing at home in Japan, particularly in the elderly. They presumed syncope due to the hot environment as the cause of drowning.

The second finding was that victims found in a sitting position were significantly older than those found lying and tended to be more frequently female. These differences in demographics suggest that patients found in a sitting position at ambulance arrival may differ from other victims in terms of the direct cause of cardiac arrest. Furthermore, in the multivariable analysis, the sitting position was independently associated with chest pain before cardiac arrest and the presence of ICD or PM but not with sex and age in the case of the sitting group. The victim's orthostatic posture may indicate the possibility that cardiac arrest could be provoked by central hypovolaemia due to orthostasis or reflex mechanisms. However, a sitting position in cardiac arrest may be due to limited space, immobilization by something preventing falling, or low centre of gravity, regardless of the cause of the cardiac arrest. In contrast, some patients, who faint, may fall and regain consciousness but have profound post-syncope bradycardia and hypotension progressing to cardiac arrest in a lying position [19]. Thus, multiple factors play a part in the final position adopted by the victim of cardiac arrest.

The third finding is that only a small percentage received bystander CPR among arrested patients found in a sitting position. It could be caused by bystanders' inability to change the victim's position or lack of knowledge about its necessity. The latter explanation indicates poor knowledge of the CPR rules. CPR was rarely performed in arrested patients found by EMS in a sitting position. Moreover, it was proven that CPR is inefficient in this position. The environment in which the cardiac arrest may occur in any other than supine position is

neurosurgery. The patients who undergo neurosurgery are placed in forced, non-supine positions to improve surgical access. The current guidelines indicate the necessity to put them into a supine position when they are in sitting or lateral positions. In case of a prone position, the patients are put in the supine position when chest compressions in the prone position are ineffective [20].

The fourth finding was that ROSC frequency in the sitting and lying groups was similar but did not lead to the same survival until hospital admission and discharge, which were lower for the group found in the sitting position. A similar ROSC frequency in sitting patients with cardiac arrest, compared with those found lying, despite adverse impact factors of older age and less frequent CPR, suggests the existence of other factors that may favorably influence their prognosis. These could include the pathogenesis of cardiac arrest.

The sitting position of victims may be an example of resuscitation in the head-up position, which was initially considered to improve the chances of ROSC [21]. However, recent findings have not confirmed this, although the head elevation in the lying position is believed to reduce cerebral edema [22]. ROSC depends mainly on the blood supply to the heart. This supply could be higher when blood supply to the brain is gravitationally reduced by a partial or complete upright position. However, ultimate survival depends on brain blood supply yielding better brain preservation, which is hindered in the sitting position.

A study assessing the usefulness of specific situational information such as the patient's posture in cardiac arrest did not help its recognition [23]. In cases of cardiac arrest in a sitting position, possibly imposed by the immediate surroundings, effective chest compressions require the patient to be lowered to a supine position [24]. The results of this study indicate the necessity to include advice into dispatcher education to encourage bystanders to change the victim's position to supine even before the arrival of EMS personnel. In the recording of events by EMS personnel, the victim's position when first found will prove helpful, and if the victim has remained in a sitting position, the advice should be to lower the patient to a supine position as quickly as possible.

The last finding of the study was that the independent predictors of survival until hospital admission included bystander CPR, shockable rhythm, and endotracheal intubation. This finding is consistent with other authors' reports and stresses the importance of the chain of survival. However, body position at EMS arrival may be an indicator of the lack of CPR or poor CPR quality, and therefore, may not be an independent factor related to poor outcomes.

The resuscitation protocols provide a basis for looking for factors related to CPR outcomes [25]. The inclusion of body position in such protocols may improve resuscitation effort outcomes. Changing the victim body

position by a bystander should be considered as the first CPR manoeuvrer; however, the assessment of its significance requires further observational studies.

### Limitations

The study's main limitation is the relatively small sample size, which might not allow reaching the statistical significance for survival until hospital discharge. The survival until hospital discharge is about 5% in the whole group, while it is 0% in the patients found in a sitting position. However, the study enabled the estimation of the frequency of the observed phenomenon of maintaining a sitting position by cardiac arrest victims at ambulance arrival and to plan further studies. The lack of some data is also a shortcoming of the study; however, this applied to less than 10% of the study group.

### Conclusions

The sitting position of the out-of-hospital cardiac arrest victim at the arrival of Emergency Medical Services was recorded in 6.5% of patients in whom resuscitation attempts were undertaken. Victims found in a sitting position at the arrival of Emergency Medical Services frequently are older, more often female, experience chest pain, and have comorbidities than those found in a lying position, pointing out the need to seek the underlying mechanisms of cardiac arrest.

Victims found in a sitting position at the arrival of Emergency Medical Services received bystander CPR significantly less frequently and had similar chances for ROSC compared to those in supine position; however, those found sitting, who had ROSC, had slightly lower chances of survival until hospital admission.

**Conflict of interest:** None.

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