



Resuscitation and post resuscitation care of the very old after out-of-hospital cardiac arrest is worthwhile☆



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ABSTRACT

Background: Out-of-hospital cardiac arrest (OHCA) is associated with a poor prognosis. As comorbidity and frailty increase with age; ethical dilemmas may arise when OHCA occur in the very old.

Objectives: We aimed to investigate mortality, neurological outcome and post resuscitation care in octogenarians (≥ 80) to assess whether resuscitation and post resuscitation care should be avoided.

Methods: During 2007–2011 consecutive OHCA-patients were attended by the physician-based Emergency Medical Services-system in Copenhagen. Pre-hospital data based on Utstein-criteria, and data on post resuscitation care were collected. Primary outcome was successful resuscitation; secondary endpoints were 30-day mortality and neurological outcome (Cerebral Performance Category (CPC)).

Results: 2509 OHCA-patients with attempted resuscitation were recorded, 22% ($n = 558$) were octogenarians/nonagenarians. 166 (30% of all octogenarians with resuscitation attempted) octogenarians were successfully resuscitated compared to 830 (43% with resuscitation attempted) patients < 80 years. 30-day mortality in octogenarians was significantly higher after adjustment for prognostic factors (HR = 1.61 CI: 1.22–2.13, $p < 0.001$). Octogenarians received fewer coronary angiographies (CAG) (14 vs. 37%, $p < 0.001$), and had lower odds of receiving CAG by multivariate logistic regression (OR: 0.19, CI: 0.08–0.44, $p < 0.001$). A favorable neurological outcome (CPC 1/2) in survivors to discharge was found in 70% ($n = 26$) of octogenarians compared to 86% ($n = 317$, $p = 0.03$) in the younger patients.

Conclusion: OHCA in octogenarians was associated with a significantly higher mortality rate after adjustment for prognostic factors. However, the majority of octogenarian survivors were discharged with a favorable neurological outcome. Withholding resuscitation and post resuscitation care in octogenarians does not seem justified.

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1. Introduction

Suffering from an out-of-hospital cardiac arrest (OHCA) still carries a high mortality, despite lower overall mortality in recent years [1]. It is well-known that higher age is associated with increasing morbidity and mortality in various diseases and conditions [2,3], and as comorbidity and general frailty increases with age [2,4]; ethical dilemmas concerning resuscitation may arise, when elderly suffer from critical illnesses such as cardiac arrest [2,5].

Higher age has previously been associated with increased incidence and mortality after OHCA [6], however higher age may not necessarily be associated with a worse neurological outcome [2,7]. As the OHCA-incidence increase with age, and the worldwide elderly population is growing, reliable tools to distinguish between elderly who will benefit from a resuscitation attempt is increasingly important [5,8,9]. Currently, no standard procedure for assessing patient wishes with regard to a resuscitation attempt is available in the acute setting [5]. However, patient wishes such as do-not-resuscitate orders are more common in the elderly [10]. Elderly heart failure patients have been found to change their resuscitation preferences with decline in clinical status [11], but both the elderly patients as well as the physician have higher expectations of the chances of successful resuscitation in case of cardiac arrest than reported [12]. In addition, elderly successfully resuscitated OHCA-patients residing in nursing homes have been found to have similar 30-day survival probabilities as younger patients living at home

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after adjustment for prognostic factors [13]. Age used as a stand-alone marker therefore does not seem to be a good criterion for selecting treatment options [2,3].

In this study we aimed to investigate mortality, neurological outcome and post resuscitation care in octogenarians (all patients 80 years of age or older, including nonagenarians) suffering from OHCA, in order to assess whether resuscitation and post resuscitation care of the very old patients is meaningful or should be avoided.

2. Methods

2.1. Patients and study area

Patients with OHCA were consecutively included in the study from 2007 through 2011. OHCA of all causes with attempted resuscitation (initiation of cardiopulmonary resuscitation (CPR)) and/or more advanced resuscitative efforts (intubation, medication) in the greater Copenhagen area with dispatch by the EMS (Emergency Medical Service) were included. Patients <18 years were excluded from the study. In addition, patients who were found with obvious signs of death (rigor/livor mortis, decapitation, maceration) with no attempted CPR were identified, but these were only used to assess the distribution of patients found dead among age groups.

The Copenhagen area covers 675 km² (260 mi²), and is inhabited by approximately 1.2 million people. The EMS in Copenhagen consists of an emergency ambulance with Basic Life Support (BLS) equipment, defibrillator, and a response unit in a separate vehicle staffed with a paramedic and an attending physician (anesthesiologist). The EMS are dispatched to all patients with presumed OHCA with the treatment protocol according to the advanced life support guidelines by the European Resuscitation Council [14,15]. An Utstein registration sheet is used by the attending physician as documentation, and the pre-hospital data is entered into an OHCA-database immediately after each dispatch [16,17]. The Utstein sheet is a template that ensures uniform international reporting on factors related to OHCA, such as whether OHCA is witnessed or not, where OHCA takes place, primary rhythm and etiology of the arrest [17]. Patients who were successfully resuscitated (return of spontaneous circulation (ROSC) at hospital admission) or who were brought to the hospital with on-going CPR were admitted for post resuscitation care at one of eight hospitals in the greater Copenhagen area.

The Danish personal identification number is provided to all residents and by linking the OHCA-cohort to The National Patient Registry, data on comorbidity (diagnoses from primary care physician are not included), age, coexisting conditions and surgical procedures prior to OHCA were obtained [18]. The Charlson Comorbidity Index (CCI) was calculated based on these data. The CCI is a validated weighted index used to predict short-term mortality taking into account the severity of 22 conditions [19].

The regional ethics committee waived informed consent to the study with the reference number: H-2-2012-56, and the study was approved by the Danish Data Protection Agency.

2.2. Outcome

The primary end point of the study was successful resuscitation, and secondary endpoints were all-cause 30-day mortality and neurological outcome at discharge measured by Cerebral Performance Category scale (CPC) [17]. The CPC score ranges from 1–5, where 1–2 was defined as favorable, 3–4 was defined as unfavorable, and 5 as dead [17]. CPC was assessed by reviewing patient records, blinded to previous assessment. Inter-observer reliability for CPC at discharge was kappa weighted = 1.0, showing complete agreement. Patients with CPC 3 prior to OHCA were analyzed separately to assess differences in changes from CPC 3. Patients with CPC 4 were not analyzed, as there were only 5 patients in this group. Mortality data were acquired from the Civil Registration system, which holds data on vital status by using the personal identification number. Outcome was analyzed only for patients in whom resuscitation was attempted, excluding those found dead.

2.3. Statistics

Normally distributed continuous variables are presented as mean $\pm$ standard deviation while non-normally distributed variables are presented as median with 25–75% quartile ranges. We used Student's unpaired *t*-test or Wilcoxon rank sum test to assess differences, as appropriate. For categorical variables data are presented as number (n) and percent and we used chi-square test to assess differences. To test the association between successful resuscitation and age, as well as age and favorable neurological outcome (CPC 1 or 2) multivariate logistic regression was used with adjustment for CCI, shockable rhythm, witnessed OHCA, bystander CPR, OHCA in public, sex, time to ROSC (omitted for outcome of resuscitation attempt), with estimation of odds ratios (OR) for successful resuscitation/favorable neurological outcome and 95% confidence intervals (CI).

Furthermore, we tested the association between being octogenarian and odds of having coronary angiography (CAG) performed within 24 h of ROSC by multivariate logistic regression, adjusting for sex, primary rhythm, public arrest, witnessed arrest, CCI level, STEMI presence and bystander CPR. This analysis was performed only in patients that did not die in the emergency department.

Multivariate Cox regression analysis adjusting for CCI, gender, primary rhythm, witnessed arrest, bystander CPR, public location of OHCA, time to ROSC and cardiac etiology was used to estimate hazard ratio (HR) with 95% CI for 30-day mortality in octogenarians compared to patients <80 years. Mortality was assessed by Kaplan–Meier curves and differences were tested with the log-rank test. In order to illustrate temporal changes in successful resuscitation and 30-day mortality in patients <80 years and octogenarians, percentages of successfully resuscitated patients and 30-day survival were plotted for each year, and differences during the study period were tested using the Cochran–Mantel–Haenszel Chi-square trend test. All statistical analyses were carried out in SAS Statistics version 9.3 (Cary, NC, USA) or R 3.0.1 [20] with a level of significance defined as $p < 0.05$. The R package 'survival' was used for Cox regression and the log rank test [21,22].

3. Results

3.1. Overall patient characteristics

In total the EMS attended 3679 OHCA-patients during the five year-study period, divided into 2 groups: Patients found with obvious signs of death (hereafter: patients found dead) ($n = 1170$, 32% of all patients), and patients with resuscitation attempted ($n = 2509$, 68% of all patients, hereafter: patients with resuscitation attempted) (Fig. 1). The latter were further stratified into patients successfully resuscitated in the pre-hospital setting/on-going CPR at hospital arrival, 40% of all patients with attempted resuscitation ($n = 996$, hereafter: successfully resuscitated patients), and patients with unsuccessful resuscitation ($n = 1513$, 60% of patients with attempted resuscitation, hereafter: unsuccessfully resuscitated patients).

Of the successfully resuscitated patients, 15% ($n = 144$) were octogenarians and 2% ($n = 22$) of these were nonagenarians, while 20% ($n = 296$) of the unsuccessfully-resuscitated patients were octogenarians, and 6% ($n = 96$) were nonagenarians. In patients found dead, 28% ($n = 325$) were octogenarians, 11% ($n = 130$) were nonagenarians and 0.25% ($n = 3$) were centenarians (Figs. 1 and 2A). For further analysis, all patients ≥ 80 are referred to as octogenarians.

3.2. Successfully resuscitated octogenarians and resuscitated patients < 80 years

In successfully resuscitated patients <80 years, 75% were men vs. 53% ($p < 0.001$) in successfully resuscitated octogenarians. Compared to the successfully resuscitated patients <80 years, successfully resuscitated octogenarians had a higher comorbidity burden; with more octogenarians having CCI ≥ 3 than patients <80 years (30 vs. 19%, $p < 0.001$). Fewer had OHCA in public (26 vs. 39%, $p = 0.002$) and fewer had a witnessed arrest (84 vs. 87%, $p = 0.04$) (Table 1).

A higher proportion of successfully resuscitated octogenarians had active therapy withdrawn in the emergency department (19 vs. 10%, $p < 0.01$, Table 2), and with regard to post resuscitation care, fewer successfully resuscitated octogenarians received therapeutic hypothermia (32 vs. 52%) had an acute coronary angiography (CAG < 24 h, 14 vs. 37%), non-acute CAG (16 vs. 49%), and percutaneous coronary intervention (PCI, 10 vs. 27%), all at $p < 0.001$. These differences were still present when assessing differences in only patients with VF/VT. Being octogenarian was associated with lower odds of acute CAG in multivariate logistic regression at OR: 0.19, CI: 0.08–0.44, $p < 0.001$. The same differences were found for neurological prognostication, where fewer octogenarians had computed tomography (CT) of the head (24 vs. 42%, $p < 0.001$), neuro-prognostication with electroencephalography (EEG) (6 vs. 21%, $p < 0.001$) as well as somatosensory evoked potential (SSEP) (2 vs. 11%, $p < 0.01$, Table 2). Coronary artery bypass grafting (CABG) was not performed in any octogenarians during the study period.

3.3. Characteristics of unsuccessfully resuscitated patients

In the population of unsuccessfully resuscitated patients there were significantly fewer men among the octogenarians than patients <80 (50

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