Accepted in *Resuscitation* 24/10/2017

The Use of Trained Volunteers in the Response to Out-of-Hospital Cardiac Arrest – The GoodSAM Experience

Christopher M. Smith[a], Mark H. Wilson[b], Christopher Hartley-Sharpe[c], Carl Gwinnutt[d], Bridget Dicker[e,f], Gavin D. Perkins[a]

[a] Clinical Trials Unit, University of Warwick, Coventry, CV4 7AL, UK

[b] Imperial College Biomedical Research Centre, St Mary's Hospital, London W2 1NY

[c] London Ambulance Service NHS Trust, 18-20 Pocock Street, London, SE1 0BW

[d] Resuscitation Council UK, Tavistock House North, Tavistock Square, London, WC1H 9HR, UK

[e] St John, Auckland, New Zealand

[f] Auckland University of Technology, Auckland, New Zealand

Corresponding author: c.smith.20@warwick.ac.uk

The final version of this article is available in *Resuscitation* at: https://doi.org/10.1016/j.resuscitation.2017.10.020

Word Count: 2246

Abstract Word Count: 98

Accepted in *Resuscitation* 24/10/2017

The Use of Trained Volunteers in the Response to Out-of-Hospital Cardiac Arrest – The GoodSAM Experience

Abstract

In England, fewer than 1 in 10 out-of-hospital cardiac arrest victims survive to hospital discharge. This could be substantially improved by increasing bystander cardiopulmonary resuscitation and Automated External Defibrillator use.

GoodSAM is a mobile-phone, app-based system, alerting trained individuals to nearby cardiac arrests. 'Responders' can be notified by bystanders using the GoodSAM 'Alerter' function. In London, when a 999 call-handler identifies cardiac arrest, in addition to dispatching the usual professional resources, London Ambulance Service automatically activates nearby GoodSAM responders.

This article discusses the development of GoodSAM, its integration with London Ambulance Service, and the plans for future expansion.

Introduction

In 2014, resuscitation was attempted in 28,729 out-of-hospital cardiac arrests (OHCAs) in England, with 7.9% surviving to hospital discharge [1]. Emergency Medical Services (EMS) in England aim to arrive at 75% of OHCAs within 8 minutes [1-2] but the chance of survival is dramatically reduced by this time.

Early activation of EMS, good-quality cardiopulmonary resuscitation (CPR) and use of an Automated External Defibrillator (AED) by bystanders, often referred to as Public Access Defibrillation (PAD), have a substantial impact on survival [1] [3]. Improving the community response to OHCA could save many lives, and so efforts to motivate the public to help in an emergency are vital.

Evidence for the efficacy of PAD is clear. Survival rates of 25.9% were reported in victims defibrillated with public-access AED across the UK between 1999-2005 as part of the National Defibrillator Programme [4]. By 2015-16, London Ambulance Service (LAS) reported that 57.3% of patients receiving at least one shock from a public-access AED survived to hospital discharge [5]. Survival rates of greater than 70% have been reported in OHCA victims defibrillated by bystanders within two minutes of collapse [6].

There is a large unmet health need for OHCA victims worldwide. In England, 55.2% of OHCA victims received bystander CPR, a rate far behind the best-performing systems [6-7]. In 2014, only 2.4% of victims received PAD [1], a figure echoed in several international studies [8-10] despite evidence that up to a quarter of OHCA occur within 100m of an AED[8], [11-12].

A number of systems have been developed using mobile phone technology to rapidly alert volunteers to a nearby OHCA. Once the diagnosis of OHCA has been made by the Emergency Medical Services (EMS), volunteers are notified and may offer assistance if they are available. In the Netherlands, OHCA victims attended

by volunteers alerted via text-message were 2.8 times more likely to survive than those for whom alerted rescuers did not attend. Lay rescuers started CPR in 24.7% and attached an AED in 26.8% of cases [13]. In Stockholm, a randomised controlled trial demonstrated that a text-message alert system significantly increased rates of bystander CPR from 47.8% to 61.6%. 30-day survival was unaffected, but there was no mention of PAD provision in this trial [9]. Such systems do have problems: volunteers are not always activated and they do not always respond or arrive on scene before professional help arrives [9], [13-15].

In 2015, The International Liaison Committee on Resuscitation (ILCOR) identified a lack of knowledge in the published literature about the effect of volunteer first-responder systems and app-based digital technology, including how best to deploy AEDs within these systems [16]. The American Heart Association have similarly acknowledged that mobile apps represent an opportunity to improve the response to OHCA [17].

The development of GoodSAM

In 2012, doctors from London's Air Ambulance were concerned that trauma patients with eminently survivable isolated traumatic brain injuries might be dying because of 'Impact Brain Apnoea'. It may occur after head injury and is accompanied by airway obstruction. Basic airway manoeuvres such as a chin lift and jaw thrust can be delivered by bystanders, but without them victims would suffer significant hypoxic brain injury by the time EMS arrived [18].

The need to alert and bring trained volunteers to the scene of such events was soon recognised to be as important to the far larger population of OHCA victims. Subsequently, GoodSAM developed a not-for-profit, mobile-phone app-based alerting system notifying trained volunteers about nearby medical emergencies, including OHCA (https://www.goodsamapp.org for further information). The GoodSAM team trialled a pilot version of the GoodSAM app with volunteer paramedics from London's Air Ambulance and LAS. This confirmed that the triangulation, GPS mapping systems and the notification methods were accurate and enabled its further development.

GoodSAM has an 'Alerter' and a 'Responder' app available across multiple platforms (Android, iOS, Windows) that can be used on any smartphone in any location in the world. Activation of the 'Alerter' app allows bystanders at the scene of an OHCA to request help from volunteer first-responders, whilst the app simultaneously dials the emergency number of that country. The 'Responder' app allows trained, registered volunteers to receive notifications of a nearby emergency. The app uses the smartphone's GPS functions to track real-time locations of responders, so they can be directed to a nearby OHCA. On accepting a notification, a responder is shown the location of the OHCA and nearby AEDs (Figure 1).

Additionally, GoodSAM can be fully integrated into EMS Computer Aided Dispatch systems, allowing activation of GoodSAM responders via the emergency

services telephone number (e.g. 999 or 112). It combines the ubiquitous smartphone and existing app-based technology with a pool of willing volunteers. It has the potential to be an invaluable link between EMS dispatchers and bystanders.

There are other proprietary app-based systems for dispatching lay first-responders available, such as Pulsepoint [14] and FirstAED [19]. There are currently no data about the effect these app-based systems might have on patient outcome.

GoodSAM, good governance

GoodSAM, with its experienced clinical and technical teams, have taken several steps to ensure that both victims and responders are adequately protected when a responder offers assistance in cases of emergency. GoodSAM responders can be classified into different categories, according to local protocols. In the UK, these categories are:

- Doctors, nurses, paramedics – governed at a national level
- Community first-responders, Emergency Medical Technicians – governed at a regional level
- Individuals with current training in CPR/AED, but under no formal governance

All responders must hold either a valid professional identification or a recognised CPR training certificate. Responders indicate whether this CPR training included training in AED use. There is a written Code of Conduct all responders must agree to follow before their registration is certified by either GoodSAM or another parent organisation, which include EMS and community first-responder schemes dependent on local arrangements. Responders are responsible for ensuring that their skills are current and they only provide the assistance for which they are deemed to be competent. In most cases, this will be CPR and using an AED. Healthcare professionals that routinely carry additional life-saving equipment may use it if appropriate.

All responders are encouraged to complete a report form after being alerted. Additional reports or complaints can be made either to the statutory EMS for the region concerned or to GoodSAM directly. To date, no complaints or serious incidents have been reported.

GoodSAM complies with all the requirements of the UK Data Protection Act (1998), and has a detailed Data Protection policy [20]. Further, it is registered with the Information Commissioner's Office. All data is encrypted using a 256-bit Advanced Encryption Standard (AES-256) cipher. Although there is some limited and necessary sharing of data when a responder accepts a notification (e.g. LAS will have access to responders' locations and limited information about their skills), no data are shared with other third parties.

In the UK, there is no specific Good Samaritan legislation that protects people who offer assistance in an emergency. However, we are not aware of successful litigation in the UK against any individual who has intervened to provide life-saving treatment to an OHCA victim. In addition, the Social Action, Responsibility and Heroism Act was introduced in England and Wales in 2015 [21]. It aims to provide protection to those intervening 'heroically' but responsibly in an emergency, for the benefit of an individual. Medical professionals' existing indemnity is likely to cover them for Good Samaritan acts, although it is the responsibility of the individual to check this and to ensure that they only render assistance if they are competent to do so.

The situation regarding legal liability in other countries varies widely, along with issues regarding certification, depending on the local or national organisation responsible for certification. Information is available from GoodSAM (http://www.goodsamapp.org/faq). Ultimately, the responsibility lies with GoodSAM users, whom we urge strongly to clarify the situation in their own country.

Current usage and functionality

In October 2015, the GoodSAM app was formally integrated with the dispatch systems at London Ambulance Service (LAS) NHS Trust. When a call-handler records determinants in the Medical Priority Dispatch System (MPDS) that indicate current or imminent cardiac arrest, a GoodSAM notification is

automatically initiated alongside the dispatch of existing EMS resources. The process is fully automated: there are no added delays and it creates no extra work for the call-handler. In central London, the nearest three responders within a 300m radius are notified simultaneously via the app, although this radius can be modified according to local needs. A single button push allows the responder to accept (or decline) the notification, indicate when they arrive on scene and indicate whether or not they have an AED. If there is no response within 20 seconds, then the next nearest responder is alerted, if they are within the 300m radius. If a responder indicates that they are unable to attend, the next closest responder is alerted immediately. The person making the initial emergency call can be informed that a GoodSAM volunteer will be arriving to provide assistance, but this is a decision for local EMS and currently varies from area to area.

In the London area, there are more than 1,500 GoodSAM responders and 20-30 GoodSAM notifications triggered by LAS on a typical day, and 4,300 AEDs have been mapped. Across the UK, there are more than 8,000 responders and 13,000 mapped AEDs.

GoodSAM is being used in the UK, Australia, New Zealand, India, USA, Brazil, South Africa and in parts of Europe. There have been more than 32,000 notifications sent to GoodSAM responders and more than 24,000 AEDs mapped worldwide.

GoodSAM allows users to add the location of a public-access AED themselves. Users take a photo of the AED with their smartphone camera. Location data is recorded by the phone using GPS or via WiFi and the information sent to GoodSAM. This AED will be added to the GoodSAM system once the location has been verified. In both London and across New Zealand, data about AEDs registered with GoodSAM are shared with EMS.

The GoodSAM responder app also allows live video transmission from the scene to be sent to the EMS Emergency Operations Centre. This has huge potential to provide feedback for bystanders who provide CPR or bring an AED to the scene. Users have to agree (by accepting a 'push notification' at the time of the alert) to allow their smartphone cameras to transmit video in this way. Streamed video is received by local EMS and can be encrypted and securely stored by them if desired; this is in the same way that audio calls to the Emergency number (e.g. 999 or 112) are currently stored and so is subject to the same protections under the Data Protection Act. Video is not stored on the GoodSAM responder's phone at any time.

Emergency Medical Services, fire, police and other voluntary rescue services can register as organisations on the GoodSAM platform and approve their own staff as responders. A real-time resource map is available for such organisations, allowing administrators to locate all its members and direct either specific individuals or multiple appropriate resources in certain circumstances, such as when a 'major incident' is declared.

Future use

The GoodSAM Cardiac Arrest Volunteer response platform will continue to be run not-for-profit. Financial support for development and integration of GoodSAM with UK EMS is being provided by The Cabinet Office and The Big Lottery Fund, administered through the innovation charity Nesta. East Midlands Ambulance Service (England) integrated GoodSAM into their CAD systems in June 2017, and five of the remaining eight English ambulance services (EMS) are in the process of doing this at time of writing. It will also be fully integrated with EMS in New Zealand and Victoria, Australia, during 2017.

GoodSAM is an internet, cloud-based platform and does not require specific software to integrate with EMS, so start-up and maintenance costs are modest. It is also being used in regions where there is no formal EMS: e.g. in Brazil, to alert trained fire responders to acute medical emergencies. In all other areas, notification of nearby responders relies on members of the public using the Alerter app to call EMS and summon help. However, it is the linkage with EMS that is likely to result in the most notifications and where the real benefits for patients will probably emerge.

Next steps

It must be noted that to date, there has been no scientific evaluation of GoodSAM to determine its effect on patient survival or on other metrics such as bystander CPR rate and bystander AED use. LAS and GoodSAM are liaising with the University of Warwick, UK, and will commence this evaluation work in 2017. Key outcome measures will include the proportion of OHCAs for which a GoodSAM responder was available and accepted the notification, time from accepting notification to arrival on scene, provision of bystander CPR, use of an AED and survival to hospital discharge. Subsequent qualitative analysis will focus on identifying barriers and facilitators to the effective working of GoodSAM, by interviewing responders and those responsible for setting up the technical interface between LAS and GoodSAM.

Concluding remarks

The ultimate aim of GoodSAM, and other similar systems to alert volunteer first-responders, is to increase the number of people who survive after OHCA. Its strength is that it uses existing technologies, requires little capital investment and is easily adaptable to the needs of different EMS across the UK and worldwide. With proper evaluation and optimisation of the GoodSAM system it could have a significant impact on OHCA survival.

Acknowledgments

The authors wish to thank Ali Ghorbangholi, co-founder and the technical engineer behind the development of GoodSAM, for providing important information for this article.

Conflict of interest statement

MHW is a co-founder and Medical Director at GoodSAM. GDP and CMS will be conducting an evaluation of GoodSAM at Warwick University. GDP is a National Institute for Health Research (NIHR) Senior Investigator and is supported by research grants from NIHR, Resuscitation Council (UK) and the British Heart Foundation. CHS is Head of First Responders at London Ambulance Service. BD represents St John, one of two ambulance services in New Zealand, which will soon be integrating GoodSAM into their systems. CG is the President of the Resuscitation Council (UK), and represents the Resuscitation Council (UK) on the advisory board for GoodSAM.

No author has or will receive payment from GoodSAM or for this article.

References

[1] Hawkes C, Booth S, Ji C et al. Epidemiology and outcomes from out-of-hospital cardiac arrests in England. *Resuscitation* 2017;110:133–40.
[2] Deakin CD, Shewry E, Gray HH. Public access defibrillation remains out of reach for most victims of out-of-hospital sudden cardiac arrest. *Heart* 2014;100:619–23.
[3] Perkins GD, Handley AJ, Koster RW et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 2. Adult basic life support and automated external defibrillation. *Resuscitation* 2015;95:81–99.
[4] Colquhoun MC, Chamberlain DA, Newcombe RG et al. A national scheme for public access defibrillation in England and Wales: early results.

Resuscitation 2008;78:275–80.
[5] London Ambulance Service NHS Trust (November 2016). Cardiac Arrest Annual Report: 2015/16. Available from: http://www.londonambulance.nhs.uk/about_us/idoc.ashx?docid=f4cae03f-8ba2-4b8f-aee7-1e03001a7602&version=-1 [last accessed 9th October 2017]
[6] Blom MT, Beesems SG, Homma PCM et al. Improved survival after out-of-hospital cardiac arrest and use of automated external defibrillators. *Circulation* 2014;130:1868–75.
[7] Lindner TW, Søreide E, Nilsen OB, Torunn MW. Good outcome in every fourth resuscitation attempt is achievable—an Utstein template report from the Stavanger region. *Resuscitation* 2011;82:1508–13.
[8] Agerskov M, Nielsen AM, Hansen CM et al. Public Access Defibrillation: Great benefit and potential but infrequently used. *Resuscitation* 2015;96:53–8.
[9] 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.
[10] Rea TD, Olsufka M, Bemis B et al. A population-based investigation of public access defibrillation: role of emergency medical services care. *Resuscitation* 2010;81:163–7.
[11] Ho CL, Lui CT, Tsui KL, Kam CW. Investigation of availability and accessibility of community automated external defibrillators in a territory in Hong Kong. *Hong Kong Med J* 2014;20:371–8.
[12] Chan TC, Li H, Lebovic G et al. Identifying Locations for Public Access Defibrillators Using Mathematical Optimization. *Circulation* 2013;127:1801–9.
[13] Pijls RWM, Nelemans PJ, Rahel BM, Gorgels APM. A text message alert system for trained volunteers improves out-of-hospital cardiac arrest survival. *Resuscitation* 2016;105:182–7.
[14] 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.
[15] 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.
[16] Perkins GD, Travers AH, Berg RA et al. Part 3: adult basic life support and automated external defibrillation: 2015 international consensus on cardiopulmonary resuscitation and emergency care science with treatment recommendations. *Resuscitation* 2015;95:e43–e69.
[17] Rumsfeld JS, Brooks SC, Aufderheide TP et al. 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.
[18] Wilson MH, Hinds J, Grier G, Burns B, Carley S, Davies G. Impact brain apnoea - A forgotten cause of cardiovascular collapse in trauma.

Resuscitation 2016;105:52–8.

[19] Henriksen FL, Schakow H, Larsen ML. The FirstAED global positioning system organizes a first responder team with distinct roles and ensures the possibility for early cardiopulmonary resuscitation and defibrillation [abstract]. *Resuscitation* 2015;96 Suppl:11.

[20] GoodSAM. (1st January 2015). Data Protection Policy. Available from: https://www.goodsamapp.org/assets/pdf/DataProtectionPolicy.pdf [last accessed 9th October 2017]

[21] The National Archives (2015). Social Action, Responsibility and Heroism Act 2015. Available from: http://www.legislation.gov.uk/ukpga/2015/3/contents/enacted [last accessed 9th October 2017]