

Potential impact of public access defibrillators on survival after out of hospital cardiopulmonary arrest: retrospective cohort study

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Abstract

Objective To estimate the potential impact of public access defibrillators on overall survival after out of hospital cardiac arrest.

Design Retrospective cohort study using data from an electronic register. A statistical model was used to estimate the effect on survival of placing public access defibrillators at suitable or possibly suitable sites.

Setting Scottish Ambulance Service.

Subjects Records of all out of hospital cardiac arrests due to heart disease in Scotland in 1991-8.

Main outcome measures Observed and predicted survival to discharge from hospital.

Results Of 15 189 arrests, 12 004 (79.0%) occurred in sites not suitable for the location of public access defibrillators, 453 (3.0%) in sites where they may be suitable, and 2732 (18.0%) in suitable sites.

Defibrillation was given in 67.9% of arrests that occurred in possibly suitable sites for locating defibrillators and in 72.9% of arrests that occurred in suitable sites. Compared with an actual overall survival of 744 (5.0%), the predicted survival with public access defibrillators ranged from 942 (6.3%) to 959 (6.5%), depending on the assumptions made regarding defibrillator coverage.

Conclusions The predicted increase in survival from targeted provision of public access defibrillators is less than the increase achievable through expansion of first responder defibrillation to non-ambulance personnel, such as police or firefighters, or of bystander cardiopulmonary resuscitation. Additional resources for wide scale coverage of public access defibrillators are probably not justified by the marginal improvement in survival.

Introduction

Defibrillation is an independent predictor of survival after cardiac arrests that take place out of hospital. Within 2 minutes of arrest, two thirds of patients have electrocardiographic evidence of ventricular fibrillation or tachycardia,¹ but the probability of a rhythm being amenable to defibrillation declines over time.² Even when an ambulance meets its target response time, some delay between the emergency telephone call and attendance is inevitable. Therefore, bystander

interventions must be considered together with efforts to minimise ambulance response times. To shorten time to defibrillation, locating automated external defibrillators in public places, for use by bystanders before the arrival of the ambulance, has been considered. The Department of Health is committed to providing 700 public access defibrillators in 72 sites across England and Wales.³ The present study aimed to estimate the potential impact of public access defibrillators on overall survival after out of hospital cardiopulmonary arrest.

Methods

Setting

The Scottish Ambulance Service is the sole provider of emergency pre-hospital ambulance care in Scotland. In the period of study no public access defibrillators were deployed in Scotland. Pre-hospital defibrillations were undertaken by ambulance personnel (98.9%) or general practitioners (1.1%).

Data

Ambulance crews collect data on all resuscitation attempts after out of hospital cardiopulmonary arrests. The forms include the time from the emergency telephone call to the arrival of the ambulance crew at the arrest scene, location of the arrest, and whether defibrillation was performed. Forms completed by hospital staff document whether patients admitted to hospital after cardiac arrest survive to discharge.

Cohort study

Our cohort comprised all out of hospital cardiopulmonary arrests over a seven year period from May 1991 that fulfilled criteria for having a cardiac cause,⁴ were not witnessed by the ambulance crew, and did not occur in an ambulance, ambulance helicopter, general practice, dental surgery, or non-acute hospital. We reached a consensus on individual arrest sites that were suitable for locating public access defibrillators, possibly suitable (if defibrillators were to be very widely distributed), or unsuitable (see also bmj.com). Actual survival to discharge was calculated for each of the three types of site.

Statistical model

We assumed that public access defibrillators could improve survival, at best, to that obtained by early

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Actual survival and predicted survival (assuming availability of public access defibrillators) by suitability of site of cardiopulmonary arrest for public access defibrillator. Figures are numbers (percentages) of arrests unless stated otherwise

| Site | Response time ≤3 min | | | Response time >3 min | | | Overall total | Actual overall survival | | Predicted overall survival* | |
|-------------------|----------------------|------------------------|-------------------|----------------------|------------------------|-------------------|---------------|-------------------------|------------------|-----------------------------|---------------------|
| | Total | Patients defibrillated | Patients survived | Total | Patients defibrillated | Patients survived | | No | % (95% CI) | No | % (95% CI) |
| Not suitable | 1136 | 739 (65.1) | 113 (9.9) | 10 625 | 5867 (55.2) | 381 (3.6) | 11 761 | 494 | 4.2 (3.8 to 4.6) | 494 | 4.2 (3.8 to 4.6) |
| Possibly suitable | 48 | 36 (75.0) | 4 (8.3) | 395 | 265 (67.1) | 16 (4.1) | 443 | 20 | 4.5 (2.6 to 6.4) | 37 | 8.3 (0.5 to 16.2) |
| Suitable | 340 | 294 (86.5) | 55 (16.2) | 2 306 | 1633 (70.8) | 175 (7.6) | 2 646 | 230 | 8.7 (7.6 to 9.8) | 428 | 16.2 (12.3 to 20.1) |
| All sites | 1524 | 1069 (70.1) | 172 (11.3) | 13 326 | 7765 (58.3) | 572 (4.3) | 14 850† | 744 | 5.0 (4.7 to 5.4) | 959 | 6.5 (5.7 to 7.2) |

*Model assumes that survival among patients where the response time was >3 minutes becomes equivalent to that in the ≤3 minute group were public access defibrillators to be available at suitable or possibly suitable sites.

†Excludes 13 patients with missing data on defibrillation, 97 with missing response time, and 119 with missing outcome.

ambulance attendance. We calculated predicted survival in the suitable and possibly suitable sites by applying the survival rate among patients attended in ≤3 minutes to the number of patients who experienced a delay of >3 minutes. We assumed that future arrests would have the same distribution of arrest sites and attendance times as the cohort data. We calculated two predicted overall survival rates, according to location of public access defibrillators only in suitable sites or in both suitable and possibly suitable sites.

Results

Cohort study

Over the seven year study period, 21 481 cardiopulmonary arrests were attended by the Scottish Ambulance Service, and 15 189 fulfilled the inclusion criteria. Of these, 12 004 (79.0%) occurred in sites not suitable for the location of public access defibrillators, such as the person's home or a friend's home, 453 (3.0%) occurred in possibly suitable sites, such as buses and multistorey car parks, and 2732 (18.0%) occurred in suitable sites, such as shops, places of business, and sports centres (see *bmj.com*).

In all types of site, patients who received defibrillation were significantly more likely to survive (8.0% of patients (95% confidence interval 7.4% to 8.6%) versus 0.6% (0.5% to 0.9%)). Among all patients, people who had an arrest in sites suitable for public access defibrillators had a higher baseline survival rate (8.7% (7.7% to 9.9%)) than people who had an arrest in possibly suitable sites (4.5% (2.7% to 6.8%)) or in sites that were not suitable (4.2% (3.8% to 4.6%)).

Overall, 70.1% of patients who were attended in ≤3 minutes received defibrillation, compared with 58.3% in patients who experienced longer delays (table). Among the 14 850 patients with complete data on ambulance response time and defibrillation, 744 (5.0% (95% confidence interval 4.7% to 5.4%)) survived to discharge from hospital.

Statistical model

The model predicted that locating public access defibrillators only in suitable sites would increase the number of survivors from 744 to 942, a survival rate of 6.3% (5.6% to 7.1%). If defibrillators were located in suitable and possibly suitable sites, the predicted number of survivors increased only slightly further to 959, a survival rate of 6.5% (5.7% to 7.2%) (table). In Scotland, with a population of 5.1 million, these rates equate to an average number of additional lives saved a year of 28 and 31, respectively.

A response time cut-off of 2 minutes rather than 3 minutes produced a predicted number of survivors of

1008 (6.8% (5.6% to 7.9%)) for suitable sites only and 1028 (6.9% (5.7% to 8.1%)) for suitable and possibly suitable sites. A cut-off of 4 minutes produced figures of 892 (6.0% (5.7% to 6.3%)) and 903 (6.1% (5.5% to 6.7%)).

Discussion

Cost effectiveness

Making public access defibrillators as widely available as fire extinguishers would greatly increase early access but would incur considerable costs and would be problematic in terms of maintenance and avoiding misuse and vandalism. Nichol et al modelled the incremental cost effectiveness of expanding access to automated external defibrillators beyond the emergency medical services in the United States.⁵ Their model excluded the 25% of arrests in the United States that occur in non-urban areas. They reported a baseline survival of 7.9%, which increased to a predicted 8.7% with lay responder defibrillation and to 11.8% with the police as additional first responders. The incremental costs per patient treated were estimated as \$7100 (£4590;

What is already known on this topic

Three quarters of all deaths from acute coronary events occur before the patient reaches a hospital

Defibrillation is an independent predictor of survival from out of hospital cardiac arrest

The probability of a rhythm being amenable to defibrillation declines with time

Interest in providing public access defibrillators to reduce the time to defibrillation has been growing, but their potential impact on overall survival is unknown

What this study adds

Most arrests occur in sites unsuitable for locating public access defibrillators

Arrests that occur in sites suitable for locating defibrillators already have the best profile in terms of ambulance response time, use of defibrillation, and survival of the patient

Public access defibrillators are less likely to increase survival than expansion of first responder defibrillation or bystander cardiopulmonary resuscitation

€7148) and \$9200, respectively, and the cost per additional quality adjusted life year (QALY) was \$44 000 and \$27 200. The authors concluded that these costs were similar to those of a number of existing medical interventions. However, their lay responder model used costs from a police responder pilot. It is likely that the cost per QALY of a public access scheme will be much higher, owing to the large number of defibrillators needed to provide adequate coverage. Unlike automated external defibrillators used by a police service, public access defibrillators are fixed to a location, and the location of future arrests cannot be predicted precisely from the location of previous arrests.

Conclusions

Targeted placement of defibrillators in public places such as airports and shopping centres, frequented by a large number of susceptible people, could, at best, increase overall survival from 5.0% to 6.3%. Further expansion of the coverage of public access defibrillators to enable lay use in all potentially suitable sites would require much greater resources and would pro-

duce little additional improvement in survival. Public access defibrillators should not be provided in preference to the expansion of defibrillation given by first responders or increased cardiopulmonary resuscitation by bystanders.

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Angiotensin converting enzyme insertion or deletion polymorphism and coronary restenosis: meta-analysis of 16 studies

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Abstract

Objective To assess the association between genotype at the insertion or deletion polymorphism of the angiotensin converting enzyme gene and risk of coronary restenosis after percutaneous coronary intervention.

Design Meta-analysis of studies before July 2001 that reported on these genotypes and risk of coronary restenosis after a percutaneous coronary intervention, with or without coronary stenting.

Results 16 studies, involving 4631 patients undergoing a percutaneous coronary intervention, yielded 1683 patients with restenosis after a mean weighted follow up of 5.5 months. The combined odds ratio for restenosis in people with the DD genotype was 1.23 (99% confidence interval 1.03 to 1.46). When studies were grouped by size, however, the combined odds ratios for restenosis in people with the DD genotype were 1.94 (1.39 to 2.71) for studies with less than 100 cases, 1.33 (0.92 to 1.93) for studies with 100-200 cases, and 0.92 (0.72 to 1.18) for studies with more than 200 cases (trend $P=0.02$). Similarly, when studies were grouped by genotyping procedures, significantly larger odds ratios were found in the studies that did not conceal disease status from laboratory staff and in the studies that did not use a second polymerase chain reaction amplification to reduce genetic mistyping.

Conclusion Compared with other studies, larger and more rigorous studies show a weaker association between the angiotensin converting enzyme gene DD genotype and restenosis. Publication bias or detection biases can produce artefactual associations at least as large as those that might be expected for common polymorphisms in complex diseases, suggesting the need for larger and more rigorous genetic epidemiological investigations than are now customary.

Introduction

Restenosis after a percutaneous coronary intervention is one of the principal limitations of this technique, occurring in up to 50% of patients undergoing the procedure without stenting and in about 20% of patients receiving stents.¹ Despite a lack of good evidence that susceptibility to restenosis is genetically determined, several studies have investigated polymorphisms that might be associated with restenosis. As the angiotensin converting enzyme insertion or deletion (I/D) polymorphism is strongly associated with plasma and cellular angiotensin converting enzyme concentrations, it has been considered a strong candidate.² It has been suggested that the incidence of coronary restenosis after a percutaneous coronary intervention is much higher in patients with the angiotensin converting enzyme DD genotype (which is associated with particularly high plasma angiotensin converting enzyme levels) than in others, but published

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