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Clinical Paper

Mobile phone technology identifies and recruits trained citizens to perform CPR on out-of-hospital cardiac arrest victims prior to ambulance arrival☆

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ABSTRACT

Aim: In a two-parted study, evaluate a new concept were mobile phone technology is used to dispatch lay responders to nearby out-of-hospital cardiac arrests (OHCAs).
Methods: Mobile phone positioning systems (MPS) can geographically locate selected mobile phone users at any given moment. A mobile phone service using MPS was developed and named Mobile Life Saver (MLS). *Simulation study*: 25 volunteers named mobile responders (MRs) were connected to MLS. Ambulance time intervals from 22 consecutive OHCAs in 2005 were used as controls. The MRs randomly moved in Stockholm city centre and were dispatched to simulated OHCAs (identical to controls) if they were within a 350 m distance. *Real life study*: during 25 weeks 1271–1801 MRs trained in CPR were connected to MLS. MLS was activated at the dispatch centre in parallel with ambulance dispatch when an OHCA was suspected. The MRs were dispatched if they were within 500 m from the suspected OHCA.
Results: Simulation study: mean response time for the MRs compared to historical ambulance time intervals was reduced by 2 min 20 s (44%), $p < 0.001$, (95% CI, 1 min 5 s – 3 min 35 s). The MRs reached the simulated OHCA prior to the historical control in 72% of cases. *Real life study*: the MLS was triggered 92 times. In 45% of all suspected and in 56% of all true OHCAs the MRs arrived prior to ambulance. CPR was performed by MRs in 17% of all true OHCAs and in 30% of all true OHCAs if MRs arrived prior to ambulance.
Conclusion: Mobile phone technology can be used to identify and recruit nearby CPR-trained citizens to OHCAs for bystander CPR prior to ambulance arrival.

1. Introduction

Survival from out-of-hospital cardiac arrest (OHCA) is generally low, about 5–10%, with the exception of a few controlled settings (casinos, airports and some cities).[1,2] The poor prognosis of OHCA is mainly explained by long time intervals between cardiac arrest, cardiopulmonary resuscitation (CPR) and defibrillation.[3] To increase bystander actions and to decrease time to defibrillation substantial resources have been put into CPR educational campaigns and in recent years into the spread of automated external defibrillators (AEDs) in public venues.[4] Still, the vast majority of the public with CPR training will never use their skills in real life and most public AEDs will never be deployed.[5] Mobile phone technology offers the possibility to locate single mobile phone users at any given moment. If designated lay responders immediately can be identified and recruited to the scene of nearby suspected OHCAs bystander CPR, CPR quality and the use of public access AED might be increased.

The aim of this paper is to describe how mobile phone technology and mobile positioning systems (MPS) can be used to identify lay responders and recruit them to the scene of nearby OHCAs prior to ambulance [emergency medical responders (EMS)] arrival. This paper describes the PILOT-part (focus on technological potentiality and time cuts in cardiac arrest treatment) of the RUMBA (Response to Urgent Mobile Message for Bystander Activation)-project. The RUMBA-project has an overall purpose of increasing survival after OHCA in Stockholm by the activation of CPR-trained citizens and mobilisation of public defibrillators.

2. Methods

2.1. Mobile positioning system (MPS)

A mobile phone positioning system (MPS) uses the infrastructure of a mobile phone network to obtain the geographical position of selected mobile phones at any given moment. In urban areas the accuracy varies between 0 and 75 m. In Sweden, where this study

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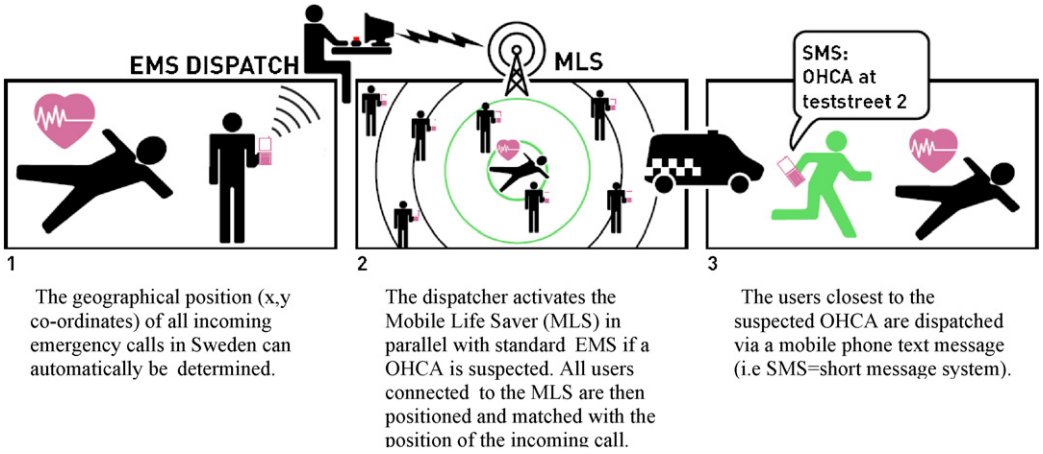

Fig. 1. Logistics and infrastructure of the Mobile Life Saver Service.

was carried out, all major mobile phone service providers use GSM (Global System for Mobile Communications) networks.

2.2. Mobile phone positioning and dispatching of lay responders

Tailored mobile phone services that use MPS to locate selected mobile phone users can be developed for different purposes. A computer-based application for mobile phone positioning and dispatch of lay responders was developed by LEKAB Communication Systems and is referred to as the *Mobile Lifesaver Service* (MLS). All participants connected to the MLS were called *Mobile Responders* (MRs). The MLS acts as an interface between the emergency medical service (EMS) data system and the MPS. The MLS handles the localisation and dispatching of MRs based on the data present in the EMS data system (Fig. 1). The location of all incoming calls to all dispatch centres in Sweden is determined. When the dispatcher receives an emergency call from a witness of a suspected OHCA the dispatcher activates the MLS in parallel with standard EMS. When the MLS is activated it uses the MPS to compare the current geographical position of all MRs connected to the MLS with the position of the incoming emergency call of the suspected cardiac arrest. If one or more MRs is present within a radius of 500 m (optional) from the suspected arrest the MRs receives a cardiac arrest alert with a computer generated phone call and a text message (i.e. SMS = short message system) with information about the place of the suspected cardiac arrest (Fig. 1). Additional information can, if needed, be sent to the MRs.

2.3. Study design

The study was carried out in two separate phases, a simulation study and a real life study. The simulation study evaluated the technology and potentiality in decreasing time intervals for mobile phone dispatched lay responder to simulated OHCAs compared to standard EMS. The real life study was a large scale study carried out in a real life environment with >1500 MRs and suspected OHCAs.

2.4. Simulation study

During one day in April 2008, 25 volunteers acting like MRs, each carrying a mobile phone connected to the MLS, received specific instructions to move randomly in an area of 2.3 sq km in downtown Stockholm (Fig. 2). The MRs received simulated cardiac arrest alarms as dialled up voice messages and SMS messages with information that was identical to the information presented by the EMS dispatchers (in terms of place of arrest, EMS time intervals and information available at the time of dispatch) for 22 consecutive real life cardiac arrests from 2005. These 22 cases that were used as historical controls had all taken place in public places in the city centre of Stockholm, Sweden and were all bystander witnessed. The MRs received alarms only if they happened to be within a distance of 350 m from the place of the simulated arrest. The assumption was made that this was the distance the MRs could walk in brisk pace in 3 min. Observers were placed at the same location as the historical arrests and the time from dispatching to arrival on scene for the MRs was measured. The time intervals for each alarm were then matched and compared to the EMS time intervals for the corresponding historical control. Watches of the observers were synchronised using atomic clock references.

2.5. Real life study

The real life study was carried out from June 2, 2010 until November 23, 2010. In the beginning of the study period, 1261 volunteers had signed up and been registered as MRs and were connected to the MLS. This number increased to 1801 at the end of the study. The MRs were recruited through mass media campaigns including advertisements in newspapers and at web sites. A project web site was launched for registration of participants and for information about the RUMBA project.[6] The only condition for registration was that the MRs had undergone CPR training.

The dispatchers at the EMS centre had been given instructions to activate the MLS in parallel with standard EMS if a witnessed non-traumatic cardiac arrest was suspected. The activation of the MLS was integrated into the EMS data system in order not to delay regular EMS dispatch. All suspected OHCAs where the MLS was triggered were included regardless of location or cause of the suspected OHCA. The MRs received cardiac arrest alarm calls and SMS messages if they were closer than 500 m from a suspected arrest. The dispatcher at the EMS centre had the possibility to send additional information to the MRs (i.e. door codes) via SMS.

The study area had a size of approximately 26 sq km and included the most densely populated areas of the Stockholm city area (Fig. 2) with a total number of 612,784 inhabitants.[7] On average each MR covered a circular area with a radius of 83 m in the beginning of the study period (decreasing to 68 m in the end of the study period due to an increase in the number of MRs).