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Clinical paper

Effect of bystander CPR initiated by a dispatch centre following out-of-hospital cardiac arrest on 30-day survival: Adjusted results from the French National Cardiac Arrest Registry



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Abstract

Aim: Cardiac arrest (CA) was considered irreversible until 1960, when basic cardiopulmonary resuscitation (CPR) was defined. CPR guidelines include early recognition of CA, rapid and effective CPR, effective defibrillation strategies and organized post-resuscitation to ensure a strengthening of the survival chain. Bystanders are the key to extremely early management, which is associated with the early medical care provided by EMS. This study aims to assess the prognosis of a bystander's cardiac CPR when it is initiated by the Dispatch Centre (DC).

Methods: We included patients in 3 groups according to who initiated the CPR. The groups were matched according to multiple propensity partition methods. We presented our results in terms of 30-day survival and neurological prognosis.

Results: 85,634 patients were included. Statistical study focused on 18,185 patients once the exclusion criteria were applied. 12,743 (70.1%) are men and the average age is 70.1 years. Survival at D30 was 5.11% in the absence of CPR, 8.86% with bystander initiation and 7.35% with DC initiation ($p < 0.001$). Survival at D30 with favourable neurologic prognosis (CPC 1–2) was 76.30%, 83.69% and 82.82%, respectively. Our results show a 3.75% increase in the chance of survival at D30 if CPR was initiated by bystanders compared to patients for whom CPR was not initiated, a 2.25% increase in survival in the group that received from CPR initiated by the DC compared to the group that did not receive CPR.

Conclusions: Bystander CPR initiated by the DC represents a suitable option following out-of-hospital cardiac arrest.

Keywords: Out-of-hospital cardiac arrest, Prognosis, Cardiopulmonary resuscitation, Bystanders, Dispatch Centre

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Introduction

Out-of-hospital cardiac arrest (OHCA) is a major cause of mortality in the industrialized world.^{1–3} Epidemiological data estimate the global incidence of OHCA at 95.9 cases per 100.000 person-years.^{1,4} OHCA affects 40.000 to 50.000 people per year in France⁵ and approximately 300.000 in Europe,⁶ where OHCA survival can range from 3% to 31%. In France, survival rates vary from 4.9% to 11.4% according to the context (initial rhythm, location, bystander, . . .).^{1,6,7} Importantly, we also note variations on telephone directed CPR.⁸ The key elements of the treatment include early recognition of CA, rapid and effective CPR, effective defibrillation strategies, and post-resuscitation care.⁹ The early initiation of CPR followed by rapid intervention of emergency services that provide high quality CPR is essential.

It has been reported that bystander-initiated CPR increases survival and favourable neurologic outcomes for patients presenting with OHCA.^{10,11} Therefore, the impact of early CPR initiation has been widely documented.^{1,6,12} However, it is not known whether outcomes differ when resuscitation has been specifically encouraged or not by the Dispatch Centre (DC).

In this context, the aim of this study was to assess the effect of dispatch-directed (DD) telephonic cardiopulmonary resuscitation (TCPR) on patients' survival. We compared survival and neurological outcomes of three groups of patients: (1) patients who have not received from bystander CPR; (2) patients who received from bystander-initiated CPR; and (3) patients who received from bystander CPR initiated following the advice of the DC.

Methods

Study setting

In France, the EMS¹³ is a two-tiered, physician-based system with a Fire Department ambulance for prompt intervention and basic life support (BLS), a single DC in each county, and several prehospital Emergency Departments, which are called Mobile Emergency and Resuscitation Services (MERS; "Service Mobile d'Urgence et de Réanimation" - SMUR) and are responsible for out-of-hospital emergencies. Each MERS unit includes one or more mobile medical teams (MMTs) that operate at the scene. These teams complement previously attempted care (BLS) by initiating advanced cardiac life support (ACLS). When a call arrives in one of the French Dispatch Centres, it is first taken by a call handler, who will record all administrative data (address, identity, phone number) and the complaint. The call is then transferred with an open communication to an Emergency Physician with CA notion and on whether or not CPR is in progress. As soon as a CA is diagnosed on the phone, the bystander will be asked to start or continue BLS if needed and to have someone bring an AED, if one is available.

Study design

Our study was retrospective, comparative and multicentre, based on data from the French National Cardiac Arrest Registry (RéAC). The registry is used by most French Emergency Departments (90%) and 286 MERS and 94 DC participate to the data collection.¹⁴ The RéAC includes OHCA patients of any age, regardless of the aetiology, and the time at which an MMT was involved. Investigators use a specific

recording form during OHCA intervention to enter patient data, times, care, and immediate survival status. The RéAC form meets the requirements of the French Emergency Medical System (EMS) organizations and is structured according to the Utstein universal style.¹⁵ Data are reported in the RéAC secure database (www.registreac.org). Each RéAC centre is provided with a data manager in charge of the registry data input that the MERS teams have completed on a paper CRF. Files are completed within 24 to 48 h of their inclusion. A follow-up 30 days after the onset of the OHCA or at hospital discharge is also performed and entered into the database.

Data were collected between 1st January 2012 and 1st May 2018.

We compared survival and neurological outcomes of three groups of patients:

- Group A: patients who have not received from bystander CPR;
- Group B: patients who received from bystander-initiated CPR
- Group C: patients who received from bystander CPR initiated following the advice of the DC

Inclusion criteria

- medical OHCA according to the Utstein template^{15,16}
- patients in whom ACLS was attempted.

Exclusion criteria

- identification of cadavers (rigor mortis)
- non-medical CA
- no resuscitation by MMT
- files lacking data on mandatory criteria (Utstein core data)
- no flow (=no CPR) > 60 min
- patients with a known Do Not Attempt Resuscitation (DNAR) order.

Data collected included baseline clinical characteristics, times, history, bystander BLS, first aid provider BLS, first rhythm recorded by MMT, ACLS, pre-hospital treatment, ROSC, status at admission, patient transport, and admission parameters. Thirty-day follow-up included patient vital status and neurological outcomes.

We considered the patient shockable if the patient was shocked by an AED used by bystander or firefighter. Furthermore, if the patient had a shock-free AED pose before the arrival of the MMT, the rhythm was considered non-shockable. In the absence of this information, the chosen rhythm was the same as that recorded at the arrival of the MMT with a manual defibrillator.

No-Flow was determinate by the MMT at arrival on scene. It was determinate using the CA time, the first call and the time BLS was started by the bystander. For group C, (CPR directed by DC), the MMT retrieves starting time of directed-CPR in order to complete the registry database. Several quality controls were performed in real-time during data input to detect errors, inconsistencies, or out-of-bound values. Offline tests were performed to detect other types of errors that require verification from the participating MERS. Randomly chosen records were assessed by a clinical research associate to identify other inconsistencies or errors that should be included in the automated tests (on- or offline).

The main outcome was survival at day 30 (D30). The secondary outcome were the vital status at hospital admission, return of spontaneous circulation (ROSC) and neurological outcomes of survivors assessed by the cerebral performance category (CPC)

scale, with a CPC score of 1–2 at D30 considered to be a favourable outcome.

Ethical approval

The present study was approved by the French Advisory Committee on Information Processing in Health Research (CCTIRS) and the French National Data Protection Commission (CNIL, authorization number 910946). The present study was also approved as a medical assessment registry without a requirement for patient consent.

Statistical analysis

The first step was a comparison of main characteristics between 3 groups of OHCA patients who were classified according to the primary resuscitation performed: no CPR initiated by the bystander, CPR initiated by the bystander, CPR initiated by the DC.

The second step was a comparison of survival between groups after adjustment for different confounding factors using a multiple propensity score method.

Description and comparisons of groups

Data are expressed as frequencies (%) for qualitative variables or the median [first quartile–third quartile] depending the normality of the distribution. The normality of distributions was assessed using the Kolmogorov–Smirnov test.

Categorical variables are expressed using a percentage (frequency). The group comparisons were performed using Kruskal–Wallis and chi-square tests depending on the nature of the variables.

Adjustment method

Propensity score methods were used to reduce the effects of potential confounding factors in comparisons between groups. The propensity score was used to assemble well-balanced groups. We performed a multiple propensity score adjustment approach, based on the Imbens' description.¹⁷ This approach is similar to the Austin's description¹⁸ for estimating marginal treatment effects using logistic regression models.

The multiple propensity score method was adapted to the sample and to the number of groups (3 in the case of the study). We therefore used a multinomial logistic regression for estimating the multiple propensity scores as described by Spreeuwenberg.¹⁹ The dependent variable was the groups previously described, and independent variables were introduced in the model according to their statistical significance ($p < 0.05$) and/or their clinical relevance: sex, age group (0–44 years, 45–59 years, 60–74 years and >74 years), initial rhythm (Asystole, PEA, and VF/VT), cardiovascular and respiratory history, duration of no flow (time with no CPR at all) (0–3 min, 4–8 min, 9–14 min and >14 min) and CA location. Then, for each participant, 3 predicted probabilities (multiple propensity scores) were obtained related to the 3 groups.

We evaluated the success of the multiple propensity scores with significance testing. For the dichotomous variables, we used a logistic regression analysis with the categorical treatment variable along with 2 multiple PSs as independent variables. For nominal variables, we used multinomial logistic regression analysis with treatment as a factor and the 2 multiple PSs as covariates.

To estimate the effect of bystander BLS (according to the 3 groups) on survival (survival at day 30, vital status at hospital admission, ROSC and neurological outcome), taking into account the influence of confounding characteristics, we used a logistic regression. Survival was used as a binary dependent variable, and as independent variables, we included the following covariates: a nominal variable indicating group membership (the no-CPR group being considered as a reference), and 2 multiple propensity scores, and their product terms.

The results are expressed in terms of odds-ratios and their 95% confidence intervals. Based on logistic regression, the average probability of survival for each group was computed.

All statistical analyses were performed using the IBM SPSS Statistics[®] v25.0 software (SPSS, Chicago, IL), and differences were considered significant at a type 1 error of 5%.

Results

RéAC database identified 85,634 OHCA between January 1st, 2012, and May 1st, 2018. In line with inclusion and exclusion criteria, 18,185 OHCA were finally included in the study (Fig. 1)

Comparisons among populations (Tables 1 and 2)

Overall, approximately 70% of the population was male (69.6% in group A, 68.7% in group B and 71.7% in group C). A cardiac cause of CA was suspected in 71.8% of the overall population. The bystander was a family member in 71.8% of the cases. For group B with spontaneous bystander CPR, family represented only 35.5% of the bystanders ($p < 0.001$).

For 40.2% of the patients in group B, CPR was performed with chest compressions (CC) associated with ventilation (V). This rate decreased to only 7.4% for group C ($p < 0.001$).

Non-shockable rhythm represented 70.5% in the general population. There was a higher proportion of FV or pulseless TV in group C ($n = 1980$, 36.3%) and a higher asystole proportion in group A ($n = 6926$, 69.4%) ($p < 0.001$).

We found a small proportion of patients who were shocked by a “public” AED (2.2% of the overall population), although this proportion was higher in group B, 8% ($p < 0.001$). Only 3.2% in group C were shocked by a “public” AED.

Regarding the “firefighter” AED shocks, 24.8% of the general population received at least one shock. This rate was higher in the groups that received CPR: 29.2% for group B and 30.2% in group C. On the other hand, this rate was one-fifth of the population (20.6%) in group A ($p < 0.001$).

Regarding ACLS, there was no difference in the proportion of patients who were intubated between groups ($p = 0.127$). On the other hand, adrenaline was administered in 90% of cases ($n = 16,370$) in the global population.

The study showed, before any adjustments to the population, a better survival rate at D30 for patients receiving bystander CPR (groups B and C) (Table 2). The survival rate at D30 in group B ($n = 315$) was 11.5% vs 9.3% in group C ($n = 508$), and it decreased to 3.9% in group A ($n = 390$) ($p < 0.001$).

We found, for group A ($n = 2809$), 28.1% of ROSC at scene versus 38.3% for group B ($n = 1054$) and 35.7% for group C ($n = 1949$) ($p < 0.001$) (Table 2). Finally, the neurological prognosis was also better in groups B ($n = 254$) and C ($n = 390$), with 84.9% and 83.2% of patients with CPC scores of 1 and 2, respectively, whereas only 74.5% ($n = 266$) of patients of group A had CPC scores of 1 and 2 ($p < 0.001$).

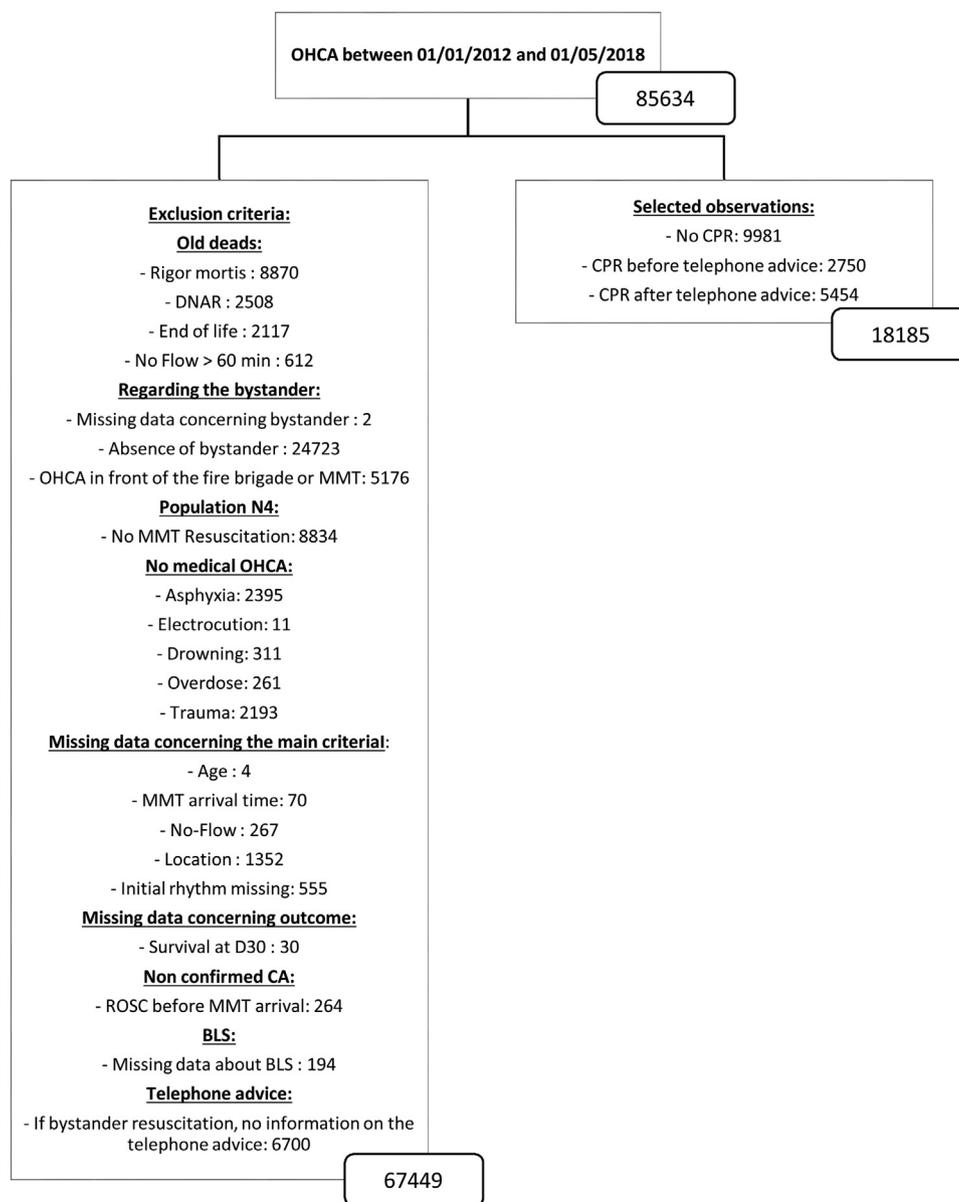


Fig. 1 – Flow-Chart of the study.

Comparison of adjusted population

After adjustment, the population of groups A, B and C were no longer significantly different for the following variables: age, sex, cardiovascular and respiratory history, initial rhythm and no-flow duration, as shown in Table 3.

However, the location of cardiac arrest maintained a statistically significant difference after adjustment, with a higher prevalence of CA occurring at home in group A (n=8249, 82.6%) versus 55.5% (n=1527) for group B and 75.9% (n=4138) for group C (p=0.01) (Table 3).

There was a better survival rate at D30 in the group with bystander-initiated CPR (8.86%). Nevertheless, the rate of survival in group C was (7.35%), which was higher than that for group A (5.11%) (Table 4). The odds ratios comparing group A to groups B and C show a significantly increased chance of survival with OR

of 1.82 [1.53;2.17] for group B and 1.48 [1.26;1.74] for group C compared to group A.

ROSC and survival at hospital admission were also better in groups B and C compared to group A after adjustment. The odds ratios for ROSC were 1.25 [1.13;1.37] (35.22%) for group B and 1.13 [1.03;1.22] (32.94%) for group C. For survival at hospital admission, the OR was 1.27 [1.15;1.41] (30.20%) for group B and 1.21 [1.11;1.31] (29.14%) for group C.

Finally, the neurological outcomes of the surviving patients were also evaluated in this population. A CPC score of 1 or 2 at D30 was considered a good outcome. Good neurological outcomes were significantly more prevalent in group B (83.69% of patients) and had an OR of 1.86 [1.48;2.32] compared to group A (76.30% of patients). The rates are slightly lower in group C with 82.82% of patients having a good neurological outcome, but the OR was still positive compared to group A (1.50 [1.23;1.84]).

Table 1 – Global and bystander CPR groups characteristics.

Characteristics	Global population N = 18,185	Group A No CPR by bystander N = 9981	Group B CPR by bystander N = 2750	Group C CPR directed by DC N = 5454	P
Age (years)					<0.001
(0–44) years	1756 (9.7%)	785 (7.9%)	296 (10.8%)	675 (12.4%)	
(45–59) years	4073 (22.4%)	2039 (20.4%)	625 (22.7%)	1409 (25.8%)	
(60–74) years	6244 (34.3%)	3467 (34.7%)	871 (31.7%)	1906 (34.9%)	
>74 years	6112 (33.6%)	3690 (37.0%)	958 (34.8%)	1464 (26.8%)	
Gender (% men)	12,743 (70.1%)	6945 (69.6%)	1888 (68.7%)	3910 (71.7%)	0.005
Place (% home)	13,914 (76.5%)	8249 (82.6%)	1527 (55.5%)	4138 (75.9%)	<0.001
Bystander (% family)	13,055 (71.8%)	8172 (81.9%)	977 (35.5%)	3906 (71.7%)	<0.001
Known cardiovascular history (%)	9048 (49.8%)	5072 (50.8%)	1369 (49.8%)	2607 (47.8%)	0.002
Known respiratory history (%)	2610 (14.4%)	1582 (15.9%)	342 (12.4%)	686 (12.6%)	<0.001
Cardiac cause (%)	13,065 (71.8%)	7081 (70.9%)	1883 (68.5%)	4101 (75.2%)	<0.001
BLS					
CPR	6927 (38.1%)	0 (0%)	2530 (92.0%)	4397 (80.6%)	<0.001
Chest compression only	6081 (33.4%)	0 (0%)	1605 (59.2%)	4476 (82.4%)	<0.001
Ventilation only	26 (0.3%)	0 (0%)	15 (0.6%)	11 (0.2%)	<0.001
Chest compression and ventilation	2037 (25%)	0 (0%)	1089 (40.2%)	948 (7.4%)	<0.001
« public » shock AED	393 (2.2%)	0 (0%)	220 (8.0%)	173 (3.2%)	<0.001
« FF » shock AED	4509 (24.8%)	2058 (20.6%)	804 (29.2%)	1647 (30.2%)	<0.001
Specialized resuscitation time:					
Call - MMT arrival (min)	20 (14 ; 27)	20 (14 ; 28)	19 (13 ; 27)	19 (13 ; 25)	<0.001
Call - ROSC or death (min)	47 (35 ; 59)	47 (37 ; 59)	45 (32 ; 60)	46 (34 ; 58)	<0.001
No flow:					<0.001
(0–3) min	5036 (27.7%)	720 (7.3%)	1379 (50.2%)	2937 (53.9%)	
(4–8) min	3957 (21.8%)	2520 (25.2%)	433 (15.7%)	1004 (18.4%)	
(9–14) min	4412 (24.2%)	3248 (32.5%)	420 (15.3%)	744 (13.6%)	
>14 min	4780 (26.3%)	3493 (35.0%)	518 (18.8%)	769 (14.1%)	
Initial rhythm:					<0.001
Asystole	11759 (64.7%)	6926 (69.4%)	1625 (59.1%)	3208 (58.8%)	
PEA	1060 (5.8%)	603 (6.0%)	191 (6.9%)	266 (4.9%)	
VF/VT	5366 (29.5%)	2452 (24.6%)	934 (34.0%)	1980 (36.3%)	
Advanced life support					
Shock by MMT	5003 (27.5%)	2435 (24.4%)	765 (27.8%)	1803 (33.1%)	<0.001
Intubation	17238 (94.8%)	9431 (94.5%)	2616 (95.1%)	5191 (95.2%)	0.127
Venous catheter	18051 (99.3%)	9888 (99.1%)	2740 (99.6%)	5423 (99.4%)	0.002
Epinephrine injection	16,370 (90%)	9067 (90.8%)	2414 (87.8%)	4889 (89.6%)	<0.001

*Data are expressed as frequencies (%) for qualitative variables or median (Q1; Q3) for quantitative variables.

OHCA: Out-hospital cardiac arrest. BLS: Basic Life Support. CPR: Cardio pulmonary Resuscitation. AED: External automatic defibrillator. FF: Firefighter. MMT: Mobile Medical Team. ROSC: Return of spontaneous circulation. PEA: pulseless electrical activity. VF: ventricular fibrillation. VT: ventricular tachycardia.

Table 2 – Global and groups survival before adjustment.

Description	Global population n = 18,185	Group A No bystander's CPR n = 9981	Group B Bystander's CPR n = 2750	Group C CRP directed by DC ^c n = 5454	p
- ROSC ^a	5812 (32%)	2809 (28.1%)	1054 (38.3%)	1949 (35.7%)	<0.001
- Survival at hospital admission	4983 (27.4%)	2249 (22.5%)	936 (34.0%)	1798 (33.0%)	<0.001
- Survival at D30	1213 (6.7%)	390 (3.9%)	315 (11.5%)	508 (9.3%)	<0.001
- If survival, CPC ^b 1–2 at D30	910 (80.9%)	266 (74.5%)	254 (84.9%)	390 (83.2%)	0.001

^a ROSC: Return of spontaneous circulation.

^b CPC: Cerebral performance category.

^c DC: Emergency call centre.

Table 3 – Differences groups before and after adjustment.

Characteristics	Group A No CPR by bystander N = 99,981	Group B CPR by bystander N = 2750	Group C CPR directed by ECC N = 5454	p Before adjustment	p After adjustment
Age (years)				<0.001	0.999
(0–44) years	785 (7.9%)	296 (10.8%)	675 (12.4%)		
(45–59) years	2039 (20.4%)	625 (22.7%)	1409 (25.8%)		
(60–74) years	3467 (34.7%)	871 (31.7%)	1906 (34.9%)		
>74 years	3690 (37.0%)	958 (34.8%)	1464 (26.8%)		
Gender (% men)	6945 (69.6%)	1888 (68.7%)	3910 (71.7%)	0.005	0.997
Place (% home)	8249 (82.6%)	1527 (55.5%)	4138 (75.9%)	<0.001	0.010
Known cardiovascular history (%)	5072 (50.8%)	1369 (49.8%)	2607 (47.8%)	0.002	0.998
Known respiratory history (%)	1582 (15.9%)	342 (12.4%)	686 (12.6%)	<0.001	0.999
Initial rhythm:				<0.001	0.999
VF/VT	2452 (24.6%)	934 (34.0%)	1980 (36.3%)		
PEA	603 (6.0%)	191 (6.9%)	266 (4.9%)		
Asystole	6926 (69.4%)	1625 (59.1%)	3208 (58.8%)		
No flow:				<0.001	0.686
(0–3) min	720 (7.3%)	1379 (50.2%)	2937 (53.9%)		
(4–8) min	2520 (25.2%)	433 (15.7%)	1004 (18.4%)		
(9–14) min	3248 (32.5%)	420 (15.3%)	744 (13.6%)		
>14 min	3493 (35.0%)	518 (18.8%)	769 (14.1%)		

^aOHCA: Out-hospital cardiac arrest, ^bBLS: Basic Life Support, ^cCPR: Cardio pulmonary Resuscitation, ^dAED: External automatic defibrillator, ^eFF: Firefighter, ^fMMT: Médical Mobile Team, ^gROSC: Return of spontaneous circulation, ^hEAWP: electrical activity without pulse, ⁱFV: ventricular fibrillation, ^jTV: ventricular tachycardia.

Table 4 – Average secondary criteria according to adjusted groups.

Description N = 18,185	Group A		Group B		Group C	
	No bystander's CPR		Bystander's CPR		CPR directed by DC ^c	
	%	OR [95%CI]	%	OR [95%CI]	%	OR [95%CI]
- Survival at D30	5.11	1	8.86	1.82 [1.53;2.17]	7.35	1.48 [1.26;1.74]
- ROSC ^a (%)	30.41	1	35.22	1.25 [1.13;1.37]	32.94	1.13 [1.03;1.22]
- Survival at hospital admission (%)	25.43	1	30.20	1.27 [1.15;1.41]	29.14	1.21 [1.11;1.31]
- If survival, CPC 1–2 ^b at D30 (%)	76.30	1	83.69	1.86 [1.48;2.32]	82.82	1.50 [1.23;1.84]

^a ROSC: Return of spontaneous circulation.

^b CPC: Cerebral performance category.

^c DC: Dispatch centre.

Discussion

First, our study highlights the favourable 30-day survival outcome of patients who received bystander CPR initiated by the DC providing T CPR advice when the onsite bystander(s) did not initiate CPR on their own. Second, these results point out favourable effects of early CPR initiated spontaneously by bystanders and emphasize the necessity of ongoing generalized CPR training at the population-wide level.

Bystander CPR

CPR was started by a bystander in 45.1% of cases, whether it was initiated by the DC or not. Those results are similar to those reported in

other studies, for example in a European study EuReCa (41.3%) and in a Korean study KoCARC (48.7%).^{20,21} It has also been underlined that in the German Resuscitation Registry (GRR), the overall bystander CPR rate (excluding first responders) on all CPR patients (including e.g. trauma) was 39.7% and the dispatcher directed CPR rate was 21.2%.^{8,22}

We noticed that in the CPR directed by DC group, over 70% (71.7%) of the bystander were family, which suggest that they are willing to help but unable to start before being directed to. Whereas, in the immediate CPR group, only 35.5% of the bystanders were family ($p < 0.001$). This could be explained by the fact that more CA in the CPR directed group occurred at home than in the group immediate CPR (75.9% vs 55.5%).

A study conducted in Japan investigated the effects of T CPR on outcome, and more specifically by type of bystander. CPR was more

easily performed by a non-family bystander.²⁰ This trend was also observed in our study. The explanations for this trend are probably based on the emotional state of the family member, where following instructions is difficult, with a fear of hurting a loved one, or risking of failing resuscitation that can lead to post-traumatic stress.²³ This finding strongly suggests the need to continue awareness campaigns about the need and importance of early CPR.

CPR quality and defibrillation

ERC (European Resuscitation Council) guidelines for CA, underline that for a non-trained bystander, only CC only should be delivered, and CC and ventilation should be delivered by trained teams. In the subgroup of our study receiving bystander CPR, 40% received CPR delivered with CC and ventilation. This high rate is probably related to the fact that a bystander who initiated CPR is likely to have had a previous CPR training emphasizing the need for compression and ventilation, if possible.

It is important to highlight the low rate of use of AEDs in our study, although it has been established that the delay to the first shock is decisive for survival^{2,24–26} and must be issued as soon as possible.

Recently, we have noticed a great decrease in the delay from CA to first shock, due to the French campaign to place AEDs everywhere, especially in most public places. Many recent studies recognize that the use of public AEDs increases the chances of survival of patients with OHCA.^{27–33}

A previous study has described a graphical model for predicting survival during OHCA.³⁴ This model was used to evaluate survival (discharge from the hospital). A multiple logistic regression model using time between collapse and CPR (I_{CPR}), time between collapse and first shock (I_{defib}) and time between collapse and advanced care (I_{ACLS}) to limit the effect of confounding factors was applied. The shorter the time required for the procedure is, the higher the survival rates are. This model shows the quantitative contribution of each intervention (CPR, EEC, initiation of specialized resuscitation) to the survival rate.

Dispatch-directed telephonic CPR

To this point, it is also relevant to highlight the DC rule in the management of OHCA. A literature review in 2011 focused on the survival benefit after OHCA depending on whether the CPR was conducted with or without the DC telephone assistance. All studies found an improvement in survival with the DC instructions, but the authors report a lack of power in statistical analysis, not concluding that there was a statistically significant difference.³⁵

Another study conducted between 2015 and 2016 in Korea, published in 2018, highlighted the importance of dispatch-directed telephonic CPR. Two groups were presented: smartphone-based advanced cardiac life support (SALS) and basic life support (BLS), i.e., those who received advanced resuscitation initiated by telephone and those who received conventional resuscitation. The survival rate was slightly higher in the SALS group than in the BLS group (4.0% vs. 1.7%), but the difference was not shown to be significant ($p = 0.078$).³⁶

Interestingly, and to the best of our knowledge, our study is the first study with sufficient statistical power to show a prognosis significant difference in OHCA with initiated dispatch-directed telephonic CPR.

Another aspect of the issue has been studied recently.²⁶ A mobile-phone positioning system to locate CPR-trained volunteers was

activated when ambulances, firefighters or police officers were dispatched. 9828 volunteers trained in CPR were recruited.

The positioning system was activated in 667 OHCA: CPR initiated by the volunteers was 62% (188 patients out of 305) in the intervention group and 48% in the control group (172 patients out of 360) $p < 0.001$ but without any improvement in patient prognosis.²⁶

Limitations of the study

In our study, inclusion criteria may differ to other registries where any BLS or defibrillation were the relevant criteria and not the start of ALS, that can make data analysis and comparisons more challenging. Moreover, and for completeness, we conducted this 18,185-patient study excluding 78% of the population from the ReAC registry analysis, including 16.5% ($n = 14,107$) of whom were old dead and 28.8% ($n = 24,723$) of whom without bystander.

We must mention that we were not able to assess the MERS team compliance to the ReAC protocol and so it might have an impact of the outcomes measured.

Another point is that we were not interested in long-term survival or neurological and functional prognoses. There are uncertainties about the exact aetiology in many cases of OHCA. ReAC registry does not contain some characteristics that are evaluated in other registers and that omission could have influenced the results (for example ethnicity, even if the data on ethnicity are actually still debated²¹).

Finally, we also do not have all relevant information about the bystanders, such as age, whether or not the bystanders were trained in CPR, or the number of bystanders involved in CPR, which could have been interesting information to have to create a typical bystander profile.

Conclusion

Immediate bystander CPR is the most favourable case for a patient's prognosis. However, our study highlights the effectiveness of dispatch-directed telephonic CPR by bystanders.

Conflict of interest statement

No conflicts of interest to declare.

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