Experiences from treatment of out-of-hospital cardiac arrest during 17 years in Göteborg

J. Herlitz, E. Andersson, A. Bång, J. Engdahl, M. Holmberg, J. Lindqvist, B. W. Karlson and L. Waagstein

Division of Cardiology, Sahlgrenska University Hospital, Göteborg, Sweden

Aims To describe changes in different factors at resuscitation and survival in a 17-year survey of patients suffering from out-of-hospital cardiac arrest.

Method The investigation was carried out in the community of Göteborg with 450,000 inhabitants during 1981–1997 on all patients suffering out-of-hospital cardiac arrest in whom resuscitation was attempted.

Results The number of cases per year, the proportion of witnessed arrests and the proportion of arrests of cardiac aetiology remained similar over time. There was an increase in median age from 68 to 73 years (P<0.0001), in the proportion of females from 27% to 33% (P=0.035) and in the proportion of patients receiving bystander cardiopulmonary resuscitation from 14% to 28% (P<0.0001) with time. There was a shortening of the median interval from collapse until defibrillation from 9 min to 6 min (P<0.0001) over time but a decrease in the occurrence of ventricular fibrillation as the initially recorded arrhythmia from 39% to 32% (P=0.022). There was an increase in the proportion of patients having a bystander witnessed cardiac arrest of cardiac aetiology being hospitalized alive from 32% to 45% (P<0.0001 for change over time). The proportion of patients discharged alive from hospital increased from 16% to 29% until 1993, but thereafter decreased to 13% in 1997 (P=0.002 for change over time).

Conclusion In a survey covering 17 years of resuscitation of out-of-hospital cardiac arrest patients we found that the occurrence of ventricular fibrillation as the initially recorded arrhythmia decreased. There was an increase in age, in the proportion of females and in the use of bystander cardiopulmonary resuscitation. The interval between collapse and defibrillation was shortened. Survival changed over time with an increase until 1993 but with a decrease thereafter.

(Eur Heart J 2000; 21: 1251–1258)
© 2000 The European Society of Cardiology

Key Words: Out-of-hospital cardiac arrest, survival.

See page 1209 for the Editorial comment on this article

Introduction

The majority of cardiac deaths in ischaemic heart disease occur outside hospital[1,2]. During the last two decades enormous efforts have been made to increase survival among these patients[3]. The concept of ‘chain of survival’ has emerged[3]. Education of people in the community in bystander cardiopulmonary resuscitation and the introduction of automated external defibrillators in ambulances have shortened the interval from collapse until initiation of treatment.

The changes in survival in a prolonged perspective that have resulted from such changes in availability of treatment has not been extensively described in the literature.

In this survey we describe the changes during 17 years for patients suffering out-of-hospital cardiac arrest in whom resuscitation efforts were attempted. We describe changes in age and gender distribution, the proportion of patients having a witnessed cardiac arrest or having an arrest of cardiac aetiology, the distribution of patients according to the initial arrhythmia observed by the ambulance crew, the interval between collapse and defibrillation, and the proportion of patients receiving bystander cardiopulmonary resuscitation and survival.

Methods

Target population

Since 1974, the municipality of Göteborg has been 455 km² in area, areas of water excluded. The
The population increased from 431 000 to 455 000 between 1980 and 1996. Forty-nine per cent of the total population are men. The age distribution of the population in 1996 is shown in Fig. 1.

In 1990, there were 5108 deaths in Göteborg, 1360 of which were attributable to ischaemic or coronary heart disease (International Classification of Diseases, Injuries and Causes of Death, codes 410–414). This survey included all patients suffering from out-of-hospital cardiac arrest between 1 October 1980 and 31 December 1997. The results in the figures shown here include all patients in whom resuscitation efforts were attempted, with the exception of figures showing the interval between collapse and defibrillation (Fig. 6) and the proportion of patients with bystander initiated cardiopulmonary resuscitation (Fig. 7) for which we included only patients with out-of-hospital cardiac arrest witnessed by a bystander. In looking at survival, we primarily analysed patients with a bystander witnessed cardiac arrest of a cardiac aetiology in order to adapt to the Utstein recommendations[4]. However, we also analysed survival in the total series of patients.

Organization and equipment

All emergency patients arrived at one of the two city hospitals (Sahlgrenska and Östra). All ambulances were dispatched by one ambulance centre. Ambulances were dispatched according to a two-tiered system, i.e. for each call judged as cardiac arrest, a mobile coronary care unit, if available, and the nearest standard ambulance were dispatched simultaneously. During the earlier years, one mobile coronary care unit was operating full-time and one part-time. During the latter part of the period, both mobile coronary care units were operating full-time. There were 11 available standard ambulances based at six fire departments. The fire departments are located in such a way that 50% of patients will be reached within 5 min and 97% will be reached within 10 min. The median time from the alarm until the patient was reached was 5 min for the standard ambulance and 8 min for the mobile coronary care unit.

One mobile coronary care unit was staffed by one nurse during week-days from 0800 to 1700h. During 1991 and 1992 the other mobile coronary care unit was staffed by a nurse part-time during week-days and thereafter full-time. The nurses were delegated to give adrenaline, atropine, lidocaine, morphine, furosemide and bicarbonate according to a standard protocol.

Each mobile coronary care unit was staffed by two paramedics who had received 39 weeks of medical training including resuscitation techniques and intubation. During the latter part of the period all paramedics were delegated to give all these drugs, with the exception of morphine, according to a standard protocol.

Cardiopulmonary resuscitation education

Since 1985 there has been organized cardiopulmonary resuscitation education for lay people and, by 1989, 100 000 had been educated in Göteborg. By 1997 another 35 000 persons had completed such a training. Today more than 150 000 persons have been educated in cardiopulmonary resuscitation in the community of Göteborg. The cardiopulmonary resuscitation education is systematic and includes a 3 h course with a video-film and practical training on a manikin. The education includes a large proportion of school children in the ninth year of school.

Treatment of cardiac arrest

Treatment of cardiac arrest has changed over time. In general we have followed the guidelines recommended by the American Heart Association[5] and the European Resuscitation Council[6].

Classification of the cause of cardiac arrest

These classifications have in many instances been made by a team consisting of two doctors and a nurse. They were made according to clinical judgement after receiving all available information of the case history, including an autopsy report if available.

However, in many cases the classification was made by the ambulance crew. Patients with cardiac arrest, in whom there were no known previous symptoms and for whom there was no other explanation for the arrest, were classified as having an arrest of cardiac origin. We did not specifically define death attributable to coronary artery disease.

Registry

The documentation system was constant during the registration period and all data have been prospectively
computerized, with the exception of survival and classification of cardiac arrest, which has been evaluated with some time delay.

Statistics
Results are expressed as percentages and continuous variables in terms of the median. Changes in the variables over time shown in Figs 3–9 were analysed with Pitman’s non-parametric permutation test. A P value <0.05 was regarded as significant.

Results
During the survey there was a total of 4662 cardiac arrests outside hospital reached by the emergency medical service system and in whom resuscitation efforts were attempted.

Number of cardiac arrests (Fig. 2)
The number of cardiac arrests per year did not change significantly over time. In 1981 there were 239 cardiac arrests and in 1997 there were 234. The highest number was seen in 1986 (314) and the lowest in 1982 (226).

Distribution of patients according to gender and age (Fig. 3)
The proportion of females increased over time from 27% in 1981 to 33% in 1997 (P=0.0365). The median age increased over time from 68 years in 1981 to 73 years for 1995–1997 (P<0.0001).

Figure 2  Number of cardiac arrests per year (n) in whom resuscitation was attempted.

Figure 3  Change in the proportion of females=◆ (P=0.035) and median age=□ (P<0.0001) over time.
Witnessed arrests and arrests of cardiac aetiology (Fig. 4)

The proportion of cardiac arrests witnessed did not change over time, being 68% in 1981 and 68% in 1997. The proportion of patients in whom the cardiac arrest was judged to be of cardiac aetiology was also approximately similar over time: the highest value was observed in 1993 (96%) and the lowest in 1997 (70%).

Distribution of patients according to initial arrhythmia (Fig. 5)

The proportion of patients found in ventricular fibrillation was below 50% each year with a slight decrease over time ($P<0.0001$). It was 39% in 1981 and 32% in 1997. The proportion of patients found in asystole decreased from 49% in 1981 to 36% in 1997 ($P=0.038$). The proportion of patients found in pulseless electrical activity increased from 6% in 1981 to 26% in 1997 ($P<0.0001$).

Interval between collapse and defibrillation (Fig. 6)

The median interval between collapse and defibrillation declined over time ($P<0.0001$). The shortest interval was observed for 1991–1993 and 1996–1997 (6 min). Overall the interval ranged between 6 and 10 min.
Bystander initiated cardiopulmonary resuscitation (Fig. 7)

The proportion of victims in whom cardiopulmonary resuscitation was initiated by a bystander prior to arrival of the ambulance crew has increased gradually over time ($P<0.0001$). At the beginning of the 1980s 14% received bystander cardiopulmonary resuscitation and in the end of the 1990s between 20 and 30% received such treatment. The highest percentage was observed in 1994 (31%).

Initial survival (Figs 8 and 9)

The proportion of patients hospitalized alive after a bystander witnessed cardiac arrest has increased from 32% in 1981 to 45% in 1997 ($P<0.0001$ for change over time) (Fig. 8). The proportion of patients with a bystander witnessed cardiac arrest of cardiac aetiology found in ventricular fibrillation similarly increased ($P<0.0001$) (Fig. 9). In the proportion of patients discharged alive from hospital survival also changed over time in both groups ($P=0.002$ and $P=0.0006$, respectively) with an increase from 16% in 1981 to 29% 1993 among patients with a bystander witnessed arrest of a cardiac aetiology. However, there was a reduced proportion of patients discharged alive from hospital during the last 4 years (13% in 1997; Fig. 8). Results were similar when all patients were included in the analyses and when patients found in ventricular fibrillation (Fig. 9) were included.

The percentage of patients with a bystander witnessed arrest of a cardiac aetiology being hospitalized alive prior to full implementation of automated external defibrillators during 1981–1990 was 25% and during 1991–1997 was 39% ($P<0.0001$). The corresponding
values for the proportion of patients being discharged alive were 10% and 18%, respectively ($P<0.0001$).

**Discussion**

This study describes the epidemiological development and outcome for patients suffering from out-of-hospital cardiac arrest in one single community during 17 years.

The number of patients with cardiac arrest in whom resuscitation efforts were attempted per year remained similar over time. Since there has been no change of the indication for initiating treatment in such patients our data suggest that the number of patients in the community of Göteborg suffering out-of-hospital cardiac arrest who are suitable candidates for resuscitation has remained similar over time.

It is significant these patients are older compared with 15 years ago. One might therefore guess that victims of out-of-hospital cardiac arrest today will have more concomitant diseases. It is therefore not unlikely that the possibilities for a successful outcome for these patients are now less advantageous. The observation of an increase in the proportion of females suffering out-of-hospital cardiac arrest was expected with this increase in age.

There was no indication of a change in the proportion of witnessed cardiac arrests or in the proportion of cardiac arrests of cardiac aetiology. Such information indicates that the overall circumstances around such arrest has not changed over time.

The proportion of patients found in ventricular fibrillation decreased slightly over time. This could be looked upon as a disappointing finding. The increase in
Introduction of automated external defibrillation as the initially registered arrhythmia as well as co-morbidity on the occurrence of ventricular fibrillation during more recent years. As previously indicated, it is possible that the impact of improved handling of these cases of cardiac aetiology remained similar over time. The proportion of patients found in ventricular fibrillation decreased slightly. There was an increase in age, an increase in the proportion of females and an increase in the use of bystander cardiopulmonary resuscitation. The interval between collapse and defibrillation shortened. Survival increased until 1993 but thereafter decreased.

This study was supported by grants from the Swedish Heart and Lung Foundation, Stockholm.

Conclusion

In a survey covering 17 years of resuscitation of out-of-hospital cardiac arrest patients we found that the occurrence of cases, the proportion of witnessed cases and cases of cardiac aetiology remained similar over time. The proportion of patients found in ventricular fibrillation decreased slightly. There was an increase in age, an increase in the proportion of females and an increase in the use of bystander cardiopulmonary resuscitation. The interval between collapse and defibrillation shortened. Survival increased until 1993 but thereafter decreased.

References


