Fahmi, I, & Nurachmah, E. Belitung Nursing Journal. 2018 December;4(6):530-536
Received: 15 September 2018 | Revised: 17 October 2018 | Accepted: 24 October 2018
https://belitungraya.org/BRP/index.php/bnj/index

REVIEW ARTICLE **ISSN: 2477-4073**

IMPLEMENTATION OF INTERNET-BASED EMERGENCY MEDICAL SERVICE: A SOLUTION TO IMPROVE RESPONSE TIME IN OUT-OF-HOSPITAL CARDIAC ARREST AND ITS POTENTIAL APPLICATION IN INDONESIA

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Abstract
Out-of-Hospital Cardiac Arrest (OHCA) is a condition when heart stops beating in out of the hospital. The majority of OHCA leads to death because of the delay response. Emergency Medical Service (EMS) system is needed to take care of the patients carefully. The development of Internet-based EMS is one of the best solutions, which is not only to improve the response time, but also to help patients to get the ambulance immediately. The aim of this paper is to understand how the Internet-based EMS can be used and how it will affect the patients with OHCA. Our findings indicated that the Internet-based EMS with mobile web service is critically needed for immediate response of cardiac arrest and accident situation in pre-hospital condition. However, the Internet-based EMS development needs to involve inter-sectoral agencies, such as fire fighter, police, and National Search and Rescue (SAR) Agent.

Keywords: Out-of-hospital cardiac arrest; emergency medical service; Internet-based emergency medical service

INTRODUCTION

Cardiac arrest is one of the most life-threatening emergency cases and requires fast response time and good management. Without the heart compression or defibrillation used, patients with cardiac arrest will be death within minutes (Vaillancourt & Stiell, 2004). The incidence of Out-of-Cardiac Arrest (OHCA) in the United States is recorded with the 360,000 victims, accounting for 15% of all deaths annually (Sasson et al., 2013). Centers for Disease Control and Prevention (CDC) has conducted a study of cardiac arrest events in the United States during the period October 1, 2005 until 31 December 2010, and obtained approximately 31,689 cases of OHCA (Sasson et al., 2013). Of these, less than 33.3% of cardiac arrest cases received resuscitation assistance from bystanders and only 3.7% received Automated External Defibrillator (AED) support before the Emergency Medical Service (McNally et al., 2011).

Emergency Medical Service (EMS) is the most important part of the entire health care system

Editor's Note: This article has been corrected on 22 June 2020. A separate erratum can be seen at https://doi.org/10.33546/bnj.1147 . The update is according to BNJ Policy on article correction.

at the pre-hospital. EMS can improve patient's health condition by providing optimal emergency services, developed in various medical emergencies such as heart attack, paralysis, labor, accidents, insect bites and others (Agrawal & Chavan, 2014). Currently, several organizations and governments trying to realize the importance of building a better emergency system to maintain patient's life during injuries due to the accidents and cardiac arrest (El-Masri & Saddik, 2011). In 1998, the Australian Department of Ambulance has developed an Internet-based Medical Emergency Service, and then Singapore through the Hospital & Emergency Ambulance Link (HEAL) has also implemented a wireless data communication system between ambulances and hospitals, and providing the information to the doctors in hospitals about the patient's condition before the patient arrived at the hospitals (El-Masri & Saddik, 2011).

Indonesia is a huge, diverse, and lower middle-income country that until recently had no internet-based EMS of pre-hospital care, included the patients with cardiac arrest. In the case of emergency in Indonesia, the patient or bystander calls the hospital emergency department to get an ambulance and professional medical personnel help. Whereas, OHCA events in several Asia-Pacific countries, including Indonesia, in the last three years amounted to 60,000 cases (Hock & Pin, 2014). This paper describes how the application of Internet-based Emergency Medical Service (EMS) to accelerate the provision of assistance in emergency cases, especially Out-of-Hospital Cardiac Arrest (OHCA) in Indonesia.

METHODS

The articles used in this literature are obtained from EBSCOHost, Google Scholar, Wiley Online Library, and ProQuest using the term "cardiac arrest", "emergency medical service", "out-of-hospital cardiac arrest" and "Internet-based Emergency Medical Service in lower-middle income countries". Literature relevant to clinical pathways published from 2013 to 2015 was reviewed. These terminologies are used in combination so that the literature found is more specific.

Cardiac Arrest

Cardiac arrest is a state that the cessation of cardiac mechanical function characterized by an absence of carotid pulse, absence of breathing and decreased consciousness, that occurs very quickly (American Heart Association, 2010; Lenjani et al., 2014). Causes of cardiac arrest occur due to heart disease, circulatory disorders, respiratory problems, metabolic disorders, or poisoning (American Heart Association, 2010). The American Heart Association (AHA) at 2015 divides the incidence of cardiac arrest into 2 types, namely Intra hospital of Cardiac Arrest (IHCA) and Out-of-Cardiac Arrest Hospital (OHCA) (American Heart Association, 2015). OHCA management includes the introduction and activation of an emergency response system, subsequent quality CPR, defibrillation and referral transport also follow-up care at the hospital (American Heart Association, 2015).

Emergency Medical Service (EMS)

The focus of EMS is on emergency medical care, hospital transportation, documentation of patient condition and treatment that has been implemented by medical team or paramedics (Blackwell & Kaufman, 2002). EMS is an organized medical response and treatment system that involves many people and comprehensive system. The purpose of EMS for the patients is to perform stabilization, treatment and timely transportation to a hospital that provides necessary medical care services (Blackwell & Kaufman, 2002). EMS has a complex framework, which each component of its system has an important role as part of a coordinated system of emergency care. The EMS components include EMS organizations or public bodies, communication and transport networks, trained doctors and nurses, and people with an understanding of the emergencies (Blackwell & Kaufman, 2002).

Internet-based EMS System

Internet-based EMS is the applications that can be used by anyone located at the scene to obtain emergency services. This application system has three main parts: (1) the emergency alarm, which will provide the emergency assistance and health services from the hospital. The alarm will send emergency messages to the family, application users and nearby hospitals; (2) emergency messages including location information; and (3) medical assistance requests (Agrawal & Chavan, 2014). All methodologies are shown in **Figure 1**.

Overall, the Internet-based EMS has 5 main components as shown in **Figure 2** (El-Masri & Saddik, 2011). The 5 components are: (1) Emergency requester device (emergency application on mobile device that has a geographical positioning system (GPS), (2) Main Central System (MCS), (3) Ambulance System (Each ambulance will be equipped with GPS system and navigation that will use the touch screen), (4)SOEHR: Smart Online Electronic Health Record, and (5) HEDS: Hospital Emergency Department System.

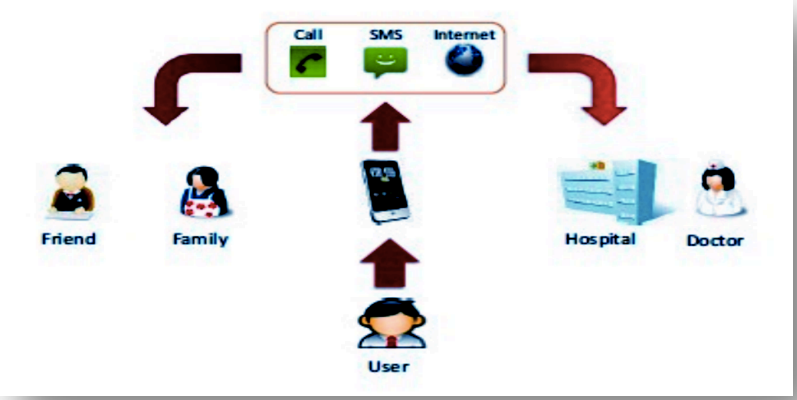

Figure 1 Application system (Agrawal & Chavan, 2014)

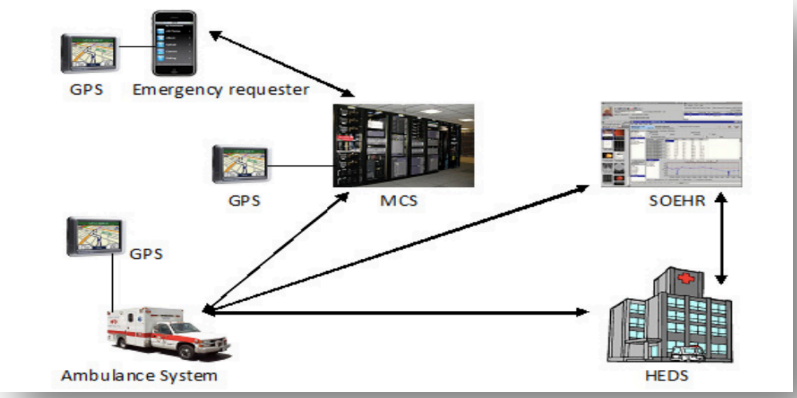

Figure 2 System and communication components (El-Masri & Saddik, 2011)

This Internet-based EMS system has two parts, namely client or user side and server (**Figure 3**). On the user side, all the user takes their own function, such as filling personally data, sending the emergency information, and editing the information. After that, the user's phone will be connected with EMS server via Internet, and then server will find the hospitals that are located nearest to the user. The user will inform to the hospital about patient's location and conditions, while the hospital will provide assistance. All database management is done by EMS server (Agrawal & Chavan, 2014).

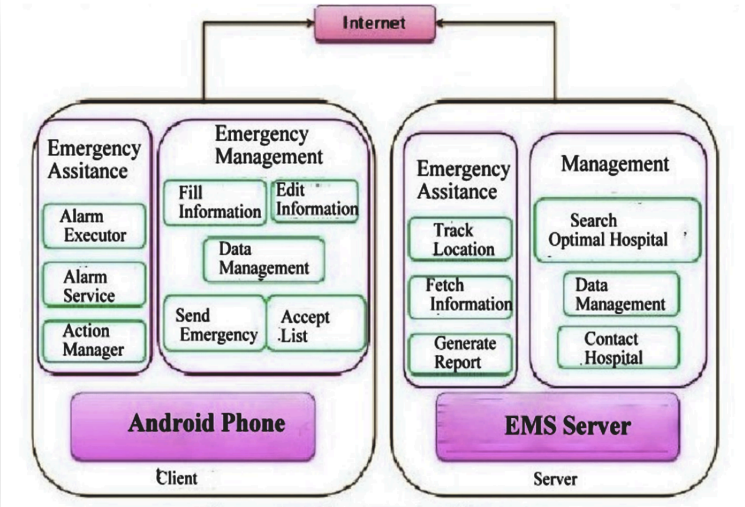

Figure 3 System architecture of EMS

ANALYTICAL FINDINGS

A total of 34 articles were obtained from our research. After screening and comparing among articles, we finally included 5 articles. The included studies described about the advantages of the implementation of Internet-based emergency system.

First study developed a software tool, the Emergency Response Community Effectiveness Modeler (ERCEM), which accepts parameters and compares the potential smartphone-initiated Samaritan/member response to traditional EMS response for a specific medical condition in a given geographic area (Khalemsky & Schwartz, 2017). From three experiments, this tool is expected to investigate anaphylaxis, hypoglycemia and opioid overdose occasions over distinctive population density characteristics, with advance stages to consider an arrangement of potential app selection levels. The study emphasizes how therapeutic condition, medicine adherence levels, community arranges participation, and population density are key variables in deciding the adequacy of Samaritan-based Crisis Reaction Communities (ERC). This study showed how effectiveness of mHealth applications for crisis reaction when compared with EMS (Khalemsky & Schwartz, 2017).

Another study identified the technological challenges that face healthcare services in terms of the EMS system (Sukkird & Shirahada, 2015). Based on a factual investigation from systematic review and the secondary data of World Health Organization (WHO) to distinguish desires of healthcare innovation related to maturing based on the benefit framework, the researchers indicated that co-creation concept in EMS system is emphatically noteworthy framework affecting

healthcare benefit development for chosen nations (Sukkird & Shirahada, 2015).

The third study is a blinded, randomized, controlled study using a mobile-phone positioning system that was activated when ambulance, fire, and police services were dispatched was used to locate trained volunteers who were within 500 m of patients with OHCA. Volunteers were at that point dispatched to the intervention group or not dispatched to the control group. The result of this study showed that a mobile-phone positioning system to dispatch lay volunteers who were trained in cardiopulmonary resuscitation (CPR) was significantly correlated with increased rates of bystander-initiated CPR among persons with out-of-hospital cardiac arrest (Ringh et al., 2015).

The fourth study used a smartphone application for locating and alerting nearby trained laymen/women in cases of OHCA and found that a smartphone application can be utilized to alert CPR-trained lay volunteers to OHCAs for CPR (Berglund et al., 2018). Supported by another study, which concluded that the measurement of OHCA recognition and CPR initiation by phone should be encouraged in dispatch centers as a key to initiating corrective measures (Travers et al., 2014).

POTENTIAL APPLICATION OF INTERNET-BASED EMS SYSTEM IN INDONESIA

The successful of basic life support is depending on the chain of CPR. The first step of the chain is to activate the EMS by accessing the local EMS telephone number (Sasson et al., 2013). The latest guideline of the AHA mentioned that the application of social media technology is to call the helper near the OHCA's patients. The impact of EMS telephone number is increasing significant score of the CPR performed by a companion with low hazard levels and large potential benefit (American Heart Association, 2015). Most OCHA events have been witnessed by the public, and immediate intervention is needed (Sasson, Rogers, Dahl, & Kellermann, 2010). The importance of integrated emergency service system, good Automated External Defibrillators (AED) and EMS provisioning access provide the good results in handling OHCA, so that the response time in cardiac arrest can be increased and the patient can be survived (Murakami et al., 2014).

The EMS application is developed to improve the quality of emergency services at the pre-hospital level, especially for OHCA events. EMS begins when an emergency services user device reports OHCA events through a simple mobile app installed on the device. The user can send quickly and easily find information about coordinates events and phone numbers to the Main Central System (MCS). After that, the mobile app will send the estimated location of the crash using GPS, and bystander and ambulance at the closest coordinates will be automatically activated. The another thing is MCS can accept the phone request if user wants to talk to the operator (El-Masri & Saddik, 2011). After the MCS receives an emergency service request from the user and again without human intervention, MCS sends requests to all bystanders, and ambulances are available to report their GPS coordinates. MCS will compare the coordinates of accidents and ambulances and send service requests to the nearest ambulance based on the map of the navigation system. The ambulance officer has 10 seconds to accept or reject the request. If the request is received, the MCS will send the event coordinates to the ambulance and bystander automatically, then the ambulance system shows the road map to the crash site while the bystander will see the location using the mobile app. Whereas if the ambulance officer declines the request or does not respond within 10 seconds, MCS will take the second nearest ambulance to the cases, assuming that within 10 seconds the ambulance position has not changed much (El-Masri & Saddik, 2011).

The speed of helper and ambulance will affect the quality of assistance provided. Research showed that sending patients using ambulances quickly to the intensive heart

hospitals to get percutaneous coronary intervention PCI services would make the patients survived. In addition, long-term responses showed the worse survival and poor neurological outcomes (Tsai et al., 2017). Another study in Spain described that OHCA helps by using mobile emergency teams could increase the patient safety (Rosell-Ortiz et al., 2017). The advantage of EMS application system compared to other systems is that the EMS system is fully computerized from start to finish and very comprehensive. In addition, the system is also capable of identifying hospitals according to the patient's conditions, and allowing communication of the patient's condition between the ambulance and the intended hospital (El-Masri & Saddik, 2011).

Despite the many advantages of this technology, there are some disadvantages of the system. First, because the system is internet-based, so it needs a good Internet network as well as a better server. In addition, the system involves many components that must be supported government systems, hospitals, and communities. So, the question is: “can it be applied in Indonesia?”

In accordance with the Decree of the Minister of Health of the Republic of Indonesia number 19 of 2016 on Emergency Management System, to realize the improvement of service quality of emergency system, the patients need an integrated system management. Integrated Emergency Management System (called as SPGDT) is an integrated and call center-based Emergency Management System using the 119 telecommunication access code by involving the community (MOH, 2016). Based on the Minister of Health's Decree, the possibility of implementing this Internet-based EMS system is very possible in Indonesia. This is because the system is more flexible and easier to use.

CONCLUSION

OHCA is a cardiac arrest that occurs outside hospital, which requires prompt relief and response time. To improve the response time and the ability of survivors to survive, a good Emergency Medical Service (EMS) service is required. The development of Internet-based EMS is one of the solutions to improve the emergency response time. This service uses a mobile-web service that has a complex component where the service involves users, servers, ambulances and hospitals as an EMS service system. This internet-based EMS application is potentially implemented in Indonesia, which an integrated Emergency Management System already exists with clear rules. It is recommended that emergency management at the pre-hospital level, especially for the OHCA cases outbreaks and accidents need to be a concern in order for the survivor to survive. The government of Indonesia needs to build the fast, flexible and efficient emergency services. The Internet-based EMS Application System should be developed by involving the police, fire department and other rescue departments, such as the National SAR Agency to align the emergency handling flow (Fahmi & Afriani, 2017).

Ethical Consideration

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Declaration of Conflicting Interest

None declared.

Funding

This study is supported by Faculty of Nursing, University of Indonesia

Authors Contribution

All authors equally contributed in this study.

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Cite this article as: Fahmi, I., & Nurachmah, E. (2018). Implementation of Internet-based emergency medical service: A solution to improve response time in out-of-hospital cardiac arrest and its potential application in Indonesia. *Belitung Nursing Journal,4*(6), 530-536. https://doi.org/10.33546/bnj.573