Life Saving Apps: Linking Cardiac Arrest Victims to Emergency Services and Volunteer Responders

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Abstract. In cases of emergency, such as out-of-hospital cardiac arrests, the first few minutes are crucial for victims to receive care and have a positive outcome. However, emergency services often arrive on scene after those first few minutes, making any bridging solutions key. Finding a defibrillator or accessing a trained volunteer responder are some of the technological solutions that are being developed to support the chain of survival. This paper looks at technologies, in particular those linked to mobile apps that have been used to locate defibrillators and responder apps that enable responders to attend to nearby emergencies. We review a selection of apps and also assess the challenges and considerations for such apps.

Keywords. Mobile Applications, Defibrillator, Emergency Medical Services

Introduction

Survival rates of out-of-hospital cardiac arrest (OHCA) victims to hospital discharge are less than 10% in the United Kingdom (England 8.6% 2014-15[1]; Scotland 5% [2]; Northern Ireland <10% [3]). In comparison, the best-performing emergency medical services' systems achieve survival rates of 20-25% [4]. In England alone, a 50% increase in OHCA survival would lead to an additional 1000 lives saved each year [4].

The chain of survival [5], [6] is a sequence of time-sensitive interventions that need to be optimized in order to improve cardiac arrest outcomes. The four links are: (i) *early access to help* through recognition of the emergency and calling for help; (ii) *early cardiopulmonary resuscitation* (CPR) to maintain blood circulation to the brain and heart; (iii) *early defibrillation* to re-establish a normal heart rhythm; (iv) *post-resuscitation care* by emergency medical services (EMS) and hospitals to further improve the chances of survival. Different strategies are being used to target each link in the chain to impact on the improvement of the whole chain [7].

As the probability of survival decreases by approximately 10% for every minute without CPR and defibrillation [8] after cardiac arrest, the links (ii) and (iii) of the chain of survival need to be optimized as they are perceived to be the weakest links [4]. As emergency services cannot normally reach OHCA victims within the first few minutes, response by lay persons and volunteer responders is increasingly important. In addition,

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early location and use of defibrillators by laypersons at the scene of an event is critical for survival in the first few minutes before arrival of the EMS. Publicly Accessible Defibrillators (PADs) are a subset of Automated External Defibrillators (AEDs) that are accessible to members of the general public for use in the event of an emergency to shock the heart of an OHCA victim and are designed to be easy to use without any specific training. AEDs are small portable defibrillators that are often seen in public places such as transport hubs and shopping centres. PADs have been placed in communities since early 2000 in the UK [9].

In this paper, we focus on how technology and mobile apps in particular are used to support the location and deployment of PADs for use by lay persons or volunteer responders before the arrival of the EMS.

1. Methodology

In 2015, the British Heart Foundation [10] commissioned a feasibility study to look into the establishment of a national Publicly Accessible Defibrillator (PAD) database for the UK. No single national database of PADs exists in the UK.

A rapid review of the published and grey literature was undertaken to find answers to the four broad questions on effective PAD programme characteristics; facilitators and barriers to PAD use; the role of a PAD database in the effectiveness of a PAD programme; and the systems that have been used to map PADs. For the published literature, search strategies for MEDLINE and EMBASE were developed with the expertise of a subject librarian. Full-text articles were identified and reviewed. These were complemented with grey literature from bibliographical and opportunistic searches; International Advisory Group and stakeholder consultations; and project team expertise to search and review information from websites, in particular reports, policy documents and technical documents. In this paper, the mobile apps supporting defibrillation by lay persons have been identified through the published and grey literature searches, as well as through consultations with key stakeholders in the feasibility study, such as ambulance services, charities and community first responders.

2. Feasibility Study Findings

There is no direct evidence in the published literature that a database of PAD locations improves the effectiveness of a PAD system (placement and usage of PADs in public places for OHCA). However, a comprehensive PAD database, linked to ambulance service Emergency Operations Centres, is likely to have a vital role in dispatch-assisted PAD. An emergency service call handler can only guide a caller to a nearby PAD or dispatch a nearby PAD with a trained first responder, if the AED is registered on their database. Ambulance services usually have a regional PAD database that makes the location information available to their Computer-Aided Dispatch (CAD) systems.

There are a number of AED maps that provide information of the location of AEDs or PADs. Additionally, there are existing mobile phone alerting systems that activate lay rescuers to a potential OHCA, and indicate the position of an AED to them. These, however, rely on the existence and integration of information in a PAD database. There is little information in the published literature about methods to locate and verify AEDs and no data about the effect of such strategies on patient outcome.

2.1. AED maps

Numerous online maps and apps exist that provide locations of AEDs. In the UK, examples include the South Central Ambulance Service AED map [11], HeartSafe AED Locator [12], and Defibtracker [13]. These maps are maintained by groups such as ambulance services and community groups and they usually rely on their own sources of AED locations (AED manufacturers, AED provision and maintenance, regional ambulance services) and also encourage people to register their AEDs for inclusion. Besides location, information such as availability and accessibility may also be available. The level of maintenance of the information is unknown. Crowdsourcing is often used in campaigns to get the public involved in locating AEDs [14], [15]. These apps are mainly for public awareness.

2.2. Lay responder alert apps

The first type of alerting solution links nearby lay responders to victims of OHCA via app alerts on their mobile phone which can be triggered by 'alerter' apps, an example of this is GoodSAM [16]. These apps are able to direct the responders to the victim and to nearby PADs using maps. The second solution is an extension of the first and allows dispatch of lay responders by emergency services at the same time as an ambulance crew. This functionality is usually integrated within the CAD system and is available in systems such as FirstAED [17], PulsePoint [18], GoodSAM with the London Ambulance Service and HeartSafe Living [19]. The benefit of linking to the emergency services is that lay responders can be included as a resource, visible to the emergency services, allowing roles to be assigned such as one responder being sent to perform CPR while another is sent to retrieve an AED.

3. Discussion

A number of AED maps and locators as well as lay responder alert apps exist that aim to support the awareness of OHCA and use of AEDs by lay persons. While the usage of these solutions is increasing, there are a number of challenges that they need to overcome. The large number of apps is seen as potentially causing confusion among the public about which one as they have varying levels of comprehensiveness and up-to-date information. Concerns have also been raised about the appropriate use of AED locator apps, especially the view that they distract from calling the emergency services and performing timely CPR. Accuracy of information is also a concern, especially if they are to be used in critical situations – emergency services, in particular, need to make sure the information is reliable, especially when crowdsourced.

Some responder apps have addressed the potential issue of having too many responders responding to an emergency by considering the distances of responders from the victim and alerting the closest ones initially. Solutions are also looking at gaps in the coverage of AEDs and responders to improve coverage and response times. Responder apps are particular seen as potentially useful for OHCA that occur in the home, as these are the most common and less likely to be witnessed. While these are potentially useful to improve patient outcome, issues such as lack of mobile connectivity, especially in more rural locations, as well as lack of familiarity with apps by some population groups,

highlight that such solutions should be used to complement other solutions to ensure a population-wide improvement in survival.

In this paper, we have presented some of the apps and AED-related technological solutions that support cardiac arrest survival, especially for locating PADs and alerting volunteer responders to OHCA victims.

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