Smartphone Based Alerting of First Responders During the COVID-19 Pandemic

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Abstract

Background

Smartphone Alerting Systems (SAS) for first responders potentially shorten the resuscitation-free interval of patients with acute cardiac arrest. During the COVID-19 pandemic, many systems were suspended due to potential risks for the responders. Therefore, a COVID-19 concept for the SAS in Freiburg/Germany was established and evaluated.

Methods

Due to the pandemic, SAS was stopped in March 2020. A concept for a safe restart was elaborated with provision of a set with ventilation bag/mask, airway filter and personal protective equipment (PPE) for every volunteer. A standard operating procedure followed the COVID-19 guidelines of the European Resuscitation Council (ERC). Willingness of the participants to respond alarms during the pandemic was investigated using an online survey.

Results

The system was restarted in May 2020. The willingness to respond to alarms was lower during the pandemic without PPE. It remained lower than before the pandemic when the volunteers had been equipped with PPE, but the alarm response rate remained at approximately 50% during the ongoing pandemic.

Conclusions

When volunteers are equipped with PPE, the operation of a SAS does not need to be paused, and the willingness to respond remains high among first responders.

Introduction

The survival rate of patients suffering from out of hospital cardiac arrest (OHCA) is poor. Promising efforts to increase survival after OHCA include Basic Life Support (BLS) training for lay persons, telephone instructions by dispatch services and activation of nearby trained persons. This approach has been supported comprehensively in the current guidelines for cardiopulmonary resuscitation (CPR) [1]. Increasing use of mobile phones/ smartphones resulted in the option to use modern digital technology for improving the first links of the chain of survival. Zijlstra and colleagues registered lay rescuers who have attended a BLS course [2]. In case of an emergency call with suspected OHCA, the system activated first responders with a registered home or work address within a 1,000 meters radius around the emergency location, and they were dispatched with a text message. The next evolutionary step in technology was to locate first responders via their cell phone [3]. First responders, who are within a given radius around the emergency location, are activated via text message. The implementation of this system in Stockholm lead to a higher proportion of patients receiving CPR before the ambulance arrived, but not a higher survival rate [4].

Smartphone Alerting Systems (SAS) are the most recent development using global positioning system (GPS) to locate first responders. SAS offer the advantage in case of an alarm to respond via a smartphone app and the dispatch center receives notification about the number of accepting first responders. Furthermore, the system assists the first responders in navigation to the emergency location, or even the next available AED. These systems are associated with shorter response intervals and even higher survival rates [5]. Many SAS accept lay rescuers, who have completed a BLS course: In the Ticino system 70% of the first responders are lay rescuers [5]; in the Stockholm system nearly 10,000 first responders are registered in an area with a population of 2 million [4]. This increases the potential that BLS caregivers are very close to the location where they are needed.

The current COVID-19 pandemic has severely impacted public healthcare. Regarding cardiac arrest care, several parts of the chain of survival have been weakened [7,8]. These structural challenges may lower the resuscitation quality and subsequently lead to worse outcomes. Regarding bystander-CPR rates, the willingness to help might be reduced due to the fear of virus transmission. Sending volunteers without protective gear to potentially infectious patients was therefore a not considered option.

Immediately after declaration of the COVID-19 pandemic by the Word Health Organization (WHO), the German Red Cross recommended suspension of dispatching first responders. The RDL board deactivated the SAS on March 16th, 2020. Main reasons for the board decision were: (1) The Freiburg region was a hotspot regarding COVID-19 infections, (2) first responders had not been equipped with personal protective equipment, (3) the vast majority of first responders were systemically important employees in the health care system. Stopping the first responder system resulted in a significant deterioration of the chain of survival. Consequently, the board discussed the conditions for a safe restart of the SAS during the pandemic.

Objective of this study was to elaborate a COVID-19 concept for a SAS and to evaluate whether it is possible to keep a high willingness to accept alarms among first responders.

Methods

The SAS used in the Freiburg area is based on the FirstAED System, which had been established in Denmark in 2012 [6]. The charity organization *Region of Lifesavers* (Region der Lebensretter, RDL) is responsible for the operations of the SAS. According to a ministerial directive for first responder systems, participation requires a qualification as nurse, physician, paramedic, emergency medical technician with 48 hours of training, or medical student. The number of first responders, who registered for the system, the number of calls per month as well as the response rates and response times were monitored before and after the restart of the system. The study region is defined by the district of dispatch center Freiburg. Response times were obtained by tracking using global positioning system (GPS). Every first responder, who accepted an alarm was registered as arrived at the emergency location when his or her position according to the GPS position of the smartphone differed less than 100 meters from the location of the emergency.

After deactivation of the system a COVID-19 concept for a safe restart was elaborated in close cooperation with the local authorities. It was decided that every first responder should receive the following personal protective equipment (PPE): N95 mask, protective gown, safety glasses, gloves. Furthermore, the equipment should contain a bag and mask with an airway filter. A mouth and nose protection was added to cover the patients face, when performing single-rescuer, compression-only BLS. We decided to provide a backpack for carrying the PPE and initiated a fundraising campaign to collect the required funds of 30,000 Euro for 1,000 first responder units.

The RDL board developed a COVID-19 pandemic standard operating procedure (SOP) for first responder alarms (*appendix A*), which was based on the recently published COVID-19 guidelines of the ERC [9].

Volunteers' willingness to respond was evaluated with an online questionnaire

via LimeSurvey®. It was distributed to all registered first responders via e-mail, including two more reminders. The survey was anonymous; thus, it was not possible to track personal responses. It contained 3 items regarding sex, age, and qualification. 4 items evaluated the willingness to respond to alarms under different conditions before and during the pandemic using a 11-point ordinal scale. One item evaluated the willingness to provide different measures during the pandemic. Furthermore, the volunteer´s personal fears regarding infection with COVID-19 and suffering a serious course of disease were investigated using a 11-point ordinal scale. All methods were carried out in accordance with relevant guidelines and regulations. Ethics approval was waived by the institutional ethics board because the survey was anonymous (No 20-1279, issued by the University of Freiburg Ethics Committee, Chair Prof. Dr. R. Korinthenberg). Figure 1 and Supplemental material contains images of two of the authors of the paper. They gave their consent for publication and are ready to submit a consent form. Their informed consent for publication of identifying information/images in this online open-access publication is included.

The answers of the first responders in the four items regarding the readiness to answer calls have been tested using Wilcoxon signed rank test for statistical significance between dependent samples. Statistical testing was performed using R statistic software (version 3.6 for MacOS), $p < .05$ was considered significant.

Results

The fundraising campaign led to the acquisition of more than 34,000 Euro within 8 weeks, and 1,000 backpacks with PPE (*figure 1*) and the printed COVID-19 SOP were distributed to the volunteers. The SAS was restarted on May 26th, 2020. The fact, that it is at the responders´ personal discretion to accept an alarm was again emphasized. At the same day, the registration of volunteers was resumed. While initially the response rate was lower than before the lockdown, within one week it increased to a level higher than before the lockdown. Furthermore, the number of new registrations per month reached the same level as before. The response times after the restart were at the same level than before the time the system was paused, but in August the response times decreased and remained on a lower level until November. The number of first responders, the number of alarms, and the response rates and times of volunteers are depicted in *table 1*.

Regarding the online survey, we received 571 answers. Sex, age, and qualifications of the first responders are given in *table 2*. The willingness to accept alarms in different conditions before and during the pandemic is depicted in *figure 2*.

522 of the volunteers declared to be ready to perform chest compressions, and 514 are willing to defibrillate using an AED. 499 are willing to ventilate a patient using a bag and mask and an appropriate airway filter, 97 volunteers would ventilate a patient using a face mask.

Discussion

Smartphone alerting systems have been established and are being scientifically evaluated in many countries. To achieve short response times, a high number of volunteers and a high willingness to accept alarms is of utmost importance. Many systems register lay persons, who are only qualified as BLS caregivers [10, 11, 12]. In the Freiburg RDL system, according to legal issues, lay rescuers cannot be registered. With regards to the achievable number of volunteers, we rated this as disadvantage.

Under pandemic conditions, lay people may tend not to start BLS due to a risk of infection. Although the COVID guidelines suggest compression-only resuscitation for lay rescuers [9], these guidelines are typically not known to lay rescuers.

Several studies have addressed this issue, demonstrating an increased incidence of OHCA and at the same time a severe impact on the chain of survival [7, 8]. Reduced willingness to help has been considered one of the most important factors on the side of the community response. Smartphone alerting systems activating more qualified volunteers may fill this void and help save more lives. First responders working as healthcare professionals in ambulance services or in the hospital are trained in BLS as well as hygiene and they know how to safely treat infectious patients. Even those volunteers in our system who have the lowest possible qualification, very basic emergency medicine technicians, are trained to wear PPE when treating casualties. This was a strong advantage when planning to restart the system during pandemic conditions.

Whilst some systems remained inactive or restarted with the recommendation to merely wear a mouth and nose protection, other systems provide PPE to their volunteers. FFP-2 or FFP-3 masks can easily be carried. However, according to the COVID guidelines, these masks alone do not meet the minimum hygiene recommendations. Mackler et al. performed a survey investigating the willingness of paramedics to remain on duty if they had to care for patients with smallpox. Only 4% of the respondents would stay on duty if they had no protective gear and no vaccine was available, but 39% would be ready to care for the infectious patients if protective gear was available [13]. The mortality rate of COVID-19 is much lower than smallpox, but it is assumed that providing adequate PPE would increase the number of volunteers answering calls. Based on data from their EMS and health services, Sayre and coworkers estimated how in their area, the risk of a fatal SARS-CoV-2-infection for an unprotected lay rescuer would be 1:10,000 bystander CPR events, while 300:10,000 OHCA patients could be saved with bystander CPR [14].

We had expected that the rate of alarms with at least one first responder accepting the call would decrease after the restart of the system under pandemic conditions. Even if the volunteers felt safe with their PPE, we expected that they would not have the backpack with PPE with them permanently, therefore rejecting the alarm. The results of our survey showed that the readiness of the first responders to answer calls after being equipped with PPE is slightly but significantly lower than before the pandemic, but it is still much higher than without PPE. The number of volunteers who registered as first responders remained unchanged after the restart of the system, and the response rate of first responders after the restart is even slightly higher than before the lockdown. This may not only be due to a higher readiness, but also due to the increasing number of registered volunteers.

In Germany, neither the country/ federal state nor the health insurances cover the costs of first responder systems. Thus, it is a challenge to find funding for additional costs like PPE. The most expensive part of the personal equipment is the bag and mask. As the bag is further used by the ambulance paramedics when they arrive at the scene, an agreement was made with the EMS to replace the used bag/mask of the first responders. Thus, the responder is ready for the next call and RDL must only replace the less expensive other parts of the set.

In summary, weighing the safety of BLS providers, including trained volunteers, against the additional lives that can be saved from sudden cardiac arrest by immediate bystander CPR is a major challenge in the current pandemic. It will remain an individual decision on an institutional level, for how long, with which precautions and at which risk the single components of the rescue system can be maintained.

Continuing to send unprotected volunteers in our SAS was not an option during the pandemic. We consider the provision of PPE as a key factor for continuing an SAS. This is not only confirmed by the stable numbers of registered volunteers and high response rates, but also by the replies to our survey. These indicate that the willingness to help is preserved even under pandemic conditions, when PPE, or a vaccine in the near future, are provided, while it dramatically drops when protective gear is not available.

The community's engagement in terms of crowdfunding the PPE as well as further volunteer registration and alarm acceptance was surprisingly intense and encouraging.

This, and the subsequent early restart of the system became an important intervention to fill the serious void in the chain of survival caused by reduced bystander CPR rates.

Conclusion

First responders with a medical qualification may be beneficial in a SAS under pandemic conditions. The number of volunteers who registered in our SAS remained stable, and the response rate did not drop. It seems that the volunteers felt safe during their activity, being protected adequately. This was confirmed by an online survey, showing that willingness to help during the pandemic with PPE available was as high as before the pandemic, and significantly lower without PPE.

A coordinated effort including stakeholders of the rescue system as well as the general public may help to mitigate the so-called collateral damage due to the pandemic, i.e. threats to the whole chain of survival.

Declarations

Ethics approval

This manuscript does not involve experiments on human participants, human data, or human tissue. Ethics approval for the anonymous survey was waived by the institutional ethics board because the survey was anonymous (Waiver letter No 20-1279, issued by the University of Freiburg Ethics Committee, Chair Prof. Dr. R. Korinthenberg).

Consent for publication

Figure 1 contains an image of Julian Ganter, who is among the authors of the paper. He gave his consent for publication and is ready to submit a consent form. His informed consent for publication of identifying information/images in this online open-access publication is included. Photographs in the supplement contain images from this same author, as well as a second author from this manuscript, Klemens Baldas. He gave his consent for publication and is ready to submit a consent form. His informed consent for publication of identifying information/images in this online open-access publication is included.

Availability of data and materials

The datasets generated during and/or analysed during the current study are not publicly available. They are stored in the FirstAED software backend in the dispatch center in Freiburg/ Germany. Anonymized datasets are available from the corresponding author on reasonable request.

Competing interests

GT is board member (secretary) in the German Resuscitation Council (GRC), board member of the charity organization "Region of Lifesavers" (RDL), which is responsible to operate the SAS, and shareholder of Resuscitec GmbH, Freiburg/ Germany.

MPM is member of the executive committee of the GRC, chair of the charity organization "Region of Lifesavers" (RDL), which is responsible to operate the SAS, and shareholder of SmartResQ ApS, Svendborg/ Denmark.

HJB and KB are board members of the charity organization “Region of Lifesavers” (RDL), which is responsible to operate the SAS.

DD, JG, and MH have no competing interests to declare.

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Authors´ contributions

JG: Conception of the study, analysis of the data, drafting the article

DD: Design, analysis of the data, revising the manuscript critically

GT: Design and conception of the study, interpretation of the data, drafting the manuscript

HJB: Conception, interpretation of the data, revising the manuscript

KB: Conception, interpretation of the data, revising the manuscript

MPM: Conception and design, interpretation of the data, drafting and revising the manuscript critically

MH: Conception of the questionnaire, interpretation of the data, and revising the manuscript critically

All authors gave their final approval of the version to be submitted.

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References

1. Perkins, G.D. et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 2. adult basic life support and automated external defibrillation. *Resuscitation* **95**, 81–99 (2015).
2. Zijlstra, J.A. et al. Local lay rescuers with AEDs, alerted by text messages, contribute to early defibrillation in a Dutch out-of-hospital cardiac arrest dispatch system. *Resuscitation* **85**, 1444–9 (2014).
3. Ringh, M., Fredman, D., Nordberg, P., Stark, T. & Hollenberg, J. Mobile phone technology identifies and recruits trained citizens to perform CPR on out-of-hospital cardiac arrest victims prior to ambulance arrival. *Resuscitation* **82**, 1514–8 (2011).
4. Ringh, M. et al. Mobile-phone dispatch of laypersons for CPR in out-of-hospital cardiac arrest. *N Engl J Med* **372**, 2316–25 (2015).
5. Caputo, M.L. et al. Lay persons alerted by mobile application system initiate earlier cardio-pulmonary resuscitation: A comparison with SMS-based system notification. *Resuscitation* **114**, 73–8 (2017).
6. Henriksen, F.L., Schorling, P., Hansen, B., Schakow, H. & Larsen, M.L. FirstAED emergency dispatch, global positioning of community first responders with distinct roles - a solution to reduce the response times and ensuring an AED to early defibrillation in the rural area Langeland. *Int. J. Netw. Virtual Organ.* **16**, 86–102 (2016).
7. Baldi, E. et al. COVID-19 kills at home: the close relationship between the epidemic and the increase of out-of-hospital cardiac arrests. *Eur Heart J* **41**, 3045–54 (2020).
8. Marijon, E. et al. Out-of-hospital cardiac arrest during the COVID-19 pandemic in Paris, France: a population-based, observational study. *Lancet Public Health* **5**, e437–43 (2020).
9. Nolan, J.P. et al. European Resuscitation Council COVID-19 guidelines executive summary. *Resuscitation* **153**, 45–55 (2020).
10. Scquizzato, T. et al. Enhancing citizens response to out-of-hospital cardiac arrest: A systematic review of mobile-phone systems to alert citizens as first responders. *Resuscitation* **152**, 16–25 (2020).
11. Sarkisian, L. et al. Global positioning system alerted volunteer first responders arrive before emergency medical services in more than four out of five emergency calls. *Resuscitation* **152**, 170–6 (2020).

12. Berglund, E. et al. A smartphone application for dispatch of lay responders to out-of-hospital cardiac arrests. *Resuscitation* **126**, 160–5 (2018).
13. Mackler, N., Wilkerson, W. & Cinti, S. Will First-Responders Show Up for Work During a Pandemic? Lessons From a Smallpox Vaccination Survey of Paramedics. *Disaster Manag Response* **5**, 45–8 (2007).
14. Sayre, M.R. et al. Prevalence of COVID-19 in Out-of-Hospital Cardiac Arrest: Implications for Bystander Cardiopulmonary Resuscitation. *Circulation* **142**, 507–9 (2020).

Tables

Table 1: First responder registrations and missions before and during the pandemic.

Month	January 2020	February 2020	March 2020	April 2020	May 2020	June 2020	July 2020	August 2020	September 2020	October 2020	November 2020	December 2020
New first responder registrations	45	40	10	-	15	15	60	27	10	71	29	11
Total number of registered first responders	730	770	780	780	795	810	870	897	907	978	1007	1018
Number of SAS missions	101	89	48	-	20	76	129	128	91	116	103	99
Number of calls with ≥ 1 first responder accepting	42 (42%)	44 (49%)	23 (48%)	-	6 (30%)	49 (64%)	71 (55%)	49 (38%)	49 (54%)	52 (45%)	55 (53%)	48 (48%)
Response times of first responders (median), [IQR; n]	05:32 [02:16; 28]	05:52 [02:17; 25]	06:01 [00:32; 13]	-	05:55 [05:47; 4]	05:57 [02:40; 26]	06:45 [03:21; 35]	03:20 [03:46; 38]	02:58 [02:08; 41]	03:17 [02:12; 46]	03:55 [02:01; 48]	03:43 [02:21; 47]

The System was paused from March 16th until May 26th (grey cells). IQR – interquartile range.

Table 2: Sex, age, and professional background of first responders

Sex	Male	Female				
	68%	32%				
Age	18-25 years	26-35 years	36-45 years	46-55 years	56-65 years	> 65 years
	24%	34%	23%	12%	6%	1%
Qualification*	Physician	Medical student	Nurse	Paramedic	Emergency medical technician	
	86 (12%)	56 (8%)	128 (18%)	246 (35%)	184 (26%)	

In total, 571 questionnaires were received; *mulitple answers were possible.