

Original Article

Survival following cardio-respiratory arrest after cardiopulmonary resuscitation was carried out as part of out-of-hospital care

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ABSTRACT

Objective: To describe the epidemiological profile of extrahospital cardiopulmonary arrests attended by the Medical Emergency Service of Madrid (SUMMA 112) and survival of the patients on arrival at hospital.

Material and methods: Retrospective observational cohort clinical study on 582 patients with extrahospital cardiac arrests treated by the SUMMA 112 emergency units of Madrid from January 2002 to December 2003. The independent variables of the study were the following: date and hour of the cardiac arrest; age and sex of the patient; initial heart rate; medical or traumatic cause; presence of anybody at the moment of the cardiac arrest and who was him/her; previous Cardiopulmonary Resuscitation (CPR) interventions done/not done before the services of emergency arrived; presence of the emergency team when the cardiac arrest occurred; pulse and/or heart rate recovery at any moment. The dependent variable was to be alive on arrival at the hospital.

Results: 148 out of 584 patients (25.4%) included in the study were alive when they arrived at the hospital. The survival was significantly higher (43.8 %, $p < 0.001$) when the emergency unit was present than when the emergency unit was not present (21.9 %, RR 2.0; 95% CI 1.5-2.6). The highest survival rate (40.0 %) was related to ventricular fibrillation/ventricular tachycardia (VF/VT) compared to other rhythms (RR 1.9; 95% IC 1.5-2.5).

Conclusions: More men with a mean age of 65 years old are attended for cardiac arrest. The survival is two-fold higher when the emergency team is present. Also the survival is higher when the initial heart rate is VF/VT.

Key Words: Out-of-hospital CPR. Cardiac arrest. Emergency Medical Service. Ventricular Fibrillation.

RESUMEN

Supervivencia en las paradas cardiorrespiratorias en las que se realizó reanimación cardiopulmonar durante la asistencia extrahospitalaria

Objectivo: Describir el perfil epidemiológico de las paradas cardiorrespiratorias extrahospitalarias atendidas por el Servicio de Urgencias Médicas de Madrid 112 (SUMMA 112) y la supervivencia a la llegada al hospital.

Material y método: Se ha realizado un estudio observacional de cohorte clínico retrospectivo desde enero de 2002 a diciembre de 2003, sobre 582 paradas cardiorrespiratorias extrahospitalarias tratadas por las unidades de emergencia del SUMMA 112 de Madrid. Se estudiaron como variables independientes: fecha y hora de la parada; edad y sexo del paciente; ritmo inicial de la parada; si la causa era médica o traumática; si fue presenciada y quién la presenció; si se realizaron maniobras de resucitación cardiopulmonar (RCP) previa a la llegada de los servicios de emergencia; si estaba presente el equipo de emergencia cuando se produjo la parada; si se recuperó pulso y/o ritmo en algún momento. Como variable dependiente se consideró si el paciente llegó con vida al hospital.

Resultados: De los pacientes atendidos, llegaron con vida al hospital 148 lo que representa un 25,4%. Si la unidad de emergencia es la que presencia la PCR la supervivencia es significativamente mayor ($p < 0,001$) y alcanza al 43,8% frente al 21,9% cuando no está presente (RR 2,0; 95% CI 1,5-2,6). La mayor tasa de supervivencia (40,0%) es para la fibrilación ventricular/taquicardia ventricular (FV/TV) frente a otros ritmos (RR 1,9; 95% IC 1,5-2,5).

Conclusiones: Se atienden más PCR en hombres, con una mediana de edad de 65 años. Cuando está presente un equipo de emergencias en el momento de la PCR la supervivencia es el doble que cuando no lo está. La supervivencia es mayor cuando el ritmo inicial de la parada es FV/TV.

Palabras clave: Reanimación cardiopulmonar extrahospitalaria. Parada cardiorrespiratoria. Servicios de emergencias médicas. Fibrilación ventricular.

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INTRODUCTION

Due to high incidence levels and mortality rates, out-of-hospital cardiac arrest is a significant health issue in developed countries. The incidence of sudden death caused by heart conditions in Spain is of at least 60 cases per year per 100,000 inhabitants and that of extrahospitalary-cardiac arrest (EH-CA) treated patients is 24 per 100,000¹. There are few studies in Spain on EH-CA. However, some studies indicate that out-of-hospital emergency systems have increased EH-CA²⁻⁴ survival rates, while other authors question the effectiveness of these services^{5,6}. The results obtained on the treatment of EH-CA have been highlighted as an indication of the quality of the health service. The survival prognosis of patients who have undergone no EH-CA remains poor and stands between 4% and 33% depending mainly on how the chain of survival is organised⁷. We know that if blood flow is suppressed for several minutes then this can cause irreparable damage to the brain and for that reason the first aid carried out by the first responders at the emergency service plays a very important role in emergency medicine⁸.

SUMMA 112 is a public, out-of-hospital, emergency service serving the population of the autonomous community of Madrid that is 8,021.80 km² in area, with a population of 6,008,183 inhabitants according to the 2006 census. The population distribution of the autonomous community of Madrid is characterised by its high density because of the large cities in this region. The capital has a population of 2,938,723 people and there are another 24 towns with over 30,000 people each that together make up 89.15% of the total population of this region. During the period of this study, SUMMA 112 had one coordinating centre with 22 Mobile Emergency Units (MEU), 4 Rapid Intervention Vehicles (RIV) and 2 ICU helicopters. All these emergency devices have medical and nursing personnel and one or two emergency technicians or pilots. The MEU and the helicopters have all the materials necessary for treating and transporting critical patients, while the RIV have material for treatment but require a medically equipped ambulance to transport the patient. This service was a pioneer in the use of out-of-hospital emergency units as they are known in Spain, dating back to 1990 when the first mobile ICU was launched as part of the 061 emergency services.

The objective of this study was to describe the epidemiological profile of EH-CA in Madrid, survival on arrival at the hospital and the patient-dependent and independent intrinsic factors, that affect survival until arrival at the hospital.

MATERIAL AND METHODS

A retrospective observational clinical study was carried out from January 2002 until December 2003 on EH-CA treated by the 061 Emergency Services that are part of SUMMA 112 in Madrid. The records of all patients who suffered a cardiac arrest, died (codes CIE 427.5), suffered sudden death (798.1) underwent CPR (CIE 99.60) and/or died after treatment (CIE 798.2) were selected from the computerised database.

Independent variables were studied: date and time of the cardiac arrest; age and sex of the patient; initial heart rate; medical or trauma-related cause; who was present at the time of the cardiac arrest cardiopulmonary resuscitation (CPR) carried out or not before the arrival of SUMMA 112; emergency team were present/not present when the cardiac arrest occurred; pulse and/or heart rate recovery at any given time. The dependent variable was whether the patient was alive on arrival at the hospital or not. In order to evaluate survival according to age, the study was divided into groups of 20 years, similar to the study carried out by Kila et al.⁸.

The quantitative variables were the mean (standard deviation) or the median [interquartile range (IQR), 25th-75th percentile] in relation to whether the distribution was normal or not. The categorical variables are presented with their frequency distribution. To study the association between the qualitative variables the χ^2 or Fisher tests were used. The significance of the association was evaluated using the Odds Ratio (OR) calculation with a confidence interval of 95% (CI 95%). The differences in means were contrasted in quantitative variables using the Student's t or ANOVA test, in relation to what was considered normal. The Mann-Whitney U or Kruskal-Wallis tests were used for non normal variables. A multivariate study was carried out using a multiple logistic regression model which including variables with $p < 0.05$ on univariate analysis following dichotomous transformation. $P < 0.05$ was considered significant. The software used for the statistical analysis was the Statistical Package for Social Sciences (SPSS) version 12.0.1.

RESULTS

A total of 834 cases fulfilled the selection criteria, with 252 being excluded because of the following criteria: 223 did not receive CPR, 8 did not have a clinical record in the database, 8 received CPR from someone outside the Emergency Medical Services, 5 did not have a cardiac arrest, 4 had the wrong code and in 4 had been records after attendance seen by more than one SUMMA unit.

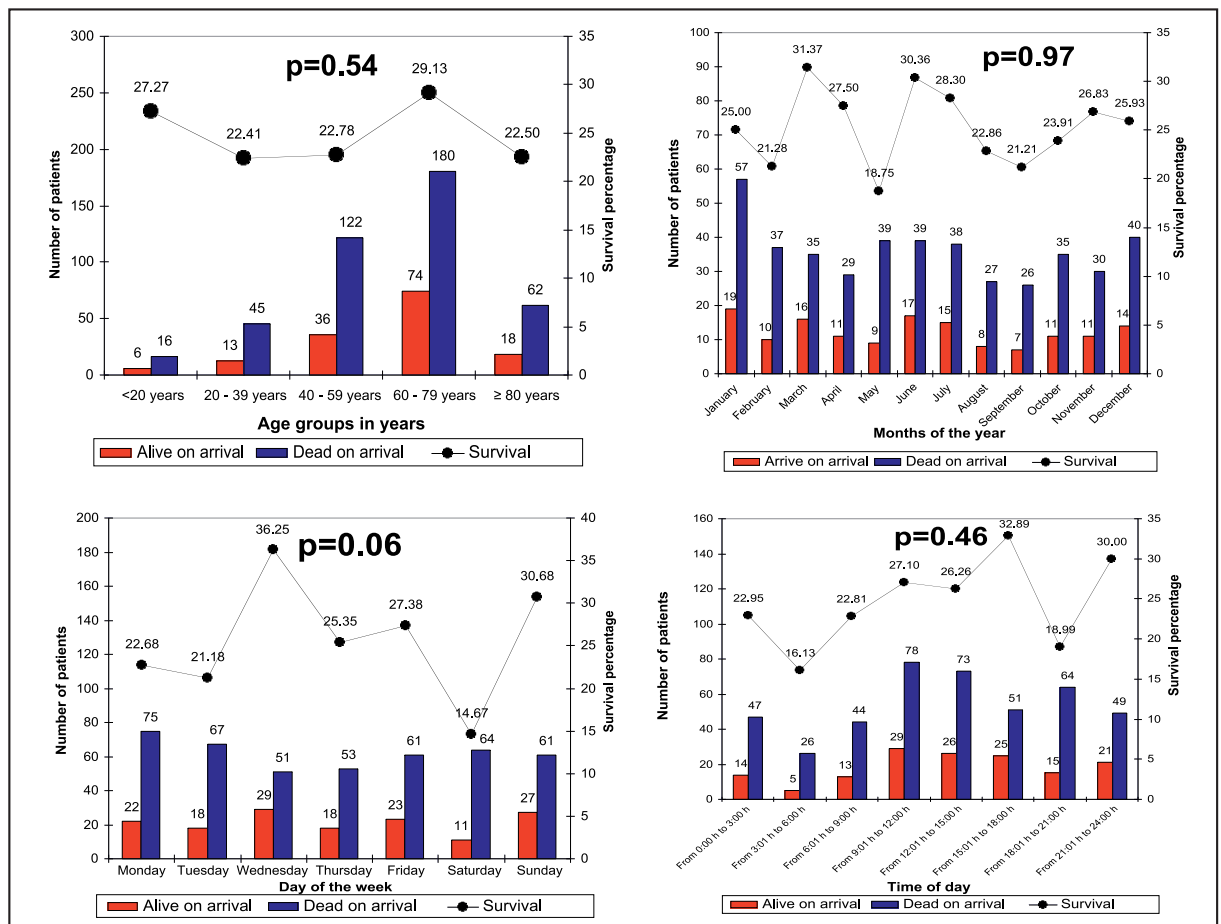


Figure 1. The distribution of survival in relation to age, month of the year, day of the week and time of day in patients with cardiac arrest.

A total of 582 cases of cardiac arrest which received EHCPR were included in the study, with 71.1% (414 cases) being males with a mean (IQR) age of 65 years (48-75). There is a significant difference in age ($p < 0.001$) between men [62.5 (47-73)] and women [71 (50-78)]. The most common initial heart rate was extreme bradycardia or asystole in 67.6% (393 cases), followed by ventricular fibrillation or pulseless ventricular tachycardia (VF/VT) in 26.6% (155 cases) and pulseless electrical activity (PEA) in 5.8% (34 cases).

The cause of cardiac arrest was trauma-related in 5.7% of patients (33 cases) and non trauma-related in 94.3% of patients (545 cases). The cause was not specified in 4 cases. The cardiac arrest was witnessed by medical personnel in 34.5% of cases (194), by non-medical personnel in 57.8% of cases (358) and by no one in 7.7% of cases (43) and was not reported in 20 cases. CPR was carried out before arrival at the emergency unit in 36.8% of cases (211), it was not carried out in 46.2% of cases (265 cases) and in the remaining 17% (98 cases) CPR was carried out by the emergency unit when the car-

diac arrest took place in their presence. This information was unavailable in 8 cases. In the cases involving the emergency unit, 42 patients arrived at the hospital alive (43.8%). 29.8% (173 cases) recovered a pulse at some point, 4.3% (25 cases) recovered their heart rate and 65.9% recovered neither a pulse nor heart rate. This information was not available in 2 cases.

In total, 148 patients arrived at the hospital alive, representing 25.5% of the patients seen. The mean (IQR) age of patients that arrived at the hospital alive was 65 years (50-74) and 65 years for those who did not arrive alive (47-75) ($p = NS$). The distribution of the cardiac arrests, as well as the survival as a result of out-of-hospital CPR, according to the age group, month of the year, day of the week and time of day when the cardiac arrest patient was seen can be found in Figure 1. As shown, that there were no significant differences in the distribution of any of these variables. The only identifiable trend was observed with the day of the week, where a lower survival rate was observed on Saturdays (14.7%) and a higher survival rate on Wednesdays (36.2%) ($p = 0.06$).



TABLE 1. Univariate study on the effect of several dichotomous variables on the survival (on arrival at the hospital) following a cardiac arrest received extrahospitalary CPR from SUMMA 112

	CPR total* (n=582)	Alive on arrival at the hospital* (n=148)	Dead on arrival at the hospital* (n=434)	OR (CI 95%) (univariate)	p
Sex					0.31
Male [n (%)]	412	100 (24%)	312 (76%)	1	
Female [n (%)]	167	48 (29%)	119 (71%)	1.26 (0.84 a 1.88)	
Age					0.56
Under 80 [n (%)]	492	129 (26%)	363 (74%)	1	
80 or over [n (%)]	80	18 (22%)	62 (78%)	0.82 (0.47 a 1.43)	
Cause of cardiac arrest					0.07
Non trauma-related [n (%)]	33	4 (12%)	29 (88%)	1	
Trauma-related [n (%)]	543	144 (27%)	399 (73)	0.38 (0.13 a 1.10)	
Cardiac arrest in the presence of a bystander					0.15
No [n (%)]	45	7 (16%)	36 (84%)	1	
Yes [n (%)]	517	140 (27%)	377 (73%)	1.91 (0.83 a 4.39)	
Cardiac arrest in the presence of SUMMA 112					<0.001
No [n (%)]	474	106 (22%)	378 (78%)	1	
Yes [n (%)]	96	42 (44%)	54 (56%)	2.77 (1.76 a 4.38)	
CPR carried out on arrival of SUMMA 112**					0.74
No [n (%)]	265	61 (23%)	204 (77%)	1	
Yes [n (%)]	211	45 (21%)	166 (79%)	0.91 (0.59 a 1.40)	
VT/VF heart rate					<0.001
No [n (%)]	416	87 (21%)	329 (79%)	1	
Yes [n (%)]	150	60 (40%)	90 (60%)	2.52 (1.68 a 3.77)	

*In some groups the sum of the figures does not equal the total value because some information has been lost.

**Only patients with cardiac arrest not witnessed by SUMMA 112 were included.

The analysis of possible factors associated with higher survival on arrival at the hospital where the cardiac arrest was treated by carrying out EH-CPR can be seen in Table 1. The univariate study showed that ventricular fibrillation/ventricular tachycardia (VF/VT) in the electrocardiogram and the presence of the SUMMA 112 medical team at the time of the cardiac arrest were significantly associated with higher survival rates (2.52 and 2.77 OR respectively, $p < 0.001$ for both). When these variables were adjusted to a multiple logistic regression model, both continued to be statistically significant ($p < 0.001$) as variables associated with patient survival.

DISCUSSION

This study demonstrates that cardiac arrest and EH-CPR is more common among men than women and also that men have from cardiac arrest at a younger age. However, survival did not significantly differ in relation to sex. This had been observed in previous studies⁹. The heart rate most frequently observed was extreme bradycardia or asystole followed by VF/VT, with PEA

being the least common. This coincides with the findings of many other previous studies¹⁰, although in some series PEA was more common than VF/VT^{11,12}.

Only two factors were related to higher patient survival on arrival at the hospital. On the one hand, the survival is higher when the initial heart rate of the cardiac arrest is VF/VT¹³⁻¹⁵, although this is less common than bradycardic heart rates. On the other hand, when cardiac arrest occurs in the presence of emergency medical services, the survival increases by more than double compared to when they are not present. The explanation for this may lie in the fact that advanced CPR is performed more quickly. Numerous studies support this conclusion given that the survival increases as the time elapsed between the cardiac arrest and the administration of advanced treatment decreases¹⁶⁻¹⁸. Finally, a higher survival rate was observed in patients with non trauma-related cardiac arrests, as in previously described studies¹⁹⁻²¹. However, the present study shows that this trend is not clear enough to observe significant differences.

This study also shows that when cardiac arrest occurred before the arrival of SUMMA 112 arrived, CPR had not been carried out by the first responders in over 50% of cases. One

possible reason for this could be the lack of training in CPR techniques in Spain. Another important aspect that should be highlighted is that there should be a section in the cardiac arrest patient information form where the reason why CPR was abandoned can be stated, since CPR is delayed in many cases because of a lack of information about the patient. In other cases, CPR is carried out in patients when this course of action is not indicated, resulting in biased information not only in this study but also in all the studies carried out until now given that they refer to cases in which CPR was not indicated. This information is currently not included in the Utstein style forms²².

With regard to the chronological factors analysed, a low number of cardiac arrests were observed from 00:00 to 09:00 and although the differences observed are not significant, this trend could be explained by the fact that during these hours it is more difficult to discover this kind of event as the patient cannot alert anyone (unless they feel unwell beforehand) and often the families do not realise what is happening because they are asleep. Moreover, survival rates are also low during this time of day, although not statistically significant, and can be explained by the fact that the person who informs the emergency medical services may not be with the patient at the time of the cardiac arrest and therefore a later discovery leads to a delayed response. In the study carried out by Kida et al.⁸ it was also observed that most cardiac arrests took place between 00:00 and 06:00 and survival rates were lower from 00:00 to 09:00. During the colder months (December and January) there are more cases of cardiac arrest and even though there were no significant differences, an explanation for this trend could be an increase in the worsening of pulmonary di-

seases, decompensation of heart diseases and other complications that result in an increased demand for all types of emergency medical care. In contrast, the lowest number of cases occurred during the summer in August and September when the demand for medical care drops. There is no rational explanation for the highest survival rates found in March and June, or the lowest found in May, September and February, although the general monthly distribution does not show any significant differences.

It is worth mentioning that this study was limited in a number of ways. Although we attempted to calculate the time elapsed between when the activation of the emergency services and their arrival at the place where the cardiac arrest had taken place, this could not be reliably analysed because of the large number of cases (124, which represents 21.3% of the total) that could not provide a time of arrival. Furthermore, this study did not record survival rates at the time of hospital discharge, after one month and at one year or include information on whether any significant neurological damage had been avoided, which is the main objective when carrying out CPR. In conclusion this study shows that a relationship between the survival of patients following EH-CPR and the presence of an emergency medical team when the cardiac arrest occurs, and an initial VF/VT heart rate.

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