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Clinical Paper

Systematic downloading and analysis of data from automated external defibrillators used in out-of-hospital cardiac arrest☆

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ABSTRACT

Background: Valuable information can be retrieved from automated external defibrillators (AEDs) used in victims of out-of-hospital cardiac arrest (OHCA). We describe our experience with systematic downloading of data from deployed AEDs. The primary aim was to compare the proportion of shockable rhythm from AEDs used by laypersons with the corresponding proportion recorded by the Emergency Medical Services (EMS) on arrival.

Methods: In a 20-month study, we collected data on OHCAs in the Capital Region of Denmark where an AED was deployed prior to arrival of EMS. The AEDs were brought to the emergency medical dispatch centre for data downloading and rhythm analysis. Patient data were retrieved from the medical records from the admitting hospital, whereas data on EMS rhythm analyses were obtained from the Danish Cardiac Arrest Register between 2001 and 2010.

Results: A total of 121 AEDs were deployed, of which 91 cases were OHCAs with presumed cardiac origin. The prevalence of initial shockable rhythm was 55.0% (95% CI [44.7–64.8%]). This was significantly greater than the proportion recorded by the EMS (27.6%, 95% CI [27.0–28.3%], $p < 0.0001$). Shockable arrests were significantly more likely to be witnessed (92% vs. 34%, $p < 0.0001$) and the bystander CPR rate was higher (98% vs. 85%, $p = 0.04$). More patients with initial shockable rhythm achieved return of spontaneous circulation upon hospital arrival (88% vs. 7%, $p < 0.0001$) and had higher 30-day survival rate (72% vs. 5%, $p < 0.0001$).

Conclusion: AEDs used by laypersons revealed a higher proportion of shockable rhythms compared to the EMS rhythm analyses.

1. Introduction

Out-of-hospital cardiac arrest (OHCA) is a leading cause of death among adults in the industrialised world and survival rates have been reported below 10% over the past decades.[1] Early defibrillation comprises a key element in the chain of survival and increases survival rates when bystanders use an automated external defibrillator (AED).[2–7] Survival rate is as high as 74% after OHCA with rapid defibrillation.[2,8–10] These studies were performed at selected locations or with persons trained to use an AED and therefore does not reflect the general effect of public-access defibrillation (PAD). The proportion of shockable rhythm has declined and is now reported to be approximately 25%,[11–14] thus questioning the lifesaving potentials of the PAD. Recently, a large nationwide Danish study showed that 27.6% (95% CI [27.0–28.3]) of the victims with OHCA of presumed cardiac origin had a shockable rhythm.[15] Rhythm analysis was performed by the Emergency Medical Services (EMS) and data were based on 19.468 patients with OHCA witnessed by laypersons and in which resuscitation was attempted. The prevalence of the shockable rhythms may have been higher if an AED was attached to the victims prior to the arrival of EMS due to reduction in time from collapse to rhythm analysis. However, literature describing the rhythm analyses from AEDs, deployed by untrained laypersons, is scarce.[16]

Retrieval of AED data is not performed routinely in Denmark due to logistical and technical challenges. In addition, there is no

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standardised way of downloading the electrocardiograms (ECGs) and manage the data. In October 2011, a project was initiated in the Capital Region of Denmark (population 1.7 million) with systematic downloading of AED data to gain detailed information about the significance and potential of PAD when used by bystanders in both rural and urban areas of Denmark.

The aim of this study is to describe our experience with systematic downloading of deployed AEDs with the specific aim to compare the proportion of shockable rhythm when an AED was deployed by laypersons with the proportion from EMS rhythm analyses on arrival.

2. Methods

2.1. Study design and setting

This 20-month, prospective, observational study was conducted in the Capital Region of Denmark from October 27, 2011 to June 26, 2013. The Capital Region of Denmark is one of five administrative units in Denmark with a population of 1.7 million (approximately 30% of the Danish population). It comprises 2.561 km^2 and includes both urban and rural areas. Although belonging to the Capital Region, the Danish island of Bornholm (population 42.000, area of 588 km^2) was not included in this study due to logistical problems with delivery of AEDs to the emergency medical dispatch centre (EMD).

2.2. Defibrillators

In 2006, a network of public available AED's was established in Denmark and based upon voluntary registration by laypersons on a public accessible webpage (www.hjertestarter.dk). On June 26, 2013, 2.397 AEDs were registered on a location within the Capital Region of Denmark and of these were 2.120 registered for public use. Currently, 12 AED companies are registered in Denmark selling at least 20 different devices.

2.3. Study subjects and data collection

We included all cases of OHCA in the Capital Region of Denmark where an AED was deployed prior to arrival of EMS and the AED was subsequently delivered to the regional EMD. Two primary sources of data collection were linked to describe each OHCA adequately; the AED data downloaded by the EMD and the medical record from the admitting hospital. On the scene, the EMS provider collected the used AED. After the patient was admitted to definitive care, the AED was delivered to the EMD by taxi. Specially trained personnel downloaded the ECG data with the use of dedicated equipment. Data were immediately sent to the receiving hospital. Thirty health care professionals working at the EMD were trained to download the AED data through a 3-h course. Additionally, each person spent around 5 h per month updating instructions and testing new devices. The AED was returned to the owner by taxi after data retrieval. Transport and new patches were paid by the EMS.

The first author analysed all the AED ECGs and assessed the neurological status at day 30 using the cerebral performance category (CPC) scale (1, good cerebral status; 2, moderate cerebral disability; 3, severe cerebral disability; 4, coma or vegetative state; 5, brain death). Information about the CPC was retrieved from the patients' medical records. The treatment of cardiac arrest was in accordance with the European Resuscitation Council guidelines and the Utstein-recommendations were used for the reporting of resuscitation outcomes. The arrest was presumed to be of cardiac origin if it was not caused by trauma, exsanguination, drowning, intoxication, hypoxia or other obvious non-cardiac causes.

2.4. EMS system in the capital region of Denmark

The EMS system is two-tiered with initial EMD triage. OHCA results in the simultaneously dispatch of a primary unit staffed by two EMS providers trained in basic life support capable of using a defibrillator in AED-mode as well as in the dispatch of a physician-manned mobile emergency unit with the capability to provide advanced life support.

2.5. Ethics

Approval to retrieve the patients' medical records was obtained from The National Board of Health (J. no. 7-604-04-2/319/KWH). According to Danish law, approval from the Ethics committee was not required, whilst The Danish Data Protection Agency approved the processing of personal data (J. no. 30-0616).

2.6. Outcome

Our primary analysis focused on the proportion of initial shockable rhythm in patients with OHCA of presumed cardiac aetiology. We compared AED data with national EMS data obtained from the Danish Cardiac Arrest Register between June 1, 2001 and December 31, 2010.[15] Secondary end-points were return of spontaneous circulation (ROSC) and 1-month rate of survival with minimal neurological impairment (CPC 1).

2.7. Statistics

Statistical analyses were performed using Statistical Package for the Social Sciences 15.0 software (SPSS Inc., Chicago, IL, USA). Continuous data are reported as median with [25–75% range] unless otherwise indicated and comparisons were done using Mann–Whitney test. For categorical data we report absolute number with (proportion) with the use of with the use of χ^2-test or Fisher's exact test for comparisons. *P*-values <0.05 were considered statistically significant.

We calculated that a sample of 120 cardiac arrests would allow us to detect a difference in shockable rhythms between initial EMS and AED rhythm analyses from 25% to 50% with a statistical power of at least 80% at the 5% significance level.

3. Results

During the 20-months data collection period we recorded 1.866 OHCAs in the Region where resuscitation was attempted. A total of 121 AEDs were connected prior to arrival of the EMS and delivered to the EMD afterwards (Fig. 1). An AED was connected to 13 cases without cardiac arrest: two with chest pain, one with respiratory arrest, one with multiple stab wounds, one with seizures, one with supraventricular tachycardia, and six due to syncope. 91 cases were presumed to be of cardiac origin and the following report of data is based on these cases (Table 1).

3.1. Rhythm analyses and outcome

With the exception of two cases, information about initial rhythm could be downloaded from all AEDs delivered to the EMD. The analyses revealed an initial shockable rhythm in 55.0% (95% CI [44.7–64.8%]) of the victims. This was significantly greater than the proportion recorded by the EMS 27.6% (95% CI [27.0–28.3%], $p < 0.0001$). Shockable arrests were significantly more likely to be witnessed (92% vs. 34%, $p < 0.0001$), occur during exercise (28% vs. 2%, $p = 0.001$), and the bystander CPR rate was also higher (98% vs. 85%, $p = 0.04$) (Table 1). More patients with initial shockable rhythm achieved ROSC upon hospital arrival (88% vs. 7%, $p < 0.0001$) and