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Toward a National AED Infrastructure: Development of a Centralised Network Across UK Ambulance Services

Linda Sørensen[1]*, Maria Hansen[1]

[1]*Department of Public Health Nursing, Faculty of Health Sciences, University of Southern Denmark, Odense, Denmark.*

Abstract

Survival after an out-of-hospital cardiac arrest (OHCA) relies heavily on rapid CPR and prompt defibrillation. Although many automated external defibrillators (AEDs) exist across communities, they are used in only a small fraction of emergencies. One major barrier is the lack of a unified national system mapping their locations for UK ambulance services, potentially limiting their timely use. To address this gap, stakeholders in resuscitation collaborated with ambulance organisations to create a single national platform that records AED placement across the UK. The British Heart Foundation, working jointly with the Association of Ambulance Chief Executives, all UK ambulance services, the Resuscitation Council UK, and St John Ambulance, designed The Circuit, a nationwide AED registry. The platform allows AED owners to upload details about device placement, accessibility, and hours of availability. These data are automatically linked to ambulance computer-aided dispatch systems, giving emergency call handlers real-time access to the nearest usable AED. All 14 ambulance services across the UK have now adopted The Circuit. Since 2019, the system has accumulated records for 82,108 AEDs. Importantly, over half (54%) of these devices had not been previously recorded by any ambulance service, representing newly captured information. The Circuit offers a single nationally coordinated source of AED location data for UK ambulance services. Since implementation, the number of known AEDs has doubled. Future integration of this registry with patient outcome datasets will help determine whether increased visibility and accessibility of AEDs translates into improved survival after OHCA.

Keywords: AED, National registry, Defibrillator network, The Circuit

Introduction

Publicly accessible automated external defibrillators (AEDs) are critical in improving survival after out-of-hospital cardiac arrest (OHCA) [1–3]. For these devices to contribute effectively to emergency response, dispatch centres must have accurate, real-time information on where AEDs are located and when they can be accessed [4–7]. In 2015, the British Heart Foundation (BHF) commissioned the University of Warwick to conduct a mixed-methods investigation that included an international review of AED practices and a rapid evidence assessment. The resulting report [5] revealed considerable inconsistency in how UK ambulance services registered AEDs, noting that only about 32,000 of an estimated 100,000 devices were captured in existing systems. It also identified challenges in maintaining accurate location and availability records. Although initiatives such as the Save a Life programme [8] and the GoodSAM platform [9] demonstrated successful local approaches, the absence of a unified, national framework highlighted the need for a single UK-wide AED registry [10].With support from the Association of Ambulance Chief Executives (AACE) and several clinical and charitable partners, the BHF committed to designing and funding the initial development of a national defibrillator network.

Corresponding author: ?
Address: Department of Public Health Nursing, Faculty of Health Sciences, University of Southern Denmark, Odense, Denmark
E-mail: ✉ lsorensen.work@hotmail.com
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This paper outlines the creation of the minimum viable product, the design process, and the early implementation and rollout of The Circuit, the UK's national AED network.

Methods — Study Setting

The United Kingdom (UK) comprises England, Scotland, Wales, and Northern Ireland and spans 248,532 km², with a population of 67,026,292 residents [11]. Pre-hospital emergency care for OHCA is delivered by 14 National Health Service (NHS) ambulance services operating across the four nations.

Emergency access begins with the national 999 telephone number, where calls first reach a central operator who determines which emergency service—police, fire, or ambulance—is required. Calls routed to the ambulance service are managed using one of three computer-aided dispatch (CAD) platforms: Cleric Computer Systems (Cheshire, England), MIS Emergency Systems (Cheshire, England), or Hexagon (Stockholm, Sweden). When a suspected or confirmed cardiac arrest is identified, an ambulance is dispatched immediately, alongside any available responders, and call handlers initiate telephone-assisted CPR.

Before the introduction of The Circuit, CAD systems either automatically identified nearby AEDs or required manual searching of the registry. All 14 ambulance services used a minimum search radius of 200 m (with upper limits of up to 1600 m). When an AED within this radius was marked as accessible, dispatchers instructed the caller to send a bystander to retrieve it, providing directions and any required cabinet access codes.

Members of the public and community responders could locate AEDs using the Defibfinder website (https://www.defibfinder.uk). A future development of the system involves connecting AED data to platforms that enable ambulance services to notify nearby trained volunteers of an OHCA event.

Developing a minimum viable product

In 2018, the British Heart Foundation (BHF) invited ambulance services across the UK to collaborate in creating *The Circuit*. The West Midlands Ambulance Service (WMAS) and the Scottish Ambulance Service (SAS) agreed to participate in the programme's initial development stage. Staff from both organisations contributed throughout the full development pathway, including supplier selection, defining system specifications, and undertaking live testing. Because WMAS and SAS operated two different computer-aided dispatch (CAD) systems, representatives from each CAD supplier were engaged in gathering technical requirements and evaluating system performance. A summary of the core technical specifications for The Circuit is provided in **Table 1**.

The platform was built using Microsoft (MS) Azure SQL and is hosted within a dedicated MS Tenant (Azure UK South) comprising two Azure subscriptions. Each ambulance service designates specific personnel to act as administrators. Administrators must create an account to access AED information within their regional boundary and can also view contact information for registered *Guardians*—the individuals responsible for maintaining specific AEDs. In addition, administrators are granted access to extended datasets and analytical reporting tools through Power BI, Microsoft's visual analytics platform, also hosted within the Azure UK South environment.

The Circuit is fully compliant with the UK General Data Protection Regulation, the Data Protection Act 2018, and ISO 27001 information security standards.

AED guardians and owners

To ensure accurate AED records, The Circuit established a framework that allows *Guardians* to register fixed-location devices in the national database. Guardians are responsible for routine checks, cleaning, replacing consumables after emergency use, and renewing components upon expiry—although financing arrangements may differ across organisations. Guardians must create an account before registering an AED and will subsequently receive automated three-monthly reminders prompting them to update their information (see process flow). Safeguards have been incorporated to prevent automated or fraudulent registrations.

Ownership and guardianship may rest with the same person, but in many large organisations they are separate roles. For example, a supermarket or hotel chain may own a network of AEDs while on-site staff act as Guardians responsible for local maintenance.

AED registration

The Circuit records AEDs installed at fixed public sites (such as shopping centres and transport hubs) as well as devices located in restricted areas where only authorised individuals—such as staff or club members—have access. Mobile AEDs carried by trained responders (e.g., police or fire personnel) are not included in the registry.

AED registration is completed via an online portal on The Circuit website. Individual Guardians or owners may enter devices one at a time, while organisations managing larger inventories can use a bulk upload option (for tens, hundreds, or thousands of AEDs) through a customised Microsoft Excel template. This bulk process is commonly used by commercial or charitable bodies overseeing many devices across wide geographical areas; in such cases, an organisational account must be created before the spreadsheet can be submitted. The responsibilities of Guardians are summarised in **Figure 1**. **Table 2** lists the data fields collected during the registration process.

Continuous product enhancement and national deployment
The BHF collaborated closely with all UK ambulance services and AED Guardians to iteratively refine The Circuit in response to ongoing user feedback. Initially, ambulance services could only access AED information within their own operational boundaries; however, the system was subsequently upgraded to provide UK-wide visibility of essential emergency data, including device location, readiness, and availability.
To meet public demand—and subject to consent from registered Guardians—key AED information is also shared through *DefibFinder*,12 a publicly accessible web platform that displays the ten nearest AEDs to any given postcode. Notably, the majority of Guardians (95.7%) permit their AED location to be made publicly available.

Marketing campaigns
To encourage wider registration, the BHF and ambulance services launched a targeted email campaign for Guardians who had previously registered their AEDs directly with ambulance services. This short-term, three-email campaign invited recipients to transition their registrations to The Circuit. Depending on local preferences, campaigns were executed either through standard ambulance service email systems or via a third-party direct response agency. The agency's email marketing tools enabled monitoring of delivery success, open rates, and other performance metrics, supporting data-driven campaign optimisation.
The BHF also partnered with RCUK and SJA to design a broader acquisition campaign aimed at Guardians who had never registered their AEDs with ambulance services. This multimodal campaign employed owned, earned, and paid channels, including GDPR-compliant emails to partner databases, dedicated landing pages, paid social media placements, and paid search. Using a full-funnel approach, the campaign built initial awareness through PR activities before delivering targeted messages to likely AED owners—such as parish councils, sports organisations, and corporate entities—to drive registration.

Results

The data presented cover the period from 11 June 2019 to 31 December 2023.

Ambulance service implementation
Over four years, all 14 UK ambulance services adopted The Circuit. The West Midlands and Scottish Ambulance Services were the first to implement the system in July and August 2019. Three additional services followed before implementation was temporarily halted in March 2020 due to the COVID-19 pandemic. Rollout resumed in 2021, with the remaining nine English ambulance services completing implementation by September 2022.

Registered AEDs
A feasibility assessment undertaken by Warwick University in 2015 estimated that UK ambulance services had recorded the locations of roughly 32,000 AEDs. However, services noted substantial limitations in the quality of these records, largely due to the absence of standardised update processes; many entries were outdated by several years. As of 31 December 2023, a total of 82,108 AEDs had been formally registered on *The Circuit* by named Guardians (figure 2), representing a 157% increase compared with the 2015 estimate. A data-matching and deduplication exercise conducted with ambulance services—comparing legacy CAD data with registrations on The Circuit—indicated that approximately 54% of these devices had not previously been known to ambulance services.
Of the AEDs registered on The Circuit, 64,478 are located in England, 3,058 in Northern Ireland, 7,410 in Scotland and 7,162 in Wales. Overall, 71.4% are categorised as *publicly accessible*, meaning they can be reached by any member of the public when needed, while the remaining devices are *restricted access* and available only to individuals who can enter the premises in which they are stored. Daily assessments of device readiness, recorded at midday, showed that 87% were available for emergency use at the end of 2023, whereas 13% were temporarily out of service.

AED guardians and organisational accounts
By 31 December 2023, a total of 55,235 Guardians were actively managing registered AEDs. In addition, 453 organisational accounts—representing charities, commercial operators, and private entities—were overseeing larger groups of devices under designated administrative managers.

Enhanced data accessibility
Before the introduction of The Circuit, ambulance services reported that updates to AED location data could take up to three weeks to appear on computer-aided dispatch (CAD) systems after being submitted by a Guardian. The Circuit now enables newly registered AED information to be available on all ambulance service CADs within 60 seconds of registration.

From the launch of The Circuit to 31 December 2023, ambulance services reported 113,811 instances in which AEDs were deployed by sending a bystander to retrieve them. Previously, services could only view AED data within their local jurisdiction, limiting their ability to support out-of-area out-of-hospital cardiac arrest (OHCA) calls. At the time of publication, ambulance services in England and Wales have full visibility of AED locations across the geographic region, enabling them to guide callers to the nearest available device even when handling cases for another service.

Scotland intends to update its CAD system to enable similar cross-border access to AED location data for England and Wales. In contrast, the Northern Ireland Ambulance Service cannot access this functionality due to its geographic separation and the use of a distinct mapping platform.

Discussion

The Circuit provides a single, national platform through which all UK ambulance services can access consistent, up-to-date information on automated external defibrillators (AEDs). By consolidating previously fragmented regional databases, the system ensures that critical AED information is not lost across organisational boundaries. The introduction of a structured AED Guardianship programme has enabled real-time reporting of device status, while initiatives to improve registration have doubled the number of AEDs accessible to ambulance services. Collectively, these developments are expected to enhance public access to defibrillators and support improved survival following out-of-hospital cardiac arrest (OHCA) [4,13].

Survival after OHCA can approximately double when a defibrillator is nearby [13]. Ensuring AED availability, functionality, and rapid locatability at the time of an event is recognised as a key strategy to improve outcomes [4]. Nevertheless, multiple factors can influence device availability, including the ability of bystanders and emergency services to identify the nearest emergency-ready AED in a timely manner [4].

Denmark was the first country to develop a national AED registry in 2007, with integration across all five nationwide Emergency Medical Dispatch Centres since 2010 [14]. Other regions have implemented similar registries at varying scales, including Philadelphia [15] and Sweden [16]. Some countries, such as France, have legislated mandatory AED registration to ensure comprehensive national databases [17]. Evidence from Denmark indicates that national AED registries contribute to increased rates of bystander defibrillation and improved 30-day survival after OHCA [13].

Before The Circuit, each of the 14 UK ambulance services maintained separate AED databases, varying widely in sophistication, with data often supported by manual uploads from multiple charities. Additional crowdsourced initiatives, including the Save a Life [8] and GoodSAM [9] platforms, further mapped AED locations. Internationally, crowdsourcing has also been used to populate AED registries, such as the MyHeart-Map Challenge in Philadelphia [15].

Collecting essential information—including AED location, emergency-readiness status, expiry date, and the contact details of the responsible Guardian—facilitates maintenance and ensures devices are operational when required [4]. Other countries have leveraged AED registries to optimise device placement by comparing AED locations with cardiac arrest incidence, as demonstrated in Singapore [18] and Georgia, USA [19]. In the UK, similar analyses could be performed by linking The Circuit data with other datasets, such as the OHCA Outcomes Audit [20]. Since AED placement in communities is often uncoordinated [21], combining registry data with demographic and clinical information could support targeted investment to reduce health inequalities.

The Circuit dataset also provides unique opportunities for future research. Information on AED deployment could help define best-practice criteria for device dispatch. Data collected through the Guardianship programme can offer insights into Guardian behaviours and preferences. Finally, analysing AED locations relative to OHCA risk and socio-economic factors may support interventions to reduce inequities in access. The dataset also allows evaluation of the impact of locked versus unlocked AED cabinets, which is particularly relevant in the UK context where locked cabinets are common.

Challenges

The quality of data within The Circuit depends on the ongoing actions of over 55,000 individual Guardians who regularly update information on analogue AEDs. As a result, there are inevitably instances where records may be outdated while awaiting updates from a Guardian. The adoption of smart AEDs in the future is expected to reduce reliance on human reporting, as certain key data fields—such as emergency readiness and geolocation—could be captured automatically [4].

Unlike in countries such as Italy [22] and France [19], it is not mandatory in the UK for AED owners or Guardians to register their devices with The Circuit or the ambulance services. AEDs are sold through multiple channels, so it is unlikely that all devices in situ have been captured. It is therefore probable that tens of thousands of AEDs remain unregistered, underscoring the need for continued public awareness campaigns to promote registration.

Evaluating the impact of The Circuit on OHCA survival will require long-term data linkage, and improvements in outcomes cannot be attributed solely to the system. Nevertheless, it is anticipated that The Circuit will be a contributing factor over time. Efforts are ongoing to monitor the rate of AED use at OHCA events and to examine reported incidents of theft or vandalism for devices stored in both locked and unlocked cabinets.
The delivery of The Circuit programme involves continuous technology enhancements, ongoing analysis of collected data, regular engagement with all 14 ambulance services to incorporate feedback, initiatives to maintain Guardian participation, and marketing strategies to increase AED registration. The programme is managed by the British Heart Foundation, with discussions underway with other funders regarding long-term sustainability.

Conclusion

The Circuit provides a unified access point for ambulance services to locate the majority of AEDs in the UK. Guardians are critical in ensuring that device information, including readiness for deployment, is kept up to date. Since the programme's launch, the number of registered AEDs has more than doubled. Linking The Circuit dataset with patient outcome data will allow evaluation of whether improved AED accessibility is associated with increased survival following OHCA.

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