Dane County EMS Newsletter

January, 2021

A High-Performing CPR County

December's newsletter showed Dane County's community engagement in cardiac arrest care through the PulsePoint app. Using data from AEDs and agency monitors, the EMS office has been able to provide over 130 detailed cardiac arrest summaries to agencies and their crews since May of 2020. A big focus of these summaries is the Chest Compression Fraction (CCF). CCF is a metric used to look at the percentage of time chest compressions are happening during a resuscitation attempt. An increased CCF is independently associated with improved survival. Our goal is to reach a CCF of 80% or higher. So far, crews throughout Dane County have met this goal in 90% of cardiac arrest resuscitations. Going into 2021, these summaries will continue to go out to highlight the outstanding efforts by Dane County EMS agencies. A few key takeaways from the events thus far are below.

Maximize time on the chest! It takes approximately 1 minute of compressions to build up effective pressure. Any pause results in an immediate drop of perfusion pressure resulting in longer times of inadequate perfusion.

Use a metronome to provide consistent rate when performing manual CPR

Charge your monitor prior to each rhythm check. This will reduce time to defibrillation should the patient convert into a shockable rhythm.

Viz Quiz

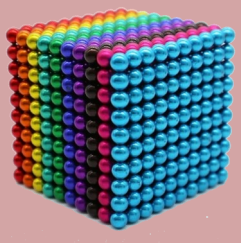
•3 year-old boy crying with abdominal pain.

•No fevers, nausea, vomiting, or diarrhea.

•Mother notes that there is a chance he may have swallowed magnet ball building blocks yesterday as a few were noted to be missing – but he had not had any symptoms until now and no one witnessed ingestion.

•What is on your differential? Any priorities for management in the field?

•On reassessment, the boy now appears fine and is easily comforted by parents. Parents are unsure if they want to transport. What are your recommendations?



Email dcems@countyofdane.com with your answers for the chance to win a prize!

November Follow-Up

•A unilaterally fixed mydriasis, also known as a 'blown pupil,' is considered an ominous sign concerning for intracranial pathology. Causes of anisocoria can range from benign to immediately life-threatening.

•On history, we learn that a scopolamine transdermal (skin patch) had been used to prevent nausea and vomiting caused by motion sickness for the flight.

•Scopolamine acts as a competitive antagonist to acetylcholine, which blocks muscarinic receptors of the sphincter pupillae in the iris, resulting in mydriasis. Several cases of pharmacological mydriasis have been documented in previous literature. It usually occurs when there is hand-to-eye contact in individuals who have contact with such agents, for example, as a scopolamine patch for motion sickness, administration of eye drops for a family member with ophthalmic disease or exposure to plants that have anticholinergic properties.

Dane County EMS Newsletter

January, 2021

Ask the Doc

By Dr. Kacey Kronenfeld and Dr. John Aguilar

Case: You're dispatched to a 19 y/o female with no medical problems who had a syncopal episode just before calling 911. She says all day she was feeling like she was coming down with the flu with some mild nausea, headache and fatigue. Her family has similar symptoms. While walking up from the basement she had a witnessed 1-2 minute episode fainting spell with no seizure-like activity. She woke up and was back to normal right after she fainted. Due to the change in weather they have been using a gas powered space heater to improve the temperature of their drafty home.

•Carbon monoxide poisoning can be a really tricky diagnosis even for the experienced provider! A wise clinician once said, "you'll never make the diagnosis that you don't consider."

•Signs and symptoms of carbon monoxide poisoning can be really subtle and can include headache, lightheadedness, fatigue, or nausea. Some more serious symptoms include seizures, syncope, and altered mental status. A clinical pearl is if multiple people who have had the same exposure and have developed similar symptoms all at the same time this is something to consider.

(i.e. families with gas powered generators, firefighting crew that was interior on a structure fire, etc.).[1] A textbook sign to look for is "cherry red lips or skin," which isn't necessarily a common finding.

•Mainstay of treatment is high flow oxygen. The half-life of carbon monoxide in a healthy adult (essentially the time it takes for the amount of carbon monoxide in your body to get cut down in half) is 4-5 hours. By applying 100% O2 via a non-rebreather it cuts down the half-life to ~ 40-80 minutes. For more severe cases there are criteria to utilize hyperbaric oxygen a.k.a. a diver chamber, which cuts down the half-life to ~ 23 minutes.[2]

Sources

1. Clardy, P., Manaker, S. et. al. Carbon monoxide poisoning. Uptodate. 6 June 2018
2. Nickson, C. Carbon monoxide poisoning. Life in the fast lane. 3 Nov 2020. https://litfl.com/carbon-monoxide-poisoning/

Indications for Hyperbaric Oxygen Therapy Due to Carbon Monoxide Poisoning
Evidence of end-organ damage regardless of COHb level
Loss of consciousness, coma, seizures
Confusion, cognitive deficits, focal findings, visual symptoms
Myocardial ischemia, life-threatening dysrhythmia
Persistent symptoms after treatment with 1 atm oxygen
COHb level > 25% (15% in pregnant women) regardless of symptoms

Improving Response to Out-of-Hospital Cardiac Arrest: The Verified Responder Program Pilot

To Dane County EMS Providers,

We are excited to share an update on the local efforts for out-of-hospital cardiac arrest care. As you know, Dane County and the collective EMS services have maintained a strong commitment to improving cardiac arrest care and patient outcomes. The research paper attached was recently published in *Resuscitation*, a peer reviewed scientific journal. The article highlights the Pulse Point Verified Responder pilot program, including implementation feasibility and provider experience data. The project voluntarily enrolled EMS providers (EMT-basic and above) from the Madison Fire Department as designated "verified responder" status within the Pulse Point platform to allow for automatic notifications of cardiac arrests within public and Private Residence locations. The aim was to expand existing response mechanisms and early interventions for out-of-hospital cardiac arrest. The pilot study was a collaboration between 5 cities throughout the United States as well as the Seattle/King County EMS Division of Public Health. Overall, the pilot project was overwhelmingly viewed positively among providers. We are proud that our system remains on the forefront of cardiac arrest care at the national level and we hope to expand upon projects like this throughout our county. Thank you for all that you do.

Stay safe.

Mike Mancera, MD

Upcoming Events and Training

1/21, 6:80-8:30pm: SSM Health—Caring for OB Trauma Patients

Register at http://bit.ly/ssmemstraining

1/23, DCEMS EVOC Driving Range

Register through your Director or Training Director

3/3, DCEMS CEVO IV Lecture

Register through your Director or Training Director

Thank you for reading! For questions, comments, or feedback you can contact the DCEMS office at dcems@countyofdane.com or by calling 335-8228. All other staff contact information can be found at em.countyofdane.com/EMS/contactus.

Available online at www.sciencedirect.com

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Improving response to out-of-hospital cardiac arrest: The verified responder program pilot

Jennifer Blackwood[a], *Michael Mancera*[c,d], *Scott Bavery*[d], *Christopher Carbon*[d], *Mohamud Daya*[e,f], *Brent VanKeulen*[f], *Dana N. Alteneder*[f], *Jeff Helm*[g], *Jeremy Robertson*[g], *Julie Charbonneau*[h], *James M. Nania*[i,j], *Brian Schaeffer*[i], *Mike Lopez*[i], *Tim Loncon*[i], *Bryan Collins*[j], *Michael Charter*[j], *Dawn B Jorgenson*[k], *Mengqi Gao*[k], *Richard Price*[l], *Thomas Rea*[a,b,*]

[a] *EMS Division Public Health – Seattle & King County, United States*
[b] *University of Washington Department of Medicine, United States*
[c] *University of Wisconsin Department of Emergency Medicine, United States*
[d] *Madison Fire Department, United States*
[e] *Oregon Health and Science University, United States*
[f] *Tualatin Valley Fire and Rescue, United States*
[g] *Sioux Falls Fire Rescue, United States*
[h] *City of Sioux Falls, United States*
[i] *City of Spokane Fire Department, United States*
[j] *Spokane Valley Fire Department, United States*
[k] *Philips Healthcare, United States*
[l] *PulsePoint, United States*

Abstract

Background: Survival following out-of-hospital cardiac arrest (OHCA) decreases as the interval from collapse to CPR and defibrillation increases. Innovative approaches are needed to reduce response intervals, especially for private locations.

Methods: We undertook the Verified Responder Program in 5 United States communities during 2018, whereby off-duty EMS professionals volunteered and were equipped with automated external defibrillators (AEDs). Volunteers were alerted using a geospatial smartphone application (PulsePoint) and could respond to nearby private and public suspected OHCA. The study evaluated the frequency of Verified Responder notification, response, scene arrival, and initial care prior to EMS arrival. OHCA surveillance used the CARES registry.

Results: Of the 651 OHCA events (475 private, 176 public), Verified Responders were notified in 7.4% (n = 49). Among the 475 in a private location, volunteers were alerted in 8% (n = 38), responded in 2.7% (n = 13), arrived on scene in 2.3% (n = 11), and provided initial care in 1.7% (n = 8). Among the 176 in a public location, volunteers were alerted in 6.3% (n = 11), responded in 2.3% (n = 4), arrived on-scene in 2.3% (n = 4), and provided initial care in 2.3% (n = 4). Over 96% surveyed had positive impression of the program and intended to continue participation. No responder reported any adverse event.

Conclusions: In this initial US-based experience of a smartphone program for suspected OHCA in private and public locations, Verified Responders reported a positive experience, though were only involved in a small fraction of OHCA. Studies should determine how this type of program could be enhanced to involve more OHCA events.

Keywords: Out-of-hospital cardiac arrest, Cardiopulmonary resuscitation, Social media, Smartphone, Automated external defibrillator, Emergency medical services

* Corresponding author at: Public Health-Seattle & King County and the University of Washington, 401 5thAve, Suite 1200, Seattle, WA 98104, United States.
E-mail address: rea123@uw.edu (T. Rea).

https://doi.org/10.1016/j.resuscitation.2020.06.015
Received 21 January 2020; Received in revised form 3 June 2020; Accepted 10 June 2020
Available online xxx
0300-9572/

Introduction

Out of hospital cardiac arrest (OHCA) is a leading cause of mortality in the United States and around the world.[1,2] Successful resuscitation relies on time-sensitive, coordinated care described by the links in the chain of survival.[3] The foundational links are early CPR and early defibrillation.[4,5] However, even in communities with a mature infrastructure of community education and emergency response, only about half of cardiac arrest victims receive CPR prior to emergency medical services (EMS) arrival and less than 5% receive defibrillation prior to EMS arrival.[5–7] Survival with good neurological function could potentially be improved if these gaps in resuscitation care could be addressed.[8]

One promising strategy leverages advances in technology to combine smart phone global positioning information and the 9-1-1 emergency dispatch system.[9–11] This approach provides the potential to activate a cohort of individuals with CPR and AED skills who could respond to a suspected cardiac arrest in the community. Volunteer responders are asked to register with the application so that 9-1-1 automatically alerts responders who are nearby a suspected cardiac arrest and may be able to provide care prior to EMS arrival.

In North America, this geospatial smart response strategy has largely been restricted to public setting OHCA given perceived safety issues, legal concerns, and cultural considerations of good-Samaritans responding into private residences. Most OHCA however occur in residential settings; thus relatively few arrests are eligible for this volunteer response strategy.[6] There are however a handful of published examples from Europe where a large cohort of community volunteers respond into private residences and deliver lifesaving care prior to EMS arrival, suggesting that such a strategy has real promise to improve survival if it can be effectively implemented in the United States.[12–15]

One approach to address the perceived barriers to good-Samaritan residential response in the United States would be to enlist vetted public safety professionals as the (off-duty) volunteer who would receive notification of suspected public and private OHCA This select group, referred to as "Verified Responders", has the advantage of professional resuscitation training and routinely responds on-duty to private residences for all types of medical emergencies. Indeed, a survey of Washington State public safety professionals found substantial enthusiasm for an off-duty volunteer response program for suspected OHCA occurring in both residential and public locations.[16]

We undertook the Verified Responder Study in five US communities to evaluate an initial experience of a public-safety volunteer response for suspected OHCA in private and public location using geospatial smart phone technology.

Methods

Study population and design

The Verified Responder study was a prospective cohort investigation of adult OHCA (> = 18 years of age) occurring in five US communities for a one-year period in 2018. The study excluded OHCA that occurred after EMS arrival as these events would not be eligible for program response. The program was approved by each community's pertinent oversight bodies, and the study was approved by the University of Washington Investigational Review Board.

Verified responder program and study setting

The Verified Responder Program sought to involve public safety providers already trained and practiced in emergency response and lifesaving care to respond while off-duty to suspected OHCA in public and private locations via a geospatial smart phone application. Prerequisites for participation were deployment of the PulsePoint geospatial smartphone application in the community 9-1-1 communication center and use of CARES (Cardiac Arrest Registry to Enhance Survival) for OHCA surveillance.[17] The primary EMS agency for each participating community was contacted to gauge interest. In each case, there was strong interest such that the agency was enrolled in the Verified Responder Program evaluation. No additional agencies were contacted to gauge interest. All participating organizations were public, fire-based EMS agencies. In each community, program participation required that the employer organization contractually offer compensation and liability protection to providers in the event of an off-duty response.

As part of the Verified Responder Program, EMS agencies identified individual members who voluntarily agreed to participate. Each participant was registered for a special "Verified responder" status in the PulsePoint™ geospatial smartphone application. Once registered, the Verified Responder could be alerted via his or her personal smartphone using a 9-1-1 dispatch integrated activation to all nearby suspected OHCA. Specific to the study, the first 500 volunteers were equipped with an AED (Philips FRx and HS1). The storage of the AED was at the discretion of the individual volunteer. Given that the Verified Responders were already CPR and AED certified, there was no standard CPR or AED training for the program. Some agencies opted for a special agency-issued Verified Responder badge to be carried while off-duty, but there were no standardized identification requirements (e.g. clothing) for off-duty response. Each community specified the individual dispatch codes that would trigger a Verified Responder volunteer notification as detailed in Supplemental Table e1. At the outset, the volunteer was alerted to respond if the suspected OHCA was within a quarter mile radius. During the course of the study, four communities expanded their notification radius to a half mile on October 1, 2018 in an effort to activate more Verified Responders for suspected OHCA. The notification would not override the phones sleep or silence setting initially. All volunteer participants were provided the option to install a silence override when this software upgrade became available in December 2018.

In all cases of notification, response was entirely voluntary and at the discretion of the alerted individual. The volunteer response was independent of the conventional on-duty 9-1-1 public safety EMS response which was not changed as part of the Verified Responder Program. After a notification, the volunteer was sent an electronic survey asking about whether the individual responded and the circumstances of the response. The Verified Responder volunteers were also sent an annual survey to assess their general experience following the first year of the program.

The Verified Responder Program involved 593 volunteers from five fire-based organizations in five US communities: Madison WI, Sioux Falls SD, Spokane WA, Spokane Valley WA, and Tualatin Valley, OR (Table 1). Collectively the communities have population of 1.3 million persons, living in 708 square miles of primarily urban and suburban areas. During 2017, there was a run-in phase that ranged from 3 to 9 months depending on the community during which the volunteer participants registered as Verified Responders in the PulsePoint smartphone application and were equipped with the FRx or HS1 AED.

Table 1 – Characteristics of the communities.

Agency	Service population	Service Area (miles^2)	Employees	Verified responders	AEDs
Tualatin Valley Fire &Rescue, OR	500,000	390	422	287	300
Sioux Falls Fire, SD	190,000	80	208	65	50
Spokane Fire, WA	217,000	69	291	60	50
Spokane Valley Fire, WA	125,000	75	165	71	50
Madison Fire, WI	250,000	94	420	110	100

Measurement

The study used information from PulsePoint, the CARES registry, and volunteer surveys. The PulsePoint information included information about the location and time of call, the associated dispatch code, and the number and identification of verified responders, and whether there was a fire station within the notification radius. The CARES registry included information about the time and location of the OHCA, patient demographics, layperson and EMS care, and clinical outcome, and is organized according to the Utstein template.[18] The PulsePoint and CARES data were linked using incident number, date, time, and location of the event. A case-specific survey and annual survey were administered using SurveyMonkey™ to help assess the acceptability, safety, and sustainability of the program. The survey was developed by study investigators (JB, TR) and then critically revised by the larger study group. The case-specific survey was sent electronically to each verified responder who received notification to inquire if and how they had responded. In addition, the annual survey of all verified responders rated their experience regarding responder activations, response challenges, and overall satisfaction with the program. Surveys used a used a five-point Likert Response Scale ranging from 1 (very negative) to 5 (very positive).

Outcomes and analysis

We used descriptive statistics to assess the proportion of eligible OHCA that received a Verified Responder notification, initiated response, arrived at scene, and provided treatment overall and according to location (residential versus public). Results were also stratified according to time of day (7 a.m. –11 pm compared to 11 pm –7 am) and before versus after the expansion of the response radius from a quarter mile to a half mile. Survey responses were tabulated to identify challenges to response.

Results

During the study year, there were a total of 651 adults treated for OHCA prior to EMS arrival in the participating communities, 475 in residential settings and 176 in public settings. A total of 213 off-duty Verified Responders were notified to 187 9-1-1 medical emergencies, of which 49 events were ultimately determined to be treated OHCA (Fig. 1). The Utstein characteristics of off-duty Verified Responder activations and the larger treated OHCA population were similar (Table 2). Among those OHCA in which off-duty Verified Responder were notified (n = 49), Verified Responders responded in 35% (17/49, site range 30%–50%), arrived on scene in 31% (15/49, site range 22%–50%), and provided initial care in 25% (12/49, site range 22%-33%). When Verified Responders arrived on scene, resuscitation care almost always involved CPR (11/12) and commonly included AED application (7/12).

The proportion of calls receiving notification, initiating response, arriving on scene, and providing resuscitation care were similar according to public versus residential location and according to time of day (7am to 11 pm versus 11 pm –7 am). Among the 475 in a private location, volunteers were alerted in 8% (n = 38), responded in 2.7% (n = 13), arrived on scene in 2.3% (n = 11), and provided initial care in 1.7% (n = 8). Among the 176 in a public location, volunteers were alerted in 6.3% (n = 11), responded in 2.3% (n = 4), arrived on-scene in 2.3% (n = 4), and provided initial care in 2.3% (n = 4). Of the 49 notifications, 47% (23/49) occurred in the 3-month period after expansion of the notification radius from a quarter mile to a half mile (2.9 activations/month with quarter mile radius vs. 7.7 activations/month with half mile radius). Two-thirds (10/15) of on-scene arrivals occurred during this latter 3-month period even though the response radius was greater.

In the survey of individual responders who received notification including on-duty and public notifications (n = 253 among 187 total events, median 1 [1,2]), the most common reasons for not responding were having the phone placed on mute (n = 30) or unaware of the activation due to being away from the phone (n = 48). An additional 34% (86/253) of notifications were received while volunteers were on-duty and therefore unable to respond as volunteers. There were no reports of 9-1-1 callers who were upset or concerned by the unconventional Verified Responder response. There was a 79% (466/593) response to the annual survey (Table 3). Responders felt confident and prepared to respond to activations. Most volunteers viewed the program positively or very positively (96% [428/446]) and nearly all volunteers (97% [431/446]) planned to continue as Verified Responders after the study was completed.

Discussion

In this initial US-based experience of smartphone alert program for suspected OHCA in residential and public locations, the experiences of select public safety volunteer responders were favorable. Volunteers were notified, responded, and involved in a small fraction of OHCA of which about two thirds were in residential settings. In conjunction with the survey findings, the results suggest safety, acceptability, and feasibility that may encourage communities to consider this novel strategy to address the challenge of OHCA resuscitation especially in the residential location.

There is substantial scientific understanding regarding effective treatment for OHCA; however translation of this understanding into real-world, community-based practice is challenging.[19] Although early CPR and early defibrillation can substantially improve the likelihood of meaningful survival, these critical therapies are often delayed until the arrival of structured EMS response despite a range of strategies designed to increase early CPR and AED application.[20]

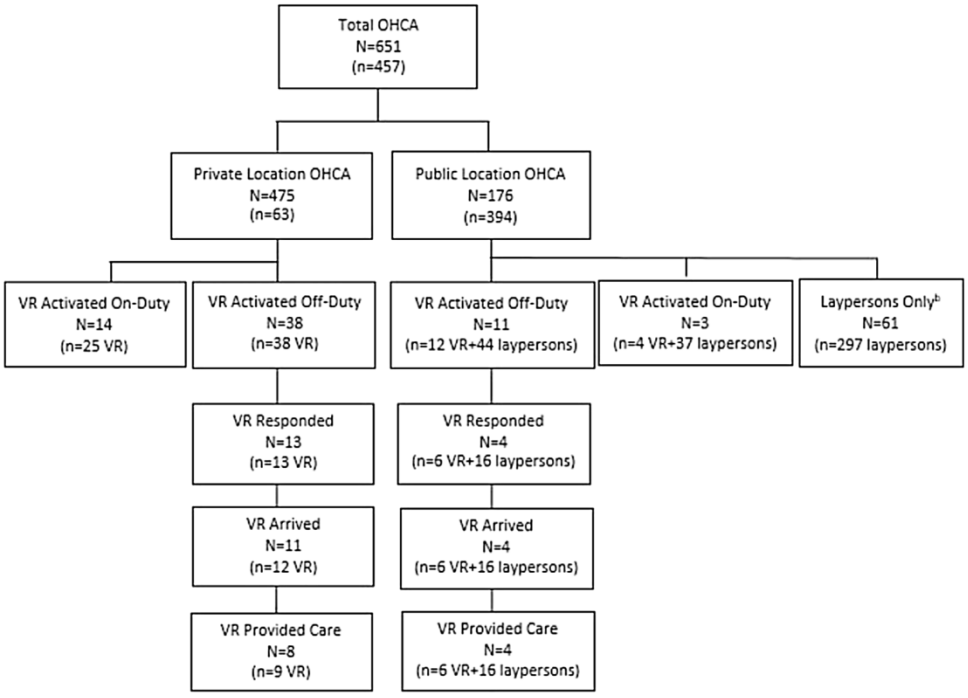


Fig. 1 – Flow diagram of cardiac arrest events (N) and verified responders (n)[a].
a - "N" indicates number of cardiac arrest events and "n" indicates number of individual activations/responders. Verified Responders is abbreviated VR.
b - Layperson refers to those volunteers who are not part of the Verified Responder platform and who are restricted to public setting activations.

Newer strategies have involved geospatial smartphone technology integrated with 9-1-1 communication activation to notify volunteer citizens of a nearby suspected OHCA.[9–14] However this approach has been limited to the public setting in the US. The current study provides insight into how such a program might proceed in North America or other geographies where there may be reticence to have volunteers respond into private residences.

As there is no singular gold standard for whether this type of program is acceptable, safe, and feasible, stakeholders should consider the results in the context of their own system or community. In

Table 2 – Characteristics of OHCA.

	All OHCA (n = 651)	VR responses (n = 49)	VR private (n = 38)	VR public (n = 11)
Age(SD)	59.1(20.1)	63(22.4)	61.6(23.7)	67.6(17.8)
Sex (male), N (%)	412 (63.3)	35 (71.4)	24 (63.2)	11 (100)
Evening arrests (11PM–7AM), N (%)	158 (24.3)	11 (22.4)	10 (26.3)	1 (9.1)
Witness, N (%)	276 (42.4)	16 (32.7)	11 (28.9)	5 (45.5)
Bystander CPR, N (%)	409 (62.8)	30 (61.2)	22 (57.9)	8 (72.7)
Bystander defibrillation, N (%)	39 (6)	3 (6.1)	1 (2.6)	2 (18.2)
EMS response time, median (IQR)	5.2 (4.2, 6.5)	4.4 (3.8, 4.9)	4.3 (3.8, 4.8)	4.5 (4.2, 5.1)
Location, N (%)				
Home	473 (72.7)	38 (77.6)	38 (100)	0(0)
Nursing home	46 (7.1)	2 (4.1)	0(0)	2 (18.2)
Public outdoors	47 (7.2)	2 (4.1)	0(0)	2 (18.2)
Public indoors	85 (13.1)	7 (14.3)	0(0)	7 (63.3)
Cardiac etiology, N (%)	536 (82.3)	42 (85.7)	32 (84.2)	10 (90.9)
Initial arrest rhythm, N (%)				
Shockable	155 (23.8)	13 (26.5)	9 (23.7)	4 (36.4)
Non-shockable	496 (76.2)	36 (73.5)	29 (76.3)	7 (63.3)
Sustained ROSC, N (%)	228 (35.0)	15 (30.6)	10 (26.3)	5 (45.5)
Admit to hospital, N (%)	217 (33.3)	17 (34.7)	11 (28.9)	6 (54.5)
Survival, N (%)	89 (13.7)	10 (20.4)	5 (13.2)	5 (45.5)
CPC 1 or 2, N (%)	84 (12.9)	10 (20.4)	5 (13.2)	5 (45.5)

Table 3 – Annual survey results.

	Survey responses (n = 466)
Received a notifications in past year, N (%)	253 (54.3)
Average # notifications in past year, n (SD)	1.1 (1.2)
If notified, response attempted, N (%)	82 (32.4)
Reason for no response, N (%)[a]	
On-duty	86 (34.0)
Location too far/EMS near or on scene	50 (19.8)
Phone on mute or away from phone	78 (30.8)
Unavailable	34 (13.4)
Physical barrier or traveling on highway	31 (12.6)
Barriers during attempted response, N (%)[b]	
Unable to locate/location challenges	29 (35.4)
Time of day	5 (6.1)
Physical barrier preventing access	15 (18.3)
Location of AED N (%)	
At home	46 (10.3)
In vehicle	388 (87.0)
On person	12 (2.7)
Program perspectives N (%)	
Most or always prepared for activation	380 (85.2)
Confident or very confident responding	424 (95.1)
Positive or very positive regarding program	428 (96.0)
Continued participation	431 (96.6)

[a] Among 253 question-specific responses.
[b] Among 82 question-specific responses.

the communities involved in the current investigation, EMS leadership was essential to advancing the program to respond to all locations. Although there was strong conceptual support among the participating public safety organizations, each organization negotiated arrangements that provided compensation as well as liability coverage for volunteer response. EMS organization leadership also needed to navigate approvals from community government. In each community, the Fire Chief, EMS leadership, and the EMS medical director all actively supported the program.

Although these responses are triggered by a 9-1-1 call for suspected OHCA and an implied request for help, one obstacle to residential response is the concern for safety given a volunteer entering a private home while off-duty. Each agency developed its own specific policy for their organization. To help address this potential concern, volunteer response was always at the discretion of the individual. Volunteers were not mandated to carry a specific badge or uniform but rather typically verbally alerted the bystander that they were part of the fire department's early response program before entering a private residence. Based on survey with those volunteers who participated in actual responses, none experienced a safety concern. Most Verified Responders had a favorable impression of the program and planned to continue to participate. Moreover, there was no report of safety concern by 9-1-1 callers. Participating communities were mid-sized (125,000–500,000 population) and statistically safer than many communities with regard to assault and homicide.[21] The current experience suggests that reasonable discretion by an experienced responder group enables safe implementation of the program. Communities should consider safety issues as they balance the risk and benefit of an all-locations volunteer response.

Although the results of the current study support safety and acceptability, actual notification and response was relatively modest. The potential benefit of the program must be considered in the context of other interventions, appreciating that the current initiative was a first-step to engage a larger Verified Responder volunteer cohort for private OHCA response. In the current study, volunteers were notified in 8% and involved on scene with 3% of all OHCA that occurred before EMS arrival. Importantly about two-thirds of these volunteer-attended OHCA events occurred in private residences. The study provided insight into how the response might be increased as notification and response increased in association with a larger radius, broader dispatch criteria, and perhaps the silence override feature of the phone application.

Another important consideration is if and how to expand the "Verified Responder" cohort. The current investigation involved 593 Verified Responders and a geographic area of 708 square miles. At any given time, some participants could be on duty, outside of the community response area, or otherwise not able or willing to respond; all realities that limit the involvement of such a program. Next steps might consider the involvement of other credentialed medical professionals (physicians, nurses, allied health professionals) and public safety personnel (law enforcement), though ultimately an even larger pool of all-location responders would likely be required to maximize survival benefits. Based on select European experience, an optimal responder group may need to draw from the entire adult public that have been trained in CPR and AED skills given the unpredictability of OHCA with regard to individual, time, and location.[12–15]

The current investigation equipped many of the Verified Responders with a personal AED to be stored/carried at their discretion while off-duty; the AED was applied by the Verified Responder about half the time if they arrived on-scene and provided care. Early defibrillation is a powerful determinant of survival in ventricular fibrillation OHCA. Moreover, the inclusion of an AED could influence the likelihood of participation and response of an all-location Verified Responder program. Ultimately there is little risk and potential important benefit for early AED via Verified Responder program but issues of cost and cost effectiveness may limit its role. Moreover, there may also be a role for other supporting equipment in such a program. Many of the notifications were for conditions ultimately determined not to be OHCA. Whether these responses could be effectively supported with other types of equipment (i.e. bag-valve-mask for ventilation, naloxone for opioid overdose, epinephrine for anaphylaxis) is uncertain, but deserves further investigation.

Limitations

The current investigation has limitations. Although the study involved multiple communities, different communities may experience variable interest among their public safety professionals. As highlighted in the current study, the extent of volunteer responder involvement may also depend in part on specific settings of the smart phone application (radius for alert) and activation dispatch codes. A clear strategy to increase impact is to expand the number of designated Verified Responders. The best strategy to expand this specific pool beyond public safety responders has not been established though some European communities with experience require only CPR training to respond into private residences. The pattern and extent of expansion in the US and other parts of the world will likely be an important determinant of the strategy's ability to save lives. The large majority of Verified Responders in the current study were equipped with an AED. Future study needs to evaluate the types of equipment support appropriate for a Verified Responder. Finally the study was not designed to assess more patient-orientated outcome effects of the

strategy. Future investigation should gauge survival implications and cost, understanding that these effects may depend on the aforementioned factors (i.e. number of Verified Responders, dispatch codes for activation, response radius, silence override, supporting equipment, and agency operations).

Conclusions

This multi-community US investigation piloted a smartphone alert program for off-duty public safety to respond to suspected OHCA in private and public locations. This group of volunteer rescuers – termed Verified Responders - reported uniformly favorable impressions. Verified Responders were notified, responded, and involved in a small fraction of OHCA. Further studies are needed to determine how this type of response program could be enhanced to involve more OHCA events and impact survival.

Conflicts of interest and disclosures

Drs. Jorgenson and Gao are employees of Philips. Mr. Price is an employee of PulsePoint.

Acknowledgements

The study was supported by Laerdal Foundation for Acute Medicine and Philips Healthcare through a research grant and the donation of AEDs by Philips Healthcare. PulsePoint provided technical support and consultation. We thank the respective Fire Department leadership and the Verified Responders from each community.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.resuscitation.2020.06.015.

REFERENCES

1. Berdowski J, Berg RA, Tijssen JGP, Koster RW. Global incidences of out-of-hospital cardiac arrest and survival rates: systematic review of 67 prospective studies. Resuscitation 2010;81:1479–87.
2. Benjamin EJ, Blaha MJ, Chiuve SE, et al. American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart Disease and Stroke Statistics-2017 Update: A Report From the American Heart Association. Circulation 2017;135:e146–603.
3. Olasveengen TM, de Caen AR, Mancini ME, et al. ILCOR Collaborators. 2017 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary. Resuscitation 2017;121:201–14.
4. Sasson C, Rogers MA, Dahl J, Kellermann AL. Predictors of survival from out-of-hospital cardiac arrest: a systematic review and meta-analysis. Circ Cardiovasc Qual Outcomes 2010;3:63–81.
5. Rea TD, Cook AJ, Stiell IG, et al. Predicting survival after out-of-hospital cardiac arrest: role of the utstein data elements. Ann Emerg Med 2010;55:249–57.
6. Weisfeldt ML, Everson-Stewart S, Sitlani C, et al. Resuscitation outcomes consortium investigators. ventricular tachyarrhythmias after cardiac arrest in public versus at home. N Engl J Med 2011;364:313–21.
7. van Diepen S, Girotra S, Abella BS, et al. Multistate 5-year initiative to improve care for out-of-hospital cardiac arrest: primary results from the HeartRescue project. J Am Heart Assoc 20176:, doi:http://dx.doi.org/10.1161/JAHA.117.005716 pii: e005716.
8. Pollack RA, Brown SP, Rea T, et al. ROC Investigators. Impact of bystander automated external defibrillator use on survival and functional outcomes in shockable observed public cardiac arrests. Circulation 2018;137:2104–13.
9. Rumsfeld JS, Brooks SC, Aufderheide TP, et al. American Heart Association Emergency Cardiovascular Care Committee; Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation; Council on Quality of Care and Outcomes Research; Council on Cardiovascular and Stroke Nursing; and Council on Epidemiology and Prevention. Use of Mobile Devices, Social Media, and Crowdsourcing as Digital Strategies to Improve Emergency Cardiovascular Care: A Scientific Statement From the American Heart Association. Circulation 2016;134:e87–e108.
10. Brooks SC, Simmons G, Worthington H, Bobrow BJ, Morrison LJ. The PulsePoint Respond mobile device application to crowdsource basic life support for patients with out-of-hospital cardiac arrest: challenges for optimal implementation. Resuscitation 2016;98:20–6.
11. Ringh M, Rosenqvist M, Hollenberg J, et al. Mobile-phone dispatch of laypersons for CPR in out-of-hospital cardiac arrest. N Engl J Med 2015;372:2316–25.
12. Berglund E, Claesson A, Nordberg P, et al. A smartphone application for dispatch of lay responders to out-of-hospital cardiac arrests. Resuscitation 2018;126:160–5.
13. Pijls RW, Nelemans PJ, Rahel BM, Gorgels AP. A text message alert system for trained volunteers improves out-of-hospital cardiac arrest survival. Resuscitation 2016;105:182–7.
14. Zijlstra JA, Stieglis R, Riedijk F, Smeekes M, van der Worp WE, Koster RW. Local lay rescuers with AEDs, alerted by text messages, contribute to early defibrillation in a Dutch out-of-hospital cardiac arrest dispatch system. Resuscitation 2014;85:1444–9.
15. Stroop R, Kerner T, Strickmann B, et al. Mobile phone-based alerting of CPR-trained volunteers simultaneously with the ambulance can reduce the resuscitation-free interval and improve outcome after out-of-hospital cardiac arrest: a German, population-based cohort study. Resuscitation 2020;147:57–64.
16. Blackwood J, Eisenberg M, Jorgenson D, et al. Strategy to address private location cardiac arrest: a public safety survey. Prehosp Emerg Care 2018;22:784–7.
17. McNally B, Stokes A, Crouch A, Kellermann AL. CARES Surveillance Group CARES: cardiac arrest registry to enhance survival. Ann Emerg Med 2009;54:674–83.
18. Nolan JP, Berg RA, Andersen LW, et al. Utstein Collaborators. Cardiac Arrest and Cardiopulmonary Resuscitation Outcome Reports: Update of the Utstein Resuscitation Registry Template for In-Hospital Cardiac Arrest: A Consensus Report From a Task Force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia). Circulation 2019 PMID: 31522544.
19. Strategies to improve cardiac arrest survival: a time to act. In: Graham Robert, McCoy Margaret A, Schultz Andrea M, editors. Authors: Committee on the Treatment of Cardiac Arrest: Current Status and Future Directions; Board on Health Sciences Policy; Institute of Medicine. Washington (DC): National Academies Press (US); 2015 ISBN-13: 978-0-309-37199-5ISBN-10: 0-309-37199-6.
20. Rao P, Kern KB. Improving community survival rates from out-of-hospital cardiac arrest. Curr Cardiol Rev 2018;14:79–84.
21. FBI Uniform Crime Reporting https://www.fbi.gov/services/cjis/ucr/. Accessed September 17, 2019.