

RELATIONSHIP BETWEEN THE DISTANCE OF CARDIAC ARREST LOCATION FROM THE EMERGENCY MEDICAL DEPARTMENT AND THE FINAL OUTCOME OF CARDIOPULMONARY RESUSCITATION

Mirko Maglica^{1,2}, Anela Kasalo-Pešić³, Verica Ćavar⁴, Ante Šesto³

¹ Cantonal Hospital Livno, 80101 Livno, Bosnia and Herzegovina

² Medical School, University of Mostar, 8800 Mostar, Bosnia and Herzegovina

³ Emergency department, Health Center Livno, 80101 Livno, Bosnia and Herzegovina

⁴ Gynecological department, Health Center Livno, 80101 Livno, Bosnia and Herzegovina

Received on 25.07.2023.

Reviewed on 10.08.2023.

Accepted on 25.08.2023.

ABSTRACT

Introduction: Cardiopulmonary arrest is a serious medical emergency that can be reversed with prompt and sufficient cardiopulmonary resuscitation (CPR). Out-of-hospital cardiac arrests (OHCA) occur on average at a rate of 60 per 100.000 people. Cardiopulmonary resuscitation must start immediately in order to achieve the desired outcome.

Aim: To investigate the association between proximity to the emergency department and the return of spontaneous circulation (ROSC).

Subjects and methods: This study is a single-center registry-based retrospective cohort study. All the patients from the cardiopulmonary resuscitation registry of the Emergency department of the Health Center Livno were included and divided into 2 groups: the patients who experienced cardiac arrest within a radius of less than five kilometers and the patients who experienced cardiac arrest within a radius of more than five kilometers.

Results: Patients who experienced OHCA within a radius of less than five kilometers had an overall better prognosis for achieving ROSC ($p=0.002$). Even though men experienced cardiac arrest at a higher percentage (74.1 %) than women, there was no significant difference regarding the final outcome. The total incidence did not differ regarding the initial cardiac rhythm.

Conclusion: Providing prompt, sufficient CPR is essential for attaining the most favorable outcomes regarding OHCA.

Keywords: Cardiopulmonary Resuscitation, Out-of-Hospital Cardiac Arrest, Return of Spontaneous Circulation

Corresponding author: Mirko Maglica, MD

E-mail: mirko.maglica@mef.sum.ba

INTRODUCTION

Cardiopulmonary arrest is unquestionably one of the most serious medical emergencies. Without prompt and sufficient cardiopulmonary resuscitation (CPR), the patient will pass away or suffer severe brain damage in a matter of minutes (1). According to several registries, there are on average 60 out-of-hospital cardiac arrests (OHCA) per 100.000 people; the majority of these happen at home (75.0 %), followed by workplaces (15.0 %) (2). Furthermore, there is a wide range in the reported outcomes for cardiac arrests that take place outside of a hospital. Even though the incidence of the return of spontaneous circulation (ROSC) is approximately 30.0 % (3), only 6.7 % of all OHCA patients, according to one meta-analysis, are reported to have survived past hospital release (4, 5). A recent study found that in Europe, 10.0 % of patients who experienced cardiac arrest survived to be discharged from the hospital (1). The main contributor in the increased survival rate after cardiac arrest is so-called "bystander CPR," as shown in a recent study by Wissenberg et al. (6) This places emphasis on the importance of required training in effective cardiac resuscitation (7), following five key components of high-quality CPR: minimizing interruptions in

chest compressions, providing compressions of adequate rate and depth, avoiding leaning on the chest between compressions, and avoiding excessive ventilation (8). The prompt recognition of cardiac arrest is essential since the possibility of survival depends heavily on the interval between the onset of the event and the beginning of CPR. A person in cardiac arrest is unresponsive, unconscious, and not breathing normally or not at all. Electrocardiography or other advanced monitoring techniques, as well as palpating for a carotid pulse, should only be used by medical professionals with clinical evaluation abilities because they consume a lot of time (9). The European Resuscitation Council currently recommends 30 chest compressions followed by two ventilations until a tracheal tube or other airway device has been inserted, then continuing ventilation at 10 breaths per minute while compressing the chest continually (10). When possible, defibrillators should be used. Two high-quality population-based cohort studies have demonstrated that automated defibrillators, which are simple to use and do not require special training, double survival following out-of-hospital cardiac arrest (11, 12). There are some disagreements regarding gender relations and the final outcome after OHCA. Some

studies suggest that women have a higher rate of ROSC (13, 14). But Winther-Jensen et al. showed that there were no gender differences in mortality following OHCA (15). Early recognition of OHCA, followed by bystander CPR and early defibrillation lead to improved survival (16, 17). According to a study by Meaney et al., the most common initial rhythm in OHCA is asystole (39.0 %), followed by pulseless electrical activity (37.0 %), ventricular fibrillation (17.0 %), and ventricular tachycardia (7.0 %) (18). In a recent study from Germany, researchers found that patients who experienced cardiac arrest in public places had overall higher chances of surviving, as well as, when the first rhythm was shockable and defibrillation was performed (19).

The aim of this study was to investigate the association between proximity to the emergency department and the return of spontaneous circulation (ROSC).

SUBJECTS AND METHODS

Study design

It is designed as a single-center retrospective cohort study based on the cardiopulmonary resuscitation registry of the Emergency department of Health Center Livno. All of the patients who were unresponsive, had no palpable pulse, and

had received basic life support and/or advanced life support as specified in the resuscitation guidelines were included in the aforementioned registry.

Data collection

The study included all OHCA cases treated with CPR by the emergency department staff of Health Center Livno between February 2019 and May 2023. The only excluding factor was insufficient medical data in the registry. In total, 27 patients were included in our study, with seven cases excluded due to a lack of medical documentation. The informations used were gender (male or female), date of the OHCA, location, initial rhythm (shockable or unshockable), duration of the CPR, and the final outcome (ROSC or death). All of the data was input into previously created Excel tables. Regarding the location in which OHCA occurred, two groups were formed: the patients who experienced cardiac arrest within a radius of less than five kilometers of the Health Center Livno formed the first group, and the second group were the patients who experienced cardiac arrest within a radius of more than five kilometers.

Statistical analyses

Data analysis was performed using Statistical Package for Social Science statistical software version 26.0 (IBM

Corp., Armonk, NY, USA) with a probability level of $p < 0.05$ regarded as statistically significant. To identify significant differences chi square (χ^2) test followed by Fisher's exact test for small samples were used and to test the strength of association between two nominal variables Cramér's V measurement was used. The results are presented as mean, maximum and minimum values, or absolute (f) and relative (%) frequencies when appropriate.

This study was approved by the Committee of the Health Center Livno (01/1-732/2-23).

RESULTS

Association between gender and the final outcome

Of the total number of patients 20 were men, and 7 were women. As shown in Table 1, there was no significant difference between gender and the final outcome.

Table 1. Association between gender and the final outcome

		ROSC ¹		Death		p
		f	%	f	%	
Gender	Male	5	83.3	15	71.4	0.498
	Female	1	16.7	6	28.6	

¹ Return of spontaneous circulation

Association between the initial rhythm and the final outcome

There were 19 individuals with unshockable rhythms (asystole or pulseless electrical activity) compared to 8 patients with shockable rhythms (ventricular

tachycardia or ventricular fibrillation). As shown in Table 2, despite the fact that a higher percentage of patients with an unshockable rhythm passed away, there was no apparent association between the initial rhythm and the outcome.

Maglica M, Kasalo-Pešić A, Čavar V, Šesto A. Relationship between the distance of cardiac arrest location from the emergency medical department and the final outcome of cardiopulmonary resuscitation. *Zdravstveni glasnik*. 2023;9(2):28-38.

Table 2. Association between the initial rhythm and the final outcome

		ROSC ¹		Death		p
		f	%	f	%	
Rhythm	Shockable	3	50	5	23.8	0.319
	Unshockable	3	50	16	76.2	

¹ Return of spontaneous circulation

Additionally, there was not a statistically significant difference in the association

Association between the location and the final outcome

Eleven patients (40.7 %) experienced cardiac arrest within a radius of less than 5 kilometers of the emergency department, and 16 patients (59.3 %) were distant by

between the initial rhythm and gender (p=0.633).

more than 5 kilometers. As shown in Table 3, there was a significant difference (p=0.002) as well as a strong association (Cramer's V=0.645) between the location and the final outcome.

Table 3. Association between the location and the final outcome

		ROSC ¹		Death		p	Cramer's V
		F	%	f	%		
Location	< 5 kilometers	6	100	5	23.8	0.002	0.645
	>5 kilometers	0	0	16	76.2		

¹ Return of spontaneous circulation

Cardiopulmonary resuscitation procedures ranged in length from 15 minutes to 65 minutes, with the average time being 31 minutes and 30 seconds.

DISCUSSION

In the analyzed period of time, men encountered cardiac arrest at a proportion

that was noticeably higher than that of women. This result is entirely consistent with the majority of studies that investigated the association between gender and the frequency of cardiac arrests (20-22). Gender structure in a recent study by Mody et al. was 63.0 % in favor of men, which is closely comparable to our study structure

(21). This finding might be explained by higher risk factors in men, including high cholesterol, smoking, high blood pressure, diabetes and a high body mass index, as well as a lack of physical activity.

According to research conducted by Bloom et al., women had a much worse prognosis after cardiac arrest and had a lower chance of surviving to be discharged from the hospital (23). Same findings regarding prognosis after OHCA were confirmed by multiple authors (21, 24-26). However, Winther-Jensen et al. demonstrated that there is no significant difference in mortality between men and women if we eliminate disparities in arrest circumstances (15), which is in agreement with our findings.

Shockable rhythms made up around 30.0 % of all cases in our study. According to different authors, the incidence of VF/VT is anywhere between 25.0 and 30.0 % of all cardiac arrests (18, 27). Additionally, these researchers found that successful CPR outcomes and hospital release are less frequent when the initial rhythm of cardiac arrest is unshockable (PEA or asystole). It is probably because these patients are more likely to have pre-existing cardiac disease, myocardial infarctions, and congestive heart failure (18, 27-29). However, there was not a significant difference in survival

between shockable and unshockable rhythms in our study, which included 19 patients with PEA/asystole and 8 patients with VF/VT.

Studies comparing the incidence of shockable rhythms in men and women were not widely available. Women are less likely to initially present with VF or VT in OHCA, according to research by Lakbar et al. (30). This conclusion is likely the result of ignoring the risk factors and possibly referring patients too late if symptoms appear prior to cardiac arrest. However, we did not find association between these two variables.

Since time and distance are proportionate, determining the distance will help us determine the approximate start time of the CPR procedure for both groups of patients. In our study, patients with cardiac arrest who were less than 5 kilometers from the emergency department had a considerably greater incidence of ROSC than those who were more than 5 kilometers away. Our findings are consistent with the most recent literature; the majority of authors were in the agreement that patients who had cardiac arrests in public places and when CPR was initiated immediately after the arrest had a considerably higher percentage of ROSC (19, 31, 32).

Cardiopulmonary resuscitation must begin right away in order to achieve desirable outcome. The patient has little to no chance of a ROSC if the spectators are reluctant to start the procedure and wait until the emergency department staff arrives (6, 33). Unfortunately, out of all patients that were enrolled in our study, only two were cardiopulmonary resuscitated before the arrival of our team. In both cases, medical doctors were the spectators of the cardiac arrest and without hesitation started the procedure. This occurrence highlights the value of training in basic life support techniques, and that is one of the reasons why we decided to investigate this issue.

Our study has several limitations. This was a registry-based retrospective study. The data sample collected from one center is quite small. The incidence of OHCA is around 60 cases per 100,000 inhabitants, meaning that the emergency department of our city encounters around 10 arrests per year. As data collection stopped at hospital admission, we did not follow-up on mortality or other outcome parameters, so in this study we examined the incidence of ROSC and not of "survival to discharge". Hopefully other emergency departments in our region will soon start to keep records/registries of CPR procedures, and

we will be able to expand our study in terms of total cases.

CONCLUSION

We demonstrated that the incidence of ROSC is significantly influenced by the location of OHCA. However, the total incidence did not differ regarding gender or initial rhythm. This shows that providing prompt, sufficient CPR is essential for attaining the most favorable outcomes.

REFERENCES

1. Nolan JP, Soar J, Perkins GD. Cardiopulmonary resuscitation. *BMJ*. 2012;345:e6122.
2. Berdowski J, Berg RA, Tijssen JG, Koster RW. Global incidences of out-of-hospital cardiac arrest and survival rates: Systematic review of 67 prospective studies. *Resuscitation*. 2010;81:1479-87.
3. Seewald S, Wnent J, Grasner JT, Tjelmeland I, Fischer M, Bohn A, et al. Survival after traumatic cardiac arrest is possible—a comparison of German patient-registries. *BMC Emerg Med*. 2022;22:158.
4. Wang HE, Min A, Hostler D, Chang CC, Callaway CW. Differential effects of out-of-hospital interventions on short- and long-term survival after cardiopulmonary arrest. *Resuscitation*. 2005;67:69-74.

5. Nichol G, Stiell IG, Laupacis A, Pham B, Maio VJ, Wells GA. A cumulative meta-analysis of the effectiveness of defibrillator-capable emergency medical services for victims of out-of-hospital cardiac arrest. *Ann Emerg Med*. 1999;34:517-25.
6. Wissenberg M, Lippert FK, Folke F, Weeke P, Hansen CM, Christensen EF, et al. Association of national initiatives to improve cardiac arrest management with rates of bystander intervention and patient survival after out-of-hospital cardiac arrest. *JAMA*. 2013;310:1377-84.
7. Nolan J, Soar J, Eikeland H. The chain of survival. *Resuscitation*. 2006;71:270-1.
8. Meaney PA, Bobrow BJ, Mancini ME, Christenson J, de Caen AR, Bhanji F, et al. Cardiopulmonary resuscitation quality: [corrected] improving cardiac resuscitation outcomes both inside and outside the hospital: a consensus statement from the American Heart Association. *Circulation*. 2013;128:417-35.
9. Perkins GD, Walker G, Christensen K, Hulme J, Monsieurs KG. Teaching recognition of agonal breathing improves accuracy of diagnosing cardiac arrest. *Resuscitation*. 2006;70:432-7.
10. Nolan JP, Soar J, Zideman DA, Biarent D, Bossaert LL, Deakin C, et al. European Resuscitation Council Guidelines for Resuscitation 2010 Section 1. Executive summary. *Resuscitation*. 2010;81:1219-76.
11. Dumas F, Bougouin W, Geri G, Lamhaut L, Rosencher J, Pene F, et al. Emergency Percutaneous Coronary Intervention in Post-Cardiac Arrest Patients Without ST-Segment Elevation Pattern: Insights From the PROCAT II Registry. *JACC Cardiovasc Interv*. 2016;9:1011-8.
12. Nolan JP, Neumar RW, Adrie C, Aibiki M, Berg RA, Böttiger BW, et al. Post-cardiac arrest syndrome: epidemiology, pathophysiology, treatment, and prognostication: a scientific statement from the International Liaison Committee on Resuscitation; the American Heart Association Emergency Cardiovascular Care Committee; the Council on Cardiovascular Surgery and Anesthesia; the Council on Cardiopulmonary, Perioperative, and Critical Care; the Council on Clinical Cardiology; the Council on Stroke (Part II). *Int Emerg Nurs*. 2010;18:8-28.
13. Safdar B, Stolz U, Stiell IG, Cone DC, Bobrow BJ, deBoehr M, et al. Differential survival for men and women from out-of-hospital cardiac arrest varies by age: results from the OPALS study. *Acad Emerg Med*. 2014;21:1503-11.

14. Wigginton JG, Pepe PE, Bedolla JP, DeTamble LA, Atkins JM. Sex-related differences in the presentation and outcome of out-of-hospital cardiopulmonary arrest: a multiyear, prospective, population-based study. *Crit Care Med*. 2002;30:S131-6.
15. Winther-Jensen M, Kjaergaard J, Wanscher M, Nielsen N, Wetterslev J, Cronberg T, et al. No difference in mortality between men and women after out-of-hospital cardiac arrest. *Resuscitation*. 2015;96:78-84.
16. Tanaka H, Ong MEH, Siddiqui FJ, Ma MHM, Kaneko H, Lee KW, et al. Modifiable Factors Associated With Survival After Out-of-Hospital Cardiac Arrest in the Pan-Asian Resuscitation Outcomes Study. *Ann Emerg Med*. 2018;71:608-17 e15.
17. Stiell IG, Wells GA, DeMaio VJ, Spaite DW, Field BJ 3rd, Munkley DP, et al. Modifiable factors associated with improved cardiac arrest survival in a multicenter basic life support/defibrillation system: OPALS Study Phase I results. *Ontario Prehospital Advanced Life Support*. *Ann Emerg Med*. 1999;33:44-50.
18. Meaney PA, Nadkarni VM, Kern KB, Indik JH, Halperin HR, Berg RA. Rhythms and outcomes of adult in-hospital cardiac arrest. *Crit Care Med*. 2010;38:101-8.
19. Borgstedt L, Schaller SJ, Goudkamp D, Fuest K, Ulm B, Jungwirth B, et al. Successful treatment of out-of-hospital cardiac arrest is still based on quick activation of the chain of survival. *Front Public Health*. 2023;11:1126503.
20. Vukmir RB. Prehospital cardiac arrest and the adverse effect of male gender, but not age, on outcome. *J Womens Health (Larchmt)*. 2003;12:667-73.
21. Mody P, Pandey A, Slutsky AS, Segar MW, Kiss A, Dorian P, et al. Gender-Based Differences in Outcomes Among Resuscitated Patients With Out-of-Hospital Cardiac Arrest. *Circulation*. 2021;143:641-9.
22. Johnson PA, Goldman L, Orav EJ, Zhou L, Garcia T, Pearson SD, et al. Gender differences in the management of acute chest pain. Support for the "Yentl syndrome". *J Gen Intern Med*. 1996;11:209-17.
23. Blom MT, Oving I, Berdowski J, van Valkengoed IGM, Bardai A, Tan HL. Women have lower chances than men to be resuscitated and survive out-of-hospital cardiac arrest. *Eur Heart J*. 2019;40:3824-34.
24. Hasan OF, Al Suwaidi J, Omer AA, Ghadban W, Alkilani H, Gehani A, et al. The influence of female gender on cardiac arrest outcomes: a systematic review of the

literature. *Curr Med Res Opin*. 2014;30:2169-78.

25. Hochman JS, Tamis JE, Thompson TD, Weaver WD, White HD, Van de Werf F, et al. Sex, clinical presentation, and outcome in patients with acute coronary syndromes. Global Use of Strategies to Open Occluded Coronary Arteries in Acute Coronary Syndromes IIb Investigators. *N Engl J Med*. 1999;341:226-32.

26. Maynard C, Every NR, Martin JS, Kudenchuk PJ, Weaver WD. Association of gender and survival in patients with acute myocardial infarction. *Arch Intern Med*. 1997;157:1379-84.

27. Weil MH, Tang W. Rhythms and outcomes of cardiac arrest. *Crit Care Med*. 2010;38:310.

28. Tortolani AJ, Risucci DA, Rosati RJ, Dixon R. In-hospital cardiopulmonary resuscitation: patient, arrest and resuscitation factors associated with survival. *Resuscitation*. 1990;20:115-28.

29. Parish DC, Dane FC, Montgomery M, Wynn LJ, Durham MD. Resuscitation in the hospital: differential relationships between age and survival across rhythms. *Crit Care Med*. 1999;27:2137-41.

30. Lakbar I, Ippolito M, Nassiri A, Delamarre L, Tadger P, Leone M, et al. Sex and out-of-hospital cardiac arrest survival: a systematic review. *Ann Intensive Care*. 2022;12:114.

31. Deri Y, Berzon B, West D, Machloof M, Strugo R, Kaplan T, et al. The Impact of Prehospital and Hospital Care on Clinical Outcomes in Out-of-Hospital Cardiac Arrest. *J Clin Med*. 2022;11.

32. Seyed Bagheri SM, Sadeghi T, Kazemi M, Esmaeili Nadimi A. Dispatcher-Assisted Bystander Cardiopulmonary Resuscitation (Telephone-CPR) and Outcomes after Out of Hospital Cardiac Arrest. *Bull Emerg Trauma*. 2019;7:307-13.

33. Olasveengen TM, Mancini ME, Perkins GD, Avis S, Brooks S, Castren M, et al. Adult Basic Life Support: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Circulation*. 2020;142:S41-S91.

POVEZANOST UDALJENOSTI LOKACIJE SRČANOG ZASTOJA OD SLUŽBE ZA HITNU MEDICINSKU POMOĆ I KONAČNOG ISHODA KARDIOPULMONALNE REANIMACIJE

Mirko Maglica^{1,2}, Anela Kasalo-Pešić³, Verica Ćavar⁴, Ante Šesto³

¹Županijska bolnica Livno, 80101 Livno, Bosna i Hercegovina

²Medicinski fakultet, Sveučilište u Mostaru, 8800 Mostar, Bosna i Hercegovina

³Služba za hitnu medicinsku pomoć, Dom zdravlja Livno, 80101 Livno, Bosna i Hercegovina

⁴Ginekološki dispanzer, Dom zdravlja Livno, 80101 Livno, Bosna i Hercegovina

SAŽETAK

Uvod: Kardiopulmonalni zastoj je ozbiljno medicinsko stanje, koje može biti "preokrenuto" brзом i dostatnom kardiopulmonalnom reanimacijom (KPR). Vanbolnički srčani zastoj ima incidenciju od 60 slučajeva na 100,000 ljudi. Kardiopulmonalna reanimacija mora biti započeta odmah kako bi se postigao željeni ishod.

Cilj: Ispitati povezanost između udaljenosti od službe za hitnu medicinsku pomoć i povratka spontane cirkulacije.

Ispitanici i metode: Istraživanje koje je retrospektivno, kohortno, provedeno je u jednom centru (Dom Zdravlja Livno), koristeći "Reanimacijski protokol" Službe za hitnu medicinsku pomoć Livno. Pacijenti su podijeljeni u 2 grupe: oni koji su imali srčani zastoj na udaljenosti manjoj od 5 kilometara i oni koji su bili udaljeni više od 5 kilometara u trenutku srčanog zastoja.

Rezultati: Pacijenti koji su imali srčani zastoj na udaljenosti manjoj od 5 kilometara su imali veću učestalost postizanja povratka spontane cirkulacije ($p=0,002$). Iako su muškarci u većem postotku imali srčani zastoj, nije pokazana statistička značajnost između spolova u konačnom ishodu. Ukupna incidencija nije ovisila o inicijalnom srčanom ritmu.

Zaključak: Pružanje brze i kvalitetne KPR je ključno za postizanje najpoželjnijeg ishoda kod pacijenata s vanbolničkim srčanim zastojem.

Ključne riječi: Kardiopulmonalna reanimacija, vanbolnički srčani zastoj, povratak spontane cirkulacije

Autor za korespondaciju: Mirko Maglica, dr. med.

E-mail: mirko.maglica@mef.sum.ba