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Clinical paper

Perceived threats and challenges experienced by first responders during their mission for an out-of-hospital cardiac arrest

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Abstract

Aim: No study has systematically captured the perceived threat, discomfort or issues experienced by First Responders (FRs). We aimed to report the FRs' experience during a mission for an out-of-hospital cardiac arrest (OHCA) in a ten-year span.

Methods: We collected all the 40-items questionnaires filled out by the FRs dispatched in Ticino Region (Switzerland) from 01/10/2010 to 31/12/2020. We compared results between FRs alerted by SMS or APP and between professional and citizen FRs.

Results: 3391 FRs filled the questionnaire. The OHCA information was considered complete more frequently by FRs alerted by APP (85.6% vs 76.8%, $p < 0.001$), but a challenge in reaching the location was more frequent (15.5% vs 11.4%, $p < 0.001$), mainly due to wrong GPS coordinate. The FRs initiated/participated in resuscitation in 64.6% and used an AED in 31.9% of OHCAs, without issue in 97.9%. FRs reported a very high-level of satisfaction (97%) in EMS collaboration, but one-third didn't have the possibility to debrief. Citizen FRs used AED more frequently than professional FRs (34.6% vs 30.7%, $p < 0.01$), but experienced more often difficulties in performing CPR (2.6% vs 1.2%, $p = 0.02$) and wore more in need to debrief (19.7% vs 13%, $p < 0.01$).

Conclusions: We provide a unique picture from the FRs' point of view during a real-life OHCA reporting high-level of satisfaction, great motivation but also the need of systematic debrief. We identified areas of improvements including geolocation accuracy, further training on AED use and support program dedicated to citizen FRs.

Keywords: Out-of-hospital cardiac arrest, First Responder, Questionnaires

Background

Out-of-hospital cardiac arrest (OHCA) represents one of the major health issues, with a survival rate from 3.1% to 20.4%[1] Rapid initiation of cardiopulmonary resuscitation (CPR) and use of an automated external defibrillator (AED) are of paramount importance to improve survival.[2,3] The dispatch of first responders (FRs) trained in CPR and AED use to nearby OHCAs has been implemented in many countries.[4–7] FRs are either police officers and firefighters trained in CPR (named "professional FRs"), or off-duty medical personnel or trained laypersons (named "citizen FRs").[8,9] FRs dispatch, alerted by a short-text-message (SMS) system[7,10] or by smartphone-based applications (APP),[5,6,11] increases the CPR rate performed before Emergency Medical System (EMS) arrival, reduces the time to first CPR and defibrillation attempt and finally, increases the return of spontaneous circulation (ROSC) and survival.[12,13] This strategy is strongly recommended by international resuscitation and cardiological scientific societies.[13–16].

FRs are aware of the possibility to encounter challenges during their mission. Analysis of post-mission emotional status of FRs indicated that they have high level of wellbeing and less post-traumatic stress disorders after the mission[17] compared to that reported by paramedics and bystanders.[18,19] However, no study has systematically captured the perceived threat, discomfort or issues experienced in real-life by FRs participating in a OHCA mission.

Since 2010, FRs participating in the network active in Ticino Region (Switzerland) are asked to fill out a self-administered

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questionnaire about the intervention. In the early days FRs have been alerted by a SMS which technology has been replaced in 2014 by an APP-system.[6,20] The aim of this study is to report the experience of the FRs during a mission for an OHCA using the available questionnaire that could be filled shortly after the intervention. In the analysis of the results, we paid particular attention to the technology used - SMS or APP - to activate the FR network.

Methods

Study design

This is a prospective observational study including all self-administered questionnaires filled by a FR on voluntary basis after the intervention on a suspected OHCA. The analysis covers all interventions occurred from 1st January 2010 to 31st December 2020 in Ticino Region, Switzerland.

EMS/FRs organization in Ticino Region

The EMS organization, the resuscitation network, and the alert of the FR network in Ticino Region has been extensively reported in previous manuscripts[6,21] and in Supplementary File 1.

Self-administered questionnaire and data collection

Immediately after an intervention, each FR participating to a mission was asked to fill-out a web-based self-administered questionnaire (Supp.File 2). The invitation link was sent via SMS up to May 2014 and via the APP from June 2014 to everyone who was accepted for intervention regardless of whether they went to the scene. No reminders were provided. The questionnaire consists of 40-items covering intervention, perceived intervention times, challenges in accessing OHCA victim, attempted treatment, level of collaboration with EMS personnel, interaction with EMS dispatcher, and willingness to continue the engagement in the FR network. Over time, some modest changes of the self-administered questionnaire were performed, in particular in the section related to challenges in accessing the OHCA victim.

Ethical statements

The study was considered exempt from ethical committee evaluation as it is not a clinical study. No informed consent was needed.

Statistical analysis

All responses were entered into a database and analyzed with MedCalc version 15.2 (MedCalc Software). Further details in supplementary file 1.

Results

During the 10-year study period, 3750 OHCA occurred in Ticino Region and resuscitation was started by EMS in 2608. A total of 3391 FRs accepted the mission and reported their experience by filling the questionnaire out of 4709 invitations for a response rate of 72%. The yearly number of FRs reporting their experience and the yearly number of OHCAs are indicated in Fig. 1. An increase in questionnaires filled out by FRs year-by-year is shown and this probably reside in the increase of the total number of FRs included in the network. About 68.4% were professional FRs, and the remaining were citizen FRs. Table 1 reports the categories of FRs, the modality of alert, and their activity at the time of alert. The median age of FRs was 40 years, 1% of them were younger than 20 years or older than 70 years. The vast majority of FRs were alerted by the APP (Table 1) and they were roughly evenly distributed throughout the day.

Alert and OHCA location

Shortly after the alert, the intervention was halted by the dispatcher in a negligible percentage of cases due to various reasons. The FRs considered the information received by the dispatch center as complete in 76.8% of cases when SMS was used and 85.6% with an APP ($p < 0.001$). As far as challenges in reaching the OHCA location is concerned, a minority of FRs reported an issue: 11.4% of FRs and 15.5% of FRs when alerted by SMS or APP ($p < 0.001$), respectively. The most common reasons were: incomplete address in 33.8%, wrong GPS coordinate in 24.5%, challenges in reaching the building (24.2%), an error to operate the APP in 2%, and other not-well specified issues in 15.5%. FRs indicated that in 50.4% of cases the bystander was aware of their arrival (Table 2). The OHCA scene was considered unsafe by 2% due to presence of road vehicles in 26.1%, health and hygienic conditions in 13.8%, presence of animals and impervious area (e.g. mountain areas, wooded areas, etc.) in 10.8% each, presence of weapons in 9.3% and hazard in the building in 7.7%.

FRs' activity at OHCA scene

The patient was in cardiac arrest at the FR's arrival in 71.6% of cases, whilst the First Responder had the opportunity to initiate or participate in the cardio-pulmonary resuscitation of the victim in 64.6% of all FRs' missions in which the patient was in cardiac arrest. Among those who performed CPR, only 2.1% reported some difficulties, mostly due to the fact that it was their first ever intervention thus, fearing inability to well perform CPR (Table 3). An AED was used by FRs in 31.9% of OHCAs without any issue in the vast majority (97.9%) of cases. In the remaining OHCAs, AED was already in-use by previously arrived FRs or EMS personnel (Table 3).

Collaboration with EMS and debriefing

FRs reported a very high level of satisfaction (97%) in the collaborative work done with EMS. A significant proportion of FRs (62.2%) had the opportunity to debrief with the EMS personnel. About 15% of those who didn't have the opportunity to debrief their intervention would be interested in doing so. Almost all participants confirmed their commitment for future OHCAs. About 5% asked for a contact from the Fondazione Ticino Cuore team to discuss about the intervention (Table 4).

Comparison between professional and citizen FRs

The citizen FRs started or participated in CPR in approximately the same proportion as FRs professional FRs (64.7% vs 64.6%, $p = 0.93$), used more frequently an AED (34.6% vs 30.7%, $p < 0.01$) but experienced more often difficulties in performing CPR (2.6% vs 1.2%, $p = 0.02$). Professional FRs reported more frequently a good collaboration with EMS team (94.3% vs 81.4%, $p < 0.001$) and were more willing to intervene again in case of OHCA than citizen FRs (99.6% vs 98.9%, $p = 0.02$). Compared to professional FRs, citizen FRs indicated the need to more frequently debrief with the EMS team (19.7% vs 13%, $p < 0.01$), and more frequently requested a contact with the managing organization team to discuss about the intervention (9% vs 3%, $p < 0.001$).

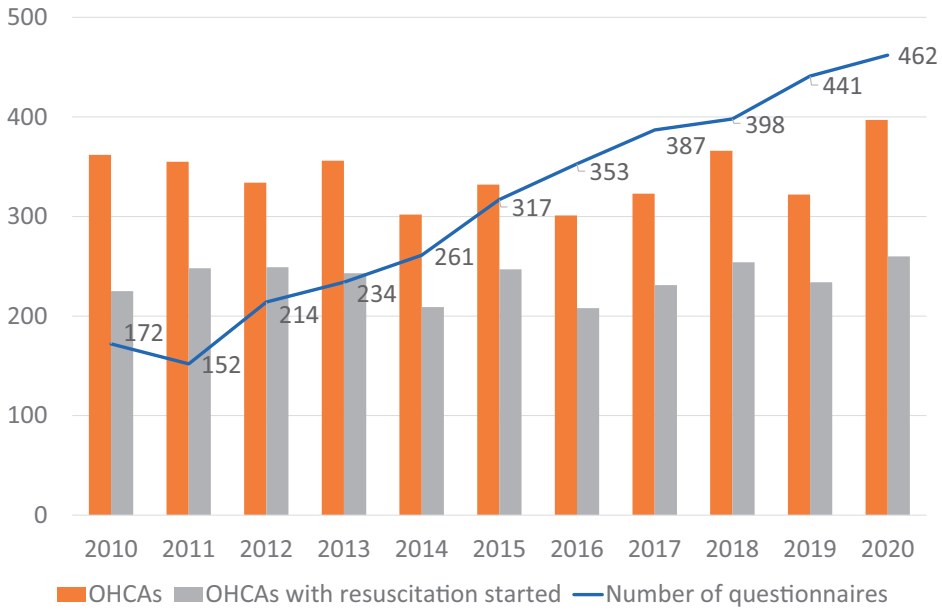

Fig. 1 – Trend in questionnaires completed by First Responders' year-by-year and yearly number of OHCAs and OHCAs with resuscitation started. The number presented in the table refers to the number of questionnaire completed by FRs.

Table 1 – Characteristics of the First Responders who completed the questionnaire.

Variable	*n = 3391*
Category of First Responders	
Professional first responders	2321 (68.4%)
- Police	*1964 (57.9%)*
- Firefighter	*357 (10.5%)*
Citizen first responders	1070 (31.6%)
- Layperson	*526 (15.5%)*
- Out-of-duty healthcare professional	*544 (16.0%)*
Citizen First Responder activity at the time of alert *	
- At work	236 (22.1%)
- Free time	834 (77.9%)
Modality of alert	
- SMS	887 (26.1%)
- APP	2504 (73.9%)

* evaluated on the 1070 citizen FRs who completed the questionnaire.

Discussion

This study is the first report on the experience and challenges of both professional and citizen FRs during an OHCA mission. The study presents the analysis of a unique dataset including over 3000 FRs who were requested at attend an OHCA mission in more than 10 years. They were activated using past, such as SMS, and modern technologies, such as mobile application on smartphone. It provides helpful insights for improving FR engagement, for better defining the role of FRs and, more importantly, their expectations. We found that the greatest majority of FRs are middle-age persons, extremely motivated in performing CPR and to support EMS personnel during OHCA. Many of them were looking for feedback by EMS and/or by institutions managing FRs.

Overall, there was a high level of satisfaction by FRs in the accomplishment of their mission. We identified throughout our questionnaire that the unique possibility to interact with EMS team right at the end of the event or possibly shortly after represents one of the most important unmet needs in our chain-of-survival; this need was clearly expressed by about 15% of the FRs. Whether this issue is restricted to our reality or may equally apply to many other countries is unknown. The post-event debrief should have a high educational goal, and lead to psychological reinforcement especially after an unsuccessful resuscitation attempt. During such debriefing, it should be emphasized the appreciated work performed by each FR who intervened and the team synergy created during the resuscitation maneuvers. Therefore, a protocol for debriefing immediately after the event, if possible, or shortly after could be encouraged. Of great interest is the fact that nearly all FRs indicated their availability to continue their voluntary work. One should not forget that the risk of the development of post-traumatic stress disorders in FRs is present albeit lower than that observed in bystanders.[17,18,22] A key element to mitigate this risk is to emphasize the collaboration with the EMS team and to manage regular debriefing session. Although a post-intervention contact was requested by a minority of FRs, it is imperative that institution like Fondazione Ticino Cuore which trains and certifies FR, and manages them has an in-place a structure debriefing program which may include the participation of a psychologist. Since 2018 this is the case in our region, where a team of three psychologist offer free counselling. The support activity is based on in-person meetings, the number of which is decided by the professionals according to each specific situation.

Consistent with previous data,[11] citizen FRs used an AED more frequently than professional FRs most probably because they were the first to be on scene. As expected, citizen FRs experienced more often difficulties in performing CPR and in using an AED. Indeed, professional FRs such as police officers and firefighters are trained

Table 2 – Information concerning the alert from the APP and OHCA location.

Variable	*n = 3391*	*SMS-group n = 887*	*APP-group n = 2504*	*p*
Has the mission been halted by EMS dispatcher?				
Yes	197 (5.8%)			
No	3194 (94.2%)			
Was the information received at the time of alert complete?				<0.001
Yes	2618 (77.2%)	681 (76.8%)	1937 (85.6%)	
No (incomplete or wrong)	533 (15.7%)	206 (23.2%)	327 (14.4%)	
Unknown	240 (7.1%)			
Have you had difficulties in reaching the OHCA location?				<0.01
Yes	456 (13.4%)	101 (11.4%)	355 (15.5%)	
No	2728 (80.5%)	786 (88.6%)	1942 (84.5%)	
Unknown	207 (6.1%)			
To your knowledge, was the bystander informed about your intervention?				
Yes	1605 (47.3%)			
No	1577 (46.5%)			
Unknown	209 (6.2%)			
If not, has this caused problems in reaching patients?				
Yes, already enough people there	14 (0.9%)			
Yes, difficult to reach/enter the location	16 (1.1%)			
Yes, reluctance of bystander / relatives	8 (0.5%)			
Yes, not specified	7 (0.4%)			
No	1532 (97.1%)			
Did you consider the scene safe?				
Yes	3117 (91.9%)			
No	65 (1.9%)			
Unknown	209 (6.2%)			

to work in challenging environments including physical and verbal conflictual conditions, risky situations presenting high level of physical and psychological stress. Furthermore, their participation to an OHCA is granted by the organizations to which they belong. This observation also strongly suggests to develop different training program for citizen FRs which may include simulated scenarios of most commonly observed OHCA situations.

According to FR questionnaire response, the bystanders were apparently not aware of the arrival of FRs. This result is highly relevant and certainly unexpected. It does not match the well-established protocol followed by the EMS dispatcher at the time of the call. Indeed the EMS dispatcher always inform the bystander about FR arrival, and of the arrival of the EMS by ambulance. Although speculative, it is possible that a significant amount of bystanders either do not understand the information due to their emotional state or that they are exclusively expecting EMS personnel rather than a police officer, a firefighter or even a layperson to start CPR. This issue emphasizes the great need to further promote the importance and the role of FR, and to increase public awareness about citizen FRs and their role during OHCA. Whether this issue is restricted to Ticino Region or not is currently unknown given the lack of comparative data.

The scene was reported as safe by nearly all FRs. This is a remarkable finding if one considers that in our region FRs are dispatched to public location and private houses and stresses the importance of the search for clues related to an unsafe scene carried out by dispatchers during the call and before alerting the network. Although the observation may support recent evidence of limited potential risks for dispatched citizen FRs to private places, larger studies are needed before widely adopting this model. At the same time, continuous monitoring of citizen FRs activity and about the perceived safety of OHCA location is of paramount importance to keep this selected group of FRs engaged.[23].

About one-third of FRs faced with a patient not in cardiac arrest when they arrived, and about half of them did not have the opportunity to participate in the resuscitation. Although this scenario seems quite obvious to paramedics, to an EMS team or to professional FRs who participate very frequently to OHCA mission, in contrast, this situation may generate disappointment or frustration for a citizen FR who may be at his/her first mission. It emphasizes the need to reiterate during BLS certification and re-certification that such circumstances are more frequent that thought. On the other hand, when a FR started CPR nearly no issues were reported and most of them indicated that they would be available for another mission. This result is remarkable as real-life OHCA is different from the training situation and may have an impact on the FR. Moreover, this evidence is significantly different from past evidence. Indeed, Savastano[24] and Baldi[25] reported that about 15% of the people immediately after CPR/AED training were not willing to perform CPR in a real-life OHCA scenario. One may postulate that periodic retraining of FRs removes some psychological barriers and reinforce the positive aspects of life saving maneuvers.

About one-third of FRs indicated a successful use of an AED during the mission. However, some FRs reported a potential AED malfunction with inability to deliver a shock. A careful technical examination of each case, found no defective AED. It may suggest the need of additional training in patch preparation and application on the chest for some FRs. An alternative explanation could be found on the difference between the AED model used at the time of training/certification and the device used at the time of OHCA. Indeed, the over 1200 + AEDs available in Ticino Region are made by AEDs of at least 5 different manufacturers; the lack of standardization of

Table 3 – Information regarding OHCA scenario and First Responders' actions and issues.

Variable	*N = 3391*	*Professional FRs (n = 2321)*	*Citizen FRs (n = 1070)*	*p*[#]
Was the patient in cardiac arrest?				0.11
Yes	2277 (71.6%)	1591 (70.7%)	686 (73.5%)	
No	905 (28.4%)	658 (29.3%)	247 (26.5%)	
Did you started or participated in CPR? [*,†]				0.93
Yes	1471 (64.6%)	1027 (64.6%)	444 (64.7%)	
No	806 (35.4%)	564 (35.4%)	242 (35.3%)	
Did you perceive difficulties in performing CPR?				0.02
Yes	32 (2.1%)	18 (1.2%)	14 (2.6%)	
No	1471 (97.9%)	1502 (98.8%)	517 (97.4%)	
If yes, why?				0.14
First real CPR, afraid to be ineffective	10 (31.3%)	6 (33.3%)	4 (28.7%)	
Difficult patient position for performing CPR	2 (6.2%)	1 (5.5%)	1 (7.1%)	
Physical interference AED electrodes	2 (6.2%)	0 (0%)	2 (14.2%)	
Obese patient	2 (6.2%)	0 (0%)	2 (14.2%)	
Gasping	1 (3.1%)	0 (0%)	1 (7.1%)	
Not specified	15 (47%)	11 (61.2%)	4 (28.7%)	
Have you used the AED?[*,¶]				<0.001
Yes	694 (31.9%)	465 (30.7%)	229 (34.6%)	
No, I didn't have it	115 (5.3%)	34 (2.2%)	81 (12.3%)	
No, already in use	893 (41.1%)	632 (41.9%)	261 (39.5%)	
No, other	121 (5.6%)	74 (4.9%)	47 (7.1%)	
No, not specified the reason	351 (16.1%)	308 (20.3%)	43 (6.5%)	
Had you difficulties in using AED?				0.08
Yes	15 (2.1%)	7 (1.5%)	8 (3.5%)	
No	697 (97.9%)	474 (98.5%)	223 (96.5%)	
If yes, which was the perceived cause?				0.42
Exhausted battery	3 (20%)	1 (14.3%)	2 (25%)	
Incorrect electrode application	2 (13.3%)	0 (0%)	1 (12.5%)	
Perceived AED malfunctioning	6 (40%)	2 (28.6%)	4 (50%)	
Difficulties in opening AED pads	1 (6.7%)	2 (28.6%)	0 (0%)	
Water on the scene	1 (6.7%)	1 (14.3%)	0 (0%)	
Not specified	2 (13.3%)	1 (14.3%)	1 (12.5%)	

[*] calculated on the 2277 cases in which the patient was in cardiac arrest;
[†] missing data for 209 participants (6.2%);
[¶] missing data for 103 participants (4.5%).
[#] p-value refers to the comparison between "professional FRs" and "citizen FRs" for each question.

activation sequence and instructions automatically provided to a FRs may occasionally results in a suboptimal device use.[26] The last and not least important, may also be the emotional status of the FR who, for the first time in his/her life, performs a CPR and uses an AED; psychological stress may lead to errors even in trained individuals well capable of an AED use during the certification process.

A non-negligible percentage of citizen FRs received an alert during their worktime. Considering that international guidelines about OHCA treatment recognize the importance of FRs in increasing the chance of survival of OHCA victims,[13,15,16] our finding may represent a first evidence on the need to promote governmental initiatives which may allow FRs to intervene in case of alert even during their worktime.

A non-negligible number of FRs reported missing information when an alert was launched using SMS technology. After the implementation of a mobile application,[4,6] the data completeness has significantly improved highlighting the need to replace SMS-system for better performing mobile applications.[4,6] Notably still challenges have been reported with APP-system, mostly related to precise geo-localization of the caller which modern telecommunication technology have recently overcome by sharing his/her location coordinates. Inaccurate GPS coordinates especially in mountain area as those present in northern part of Ticino Region may still represent a potential issue in precise OHCA location,[27] and could be solved by additional personal interaction with the dispatch.

Limitations

Answers to the questions represent a subjective perception by each FR about the intervention which may not represent the real situation. Because participation is on voluntary basis and it is done in anonymous form, including the date and the time of intervention, it is not possible to double check the data accuracy by cross-verification with EMS protocol or feedback received by other FRs. There is still a great value in our data collection because it represented an unbiased personal perception of a life-threatening event.

We divided our population of FRs in two categories "professional FRs" (police officers and firefighters trained in CPR) or "citizen FRs" (off-duty medical personnel or trained laypersons). Despite this classification is the most used in the recent literature,[8,9] we are aware that may introduce a little bias regarding the citizen FRs category as off-duty medical personnel may be more experienced in handling an emergency situation than laypersons.

The percentage of professional FRs who answered to the questionnaire is higher than citizen FRs: this seems in contrast

Table 4 – Information regarding the collaboration with EMS and debriefing.

Variable	*N = 3391*	*Professional FRs (n = 2321)*	*Citizen FRs (n = 1070)*	*p*
How was the collaboration with EMS team? *				<0.001
Good	2879 (90.5%)	2120 (94.3%)	759 (81.4%)	
Sufficient	75 (2.4%)	41 (1.8%)	34 (3.6%)	
Insufficient	10 (0.3%)	2 (0.1%)	8 (0.8%)	
Not actively participated in rescue (over-crowded scene)	217 (6.8%)	86 (3.8%)	131 (14%)	
Had you the opportunity to discuss with EMS team about the intervention? †				0.29
Yes	1852 (62.2%)	1360 (73.4%)	492 (60.7%)	
No	1126 (37.8%)	807 (37.2%)	319 (39.3%)	
If not, do you believe it would be useful?				<0.01
Yes	168 (14.9%)	105 (13%)	63 (19.7%)	
No	958 (85.1%)	702 (87%)	256 (80.3%)	
Are you willing to intervene again in case of OHCA?¶				0.02
Yes	3168 (99.4%)	2231 (99.6%)	937 (98.9%)	
No	18 (0.6%)	8 (0.4%)	10 (1.1%)	
Do you need contact by the Fondazione Ticino Cuore team? ‡				<0.001
Yes	153 (4.8%)	68 (3%)	85 (9%)	
No	3031 (95.2%)	2169 (97%)	862 (91%)	

* unknown data for 210 participants (6.2%);
† missing data for 413 participants (12.2%);
¶ missing data for 205 participants (6.1%);
‡ missing data for 207 participants (6.1%).

with the percentage of FRs who accepted the mission in real-life OHCA scenario who are about 60% citizen FRs and 40% professional FRs. Therefore, the study population is not perfectly representative of the real situation, but we believe that the reason may reside in the fact that professional FRs feel themselves more involved in the system and are more willing to complete the questionnaire.

The questionnaire was not tested and validated as it was developed with the main aim of managing of the FRs network.

Our period analysis includes the year 2020 and, consequently, COVID-19 pandemic period, who demonstrated to have an important effect on OHCA and FR networks both worldwide[8,28] and in Ticino Region.[9,29] However, both considering that the COVID-19 period represent a small percentage of the whole period analysis, and that our questionnaire is focused on FRs replies, we believe that this has not affected our results.

Conclusions

Our study provides a unique picture taken from the point of view of FRs during a real life OHCA intervention. The feedback reported by the vast majority of the participants indicates high level of satisfaction, great motivation but also the need of systematic debrief with the EMS team after the intervention. Our study also identified areas of major improvements including accuracy of geolocation, further training on AED use and support program - in particular - dedicated to citizen FRs to achieve a high level of retention.

CRediT authorship contribution statement

Enrico Baldi: Conceptualization, Investigation, Formal analysis, Writing – original draft. **Alessia D'Alto:** Investigation, Formal analysis, Writing – original draft. **Claudio Benvenuti:** Investigation, Data curation. **Maria Luce Caputo:** Investigation. **Ruggero Cresta:** Investigation, Data curation. **Roberto Cianella:** Data curation, Validation. **Angelo Auricchio:** Supervision, Project administration, Writing – review & editing.

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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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2023.100403.

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