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An app to keep: smartphone-based dispatch of community first responder to cardiac arrest

Tore Marks^{1*} , Bibiana Metelmann¹ , Peter Brinkrolf¹ , Karl Christian Thies² , Klaus Hahnenkamp¹  and Camilla Metelmann¹ 

Abstract

Background Smartphone-based alerting of community first responders to out-of-hospital cardiac arrest (OHCA) is associated with enhanced survival. Community first responders are volunteers, who are dispatched by the emergency dispatch centre, if they are in close proximity to an OHCA to decrease time until first chest compression. For a community first responder system to be successful, it is essential to recruit and retain as many qualified community first responders as possible. This study evaluates the appraisal and retention rate of an app-based community first responders system over a period of 3 years.

Methods A longitudinal study among community first responder in a rural northern Germany was conducted using an online-survey. A questionnaire (7 open questions, 22 single choice questions and 2 multiple choice questions) was distributed to all community first responders (FR) via e-mail in October 2018, 2019 and November 2020. Ethical approval was obtained, informed consent was given by all participants.

Results The response rate was 69%, 43% and 38% in the first, second and third year, respectively. Three years after implementing the system 96% of the users stated they still had the app installed. After the first year, 21% of participants observed improvements. In the second year, this number was 15%, and 31% in the third year. The opinion regarding the medical benefit of the app was stable. Nine out of ten participants would recommend the app to others. Of all participants 70% identified as male and 66% were 35 years old or younger. Main barrier to using the app was excessive „battery consumption“.

Conclusions The community first responder system attracts a predominantly young and male user base. The retention rate of 96% over the three years observation period is high. The main barrier to app usage is excessive battery consumption. The users' positive perceptions regarding the app's medical advantages and the favorable perception of its functionality have resulted in a steadfast high recommendation rate.

Keywords Out-of-hospital cardiac arrest, First responder, Citizen responder, Smartphone, Technology acceptance

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Background

In cardiac arrest, early resuscitation is vital [1, 2]. During out-of-hospital cardiac arrests (OHCA), there is an unavoidable time lag between alerting emergency systems and the arrival of the Emergency Medical Service (EMS) [3, 4]. Even with ambulance response within five minutes, survival is poor without immediate cardiopulmonary resuscitation (CPR) [4, 5, 6, 7]. Several global programmes have trained laypersons in CPR, but bystander response remains limited [8, 9, 10, 11, 12, 13, 14]. To address this delay and support bystanders, many regions introduced first responder systems [15, 16, 17, 18, 19, 20, 21]. When first responders are nearby during an OHCA, they are alerted alongside ambulances [20]. Such systems help expedite CPR [16, 22], leading to enhanced survival and neurological outcomes [17, 23, 24, 25]. Regions with these systems report improved cardiac arrest survival rates [26]. The European Resuscitation Council and the American Heart Association recommend to implement first responder systems [27, 28]. Internationally, different hardware and software solutions are used to alert first responder through a smartphone app. Additionally, there are two different approaches to recruit first responder [29]. One approach is to dispatch crews of firefighters or police officers during their shifts [30]. The other approach is to recruit volunteers, who act as community first responder independent of their working shifts [31]. Community first responder can decide, whether they attend the mission and rush to the OHCA patient. While some community first responder systems recruit volunteers regardless their medical knowledge, other systems require resuscitation training or even limit their system to community first responder with medical background [32].

For a community first responder system to be successful, it is essential to recruit and retain as many community first responders as possible [20]. However, in our fast-paced world, smartphone applications (apps) are often dismissed quickly [33, 34]. Most apps lose more than half of their users within the first week [34]. User acceptance is thought to depend on several aspects, but foremost on perceived experience and appropriateness to user's context and needs [35]. As a high user acceptance is associated with high retention rates, it is crucial for a functional first responder system to find out how satisfied users are with the apps. The existing literature in this field is sparse. Longitudinal studies are still pending.

Thus the aim of this study is to evaluate the users' perception of the app, barriers to utilization and retention rates over a period of 3 years.

Methods

Background

In September 2017 a smartphone-based alert of community first responders to attend OHCA was launched in Vorpommern-Greifswald, a rural area in northern Germany. An app called "Land|Retter" was made available free of charge in both major app stores (Google Play Store and Apple App Store). Participation as first responder was voluntary. To participate, users had to (i) register and provide information on their qualification regarding resuscitation skills and (ii) attend a 2-hour seminar. Qualification could include employment in health care (e.g. physician, nurse, paramedic, medical student) or regular basic life support training (e.g. as a firefighter). The seminar focused on practical, medical, technical and legal aspects of app usage and included hands-on CPR-training. During the seminar first responders had to consent (i) to participate in the system, and could consent (ii) to anonymous mission data analysis, and (iii) to being contacted and invited for surveys.

Description of the app

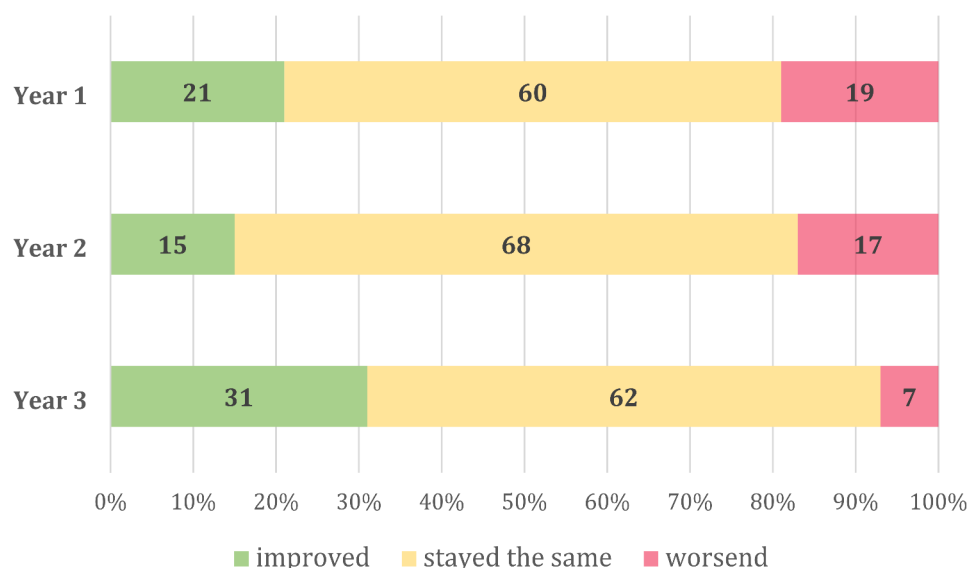
The Emergency Dispatch Center can activate the app "Land|Retter" 24/7 in addition to the regular EMS response if an OHCA is suspected. The system automatically alerts registered community first responders, who are coincidentally in close vicinity of the OHCA patient. The radius of activation around an OHCA is 750 m in urban and up to 2000 m in rural areas. FR are not alerted in case of potential danger at the emergency site (e.g. fire, violence, traffic accident). First responders are alerted by sound and message and can choose, whether they accept or decline this mission. During the study period up to two first responders could accept per mission. After accepting the mission, FR have to insert a pin code to start the navigation to the target site. FR can choose to cancel the mission at any point. Once they arrive at the emergency site, a metronome is activated to support chest compressions with the correct compression rate. During the study period 20 updates were made to improve functionality of the app software.

Description of the questionnaire

To assess the system's appraisal and retention rate a questionnaire was devised. As no validated questionnaires could be identified for this matter, a new questionnaire was developed and evaluated in a pretest regarding comprehensibility and feasibility. The questionnaire contains 31 questions (7 open questions, 22 single choice questions and 2 multiple choice questions). The online survey tool "SurveyMonkey" (Survey-Monkey Inc., San Mateo, CA, USA) was used. All active FR (of whom a declaration of consent was available at the time of the survey) were contacted via e-mail. Invitations to

Table 1 Number of invited FR, number of responses shown in absolute numbers (n) and response rate shown in percentage (%)

	Year 1	Year 2	Year 3
Number of invited FR	182	290	344
Number of responses	126	124	129
Response rate	69%	43%	38%

**Fig. 1** Attitude regarding the functionality of the app. Shown in percentage

participate were sent in October 2018, 2019 and November 2020. A reminder email was sent in all three years to all non-replying study participants one, two and three weeks after the initial survey invitation.

As recruiting of first responder continued between October 2018 and November 2020 the number of FR increased over time. Study participation was voluntary and without monetary or other compensation.

Statistics

The study was designed as a longitudinal survey study. As the aim was to conduct a complete survey, a power analysis was not necessary.

Descriptive statistics were used for all participants with mean, standard deviation, median, relative and absolute frequencies. Statistical analysis was carried out using SPSS Statistics version 25.0.0.0 for Mac OS (SPSS Inc., Chicago, IL, USA).

Results

Invitations to participate in the survey were sent to all first responders (in total 816 invitations in three years). Table 1 shows the response rate, which dropped from 69% ($n=126$) in year one to 43% ($n=124$) in year two to 38% ($n=129$) in year three.

Participants' characteristics

In the aggregated data of all three years, 70% ($n=244$) of participants identified as male. 66.2% of the first responder were 35 years old or younger, 24.1% were between 36 and 50 years old and 9.7% were older than 51 years. When asked about their qualification 35.3% stated „ambulance service“, 20.3% answered „fire fighter“, 22% specified being a „medical student“, and 22.4% had other qualifications. 54% ($n=199$) of the FR stated using an android phone.

Apart from their duties as FR, 28.7% had never performed CPR before, 15.8% had only performed it once, 12.3% had performed CPR two to five times, and 43.3% had performed it more than five times.

Evaluation by first responders

Participants were asked how their opinion on the functionality and the medical benefit of the app changed over time, see Figs. 1 and 2.

First responders can decide whether to accept or decline a mission alert. In year one 43% ($n=23$) indicated, that they had declined a mission. In year two 42% ($n=31$) and in year three 63% ($n=57$) reported to have declined a mission.

Table 2 presents the reasons for mission declinations.

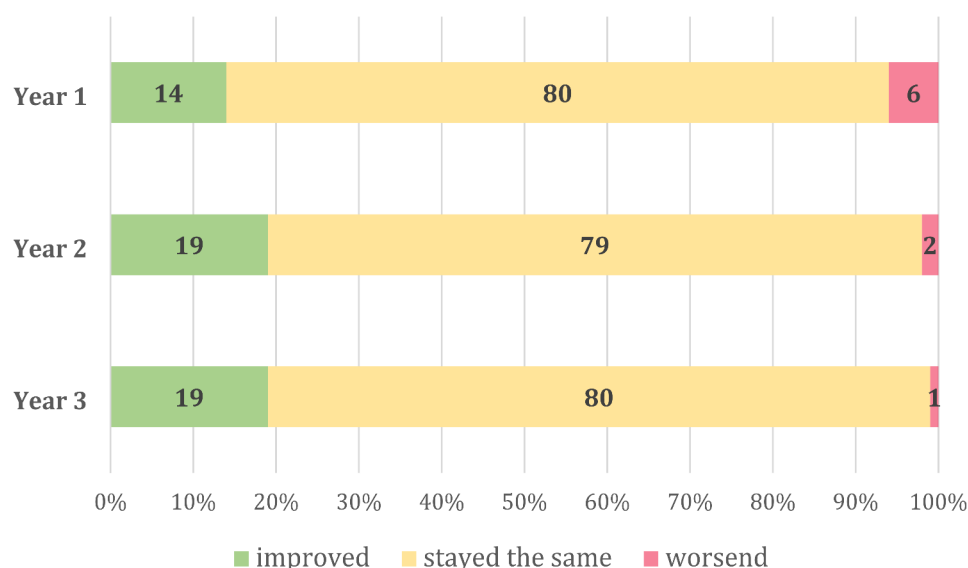


Fig. 2 Attitude regarding the medical benefit of the app. Shown in percentage

Table 2 Answers to the question: “why did you decline a mission?” (multiple answers possible), shown in absolute numbers (n)

	Year 1	Year 2	Year 3
Malfunction of the app	5	7	9
The mission was not available any more	13	17	32
Deployment during working hours	9	10	21
Deployment in an inappropriate situation (e.g. going to the cinema/meeting)	4	10	18
I was looking after minors	4	2	10
I was unwell	2	3	8
I was concerned of not finding the mission site	0	2	0
I had drunk alcohol	0	5	6
I could not interrupt my activity	4	6	12
I was concerned of making a mistake during the mission	0	1	4
Other	1	3	12

Table 3 Answers regarding the question: “are there barriers to using the app?” (multiple answers possible), shown in absolute numbers (n)

	Year 1	Year 2	Year 3
No reasons	61	76	68
Battery drainage	39	25	21
Data security	4	3	3
Mental stress caused by the permanent possibility to get dispatched	8	6	9
Concerned to get alarmed at an inconvenient time	20	28	32
Doubts regarding medical benefit	3	0	2
Legal aspects	3	0	2
Other	14	9	10

Retention and recommendation rate

One year after implementing the system 97% ($n=122$) of the participants still had the app installed. After two years 98% ($n=121$) and after three years 96% ($n=123$) had retained the app. Nine out of ten participants recommended the app to others: 84% ($n=100$) in year one and 91% ($n=109$) and 90% ($n=107$) in year two and three.

Barriers to use the app

Table 3 shows barriers to using the app.

Discussion

Recommendation rate, functionality and medical benefit

By surveying the Land|Retter app users repeatedly, we were able to profile detailed user characteristics and also compare user behaviour over a period of three years.

Throughout these three survey years, the proportion of first responders who retained the Land|Retter app remained stable at 97%, 98%, and 96% respectively. This is noteworthy considering the general tendency among smartphone users to employ most of their apps for only a short duration, with merely 4% continuing usage beyond 15 days [36, 37, 38].

The percentage of first responders recommending the app to others rose from 84% in the first year to 91% in the succeeding year, sustaining a robust recommendation rate of 90% in the third year. Despite already favourable initial values, the recommendation rate remained stable over the span of these three years. The perception of the first responders regarding the app's functionality did not deteriorate over time. After Year 1, results showed that 21% of participants perceived improvements. In Year 2, 15% of participants reported improvements, followed by 31% in Year 3. During the first year after the launch iOS users could not be alerted whilst their phone was in silent mode. The update in the second year to override the silent mode has proved effective, as evidenced by a rising percentage of first responders who noted improved functionality. Other first responder systems experienced similar problems: The users of the Belgian "EVapp" interviewed by Vercammen et al. reported alert malfunctions in silent mode. The developers of the British app "GoodSAM" also recognized the problem and were able to implement suitable modifications in the alarm system [20, 39].

Despite technical challenges, the users' attitude towards the medical benefit of the first responder app appears to remain consistently good over three survey years. The percentage of first responders stating that their opinion on the medical benefit of the app decreased dropped from 6% to 2% and 1% in the first, second and third year respectively.

Wade et al. demonstrated the crucial role of acceptance of a telemedicine application for a successful implementation. Through interviewing Australian users of telemedicine applications they found that staff acceptance is the foremost positive predictor for successful deployment of a telemedical application. If users are enthusiastic about the concept, they are less likely to be deterred by obstacles such as technical problems or funding issues [40].

First responder characteristics

It is noteworthy that 7 out of 10 first responders who answered the questionnaire identified as male. International comparative studies implicate that more than two-thirds of first responders who register and perform CPR are male [41, 42]. A plausible explanation for the gender distribution among the first responders can be discerned when evaluating the qualifications. A significant 55.6%

of first responder indicated "ambulance service" or "fire brigade" as their qualification. The predominance of male gender in these professional groups could elucidate the accumulation of the male gender among the volunteers.

The majority (66.2%) of first responders who completed the questionnaire were aged below 36 years. The high proportion of young FR is in line with the fact that the prevalence of smartphone app usage tends to diminish in the older population [43]. Additionally, social commitment underlies "age-specific differences" [44]. Younger individuals tend to engage in volunteer emergency services and volunteer fire services more often than older individuals and are thus more likely to participate in first responder systems [45]. This trend is mirrored in the age distribution among users of first responder apps [46] and can be confirmed by the data collected about the Land|Retter App.

Barriers to app utilisation

The survey consistently reveals over a three year period that battery drainage emerges as the foremost obstacle for first responders. Latency and energy depletion contribute to frustration significantly impacting app retention and abandonment rates [33].

Another major obstacle perceived by first responders is the concern of being alerted at an inconvenient time. However, only a few first responders reported declining a mission due to being alerted at such a moment. This suggests that their concerns about being alerted at inopportune times may not be fully justified. Although Phung et al. propose that the anxiety of being alerted at an inconvenient moment can be alleviated through regular training, this concern is challenging to eliminate entirely [47]. This highlights other advantages of recruiting qualified first responders: firefighters and EMS personnel are accustomed to the on-call nature of their roles. Plus, studies indicated that victims of OHCA would feel safer if resuscitated by a qualified first responder [48]. An implementation of fixed, schedulable absence times in the app could serve to prevent alerts during inconvenient moments.

Before participating in the described first responder system, individuals must complete comprehensive training covering technical, medical and legal aspects. Notably, over the course of three years, only a total of 5 first responders expressed concerns about legal aspects. This data emphasises the effectiveness of the provided training as a preparatory measure.

Over the span of three survey years, only five of the first responders cited a lack of medical meaningfulness as an obstacle to using the app.

Reasons to decline a mission

The Land|Retter App operates on a voluntary base; hence declined calls are neither reported nor recorded. Information regarding these missions can only be gathered from the questionnaires. Over the course of three survey years, the percentage of first responders who stated that they had previously declined an alarm rose from 43 to 63%. The longer users participate, the higher is the number of alarms per user and the likelihood of having to decline a mission at some point increases.

Ozcan et al. explored the reasons why first responders might have to refuse to respond to an alarm, categorizing them into four barriers that need to be overcome: (1) “Barriers to commitment”, (2) „Barriers to notification“, (3) „Barriers to leave“, and (4) „Barriers to perform“ [49]. The methodological approach of the survey provides nuanced reasons for refusing an intervention. Most of which align with the four categories delineated in Ozcan's group model. As survey participants were only individuals, who already committed to being a first responder, the first category “Barriers to commitment” was not assessed.

Unfortunately, alerts that failed to reach the first responder during an emergency due to, for instance, lack of network coverage, could not be accounted for in the first responder survey. Hence, the precise number of missions not accepted due to disruptions in the notification chain remains an estimation. Two barriers to notification were assessed: “mission was not available anymore” and “malfunction of the app”: In the first year 13 first responders reported not being able to accept an assignment because it was not available – a figure that rose to 17 in the second year and further to 32 in the third year. The system alerts all first responders in the vicinity of an OHCA simultaneously. The first two responders to accept the mission, receive the assignment, while others receive the notification that the mission is no longer available. An increasing density of first responders could explain the rising number of first responders for whom the operation was no longer available.

The third category “Barriers to leave” encompassed response options as “deployment during working hours”, “deployment in an inappropriate situation (e.g. going to the cinema/meeting)”, “I was looking after minors”, “I was unwell” and “I had drunk alcohol”. All reasons were cited more frequently in the third year than in the first year.

Over the span of four years, only five first responders reported refusing an assignment due to concerns of making a mistake. This underscores the confidence of the first responders in their own abilities and aligns with Ozcan's assertion, that the fourth category (“Barriers to perform”) make up the smallest group among the reason for mission rejections.

Given the varying technical specifications and alarm modalities across different first responder systems,

crafting a uniform, detailed questionnaire to ascertain reasons for mission refusal proves challenging. However, adopting a classification into groups, as proposed by Ozcan et al., appears to be a viable approach for future surveys.

Limitations

The response rate exhibited a decline from 69% in the first year to 43% in the second year and further to 38% in the third year while noting an increased number of total first responders due to ongoing recruiting within the system. This poses challenges for comparative statistical analysis. Despite the decline, a response rate of 38% in the third year remains a commendable participation for online surveys, when compared internationally [50, 51]. The diminishing response rate could be attributed, for instance, by the repetitiveness of the surveys – using almost identical surveys consecutively over three years. First responders who participated in previous years may find their motivation waning. Moreover, there is no requirement to formally exit the Land|Retter system if one no longer wishes to receive alerts. Likewise, relocations out of the region is rarely reported back to the administrators. This also contributes to a scenario where, with the escalating total numbers of registered first responders, the proportion of first responders who can be alerted in the district of Vorpommern-Greifswald is lower than the total number of registered first responders, thereby distorting the response rate. Another limitation lies in the low external generalisability. Given the substantial disparities among smartphone based first responder systems, transferring data becomes a complex challenge.

Furthermore non-responder bias has to be considered [52]. Non-respondents are less likely to use the app or answer a questionnaire potentially skewing the results and overestimating its retention rate and functionality.

Conclusions

Systems, that alert community first responders to OHCA by smartphone application, rely on a well-functioning app and need to retain as many first responders as possible over a long time span. By surveying community first responders using the Land|Retter app over a period of three years we identified excessive battery consumption and the apprehension of receiving alerts in an inconvenient moment as the main hindrances to its usage. Notwithstanding the technical hurdles, users' perceptions regarding the app's medical advantages have remained consistently positive.

This favorable perception of its functionality has resulted in a high retention and recommendation rates. In essence, users seem to view the Land|Retter app as precisely what it was designed to be: an app to keep.

Abbreviations

APP	Application
CPR	Cardiopulmonary resuscitation
ERC	European Resuscitation Council
EMS	Emergency Medical Service
FR	First responder
GRC	German Resuscitation Council
OHCA	Out-of-hospital cardiac arrests

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12872-025-04586-y>.

Supplementary Material 1

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Author contributions

Tore Marks: Conceptualization, Methodology, Investigation, Interpretation and Validation of data, Data curation, Visualization, Writing- Original draft preparation

Bibiana Metelmann: Conceptualization, Methodology, Investigation, Interpretation and Validation of data, Writing- Reviewing and Editing

Peter Brinkrolf: Funding acquisition, Methodology

Karl Christian Thies: Methodology, Interpretation and Validation of data, Writing- Reviewing and Editing

Klaus Hahnenkamp: Funding acquisition, Supervision

Camilla Metelmann: Conceptualization, Methodology, Investigation, Interpretation and Validation of data, Writing- Reviewing and Editing, Supervision

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. All participants provided written informed consent prior to their inclusion in the study, and the study protocol was approved by the independent ethics committee of the University Medicine Greifswald in October 2017 (reference number B111/17).

Consent for publication

Not applicable.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Clinical trial number

Not applicable.

Conflict of interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: All authors are registered first responders in the Land|Retter app. BM, KCT and CM are members of the German Resuscitation Council (GRC) and European Resuscitation Council (ERC). All other 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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