The Role of Informatics in Prehospital Emergency Resuscitation and Defibrillation

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Abstract

Out-of-hospital cardiac arrests account for a large number of deaths as the time window for successful resuscitation is very short. Timely call for help, resuscitation and defibrillation by laypersons are crucial for the survival and outcome of cardiac arrest victims. Good quality data and informatics play an important role in the effectiveness of the chain of survival. Information about defibrillator location is vital for emergency services to direct bystanders; informatics also helps to strategically place defibrillators for optimal use. Technologies, such as location-based systems are being used to keep track of defibrillators and also alert volunteer responders to emergencies. Informatics also plays a role in post resuscitation care and research by facilitating the linkage and interoperability of health data between different systems, such as ambulance service, hospital, and other health data such as cardiac arrest registries.

Introduction

In 2013 the emergency medical services (EMS) attempted to resuscitate approximately 28,000 cases of out-of-hospital cardiac arrest (OHCA), in England alone[1]. If more bystanders had the confidence and skills to call 999 quickly, deliver effective cardiopulmonary resuscitation (CPR) until the EMS arrive, and when appropriate use a public access defibrillator (PAD), the number of cases where the EMS could attempt resuscitation, and so save lives, would increase. The overall average survival to hospital discharge from the 28,000 EMS-treated OHCA in England is 8.6%, which is significantly lower than in other developed countries, such as North Holland 21%, Seattle, USA 20% and Norway 25%. PAD use is still low in OHCA, for instance, in the south of the UK, 1.75% was reported in 2012[2] and internationally, PAD use has been reported in between 0.5% and 4.9% of OHCA. In the event of a cardiac arrest, every minute without CPR and defibrillation reduces the chances of survival by about 10%, hence early bystander CPR and defibrillation being vital to improve patient outcome for OHCA in for first few minutes before the arrival of EMS.

The chain of survival (Figure 1[3]) ensures that an OHCA victim has the best chances of survival and outcome. Having the right information at each of the chain link is key to the effectiveness of the entire chain. In this paper, we present how digital technologies are used and how data is acquired, maintained, retrieved, and applied to support the chain of survival.

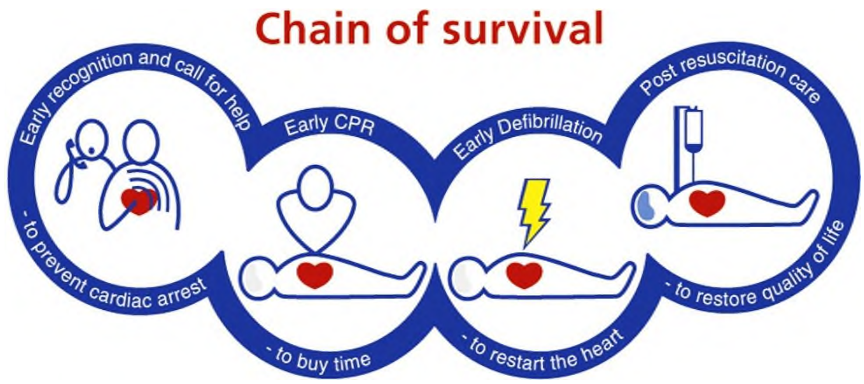

Figure 1: Chain of Survival[3]

Methods

A feasibility study into a national PAD database was conducted to gather and analyse findings to answer four main questions: (1) what is are the characteristics of an effective PAD programme? (2) What are the facilitators and barriers to PAD use? (3) How can a PAD database contribute to an effective PAD programme? (4) What systems have been used to map PADs and what are their effectiveness and cost? The study included a rapid review of the published and grey literature; consultations with key stakeholders; and international experience from an International Advisory Group.

Results

The first link in the chain of survival is preparedness, the early recognition of cardiac arrest and calling for help. The second link is for early CPR until emergency services arrive. Members of the public can prepare for such events through training and awareness sessions, many of which are conducted by ambulance services in the UK. A number of mobile apps are available for resuscitation training, but most focus on CPR with little coverage of use of a defibrillator[4]. Preparedness also includes having PADs in locations where OHCAs happen. PAD programmes have been set up in many countries to place AEDs so they can be used in cases of OHCA. Different approaches have been used to strategically place AEDs for optimal effectiveness, such as using OHCA incidence data, or use the characteristics of locations, for instance busy areas as airports and train stations, or type of activity, such as gyms or leisure centres. Mathematical models have also been used to strategically place AEDs for optimal geographical coverage while still being within reach of bystanders fetching the AED.

The third chain link is early defibrillation. A number of reasons account for the low use of automated external defibrillators (AEDs). One of them is the lack of information about their location – emergency services can only direct bystanders to a PAD if they know where it is. All 14 ambulance services in the UK have their own register of AEDs and they gather that information in a number of ways, including placing or maintaining the AEDs themselves; encouraging AED owners to report their devices via the manufacturer, online registration or registration campaigns. There are other groups that also have AED registers who may or may not work with the local ambulance service. The cluttered landscape for AED registration can cause confusion for AED owners and the public. The granularity and quality of information in the registers also vary. Some registers have only information about the location, availability

(24/7 or restricted times) and accessibility of AEDs (unlocked or code needed). While others also have information about consumables, such as battery and pads that have expiry dates. New methods of automatically locating and maintaining AEDs are starting to be available, for instance, the use of unique device identifiers, GPS-location, machine-to-machine communication, as well as self-testing and notification capabilities.

There are three main types of apps and systems for mapping AEDs. The first type are for awareness and usually have a map showing the locations of AEDs, e.g. South Central Ambulance Service app[5]. The second type alerts volunteer responders of OHCA events close to where they are located so they can respond. The third type involves the alert and dispatch of volunteer responders by emergency services directly from their computer assisted dispatch (CAD) systems – many systems in the second category have these features, e.g. PulsePoint[6], GoodSAM[7], FirstAED[8], Heartsafe Living[9]. Those two categories of systems keep a database of volunteer responders with their real-time locations and enable them to respond or decline requests to assist.

The fourth link in the chain of survival is post-resuscitation care, usually when the OHCA victim is taken by the ambulance service to hospital for follow-up care. To support this process, clinicians at the hospital need to know as much information as possible about the patient and how an AED was used. In the UK, patient records at the ambulance service are largely separate from the hospital records and handovers are not done using electronic means. Important information also lies within the AED itself and this information is not systematically downloaded. Challenges include the lack of standardization which means that information can be downloaded from devices using USB ports, memory cards, etc. and AED manufacturers have their own software to support the download process. The AED data is useful for clinical care and research, but some AEDs have limited memory and data may be lost if data is not downloaded regularly.

Linking back to preparedness is to prepare and return the used AED to its original location, ready to be used. Informatics plays a role in this step as owners need to be notified that their AEDs have been used and need to have the consumables replaced. Additionally, ambulance services set used AEDs as inactive on their CAD system, until they have been serviced. Increasingly automated solutions to support these processes will ensure the effectiveness of the chain of survival.

Discussion and Conclusion

Public access defibrillators play a vital role in the positive outcomes of OHCA victims, especially when they are used by laypersons before the arrival of emergency services. In this paper, we presented where informatics is used at different points along the chain of survival. The collection, maintenance and retrieval of AED location information is crucial for emergency services to be able to accurately direct lay responders to accessible, available and working AEDs. Advances in automatic alerts to first responders via mobile apps are increasingly involving the community in actively participating in emergency situations when ambulance services would often be too late for an OHCA victim. Increasing the automation for AED maintenance alerts to facilitate the process for AED owners should be considered, especially as an increasing number of PADs are being purchased. Finally, improving the linkage of electronic records between ambulance services and hospitals, as well as other relevant health and care data can help to build a better picture of how OHCA can be better managed and prevented.

Acknowledgement

This work has been supported by the British Heart Foundation as part of the National Public Access Defibrillation Database Feasibility Study.

References

1. Resuscitation Council UK, NHS England & British Heart Foundation. Consensus Paper on Out-of-Hospital Cardiac Arrest in England. (2015). https://www.resus.org.uk/EasySiteWeb/GatewayLink.aspx?alId=845
2. Deakin, C. D., Shewry, E. & Gray, H. H. Public access defibrillation remains out of reach for most victims of out-of-hospital sudden cardiac arrest. *Heart* **100,** 619–623 (2014).
3. Koster, R. W. *et al.* European Resuscitation Council Guidelines for Resuscitation 2010 Section 2. Adult basic life support and use of automated external defibrillators. *Resuscitation* **81,** 1277–1292 (2010).
4. Kalz, M. *et al.* Smartphone Apps for Cardiopulmonary Resuscitation Training and Real Incident Support: A Mixed-Methods Evaluation Study. *J. Med. Internet Res.* **16,** e89 (2014).
5. Burtoogle. AED Locator UK – Android Apps on Google Play.
6. https://play.google.com/store/apps/details?id=com.burtoogle.aedlocator&hl=en_GB
7. PulsePoint.org. http://www.pulsepoint.org/
8. GoodSAM. https://www.goodsamapp.org/
9. FirstAED. http://firstaed.com/
10. HeartSafe Living. http://heartsafeliving.com/