ORIGINAL ARTICLE

Public access defibrillation remains out of reach for most victims of out-of-hospital sudden cardiac arrest

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ABSTRACT

Introduction Public access defibrillation (PAD) prior to ambulance arrival is a key determinant of survival from out-of-hospital (OOH) cardiac arrest. Implementation of PAD has been underway in the UK for the past 12 years, and its importance in strengthening the chain of survival has been recognised in the government's recent 'Cardiovascular Disease Outcomes Strategy'. The extent of use of PAD in OOH cardiac arrests in the UK is unknown. We surveyed all OOH cardiac arrests in Hampshire over a 12-month period to ascertain the availability and effective use of PAD.

Methods A retrospective review of all patients with OOH cardiac arrest attended by South Central Ambulance Service (SCAS) in Hampshire during a 1-year period (1 September 2011 to 31 August 2012) was undertaken. Emergency calls were reviewed to establish the known presence of a PAD. Additionally, a review of all known PAD locations in Hampshire was undertaken, together with a survey of public areas where a PAD may be expected to be located.

Results The current population of Hampshire is estimated to be 1.76 million. During the study period, 673 known PADs were located in 278 Hampshire locations. Of all calls confirmed as cardiac arrest (n=1035), the caller reported access to an automated external defibrillator (AED) on 44 occasions (4.25%), successfully retrieving and using the AED before arrival of the ambulance on only 18 occasions (1.74%).

Conclusions Despite several campaigns to raise public awareness and make PADs more available, many public areas have no recorded AED available, and in those where an AED was available it was only used in a minority of cases by members of the public before arrival of the ambulance. Overall, a PAD was only deployed successfully in 1.74% OOH cardiac arrests. This weak link in the chain of survival contributes to the poor survival rate from OOH cardiac arrest and needs strengthening.

INTRODUCTION

Sudden cardiac arrest (SCA) accounts for approximately 30 000 out-of-hospital (OOH) events per annum in the UK.[1] The sudden, unpredictable and geographically challenging nature of this emergency makes rapid treatment difficult, and with every minute's delay without resuscitation, mortality increases by 7–10%.[2] These factors weaken the first three of four links in the Chain of Survival (early recognition and call for help, early cardiopulmonary resuscitation (CPR) and early defibrillation)[1] and contribute to the poor survival to hospital discharge rates of 2–12% across England.[2] SCA remains a significant health issue, being recognised in the recent Cardiovascular Disease Outcomes Strategy as a priority area for improved care.[3]

With the UK ambulance service's performance indicator being a response to at least 75% of cardiac arrest within 8 min, bystander resuscitation provides a vital therapeutic bridge while awaiting the arrival of trained responders and can increase survival rates twofold to threefold.[4–6] The additional availability of an automated external defibrillator (AED) to allow bystanders to deliver defibrillation prior to the arrival of emergency medical service (EMS) through public access defibrillation (PAD) improves survival still further.[7–10] The use of AEDs before the arrival of the EMS is associated with almost a doubling of survival after OOH cardiac arrest.[11]

With the knowledge that PAD is safe and effective when used by members of the public even with minimal or no first aid training,[12] AEDs have become more common in public places. Local and government programmes have aimed to make AEDs available in areas of high-population density such as shopping centres and transport hubs where they are likely to see service. The introduction of AEDs has now been underway for more than a decade and parallels the growing awareness of the public for immediate resuscitation following sudden collapse, fuelled by campaigns such as the recent 'push hard, push fast campaign' narrated by Vinnie Jones.[13] The first recommendation that PADs were an important contributor to outcome from SCA came in the Government policy paper of 1999 'Saving lives-our healthier nation',[14] and at about this time, the BHF began placing some PADs in public areas. In 2000, the Department of Health (England) and the British Heart Foundation introduced a formal PAD programme, placing 681 AEDs in 110 public places for use by volunteer lay first responders.[15 16] This achieved AED placement within 3–5 min of collapse in most cases, and within the first 4 years of the programme, 250 of the defibrillators had been used to deliver a least one shock, with 44 patients subsequently surviving to discharge.

More recently, the government's 'Cardiovascular Disease Outcomes Strategy', published in March 2013, has set as its aim to improve acute care by (inter alia) working to "…promote automatic external defibrillators (AED) site mapping/registration and first responder programmes by ambulance services and consider ways of increasing the numbers trained in cardiopulmonary resuscitation (CPR) and using AEDs".[3]

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Early studies of PAD suggested that the few AEDs available were actually underused even when trained bystanders were on scene,[7 17] and although distribution of AEDs is increasing,[8 18 19] little is known about the current availability and use of AEDs in the community. With clearly documented survival benefits of PAD programmes, it is important to understand how the early links in the chain of survival can be strengthened. We therefore reviewed all known OOH cardiac arrests in Hampshire, a county with a population of 1.76 million spread across a typical UK mix of urban and rural communities, in order to ascertain AED availability and use during OOH cardiac arrests that occurred over a 12-month period. We have not surveyed AEDs provided by community first responders (CFR) who are dispatched by the ambulance service ahead of the ambulance arrival, as these trained responders use mobile defibrillators in a more formal response. We have also surveyed the availability of AEDs particularly in areas of high public density.

METHODS

Study design

A retrospective review of all patients with documented cardiac arrest on scene in Hampshire, attended by South Central Ambulance Service (SCAS) during a 1-year period (1 September 2011 to 31 August 2012), was undertaken. Calls were reviewed to establish the known presence of a PAD. There are a number of differing definitions of what constitutes a 'public access defibrillator'. We have used a broad definition to encompass all defibrillators that are placed in the community and healthcare institutions (doctors surgeries, nursing homes, etc.) that may be available to individuals (both members of the public and those attending healthcare institutions) suffering a cardiac arrest outside hospital, prior to arrival of a formal ambulance response.

Additionally, a review and mapping of all known PAD locations in Hampshire were undertaken, together with a survey of public areas where a PAD may be expected to be located.

System overview

South Central Ambulance Service NHS Foundation Trust (SCAS) was established in 2006 following the merger of four ambulance trusts in the counties of Berkshire, Buckinghamshire, Hampshire and Oxfordshire. SCAS now covers approximately 3554 sq. miles, with a residential population of over four million. The emergency operations centre receives approximately 500 000 emergency and urgent calls each year.

Within the SCAS area, Hampshire covers 1400 sq. miles, comprising a mixed urban and rural population of 1.76 million, with approximately 12% being aged over 70 years.

Evaluation of 999 calls

All 999 emergency calls made to SCAS are recorded electronically, and details of the call stored on a central database. The nature of the call is classified according to Advanced Medical Priority Dispatch (AMPDS) categorisation, enabling interrogation of the database to identify probable cardiac arrest calls.

All incidents identified as a probable cardiac arrest in Hampshire from 1 September 2011 to 31 August 2012 were identified from a total of 217 463 emergency ambulance calls. These incidents were cross-referenced with the subsequent ambulance Patient Clinical Record to identify those where the attending ambulance crew confirmed a cardiac arrest on their arrival.

Identification of public AED (PAD) availability and use

For emergency calls from locations other than a private address, the ambulance call taker specifically asks the caller whether there is a defibrillator at the location. If the response if affirmative, further directions are given to encourage the caller to locate and use the PAD. The SCAS database records whether a PAD was available and whether it was used prior to the ambulance crew arrival. We recorded when the caller was aware of a PAD being available, when the PAD was located and its subsequent use.

Survey of public AED locations in Hampshire

SCAS maintains a database of known PADs, which is available to ambulance call takers and is aimed at improving PAD use. These locations, as at October 2012, were reviewed.

Additionally, we reviewed areas of high public density and clinical facilities in Hampshire, identified as having a greater chance of a cardiac arrest being witnessed.[20 21]

We undertook an internet search for specific public facilities in Hampshire, focusing on public sites know to be common locations for cardiac arrests,[20] including airports, train stations, sporting facilities and schools. Direct contact was made with these identified organisations and establishments to ascertain whether a PAD was available.

RESULTS

Identification of public AED (PAD) availability and use

During the year 1 September 2011 to 31 August 2012, SCAS recorded in Hampshire a total of 1035 calls confirmed as cardiac arrests. This equates to one OOH cardiac arrest, per 600 members of the public, per annum.

At 44 of the 1035 cardiac arrests (4.25%), the caller was aware of an AED being available at that location. The 44 cardiac arrests occurred in 34 different locations.

Of these 44 cardiac arrests, the AED was retrieved and attached to the patient in 18 cases (40.9%) prior to the arrival of SCAS or a CFR. Thus, overall a PAD was successfully deployed prior to arrival of the trained responders at 1.74% of all cardiac arrests.

Survey of public AED locations in Hampshire

In October 2012, SCAS were aware of 278 locations where a total of 673 PADs were available in Hampshire. Thirty locations within Hampshire had more than one PAD. Table 1 lists common PAD locations in Hampshire according to type of property. All large shopping complexes had multiple PADs available.

Table 1 Common public access defibrillator (PAD) locations in Hampshire, listed by type of property and ranked by numbers

Type of property	Number of PADs
Shopping centre	146
General commercial	129
Dwelling	92
GP surgery	86
Health centre	37
Nursing home	22
Golf	11
Sport/leisure centre	9
Residential homes	5

Table 2 Percentage of main public facilities within Hampshire with a known public access defibrillator (PAD) (*estimate), ranked by % PAD availability

	Number of facilities	No. of PADs (%)
Commercial airport	1	1 (100)
Police station	14	7 (50)
Football stadiums	2	1 (50)
GP surgeries	177	86 (48.6)
Major bus terminal	6*	2 (33.3*)
University	4	1 (25)
Golf courses	66	11 (16.7)
Nursing homes	173	22 (12.7)
Local government offices	45*	4 (8.9*)
Train stations	52	3 (5.8)
Community centres/village hall	40	2 (5)
Library	53	2 (3.8)
Dentists	195	1 (0.5)
Primary schools	135	5 (3.7)
Secondary education	60	2 (3.3)

Table 2 lists public locations identified as areas where a PAD may be of particular benefit,[20 21] together with details of known PADs at corresponding Hampshire locations. There are 52 train stations of varying sizes within Hampshire, but only three AEDs are located at these sites (South West Trains, personal communication, 2011).

DISCUSSION

With early defibrillation forming a key link in the chain of survival, and mortality increasing 7–10% for every minute's delay in defibrillation, the ability of bystanders to undertake basic life support and deploy a PAD prior to ambulance arrival significantly increases the chances of successful defibrillation and subsequent survival. The safety and benefits of PAD programmes for the estimated 6000–12 000 UK patients who suffer SCA in public places are now well established and, where implemented, can double survival from OOH cardiac arrest.[22]

These benefits have been recognised by the Department of Health, British Heart Foundation and Resuscitation Council (UK), for the past decade, all of whom have supported the introduction of PAD schemes across the UK. The recent Department of Health's 'Cardiovascular Disease Outcomes Strategy' (a document endorsed by Government, NHS England and Public Health England) has also recognised the need to "… consider ways of increasing the numbers trained in cardiopulmonary resuscitation (CPR) and using AEDs". We are unaware of any UK study examining the public use of AEDs nor any recent study examining the availability of AEDs in the community, which is important to ascertain if this important strategy is to be developed.

Overall, less than 2% of all OOH cardiac arrest victims had potential access to a PAD (although it is likely that at some cardiac arrests PADs were available but their presence unknown by the rescuer), and of those who did, only approximately 1% benefitted from its actual deployment. This disappointingly low figure is of the same magnitude as that recently reported by London Ambulance Service, where only 31/9657 (0.32%) cardiac arrests benefitted from PAD[23] and similar to the 2.1% reported from the USA overall,[11] where similar PAD programmes have been introduced. Although distribution of AEDs is increasing,[8 18] the usage rate is poor, even when trained bystanders are on scene.[7 17] We found that when a PAD was known to be available, it was only used in 40.7% of cases. The reasons for this are unclear but appear related to a lack of bystander willingness to use an AED in an emergency situation, poor 'visibility' or accessibility of the AED, mistaken concerns over legal liabilities and poor levels of community knowledge about PAD,[24] even following campaigns to improve public awareness.[25] It would appear that there remains a significant barrier with public perception and education regarding the use of PADs.

Although the frequency of use of deployed PADs is relatively low, there is an inverse relationship between the geographic density of PADs and the time to first shock, with a positive relationship to survival.[8] Where PADs are available, they are generally placed on the patient within 3–5 min.[19] At the time of the study, the location of the nearest AED for each cardiac arrest was unknown. Matching the cardiac arrest location to PAD coverage would be a useful undertaking in future studies in order to ascertain whether geographic distribution of PADs could be optimised.

With SCAS median ambulance response times to cardiac arrest calls of 6 min, the majority of patients with OOH cardiac arrest should receive defibrillation prior to ambulance arrival in locations where a PAD is available and used. Ambulance call takers now routinely question the caller about the availability of a PAD in order to prompt PAD use if available. In addition to wider availability of AEDs, a more comprehensive national system for recording the presence and site of an AED, accessible to all ambulance services and to bystanders who witness an arrest, could greatly improve survival rates from OOH cardiac arrest.

The commonest location for an OOH cardiac arrest outside the private home is a care home, which accounts for approximately 10% of cardiac arrests.[23] We identified a total of 18 PADs located at 658 registered care homes in Hampshire,[26] representing only 2.7% of all care homes. Cardiac arrests occurring on public transport systems are also relatively common, particularly at railway stations.[15 23 27] This contrasts with the very few PADs available on the Hampshire railway network, particularly considering the large number of passengers passing through rail stations or travelling on trains. During 2011–2012, people entered or left Hampshire's busiest station (Southampton Central Station)[28] on 5 951 224 occasions, a location without a PAD. Almost as common a location for an OOH cardiac arrest is a leisure or sports facility,[23] but only 9 of the estimated 68 facilities (13.2%) had a known PAD available. Although schools contain a mostly fit and healthy population, SCA, particularly during exercise, is known to occur as a result of inherited cardiac conditions. With approximately 400 000 primary and secondary school children in Hampshire,[29] we were disappointed that so few schools had a PAD available. This is a missed opportunity to educate school children about the benefits of bystander resuscitation and use of PADs, particularly as a greater awareness of PAD benefits would be likely to translate into greater placement of devices in the future.

In estimating the number of PADs in Hampshire, our telephone survey relied on contacted individuals passing accurate information. A number of the institutions contacted appeared unsure as to whether a PAD was available, reinforcing suggestions that education of potential users is a priority. We may therefore have underestimated the availability of a PAD at some locations, although PAD equipment is unlikely to be used if staff are unaware of its existence. This study has not examined the benefits of rapid defibrillation by CFR who are dispatched by the ambulance service ahead of the ambulance arrival. Although

CFR delivery of an AED generally takes longer than that achieved through PAD, it does offer some prospect of resuscitation for many patients who would otherwise receive no treatment.[19]

This study demonstrates that PAD is not available or is not used for the vast majority (over 98%) of people suffering an OOH SCA in Hampshire. While we have not surveyed other parts of the UK, we believe our findings would probably be similar elsewhere. There are relatively few PAD devices available, and when they are, there is a lack of confidence by the lay public in using them. As a consequence, a real opportunity to save lives is missed. Greater numbers of PADs are required to improve rapid deployment at OOH SCA, and more people should be trained in their use and in basic life support techniques. It is impractical to deploy PADs to cover the entire population, but any location that has 1000 adults over the age of 35 years present during normal business hours can expect one incident of SCA every 5 years[30]—a threshold that has been suggested as a level at which a PAD should be available.

From February 2007, responsibility for continuing the legacy of the National Defibrillator Programme was devolved to ambulance trusts. Although most ambulance trusts across the UK have community resuscitation departments or similar, these generally raise funds for AEDs and community responders schemes rather than AEDs placed in fixed locations in public areas. Fund raising campaigns to increase PAD availability should be commended, and the government has been petitioned to introduce defibrillators to all public buildings by 2017, together with providing staff with the appropriate training (http://epetitions.direct.gov.uk/petitions/29399). The need for a centrally coordinated database to maximise PAD availability is clear, preferably accessible to the ambulance service, so that whenever an OOH cardiac arrest is identified, the operator can immediately advise of an AED location. Improving confidence by members of the public in using the PAD would also appear to be a priority for successful deployment. Further, PAD publicity should focus on the safety, effectiveness and ease of use of AEDs and counter perceived fears over litigation if used by the public 'inappropriately', which are unfounded and hinder wider use.

This study highlights the need for both improved PAD availability and the need to improve bystander confidence in the use of these devices. With survival from OOH cardiac arrest doubling in cases where PAD is used,[11] there is a need to improve PAD availability, publicise locations and support bystanders in deploying the device. OOH cardiac arrest and PAD is an area appropriately prioritised by the Cardiovascular Disease Outcomes Strategy.[3]

Key messages

What is already known about this subject?
Public access defibrillation (PAD) prior to ambulance arrival is a key determinant of survival from out-of-hospital (OOH) cardiac arrest. Implementation of PAD has been underway in the UK since the late 1990s, with many public areas now having access to a community defibrillator. The importance of PAD has been recognised by the British Heart Foundation, Resuscitation Council and, more recently, the current DH 'Cardiovascular Disease Outcomes Strategy'.

How might this impact on clinical practice?
The poor survival rates from OOH cardiac arrest are in part related to delays in defibrillation. More defibrillators are required in public areas and more education is needed to give bystanders the confidence to use the PAD when it is available. Ambulance services also need to update and use PAD location knowledge to improve use of PADs.

What does this study add?
Despite several campaigns to raise public awareness and make PADs more available, many public areas have no recorded automated external defibrillator (AED) available, and in those where an AED was available it was only used in a minority of cases by members of the public before arrival of the ambulance. Overall, a PAD was deployed successfully in only 1.74% OOH cardiac arrests. This weak link in the chain of survival contributes to the poor survival rate from OOH cardiac arrest and needs strengthening.

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Contributors CDD conceived the study and is guarantor. ES and CDD collated and analysed the data. All authors discussed, drafted and revised the manuscript.

Competing interests All authors have completed the Unified Competing Interest form at http://www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare the following interests: CDD—Divisional Medical Director, South Central Ambulance Service; Immediate past Co-Chair, Advanced Life Support, ILCOR; Director, Prometheus Medical. HHG–National Clinical Director for Cardiac Disease, NHS England.

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HEART

Public defibrillator shortage helping to boost heart attack deaths away from hospital

Decade-long campaigns to increase public availability and awareness have gone unheeded

[Public access to defibrillation remains out of reach for most victims of out of hospital sudden cardiac arrest Online First doi 10.1136/heartjnl-2013-305030]

[Accelerating progress in community resuscitation Online First doi 10.1136/heartjnl-2013-305356]

The restricted availability of defibrillators, and poor understanding of how to use them, are helping to boost the number of deaths from heart attacks occurring outside hospitals, suggests a study of one English county, published online in the journal Heart.

This is despite several campaigns to increase the numbers of these life-saving devices in public places, and the acknowledgement of the importance of their role in the English government's Cardiovascular Disease Outcomes Strategy, published last March, say the authors.

Every minute of delay in administering resuscitation increases the risk of death after a heart attack by between 7% and 10%. Currently, only between 2% and 12% of those who have a heart attack outside hospital live to tell the tale, with the death toll reaching an annual 30,000 across the UK.

External defibrillators can be used to shock an arrested heart back into rhythm before the arrival of an ambulance. They don't require any specialist expertise, and can be used by anyone - which is particularly important as the evidence shows they can triple the chances of survival, say the authors.

They wanted to find out how available external defibrillators are, given the push for their deployment in public places, such as shopping centres and train stations, over the past decade.

They concentrated on one typical county of England - Hampshire - which has a mix of rural and urban settlements, covering an area of 1400 square miles, with a population of around 1.76 million, 12% of whom are aged over 70.

They reviewed all calls made to the South Central Ambulance Service between September 2011 and August 2012 following a heart attack. For all emergency calls made from locations other than a person's home, the service specifically asks whether the caller can access a defibrillator, and if so, instructions are given in how to use it.

During the study period, 1035 calls were made following confirmed cardiac arrests away from a hospital, equivalent to one for every 600 members of the public each year.

For 44 of these incidents (4.25%), in 34 different locations, the caller was able to access an external defibrillator, but only attach it to the victim in less than half the cases (18, 41%) before the arrival of the emergency services.

This gives an overall deployment rate of just 1.74% of all cardiac arrests recorded, which the authors describe as "disappointingly low."

Across the county, 673 external defibrillators were located in 278 places as of October 2012, including in all large shopping centres. But only just over one in 10 nursing homes, around one in 20 train stations, and a similar proportion of community centres/village halls had these devices.

The authors acknowledge that they did not investigate the availability of public defibrillators across the UK, but suggest that their findings "would probably be similar elsewhere."

They add: "The poor survival rates in [out of hospital] cardiac arrest are in part related to delays in defibrillation. More defibrillators are required in public areas and more education is needed to give bystanders the confidence to use the [device] when it is available."

In an accompanying editorial, Drs Mickey Eisenberg and Tom Rea, of King County Emergency Medical Services in Seattle, USA, acknowledge that it would not be possible to make these devices available everywhere.

But they say that they should be considered a public safety device of the same order and ubiquity as smoke alarms and fire extinguishers.

Currently defibrillators are expensive, but if regulations were relaxed a little, they could be manufactured more cheaply and still bring similar benefits, they argue.

"We can be thankful for the handful who are saved with early defibrillation, but we should be troubled by the many who are denied the benefit," they write. "Collectively, we need to strive to deliver this proven treatment. If we are successful, the next decade will bring a fuller realisation of the [device's] lifesaving promise."