



## Characteristics and outcome among children suffering from out of hospital cardiac arrest in Sweden<sup>☆</sup>

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### Abstract

**Aim:** To evaluate the characteristics, outcome and prognostic factors among children suffering from out of hospital cardiac arrest in Sweden. **Methods:** Patients aged below 18 years suffering from out of hospital cardiac arrest which were not crew witnessed and included in the Swedish cardiac arrest registry were included in the survey. This survey included the period 1990–2001 and 60 ambulance organisations covering 85% of the Swedish population (8 million inhabitants).

**Results:** In all 457 children participated in the survey of which 32% were bystander witnessed and 68% received bystander CPR. Ventricular fibrillation was found in 6% of the cases. The overall survival to 1 month was 4%. The aetiology was sudden infant death syndrome in 34% and cardiac in 11%. When in a multivariate analysis considering age, sex, witnessed status, bystander CPR, initial rhythm, aetiology and the interval between call for, and arrival of, the ambulance and place of arrest only one appeared as an independent predictor of an increased chance of surviving cardiac arrest occurring outside home (adjusted odds ratio 8.7; 95% CL 2.2–58.1).

**Conclusion:** Among children suffering from out of hospital cardiac arrest in Sweden that were not crew witnessed, the overall survival is low (4%). The chance of survival appears to be markedly increased if the arrest occurs outside the patients home compared with at home. No other strong predictors for an increased chance of survival could be demonstrated.

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### 1. Introduction

Among patients who suffer from out of hospital cardiac arrest a minor fraction are children. They differ in many aspects from adults in their characteristics and outcome when suffering from out of hospital cardiac arrest [1,2]. Most previous reports dealing with children who suffer from out of hospital cardiac arrest come from urban areas.

Since 1990 there has been an ongoing registry in Sweden reporting on the majority of patients suffering from out of

hospital cardiac arrest in whom cardiopulmonary resuscitation (CPR) was started. This report aims at describing factors associated with an increased chance of survival among children who suffer from out of hospital cardiac arrest. Our hypothesis was that factors that have been shown to be associated with an increased chance of survival among adults also are associated with an increased chance of survival among children.

### 2. Patients and methods

#### 2.1. Patients

Patients with cardiac arrest to whom the ambulance was called were included in the registry, with one exception. Pa-

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tients who had obviously been dead for a long time and whose bodies were not brought to hospital by the ambulance crew were excluded. For the others, the standardised form was completed by the ambulance crew. In this survey, crew witnessed cases, patients aged <18 years and patients in whom CPR was not started were excluded. Patients who suffered from cardiac arrest within the hospitals in the community were not included. However, sometimes the ambulance was called upon to service houses and other institutions and these patients were included in the survey.

## 2.2. Methods

This study is based on material collected by the Swedish Cardiac Arrest Registry, which is a collaboration between The Federation of Leaders in Swedish Ambulance and Emergency Services (FLISA) 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 more and in 1995 the registry was based on reports from 57 ambulance services. At the end of the collection period the registry covered 85% of the total population in Sweden.

## 2.3. Study design

For each case of out of hospital cardiac arrest, the ambulance crew completed a form with information such as age, place of arrest, probable background to the arrest, bystander occupation and a standardised description of the resuscitation procedure, including 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 (AEDs), the rhythm was defined as a shockable rhythm (ventricular fibrillation) 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 interval between arrest and the 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 first defibrillation, the time of a palpable pulse, the times of starting transport to hospital and arrival at hospital. The number of direct current (DC) shocks was recorded. The ambulance crew also classified the aetiology of the arrest into nine different diagnostic categories (heart disease, lung disease, trauma, drug overdose, suicide, drowning, suffocation, sudden infant death syndrome (SIDS) 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 hospitalization.

Immediate outcome was reported by the ambulance crew as dead on arrival, dead in the emergency room (ER) or admitted alive to hospital.

The form was filled in during and immediately after the acute event. Each form was sent to the medical director and a copy was sent to the central registry in Göteborg. Another copy was sent subsequently with additional information about whether the patient was dead or alive after 1 month. If there was uncertainty about survival this was validated according to the National Registry of Deaths. All data were computerized in a database in Göteborg.

No absolute validation of adherence to the protocol was performed, 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 incorrectly omitted from the study in their own district. Percentage values from this survey varied from 0 to 30% (mean 5%).

## 2.4. Statistical methods

### 2.4.1. Descriptive statistics

Distribution of variables are given as percentages and mean  $\pm$  standard deviation and median.

### 2.4.2. Statistical analyses

For comparison of dichotomous variables between groups, Fisher's exact test was used [3].

### 2.4.3. Multivariate statistical analyses

A stepwise logistic regression was used to select independent predictors to dichotomous dependent variables.

## 3. Results

In all there were 38,750 patients reported to the registry during the time of the survey. Among them no resuscitation attempts was provided by the ambulance crew in 8111 (21%). Among the remaining 30,639 patients, 3374 were excluded since they were crew witnessed. Among the remaining 27,265 patients information on age was available in 26,177 cases (96%). Among them 457 (2%) were below 18 years of age. Thus, this study concerns 457 children suffering from out of hospital cardiac arrest in Sweden between 1990 and 2001 in whom resuscitation attempts were provided by the ambulance crew.

Table 1  
Patient characteristics ( $n = 457$ )

Age (years)	
Mean $\pm$ S.D.	5 $\pm$ 6
Median	2
Sex (%) (27) <sup>a</sup>	
Women	38
Bystander witnessed (%) (67)	32
Bystander CPR (%) (34)	68
Initial rhythm (%) (110)	
Ventricular fibrillation	6
Interval between (median; min)	
Collapse – call for ambulance (only witnessed cases)	8
Call for – arrival of ambulance	7

<sup>a</sup> Number of patients with missing information.

Table 2  
Aetiology (missing information,  $n = 23$ )

	%
Cardiac	11
Drug overdose	2
Accident	10
Lung disease	4
Suffocation	5
Suicide	3
Sudden infant death syndrome	34
Drowning	12
Other	21

### 3.1. Characteristics (Table 1)

Table 1 shows the characteristics in terms of age, sex and the various factors at resuscitation in the study cohort. It is important to note was that only 32% were bystander witnessed. In 68% bystander CPR was initiated but only 6% of patients were found in ventricular fibrillation.

### 3.2. Aetiology (Table 2)

Table 2 shows the distribution of patients according to aetiology. In children the most common aetiology was sudden infant death syndrome.

### 3.3. Place of cardiac arrest (Table 3)

Table 3 shows, where the cardiac arrest took place. In children, the most common place was at home (65%).

Table 3  
Place of arrest (missing information,  $n = 3$ )

	%
At home	65
At institution	5
On the street	9
At work	0.2
On another place	20

Table 4  
Survival to 1 month

			OR	95% CL
Age (years)				
$\leq$ Median	7/229	3.1		
$>$ Median	11/214	5.1	1.72	0.66–4.75
Sex				
Women	4/161	2.5		
Men	13/256	5.1	2.10	0.73–7.56
Bystander witnessed				
Yes	5/121	4.1	1.07	0.33–3.08
No	10/258	3.9		
Bystander CPR				
Yes	14/278	5.0	1.68	0.59–6.03
No	4/131	3.0		
Initial rhythm				
Ventricular fibrillation	4/20	20.0	6.98	1.78–23.10
No ventricular fibrillation	11/318	3.5		
Cardiac disease				
Yes	4/46	8.7	2.45	0.67–7.20
No	14/374	3.7		
Sudden infant death syndrome				
Yes	3/149	2.0		
No	15/271	5.5	3.73	1.25–16.01
Place of arrest				
At home	7/293	2.4		
Other place	11/147	7.5	3.30	1.27–9.16
Interval between call for and arrival of ambulance				
$\leq$ Median	14/226	6.2	4.38	1.40–19.20
$>$ Median	3/202	1.5		

### 3.4. Factors of importance for survival in univariate analysis (Table 4)

Information on survival was missing in 14 patients (3%). In the remaining 443 patients, 18 were alive 1 month later (4%).

Table 4 shows the odds ratio and 95% confidence limits for survival at 1 month. All factors shown in Tables 1–3 are listed in the table. There were four factors being significantly associated with an increased chance of survival. They were, in order of significance: (1) the aetiology was not sudden infant death syndrome; (2) patients were found in ventricular fibrillation; (3) the interval between call for, and arrival of, the ambulance was below the median; (4) cardiac arrest took place outside the home.

### 3.5. Factors of importance for survival in multivariate analysis

When including all factors listed in Table 4 in the model only one appeared as an independent predictor for survival, and that was the place where the cardiac arrest took place.

Thus, the adjusted odds ratio for patients being alive 1 month after cardiac arrest was if the arrest occurred outside home versus at home 8.7 (95% CL 2.2–58.1).

#### 4. Discussion

This is one of the largest patient cohorts evaluating the characteristics and outcome among patients aged less than 18 years suffering from out of hospital cardiac arrest. The study cohort has the advantage of representing almost the entire nation and not only a city ambulance organization. The major weakness was a substantial number of patients with missing information particularly with regard to the initial rhythm.

Only one-third of the patients had a witnessed cardiac arrest. Previous studies have shown that the proportion of cases that are witnessed in children vary between 28 and 38% [1,2,4–6]. Despite that, bystander CPR was initiated in 68% of the cases. In previous studies this figure has varied between 18 and 85% [2,5,6].

Among the 76% of patients in whom information on the initial rhythm was known, only 6% were found in ventricular fibrillation. This is in good agreement with previous studies where the proportion of patients found in ventricular fibrillation has varied between 4 and 23% [1,2,4–7].

The most frequent cause of cardiac arrest was sudden infant death syndrome (34%) and only in 11% was the aetiology judged to be of a cardiac origin. In previous studies it was shown that the proportion of cases where sudden infant death syndrome was the cause of cardiac arrest has varied between 15 and 60% [1,2,4,6,7]. In the same studies the proportion of whom the aetiology was cardiac disease has varied between 4 and 22% [1,4,6,7].

As in the situation of out of hospital cardiac arrest among young adults and adults, about two-thirds of patients suffered from a cardiac arrest in the home. In previous studies it was found that the proportion in whom the arrest occurred at home varied between 80 and 88% [2,4].

We found only one independent predictor for survival in this survey and that was if the patient suffered from the cardiac arrest outside their home. Most probably this reflects something other than the place where the arrest occurred, although we have not been able to define which the factors are. One could argue that if the arrest occurred at home it would be less frequently witnessed. On the other hand, we found a similar survival rate regardless of witnessed status. Only in one previous study has it been possible to identify an independent predictor for survival after out of hospital cardiac arrest among children.

Thus, in a study from Helsinki, the duration of CPR of <15 min was associated with an increased survival [2].

We had expected ventricular fibrillation to appear as an independent predictor for survival also in this cohort. However, there were only 20 patients found in ventricular fibrillation in the database. This makes it difficult to decide whether ventricular fibrillation is an independent predictor of survival. The results in the univariate analysis suggest that the type of initial rhythm is also of major importance among children.

##### 4.1. Limitation

There was missing information in most of the variables being evaluated.

#### 5. Conclusion

Among children suffering from out of hospital cardiac arrest in Sweden which were not crew witnessed, the overall survival is low (4%). The chance of survival appears to be markedly increased if the arrest occurs outside the patients home compared with at home. No other strong predictors for an increased chance of survival could be demonstrated.

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