

Location of out-of-hospital cardiac arrest as a determinant in the survival of patients

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SUMMARY

Introduction Cardiac arrest (CA) is defined as a sudden cessation of normal circulation of blood due to failure of the heart to contract effectively during systole.

Objective The aim of this study was to determine the difference in outcome among patients, depending on the location of out-of-hospital CA; to determine the influence of observed determinants on the survival rate.

Methods Observational and retrospective study was conducted in the Institute for Emergency Medical Service Novi Sad (IEMS NS). It included patients who underwent cardiopulmonary resuscitation (CPR) by medical ambulance squads. Patients were divided into three groups, based on the location of CA: private place, public place, and medical institution.

Results CA occurred in private places in 151 cases (76.26%). The shortest duration of a phone call with the dispatcher and Reaction Time I was in the group of patients with CA in a public place (59.1 ± 36.4 seconds and 137.1 ± 89.8 seconds, respectively). CA was recognized in more than 80% of cases, but CPR was initiated in only 9.09% of patients in private places and in 19.35% of patients in public places. Though they initially presented with shockable rhythm in 57.14% of cases in public places, this group has the worst immediate outcome (11.43%), in contrast to the patients with CA in medical institutions (58.33%). Factors determining the survival of patients with CA were CPR attempted immediately after collapse, initial rhythm and eyewitnesses of CA.

Conclusion In order to improve survival of patients with out-of-hospital CA, both education of laymen and introduction of standard questioning protocol in the IEMS Call Centre are necessary.

Keywords: out-of-hospital cardiac arrest; cardiopulmonary resuscitation; survival rate

INTRODUCTION

Cardiac arrest (CA) (lat. *institutio cordis*) is defined as a sudden cessation of normal circulation of blood due to failure of the heart to contract effectively during systole [1].

This condition is experienced by 800,000 people in Europe and the USA every year [2, 3]. Cardiopulmonary resuscitation (CPR) is attempted in most cases [4]. Data collected in 37 European countries demonstrate that sudden CA incidence in which CPR is initiated by ambulance is 38 per 100,000 inhabitants yearly. Hospital survival rate (defined as survival up to the discharge) was 10.7% for all initial rhythms and 21.2% for shockable rhythms (ventricular fibrillation and pulseless ventricular tachycardia) [5]. Prehospital emergency medical services in four cities in Serbia (Belgrade, Novi Sad, Niš, Kragujevac) registered 2,827 patients with CA during 12 month follow-up (2005/2006). CPR was initiated by ambulance in 591 patients (incidence: 27/100,000). Hospital survival rate was 12.5% [6].

Out-of-hospital CA most often occurred in patients' homes [6, 7]. Location of CA is considered non-relevant to the outcome, provided that CPR is initiated immediately [8].

OBJECTIVE

The aim of the study is to determine frequency of CA in relation to the location, difference in immediate survival of patients with CA in relation to the location (private/public space/medical institution) and effect of these determinants to the immediate survival rate in out-of-hospital CA.

METHODS

This observational and retrospective study was conducted in the Institute for Emergency Medical Service of Novi Sad (IEMS NS) in the period between January 1st, 2010 and December 31st, 2010.

IEMS NS covers territories of the municipalities of Novi Sad and Sremski Karlovci, with 389,130 inhabitants, according to the statistical data from public institutions. IEMS NS is the only medical institution capable of providing prehospital emergency life support in the territory of these municipalities. In the studied period, there was a single Institute for Emergency Medical Service (IEMS) Call Centre collecting the calls for medical emergencies and

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non-urgent patient transport, with five telephone lines and one radio channel for the communication with the ambulance squads. A doctor and an emergency medical technician work in the IEMS Call Centre in twelve-hour shifts. There were eight ambulance squads in each working shift consisting of a doctor, an emergency medical technician and an ambulance driver (non-medical personnel trained to provide basic life support (BLS)). All ambulances are equipped identically and are capable of providing advanced life support. Non-urgent patient transport squads consist of a medical technician and a driver, or only a driver, in some instances. There are 10 non-urgent patient transport squads on workdays, five on Saturdays and two on Sundays and in night shifts.

All patients with attempted CPR by the IEMS NS during the studied period were enrolled into the study. The patients were divided into the following three groups, based on the location of sudden CA (SCA): private place (Group I – homes, apartments, nursing homes), public place (Group II – streets, agricultural fields, offices, shopping malls, sport centers, courts, prison, police stations), and medical institution (Group III – health centers and hospitals without emergency medical squads). Determinants taken into consideration for each patient included the following:

- Gender;
- Average age;
- Duration of the phone call to the IEMS Call Centre (from the moment of taking the call to the moment of ending the call);
- Reaction Time I (RT I) – the period between the moments when the call is answered and when the ambulance squad is dispatched;
- Arrival Time – the period between the moments of receiving the order from the IEMS Call Centre and arriving to the location;
- Witnesses of SCA: laymen, medical professionals or ambulance squads;
- Early CPR initiation, before the arrival of an ambulance;
- Phone-assisted CPR – instructions provided by IEMS Call Centre operator on how to initiate CPR before the arrival of an ambulance;
- Initial rhythm – shockable (ventricular fibrillation / pulseless ventricular tachycardia) or non-shockable (asystole / pulseless electrical activity);
- Return of spontaneous circulation after initiated CPR, until hospital admission.

Collected data were coded and stored into specially created computer database. All data were calculated by using statistic packages SPSS for Windows, version 11 (SPSS Inc., Chicago, IL, USA). The three studied groups were compared and numeric data were represented by mean arithmetic values and standard deviations, while the significance of a particular parameter was determined using Student's t-test and χ^2 -test. Impact of particular factors on survival was determined by using univariate binary logistic regression analysis. The results are presented in tables.

RESULTS

In 2010, ambulance squads of IEMS Novi Sad had 35,083 patients in total. CPR was initiated in 198 patients. Number of patients with CA in Group I was significantly higher than in the other two groups (Table 1). Among patients with CA, there were more men and they were on average younger than women, especially in Group II. There is a statistically significant correlation in age and gender distribution of CA in the first two groups ($p < 0.05$).

Duration of conversation with IEMS operator was longer than one minute in all three groups. The shortest duration of conversation was with eyewitnesses of CA in Group II. IEMS dispatcher sent ambulance squad before the termination of phone call in four cases of CA which occurred in Group I, and only in one case of CA in each of the other two groups. RT I less than 60 seconds was observed in 19 patients (11.26%) in Group I, in two patients (2.86%) in Group II, and in three patients (16.67%) in Group III. The shortest arrival time was recorded in patients in Group III (Table 1).

In most cases in Groups I and II, eyewitness of CA were laymen. However, BLS was initiated before the arrival of ambulance in small number of cases. Moreover, BLS was not even initiated in some cases in all three Groups where health professionals were present. IEMS Call Centre operator gave instructions for phone-assisted CPR in only three cases in Group I (Table 1).

Shockable initial rhythm most often occurred in patients in Group II, but the immediate survival rate was the highest among the patients in Group III (Table 1).

It is possible to calculate individual impact for each observed determinants on the immediate survival rate if univariate binary logistic regression analysis is applied (Table 2). Early CPR initiation, before the arrival of an ambulance, had the highest impact on the survival rate (Table 2) and these patients were 2.4 times more likely to survive initially. Initial rhythm was also an important determinant in survival – patients with shockable rhythm were 3.2 times more likely to survive than patients with non-shockable rhythms. Presence of witnesses was comparably a less important determinant. If SCA was witnessed by the ambulance squad, patients were 2.3 times more likely to survive compared to the presence of laymen. Witnessed by other health professionals, patients were 1.3 times more likely to survive.

DISCUSSION

Out-of-hospital CA most often takes place in private houses, apartments and nursing homes (84.7%), while in small number of cases it occurs in public places (14.3%) and in health institutions (1%), according to literature [7]. A study conducted in four IEMSs in Serbia in 2004 and 2005 showed that out-of-hospital CA was also most often in private houses, apartments and nursing homes (70.2%), while small number of cases were recorded in public places (24.8%) and health institutions (5%) [6]. Out-of-hospital

Table 1. Analysis of individual determinants in all three groups of patients

Predictors		Group I	Group II	Group III	p
Number of CPRs	Total	151 (76.26%)	35 (17.68%)	12 (6.06%)	<0.001
	Male	97	28	8	<0.001 [†]
	Female	54	7	4	0.248 ^{††}
Average age (years)	All patients	65.8 ± 13.7	59.9 ± 15.1	61.1 ± 15.8	0.029 [‡]
	Male	63.6 ± 14.1	57.5 ± 15.4	59.1 ± 14.7	0.012 ^{‡‡}
	Female	69.5 ± 12.1	71.8 ± 6.0	65.7 ± 21.0	
Duration of conversation (sec.)		72.8 ± 39.0	59.1 ± 36.4	62.7 ± 48.5	>0.05
RT I (sec.)		223.9 ± 347.6	137.1 ± 89.8	80.4 ± 196.3	>0.05
Arrival time (min.)		8.4 ± 4.4	6.6 ± 4.5	4.1 ± 1.6	<0.05
CA recognized by callers		102 (84.29%)	33 (94.29%)	8 (100.00%)	<0.05
Witnesses	Laymen	116 (76.82%)	31 (88.57%)	0	
	Health professionals	5 (3.31%)	4 (11.43%)	8 (66.67%)	
	Ambulance	30 (19.87%)	0	4 (33.33%)	
CPR initiated before arrival	Total	11 (9.09%)	6 (19.35%)	6 (75.00%)	<0.001
	By laymen	9 (7.76%)	4 (12.90%)	0	
	By health professionals	2 (40.00%)	2 (50.00%)	6 (75.00%)	
Phone-assisted CPR		3 (1.99%)	0	0	
VF/VT		47 (31.13%)	20 (57.14%)	4 (33.33%)	<0.05 [‡]
Asystolia/PEA		104 (68.87%)	15 (42.86%)	8 (66.67%)	
Immediate		31 (20.53%)	4 (11.43%)	7 (58.33%)	<0.001

CPR – cardiopulmonary resuscitation; RT I – reaction time I; CA – cardiac arrest; VF – ventricular fibrillation; VT – ventricular tachycardia; PEA – pulseless electrical activity; p – statistical significance

[†] statistical significance of CA frequency between males and females in Group I

^{††} statistical significance of CA frequency between males and females in Group II

[‡] statistical significance of average age between Groups I and II

^{‡‡} statistical significance of average age between males and females in Group I

[‡] statistical significance of shockable and non-shockable rhythm frequency between Groups I and II and between Groups II and III

Table 2. Univariate binary logistic regression analysis of factors determining return of spontaneous circulation in all groups of patients

Predictors	CA at all locations		
	OR	95% CI	p
Sex	0.654	0.323–1.321	0.236
Age	1.008	0.974–1.032	0.521
Duration of conversation	1.006	0.996–1.016	0.260
RT I	0.999	0.998–1.000	0.050
Arrival time	1.087	0.991–1.192	0.076
Witnesses	0.563	0.346–0.917	0.021
Immediately initiated CPR	3.803	1.864–7.757	0.000
Phone assisted CPR	0.539	0.048–6.098	0.618
Initial rhythm	2.421	1.379–4.252	0.002
Location	0.638	0.372–1.094	0.102

CA – cardiac arrest; OR – odds ratio; CI – confidence interval; RT I – reaction time I; CPR – cardiopulmonary resuscitation; p – statistical significance

CA was more often in men, while average age was higher in women [6, 9]. The highest average age was among patients in private places [9]. Our study showed the same distribution of patients in relation to location, sex and age. Average age of patients in Group II was lower than that in Groups I and III.

RT I, for Priority I calls, should be less than one minute [10, 11, 12]. IEMS call center operators should send an ambulance without interrupting a phone call. They are supposed to provide pre-arrival instructions for CPR, so that callers (usually laymen) could initiate BLS before the arrival of the ambulance [13]. Therefore, duration of a phone call should be longer than RT I. However, due to the lack of personnel and absence of questioning proto-

cols, RT I is longer than one minute in most cases, while the duration of the phone call is shorter than RT I. After a caller provides the location of the CA, the phone call is interrupted and an ambulance is sent, while the caller is not given pre-arrival instructions for CPR. The shortest RT I was in Group II, although it should be the shortest in Group III, because CA is being reported by health professionals.

On the other hand, the shortest arrival time was in Group III, which is similar to the arrival time in most European countries, which is 5.5 minutes [9]. Arrival time in Group II, and especially in Group I, was above average. The aim of CPR is to receive early defibrillation in the period between three and five minutes, which increases chances for survival 49–75% [14].

CA is most often witnessed by laymen. If BLS is initiated immediately, delay of early defibrillation decreases the chances for survival for only 3–4% for every minute of delay (compared to 10–12% if BLS is not initiated before the arrival of an ambulance) [15]. Unfortunately, laymen rarely decide to initiate BLS, in the range of 3–45%, or 16–33% on average [16–19]. BLS was more often initiated in Group II – in 60% of cases [9]. Increase of BLS initiated by laymen has been recorded in the last 15 years, due to trainings of laymen and introduction of a standard questionnaire and guidelines for CPR in emergency call centers [20, 21]. In our study, CA was most frequently witnessed by laymen in Groups I and II. In more than 80% of cases, CA was recognized, but laymen failed to initiate CPR in most cases. The lowest number of attempted CPR before the arrival of an ambulance was in Group I, which is three times lower than

in Western European and Scandinavian countries. What is worse, not all health professionals attempted CPR before the arrival of the ambulance. This could be explained by inadequate training of both health professionals and laymen. In Serbia, BLS is taught in the final year of primary education. High school and university students are not trained to apply BLS. In driving schools, training in BLS and principles of first medical aid is still not obligatory. Until recently, first aid and emergency medicine were not taught at medical faculties, while students were informed of the principles of CPR during the courses in Surgery.

Patients in Group II more often presented with shockable rhythms, in 60%, which is equal to those in Western European and Scandinavian countries. In Group I, however, shockable rhythm was considerably lower, especially in comparison to Western European and Scandinavian countries, which is 38% [9].

Even though arrival time and RT I in Group I were the longest and most patients were in non-shockable rhythm, immediate survival was better than in Group II. This could be attributed to the higher number of CA witnessed by the ambulance. The highest immediate survival rate was in Group III, with most number of patients with initiated CPR.

Univariate binary logistic regression analysis showed that survival rate depends on the early CPR initiation, initial rhythm and presence of witnesses. In the last thirty years, more and more non-health professionals are trained to recognize CA and initiate BLS, and operators in many emergency call centers are introduced to protocols for phone-assisted CPR, as immediately attempted CPR increases chances for survival two- or three-fold [22, 23]. In addition to this, quality of life after the hospital discharge is better thanks to the lower degree of neurological damage during hypoxia [24]. If callers are not trained in providing CPR, an emergency call center operator should give instructions to initiate BLS after an ambulance is dispatched [21, 25, 26]. Until the arrival of the ambulance, chest compressions by untrained laymen could be sufficient [27]. Quality of phone-assisted CPR could be equal to the quality of CPR provided by trained persons. However, it was es-

tablished that the quality of ventilation differs between the two [28]. In our study, presence of witnesses determined the survival rate, because laymen rarely initiated CPR.

Better outcome of patients in Group II could also be attributed to the availability of automated external defibrillators (AEDs) in public places [7, 14]. In our circumstances, survival rate in Group II is low, even though most patients are relatively younger and with shockable rhythm. Because our ambulances are not always able to reach patients in less than five minutes, available AEDs and training of laymen could be part of the solution to this problem.

This study was limited to the prehospital level of health system, so we could not calculate short-term survival rate (to the hospital discharge), evaluate neurological damage at the moment of discharge, and take into consideration the application of therapeutic hypothermia.

First defibrillation, endotracheal intubation and venous access were applied in the first two minutes after the arrival of the ambulance, which is in accordance with the European Resuscitation Council Guidelines 2010 [29].

CONCLUSION

Prehospital CAs most frequently occur in private places, but the highest survival rate was recorded in patients who experienced CA in health institutions. This could be explained by the immediately initiated BLS, before the arrival of the ambulance. Laymen usually do not attempt to initiate BLS. On the other hand, IEMS call center operators rarely initiate phone-assisted CPR due to the lack of time. RT I is still over 1 minute, while the arrival time is more than 5 minutes, so early defibrillation (within 3–5 minutes) could be applied only if SCA is witnessed by the ambulance personnel.

In order to improve prehospital survival of patients with SCA, it is necessary to introduce BLS training of laymen and obligatory protocols for phone-assisted CPR in emergency call centers, and place AEDs in public places and instruct laymen on how to apply them.

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Утицај места догађаја на преживљавање болесника са ванболничким срчаним застојем

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КРАТАК САДРЖАЈ

Увод Срчани застој се дефинише као изненадни прекид нормалне циркулације крви због немогућности срца да се контрахује током систоле.

Циљ рада Циљ рада је био да се прикаже разлика у непосредном преживљавању пацијената у ванболничком срчаном застоју у зависности од места догађаја и утицај појединачних посматраних фактора на преживљавање.

Методе рада Спроведено је опсервационо и ретроспективно истраживање у Заводу за хитну медицинску помоћ Нови Сад (ЗЗХМП НС). Обухваћени су пацијенти код којих су ургентне екипе радиле кардиопулмоналну реанимацију (КПР). Пацијенти су подељени у три групе на основу места догађаја: приватна локација, јавно место и здравствена установа.

Резултати Највећи број пацијената срчани застој је доживело на приватној локацији – 151 (76,26%). Најкраће време разговора диспечера са позиваоцем и реакционо време I је било код пацијената реанимираних на јавном месту – 59,1

± 36,4 и 137,1 ± 89,8 секунди. Срчани застој је препознат у преко 80% случајева, али су мере реанимације предузете у 9,09% случајева на приватној локацији и 19,35% на јавном месту. Иако је иницијални ритам на монитору дефибрилатора био шокабилан код 57,14% реанимираних пацијената на јавном месту, најлошије непосредно преживљавање је било у овој групи – 11,43%, док је најбоље било код пацијената реанимираних у здравственим установама – 58,33%. Фактори од којих је зависило непосредно преживљавање су: одмах започете мере КПР, иницијални ритам и ко је био очевидац срчаног застоја.

Закључак Лаици се ретко одлучују на пружање мера КПР, зато је преживљавање много боље у здравственој установама. Да би се побољшало преживљавање пацијената у ванболничком срчаном застоју, потребна је обука лаика, али и увођење протокола за телефонски асистирани КПР у диспечерске центре.

Кључне речи: ванболнички срчани застој; кардиопулмонална реанимација; стопа преживљавања