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# Out-of-hospital cardiac arrest: a retrospective study in the population of Modena

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ABSTRACT

*Introduction:* cardiac arrest is the third leading cause of death in industrialized countries and in Italy it affects about 60,000 people every year. It is a time-dependent pathology, therefore, the timeliness of the actions that form the "chain of survival" is essential: early access, early CPR (Cardio-pulmonary Resuscitation), early defibrillation, early advanced care. The ERC guidelines highlight how the first 2 links in the chain are essential to increase the chances of survival by up to four times, as well as avoiding or delaying the onset of anoxic brain damage. The study aims to analyze out-of-hospital cardiac arrest in the area of Modena in 2022, assessing the frequency of patients who received chest compressions from bystanders and the frequency of patients who received resuscitation maneuvers only from healthcare professionals. The frequency of patients resuming spontaneous cardiac circulation (Return Of Spontaneous Circulation, ROSC) was also evaluated, dividing the ROSCs according to the intervention or not of bystanders.

*Materials and Methods:* data on cardiac arrests was collected by examining patient records relating to the interventions of 16 nursing ambulances and 5 medical ambulances from Modena and its province. All the files relating to the missions of the ambulances of the volunteers of Modena and its province and the nursing ambulances present in the urban area of Modena have been omitted from the search as they intervene in conjunction with an advanced rescue vehicle. The variables taken in consideration were: age, sex, assessment code, subject performing resuscitation maneuvers, rhythm of onset, place of the event.

*Results and Conclusions:* the results of the study show that the percentage of ROSC in patients who received an early massage from bystanders is 12% higher than in patients who received resuscitation maneuvers exclusively from healthcare personnel (26% *vs* 14%), emphasizing the importance of training and first aid courses aimed at citizens, regardless of age.

**Key words:** Out-of-Hospital Cardiac Arrest (OHCA), first responder, chest compressions, defibrillation, Return Of Spontaneous Circulation (ROSC).

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## Introduction

Cardiac arrest is the third leading cause of death in industrialized countries. It affects 4.5 million people worldwide each year, including 60,000 in Italy. In Europe, it is estimated that around 450,000-700,000 people are affected by sudden cardiac death each year; a study conducted in the USA quantified this condition with an incidence of about 400,000 people per year (0.86 events per 1,000 inhabitants).[1]

Sudden cardiac death is defined as a sudden and unexpected cessation of the contractile activity of the heart muscle, preceded or not by warning signs, attributable in 70% of cases to newly developed cardiac disease (acute myocardial infarction) or pre-existing disease (ischemic heart disease).[2]

It is a time-dependent condition, in which timely intervention is vital, and can also be performed by bystanders: the literature shows, in fact, that every minute that passes without cardiopulmonary resuscitation leads to a 10% decrease in the likelihood of survival and the onset of irreversible brain damage after 7 minutes.[3] For this reason, the ERC (European Resuscitation Council) 2021 guidelines highlight how the first two links in the well-known chain of survival (early alert, early basic life support, early defibrillation, early advanced life support) are fundamental in increasing survival and preventing or delaying the onset of anoxic brain damage; furthermore, early chest compressions allow to maintain, where present (59-76% of cases), a shockable rhythm (pulseless ventricular tachycardia and ventricular fibrillation).[4]

Literature shows that in Italy, Out-Of-Hospital Cardiac Arrest (OHCA) has an incidence of 86 events per 100,000 inhabitants: Cardio-Pulmonary Resuscitation (CPR) performed by bystanders is initiated in only 29.7% of cases; overall, Return Of Spontaneous Circulation (ROSC) occurs in 16.6% of patients with poor survival to hospital discharge (6.4%). Statistically, it is expected that outcomes could improve up to four times if basic life support and potential early defibrillation were provided promptly by bystanders, before the arrival of the emergency services.[5-6]

In the last decade, early resuscitation has been emphasized, even with chest compressions alone by bystanders, also through pre-arrival instructions provided by the 118 emergency dispatcher and the use of a defibrillator as soon as possible,[2] by activating community first responders through applications like the DaeRespondER App in Emilia-Romagna.[6] This latter is one of the initiatives recently introduced with the aim of increasing survival following Cardio-Respiratory Arrest (CRA) in out-of-hospital setting,[8] along with the widespreaxd distribution of defibrillators, which have become mandatory in various public places and sports facilities; despite this, literature shows that the mortality rate is estimated to be around 90%, and the survival rate at hospital discharge with positive outcomes is between 4.6% and 11%.[1-8]

A recent study conducted in Switzerland found that 45% of the 18,368 patients affected by cardiac arrest in the three-year period of 2019-2021 were rescued by bystanders and therefore received chest compressions before the arrival of emergency services. The results of the study showed that the percentage of patients who regain spontaneous circulation is 30%.[9]

In another study conducted in Italy, 32 health interventions related to cardiac arrest that occurred in workplaces were analyzed. In 15.6% of cases the intervention included the use of a defibrillator by bystanders. All patients who received timely intervention regained spontaneous circulation (5/5), and in the other cases, in which the defibrillator was only available upon the arrival of healthcare personnel, the percentage of patients with ROSC was 41% (11/27).[10]

A further study, with the aim of investigate the incidence and outcomes of out-of-hospital cardiac arrest in Europe, revealed a percentage of intervention by bystanders ranging from 13% to 82% (with an average of 58%);[11] however, the use of the AED before the ambulance arrives occurs in only 28% of cases.[12] The overall percentage of ROSC is 33%.[11]

A systematic review analyzing 28 studies involving a total of 1,931,123 patients revealed that women affected by cardiac arrest are older than men. Furthermore, cardiac arrest in women is less likely to be witnessed and less likely to present with a defibrillable initial rhythm. It has also been shown that the survival odds for females are lower compared to males, and that males have better neurological outcomes.[13]

A study was therefore conducted to evaluate the frequency and incidence of out-of-hospital cardiac arrest in the population of Modena in 2022. Additionally, variables related to early interventions by community first responders were evaluated, with particular reference to chest compressions.

## Materials and Methods

The retrospective observational study aims to analyze the frequency and incidence of out-of-hospital cardiac arrest in the context of a territorial emergency service. The survey was conducted in an area with a resident population of approximately 701,751 inhabitants, covered by an emergency system consisting of 52 rescue vehicles, including: 27 ambulances of the volunteers, 20 nursing ambulances, and 5 medical ambulances. In 2022, the service recorded approximately 75,000 rescue interventions.

For the implementation of the study, the medical records for the calendar year 2022 (from January 1 to December 31) available in the archive of the Modena Territorial Emergency Service were consulted. The records include data related to OHCA interventions carried out by 118 emergency personnel during missions conducted by 16 nurse-staffed ambulances and 5 Advanced Life Support Vehicles (ALS-M) operating in Modena and its province. All records originating from volunteer-staffed ambulances providing Basic Life Support (BLS) in Modena and its province, as well as from nurse-led advanced life support ambulances (MSA-I; Advanced Life Support vehicles with nursing leadership) operating within the city of Modena, were excluded from the study as these units are typically dispatched concurrently with ALS units under medical leadership. All cases in which resuscitation efforts were not initiated were excluded from the study. The absence of resuscitative attempts was due to the presence of conditions incompatible with life, such as livor mortis, rigor mortis, tissue decomposition, or evident fatal injuries. The focus of this study is on evaluating the incidence of cardiac arrest in the Modena area, with a particular focus on estimating the percentage of OHCA patients who received Cardiopulmonary Resuscitation (CPR) either exclusively from Emergency Medical Personnel (EMS) or also from bystanders. Subsequently, the study aims to determine how many of these patients achieved ROSC. The study also compared the rates of ROSC between patients who received resuscitation efforts that included bystander-performed interventions and those who received CPR exclusively from healthcare personnel. Furthermore, the incidence of cardiac arrests occurring at home was estimated, along with the incidence of cardiac arrests occurring in other locations. This information is useful to understand the percentage of patients in cardiac arrest for whom the DAE RespondER app was able to alert a nearby rescuer (in 2022, this feature was available only for OHCAs occurring in public places). The percentages of OHCA patients were also estimated according to the initial cardiac rhythms [asystole, Pulseless Electrical

Activity (PEA), Ventricular Fibrillation (VF), and Pulseless Ventricular Tachycardia (VT)], along with the corresponding rates of ROSC within each rhythm category. The case series was also described according to certain demographic variables, such as age and sex. The ultimate goal of analyzing these data is to better understand the importance of educating the general population, regardless of age, in first aid courses and the timeliness of early recognition of signs and symptoms of cardiac arrest or its precursors. This analysis emphasizes the educational role of nurses and contributes to the promotion of a culture of emergency response. The following variables were considered during data collection: age, sex, resuscitation maneuvers performed by bystanders or healthcare personnel, absence of resuscitation efforts, assessment code [4 = deceased patient; 3 = ROSC (patient resuscitated)], location of the event [K = home; S = street; L = workplace; P = public place; Q = school; Y = sports facility; Z = other location], and initial cardiac rhythm [asystole, PEA (pulseless electrical activity), VF (ventricular fibrillation), and pVT (pulseless ventricular tachycardia)]. These informations were recorded in a database specifically developed for this study and subsequently analyzed using the statistical software STATA, version 18. The data collected were processed in an anonymous and aggregated form. Furthermore, the study was submitted to the CE A.V.E.N. (Ethics Committee of Area Vasta Emilia Nord) and received a favorable opinion.

Table 1 provides an explanation of the variables collected in the study.

## Statistical considerations

The characteristics of patients in cardiac arrest were summarized using frequencies for binary or qualitative variables, while means and medians were used for continuous variables.

The frequency of OHCA cases was expressed both in absolute terms and in relative terms, by relating the observed frequency to the total number of residents in Modena and its province in 2022.

The frequency of patients who achieved ROSC was calculated in both absolute and relative terms. The relative frequency was obtained by calculating the ratio of ROSC patients to total OHCA cases. ROSC patients were further categorized into those who received CPR from bystanders and those who received resuscitation efforts exclusively from EMS personnel (118). The comparison of ROSC rates between the two groups was performed both in absolute terms, by calculating the difference in proportions, and in relative terms, by computing their ratio (relative risk). Both measures of association are presented along with their corresponding 95% confidence intervals.

## Results

The study included 1,128 cases of cardiac arrest that occurred in 2022; in 555 of these cases, death was confirmed without any resuscitation attempts being made, and for this reason, they were excluded from our analysis (Figure 1).

A total of 573 patients underwent resuscitation attempts. In 212 cases (37%), resuscitative efforts were initiated by bystanders before the arrival of emergency medical services (Figure 1). Of these, 55 (26%) patients achieved ROSC, while in the remaining 157 (74%) cases resuscitation efforts were unsuccessful and death was confirmed (Figure 2). In the remaining 361 (63%) patients, who were resuscitated exclusively by medical personnel (Figure 1), ROSC was achieved in only 52 cases (14%), while 309 (86%) patients were pronounced dead (Figure 3). The total number of patients achieving ROSC was therefore 107, representing 18% of those in whom resuscitation was initiated (Table 2).

The incidence of cardiac arrest was higher in male patients, with 331cases (57.8%) compared to 242 cases (42.2%) in females (Table 3). The mean age of the patients was approximately 60.2 years (Table 3). Survival rates were higher among male patients, with a ROSC rate of 21.8%, compared to 14.5% in female patients (Table 4). The majority of patients in CA were between 60 and 80

**Table 1.** The table reports and describes the variables collected.

| | |
|---|---|
| **Assessment code** | |
| 4 | Deceased patient |
| 3 | ROSC (patient resuscitated) |
| **Resuscitation Maneuvers** | |
| No | No resuscitation attempts were made by anyone. |
| Yes (EMS) | Resuscitation efforts were performed only by healthcare personnel, with no bystander involvement. |
| Yes (bystanders and EMS) | Resuscitation efforts were performed both by bystanders (before the arrival of EMS units) and by healthcare personnel. |
| **Initial cardiac rhythm** | |
| Asystole | Absence of cardiac activity |
| PEA | Pulseless Electrical Activity |
| VF | Ventricular Fibrillation |
| pVT | Pulseless Ventricular Tachycardia |
| **Location of the event** | |
| K | Home |
| S | Street |
| P | Public place |
| Z | Other location |
| L | Workplace |
| Y | Sports facility |
| Q | School |

years of age (330 cases, 57.6%). The observed data suggest that the likelihood of achieving ROSC is inversely proportional to age, consistent with findings reported in the literature; in fact, among 66 patients under the age of 40, ROSC was achieved in 25 cases (37.8%) (Table 4).

The most frequent cardiac arrest rhythm upon arrival of emergency medical personnel was asystole, observed in 375 cases (65.4%), with a ROSC rate of 6.4%. The rhythm associated with the highest chances of ROSC, consistent with the literature, was ventricular fibrillation, identified as the presenting rhythm in 69 cases, with 38 achieving ROSC (55.4%) (Figure 4).

The location where cardiac arrest most frequently occurred was private residences, accounting for 1,005 events (89.1%), followed by the street with 71 events (6%), public places with 11 events (1%), workplaces with 8 events (1%), and sports facilities with a single case (0.08%). The remaining 32 cases (3%) occurred in other locations (Table 5).

In 2022, the incidence of out-of-hospital cardiac arrest in the province of Modena was 1.6 events per 1,000 inhabitants.

## Discussion

As early as 2001, the metaphor of the 'chain of survival' was introduced, consisting of the four fundamental links still recognized today: early recognition and call for help, BLS, early defibrillation, and early ALS.

Failure to apply these four links in the correct sequence and with appropriate timing significantly reduces the patient's chances

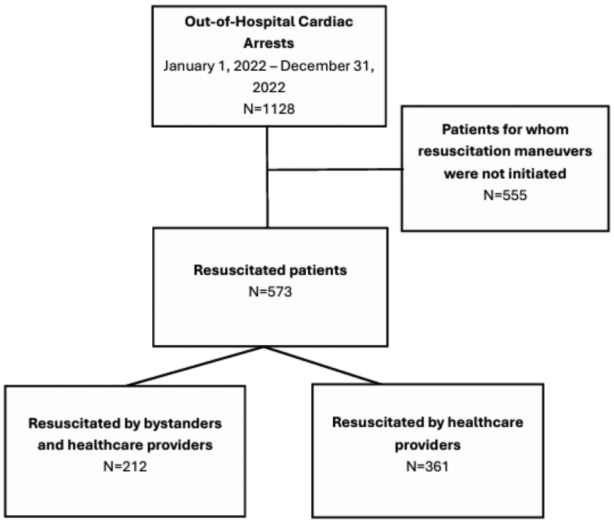


**Figure 1.** Flowchart of out-of-hospital cardiac arrest cases recorded in 2022. Of the 1128 total cases, resuscitation was not initiated in 555 patients, while 573 patients received cardiopulmonary resuscitation. Among those who were resuscitated, 212 received bystander and healthcare provider CPR, whereas 361 were treated exclusively by healthcare professionals.

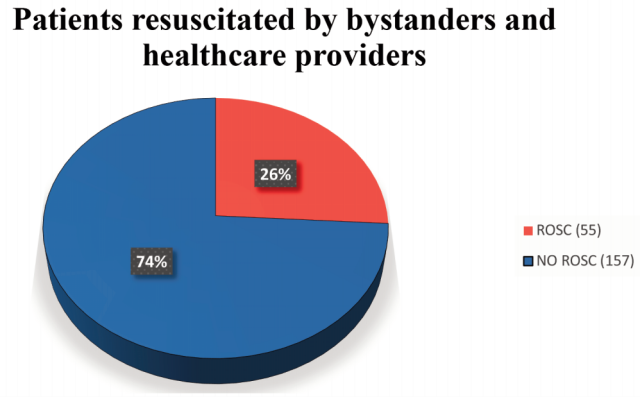


**Figure 2.** The chart shows the percentage of patients who achieved Return Of Spontaneous Circulation (ROSC) (26%) and those who did not (74%) among those who received resuscitation efforts from both bystanders and EMS personnel.

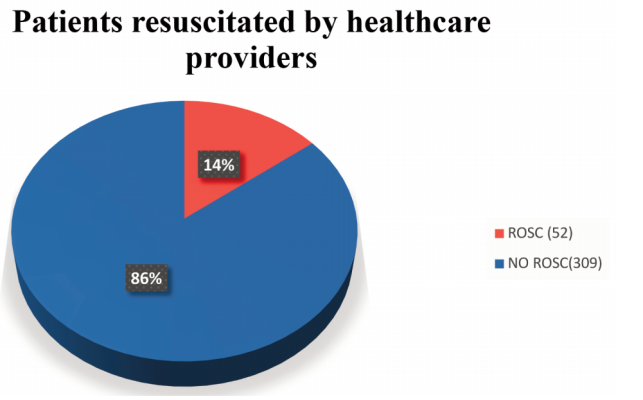


**Figure 3.** The chart shows the percentage of patients who achieved return of spontaneous circulation (ROSC) (14%) and those who did not (86%) among those who received resuscitation efforts exclusively from EMS personnel.

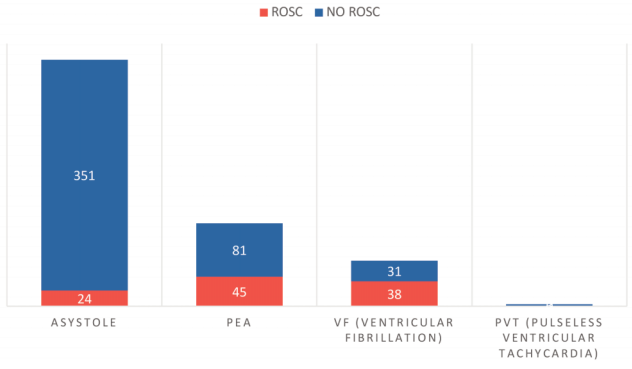


**Figure 4.** The columns represent the cardiac arrest rhythms identified by EMS personnel upon arrival at the scene, categorized according to cases with Return Of Spontaneous Circulation (ROSC) and cases without ROSC.

**Table 2.** Number of ROSC events in patients resuscitated by bystanders together with healthcare providers, and in those resuscitated exclusively by healthcare providers.

| | Subject Performing the Maneuver | | OR 95%CI | p |
|---|---|---|---|---|
| | Bystanders and Healthcare n=212 n (%) | Providers n=361 n (%) | | |
| ROSC | 55 (25.9) | 52 (14.4) | 2.08 (1.36-3.18) | 0.001 |

**Table 3.** Demographic and clinical characteristics of patients according to the provider performing the resuscitation (bystanders + healthcare providers *vs* healthcare providers alone).

| | Subject Performing the Maneuver | | p |
|---|---|---|---|
| | Bystanders and Healthcare n=212 | Providers n=361 | |
| Age | | | |
| Mean (SD) | 58.9 (14.4) | 61.4 (16.1) | 0.0689 |
| Sex | | | 0.011 |
| Number of males (%) | 137 (64.6%) | 194 (53.7%) | |
| Number of females (%) | 75 (35.4) | 167 (46.3) | |
| Rhythm | | | 0.002 |
| Number of patients with Asystole (%) | 121 (57.1) | 254 (70.4) | |
| Number of patients with VF (%) | 38 (17.9) | 31 (8.6) | |
| Number of patients with PEA (%) | 51 (24.1) | 75 (20.8) | |
| Number of patients with VT (%) | 2 (0.9) | 1 (0.3) | |

**Table 4.** Analysis of demographic and clinical characteristics associated with return of spontaneous circulation (ROSC). For each variable (resuscitation provider, patient sex, initial rhythm on EMS arrival, and patient age), the table reports the distribution of patients with and without ROSC, the odds ratio (OR) with 95% confidence intervals, and the corresponding p-value.

| | ROSC (n=107) | No ROSC (n=466) | OR 95%CI | p |
|---|---|---|---|---|
| Maneuver | | | | |
| Bystanders and Healthcare Providers | 55 (25.9) | 157 (74.1) | 2.08 (1.36-3.18) | 0.001 |
| Healthcare Providers only | 52 (14.4) | 309 (85.6) | Ref. | |
| Sex | | | | |
| Male | 72 (21.8) | 259 (78.2) | 1.64 (1.06-2.56) | 0.028 |
| Female | 35 (14.5) | 207 (85.5) | Ref | |
| Rhythm | | | | |
| Asystole | 24 (6.4) | 351 (93.6) | Ref | 0.001 |
| VF | 38 (55.1) | 31 (44.9) | 17.92 (9.55-33.64) | |
| PEA | 45 (35.7) | 81 (64.3) | 8.13 (4.68-14.10) | |
| VT | 0 (0) | 3 (100) | - | |
| Age | | | | |
| ≤40 | 25 (37.9) | 41 (62.1) | - | 0.001 |
| 40-60 | 36 (22.5) | 124 (77.4) | 0.47 (0.26-0.89) | |
| 60-80 | 45 (13.6) | 285 (86.4) | 0.25 (0.14-0.47) | |
| >80 | 1 (5.9) | 16 (94.1) | 0.10 (0.01-0.82) | |

**Table 5.** Event location and corresponding number of occurrences.

| Location | Number (%) |
|---|---|
| Home | 1005 (89.1) |
| Street | 71 (6) |
| Public place | 11 (1) |
| Workplace | 8 (1) |
| Sports facilities | 1 (0) |
| Other locations | 32 (3) |

of survival.[14-16] The most recent guideline updates have preserved the structure of the chain of survival; however, greater emphasis has been placed on the first two links, highlighting the critical role of bystander intervention and community first responders in improving the patient's likelihood of survival.[15]

As of November 25, 2024, the activation of First Responders through the DAE Responder app in Emilia-Romagna has been extended to include events occurring at home and in private settings. This extension represents a significant improvement, as the majority of cardiac arrests take place in private locations.

The importance and effectiveness of chest compressions (the second link), performed at a rate of 100–120 compressions per minute and a depth of 5–6 cm, as a means to reduce the risk of hypoxic brain injury while awaiting advanced medical care, has been well established for decades.[17] However, as shown by the present study and supported by the literature, the number of individuals who actually perform resuscitation maneuvers remains lower than the number of patients who do not receive chest compressions.

Data collected in this study revealed that chest compressions were performed by bystanders in 37% of cases, with a ROSC rate of 26%, compared to a ROSC rate of 14% in patients resuscitated exclusively by medical personnel without bystander intervention.

The most frequently observed rhythm upon the arrival of EMS was asystole (375 cases), with a ROSC rate of only 6.4%. The rhythm associated with the highest ROSC rate was ventricular fibrillation, with 55.1% of patients achieving return of spontaneous circulation. The higher ROSC rate may also be attributed to the fact that, in cases of ventricular fibrillation, bystander chest compressions were initiated in 55% of patients. The literature shows that timely chest compressions performed by bystanders help maintain a shockable rhythm when present (typically in 59–76% of cases).[4]

These findings are consistent with those of a national study, which reported a ROSC rate of 58% among patients presenting with a shockable rhythm, and an overall ROSC rate of 25%. However, some data differ; in particular, regarding the percentage of out-of-hospital cardiac arrests in which bystander cardiopulmonary resuscitation is initiated, the study reports a rate of 26%.[5]

International studies, such as the 2019-2021 annual report from SwissReca, have shown that a shockable rhythm is present in 27% of out-of-hospital cardiac arrests, while a non-shockable rhythm is observed in the remaining 69%. The same study reported that bystander cardiopulmonary resuscitation was initiated in 45% of cases, with a ROSC rate of 30% and 9% of patients transported to the hospital under ongoing resuscitation.[9]

Consistent with the literature, the study demonstrated a higher incidence in males compared to females (331 cases *vs*. 242 cases), albeit with a lower probability of survival in females than in males (14.5% *vs*. 21.8%).

The study aims to emphasize the importance of the first two links in the chain of survival, seeking to raise awareness on the topic and strengthen the understanding of the need to promote participation in first aid training courses among citizens, regardless of age or social background.

## Limitations of the study

This study presents some limitations related to the research; the most significant is the lack of consultation of patient records from volunteer ambulance services, nurse-staffed ambulances operating in the city of Modena, and the air ambulance service of the Emilia-Romagna region. As a result, it was not possible to include any potential cases of cardiac arrest related to missions carried out by these services, which are estimated to account for approximately 1–2% of the total. Moreover, the study considers ROSC as the primary outcome, which is classified in the literature as a short-term outcome and is not directly correlated with survival. It was not possible to obtain information on longer-term survival endpoints, such as hospital admission, discharge, or post-discharge outcomes (including neurological status). Another limitation is that the study does not distinguish whether bystander-initiated CPR was performed by a trained bystander who started immediately or by an untrained bystander who initiated CPR following telephone instructions provided by the EMS dispatch center. Moreover, the medical records did not allow us to determine whether only chest compressions were performed or if ventilations were also provided. An additional limitation is that, during the review of the documentation from the emergency vehicles included in the study, a very small number of records related to cardiac arrest cases may have been inadvertently overlooked.

## Conclusions

The study highlights the importance of timely bystander-initiated cardiopulmonary resuscitation, emphasizing the essential role of a well-functioning chain of survival in increasing the chances of survival for patients experiencing cardiac arrest.

In recent years, the integration between the EMS system (118) and the community has become increasingly robust. This collaborative approach (which includes the widespread availability of public AEDs, training and awareness programs, and alert systems for community first responders) represents an effective strategy to improve survival rates.

Based on the results of this study, it can be hypothesized that increasing the rate of ROSC requires enhanced public awareness efforts aimed at encouraging greater participation of the general population in BLS and Automated External Defibrillator (AED) training courses, starting from school-age generations. Significant support and undeniable benefits have been observed from initiatives carried out in the Modena area, and in Italy in general, including those implemented in various schools. In this regard, the educational role of nurses is particularly important. It would be desirable in the near future to make more frequent use of first responders, such as law enforcement officers and firefighters, to provide immediate assistance while awaiting the arrival of EMS personnel.

## References

1. Sweis RN, Jivan A. Acute Myocardial Infarction (MI). Reviewed June 2022. Available from: www.msdmanuals.com
2. Olasveengen TM, Semeraro F, Ristagno G, et al. European Resuscitation Council Guidelines 2021: Basic Life Support 2021;161:98-114.
3. Soar J, Böttiger BW, Carli P, et al. European Resuscitation Council Guidelines 2021: Adult advanced life support. Resuscitation 2021;161:115-51. Correction in Resuscitation 2021;167:105-6.
4. Lupton JR, Jui J, Neth MR, et al. Development of a clinical decision rule for the early prediction of Shock-Refractory Out-of-Hospital cardiac arrest. Resuscitation 2022;181:60-7.
5. Scquizzato T, Gamberini L, D'Arrigo S, et al. Incidence, characteristics, and outcome of out-of-hospital cardiac arrest in Italy: A systematic review and meta-analysis. Resusc Plus 2022;12:100329.

6. Del Giudice D, Semeraro F, Ristagno G, et al. DAE RespondER: The Emilia Romagna app for a regional "community saving lives" system. Resuscitation 2019;145:34-6.
7. Salhi RA, Hammond S, Lehrich JL, et al. The association of fire or police first responder initiated interventions with out of hospital cardiac arrest survival. Resuscitation 2022;174:9-15.
8. Jordan MR, Lopez RA, Morrisonponce D. Asystole. 2024 Apr 20. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan–. PMID: 28613616.
9. Burkart R, Regener H, Wilmes A. SWISSRECA Rapporto annuale 2019-2021. SWISSRECA, 2021. Available from: www.144.ch
10. Marino R, Bertocci N, Bernabei M, et al. Analysis of survival at cardiac arrest in events occurred in work environments in the territory served by an operations center of the 118 of Tuscany. Med Lav 2020;111:399-403.
11. Gräsner JT, Wnent J, Herlitz J, et al. Survival after out-of-hospital cardiac arrest in Europe - Results of the EuReCa TWO study. Resuscitation 2020;148:218-26.
12. Greif R, Lockey A, Breckwoldt J, et al. European Resuscitation Council Guidelines 2021: Education for resuscitation. Resuscitation 2021;161:388-407.
13. Lakbar I, Ippolito M, Nassiri A, et al. Sex and out-of-hospital cardiac arrest survival: a systematic review. Ann Intensive Care 2022;12:114.
14. Soar J, Böttiger BW, Carli P, et al. European Resuscitation Council Guidelines 2021: Adult advanced life support. Resuscitation 2021;161:115-151.
15. Lott C, Truhlář A, Alfonzo A, et al. European Resuscitation Council Guidelines 2021: Cardiac arrest in special circumstances. Resuscitation 2021;161:152-219.
16. Nolan JP, Sandroni C, Böttiger BW, et al. European Resuscitation Council and European Society of Intensive Care Medicine Guidelines 2021: Post-resuscitation care. Resuscitation 2021;161:220-69.
17. Yannopoulos D, McKnite S, Aufderheide TP, et al. Effects of incomplete chest wall decompression during cardiopulmonary resuscitation on coronary and cerebral perfusion pressures in a porcine model of cardiac arrest. Resuscitation 2005;64:363-72.

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