Potential impact upon community mortality rates of training citizens in cardiopulmonary resuscitation

ABSTRACT—In order to estimate the impact of a community programme of training in cardiopulmonary resuscitation (CPR), we reviewed all adult deaths in the city of Cardiff (population 292,600) during a 13-week period. Of 701 deaths, 70 were cases of fatal out-of-hospital cardiac arrest due to heart disease, for whom it was felt that CPR might have been of value. Only 34 (48.6%) deaths were witnessed, and in 22 of them the witness did not start CPR. In the majority of cases the ambulance service was not summoned immediately. We calculate that a community CPR training programme may, at best, reduce the community cardiac mortality rate by 7.5%, ie saving between 24 and 56 lives per 100,000 adult population per year; but more realistically, such a programme can only achieve a reduction of 0.4%, ie saving up to six lives per 100,000 per year. Although community CPR training programmes are likely to lead to only a modest reduction in community cardiac mortality rates, because countrywide there are many deaths, the total of lives saved would be significant. Implementation of such programmes should be carefully evaluated.

Coronary heart disease remains an important cause of death in both men and women in England and Wales [1]. Most coronary deaths occur outside hospital [2], and a large proportion are 'sudden'—occurring instantaneously or soon after the onset of symptoms [3]. Studies of resuscitation from pre-hospital cardiac arrest have demonstrated that long-term survival is feasible [4] and that the likelihood of such an outcome is associated with factors such as the presence of a witness to the collapse, bystander-initiated cardiopulmonary resuscitation (CPR), an initial rhythm of ventricular fibrillation (VF), and early defibrillation [5]. This has, in turn, led to the concept of a 'chain of survival' that emphasises 'early access, early CPR, early defibrillation and early advanced care' [6].

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In Wales various health-gain targets have been set to diminish the burden of cardiovascular disease [7]. To reduce deaths from 'heart attacks' and sudden cardiac arrest, health authorities have been instructed to train large numbers of citizens in basic emergency first aid (including CPR). Similar strategies have been advocated in England [8].

The objectives of this study were to devise a methodology for gaining detailed information of cardiac deaths in the community, to ascertain what proportion of such deaths occurred in the presence of a witness, to describe the actions of the witness in terms of calling for assistance and initiating CPR, and to estimate the potential impact upon community cardiac mortality rates of achieving bystander-initiated CPR in all witnessed cases.

Patients and methods

The study took place between 1 December 1991 and 29 February 1992 in Cardiff, South Glamorgan. The population of the city is 292,600 (adult population approx 220,000) with an average age of 40 years (21.6% being older than 64 years) [9]. The standardised mortality rate in 1990 was 97 [10]. The area is served by a university teaching hospital and two district general hospitals. All emergency ambulances were equipped with defibrillators though not all were manned by fully trained paramedics (capable of administering drugs and placing endotracheal tubes). In 1990, 22% of men and 16% of women reported that they had received training in CPR and felt confident in using the technique, though these proportions declined with age [11].

All death certificate returns to South Glamorgan Health Authority were inspected for the study period. The study population included all men and women of 18 years or older who were residents of the city and who developed cardiac arrest within the city limits, and for whom the cause of death was given on the death certificate as heart disease (codes 390–429, international classification of diseases, 9th revision). Specifically excluded at this stage were cases of congestive cardiac failure and/or cardiogenic shock. The remaining cases were termed 'provisionally included deaths'.

By analysis of emergency admissions records, hospital case-notes and ambulance report forms, cases

of cardiac arrest starting in hospital were identified and excluded. Cases of cardiac rupture (haemopericardium), trauma, suicide, drug overdose, or known terminal illness were excluded.

The remaining cases were termed 'study deaths', namely, fatal cases of out-of-hospital cardiac arrest, of presumed heart disease aetiology, in adults in which attempts at resuscitation could have been of value. Further information regarding these study deaths, the presence or absence of a witness, and attempts at resuscitation were gained from telephone interview of attending general practitioners, ambulance report forms and by access to coroner's files which contained police interviews of witnesses or those who discovered the collapsed patient.

Cases were defined as 'potentially preventable deaths' if the collapse had been witnessed (directly seen or heard) by a person capable of being trained and of performing CPR (older than 12 years of age with normal mental and physical function) but had been initial resuscitation delayed. Study deaths were designated as 'not preventable' if the collapse was unwitnessed or if CPR had been performed immediately by a witness.

Analysis

Statistical analysis is descriptive. An assessment of the impact of citizen CPR is made using an estimate of 'best case' (all potentially preventable deaths prevented) and 'worst case' (no potentially preventable deaths prevented), together with scenarios suggested from published results of attempted pre-hospital resuscitation [12,13].

Reductions in community cardiac mortality, expressed as a percentage with 95% confidence intervals, were obtained using the estimated number of lives saved during the study period as the numerator and the total adult cardiac deaths as the denominator. The range of lives saved per 100,000 of the adult population per year was calculated using the 95% confidence intervals for reduction in community cardiac mortality, assuming an adult population of 220,000 and no seasonal variation in cardiac deaths.

Results

In the 13-week period, 701 adult Cardiff residents died (Fig 1), 293 of them from heart disease. Of the 159 'provisionally included deaths' 89 were excluded: 59 because cardiac arrest started in hospital, 29 because of the presence of cardiac rupture or a non-cardiac cause for the cardiac arrest, and one because it was unclear whether cardiac arrest had started inside or outside hospital. There were therefore 70 study deaths: 41 men (58.6%) and 29 women (41.4%), mean age 72.9 years, range 45–97 years. Forty-nine (70%) cardiac arrests occurred in the patient's home, three at the place of work and 18 at other sites (eg places of entertainment or on board ambulances).

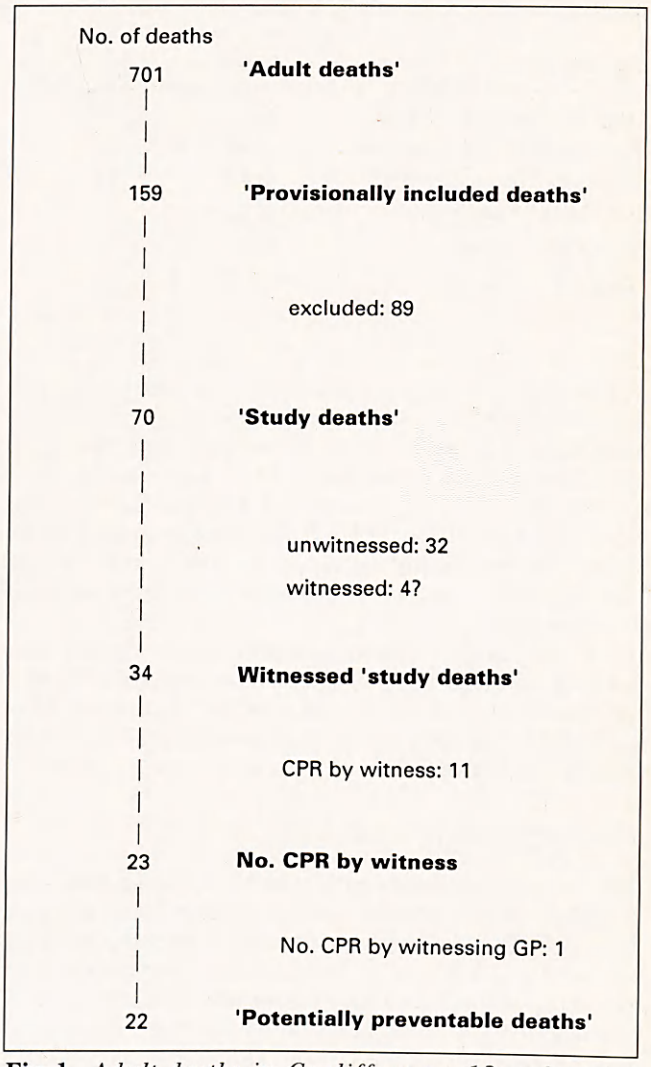

Fig 1. *Adult deaths in Cardiff over a 13-week period (1.12.91–29.2.92).*

Postmortem examination had been performed in 56 cases, and the certified causes of all study deaths are listed in Table 1. In all but five cases the cause of death was coronary heart disease.

During the 13-week study period, 34 (48.6%) of the study deaths were witnessed. However, seven were in the presence of someone acting as part of the emergency response system (general practitioner/ambulance crew) (Table 2). In four cases there was not enough evidence to ascertain whether a witness had been present or not. There were 32 unwitnessed cardiac arrests. Of the 34 witnessed study deaths, CPR was started immediately in 11, and in one case the general practitioner, who witnessed the collapse, judged resuscitation to be inappropriate. There were therefore 22 potentially preventable deaths (where a non-professional witness did not start CPR).

Table 1. Certified causes of study deaths.

Classification	ICD code	Number
Hypertensive heart disease	402	4
Acute myocardial infarction	410.0	10
Coronary atherosclerosis	414.0	44
Ischaemic heart disease	414.9	11
Aortic valve disease	424.1	1
Total		*70*

Having witnessed or discovered a cardiac arrest, individuals differed as to whom they first contacted for assistance (Table 3). For all study deaths, attempts were more likely to be made to contact the general practitioner than the ambulance service. None of the witnesses who first tried to contact a general practitioner, relative, friend or the police attempted CPR. Of the nine who contacted the ambulance service first, five also started CPR.

Considering the potentially preventable deaths: two received delayed CPR within two minutes of collapse, 12 received CPR more than four minutes after collapse, and eight were left without CPR before certification of death.

Potential impact of citizen CPR (Table 4)

The 'worst case' scenario is that all 22 potentially preventable deaths would have died even with prompt citizen CPR. The 'best case' would have resulted in 22 survivors—a reduction in community adult cardiac mortality of 7.5% and 24–56 lives saved per 100,000 of the adult population per year. Assuming 75% of the potentially preventable deaths were in ventricular fibrillation when an ambulance arrived [12], and a 35% discharge-from-hospital rate [13], a reduction in adult community cardiac mortality of 1.97% would be achieved, ie 2–19 lives saved per 100,000 of the adult population per year. In South Glamorgan we have reported that 46% of patients whose collapse is witnessed by citizens are found to be in ventricular fibrillation [14], and these patients have an 11.4% discharge-from-hospital rate. Using these figures with the 22 potentially preventable deaths, an estimated reduction in community adult cardiac mortality of 0.4% is achieved, ie up to six lives saved per 100,000 adult population per year.

Discussion

This study seeks to assess the potential impact of providing cardiopulmonary resuscitation to all cases of potentially preventable death, not the effectiveness of CPR. We do not present information regarding cases of cardiac arrest outside hospital who were subsequently discharged alive, and there is good evidence of the effectiveness of citizen CPR with regard to increasing the likelihood of such hospital discharge [6].

In common with other published studies [2,15] the majority of coronary deaths in our population occur outside hospital, usually in the home of the deceased. The spouse or a relative is the most likely witness of such a collapse, yet they are unlikely to start CPR. Another important finding is that witnesses of out-of-hospital cardiac arrest are unlikely to contact the ambulance service immediately, even though Britain has possessed a standard emergency telephone number (999) for many years. The tendency to try and contact relatives or a general practitioner before contacting the ambulance service has been reported anecdotally in a study from London [16], and undoubtedly leads to delay in the provision of emergency medical care. It would appear that those witnesses who call an ambulance first are also more likely to perform citizen CPR. However, we were unable to ascertain whether

Table 2. Type of witness of study deaths.

Witness	Number of study deaths	Started CPR
Spouse/relative	16 (22.8%)	2
Citizen	10 (14.3%)	2
Ambulance crew	5 (7.1%)	5
General practitioner	2 (2.9%)	1
Work colleague	1 (1.4%)	1
All witnessed	34 (48.5%)	11
Unwitnessed	32 (45.7%)	–
? Witnessed	4 (5.7%)	–
Total	*70 99.9%*	*11*

Table 3. First contact made by person witnessing or discovering cardiac arrest.

First contact	Witnessed	Unwitnessed
General practitioner	7 (20.6%)	14 (43.8%)
Ambulance service	9 (26.5%)	10 (31.3%)
Relative/friend	6 (17.6%)	0
Police	2 (5.9%)	2 (6.2%)
Other	6 (17.6%)*	1 (3.1%)
Member of public	1 (2.9%)	0
No one	3 (8.8%)†	0
Unknown	0	5 (15.6%)
Total	*34 (100%)*	*32 (100%)*

* Includes 5 cases in presence of ambulance crew.
† Includes 2 cases in presence of general practitioner.

Table 4. Estimate of effect of bystander-initiated cardiopulmonary resuscitation upon potentially preventable deaths during study period, and upon community adult cardiac mortality.

Scenario	Lives saved during study period	Lives saved per year	Reduction in community cardiac mortality	Lives saved per 100,000 adult population per year
'Worst case'	0	0	0	0
'Best case'	22	88	7.5% (4.5%–10.5%)*	24–56
75% in VF [12] 35% discharged [13]	5.78	23.1	1.97% (0.37%–3.57%)	2–19
46% in VF [14] 11.4% discharged	1.15	4.6	0.4% (0%–1.12%)	0–6

Figures in parentheses are 95% confidence intervals.
VF = ventricular fibrillation.

those who attempted CPR had received formal training; some citizens attempt CPR without such training [6]. The European Resuscitation Council guidelines for basic life-support emphasise the need to call for help before starting cardiopulmonary resuscitation in cases of cardiorespiratory arrest [17], and our findings support this advice.

One of the problems with a community CPR training programme is that individuals who come forward for training appear to be from a group who are less likely to witness a cardiac arrest [18]. Moreover, it has been estimated that any one individual is likely to see a cardiac arrest only every 25–112 years [19]. Thus some have advocated that CPR training should be aimed at the relatives of high-risk patients [6]. However, a study of sudden deaths in Glasgow demonstrated that only 15 of 72 high-risk individuals died in the presence of their spouse or another member of the family household, and concluded that the maximum impact of a 'family-based strategy' would have been to provide CPR to 4% of all deaths occurring outside hospital [2].

The estimated impact upon community cardiac mortality rates of providing citizen CPR to all witnessed cardiac arrests appears to be small. In an American study, of 2,074 witnessed collapses due to heart disease where the presenting rhythm was ventricular fibrillation, the survival rate to discharge from hospital was 34%. A sub-group of these patients who also received citizen CPR had a survival rate of 35% [13]. However, the average response time for attending emergency medical techniques was only four minutes, and this rapid response may have minimised the apparent effect of citizen CPR.

On the other hand, the provision of defibrillators and highly trained ambulance crew appears to have a greater effect. Eisenberg and colleagues reported a reduction in community cardiac mortality of 8.4% over a 17-month period in an area served by extended-trained paramedics compared with a reduction of 1.3% over the same period in an area served by basic ambulance crews [20]. Rowley and colleagues estimated that the provision of defibrillators on every emergency ambulance could save up to 40 lives per year in a population of 617,000: a 2% reduction in community coronary deaths and 6.6 lives saved per 100,000 of the population [21].

Our estimate of the impact of community CPR, assuming South Glamorgan resuscitation data [14], is a reduction in community cardiac mortality of 0.4% and up to six lives saved per 100,000 of the adult population per year. This is partly because only 7.5% of cardiac deaths fulfil our criteria for preventability (outside hospital, a 'reversible' cardiac cause, witnessed yet no CPR) and partly because of suboptimal discharge from hospital rates for cardiac arrests managed by the ambulance service.

Resuscitation outside hospital will not produce major reductions in community cardiac mortality but, because sudden cardiac death is so common, the absolute number of lives saved across the whole country will be appreciable.

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