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Out-of-hospital cardiac arrest management in the Swiss canton of Valais: a retrospective study on first responders' response and automated external defibrillator efficacy

Athiththan Kanthasamy[1], **Patrizio Pascale**[1], **Grégoire Girod**[1,2]

1 Cardiology Department, Lausanne University Hospital (CHUV), University of Lausanne, Vaud, Switzerland;
2 Cardiology Department, Hôpital du Valais, Centre hospitalier du Valais romand, Hôpital de Sion, Switzerland

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Correspondence
Athiththan Kanthasamy
Athiththan.kanthasamy[at]chuv.ch

Summary

STUDY AIMS: Cardiac arrest is a condition with a high mortality rate, with most cases occurring outside hospital. First responders (defined as public responders in our study) play an increasingly important role in management through the early initiation of cardiopulmonary resuscitation and defibrillation. Several studies have shown that the involvement of public responders can result in faster initiation of resuscitation and increased survival. This study evaluated the management of out-of-hospital cardiac arrest by public responders and the effectiveness of the FRED-PA1 automated external defibrillator (AED) available in the canton of Valais, Switzerland.

METHODS: This was a retrospective study including consecutive cases of out-of-hospital cardiac arrest occurring between January 2021 and December 2023 in the canton of Valais. Response times of public responders and emergency medical services (EMS) were evaluated, along with initial rhythms, survival, and the performance and safety of the available AEDs.

RESULTS: A total of 107 patients were included in the study. In 68% of cases, a public responder arrived at the scene first, with a significantly shorter interval between emergency call and on-site arrival compared with EMSs ($p = 0.019$). Ventricular fibrillation was more frequent in the EMS group than the public responders group (35 vs 23%) (non-significant [NS]). Survival on arrival at hospital was 19% in the public responder group and 24% in the EMS group (NS). Survival to hospital discharge was 9.6% in the public responder group and 15% in the EMS group (NS). Concerning the AEDs, the rhythm recognition algorithm was deemed to be effective and consistent with current recommendations.

CONCLUSION: This retrospective study demonstrates the key role played by public responders, who are frequently the first to arrive at the scene of out-of-hospital cardiac arrests. The FRED-PA1 AED algorithm meets the standards in the literature. However, ongoing prospective studies will highlight and optimise the role of public responders in out-of-hospital cardiac arrests.

Introduction

Cardiac arrest is a condition associated with significant mortality. Among the numerous key parameters in its management, the interval between cardiac arrest and cardiopulmonary resuscitation (i.e. the response time) remains a key consideration.

The majority of cases of cardiac arrest occur outside the hospital [3]. While the incidence of out-of-hospital cardiac arrest is extremely variable, it is estimated to be 89 per 100,000 inhabitants per year in Europe, with a survival rate at hospital discharge below 10% over the past 30 years [3–5].

Understandably, the role of the public as volunteer public responders has generated significant interest. Several studies have shown that the integration of public responders in the chain of survival improves survival due to shorter response times and the rapid initiation of resuscitation manoeuvres (cardiac massage and external defibrillation) [8-10]. Accordingly, the European Resuscitation Council guidelines (2021) recommend having 10 public responders per km^2 and 2 automated external defibrillators (AED) per km^2.

Switzerland can be considered a pioneer in this field: the first message alert system was introduced in 2006, which was further improved with the implementation of a cantonal and national alert application [8, 12].

The present study evaluated the response time of public responders and emergency medical services (EMS), initial rhythms and survival of out-of-hospital cardiac arrests, as well as the performance and safety of some of the AEDs available. We focused on the canton of Valais, a mountainous region with remote side valleys that are difficult to access, posing substantial logistical challenges. To date, no data exist on the effectiveness of out-of-hospital cardiac arrest management by public responders in Valais.

Context

Rescue services in the canton of Valais are organised and managed by the "Organisation cantonale valaisanne des secours (OCVS)" via the 144 (emergency number) Call Centre, which engages and coordinates EMSs.

For the purposes of this article, it is important to be aware of a particular feature of the canton of Valais: the distinction between "public responders" and "first responders". First responders in the canton of Valais are defined as people living in remote areas and side valleys who have received specific additional training from the OCVS, Héli-O2, which allows them to guide helicopters and to administer oxygen if necessary. Public responders are defined as members of the general population with BLS-AED certification (standardised training established by the Swiss Resuscitation Council and mandatory for the driving licence) who have volunteered to be public responders. They can register on a mobile application by providing the necessary proof of their qualifications. Of note, the term "first responder" is used generically in the literature for this category, but we have used the term "public responder" in the present article to avoid misunderstanding [13].

The incidence of cardiac arrest is between 320 and 400 cases per year in Valais, with 150 out-of-hospital cardiac arrests. Survival is lower than 5% based on data from 2014–2015.

When an out-of-hospital cardiac arrest occurs, the 144 Call Centre sends an alert simultaneously to both the mobile application and EMSs. On accepting an out-of-hospital cardiac arrest call, public responders undergo an eligibility check (proximity to the location of the event), before receiving further details, including a map of available AEDs and the quickest route to the scene. Public responders can stay in touch with the control centre, with the option of video-call support. This alert system is operational 24 hours a day, with alerts sent according to the geographical coverage pre-set by the public responders. The system covers an area of around 5200 km^2 with a population of around 344,000 inhabitants.

To improve the care of victims of cardiac arrest, the association Coeur Wallis, founded in 2018, has set itself the task of recruiting about 2500 public responders and making about 800 AEDs available.

Methods

Study population and data

This was a retrospective observational study of out-of-hospital cardiac arrests in the canton of Valais over a 3-year period (2021–2023), during which a programme was launched to expand the system of public responders and to provide more AEDs. At the end of the observation period, in December 2023, more than 2500 public responders had registered and 959 defibrillators were available across the whole area, including 552 models of FRED-PA1 (Schiller, Baar, Switzerland). The devices were linked to a server called Schiller Device Manager (SDM), which records data, including ECG tracings and transthoracic impedance. These data can be accessed via a data management system called LifeDataNetG2, hosted by an ISO 27001-approved medical data provider. This system also provides information on AEDs, including location and device status, and permits troubleshooting. Demographic data were collected by Coeur Wallis based on the intervention reports and anonymised, with analysis performed by Schiller Medical.

Descriptive data collection and statistics of the population were performed in agreement with the Utstein Style for out-of-hospital cardiac arrests [12].

The ECG strips were transmitted and were annotated (rhythm analysis and artefact identification) by Schiller Medical for generation of the sensitivity and specificity performance of the arrhythmia recognition algorithm embedded in the FRED PA-1 AED, as well as the effectiveness of the shocks. Concerning the quality of the data, the ECGs were annotated by two biomedical engineers; in the event of disagreement, they were also read by a trained cardiologist (24 segments of a total of 425 were reviewed by a cardiologist).

Submission to the ethics committee was not mandatory as raw data were anonymised before analysis.

Rhythm recognition algorithm performance and shock effectiveness

The arrhythmia recognition algorithm embedded in AEDs and the shock advisory system (SAS) must meet certain quality criteria to be used safely and effectively. Both the IEC 60601-2-4 standard (International Electrotechnical Commission 2018) and the AHA (American Heart Association) have published recommendations for the categorisation of rhythms and the number of samples, as well as targets to be achieved [14].

AEDs aim to place analysed rhythms into one of three categories:

- Shockable rhythms include coarse-wave ventricular fibrillation (VF) (peak-to-peak amplitude >200 µV) and rapid ventricular tachycardia >150bpm (VThi).
- Non-shockable rhythms include sinus rhythm, sinus bradycardia, supraventricular tachycardia (SVT: flutter, atrial fibrillation [AF]), atrioventricular (AV) block, idioventricular rhythm, premature ventricular contraction (PVC), etc.
- Intermediate rhythms: fine-wave ventricular fibrillation and ventricular tachycardia that do not meet shockability criteria, particularly slow ventricular tachycardia (VTlo).

We will report but not discuss this category due to the small amount of data in our study (see supplementary files).

There are no clear recommendations concerning shock effectiveness during defibrillation. Clinical studies of defibrillation with a biphasic shock show an efficacy of around 80% in a population with initial ventricular fibrillation. Resuscitation guidelines define efficient defibrillation as cessation of shockable rhythm at 5 sec post-shock, as beyond 5 seconds shock outcomes are biased by known confounders (e.g. call to AED connection time, bystander presence, cardiopulmonary resuscitation, drugs, initial VF) [15, 16]. VF appearing less than 5 sec after the shock is defined as persistent VF. Recurrence is determined by the presence of VF/VThi between 5 and 120 seconds after the shock. Time to refibrillation is the time in seconds between the shock and VF/VThi recurrence.

Inclusion and exclusion criteria

The inclusion criteria were any non-traumatic out-of-hospital cardiac arrest occurring between January 2021 and December 2023 in the canton of Valais with exclusive use of a FRED PA-1 defibrillator. This included all out-of-hospital cardiac arrests for which a 144 alarm was triggered and a FRED-PA1 defibrillator was placed on the patient. The exclusion criteria were unreadable or damaged AED data.

Primary and secondary objectives

The primary objective of our study was to compare cases of out-of-hospital cardiac arrest managed first by public responders to those managed by emergency medical services. We compared response times, defined as the interval from call to arrival of public responders or emergency medical services, initial rhythm and survival on arrival and on discharge from hospital. Out-of-hospital cardiac arrests managed by first responders with advanced training were excluded from this analysis since they represent a category unique to the canton of Valais.

The secondary objective was to evaluate the sensitivity and specificity of the FRED PA-1 arrhythmia recognition algorithm and the effectiveness of the electric shocks delivered by the FRED PA-1 AED.

Statistical analysis

Quantitative variables (continuous or discrete) are expressed as means, medians and interquartile ranges. Qualitative/categorical variables are expressed as counts and percentages. The primary objective was assessed according to the Utstein criteria [10]. When data were normally distributed, comparisons were performed using Student's t-test; otherwise, the Wilcoxon test was applied. Categorical variables were compared using Fisher's exact test.

All statistical analyses were performed using R version 4.3.0 (2023-04-21).

Results

Study population, initial rhythm and survival

During the data collection period, a total of 107 patients who met the inclusion criteria were identified. Results are summarised in table 1. The median age was 72 years and the majority were men (69%). Most cardiac arrests occurred in a private setting (66%). In 68% of cases (n = 73), the public responder was the first person on the scene; in around half of these cases, a bystander was also present. VF was the initial rhythm in 27% of cases. In terms of survival, 21% were alive at the time of arrival at hospital, but only 11% survived to discharge.

Table 1: Results according to the timing of the public responder's arrival.

Characteristic	n	Overall: n = 107	PR after EMS: n = 34	PR before EMS: n = 73	p-value
Sex	107				0.5
... male		74 / 107 (69%)	22 / 34 (65%)	52 / 73 (71%)	
... female		33 / 107 (31%)	12 / 34 (35%)	21 / 73 (29%)	
Patient type	107				>0.9
... adult		106 / 107 (99%)	34 / 34 (100%)	72 / 73 (99%)	
... paediatric		1 / 107 (0.9%)	0 / 34 (0%)	1 / 73 (1.4%)	
Age	106	72 (59–79)	68 (57–78)	73 (59–79)	0.5
Location of cardiac arrest	107				0.3
... private		71 / 107 (66%)	20 / 34 (59%)	51 / 73 (70%)	
... public		36 / 107 (34%)	14 / 34 (41%)	22 / 73 (30%)	
Location of AED	107				0.066
... fixed		61 / 107 (57%)	15 / 34 (44%)	46 / 73 (63%)	
... mobile		46 / 107 (43%)	19 / 34 (56%)	27 / 73 (37%)	
Bystander present	107	57 / 107 (53%)	22 / 34 (65%)	35 / 73 (48%)	0.11
Bystander CPR	107	49 / 107 (46%)	15 / 34 (44%)	34 / 73 (47%)	0.8
Time between call and arrival (sec)	107	318 (170–529)	480 (216–656)	280 (155–480)	0.019
Time between arrival and AED start (sec)	107	62 (23–235)	32 (12–111)	98 (31–245)	0.028
Time between call and AED start (sec)	107	506 (337–723)	582 (331–1041)	472 (338–659)	0.2
Time between call and first shock (sec)	29	590 (496–764)	702 (463–849)	550 (496–675)	0.3
Initial VF	107	29 / 107 (27%)	12 / 34 (35%)	17 / 73 (23%)	0.2
Survival on arrival at hospital	107	22 / 107 (21%)	8 / 34 (24%)	14 / 73 (19%)	0.5
Survival on discharge	107	12 / 107 (11%)	5 / 34 (15%)	7 / 73 (9.6%)	0.5

AED: automated external defibrillator; CPR: cardiopulmonary resuscitation; EMS: emergency medical service; PR: public responders (first responders excluded); VF: ventricular fibrillation.

Response time

Regarding the response time of public responders, 3 cases had a response time of 0 seconds due to a police officer witnessing the cardiac arrest.

In 15 cases, the time between arrival and switching on the AED was recorded as negative. These were situations in which either the police officers arrived before the public responder or there were several public responders at the scene and a public responder not assigned by the application started the AED.

Overall, the public responders group had a significantly shorter response time than the EMS group (280 seconds vs 480 seconds, p = 0.019). However, the public responders group had a significantly longer interval between arrival and activation of the AED (98 seconds vs 32 seconds, p = 0.028).

In total, the time between the receipt of the call and activation of the AED was 472 seconds in the public responders group compared with 582 seconds in the EMS group (p = NS). The time between the call and the administration of defibrillation was 550 seconds for public responders compared with 702 seconds for the EMS group (p = NS).

Initial rhythm and survival

An initial VF rhythm was present in 23% of cases in which the public responder arrived first, compared with 35% of cases where the EMS arrived first (p = NS). Survival on arrival at hospital was 19% in the public responders group and 24% in the EMS group (p = 0.6). Survival to hospital discharge was 9.6% in the public responders group and 15% in the EMS group (p = 0.5).

Public responders and AEDs in the system

Figure 1 shows changes in the number of public responders and AEDs in the canton over the study period.

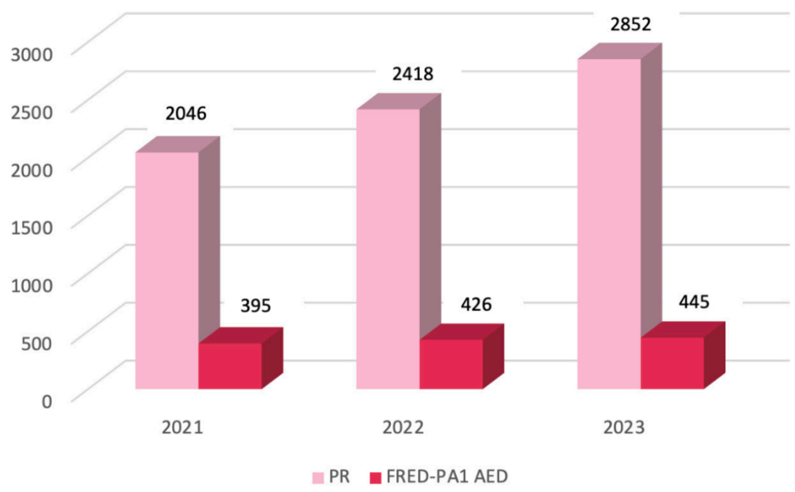

Figure 1: Evolution of PR and FRED-PA1 AED from 2021 to 2023. AED: automated external defibrillator; PR: public responders (first responders excluded).

Rhythm recognition algorithm performance

The results of the shock advisory system performance are presented in figures 2 and 3.

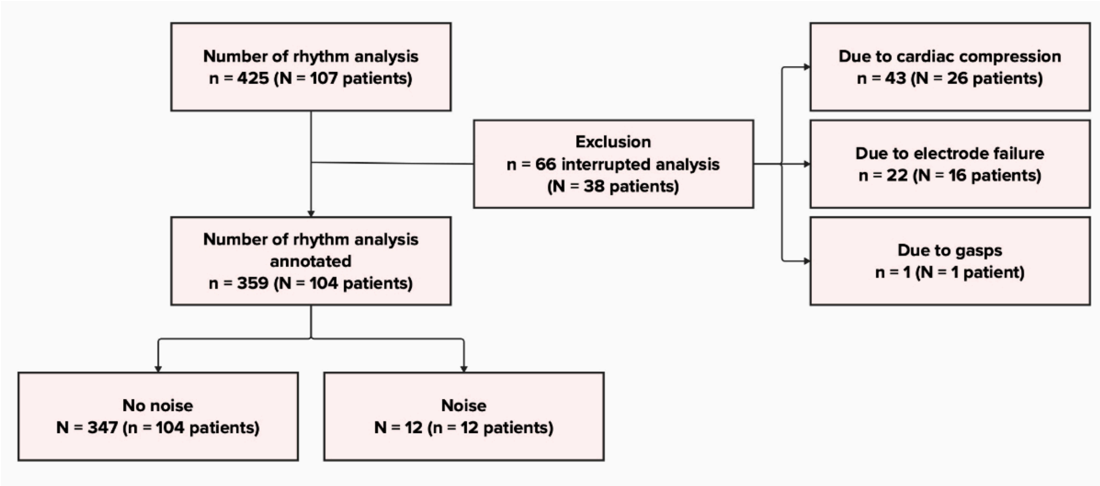

Figure 2: Flowchart of shock efficacy, including all patients who received a shock.

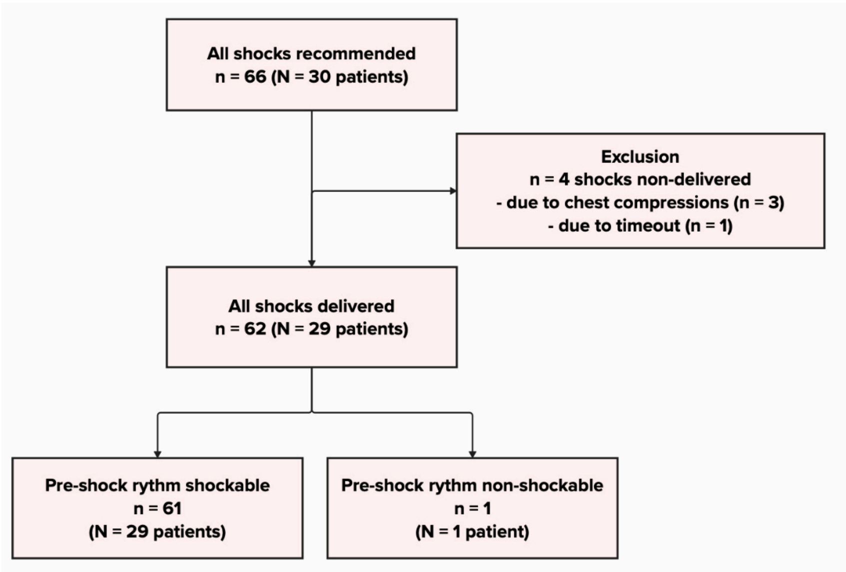

Figure 3: Flowchart of rhythm analysis by the shock advisory system (SAS).

Shock effectiveness

The algorithm recommended a shock in a total of 66 cases (16%), with 4 shocks that could not be delivered for various reasons (3 cases of cardiac massage instead of shock administration and 1 case due to the time dedicated to the electric shock being exceeded).

A total of 62 shocks were delivered to 29 patients. Unfortunately, 1 shock was delivered on a non-shockable rhythm (non-sustained ventricular tachycardia with non-shockable pre-shock rhythm). Of the 29 patients who received a shock, 28 were initially in VF.

The effectiveness of the first shock was 95.7% among patients presenting with VF as an initial rhythm. Overall defibrillation efficacy was 93.4%, with persistence of VF in 6.6% of cases (supplementary files).

The VF recurrence rate was 68.2% in the initial VF group and 61.4% in all shocks. The median time to VF recurrence was 46 seconds (10–67.5) for the first shock in the initial VF group and 20 seconds (9.75–63) for all shocks (supplementary files).

Discussion

The principal finding of this study was that public responders had a significantly shorter response time compared to emergency medical services. However, this did not translate into a detectable difference in survival. Furthermore, public responders were significantly slower in activating the AED upon arrival at the scene. These findings provide novel insights into the management of out-of-hospital cardiac arrest in the canton of Valais.

The management of out-of-hospital cardiac arrest is often depicted using the “chain of survival” framework proposed by the American Heart Association. Critically, the initiation of cardiac massage and defibrillation is considered a major rate-limiting step in the optimal management of out-of-hospital cardiac arrest. The involvement of public responders is increasingly seen as a promising means of improving this aspect of out-of-hospital cardiac arrest care.

The literature on public responders is growing rapidly, with numerous studies already demonstrating the importance of public responders in shortening response times in out-of-hospital cardiac arrest, particularly in rural areas where emergency medical services take longer to arrive [21, 22]. However, there are still many gaps in knowledge, particularly in terms of studies evaluating the implementation of the public responder system involving members of the general population with appropriate training. One example is the HEROES trial currently underway in Germany [17].

We found that, on average, the public responders group had a response time that was approximately 3 minutes shorter than that of the EMS group. Our results are comparable to the time delays reported in the literature, independent of setting (rural or urban). We found a delay of approximately 4 minutes for the public responders and 8 minutes for the emergency medical services [18, 19]. However, the public responders group was significantly slower to activate the AED. Some of these results can be attributed to a possible lack of training or practice in the use of an AED, as well as the significant distress in the face of a cardiac arrest. Of note, Coeur Wallis is currently trying to improve the training of public responders, including by requiring BLS-AED certificates to be renewed every two years to remain eligible. Better knowledge of the equipment and faster execution of resuscitation and defibrillation could ultimately increase the effectiveness of public responders.

A short response time with an early start of cardiopulmonary resuscitation is correlated with a high probability of obtaining a first shockable rhythm [20]. In our population, however, we found a higher prevalence of initial ventricular fibrillation in the EMS group compared with the public responders group. These results are unexpected and may be related to the delayed time to detect a cardiac arrest by witnesses (especially in remote areas), reducing the probability of a shockable rhythm at the time of arrival.

The overall (public responders and emergency medical services) survival rate to hospital arrival and discharge was 21% and 11%, respectively, which is comparable to the numbers in the literature. It should be noted that the rate of initial ventricular fibrillation was very low in both groups in this study, indicating a poor prognosis even before the start of resuscitation.

In addition, our data show that efforts have been made to optimise out-of-hospital cardiac arrest in the canton of Valais, particularly by recruiting more public responders and increasing the number of AEDs available. Access to AEDs can represent a significant limiting factor in some out-of-hospital cardiac arrests. Despite short response times, access to an AED is not necessarily guaranteed, especially in remote mountain areas, and this is directly correlated with survival [23]. One clinical study is underway to evaluate the effect of public responders equipped with a portable AED. This solution could stem the imbalance in the geographical location of AEDs, which are more prevalent in high-density areas, particularly urban areas [24]. The literature reports the possibility of bringing defibrillators with drones to reduce the delay to shock.

We also evaluated the effectiveness of one type of defibrillator (FRED-PA1) in the canton of Valais, in particular the rhythm recognition algorithm and the effectiveness of shocks. Shockable rhythms are likely to benefit from defibrillation, so they need high sensitivity. These elements have been discussed in the literature (AHA recommendations and IEC standard [14, 25]). FRED-PA1 defibrillators deliver a biphasic shock with a 150-200-200 J energy escalation protocol with a shock effectiveness of approximately 80% [26]. In our population, defibrillation success 5 seconds post-shock was observed in most situations, although FV recurrence was observed in more than half the cases. However, this is not a startling statistic, and similar percentages are found in the literature [27–29].

The FRED-PA1 rhythm recognition algorithm performed well and obtained satisfactory results in terms of sensitivity and specificity in line with current recommendations. However, it is important to note that we did not have a sufficient number of high-quality samples for these results to be significant in our study, particularly for shockable rhythms. We also used the one-sided 90% confidence interval to confirm the effectiveness of the algorithm whenever possible. Thus, focusing on artefact-free ECGs, the algorithm performs well for all rhythms according to the IEC recommendations, and the results are significant only for non-shockable rhythms according to the AHA recommendations.

Regardless of the specific geographical challenges in the canton of Valais, our data confirm that public responders arrive first at the scene of out-of-hospital cardiac arrests in the majority of cases. We hypothesise that better results may be seen in Switzerland's major cities, where first responder systems are already in place and more people are available in the system. Future work should include well-conducted randomised controlled trials to highlight the various factors that may ultimately lead to better management of out-of-hospital cardiac arrest and confirm the key role of public responders.

Our study has several limitations that should be noted. First, it was retrospective in nature and therefore contains the biases inherent to this type of analysis. Second, the sample size was relatively small, which may have affected the statistical significance of the analyses. Third, information on patient demographics, comorbidities and no-flow time was not available, and thus we were unable to control for significant between-group differences.

Conclusion

Out-of-hospital cardiac arrest remains a major problem and a non-negligible cause of mortality. Our retrospective study highlighted the essential elements of resuscitation, in particular cardiac massage and defibrillation. Our study showed that public responders arrive at the scene of out-of-hospital cardiac arrest before emergency medical services in the majority of cases. While this did not translate into increased survival, likely due to insufficient data, this study highlights the promising role of public responders in optimising out-of-hospital cardiac arrest care. Ongoing prospective studies may determine the elements leading to an increase in survival.

Data sharing statement

The data that support the findings of this study are available from the corresponding author on reasonable request, subject to institutional and ethical regulations.

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Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest related to the content of this manuscript was disclosed.

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Appendix

	VF	VThi	Non-Shockable Rythm (NSR/N/Asystole)
Shock	62	1	1
No shock	0	0	268
Performance goal	Se > 90%	Se > 75%	Sp > 95%
Observed performance	100%	100%	99.63%

Table 1: SAS performance goals as required by Internation Electrotechnical Commission 2018 (IEC) standard (artefact-free ECG), *VF: ventricular fibrillation, VThi: Ventricular tachycardia with rate higher than 150 bpm, NSR: normal sinus rhythm, N: Non-shockable rhythm other than NSR and Asystole*

	VF	VThi	Non-Shockable Rythm (NSR/N/Asystole)
Shock	62	1	1
No shock	1	1	276
Performance goal	Se > 90%	Se > 75%	Sp > 95%
Observed performance	98.41%	50%	99.64%

Table 2: SAS performance goals as required by Internation Electrotechnical Commission 2018 (IEC) standard (including artefacted ECG), *VF: ventricular fibrillation, VThi: Ventricular tachycardia with rate higher than 150 bpm, NSR: normal sinus rhythm, N: Non-shockable rhythm other than NSR and Asystole*

Rythms	Min test sample size	Test sample size	Se, Sp (%) goal	LCL 90% goal	Observed Se, Sp (%)	Observed LCL 90%
VF	200	62	Se>90%	>87%	100%	NA
VThi	50	1	Se>75%	>87%	100%	NA
NSR	100	1	Se>99%	>87%	100%	NA
N	30	71	Se>95%	>87%	98.59%	96.29
Asystole	100	197	Se>95%	>87%	100%	NA

Table 3: SAS performance goals as required by AHA guidelines (Kerber and al. 1997) (artefact-free ECG), *VF: ventricular fibrillation, VThi: Ventricular tachycardia with rate higher than 150 bpm, NSR: normal sinus rhythm, N: Non-shockable rhythm other than NSR and Asystole, Se: Sensibility, Sp: Specificity, LCL: Lower control limit, NA: Not Applicable*

Rythms	Min test sample size	Test sample size	Se, Sp (%) goal	LCL 90% goal	Observed Se, Sp (%)	Observed LCL 90%
VF	200	62	Se>90%	>87%	98.41%	95.82
VThi	50	2	Se>75%	>87%	50%	NA (*)
NSR	100	1	Se>99%	>87%	100%	NA
N	30	73	Se>95%	>87%	98.63%	96.39
Asystole	100	203	Se>95%	>87%	100%	NA

Table 4: SAS performance goals as required by AHA guidelines (Kerber and al. 1997) (including artefacted ECG)
VF: ventricular fibrillation, VThi: Ventricular tachycardia with rate higher than 150 bpm, NSR: normal sinus rhythm, N: Non-shockable rhythm other than NSR and Asystole, Se: Sensibility, Sp: Specificity, LCL: Lower control limit, NA: Not Applicable, (*): due to small size of some rhythm categories (VT hi), no measure of dispersion has been calculated. LCL90% value cannot be computed for an accuracy result of 100% (Se or Sp), since no dispersion is existing in the result set.

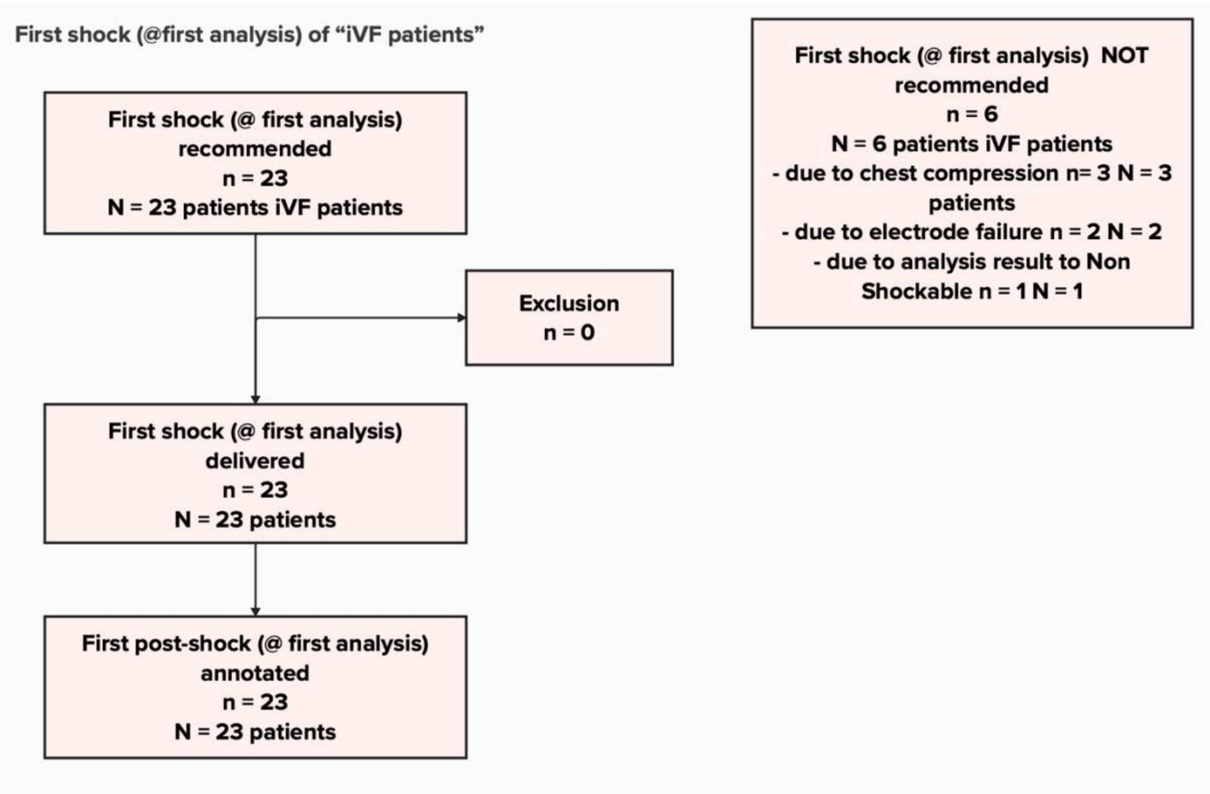
SAS performance goals as required by AHA guidelines (Kerber et al. 1997) (artefact-free ECG)

Rythms	Min Test Sample Size	Test Sample Size	Se, Sp (%) Goal	LCL 90% Goal	Observed Se, Sp (%)	Observed LCL 90%
VTlo	25	0	NA	NA	NA	NA
Fine VF	25	7	NA	NA	NA	NA
IND	NA	8	NA	NA	NA	NA

SAS performance goals as required by AHA guidelines (Kerber et al. 1997) (including artefacted ECG)

Rythms	Min Test Sample Size	Test Sample Size	Se, Sp (%) Goal	LCL 90% Goal	Observed Se, Sp (%)	Observed LCL 90%
VTlo	25	0	NA	NA	NA	NA
Fine VF	25	7	NA	NA	NA	NA
IND	NA	10	NA	NA	NA	NA

Table 5 and 6: SAS performance goals as required by AHA guidelines (Kerber and al. 1997) for intermediate rythms
VTlo: Ventricular tachycardia with rate lower than 150 bpm, Fine VF: fine ventricular fibrillation, IND: indeterminate, NA: Not Applicable



Flowchart of shock effectiveness of first shock in initial ventricular fibrillation (iVF) patients

	First shock of iVF shocked patients	All shocks of all shocked patients (iVF + niVF)
Number of shock	23	62
Type of rythm annoted during the analysis period pre-shock	23 VF	59 VF 1 VThi 1 fine VF 1 N
Shock efficacy at 5s post-shock (%)	22/23 = 95.7%	57/61 = 93.4%
Persistant VF rate (%) = Nb of persistant VF/Nb of shock	1/23 = 4.35%	4/61 = 6.56%

Table 7: Rhythm frequencies and shock effectiveness
iVF: initial ventricular fibrillation patient, niVF: non initial ventricular fibrillation patient, VF: ventricular fibrillation, fine VF: fine-mesh ventricular fibrillation, VThi: Ventricular tachycardia with rate higher than 150 bpm, N: Non-shockable rhythm other than NSR and Asystole

	First shock of iVF shocked patients	All shocks of all shocked patients (iVF + niVF)
Refibrillation rate (%) = Nb of refibrillation /Nb of shock		
Excluding persistant VF	15/22 = 68.2%	37/57 = 61.4%
Time to refibrillation (sec)		
Excluding persistant VF	46 sec (10 – 67.5) N = 15	20 sec (9.8 – 63) N = 35

Table 8 : Refibrillation rate and time to refibrillation
iVF : initial ventricular fibrillation patient, niVF : non initial ventricular fibrillation patient, VF: ventricular fibrillation

