CARDIOVASCULAR MEDICINE

Characteristics and outcome among patients having out of hospital cardiac arrest at home compared with elsewhere

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Objective: To describe the characteristics and outcome of patients who have a cardiac arrest at home compared with elsewhere out of hospital.
Patients: Subjects were patients included in the Swedish cardiac arrest registry between 1990 and 1999. The registry covers about 60% of all ambulance organisations in Sweden.
Methods: The study sample comprised patients reached by the ambulance crew and in whom resuscitation was attempted out of hospital. There was no age limit. Crew witnessed cases were excluded. The patients were divided into two groups: cardiac arrest at home and cardiac arrest elsewhere.
Results: Among a study population of 24 630 patients the event took place at home in 16 150 (65.5%). Those in whom the arrest took place at home differed from the remainder in that they were older, were more often women, less often had a witnessed cardiac arrest, were less often exposed to bystander cardiopulmonary resuscitation (CPR), were less often found in ventricular fibrillation, and had a longer interval between collapse and call for ambulance, arrival of ambulance, start of CPR, and first defibrillation. Of patients in whom the arrest took place at home, 11.3% were admitted to hospital alive, *v* 19.4% in the elsewhere group ($p < 0.0001$); corresponding figures for survival after one month were 1.7% *v* 6.2% ($p < 0.0001$). The adjusted odds ratio for survival after one month (at home *v* not at home; considering age, sex, initial arrhythmia, bystander CPR, aetiology, and whether the arrest was witnessed) was 0.40 (95% confidence interval 0.33 to 0.49; $p < 0.0001$).
Conclusions: Sixty five per cent of out of hospital cardiac arrests in Sweden occur at home. The patients differed greatly from those with out of hospital cardiac arrests elsewhere, and fewer than 2% were alive after one month. Having an arrest at home was a strong independent predictor of adverse outcome. Further research is needed to identify the reasons for this.

Patients who suffer from out of hospital cardiac arrest have generally a low chance of survival. However, the prognosis depends on the type of initial arrhythmia,[1] on whether there was bystander cardiopulmonary resuscitation (CPR),[2 3] and on whether the arrest was witnessed. A large proportion of cardiac arrests occur in the patient's home.[1 4 5] It has been suggested that these individuals have a particularly bad prognosis,[6] but the reasons for this are not well documented. In this survey we evaluated patients suffering from out of hospital cardiac arrest in terms of their age and sex, various factors at resuscitation, and their outcome in relation to whether the arrest took place at home or elsewhere. Our hypothesis was that patients having a cardiac arrest at home differ from those suffering from out of hospital cardiac arrest elsewhere in various ways, including a worse outcome. A final aim of the survey was to determine whether differences in age, sex, or various factors at resuscitation could explain a possible difference in outcome.

METHODS

Patients

All patients with cardiac arrest to whom the ambulance was called were included in the registry, with one exception—that is, individuals who had obviously been dead for a long time and whose bodies were not brought to hospital by the ambulance crew. For all other cases, a standardised form was completed by the ambulance crew. In this survey, crew witnessed cases were excluded, as were people who suffered a cardiac arrest within the two hospitals in the community. However, sometimes ambulances were called to patients in apartments (for the elderly or disabled) or other institutions and these were included in the survey.

METHODS

Our study is based on material collected by the Swedish cardiac arrest registry, which is maintained by collaboration between the Federation of Leaders in Swedish Ambulance and Emergency Services and the working group on CPR within the Swedish Society of Cardiology. Since 1993 the registry has been funded by the National Board of Health and Welfare. The registry, which is voluntary, started in 1990 with a few ambulance services. It has been successively joined by others, and in 1995 the registry was based on reports from 57 services. These covered five million of a total of 8.7 million inhabitants in Sweden at the end of the collection period.

Most of the ambulance organisations which were included initially served smaller communities with fewer than 100 000 inhabitants, but after a few years organisations in the larger cities such as Stockholm, Göteborg, and Malmö also joined the registry.

Study design

For each case of out of hospital cardiac arrest, the ambulance crew filled in a form with information including age, place of arrest, probable background to the arrest, bystander occupation, and a standardised description of the resuscitation

Abbreviations: CPR, cardiopulmonary resuscitation; PEA, pulseless electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia

Table 1 Age and other factors at resuscitation

Factor	Missing*	Cardiac arrest at home		p Value
		Yes (n=16 150)	No (n=8480)	
Sex (n (%))	722, 373			
Male		10 702 (69.4)	6259 (77.2)	<0.0001
Female		4726 (30.6)	1848 (22.8)	
Age (years)	316, 660			
Mean (SD)		68.1 (15.9)	65.9 (17.1)	0.003
Range		0–99	0–99	
Witnessed arrest (n (%))	1527, 827	8847 (60.5)	5265 (68.8)	<0.0001
Bystander CPR (n (%))	802, 343	4296 (28.0)	3942 (48.4)	<0.0001
Initial arrhythmia (n (%))	1700, 967			
VF		3809 (26.4)	3232 (43.0)	<0.0001
†Interval (min) between cardiac arrest and:				
Call for ambulance	1666, 803			
Median		5	4	
Mean (SD)		6.4 (19.5)	5.3 (22.2)	0.006
Start of CPR	2094, 1166			
Median		12	8	
Mean (SD)		14.5 (32.8)	10.1 (30.7)	<0.0001
Arrival of ambulance	1830, 934			
Median		12	10	
Mean (SD)		15.2 (36.4)	13.0 (29.9)	<0.0001
First defibrillation (if in VF)	498, 413			
Median		13	11	
Mean (SD)		14.9 (26.3)	13.3 (23.7)	<0.0001
‡Interval (min) between call for ambulance and:				
Arrival of ambulance	645, 422			
Median		6	5	
Mean (SD)		8.8 (22.6)	8.1 (21.5)	0.009
First defibrillation (if in VF)	251, 247			
Median		9	7	
Mean (SD)		10.7 (20.8)	9.7 (24.8)	NS

*Number of patients in the two categories with missing information.
†Only witnessed cases included.
‡All cases included.
CPR, cardiopulmonary resuscitation; VF, ventricular fibrillation.

procedure, including intervention times and interventions such as bystander CPR (a bystander was defined as someone starting CPR before the arrival of the first ambulance, regardless of profession), defibrillation, intubation, drug treatment, and status at the first contact.

In ambulances with manual defibrillators, the rhythm was defined as ventricular fibrillation (VF), pulseless electrical activity (PEA), or asystole. For automated external defibrillators, the rhythm was defined as shockable rhythm (VF) or non-shockable rhythm. In this study, VF includes patients with pulseless ventricular tachycardia (VT).

To establish the time of cardiac arrest in witnessed cases, the ambulance crew was instructed to interview the bystanders about the delay from arrest to call. It was stressed in written instructions that a maximum effort had to be made to obtain these times. The ambulance crew recorded the time of arrival at the patient's side, the time of starting CPR, the time of the first defibrillation, the time of a palpable pulse, the time of starting transport to hospital, and time of arrival at hospital. The number of direct current (DC) shocks was recorded. The ambulance crew also classified the aetiology of the arrest in nine different diagnostic categories (heart disease, lung disease, trauma, drug overdose, suicide, drowning, suffocation, sudden infant death syndrome, and other), based on clinical assessment and bystander information. Their diagnosis was accepted for this study and no further control was made among initial survivors during their hospital stay.

The immediate outcome was reported by the ambulance crew as dead on arrival, dead in the emergency department, or admitted alive to hospital.

The form was filled in during and immediately after the acute event. Each form was reviewed by the medical director and a copy was sent to the central registry. Another copy was subsequently sent with additional information about whether the patient was dead or alive after one month. If there was uncertainty about whether or not the patient had died, this was established from the national registry of deaths.

No absolute validation of adherence to the protocol was undertaken, as it would have been extremely complicated and expensive to do this in 57 different ambulance districts. Instead, a questionnaire was sent to all the medical directors of the ambulance organisations participating in the registry. They were asked to estimate the accuracy of the representation of the study population. They estimated the percentage of the study population that was wrongly omitted from the study in their own district; the proportions varied from 0–30% (mean 5%).

Statistical methods

The distributions of the variables are given as means and medians. For comparison between groups with ordered and continuous variables, Fisher's non-parametric permutation test[7] was used. For comparison of dichotomous variables between groups Fisher's exact test was used. Stepwise logistic regression was used to select independent predictors for multivariate analyses.

RESULTS

In all, 24 917 patients were included in the survey. Information on the place of cardiac arrest was available in 24 630 (98.8%). Among these, the cardiac arrest took place in the home in 16 150 cases (65.6%). The following comparisons are between those individuals in whom the arrest took place at home and those in whom the arrest took place outside the home.

Age, sex, and factors at resuscitation

These data are shown in table 1. Patients in whom the cardiac arrest took place at home differed from the remainder in the

Table 2 Type of bystander and type of CPR

Variable	Missing*	Cardiac arrest at home		p Value
		Yes	No	
Type of bystander	182, 111	n=4114	n=3831	
Lay person†		2728 (66.3%)	1701 (44.4%)	<0.0001
Medical personnel		718 (17.4%)	1559 (40.7%)	<0.0001
Ambulance personnel		79 (1.9%)	150 (3.9%)	<0.0001
Police		38 (0.9%)	137 (3.6%)	<0.0001
Other		634 (15.4%)	518 (13.5%)	0.018
Type of bystander CPR	493, 372	n=3803	n=3570	
Chest compression and ventilation		2466 (64.8%)	2835 (79.4%)	<0.0001
Chest compression only		327 (8.6%)	336 (9.4%)	NS
Ventilation only		1010 (26.6%)	399 (11.2%)	<0.0001

Values are n (%).
*Number of patients with missing information in the two categories.
†On a few occasions more than one category was involved.
CPR, cardiopulmonary resuscitation.

Table 3 Survival at one month in various age groups

Age (years)	Missing*	Cardiac arrest at home		p Value
		Yes	No	
0–18	13	9/285 (3.2%)	12/158 (7.6%)	NS
19–35	10	10/388 (2.6%)	34/348 (9.8%)	<0.0001
36–70	163	151/6479 (2.3%)	242/3418 (7.1%)	<0.0001
>70	180	104/8484 (1.2%)	234/3728 (6.3%)	<0.0001

Values are n surviving / n evaluated (survival rate (%)).
*Number of patients with missing information.

following ways: they were older, they were more often women, the arrest was less often witnessed, they were less likely to have received bystander CPR, they were less often found in ventricular fibrillation, and there was a longer interval between collapse and call for ambulance, arrival of ambulance, start of CPR, and first defibrillation when found in ventricular fibrillation. There was also a longer interval between call for an ambulance and the arrival of the ambulance.

Type of bystander and type of CPR

In those who were exposed to bystander CPR, the procedure was more often undertaken by lay persons when the arrest took place in the patient's home (table 2). Furthermore, combined chest compression and ventilation was done less frequently when the arrest took place in the patient's home.

Aetiology

The underlying aetiology was more often judged to be heart disease in patients with a cardiac arrest at home than in those with an arrest elsewhere (73.8% *v* 69.8%).

Admitted to hospital alive

Patients in whom the cardiac arrest took place at home had a much lower initial survival rate than those with an arrest elsewhere (11.3% *v* 19.4%; $p < 0.0001$). The corresponding values for patients found in a shockable rhythm were 21.5% *v* 30.1% ($p < 0.0001$), and for those found in a non-shockable rhythm, 7.8% *v* 11.4% ($p < 0.0001$).

Alive after one month

Survival to one month after the event was much lower among patients with a cardiac arrest at home than in patients with an arrest elsewhere (1.7% *v* 6.3%; $p < 0.0001$). The corresponding values for patients found in a shockable rhythm were 4.7% *v* 12.2% ($p < 0.0001$), and for patients found in a non-shockable rhythm, 0.6% *v* 2.1% ($p < 0.0001$). Table 3 shows survival among patients suffering from cardiac arrest at home and outside home in various age groups.

Multivariate analysis

In a multivariate analysis, age, sex, initial arrhythmia, bystander CPR, whether the arrest was witnessed, aetiology, and place where the arrest took place (that is, home *v* not at home) were included in the model (n = 16 362, comprising 66% of the total series). Cardiac arrest at home was a very strong independent predictor of a low chance of survival one month after the event (odds ratio 0.40, 95% confidence interval (CI) 0.33 to 0.48; $p < 0.0001$). The corresponding values in the univariate analysis were odds ratio 0.26, 95 CI% 0.22 to 0.30; $p < 0.0001$.

DISCUSSION

In this survey we found that two thirds of people who suffered an out of hospital cardiac arrest had it in their home. This is in good agreement with previous experience, though the proportions have varied between 59–84%.[1 4–6 8–20]

We found that patients who had a cardiac arrest at home differed notably from those having an out of hospital cardiac arrest elsewhere. In many ways individuals who had an arrest at home had characteristics that forecasted a poor outcome. These included an older age,[21 22] a lower occurrence of bystander CPR,[2 3] a lower occurrence of a witnessed cardiac arrest,[1] and a longer interval between collapse and the arrival of an ambulance.[23] Our findings are in agreement with previous surveys. Thus, Litwin and colleagues also found that patients who had a cardiac arrest at home were older, less often had a witnessed arrest, less often received bystander CPR, and were less commonly found in ventricular fibrillation,[6] while Jackson and Swor found that patients who had a cardiac arrest outside their homes were about four times more likely to receive bystander CPR.[16]

Although these differences suggest a worse outcome among patients having a cardiac arrest at home, we found that in a

multivariate analysis, even when these differences were taken into account, the place of arrest—that is, having the arrest at home—was still a strong independent predictor of an adverse outcome. This is in agreement with previous observations[16] and suggests that there are other factors which we did not incorporate in the multivariate model that explain at least part of the adverse outcome among these patients. Such factors include comorbidity, and in our study there was a complete lack of information on this. One might expect that as the individuals who had cardiac arrests at home were older, they would also have a higher prevalence of cardiovascular diseases such as congestive heart failure and diabetes. Furthermore, they would be expected to suffer more often from disorders such as cancer and other chronic diseases, all likely to make them more vulnerable to an adverse outcome.

Psychosocial factors might also influence the outcome. One might expect that patients who suffer from cardiac arrest at home would be more prone to loneliness and depression, factors that are known to affect the outcome of patients suffering from various manifestations of coronary artery disease.[24 25]

Our observation that the chance of survival is much lower if the patient has a cardiac arrest at home is in agreement with previous reports.[5 6 9]

Study limitations

It was estimated that about 5% of the patients fulfilling the inclusion criteria were wrongly omitted. Furthermore, 23% of the study population came from the three large cities in which 25% of the Swedish inhabitants live. We do not suspect that either of these two limitations would seriously bias the results.

The time of the arrest is often inaccurate in bystander witnessed cases, and in unwitnessed arrest it is not known.

Implications

In patients who have a cardiac arrest at home in Sweden, the chance of survival is extremely low (less than 2%). Only a little over one in four patients receives CPR before the arrival of the ambulance, and only one in four is found to be in ventricular fibrillation. To increase survival in this subset of patients, they would need to have better access to bystander CPR. This might be accomplished either by a more effective telephone CPR or by a better system for educating spouses of patients with heart disease in the use of CPR. However, it is probable that education and support measures will improve survival only in witnessed instances of cardiac arrest.

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APPENDIX

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