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Clinical paper

Ongoing CPR with an onboard physician

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Abstract

Introduction: Recent data are not available on ongoing CPR for emergency services with an onboard physician. The aim of the present study was to identify factors associated with the decision to transport patients to hospital with ongoing CPR and examine their survival to hospital discharge with good neurological status.

Methods: An observational study based on a registry of out-of-hospital cardiac arrests attended to by emergency services with an onboard physician. All OHCA cases occurring between the 1st of January and the 31st of December 2022 were included. Patients receiving ongoing CPR during transport to the hospital were compared with patients pronounced dead at the scene following arrival of the care team. The dependent variable was ongoing CPR during transport to the hospital. The main characteristics and the neurological status of patients surviving to discharge were described.

Results: A total of 9321 cases were included, of which 350 (3.7%) were transported to hospital with ongoing CPR. Such patients were young (59.9 ± 20.1 years vs 64.6 ± 16.9 years; $p < 0.001$; 95%CI: 0.98 [0.98; 0.99]) with arrest taking place outside of the home (151 [44.5%] vs 4045 [68.01%]; $p < 0.001$; 95%CI: 0.41 [0.31; 0.54]) and being witnessed by EMS (126 [36.0%] vs 667 [11.0%]; $p < 0.001$; 95%CI: 4.31 [3.19; 5.80]), whilst initial rhythm differed from asystole (164 [47.6%] vs 4325 [73.0%]; $p < 0.01$; 95%CI: 0.44 [0.33; 0.60]) and a mechanical device was more often employed during resuscitation and transport to hospital (199 [56.9%] vs 2050 [33.8%]; $p < 0.001$; 95%CI: 2.75 [2.10; 3.59]). Seven patients (2%) were discharged alive from hospital, five with ad integrum neurological recovery (CPC1) and two with minimally impaired neurological function (CPC2).

Conclusions: The strategy of ongoing CPR is uncommon in EMS with an onboard physician. Despite their limited efficacy, the availability of mechanical chest compression devices, together with the possibility of specific hospital treatments, mainly ICP and ECMO, opens up the possibility of this approach with determined patients.

Keywords: Out of hospital cardiac arrest, Survival, Ongoing CPR, Emergency medical services

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Introduction

The decision to terminate resuscitation manoeuvres when the return of spontaneous circulation (ROSC) is not achieved depends on diverse factors that are difficult to specify.[1] On the one hand, clinical aspects may be present that suggest that patient survival is not possible.[2,3] On the other hand, sociocultural aspects, organisational factors pertaining to the emergency services (EMS) themselves and specific local regulations that mandate the continuation of resuscitation whilst the patient is transported to hospital.[4–8] In general, a large number of EMS staffed by paramedics are able to decide on the ground by applying Termination-of-Resuscitation (TOR) guides for OHCA. These recommendations have been validated to allow them to identify patients without any real likelihood of survival.[9–12] Even more, some other specifics scores have been proposed to help clinicians to determine the probability of predict ROSC and survival of OHCA patients.[13,14] When such conditions are not present, or there are doubts about its application in each specific case it is common for resuscitation to take place during the journey to the hospital (ongoing CPR). Such a response is outlined by recommendations made by the European Resuscitation Council in the case of an EMS witnessed arrest, ROSC at any moment, shockable initial rhythm or presumed reversible cause.[2,3] TOR recommendations are not applied in cases in which EMS count with an onboard doctor. In such cases, end-of-resuscitation decisions fall on the emergency team doctor.

Recent data are not available regarding ongoing CPR in EMS with physician on board.[15] There is, particularly, a lack of updated data following the Covid-19 pandemic, which has such a huge impact on OHCA.[16] The aims of the present study were to identify incidence and factors associated with decisions to transport patients with ongoing CPR, whilst also examining subsequent survival and neurological status at hospital discharge.

Methods

An observational study was conducted using the Spanish OHCA register. The Spanish OHCA Registry (OSHCAR) is a prospective register of consecutive OHCA resuscitation attempts made by public emergency medical services (EMS) in Spain.[17] Data are collected periodically according to non-continuous time-periods. All Spanish EMS are publicly funded and have a physician on board their ambulances and their dispatch centers. Some EMS can work in two tiers, sending a first resource without a physician on board, due to the proximity to the event, but OHCA assistance always involves a doctor in the field.

Inclusion criteria: all consecutive OHCA cases in which an emergency team performed resuscitation manoeuvres or continued resuscitation or post resuscitation care following cardiopulmonary resuscitation (CPR) attempts by a witness or a first responder.

OHSCAR includes variables related with the patient, event, and pre-hospital and inhospital care in the case of patients transported to hospital, alongside patient survival and neurological status at discharge. Variable definitions were in line with the Utstein template.[18]

In order to identify factors associated with decisions to conduct ongoing CPR during the transfer to hospital, a sub-group of cases in which this took place was compared with a sub-group in which cases were declared dead in situ without in situ without being taken to hospital. Cases in which the emergency team performed ongoing CPR due to a protocolized no-heart-beating donation program were excluded. Cases in which the emergency team physician considered resuscitation futile were also excluded. A CPR attempt was considered futile when EMS found during resuscitation that CPR was not indicated (eg, terminal disease, unknown or prolonged arrest time prior to EMS arrival, do-not-resuscitate orders).

The dependent variable was ongoing CPR on route to the hospital. Following this, patients who had been transported to hospital with ongoing CPR were compared as a function of survival to hospital discharge.

Given the very low rate of survival, factors associated with good neurological recovery at hospital discharge were not analysed in patients transported with ongoing CPR. Alternatively, specific cases were described. Good neurological outcome at discharge was defined as categories 1 and 2 (CPC1-2) on the Cerebral Performance Category Scale (CPC1 = normal or good cerebral performance; CPC2 = moderate disability [disabled but independent]).[19]

For the present analysis cases recorded between 1st January and 31st December 2022 were included. A population of 39,750,883 was served by the EMS involved in the present study, corresponding to 90% of the total Spanish population.

Statistical analysis

Descriptive statistics are summarised according to the mean (standard deviation), median (interquartile range) or frequency (percent), where relevant. Between-group comparisons were performed for general patient characteristics, events and receipt of pre-hospital care. The Kruskal-Wallis test or ANOVA was performed to make comparisons between continuous variables depending on the distribution of the variable under analysis. Categorical data were compared using $\chi 2$. Odds ratios and 95% CI's in exposed and unexposed groups were calculated. All statistical tests were two-tailed with significance being set at $p < 0.05$. In order to identify factors associated with decisions to transport patients to hospital with ongoing CPR, variables producing significant outcomes ($p < 0.05$) in the univariate analysis were examined, alongside sex and variables that contribute clinically relevant information.

Statistical analyses were performed using R Version 4.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

The study received approval from the research committees of La Rioja and Navarra (CEImLAR_PI647 and PI_2020/60, respectively). Informed consent was not required. This study is reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Results

EMS initiated 9896 resuscitations, of which 575 (5.8%) were considered to be futile. A total of 9321 cases were included in the final analysis, which represents an incidence of 24.9 cases per 100,000 inhabitants and year. After resuscitation, 2860 (30.7%) patients achieved ROSC and were transferred to the hospital. A total of 911 (31.8%) patients in this group were discharged with CPC1-2. With ongoing CPR 350 (3.7%) patients were transported to hospital, which represents an incidence 0.9 cases per 100,000 inhabitants and year, respectively (Fig. 1). Survival at discharge with CPC 1–2 in our series was 918 (9.8%) patients.

When compared with patients who were pronounced dead at the scene, patients transported to hospital with ongoing CPR were younger (59.9 ± 20.1 years vs 64.6 ± 16.9 years; $p < 0.01$), with a greater proportion of patients being of paediatric age, considered as ≤ 16 years in Spain (16 [4.6%] vs 93 [1.5%]; $p < 0.01$). Further, cardiac arrest took place less often at home (151 [44.5%] vs 4045 [68.01%]; $p < 0.01$), with a greater proportion of cases being witnessed by EMS professionals (126 [36.0%] vs 667 [11.0%]; $p < 0.01$). An initial rhythm of asystole was less common (164 [47.6%] vs 4325 [73.0%]; $p < 0.01$) and a mechanical device was used to perform chest compressions during a higher number of resuscitation attempts (199 [56.9%] vs 2050 [33.8%]; $p < 0.01$) (Table 1).

Factors associated with the decision to perform ongoing CPR were age, younger age, collapse outside of the home, arrest being witnessed by EMS, initial rhythm other tan asystole and the use of a mechanical device during resuscitation and transport to hospital (Table 2).

Of the 350 patients transported with ongoing CPR overall, follow-up could not be performed for 19 (5.4%) of these cases. Seven patients (2%) were discharged from hospital, five with CPC1 and two with CPC2. No pediatric-aged patients survived. Of the 7 cases discharged alive from the hospital, the cardiac arrest occurred outside the home and was witnessed on 5 occasions by healthcare professionals. Five of the 7 patients had a shockable initial rhythm. Two of these patients received thrombolytic treatment during resuscitation, whilst a mechanical device to perform chest compressions was employed with 6 of these cases during resuscitation and transport to the hospital. Patients transferred with ongoing rcp who were discharged received more specific hospital treatments than those who died in hospital, namely percutaneous coronary intervention (PCI) (5 [71.4%] vs. 25 [7.7%]; $p < 0.01$) and extracorporeal membrane oxygenation (ECMO) (5 [71.4%] vs. 14 [4.3%]; $p < 0.01$) respectively. A comparison between patients transported to hospital with ongoing CPR who were later pronounced dead at the hospital and those discharged alive is presented in Table 3.

A detailed description of each case, including in-hospital treatment and final diagnosis, is presented in Table 4.

Discussion

The present study reports novel outcomes regarding the strategy of ongoing CPR in 2022, following the Covid-19 pandemic, involving EMS who serve 40 million inhabitants. A complete description of the results of OHCA care in Spain can be found in the corresponding report.[20] Patient transport with ongoing CPR was an uncommon measure used by units with an onboard physician and the associated efficacy of this measure in terms of survival with good neurological status was low.

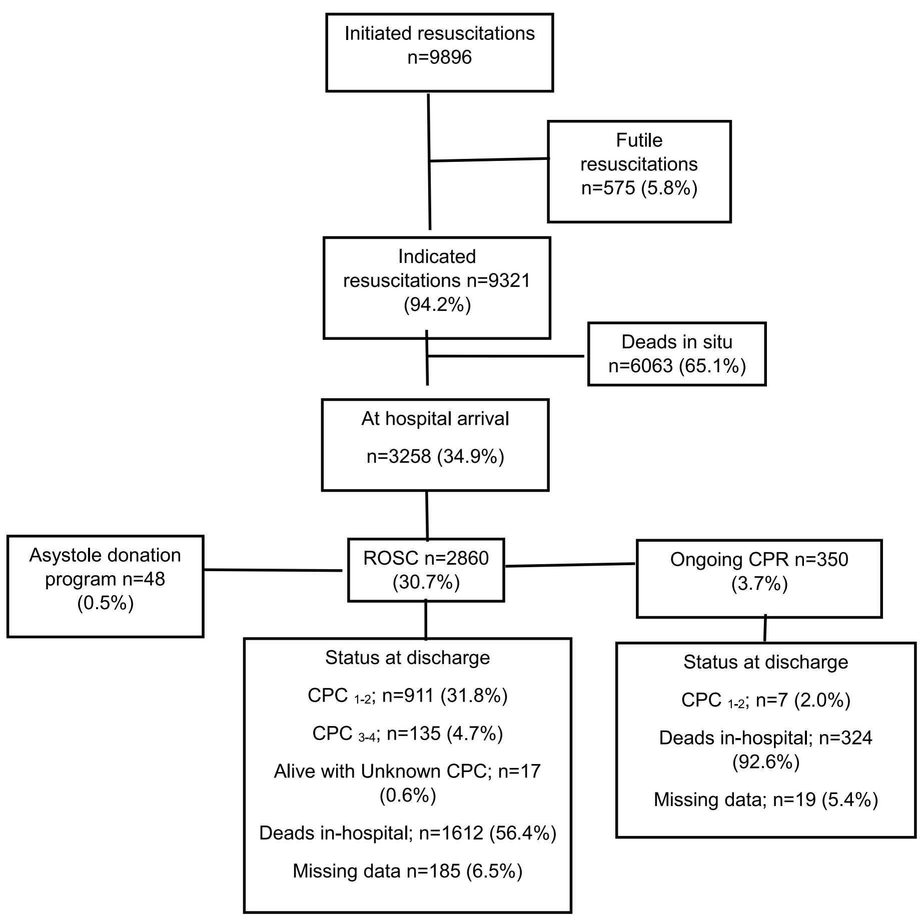

Fig. 1 – Flow diagram of patients included during the study period (2022). CPC: Cerebral performance categories, CPR: Cardiopulmonary resuscitation, ROSC: Return of spontaneous circulation.

Table 1 – Comparison of general characteristics pertaining to the patient, event and healthcare provision between patients pronounced dead at the scene and patients transported to hospital with ongoing CPR.

		In situ death	Missing	Ongoing CPR		Total		p-value
Included cases n		6063	NA	350	NA	6413	NA	
Sex, n (%)		6025 (99.4%)	38	350 (100.0%)	0	6379 (99.4%)	38	0.15
Men		4338 (72.0%)	0	253 (72.7%)		4591 (72.0%)		0.78
Women		1687 (28.0%)	0	95 (27.3%)		1782 (28.0%)		
Age (years), n (%)		6029 (99.4%)	34	350 (100.0%)	0	6379 (99.5%)	34	0.15
mean (SD)		64.6 (16.9)	0	59.9 (20.1)		64.3 (17.1)		<0.01
Men	mean (SD)	63.5 (16.5)	0	59.0 (19.2)		63.3 (16.7)		<0.01
Women	mean (SD)	67.4 (17.7)	0	62.5 (21.7)		67.1 (18.0)		0.06
Patients $\leq$ 16 year		93 (1.5%)	34	16 (4.6%)		109 (1.7%)		<0.01
Motive of the call, n (%)		5596 (92.3%)	467	309 (88.3%)	41	5905 (92.1%)	508	<0.01
Suspected CA/unconscious		3716 (66.4%)	0	151 (48.9%)		3867 (65.5%)		<0.01
Chest pain		244 (4.4%)	0	24 (7.8%)		268 (4.5%)		<0.01
Dyspnoea		642 (11.5%)	0	46 (14.9%)		688 (11.7%)		0.07
Syncope/Convulsion		340 (6.1%)	0	24 (7.8%)		364 (6.2%)		0.36
Traumatic event		561 (10.0%)	0	64 (20.7%)		625 (10.6%)		<0.01
Drowning		93 (1.7%)	0	0 (0.0%)		93 (1.6%)		0.02
Place of the arrest, n (%)		5947 (98.1%)	116	339 (96.9%)	11	6286 (98.0%)	127	0.12
Home		4045 (68.01%)	0	151 (44.5%)		4196 (66.8%)		<0.01
Witnessed arrest, n (%)		4434 (73.1%)	0	300 (85.7%)		4734 (73.8%)		<0.01
Bystander		3413 (57.4%)	0	150 (43.3%)		3565 (56.6%)		<0.01
EMS staff		667 (11.0%)	0	126 (36.0%)		793 (12.4%)		<0.01
Other public services staff		84 (1.4%)	0	3 (0.9%)		87 (1.4%)		0.55
Non-emergency healthcare staff		268 (4.4%)	0	21 (6.0%)		289 (4.5%)		0.21
Basic vital support prior to EMS arrival, n (%)*		3185 (59.0%)		151 (67.4%)		3336 (59.4%)		0.01
Bystander		2212 (41.0%)		104 (46.4%)		2316 (41.2%)		0.19
Non-emergency healthcare staff		482 (8.9%)		27 (12.1%)		509 (9.1%)		0.18
Other public service staff		491 (9.1%)		20 (8.9%)		511 (9.1%)		0.93
Use of AED by non-healthcare staff, n(%)**		360 (7.0%)		20 (9.9%)		380 (17.1%)		0.12
AED without a shock		227 (4.4%)		10 (4.6%)		237 (4.4%)		0.89
AED without a shock		133 (2.6%)		10 (4.6%)		143 (2.7%)		0.68
		In situ death		**Ongoing CPR**		**Total**		**p-value**
Initial rhythm, n (%)		5927 (97.8%)	136	344 (98.3%)	6	6271 (97.8%)	142	0.53
Shockable		859 (14.5%)	0	83 (24.1%)		942 (15.0%)		<0.01
Asystole		4325 (73.0%)	0	164 (47.6%)		4488 (71.6%)		<0.01
PEA		743 (12.5%)	0	97 (28.2%)		840 (13.4%)		<0.01
Airway management, n (%)		5080 (83.8%)	0	327 (93.4%)		5407 (84.3%)		<0.01
Supraglottic devices		1214 (23.95)	0	57 (17.4%)	0	1271 (26.5%)		<0.01
Orotracheal Intubation		3866 (76.1%)	0	270 (82.6%)	0	4136 (76.5%)		
Aetiology of CA[$,] n(%)		4644 (76.6%)	1419	315 (90.0%)	35	4959 77.3%)		
Medical		4079 (87.8%)	0	279 (88.6%)	0	4458 (88.9%)		<0.001
Trauma		329 (7.1%)	0	26 (8.3%)	0	335 (7.2%)		0.67
Overdose		50 (1.1%)	0	5 (1.6%)	0	55 (1.1%)		0.43
Drowning		77 (1.7%)	0	2 (0.6%)	0	79 (1.6%)		0.42
Electrocution		13 (0.3%)	0	0 (0.0%)	0	13 (0.3%)		0.33
Asphyxia		96 (2.1%)	0	3 (1.0%)	0	99 (2.0%)		0.18
Call-arrival of first response EMS interval*		5156 (95.6%)	240	219 (97.8%)	5	5375 (95.6%)	245	0.11
median (IQR)		12.3 (8.6, 18.2)		11.1 (8.0, 16.4)		12.2 (8.6, 18.1)		
<=12 min		2503 (48.5%)		124 (56.6%)		2627 (48.9%)		0.02
Call-arrival of first response interval		5755	308	340	10	6095	318	
median (IQR)		12.5 (8.7, 18.9)		12.1 (8.6, 19.0)		12.5 (8.7, 18.9)		
<=12 min		2737 (47.6%)		167 (49.1%)		2904 (47.6%)		0.58
Pre-hospital treatment, n(%)		6063 (100.0%)		350 (100.0%)		6413 (100.0%)		
Adrenaline		5673 (93.6%)		336 (96.0%)		6009 (93.7%)		0.07
Thrombolysis		216 (3.6%)		37 (10.6%)		253 (3.9%)		<0.01
Use of cardiac chest compressor		2050 (33.8%)		199 (56.9%)		2249 (35.1%)		<0.01

[$] Utstein model 2014. PEA: Pulseless electrical activity. DEA: Automatic external defibrillator. CA: Cardiorespiratory arrest. CPR: Cardiopulmonary resuscitation. SD: Standard deviation. IQR: Interquartile range. AVS: Advanced vital support. EMS: Emergency services.

*Arrests witnessed by EMS excluded: 5396 – 224 – 5620.

**Arrests witnessed by EMS or non-emergency healthcare staff: 5128 – 203 – 5331.

Table 2 – Factors associated with ongoing CPR being performed during transport to hospital.

	In situ death	Ongoing CPR	Univariate		Multivariate	
Variables	n(%)	n(%)	p-value	95% CI	p-value	95% CI
Sex (Male)	4338 (72.0)	253 (72.7)	0.78	1.04 (0.81;1.32)	0.24	0.84 (0.62; 1.12)
Age	64.6 (16.9)	59.9 (20.1)	<0.001	0.99 (0.98; 0.99)	<0.001	0.98 (0.98; 0.99)
Arrest took place at home	4045 (68.0)	151 (44.5)	<0.001	0.38 (0.30; 0.47)	<0.001	0.41 (0.31; 0.54)
Arrest witnessed by EMS	667 (11.0)	126 (36.0)	<0.001	4.55 (3.61; 5.74)	<0.001	4.31 (3.19; 5.80)
Asystole	4325 (73.0%)	164 (47.6%))	<0.001	0.29 (0.22; 0.38)	<0.001	0.44 (0.33; 0.60)
Cardiac chest compressor	2050 (33.8%)	199 (56.9%)	<0.000	2.58 (2.07; 3.21)	<0.001	2.75 (2.10; 3.59)
Call-arrival interval <=12 min **	2737 (47.6)	167 (49.1)	0.58	1.06 (0.86; 1.33)	0.55	0.92 (0.71; 1.20)

CPR: Cardiopulmonary resuscitation. EMS: Emergency medical services. CPR: Cardiopulmonary resuscitation.

Table 3 – Comparison of general characteristics pertaining to the patient, event and healthcare provision in patients transported to hospital with ongoing CPR as a function of survival to hospital discharge.

		Deceased		Alive		Total		p
Included cases n		324		7		331		
Sex. n (%)		322 (99.4%)	2	7 (100.0%)	0	329 (99.4%)	2	
Men		234 (72.7%)		3 (42.9%)		237 (72.0%)		<0.01
Women		88 (27.3%)		4 (57.1%)		92 (28.0%)		
Age (years). n (%)		324 (100.0%)	0	7 (100.0%)	0	331 (100.0%)	0	
mean (SD)		60.4 (19.9)		55.0 (10.4)		60.3 (19.7)		0.48
Men	mean (SD)	59.8 (18.7)		51.7 (12.6)		59.7 (18.6)		0.46
Women	mean (SD)	62.5 (22.4)		57.5 (9.5)		62.3 (22.0)		0.66
Patients ≤ 16 years		14 (4.3%)	0	0	0	14 (4.2%)	0	0.58
Motive of the call. n (%)		287 (88.6%)	37	6 (85.7%)	1	293 (88.5%)	38	0.81
Suspected CA /unconscious		138 (48.1%)		5 (83.3%)		143 (48.8%)		0.09
Chest pain		23 (8.0%)		0		23 (7.8%)		0.47
Dyspnoea		42 (14.6%)		1 (14.3%)		43 (14.7%)		0.61
Syncope/convulsion		23 (8.0%)		0		23 (7.8%)		0.47
Traumatic event		61 (21.3%)		0		61 (20.8%)		0.37
Place of the arrest. n (%)		313 (99.6%)	11	7 (100.0%)	0	320 (96.7%)	11	0.87
Home		145 (46.3%)	0	0	0	145 (45.3%)		0.02
Witnessed arrest. n (%)		277 (86.8%)	0	7 (100.0%)	0	284 (85.8%)	0	0.30
Witnessed by a bystander		141 (43.5%)		2 (28.6%)		143 (43.2%)		0.52
Witnessed by EMS staff		116 (35.8%)		3 (42.9%)		119 (36.0%)		0.70
Witnessed by other public services staff		3 (0.9%)		0 (0.0%)		3 (0.9%)		
Non-emergency healthcare staff		17 (5.2%)		2 (28.6%)		19 (5.7%)		0.23
Initial rhythm. n (%)		320 (98.8%)	4	7 (100.0%)	0	327 (98.8%)	4	0.14
Shockable		76 (23.8%)		5 (71.4%)		81 (24.8%)		0.01
Asystole		153 (47.8%)		1 (14.3%		154 (47.1%)		0.17
PEA		91 (28.4%)		1 (14.3%		92 (27.8%)		0.69
Call-arrival of first response EMS interval		203 (97.6%)	121	4 (100.0%)	0	207 (97.6%)	121	0.75
median [IQR]		11.0 [8.0–16.3]		10.4 [6.8–18.3]		11.0 [8.0–16.3]		
<=12 min		117 (57.6%)		2 (50.0%)		119 (57.5%)		0.76
Pre-hospital treatment		324 (100.0%)	0	7 (100.0%)	0	331 (100.0%)	0	
Adrenaline		312 (96.3%)		6 (85.7%)		318 (96.1%)		0.15
Thrombolysis		28 (8.6%)		2 (28.6%)		30 (9.1%)		0.07
Use of cardiac chest compressor		182 (56.2%)		6 (85.7%)		188 (56.8%)		0.12
Ongoing CPR without prior ROSC previo		172 (53.1%)	0	3 (42.9%)	0	175 (52.9%)	0	0.59
Hospital treatment		324 (100.0%)	0	7 (100.0%)	0	331 (100.0%)	0	
PCI		25 (7.7%)		5 (71.4%)		30 (9.1%)		<0.01
Thrombolysis		11 (3.4%)		0 (0.0%)		11 (3.3%)		0.62
Hypothermia		13 (4.0%)		2 (28.6%)		15 (4.5%)		<0.01
IAD		1 (0.3%)		2 (28.6%)		3 (0.9%)		<0.01
ECMO		14 (4.3%)		5 (71.4%)		19 (5.7%)		<0.01

*Arrests witnessed by EMS excluded: (208, 4, 212, respectively). **Arrests witnessed by EMS or non-emergency healthcare staff excluded: (191, 2, 193, respectively).

CA: cardiac arrest. CPR: Cardiopulmonary resuscitation IAD: Implantable automatic defibrillator. ECMO: Extracorporeal membrane oxygenation. EMS: Emergency medical services. PCI: Percutaneous coronary intervention. PEA: Pulseless electrical activity. ROSC: Return of spontaneous circulation.

Table 4 – Description of cases with ongoing CPR who were discharged alive from hospital with a good neurological status (7 patients).

Cases	case1	case2	caso3	caso4	caso5	caso6	caso7
Age	52	65	50	71	50	40	57
Sex	Female	Male	Male	Female	Female	Male	Female
Place of the arrest	Workplace	Street	Primary care A +E	Public place	Primary care A+E	Street	Street
Witnessed	Bystander	Witness	EMS staff	Non-EMS staff	Non-EMS staff	EMS staff	EMS staff
Initial rhythm	VF	VF	Asystole	PEA	VF	VF	VF
Number of shocks	8	20			5	12	5
Thrombolysis	No	No	Yes	Yes	No	No	No
Use of cardiac chest compressors	No	Yes	Yes	Yes	Yes	Yes	Yes
Aetiology	Medical	Cardiac	Medical	Medical	Cardiac	Overdose	Cardiac
Prior ROSC	No	No	Yes	No	Yes	Yes	Yes
PCI	Yes	Yes	No	No	Yes	Yes	Yes
Hypothermia	No	No	No	No	Yes	Yes	No
DAI	No	Yes	No	No	Yes	No	No
ECMO	Yes	Yes	Yes	NO	Yes	No	Yes
Diagnosis at discharge	Stroke	AMI	Pulmonary embolism	Pulmonary embolism	AMI	Overdose. Hypothermia	AMI
Neurological status at discharge	CPC1	CPC1	CPC2	CPC2	CPC1	CPC1	CPC1

AMI: Acute myocardial infarction. CPC: Cerebral performance categories. IAD: Implantable automatic defibrillator. ECMO: Extracorporeal membrane oxygenation. EMS: Emergency medical services. PCI: Percutaneous coronary intervention. PEA: Pulseless electrical activity. ROSC: Return of spontaneous circulation

Just 3.7% of cases were transported to hospital with ongoing CPR. This is lower than that reported by the majority of recent series.[12,21,22] A figure similar to previous series in our country after the increase observed during the Covid-19 pandemic, which reached percentages above 7%.[23] Overall survival with Good neurological status was seen in barely 2% of patients. This is a similar percentage to those reported in other series coming out of services staffed by paramedics.[12,21] However, it is lower than values reported in series published by Grunau et al.[22] and de Graaf[24] who reported general survival of 3.8% and survival of 4%, respectively. With regards to survival, a Danish series stands out with a rate of 20% being reported by Gregers E et al.,[25] with the EMS model under examination also incorporating medical staff. The aforementioned series included only a small number of cases, specifically, 108 patients and, as commented by the authors, in the case of as many as one third of these, the response consisted of load-and-go. This is characterised by very short periods of care in situ, something which does not take place in Spanish EMS. Nevertheless, more up-todate data provided by the same register pertaining to more recent dates and a much larger cohort, places the survival of patients transported to hospital with ongoing CPR at 1.7%.[23] This figure is more in line with the present series and with general references pertaining to the survival achieved using this strategy. In the case of all of the reported cases, patients younger than 18 years old were excluded. The present series did not include inclusion criteria specifying or limiting the age of the sample. Indeed, none of the pediatric-aged patients cared for were discharged alive.

Patients transported to hospital with ongoing CPR have a known profile. Specifically, such patients tend to be younger than the average patient. The event tends to have taken place outside of the home and been witnessed, often by the EMS themselves, and the initial rhythm of CPR tends to be shockable or pulseless electrical activity.[12,13,21,22,24–26] Of these factors, the present analysis highlights the use of mechanical devices during resuscitation and transport to hospital. In fact, in almost 6 out of every 10 patients a mechanical device was used during transport to hospital.

In the case of 5 of the 7 patients who were discharged alive from hospital in the present series, arrest was witnessed by EMS or urgent primary care health service professionals. Only one of these was transported without the use of a mechanical chest compression device. Given the small sample size of our series, we cannot affirm that there is a significant association between the use of these devices and survival to discharge of patients transferred with ongoing rcp. Nevertheless, our results would be aligned with the influence of mechanical chest compressors in prolonged reanimations.[27] It would seem advisable to have these devices available when a transfer strategy with ongoing rcp is to be approached.

Two patients, whose final diagnosis was pulmonary embolism, were treated with thrombolysis on scene, prior to the hospital, and transported to the hospital whilst being treated with a mechanical device. These two patients both had an initial rhythm different to VF. Overall, the seven surviving patients benefited from specific hospital interventions with five receiving PCI and five being treated with ECMO. This may justify the use of specific strategies in these patients.[28,29] Further, widespread use of mechanical chest compression devices during resuscitation attempts may impact debate around the viability or potential futility of this approach. These devices may partially alleviate the difficulty in maintaining good quality resuscitation during transport.[30,31] Generally overcoming the futility barrier established at 1% survival,[32] current debate pertaining to ongoing CPR as a strategy should be oriented towards appropriate decision making regarding those patients who could potentially experience a benefit. In this sense, the development of predictive models grounded in analysis of multiple variables could lead towards a future in which applications are available that enable objective assessment of the survival likelihood of patients treated for an OHCA.[33,34]

Conclusions

Ongoing CPR during transport to the hospital is an uncommon strategy employed by EMS with an onboard physician. Despite its limited efficacy, the availability of mechanical chest compression devices, together with the possibility of specific hospital treatments, mainly PCI and ECMO, lead to this approach being considered for determined patients.

Limitations

The present work has some limitations. Whilst it concerns a prospective register, both analysis and patient follow-up were conducted retrospectively. Data is not available for patients with potentially reversible causes of OHCA precluding inferences regarding such cases. Data from the follow-up of 19 patients is missing. This represents a meaningful percentage of cases transported with ongoing CPR, 5.4%, and could have ramifications regarding overall survival in the present series. This loss of information is potentially related with the administrative procedures enacted at the hospitals involved in the present register which record patients who die in the emergency room as not having been admitted to hospital. Follow-up is extremely complicated in these cases, especially in instances in which full identification was not conducted prior to CPR. Finally, the small number of survivors meant it was not possible to analyse factors related With final outcomes. This makes it difficult to define a specific profile capable of identifying patients who would benefit from this strategy.

CRediT authorship contribution statement

Alfredo Echarri Sucunza: Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization. **Patricia Fernández del Valle:** Writing – review & editing, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Jose Antonio Iglesias Vázquez:** Data curation, Formal analysis, Investigation, Writing – review & editing. **Youcef Azeli:** Data curation, Formal analysis, Validation, Writing – review & editing. **Jose María Navalpotro Pascual:** Data curation, Formal analysis, Investigation, Methodology, Resources, Writing – original draft, Writing – review & editing, Conceptualization. **Juan Valenciano Rodriguez:** Data curation. **Cristian Fernández Barreras:** Investigation, Data curation. **Sonia Royo Embid:** Validation, Data curation. **Carmen Gutiérrez-García:** Validation, Investigation. **María Isabel Ceniceros Rozalén:** Data curation. **Cesar Manuel Guerra García:** Data curation. **Carmen del Pozo Pérez:** Data curation. **María José Luque-Hernández:** Investigation, Data curation. **Silvia Sola Muñoz:** Investigation, Data curation. **Ana Belén Forner Canos:** Data curation. **María Isabel Herrera Maíllo:** Data curation. **Marcos Juanes García:** Resources, Data curation. **Natividad Ramos García:** Investigation, Data curation. **Belén Muñoz Isabel:** Data curation. **Junior Jose García Mendoza:** Data curation. **José Antonio Cortés Ramas:** Data curation. **Faustino Redondo Revilla:** Data curation. **Inmaculada Mateo-Rodríguez:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation. **Félix Rivera Sanz:** Data curation, Investigation, Software. **Emily Knox:** Methodology, Software, Writing – review & editing. **Antonio Daponte Codina:** Writing – review & editing, Validation, Methodology, Formal analysis, Data curation. **José Ignacio Ruiz Azpiazu:** Writing – review & editing, Supervision, Investigation, Data curation, Conceptualization. **Fernando Rosell Ortiz:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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