Mobile Smartphone Technology Is Associated With Out-of-hospital Cardiac Arrest Survival Improvement: The First Year "Greater Paris Fire Brigade" Experience

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ABSTRACT

Background: Out-of-hospital cardiac arrest (OHCA) remains associated with very high mortality. Accelerating the initiation of efficient cardiopulmonary resuscitation (CPR) is widely perceived as key to improving outcomes. The main goal was to determine whether identification and activation of nearby first responders through a smartphone application named Staying Alive (SA) can improve survival following OHCA in a large urban area (Paris).

Methods: We conducted a nonrandomized cohort study of all adults with OHCA managed by the Greater Paris Fire Brigade during 2018, irrespective of mobile application usage. We compared survival data in cases where SA did or did not lead to the activation of nearby first responders. During dispatch, calls for OHCA were managed with or without SA. The intervention group included all cases where nearby first responders were successfully identified by SA and actively contributed to CPR. The control group included all other cases. We compared survival at hospital discharge between the intervention and control groups. We analyzed patient data, CPR metrics, and first responders' characteristics.

Results: Approximately 4,107 OHCA cases were recorded in 2018. Among those, 320 patients were in the control group, whereas 46 patients, in the intervention group, received first responder–initiated CPR. After adjustment for confounders, survival at hospital discharge was significantly improved for patients in the intervention group (35% vs. 16%, adjusted odds ratio = 5.9, 95% confidence interval = 2.1 to 16.5, $p < 0.001$). All CPR metrics were improved in the intervention group.

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Conclusions: We report that mobile smartphone technology was associated with OHCA survival through accelerated initiation of efficient CPR by first responders in a large urban area.

Out-of-hospital cardiac arrest (OHCA) is a leading cause of death. While one episode of OHCA occurs every 6 minutes in France, fewer than one in six cardiopulmonary resuscitation (CPR) attempts is successful.[1] In Greater Paris, an average 10 OHCA events occur every day, with a survival rate approximating 7.5%.[2] Overall, outcomes following OHCA thus remain very poor despite information campaigns, structured training programs, and improved public access to automated external defibrillators (AEDs).[3,4] Interventions designed to improve the second link of the chain of survival (early initiation of effective CPR) are widely identified as most likely to save lives.[5,6] Unfortunately, since bystanders only rarely initiate CPR, median times to Basic Cardiac Life Support (BLS) remain high in France (18 minutes),[1,7] including in large urban areas such as Greater Paris (9 minutes).[8]

Beyond adequate identification of situations requiring CPR, optimized dispatch of first responders is key to initiate BLS and accelerate access to AED. Widespread availability of mobile smartphone technology (MST) not only allows alerting nearby first responders, it also facilitates localization of nearby AEDs. Once alerted through notifications, nearby first responders may rush to the scene to promptly initiate BLS before a full medical team arrives to provide Advanced Cardiac Life Support (ACLS). MST strategies have been successfully implemented in numerous countries, leading to increased first responder–initiated CPR attempts. While survival benefits remain to be demonstrated,[8–16] MST strategies are currently part of international guidelines.[17–19]

In France, the mobile application “Staying Alive” (SA) allows nearby first responders, commonly referred to as “Bons Samaritains” (BS), to be located and alerted. SA is available on all smartphone platforms and uses geolocalization services to flag nearby AEDs. It was first integrated to the Paris Fire Brigade Greater Paris Area CPR protocols in 2017.[16] We hereby summarize how the introduction of SA improved health care delivery and OHCA survival outcomes within 1 year in Greater Paris area (July 2017 to 2018).

METHODS

SA Mobile Smartphone Application

Staying Alive is a free mobile smartphone application, available in 18 languages (French, English, Spanish, Chinese . . .), that is compatible with all operating systems. Back in 2011, SA’s original version was devoted to AED mapping and developed by "AEDMAP" startup. The application is free for dispatch centers, AEDMAP is funded thanks to public and private sponsorship. Since then, SA has been updated to allow CPR-trained volunteers (BS) to register after providing a certificate of training. When necessary, BS can be easily located and alerted if notifications are turned on. Once alerted, they may accept or decline to rush to the scene of the cardiac arrest. The dispatch center may also direct activated BS toward the nearest AED through SA. Over time, SA has contributed to create a community of BS has received support from several institutions and sponsors.

To rapidly increase their number, we published in the local press and on social networks joint interviews of the first BS who had intervened and of the patients who had survived. We also communicated within the Paris Fire Brigade and its partners (red cross, civil protection), who constitute an important pool of BS and who added many AEDs to our database via the application.

Global Resuscitation Strategy in Greater Paris

The Greater Paris area is 800 km^2 wide; it hosts about 7 million people. The Paris Fire Brigade dispatch center receives approximately 1.2 million telephone calls each year. Each day, it responds to an average of 10 OHCA alerts using a dispatch-assisted CPR protocol set in 2012. The emergency medical system (EMS) is a two-tiered response system.[2,20] The first tier is activated every time loss of consciousness is suspected and a BLS team is immediately sent out. The second tier is activated when OHCA is confirmed by the dispatcher, using the previously published "Hand on Belly."[20] In this technique, the dispatcher asks the bystander to put his hand on the victim’s belly to estimate the ventilatory frequency. If there are more than 7 seconds between two movements, the dispatcher makes the diagnosis of cardiac arrest. Bystanders receive telephone instructions to initiate chest compressions (t-CPR) or use an AED until the BLS team or EMS providers arrive on the scene.

SA Activation

Staying Alive was deployed in the dispatch center in 2017. Whenever OHCA is confirmed, the chief dispatcher may decide to activate SA in addition to standard second tier EMS responses. SA activation maps AED available around the scene; it also identifies and alerts BS within a 500-meter radius (Figure 1; Data Supplement S1, Video S1, available as supporting information in the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13987/full). Per agreement, given that MST strategies were still considered experimental in France, we decided that only trained volunteers could register as BS. Chief dispatcher activates SA for all cardiac arrests, 1) in public places (approximately 20% of OHCA in the greater Paris), 2) in the absence of environmental danger for registered BS, and 3) based on the availability and assessment of the chief dispatcher of which this is one of many functions. By definition, SA was activated only on OHCAs detected by our dispatch center, which is all the more difficult in public places (younger patients, frequent gasps; about 50% in our center).[21]

When necessary, all available registered BS near an OHCA scene receive a "push" notification with a sound alarm, even if the phone is locked. SA does not need to run in the background. Upon acknowledgment of the notification, available BS are directed toward the scene of OHCA and receive a map of AEDs in the area. One or more BS may respond to an alert and rush to the scene. Registered BS can control their availability and activation status using the SA application. The chief dispatcher can track status changes ("available," "dispatched," "on the way") remotely. The chief dispatcher can also contact a BS directly. We assigned the activation and management of SA to the chief dispatcher, since our top priority was not to interfere with what was working, i.e., the guidance of the chest compressions by the first dispatcher.[20,21] This is a difficult telephone procedure that requires focus and is not compatible with other tasks.

Study Design

The Paris Fire Brigade conducted a single-center observational cohort study on SA implementation and efficacy between July 2017 and July 2018. All OHCA events in the Greater Paris Area during that period were analyzed. The following data were collected: 1) return of spontaneous circulation (ROSC; prospective Utstein-style[2] paper database on the scene by Paris Fire Brigade EMS and BLS teams); 2) hospital outcomes (retrospectively confirmed by the Paris Sudden Death Expertise Center in patients hospital records); 3) AED use as well as BS identification and activation through the SA database; and 4) BS characteristics (demographics, first aid level), feedback, and actions on the scene through a telephone interview within 1 month following the alert.

We defined two groups of patients. The intervention group included all OHCA patients for which one or more BS was identified, rushed to the scene, and started BLS as defined by 1) the initiation or continuation of lifesaving maneuvers such as chest compressions; 2) the localization, retrieval, application, and usage of an AED; 3) the combination of 1) and 2). The control group included: 1) cases in which no BS was available within the 500-meter radius, 2) no BS responded to the request, 3) at least one BS responded but none eventually reached the scene, and 4) at least BS reached the scene but none performed any resuscitation effort. Since many BS may have been involved for one OHCA, some results may include different numbers of either BS or patients.

Endpoints

Comparing cases where SA was activated to those where SA was not activated, we analyzed the rate of ROSC upon hospital admission. Comparing patients in the intervention and control groups, we analyzed survival outcomes upon hospital discharge. We also analyzed the impact of BS response on survival outcomes.

Data Analysis

Initial Data Reduction.

Continuous variables are described with medians and IQR (25th–75th percentile). Categorical parameters are summarized with numerical values and percentages. Differences between proportions were analyzed with the Fisher's exact test. We used the Mann-Whitney U-test to compare differences between unpaired groups. All statistical tests were two-sided and a $p < 0.05$ considered significant.

Propensity Score Model.

We designed a propensity score analysis using complete cases, matching with a greedy algorithm. The propensity score for the SA application success was computed using the Super Learner (SL). The SL is a combination of machine learning methods that was previously

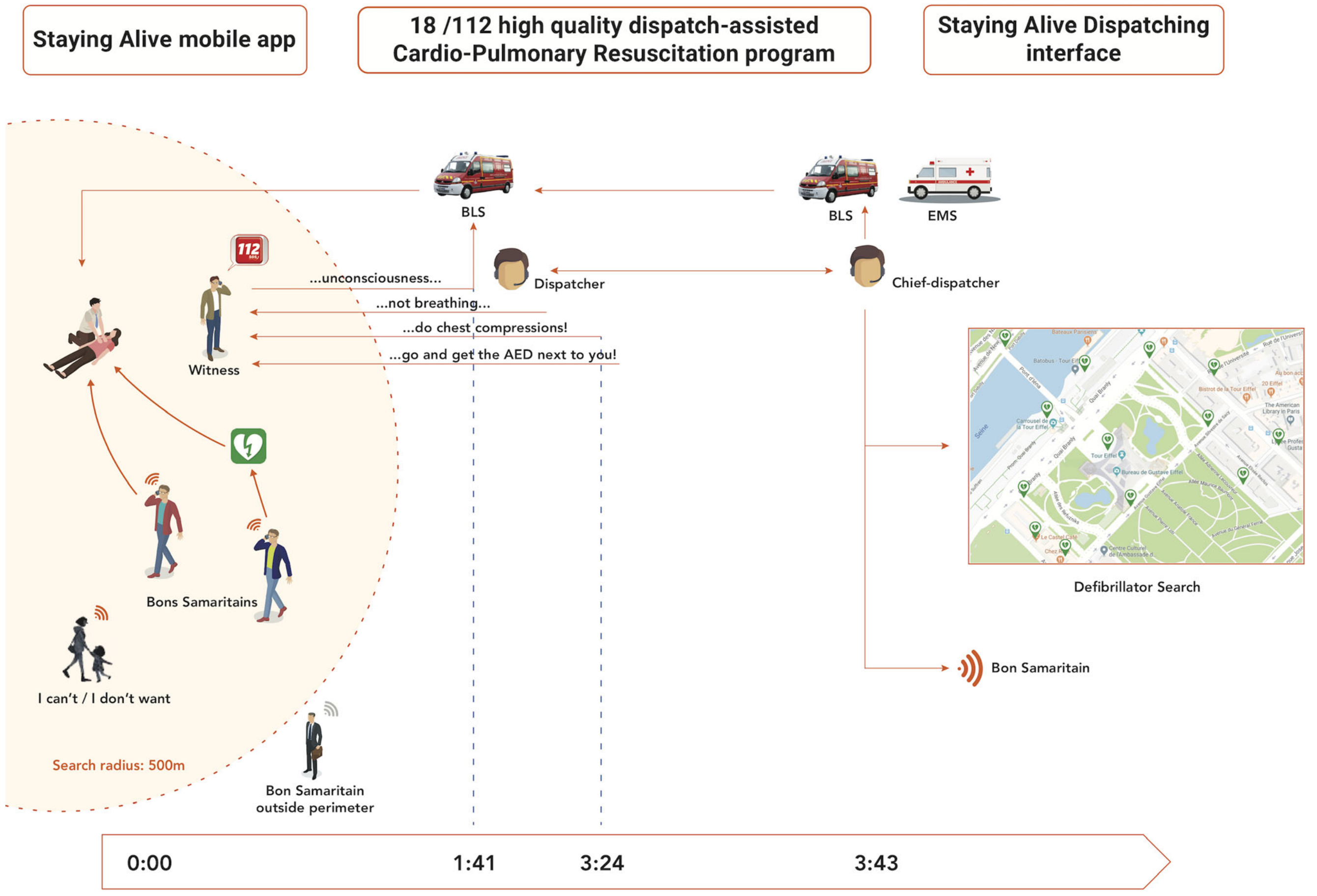

Figure 1. SA operating system and dispatch by the Greater Paris Fire Brigade. (1) The bystander calls for help, (2) the dispatcher detects unconsciousness and immediate sends team (BLS), (3) the dispatcher detects no/abnormal respiration, (4) the dispatcher guides the bystander to perform chest compressions, and (5) the dispatcher alerts chief dispatcher. The chief dispatcher (6) alerts BS and searches automatic public defibrillator and (7) sends second BLS and emergency medical service teams. (8) BS accept (or not) the alert, rush to perform chest compressions, and/or retrieve a defibrillator. (9) The first dispatcher can also guide the second bystander to a defibrillator if chief dispatcher indicates there is one nearly. The time scale indicated is the based on the median time recorded at the fire brigade dispatch center in 2017. BS = Bons Samaritains; BLS = Basic Life Support; SA = Staying Alive.

demonstrated beneficial in this context.[22–24] It improves the robustness of propensity score matching estimators to propensity score model misspecification.[25] All available variables describing preexisting conditions were included in the propensity score model. These variables were derived from the Utstein-style guidelines for uniform reporting of cardiac arrest.

Matching Parameters. Matching on the propensity score was performed using a one-to-many variable ratio matching with a nearest neighbor-matching algorithm. We set a prespecified caliper equal to 0.2 times the standard deviation of the logit of the propensity score. Replacement of controls was used to limit number of unmatched treated. The R software package "Matching" was used to process matching. To assess balance between matched groups, standardized differences were calculated and a difference between (−0.1 and +0.1) indicates balance between groups.

Outcome Model. A logistic regression model was fitted for the survival analysis between the intervention and control groups. To account for controls matched more than once and the resulting correlation, we used a generalized estimating equations method. If necessary, the final model was adjusted on the residual unbalanced variables between the matched populations. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were reported with robust variance estimates.

Causal Estimands Effect. The causal estimands effect in this study is the average treatment effect on the treated group (ATT). Whereas ATT and average treatment effect (ATE) are equivalent in a randomized clinical trial, ATT and ATE are not necessarily the same in an observational study. The effect measured in this study, which focuses on ATT, quantifies the answer to the following question: what would be the patient's outcome in the intervention group if they had not been exposed to SA? We used the R software version 3.3.3 for Windows for all analyses.

Ethics

This study was approved by the Ethics Committee of the French Anesthesia Society (IRB 00010254-2018-003). French regulations were respected (CNIL, MR003).

RESULTS

SA Application

From July 2017 to July 2018, the number of BS who registered in SA rose from 5,582 to 23,312 in France, 3,241 of which were located in the Greater Paris area. By July 2018, there were 6,821 AEDs tagged by SA in Greater Paris.

Patients

The Sudden Death Expertise Center recorded 4,107 OHCA events within the year of data collection (Figure 2). Characteristics of the study cohort are detailed in Data Supplement S1, Table S1, separating cases where SA was activated or not. SA was appropriately activated 366 times (9.8%). In the intervention group (n = 46), lifesaving maneuvers such as chest compressions were initiated without AED use in 24 cases. An AED was used without attempting lifesaving maneuvers in 18 cases (CPR already ongoing by bystander). Finally, both lifesaving maneuvers and usage of an AED were achieved in four cases. In the control group (n = 320), nearby BS failed to respond to notifications in 97 cases. Although the remaining 226 BS did respond to notifications, they either failed to locate the site of OHCA or did not start BLS once on the site of OHCA. For all the patients, it was the first cardiac arrest.

BS

Staying Alive was activated 366 times following an OHCA event: the search of BS within a 500-meter radius succeeded in 269 cases (73%). A total of 762 push notifications were sent out, because one, two, three, four, or more BS were identified by the application in 58, 32, 24, and 41 cases, respectively. Approximately 226 (30%) of the 762 push notifications were

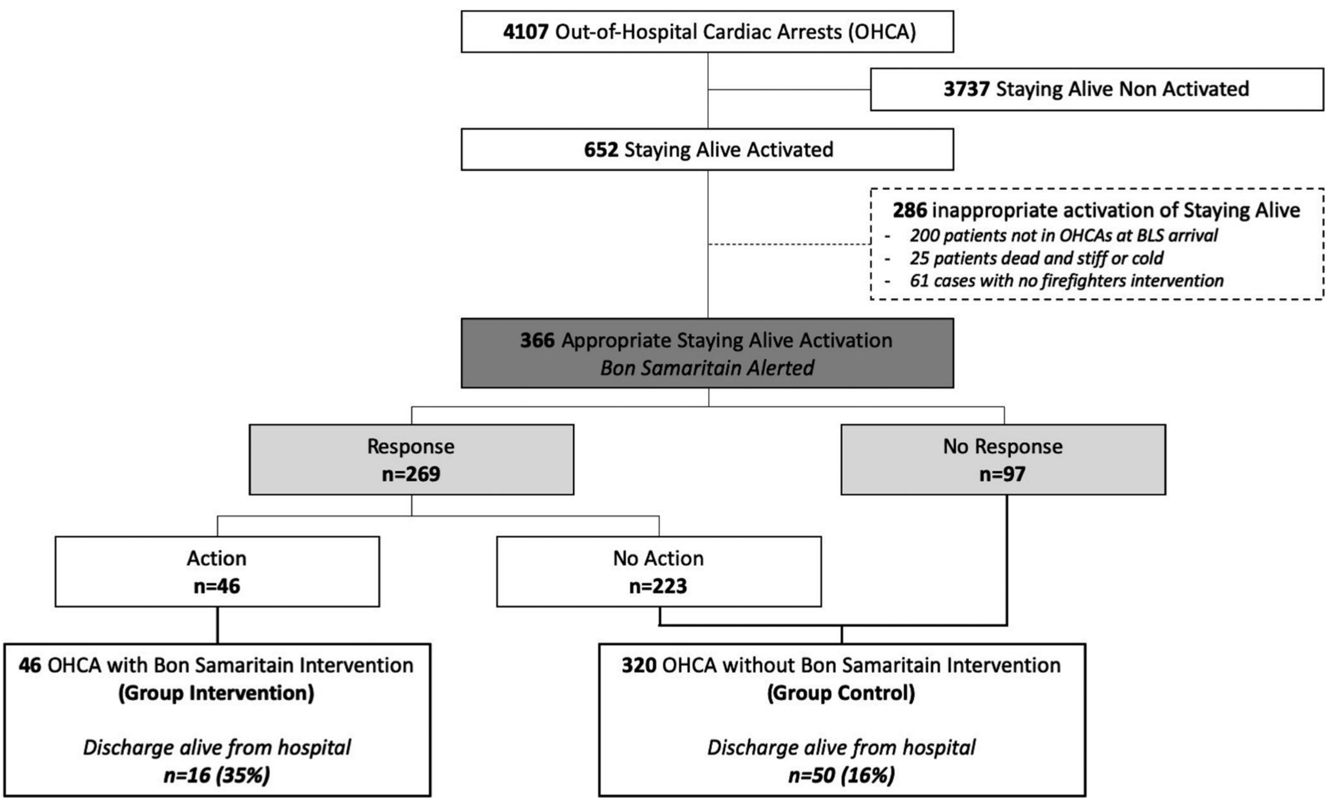

Figure 2. Flow chart of SA use for OHCA. The intervention group was defined as OHCA patients for which an alerted BS arrived to the scene performed 1) lifesaving gestures, initiation of chest compressions, or shift with a first bystander; 2) retrieve and use of an AED, 3) or both. The control group was defined as OHCA patients for which 1) BS did not respond, 2) some BS responded but none arrived, and 3) BS arrived on the scene did not perform action. BS = Bons Samaritains; OHCA = out-of-hospital cardiac arrest.

acknowledged and accepted, prompting the responding BS to rush to the site of OHCA (Figure 3). Most responding BS were young experienced men: two of three of them reported having previously performed chest compressions in real life, and three of four had completed more than 60 hours of first aid training (Table 1).

Upon identification and activation, a total of 137 BS did arrive on site. Approximately 37 of them did not perform CPR as they arrived after the BLS team (Figure 3). Two factors were associated with BS arrival on site prior to the BLS team: 1) a shorter distance between BS and the patient (median distance 350 meters vs. 500 meters, $p < 0.001$) and 2) direct phone contact with the chief dispatcher ($p = 0.02$; Table 2). Among the 100 BS who did arrive before the BLS team, 52 attempted lifesaving maneuvers and/or used an AED for 46 patients allocated to the intervention group (Figure 3).

Outcomes

Patients managed with SA were more likely to demonstrate ROSC upon hospital admission (48% vs. 23%, $p < 0.001$). A map of all OHCA events leading to SA activation is shown in Data Supplement S1,

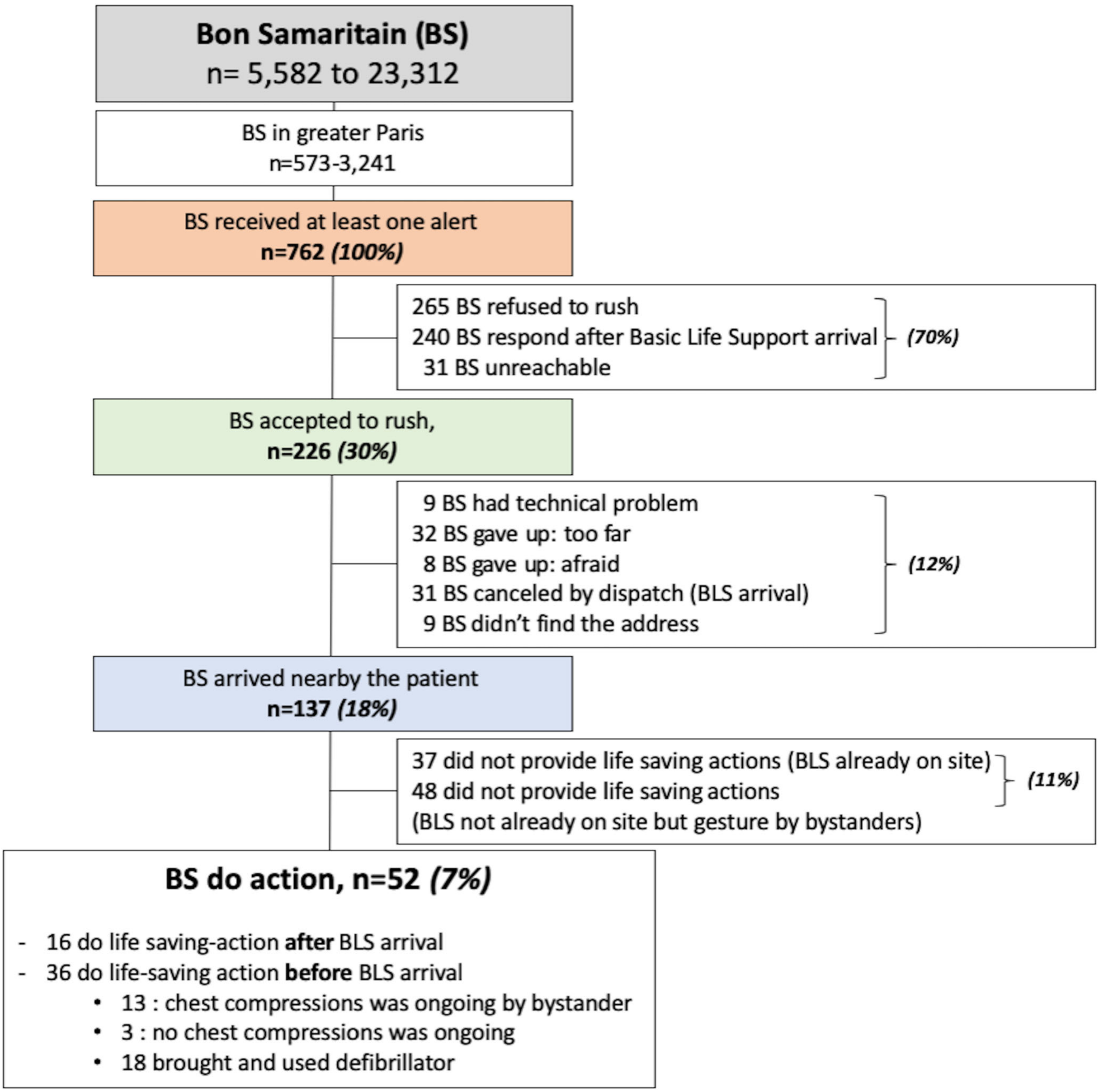

Figure 3. BS activation, response and actions. BS = Bons Samaritains.

Table 1
Characteristics of BS Who Agreed to Intervene (n = 210)

Age (years), median [25th–75th]	29.0 [24.0–37.2]
Male	164 (78)
Job	
Police and custom officers	8 (4)
Manual occupation	26 (12)
Students	26 (12)
Firefighter	34 (16)
Higher and intermediate occupations	44 (21)
Healthcare professionals	47 (22)
Others	25 (12
Regular first aid practice	
First aid association*	113 (54)
First aid level (hours of training)	
Life-saving gesture initiation (2 hours)	8 (4)
First aid level one (8 hours)	15 (7)
Health/security at work (15 hours)	17 (8)
First aid team one (35 hours)	19 (9)
First aid team two (one + 28 hours)	91 (43)
First aid team leader (two + 100 hours)	34 (16)
Nurse	13 (6)
Doctor	13 (6)
OHCAs supported before alert and notification	
0	69 (33)
1	29 (14)
2–10	36 (17)
>10	76 (36)

Data are reported as n (%) unless otherwise specified.
BS = Bons Samaritains; OHCA = out-of-hospital cardiac arrest.
*16 BS rushed twice.

Figure S1. The figure illustrates the distribution of cases allocated to the control group (blue dots) and the intervention group, whether lifesaving maneuvers were attempted (green dots) and/or an AED was used (red dots).

Among patients managed with SA, the survival rate on hospital discharge was greater in the intervention group than in the control group using univariate statistics (35% vs. 16%, p = 0.004; Table 3). With multivariate statistics with propensity scoring and SL methodology, 42 patients in the intervention group were matched to 72 patients in the control group with a variable ratio, ranging from 1:1 to 1:3. Counting replacements, controls were matched between one and 13 times. The final matched sample was balanced, except for variables describing the place of cardiac arrest (Data Supplement S1, Table S2). Using the final matched sample, logistic regression showed that survival on hospital discharge was associated with the following factors: 1) a shorter time between emergency call and BLS team arrival (adjusted OR for each elapsed minute = 0.99, 95% CI = 0.98 to 0.99, $p < 0.01$) and 2) allocation to the intervention group (adjusted OR vs. the control group = 5.9, 95% CI = 2.12 to 16.54, $p < 0.001$).

DISCUSSION

To the best of our knowledge, this report for the first time demonstrates the benefits of MST on survival following OHCA. Once deployed in Greater Paris, the SA application allowed not only to quickly identify nearby trained first responders, it also facilitated access to an AED. The 35% survival rate we observed in the intervention group is consistent with expected improvements previously anticipated elsewhere when using similar technology.[26,27]

Within a single year, we were able to show that SA activation was associated with a better outcome after OHCA, especially when the event took place during the daytime. Surprisingly given the novelty of the technology, several nearby first responders were alerted upon SA activation in more than 75% of cases. Those who responded in time to start or continue BLS on site before the presence of a full medical team nearly doubled the life expectancy of OHCA patients. Accounting for several confounding factors, we estimated that SA activation can lead up to a sixfold survival increase when trained first responders willing to start BLS are identified within 500 meters of an OHCA event.

The results of this real-life experiment may not be totally unexpected, as SA aims to facilitate early high-quality CPR and early defibrillation, two well-known predictors of successful outcome following OHCA.[18,28] Our results are observed in the most unfavorable context to highlight a difference between the groups. The OHCA patients for whom SA was activated were indeed already the one with the best prognostic, that is, witnessed arrest, in a public space and during daytime, already receiving bystander chest compression and optimized dispatch. However, our results should be further studied in different unfavorable settings to demonstrate widespread applicability.[26] For example, it is unclear whether SA activation remains beneficial in unfavorable circumstances (e.g., the cardiac arrest is not witnessed, is not followed by immediate CPR maneuvers, does not take place in a public area by

Table 2
Characteristics of BS Who Agreed to Intervene, According to Arrival Before or After BLS Team

		BS Arrival Before BLS Team (n = 44)	BS Arrival After BLS Team (n = 93)*	p-value
How many SA alert received before this alert?				
	0	31 (70)	68 (73)	0.91
	1	11 (25)	22 (24)	
	2	2 (5)	3 (3)	
Day's period				
	00:00–07:00	2 (5)	3 (3)	0.55
	07:00–19:00	30 (68)	56 (60)	
	19:00–00:00	12 (27)	34 (37)	
Location of BS when he received the alert				
	Street	10 (23)	26 (28)	0.19
	Residence	18 (41)	42 (45)	
	Work	8 (18)	7 (8)	
	Other	8 (18)	14 (15)	
Time period (seconds) between BLS notification and accepted alert†		77 [47–122.2]	116 [53-192.7]	0.053
Time period (seconds) between BS alert and BS acceptance to rush		40 [26.5–58.5]	39 [27–58.5]	0.91
Distance from BS location to scene‡		350 [220–500]	500 [350–725]	<0.01
Time period (seconds) between BLS alert and BLS arrival		480 [540–660]	480 [405–555]	0.08
BS call by chief-dispatcher before arrival		30 (89)	41 (44)	0.02
Gestures by BS‡				
	None	8	77	<0.01
	Chest compressions	16	8	
	Bag ventilation	4	4	
	Team leader§	1	2	
	Use defibrillator	22	2¶	
Duration of chest compression before BLS arrival (n = 16)		140 [90–240]	—	

Data are reported as n (%) or median [25th–75th].
BS = Bons Samaritains; BLS = Basic Cardiac Life Support.
*Same time n = 30/after BLS n = 63.
†All time periods are reported in seconds; distance is reported in meters.
‡Some BS did more than one gesture.
§Minimalize hand-off time, organize team work, always emergency physician.
¶BLS defibrillator.

daytime).[18,28] In our cohort, 41 of 44 nearby first responders who arrived prior to the BLS team did not start CPR but took over from bystanders who initiated lifesaving maneuvers such as chest compressions. Additionally, a large percentage of first responders arrived on site after the BLS team, again highlighting the very short delay from emergency call to BLS team arrival in the Greater Paris area.

The question of the cost of such an application is essential. If the app is free for both users and dispatch centers, chief dispatchers must be trained to use it (2 hours of initial training and then 1 hour every 3 months for 9 months). The recruitment of BS was carried out thanks to our communication department whose main objective was to motivate Parisians to be trained in lifesaving gestures. No other expenses related to the application have been identified.

LIMITATIONS

We demonstrated an association between the use of MST and improved survival, without being able to assert a causal link. However, a causal relationship may be consistent with the scientific knowledge on OHCA physiopathology and the international guidelines recommending that BLS be realized as quickly as possible before arrival of a rescue teams.

Our analysis does not show that the app is effective in the general population, but that it has been effective for patients who have received the "treatment": we are

Table 3
Characteristics of Patients; OHCA, BLS, and EMS Features; and Patients' Outcomes

	Intervention	Control	p-value	Adjusted OR† [95% CI]
Characteristics				
No. of patients	46	320		
Age (years)	55 [44–71]	58 [43–71]	0.96	
Male	34 (74)	238 (74)	0.96	
OHCA circumstances				
Etiology of cardiac arrest			1.0	
Medical	42 (91)	291 (91)		
Trauma	4 (9)	29 (9)		
Place of cardiac arrest			<0.001	
Residence	5 (11)	118 (37)		
Street	25 (54)	126 (39)		
Public building, work, sport facility	16 (35)	76 (24)		
Collapse witnessed by bystander	36 (78)	189 (59)	0.08	
Chest compressions before BLS arrival	40 (87)	213 (67)	0.67	
Shock delivered by public defibrillator	9/22 (41)	—	—	
BLS				
Elapsed time before BLS arrival (minutes)	8 [8–11]	9 [7–11]	0.5	0.99 [0.98–0.99]
EMS				
CPR not attempted by EMS*	4 (9)	42 (13)	0.48	
Shock delivered by BLS or EMS	23 (50)	115 (36)	0.07	
Outcome				
Discharge alive from hospital	16 (35)	50 (16)	0.004	5.9 [2.12–16.54]

Data are reported as *n* (%) or median [25th–75th].
BS = Bons Samaritains; BLS = Basic Cardiac Life Support; OHCA = out-of-hospital cardiac arrest.
*Do not attempt resuscitation orders.
†Logistic regression with propensity score for complete cases.

interested in the ATT and not the ATE. We could have been limited to studying the association between the use of SA and improvement in chest compression delay. However, this delay is rather short and we would have been asked about its association with outcome. Similarly, the question of the quality of chest compressions and the association with outcome would have remained unanswered.

Several other experiments using similar MST applications have been conducted, mainly in Europe (Sweden, the Netherlands, Denmark, the United Kingdom, Switzerland) but also in Japan and Canada.[9–16] All the available evidence, including ours, issues from monocentric, nonrandomized studies, with the potential for exposure to confounding effects. The only published randomized study[8] on this MST solution conducted in 2015 was not designed to demonstrate any effect on survival. It did however demonstrate a significant increased ratio of BLS attempt by BS, and was underpowered to demonstrate an effect on survival. In 2018, such a randomized trial seemed to us unethical to perform, and we are surprised at the ongoing HeartRunner RCT (Copenhagen). We therefore rely only on data extracted from real life to measure and demonstrate a positive effect of the BS strategy, to increase their number and motivation, and launch the system in the whole country.

Future Directions

In summary, despite study design limitations, our results showing improved OHCA survival led us to consider using SA more systematically and working on several upgrades.[17–19] We believe the four following objectives can improve SA deployment and efficiency.

First, the number of trained BS should increase significantly. At the time of the study, we recorded 0.5 BS per 1000 inhabitants, very far away from the 5/1,000 ratio observed in Ticino, Switzerland; the 8/1,000 ratio observed Limburg, Netherlands; or the 10/1,000 ratio observed in Stockholm, Sweden.[11–13] Lately, the number of BS dramatically increased (51, 252 in May 2019) locally in the Greater Paris area as well as globally at the national level where the system is now available in 35 of 95 departments. Undoubtedly, this was the result of a coordinated campaign supported by the Greater Paris Region and Foundation Funds. That being said, monitoring and maintenance of a first responders' community is challenging and time-consuming. While one may consider awarding rewards each time a life is saved, one must also respect local ethical and legal boundaries such as those established by the French Parliament.[29] Ultimately, increasing the number of BS is most likely to positively impact remote, underserved medical areas.

Second, we have recently allowed nontrained volunteers to register in SA. At this time, we expect them to assist responders by making an AED available as quickly as possible. Some may opt to pursue BLS training, thereby increasing the pool of registered trained first responders. Although AEDs are currently only available at dedicated public hotspots, we are considering making AEDs available in mobile vehicles, such as police cars, taxis, or even post office vans.

Third, we have extended the activation of SA to indoor OHCA events, since those account for nearly 75% of cases in Paris and across the world. Although we aimed to investigate SA outdoors exclusively for pragmatic and regulatory reasons, several cases of indoor OHCA led to SA being mistakenly, yet successfully, activated. Given promising results after a single year of usage, we believe that it is now safe and necessary to extend the indication of SA activation to all OHCA events during daytime, as long as first responders are not putting themselves in danger.[30]

Fourth, we are working on fully automatic algorithms that will identify which OHCA management strategy is best suited, based on variables such as the number of nearby first responders available, their level of training, and the proximity of an SA-flagged AED.[27]

CONCLUSION

We hereby demonstrate that mobile smartphone technology can accelerate first responder dispatch and may most likely be instrumental to improving out-of-hospital cardiac arrest survival. This strategy might even be more critical in the future, with possibly worsened out-of-hospital cardiac survival due to increased delay to arrival to the victim, both because of traffic or because of desertification of a nonurban area. Furthermore, empowering people by registering them into a wide community of first responders may transform bystander-initiated cardiopulmonary resuscitation happening more by design than by chance. To overcome delay, the use of digital and personalized systems may finally improve rates of survival after out-of-hospital cardiac and realize the public health potential of bystander-initiated cardiopulmonary resuscitation.

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Supporting Information

The following supporting information is available in the online version of this paper available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13987/full

Data Supplement S1. Supplementary Material.