Out-of-hospital circulatory arrest: factors determining the outcome Amsterdam resuscitation study (ARREST) 2 and 3
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Citation for published version (APA):
Chapter 3
Out-of-hospital cardiac arrests in Amsterdam and its surrounding areas: Results from the Amsterdam resuscitation study (ARREST) in Utstein style.

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Published:
Abstract

The purpose of this study was to describe the chain of survival in Amsterdam and its surroundings and to suggest areas for improvement. To ensure accurate data, collection was made by research personnel during the resuscitation, according to the Utstein recommendations. Between June 1, 1995 and August 1, 1997 all consecutive cardiac arrests were registered. Patient characteristics, resuscitation characteristics and time intervals were analyzed in relation to survival. From the 1046 arrests with a cardiac etiology and where resuscitation was attempted, 918 cases were not witnessed by EMS personnel. The analysis focussed on these 918 patients of whom 686 (75%) died during resuscitation, 148 (16%) died during hospital admission and 84 patients (9%) survived to hospital discharge. Patient and resuscitation characteristics associated with survival were: age, VF as initial rhythm, witnessed arrest and bystander CPR. EMS arrival time was significantly shorter for survivors (median 9 minutes) compared to nonsurvivors (median 11 minutes). In 151 cases the police was also alerted and arrived 5 minutes (median) earlier than EMS personnel. Using the OPC/CPC good functional health was observed in 50% of the survivors and moderate performance in 29%. All links in the chain of survival must be strengthened, but equipping the police with semi-automatic defibrillators may be the most useful intervention to improve survival.

1. Introduction

Strengthening the weakest links in the chain of survival for out-of-hospital cardiac arrests\(^1\) is a challenge for every emergency medical service (EMS) system. Detection of these weak links depend on data collected by EMS personnel involved in the resuscitation efforts at various moments during resuscitation. However, during resuscitations the priority of these personnel was to treat the patient and not to collect information, therefore accuracy of this information may be limited and possibly biased. In order to compare the various EMS, recommendations for uniform and standardised reporting of out-of-hospital cardiac arrests were introduced in 1991, the so-called ‘Utstein style’.\(^2\) Since that time, several studies were performed retrospectively,\(^3-7\) with the embedded inevitable risk of inaccuracies.

The objective of this study was to describe the chain of survival for out-of-hospital cardiac arrests in Amsterdam and its surrounding areas and to suggest areas for improvement. To ensure accurate data collection and time measurement, we used a prospective study design with trained research personnel, who were alerted simultaneously with the EMS personnel.

2. Patients and Methods

2.1. Study design

This observational prospective study was performed between June 1, 1995 and August 1, 1997. In this period all consecutive out-of-hospital cardiac arrests, confirmed by EMS personnel were included. To ensure comparability we used the definitions and nomenclature recommended as ‘The Utstein Style’.\(^7\) The study was approved by all involved ethics committees.

2.2. Population served

Amsterdam and its region encompass 1030 square kilometers, with urban, suburban and rural areas and a population of nearly 1.3 million inhabitants. In this population 13% were over the age of 65 years and 49% were men.
2.3. Emergency medical service system

The dispatch center of the Amsterdam EMS was manned by experienced nurses. They instructed seven different ambulance services with nine ambulance posts spread over this region. There was a national emergency telephone number, 112, connected to the regional dispatch center. The emergency medical service was a one-tiered system. All ambulances were manned with a nurse/paramedic and a driver. This team was qualified to perform advanced cardiac life support (ACLS), including defibrillation, endotracheal intubation, intravenous access and administration of medication, according to a protocol comparable with the ERC guidelines for ACLS. In most cases the first ambulance called for a second assisting ambulance if a cardiac arrest was recognized. If the initial call indicated a cardiac arrest, two ambulances were dispatched simultaneously. Telephone CPR was not available.

2.4. Utstein definitions

Attempted resuscitations were defined as events where EMS personnel actively performed resuscitation efforts in patients with cardiac arrests other than basic assessment. Resuscitation was not attempted in patients with obvious evidence of irreversible death: signs of rigor mortis or post mortem lividity. There were no formal criteria for EMS personnel when to start resuscitation efforts. A cardiac etiology was accepted for those patients with a clinically proven cardiac cause and for those where a non-cardiac cause could be excluded.

2.5. Data collection

Data collection was done by an experienced physician, supported by trained medical students who served as data collectors at the scene during the resuscitation efforts. The research personnel worked in shifts, covering 24 h/day, 7 days/week. When a call suggesting arrest was made by lay people or proven arrest reported by EMS personnel was received by the dispatcher, one of the researchers was notified by mobile telephone. They responded immediately to the call and drove by car to the location. In most instances they arrived at the scene during ongoing resuscitation and collected information from everyone who was involved in the event. Much attention was paid to integrating all information from family members, bystanders and EMS personnel with the emphasis on accurate time estimation. The registration was done by using a standardized registration form according to the Utstein recommendations. If the patient was transported the researchers followed the patient into the emergency room where they continued their documentation. The medical records of the patients admitted were studied in a later stage and after discharge. Information about pre-arrest morbidity and medication was received from the general practitioner. Neurologic outcome was estimated at hospital discharge with the Glasgow-Pittsburgh Cerebral Performance (CPC) and Overall Performance Categories (OPC), using data from the medical records.

2.6. Time analysis

The clock of the dispatch center served as the time standard, the watches of all research personnel were synchronized with this clock. The computer at the dispatch center recorded times of: the call, ambulance departure, ambulance stop, departure to the hospital, and arrival at the hospital. All defibrillators were equipped with a clock, therefore all timed events during resuscitation could be timed and registered. The times of defibrillation and external pacing were automatically registered, other events had to be marked manually. After resuscitation a print out from the defibrillator memory was made, so that rhythm and marked events with the corresponding times were registered. The difference in time indicated by the defibrillator and the research person's watch was also registered. Time correction was done according to the time standard.
In a witnessed collapse knowing the delay to make the call, we could estimate the time of collapse. In the group of patients whose collapse was not witnessed we recorded the time of discovering the patient as the time of recognition.

2.7. Statistical methods

Patient and resuscitation details were analyzed in relation to hospital admission, discharge from hospital and location of the collapse. Differences in proportions were expressed as relative risks (RR) with 95% confidence interval (CI). Time intervals were analyzed in relation to survival to hospital discharge and expressed in means and medians. For comparability between other studies we expressed intervals in means and to correct for extreme data values differences between means were tested by non-parametric comparison with the Mann-Whitney/Wilcoxon test. Because medians are more accurate measurements for not normal distributed time intervals we also expressed the intervals in medians with the Median rank test. Survival curves were estimated according to Kaplan-Meier method. All statistics were performed in SPSS 6.1 and JMP 3.2 for the Apple Macintosh.

3. Results

3.1. Cardiac arrests

In the study period of 26 months, 1685 patients with a cardiac arrest were considered for resuscitation, corresponding with an incidence of 60 per 100,000 inhabitants per year. Of this group 1285 patients were actually resuscitated by EMS personnel. Of this resuscitated group 1046 patients had a cardiac etiology of the arrest, according to the Utstein definition. The Utstein template (Figure 1), shows the group of patients with a cardiac arrest and its division in subgroups. Of all patients with a cardiac etiology, 747 (71%) died during resuscitation; after initial successful resuscitation 165 (16%) patients died during hospital admission and eventually 134 (13%) patients survived to hospital discharge.

3.2. Age and gender

Determinants of survival were analyzed in two levels: survival to hospital admission and survival to hospital discharge (Table 1). In our study 78% of the patients were male. There was no significant difference in survival rates between men and women. The mean age of the patients who suffered a cardiac arrest was 64 years (range: 0-96 years). There was no significant difference in initial resuscitation success between the different age groups. The young and elderly patients appeared to have a smaller chance of survival to hospital discharge than patients aged between 30-60 years, although this was not significant for all age categories.

3.3. Witnessed arrests

Figure 1 shows a division into three subgroups: (1) arrest not witnessed, (2) arrest witnessed by a bystander, and (3) arrest witnessed by EMS personnel. In 140 patients the arrest was not witnessed; only two (1%) survived to hospital discharge, while 82 of the 778 patients (11%) survived if the arrest was witnessed by a bystander. Of the 128 patients where the collapse was witnessed by EMS personnel, 50 patients (39%) survived to hospital discharge. Further analysis was carried out excluding patients whose arrest occurred in the presence of the EMS personnel, leaving 918 patients for analysis.
Figure 1. The Utstein template of 1685 out-of-hospital cardiac arrests in Amsterdam and its surrounding areas obtained in a 26 months period between 1995 and 1997. Because arrests witnessed by EMS personnel were immediately managed by advanced life support, bystander CPR was not performed.
Table 1. Relationship between patient and resuscitation characteristics and survival.

<table>
<thead>
<tr>
<th></th>
<th>Admitted alive (n=232)</th>
<th>Relative risk (95% C.I.)</th>
<th>Discharged alive (n=84)</th>
<th>Relative risk (95% C.I.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>male (n=712)</td>
<td>174</td>
<td>0.9 (0.7-1.1)</td>
<td>71</td>
<td>1.6 (0.9-2.8)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
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<tr>
<td>0-10 (n=5)</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
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<tr>
<td>11-20 (n=2)</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>21-30 (n=12)</td>
<td>2</td>
<td>0.7 (0.2-2.3)</td>
<td>1</td>
<td>0.9 (0.1-6.0)</td>
</tr>
<tr>
<td>31-40 (n=41)</td>
<td>8</td>
<td>0.8 (0.4-1.4)</td>
<td>5</td>
<td>1.4 (0.6-3.2)</td>
</tr>
<tr>
<td>41-50 (n=97)</td>
<td>21</td>
<td>0.8 (0.6-1.3)</td>
<td>14</td>
<td>1.7 (1.0-2.9)</td>
</tr>
<tr>
<td>51-60 (n=163)</td>
<td>44</td>
<td>1.1 (0.8-1.4)</td>
<td>23</td>
<td>1.7 (1.1-2.7) *</td>
</tr>
<tr>
<td>61-70 (n=230)</td>
<td>64</td>
<td>1.1 (0.9-1.5)</td>
<td>19</td>
<td>0.9 (0.5-1.4)</td>
</tr>
<tr>
<td>71-80 (n=261)</td>
<td>64</td>
<td>1.0 (0.7-1.2)</td>
<td>15</td>
<td>0.5 (0.3-0.9) *</td>
</tr>
<tr>
<td>81+ (n=107)</td>
<td>29</td>
<td>1.1 (0.8-1.5)</td>
<td>7</td>
<td>0.7 (0.3-1.5)</td>
</tr>
<tr>
<td><strong>Initial rhythm</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VF (n=570)</td>
<td>189</td>
<td>2.7 (2.0-3.6) *</td>
<td>80</td>
<td>12.2 (4.5-33.0) *</td>
</tr>
<tr>
<td>VT (n=11)</td>
<td>2</td>
<td>0.7 (0.2-2.5)</td>
<td>1</td>
<td>1.0 (0.2-6.6)</td>
</tr>
<tr>
<td>asystole (n=184)</td>
<td>14</td>
<td>0.3 (0.2-0.4) *</td>
<td>1</td>
<td>0.1 (0.0-0.3) *</td>
</tr>
<tr>
<td>other (n=153)</td>
<td>27</td>
<td>0.7 (0.5-0.9) *</td>
<td>2</td>
<td>0.1 (0.0-0.4) *</td>
</tr>
<tr>
<td><strong>Witnessed arrest</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes (n=778)</td>
<td>216</td>
<td>2.4 (1.5-3.9) *</td>
<td>82</td>
<td>7.4 (1.8-29.7) *</td>
</tr>
<tr>
<td><strong>Bystander CPR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes (n=497)</td>
<td>140</td>
<td>1.3 (1.1-1.6) *</td>
<td>63</td>
<td>2.5 (1.6-4.1) *</td>
</tr>
</tbody>
</table>

C.I. is confidence interval, * C.I. does not contain 1, VF is ventricular fibrillation, VT is ventricular tachycardia. Relative risk of each group is calculated in reference to all other patients.

3.4. Bystander CPR

Basic CPR was performed by bystanders before arrival of the EMS personnel in 497 patients (54%). Table 1 shows that these patients had 1.3 times the chance to survive to hospital admission and 2.5 times to survive to hospital discharge compared to patients who had no bystander CPR.

3.5. Initial rhythm

Ventricular fibrillation (VF) was observed in 62% (570/918) of the patients. Asystole was recorded in 184 (20%), ventricular tachycardia (VT) in 11 (1%) and other rhythms in 153 (17%) of the cases. Patients with VF as initial rhythm had over 2.5 times the chance to be admitted alive at the hospital compared to all other rhythms and over 12 times the chance to be discharged alive. Of the patients who had bystander CPR, 69% had VF as initial rhythm, compared to 54% in those who had no bystander CPR (RR: 1.3, CI: 1.1-1.4). Asystole was observed as initial rhythm in 17% of the patients with bystander CPR and in 24% in patients without bystander CPR (RR: 0.7, CI: 0.5-0.9).

Survival rate was 19% (59/309) when the situation of the resuscitation was most favourable: witnessed collapse, bystander CPR and ventricular fibrillation as initial rhythm. However this relatively ‘ideal’ circumstance occurred in only 34% of all resuscitations with a cardiac etiology.
### Table 2. Relationship between the resuscitations in the private home or in other locations and determinants of survival after resuscitation.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Home, n=499 (%)</th>
<th>Other places, n=419 (%)</th>
<th>Home vs other places RR (95% C.I.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admitted alive</td>
<td>105 (21.0%)</td>
<td>127 (30.3%)</td>
<td>0.7 (0.6-0.9) *</td>
</tr>
<tr>
<td>Discharged alive</td>
<td>31 (6.2%)</td>
<td>53 (12.6%)</td>
<td>0.5 (0.3-0.8) *</td>
</tr>
<tr>
<td>Gender: female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
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<tr>
<td>Female</td>
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<td>Age</td>
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<td>31-40</td>
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<tr>
<td>71-80</td>
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<tr>
<td>81+</td>
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<td></td>
</tr>
<tr>
<td>Initial rhythm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VF</td>
<td>272 (54.5%)</td>
<td>298 (71.1%)</td>
<td>0.8 (0.7-0.8) *</td>
</tr>
<tr>
<td>VT</td>
<td>7 (1.4%)</td>
<td>4 (1.0%)</td>
<td>1.5 (0.4-5.0)</td>
</tr>
<tr>
<td>asystole</td>
<td>124 (24.8%)</td>
<td>60 (14.3%)</td>
<td>1.7 (1.3-2.3) *</td>
</tr>
<tr>
<td>other rhythms</td>
<td>96 (19.2%)</td>
<td>57 (13.6%)</td>
<td>1.4 (1.1-1.9) *</td>
</tr>
<tr>
<td>Witnessed arrest</td>
<td>404 (81.0%)</td>
<td>374 (89.3%)</td>
<td>0.9 (0.8-0.9) *</td>
</tr>
<tr>
<td>Bystander CPR</td>
<td>221 (44.3%)</td>
<td>276 (65.9%)</td>
<td>0.7 (0.6-0.7) *</td>
</tr>
<tr>
<td>EMS arrival interval</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>12:12</td>
<td>11:18</td>
<td>p = 0.0007</td>
</tr>
<tr>
<td>median</td>
<td>12:00</td>
<td>11:00</td>
<td>p = 0.0080</td>
</tr>
</tbody>
</table>

RR is relative risk, C.I. is confidence interval, * C.I. does not contain 1.
VF is ventricular fibrillation, VT is ventricular tachycardia.
EMS arrival interval = time from collapse or finding the victim to EMS arrival at patient's side.

#### 3.6. Return of spontaneous circulation, survival

In 312 patients (34%) spontaneous circulation returned (ROSC) in the field, respectively 43% (244/570) with VF, 13% (24/184) with asystole, 36% (4/11) with VT and 26% (40/153) with other rhythms. In patients with bystander CPR, ROSC occurred in 38% (187/497) and in patients without bystander CPR, ROSC occurred in 30% (125/421). A total of 489 patients were transported to a hospital emergency room, 279 of them with continuation of resuscitation efforts, because ROSC was not achieved (194) or because circulation stopped again (85). In 4% (8/194) ROSC occurred for the first time in the emergency room, but all died later during hospital admission. Twenty-five percent of the patients (232/918) were admitted to the hospital. The majority of these patients (148/232; 64%) died during hospital admission, most (137/148; 93%) in the first two weeks after admission (Figure 2). Eventually 84/918 (9%) survived to discharge. The median admission period of the 84 patients who survived to discharge was 20 days (range: 4-200 days).
3.7. Overall Performance and Cerebral Performance Categories

At the time of discharge 42 (50%) patients had a good overall function (OPC of 1) and 24 (29%) patients had moderate overall dysfunction (OPC of 2). In 16 (19%) patients the overall function was severely impaired (OPC of 3) and two (2%) patients were in a coma or vegetative state (OPC of 4). Forty-seven (56%) patients had a good cerebral function (CPC of 1) and 21 (25%) survivors had moderate cerebral dysfunction (CPC of 2). In 14 patients (17%) the overall function was severely impaired (CPC of 3) and two patients (2%) were in a coma or vegetative state (CPC of 4) at discharge from the hospital. Two patients had a CPC of 1, but a severe overall dysfunction (OPC of 3). Forty-one patients (7%) over 60 years old survived to hospital discharge and 22% of the survivors had an OPC > 2 and 17% a CPC > 2. The risk to suffer severe overall dysfunction was equal in patient older and younger than 60 years (RR: 1.0, CI: 0.5-2.4).

3.8. Location of the arrest

Of the 918 patients the collapse occurred in or around their own home in 499 (54%), in 66 (7%) in or around another private home, in 166 (18%) on the street, in 179 (19%) in public places and in 6 (1%) in long term care facilities. Patients who collapsed in their own home had
half the chance to survive to hospital discharge compared to patients who collapsed in other places (Table 2). There were important differences in characteristics related to survival in patients who had their arrest in their own home compared to those who collapsed in other places. The chance of having the arrest witnessed, of having bystander CPR and to record VF as initial rhythm was significantly smaller at home than in other places. Also, patients at home were more often older than 60 years.

3.9. Access to dispatch center

When a bystander witnessed the arrest the collapse-to-call interval was less than 2 minutes in 75% (585/778) of the cases and over 4 minutes in only 9% (67/778) of the cases. In 21% the witness first called for other assistance, like relatives and general practitioner, before calling 112. In 38% (351/918) of the cases the call was recognized by the dispatcher as a cardiac arrest. In these cases the median response time did not differ from situations when the call was not recognized as such, both were 11 minutes. Likewise, there was no significant difference in survival, 9% (30/351) of the patients from whom the calls were recognized versus 10% (54/567) of those from whom the calls were not recognized by the dispatcher as an arrest (RR: 0.9, CI: 0.6-1.4).

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**Figure 3.** Time elapsing from collapse to arrival of EMS personnel and survival to hospital discharge. The numbers above the bars indicate the total number of patients within the group. Numbers without bars indicate zero survival.
3.10. EMS arrival time

Figure 3 shows the rapid reduction in survival when the collapse-to-EMS arrival at patient’s side increased. Witnessed and unwitnessed collapses are demonstrated separately, because the difference in estimated time of collapse in case of a witnessed arrest and time of recognition in case of an unwitnessed arrest. The interval between collapse-to-EMS arrival at the patient’s side is the sum of all time intervals (except collapse-to-bystander CPR) as shown in Figure 4. Between patients being discharged alive and patients dying any time before discharge, there was a significant difference in the mean and median of all time intervals except for the interval between the EMS vehicle stop to arrival at patient’s side. The median time interval from the collapse until the arrival of EMS personnel at the patient’s side was 11 minutes (Figure 5). In 151 cases (16%) the police was also alerted and arrived 5 minutes (median) earlier than EMS personnel, in less than 1% (6/918) they were witnesses of the arrest. The median of call-to-EMS stop interval (response time) was 8 minutes and the median of call-to-arrive at patient’s side was 9 minutes. For the police the median response time (call police-to-stop police interval) was 3 minutes.

Figure 4. Comparison between the survivors and nonsurvivors of the different time intervals, in patients whose collapse was witnessed. The templates show on the left the median times and on the right the mean times of the intervals. Even when two medians of comparable intervals are the same it is possible that they are significantly different. The figure also shows the differences between median and mean from the same interval. Time intervals of survivors compared to nonsurvivors that significantly differ are marked with an asterisk (*).
4. Discussion

This study evaluated the EMS system in the region of Amsterdam to identify possible improvement in the chain of survival. If the cardiac arrest occurred when the EMS personnel were not present, 9% survived to hospital discharge. When EMS were present at the time of the cardiac arrest, 39% of these patients survived to hospital discharge. We identified two patient characteristics associated with good survival: age 51-60 (RR 1.7, CI: 1.1-2.7) and VF as initial rhythm (RR 12.2, CI: 4.5-33.0). Resuscitation characteristics associated with good survival were

![Cumulative time of collapse-to-arrival at patient's side interval of the police and EMS personnel](image)

Figure 5. Cumulative time of collapse-to-arrival at patient’s side interval of the police and EMS personnel. The dashed curve with open blocks represents the EMS response of all non-EMS witnessed cardiac arrests (918) and the continuous curve with the filled blocks represents the EMS response in those cases where police was also activated (151). Because the curves of these groups do not differ we concluded that there was no ‘expected long delay’ selection by the dispatcher when the police was also activated.

witnessing the arrest (RR 7.4, CI: 1.8-29.7), bystander CPR (RR 2.5, CI: 1.6-4.1) and the following time intervals: collapse-to-call the dispatch center, collapse-to-bystander CPR, call-to-departure of EMS, departure-to-stop of EMS and call-to-EMS arrival at the patient’s side.

This study was almost unique in the use of dedicated research personnel to collect the data at the scene during resuscitation. One study showed the many time sources in the EMS and the differences among these sources, so accurate time recording is very complex. An optimal time registration can only be achieved when there is an observer who can fully concentrate on the different time sources and correct those with a standard time. In < 10% of the cases our data
were collected a few hours after resuscitation. Based on our clinical experience we speculate that data derived from the EMS personnel is biased toward shorter time intervals and data derived from bystanders is biased toward longer time intervals. Data were directly obtained from the primary source in more than 90% of our cases.

The survival of 9% is comparable to other studies with similar EMS, although these studies were not reported according to the Utstein recommendations. Their survival rate ranged from 7%-18%. When survival for the main subgroups are compared to the studies using Utstein reporting relatively wide variation in outcome is observed: survival in unwitnessed arrests ranged from 0.5 to 7% (our study 1%) and survival in witnessed arrests ranged from 2 to 23% (our study 11%). Although there are clinically relevant differences in ambulance response times in these studies, ranging from 5.5 to 10 minutes (median), with the poorest outcome associated with the longest response times, it is questionable if this fully explains the differences in outcome. One source of difference can be the modifications on the Utstein recommendations. One study limited the patient's age to 20-75 years and there was no separate analysis for bystander witnessed and EMS witnessed cardiac arrests. Another study used the time of the call as time zero and not the time of collapse or recognition. One of the most important goals of the Utstein recommendations is uniform reporting of data to ensure comparability between the different EMS, therefore modifications of data collection and definitions must be avoided.

Recognizing the determinants of survival, gives the opportunity to identify the weaker links in the chain of survival. The first two links of the chain of survival (early access and early CPR) are bystander initiated events. This study shows that time intervals of the call to the dispatch center, the start of bystander CPR and from the call to departure of EMS were significantly longer for nonsurvivors compared to survivors. Access to a telephone is rarely a problem, but in our study in 21% the 112-call was delayed, because the general practitioner or a family member was called first. Not recognizing a cardiac arrest or panic can trigger such a detour before calling the emergency number. If a call is recognized as a cardiac arrest, in our study only 38% of the cases, it allows the dispatcher to dispatch EMS and police simultaneously and give pre-arrival instructions. Studies have been done attempting to identify the seriousness of the situation from the telephone call. One of the recommendations was training dispatchers to use standardized question forms. Although we are aware that this is not a problem of the dispatcher alone, we think that these question forms may not only improve the proportion of recognized cardiac arrest, but also gain time.

In more than half (54%) of the non-EMS witnessed cardiac arrests basic CPR was done by lay people. This is high compared to other Utstein reports, in which bystander CPR was reported in 28%-35% of the cases and may be due to the teaching during many years by the Netherlands Heart Foundation and basic CPR performed by police officers. Our study confirms that bystander CPR doubles survival. The chance to observe VS as initial rhythm was significantly higher for patients who had bystander CPR compared to victims who had no bystander CPR. This supports the finding of another study, who concluded that bystander CPR maintains VS.

Similar to other studies we observed that ventricular fibrillation was a strong predictor for survival. We found that VS was the most common initial rhythm. In some studies asystole was the most common initial rhythm. We speculate that the high incidence of VS is partly due to the high incidence of bystander CPR. Several studies have shown that when the interval between collapse and defibrillation increases, survival to hospital discharge decreases rapidly. So improvement of survival after out-of-hospital cardiac arrest focuses on the fastest possible defibrillation, the third link of the chain of survival.

In the Netherlands a one tiered system exists and defibrillation and ACLS (third and fourth link) in the prehospital setting is only done by EMS personnel. The mean call-to-EMS arrival at patient’s side of 9 minutes in Amsterdam was comparable to the interval of the second
responder of Bonn and Helsinki, 8.6 and 10.3 minutes, respectively. When the police was also notified on a 112-call suspect for an arrest, they arrived 5 minutes (median) before the EMS and nearly always started basic CPR, if this was not yet done. Normally the police was alerted at least 1 minute after the EMS, thus their potential time gain is even greater. On the other hand in 27 cases the police was notified before 112 was called or happened to be witnesses of the arrest. With the satisfactory experience of the semi-automatic defibrillator (AED) in the hands of lay people,25-27 the possibility of equipping the police with this type of defibrillator, as already introduced in many places29 is a clear potential improvement.

It should be noted that there are also other factors related to the survival, but these factors cannot directly be influenced by improvements of the EMS, such as location of the arrest and age of the patient. Regarding the location of the arrest in a public place we found a two-fold increased chance to survive hospital discharge compared with those who had their arrest at home. One study29 already suggested that the location is not an independent predictor for survival, but is a surrogate for other underlying factors. Our study confirms the same underlying factors: less witnesses of the collapse, less bystanders initiating CPR, less VF as initial rhythm, higher age and longer response time.

Our results show a lower survival in the age categories younger than 30 and older than 60 years. The decrease was not statistically significant, probably because the different age groups did not contain many patients. Several studies found that elderly people had a lower probability of survival,30-32 however one study31 did not find a significant relationship between age and survival. Survival in the oldest age groups was still relevant. Remarkable was that initial success of resuscitation efforts was not significantly different between age groups but that survival differences occurred after hospital admission: older people were more likely to die during hospital stay. In our study patients of 60 years and older more often suffered their collapse at home compared to the younger age groups. This might explain the difference in survival between the different age categories. Overall functional outcome of the elderly patients equaled that of younger victims. We concluded that age should never be a medical criterion for the decision to initiate or cease a resuscitation attempt.

We observed a good to moderate overall functional health at the time of hospital discharge in 79% of the cases. This is in line with the literature.4,6,34 However, improvement of functioning may continue after discharge and OPC/CPC measurements at the moment of discharge may not reflect a stable end situation. It should be noted that the OPC/CPC measures the neurological functioning of the patient after resuscitation and that the observed neurologic impairment (21%) is not necessarily a consequence of the circulatory arrest per se, but can be due to the underlying disease or pre-existent morbidity.35,36

We concluded that all links in the chain of survival of Amsterdam must be strengthened. Not all measures can be implemented equally easy, especially earlier call and more and earlier bystander CPR. Earlier defibrillation can be achieved relatively simple: since the police proved to be rapid first responders, they should be equipped with semi-automatic external defibrillators. Although the chance to survive an out-of-hospital cardiac arrest can be poor, it is a misunderstanding that it is associated with severe disability.

Acknowledgements
We want to thank the medical students: I. Tulevski, P.S. Visser, D. Dalhuisen, B.P.W. de Gouw, E.J.P. Vlieger, M. Akarriou, F.R. Banga, L.A.M. Verkouteren, J.M. Immink, and S. Ritmeester who took part in the data collection and offered their day and night rest for this project. We also thank the personnel of the dispatch center: CPA Amsterdam, the ambulance services: GG&GD Amsterdam, VZA Amsterdam, GGD Amstelveen, GGD Zaanstad, GGD Hoofddorp, Ruis Purmerend, Boon Wormerveer, the police districts: Amsterdam/Amstelland,
Zaanstreek/Waterland, Haarlemmermeer, the hospitals: Boven-Y ziekenhuis, de Heel ziekenhuis, St. Lucas/Andreas ziekenhuis, Slotervaartziekenhuis, Onze Lieve Vrouwe Gasthuis, Academisch Ziekenhuis Vrije Universiteit, Waterlandziekenhuis, Ziekenhuis Amstelveen, Kennemer Gasthuis, Spaarne ziekenhuis, Academisch Medisch Centrum and all general practitioners who were willing to give medical information about the patients included in this study. Without the cooperation of all participants mentioned this study never could have been successfully performed.

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