Observational Study

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Smartphone based alerting of first responders during the corona virus disease-19 pandemic

An observational study

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Abstract

Smartphone alerting systems (SAS) for first responders potentially shorten the resuscitation-free interval of patients with acute cardiac arrest. During the corona virus disease-19 (COVID-19) pandemic, many systems are suspended due to potential risks for the responders.

Objective of the study was to establish a concept for SAS during the COVID-19 pandemic and to evaluate whether a SAS can safely be operated in pandemic conditions.

A SAS had been implemented in Freiburg (Germany) in 2018 alerting nearby registered first responders in case of emergencies with suspected cardiac arrest. 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 was elaborated following the COVID-19 guidelines of the European Resuscitation Council.

Willingness of the participants to respond alarms during the pandemic was investigated using an online survey. The response rates of first responders were monitored before and after deactivation, and during the second wave of the pandemic.

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 second wave of the pandemic.

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.

Abbreviations: AED = automated external defibrillator, BLS = basic life support, COVID = corona virus disease, CPR = cardiopulmonary resuscitation, GPS = global positioning system, OHCA = out of hospital cardiac arrest, PPE = personal protective equipment, RDL = Region der Lebensretter (Region of Lifesavers), SARS = severe acute respiratory syndrome, SAS = smartphone alerting system, WHO = World Health Organization.

Keywords: basic life support, first responders, out-of-hospital cardiac arrest, smartphone alerting system

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JG and DD contributed equally to this work.

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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1. 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 et al[2] registered lay rescuers who have attended a BLS course. In case of an emergency call with suspected OHCA, the system activated first responders with a registered home or work address within a 1000 m 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 automated external defibrillator (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 corona virus disease-19 (COVID-19) pandemic has severely impacted public healthcare. Regarding cardiac arrest care, several parts of the chain of survival have been weakened.[6,7] 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 region of lifesavers (RDL) board deactivated the SAS on March 16, 2020. Main reasons for the board decision were: the Freiburg region was a hotspot regarding COVID-19 infections, first responders had not been equipped with personal protective equipment (PPE), 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.

2. Methods

The SAS used in the Freiburg area is based on the FirstAED System, which had been established in Denmark in 2012.[8] 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 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 <100 m 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 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 were 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 1000 first responder units.

The RDL board developed a COVID-19 pandemic standard operating procedure for first responder alarms (appendix A, http://links.lww.com/MD2/A258), which was based on the recently published COVID-19 guidelines of the European Resuscitation Council.[9]

Volunteers' willingness to respond was evaluated with an online questionnaire via LimeSurvey. It was distributed to all 978 first responders, who were registered in the system in October 2020 via e-mail, including 2 more reminders. The survey was anonymous; thus, it was not possible to track personal responses. It contained 3 items regarding sex, age, and qualification. Four items evaluated the willingness to respond to alarms under different conditions before and during the pandemic using an 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 an 11-point ordinal scale. All methods were carried out in accordance with relevant guidelines and regulations. Ethics approval and informed consent for the anonymous survey had been waived by the institutional ethics board (No 20-1279, issued by the University of Freiburg Ethics Committee, Chair Prof. Dr. R. Korinthenberg). The supplemental digital content contains images of 2 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 4 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

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 16 until May 26 (grey cells). IQR = interquartile range.

(version 3.6 for MacOS, R Foundation, Vienna, Autria), $P < .05$ was considered significant.

3. Results

The SAS was restarted on May 26, 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. 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. 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 Fig. 1.

Five hundred twenty two of the volunteers declared to be ready to perform chest compressions, and 514 are willing to defibrillate using an AED. Four hundred ninety nine 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.

4. 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 are of utmost importance. Many systems register lay persons, who are only qualified as BLS caregivers.[10–12] 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.[6,7] 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.

While some systems remained inactive or restarted with the recommendation to merely wear a mouth and nose protection, other systems provide PPE to their volunteers. Filtering Face Piece 2 or Filtering Face Piece 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[13] 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

Table 2

Sex, age, and professional background of first responders.

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

In total, 571 questionnaires were received.
* Mulitple answers were possible.

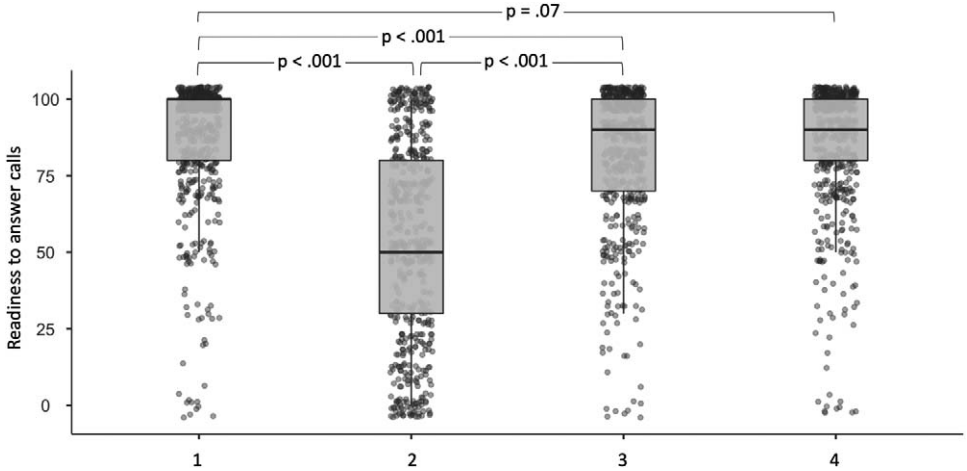

Figure 1. Readiness to answer calls before the pandemic, and during different stages of the course of the pandemic, respectively. Each item required answers using a 10 discrete scale with 2 poles ranging from 0—not willing to respond to 100—highly ready to respond. Bold lines in the boxplots depict the median value in the respective item. 1—before the pandemic; 2—during the pandemic, without PPE; 3—during the pandemic, with set of PPE; 4—during the pandemic, after being vaccinated.

available. 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 emergency medical services and health services, Sayre et al[14] 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.

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. To our knowledge most SAS do not provide PPE and the questionnaire has been elaborated to evaluate whether our measures are sufficient to maintain the life-saving system during the pandemic. These results must be interpreted carefully as the questionnaire has not been validated prior to the study.

The number of volunteers who registered as first responders remained unchanged after the restart of the system. The response rate of first responders before and after the restart is probably the best indication for the volunteers' willingness to participate during pandemic conditions. After providing PPE and restarting the system, the response rate did not drop compared with the time before the pandemic, it even increased. However, 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 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.

5. Limitations

This study was performed in Freiburg and the surrounding area in southern Germany. Whether a SAS can be operated under pandemic conditions depends on personal attitudes and fears of the first responders, the culture among first responder networks, and probably the state of the pandemic (cases per 100,000 inhabitants, distribution of virus variants of concern, status of vaccination). These factors limit the transferability of the results. Furthermore, the questionnaire had not been formally validated prior to the study and we observed a response rate of 58%, which indicates a possible bias.

6. Conclusion

We elaborated a pandemic concept to run a smartphone alerting system during the COVID-19 crisis, which included the provision of PPE and bag/mask. The volunteers' actual response rate during

the pandemic was similar to the time before the pandemic, assuming that a SAS can be effective even under pandemic conditions. 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, that is, threats to the whole chain of survival.

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