Out-of-hospital circulatory arrest: factors determining the outcome Amsterdam resuscitation study (ARREST) 2 and 3
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1. Introduction

1.1. Definition of sudden death and cardiac arrest.

Death is the irreversible cessation of all biological functions. The literature is not unequivocal about the definition of sudden death. Although there is a general agreement that it concerns natural death of a person, the definitions vary in the time elapsed between onset of symptoms and the moment of death. The suddenness is defined as death within 24 hours after onset of symptoms or within 30 seconds and all variations in between. Goldstein and Myerburg propose to use an uniform definition of death within 1 hour after onset of symptoms. Nowadays still many studies use different time intervals, with inevitable risk to find differences in incidence and causes of sudden death. The majority of sudden death are caused by acute ventricular tachyarrhythmias due to ischemic heart diseases. A cardiac arrest is an abrupt cessation of cardiac pump function resulting in unconsciousness and no detectable pulse, which may be reversible by a prompt intervention otherwise it will lead to death.


A cardiac arrest is nearly always unexpected and can occur anywhere. Most of the sudden cardiac arrests occur outside the hospital. Gillum reported, a study in 40 American states between 1980-1985, that over the age of 25 year, 56% of ischemic heart disease deaths occur outside the hospital or on the emergency room. From the out-of-hospital cardiac arrests, 75 to 80% occur at home. The survival from those at home is less than those who have their arrest in a public place. The treatment for a cardiac arrest is cardiopulmonary resuscitation (CPR), with the aim to preserve the vital organs in the period of the arrest and to restore spontaneous circulation. Outside the hospital victims of a cardiac arrest have to rely on lay people in the first moment of this life-threatening situation.

1.3. The incidence of out-of-hospital cardiac arrests.

Incidence rates of cardiac arrests in different communities ranged seriously from 36 to 128 per 100,000 people with a mean of 62. Incidence rates are negatively related to survival rates; that is, as the incidence rate increased, the survival rate seems to decline. The inverse relationship between incidence and survival could be due to true variation in risk among the populations reported. However, different research methodologies may also create artificial differences among studies as standards for designing studies, terminology, and reporting data have not been uniform. One author demonstrates that different studies use different denominators to calculate survival, resulting in a wide variety in outcome.

1.4. What can happen when a victim suffers a cardiac arrest outside the hospital?

In a prehospital setting accidental bystanders (often lay people) play a major role in the life-saving procedures. When a victim collapses, they are the one's that have to activate the EMS by calling 112. Some are brave enough to start basic CPR procedures, with or without training experience. Sometimes health care professionals are involved in the out-of-hospital resuscitation attempt, as accidental bystanders or general practitioners. Normally, they function as well-trained basic CPR performers.

After a while ambulance personnel will arrive at the scene. In the Netherlands the ambulances are manned with a paramedic and a driver. They are trained to perform advanced life support procedures, according to a national protocol. By performing these procedures they are able to restore and stabilize spontaneous circulation in about a third of these cases, especially an arrest of cardiac origin. When spontaneous circulation is restored, the patient will be transported to the hospital. When no spontaneous circulation is restored the ambulance personnel have the choice to cease resuscitation efforts in the field or by continuation of these efforts transport the patient.
to the hospital. In the latter case emergency room personnel in the hospital will continue the resuscitation attempts and offer the last chance to restore spontaneous circulation.

Once patients have regained spontaneous circulation, they will be admitted to the hospital on high care units. During admission, treatment will be focussed on the cause of the arrest, the complications, and finally the recovery of the patient. Still more than half of these patients will die during the hospital stay.

1.5. What have we learned from previous studies?
The survival of out-of-hospital cardiac arrests.

Normally, survival is defined as those who are discharged alive from the hospital after resuscitation. Survival is generally poor and ranges from approximately 2% to 25%.16 As stated previously this marked variation in survival rates can partly be explained by the use of different denominators.12,17 A large comparative study based this variation in survival rates on the difference in organization of the EMS systems.18 This study found the best survival rates (4-26%) in de double response systems (two tiered EMS systems). This compared to the survival rates (2-18%) of the single response systems (one tiered EMS systems). Survival varied considerable within each type of system, suggesting that more factors determine outcome. Another study only focussing on different European cities explained the variation of survival (15-23%) in EMS arrival times, difference in proportion of bystanders CPR, and the training level of the EMS personnel.19 Many other factors influence survival as will be discussed in more detail in the next paragraph.

The factors influencing survival of out-of-hospital cardiac arrests.

Variables influencing survival can be divided into two main groups: 1) factors related to the EMS system; 2) factors related to the patients.

System-related factors can be best described by the ‘chain of survival’ concept.20 It describes two extremely important elements, time and resuscitation events. The chain includes early access, early basic CPR, early defibrillation, and early advanced CPR (Figure 1).

![Figure 1. The ‘chain of survival’ describes the sequence of resuscitation actions after an out-of-hospital cardiac arrest; the chain includes: early access, early basic CPR, early defibrillation, and early advanced CPR.](image-url)

This concept is often used by researchers and health care authorities to search for the weakest components of this chain. Survival of an out-of-hospital cardiac arrest highly depends on the functioning of the components of this chain of survival. Many studies showed, that improvement of this survival is possible by improving the EMS system.16,17,21,22

Patient-related factors are those that could be known before the arrest (comorbidity and age) and those related to the arrest (heart rhythm and cause of the arrest). Different from the in-hospital cardiac arrest where survival depends more on patient-related factors23, survival after out-of-hospital cardiac arrest depends more on the system-related factors. Although patient-related factors can not be influenced, it may give rise to more understanding of the course and
outcome of resuscitation efforts. It may also identify the high-risk patients, so precautionary measures could be taken.

Prediction of survival of out-of-hospital cardiac arrests.

Prediction models for survival give rise to more understanding about the influencing factors on survival of prehospital resuscitation. This knowledge can be used to strengthen the weakest links in the chain of survival and for future resuscitation research programs. Previous studies described resuscitations quantitatively in regression models. They calculated survival that was mainly influenced by the intervals to basic CPR and to defibrillation. However, these studies only described resuscitations where the initial recorded rhythm was VF. A difficulty in building survival models is that apparently independent factors such as observation of VF as the initial rhythm, and the need for advanced CPR are interlinked with earlier elements of the resuscitation efforts. Basic CPR can maintain VF and delays the transition into asystole, whereas early defibrillation can restore the spontaneous circulation in patients without the need for advanced CPR procedures. Our opinion is that from the community perspective, a model limited to a subgroup that cannot be identified from the onset of the collapse is not adequate.

1.6. What could our study add to previous findings?

Before the start of our study (1994) not much was known about survival in the Netherlands. Reports of ambulance services of Utrecht (1984 and 1987), Oost Veluwe (1992), and Dordrecht (1988) were made more for internal evaluation. Retrospective studies from Rotterdam (1988) and Leiden (1992) had a scientific design and were published. However much have changed since these studies. Ambulance personnel have their own training institute (SOSA) and they are due to follow this education. Advanced life support procedures are protocolized, according to international guidelines. As a consequence of this improvement in advanced treatment; ambulance services are better equipped. A national emergency telephone number was introduced; first 06-11 and later changed in the present number 112.

Also, in the field of resuscitation research progression is made. There is an international arrangement about uniform data collection, the ‘Utstein style’. The aim of the registration according the Utstein style is to make out-of-hospital resuscitation studies more comparable.

1.7. What was the objective of our study?

First, to determine survival after an out-of-hospital resuscitation in Amsterdam and its surrounding areas. We are interested in survival to hospital admission and survival to hospital discharge.

Second, to assess the factors that influence this survival. Survival of an out-of-hospital cardiac arrest is mainly affected by factors related to the EMS system. However, also patient-related factors as age, comorbidity, and pre-arrest symptoms may influence the chance to survive an out-of-hospital cardiac arrest. Trying to clarify all determinants of survival, we analyzed both system and patient-related factors.

Third, after knowing the factors influencing survival, we also wanted to quantify their effects. The results of this study enables health care authorities to take the most effective actions to improve the weakest links of the chain of survival in their regions.

Fourth, we assessed the quality of life from those who survived to hospital discharge after an out-of-hospital cardiac arrest. Many, health care professionals have the assumption that surviving an out-of-hospital cardiac arrest is associated with serious neurological disability.
References