

# Are There Age-Related Differences in the In-Hospital Treatment of Victims from Out-of-Hospital Cardiac Arrest?

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## Abstract

**Objective:** Hardly anything is known about reasons for age-related differences in surviving out-of-hospital cardiac arrest (OHCA) with worse surviving rates in elderly. **Methods:** 204 victims from OHCA who were admitted in our hospital between January 1<sup>st</sup> 2008 and December 31<sup>st</sup> 2013 were identified. According to their mean age ( $69.1 \pm 14.2$  years) we classified those patients (pts) who were younger than mean age minus standard deviation (SD) as young, and those victims from OHCA who were older than mean age plus SD as old. **Results:** Young victims from OHCA ( $n = 32$  pts) presented more often with an initial shockable rhythm than the elderly ( $n = 38$  pts) (50.0% vs. 21.1%;  $p = 0.014$ ), received more often coronary angiography (71.9% vs. 18.4%;  $p < 0.001$ ), more often percutaneous coronary intervention (46.9% vs. 13.2%;  $p = 0.003$ ), more often mild therapeutic hypothermia (78.1% vs. 15.8%;  $p < 0.001$ ) and could be more often discharged alive (65.6% vs. 21.1%;  $p < 0.001$ ). **Conclusion:** At hospital admission, physiological data did not differ between young and old victims from OHCA. Less use of coronary angiography and mild therapeutic hypothermia in elderly victims from OHCA might suggest that the observed age-related differences in survival following OHCA might be caused by age-related differences in the in-hospital treatment.

## Keywords

Out-of-Hospital Cardiac Arrest, Mild Therapeutic Hypothermia, Coronary Angiography, Resuscitation, Elderly

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## 1. Introduction

Witnessed arrest [1] [2], bystander-initiated resuscitation [2] [3], initial shockable rhythm [2] [4], shorter dura-

tion of resuscitation [5] and also younger age [6]-[11] have been repetitively described as advantages in surviving out-of-hospital cardiac arrest (OHCA).

However, while the advantage of the most above-mentioned factors can be explained by their positive effect on shortening the no-flow time, hardly anything is known about specific reasons for the age-related differences in surviving OHCA with worse surviving rates in the elderly. We therefore initiated this study to learn more about the differences in the post cardiac arrest treatment of very old and very young patients.

## 2. Methods

### 2.1. Patients

Altogether, 204 patients with a mean age of  $69.1 \pm 14.2$  years [range 18 - 97 years] were admitted to our hospital between January 1<sup>st</sup> 2008 and December 31<sup>st</sup> 2013 following OHCA.

According to the mean age we classified those patients who were younger than mean age minus standard deviation (SD) as young, and those victims from OHCA who were older than mean age plus SD as old.

### 2.2. Data Analysis

Patients data were collected from the individual patient's health records and anonymous stored on a central data base. Statistical analysis was performed with the Statistical Package of Social Science (SPSS 22.0, IBM, Armonk, NY, USA). Continuous variables are expressed as the mean  $\pm$  SD, comparisons of categorical variables among groups were conducted using Chi-square tests or student's t-test.

Data collection and analysis was approved by the local ethical review committee.

## 3. Results

### 3.1. Young Victims from OHCA

32 victims from OHCA (19 male (59.4%) and 13 female (40.6%)) were classified as young and had a mean age of  $46.7 \pm 9.3$  years. There were 25 witnessed arrests (78.1%) in this group, 21 patients received bystander-initiated resuscitation (65.6%) and 16 patients (50.0%) presented with an initial shockable rhythm.

At admission, first body temperature was  $35.3^\circ\text{C} \pm 1.4^\circ\text{C}$  (degree Celsius), first pH  $7.15 \pm 0.25$ , first  $\text{pO}_2$   $203.2 \pm 167.1$  mmHg, first  $\text{pCO}_2$   $53.0 \pm 26.1$  mmHg, first lactate  $11.9 \pm 18.4$  mmol/l.

11 patients (34.4%) presented with myocardial infarction (8 ST elevation myocardial infarction (STEMI) (25.0%) (3 non-ST elevation myocardial infarction (NSTEMI) (9.4%)). Creatine kinase was  $373.4 \pm 540.4$  U/l and troponin I  $2.3 \pm 9.4$  ng/ml at admission. 23 patients (71.9%) received coronary angiography, 15 (46.9%) percutaneous coronary intervention (PCI). 25 patients (78.1%) were treated with mild therapeutic hypothermia (MTH), 21 (65.6%) could be discharged alive.

### 3.2. Old Victims from OHCA

38 victims from OHCA (14 male (36.8%) and 24 female (73.2%)) were classified as old and had a mean age of  $87.2 \pm 3.4$  years. There were 23 witnessed arrests (60.5%) in this group, 21 patients received bystander-initiated resuscitation (55.3%) and 8 patients (21.1%) presented with an initial shockable rhythm.

At admission, first body temperature was  $35.2^\circ\text{C} \pm 1.4^\circ\text{C}$ , first pH  $7.14 \pm 0.20$ , first  $\text{pO}_2$   $193.1 \pm 162.5$  mmHg, first  $\text{pCO}_2$   $50.7 \pm 21.8$  mmHg, first lactate  $8.0 \pm 4.3$  mmol/l.

8 patients (21.1%) presented with myocardial infarction (3 STEMI (7.9%), 5 NSTEMI (13.2%)). Creatine kinase was  $291.2 \pm 535.2$  U/l and Troponin I  $2.6 \pm 8.8$  ng/ml at admission. 7 patients (18.4%) received coronary angiography, 5 (13.2%) PCI. 6 patients (15.8%) were treated with MTH, 8 (21.1%) could be discharged alive.

### 3.3. Comparison of Old and Young Victims from OHCA

Young victims from OHCA presented more often with an initial shockable rhythm than elderly ( $p = 0.014$ ), received more often coronary angiography ( $p < 0.001$ ), more often PCI ( $p = 0.003$ ), more often MTH ( $p < 0.001$ ) and could be more often discharged alive ( $p < 0.001$ ). All data are summarized in **Table 1**.

**Table 1.** Patient's characteristics of young and old victims from OHCA.

	Young (n = 32)	Old (n = 38)	p
Male	19 (59.4%)	14 (36.8%)	0.060
Age (years)	46.7 ± 9.3	87.2 ± 3.4	<b>&lt;0.001</b>
Witnessed arrest	25 (78.1%)	23 (60.5%)	0.077
Bystander-initiated resuscitation	21 (65.6%)	21 (55.3%)	0.347
Initial shockable rhythm	16 (50.0%)	8 (21.1%)	<b>0.014</b>
First body temperature (°C)	35.3 ± 1.4	35.2 ± 1.4	0.992
First pH	7.15 ± 0.25	7.14 ± 0.20	0.688
First pO <sub>2</sub> (mmHg)	203.2 ± 167.1	193.1 ± 162.5	0.925
First pCO <sub>2</sub> (mmHg)	53.0 ± 26.1	50.7 ± 21.8	0.468
First lactate (mmol/l)	11.9 ± 18.4	8.0 ± 4.3	0.117
Creatine kinase (CK) (U/l)	373.4 ± 540.4	291.2 ± 535.2	0.653
Troponin I (ng/ml)	2.3 ± 9.4	2.6 ± 8.8	0.865
Myocardial infarction	11 (34.4%)	8 (21.1%)	
STEMI	8 (25.0%)	3 (7.9%)	0.581
NSTEMI	3 (9.4%)	5 (13.2%)	
Coronary angiography	23 (71.9%)	7 (18.4%)	<b>&lt;0.001</b>
Percutaneous coronary intervention	15 (46.9%)	5 (13.2%)	<b>0.003</b>
Mild therapeutic hypothermia	25 (78.1%)	6 (15.8%)	<b>&lt;0.001</b>
Discharged alive	21 (65.6%)	8 (21.1%)	<b>&lt;0.001</b>

STEMI: ST elevation myocardial infarction; NSTEMI: non ST elevation myocardial infarction.

### 3.4. In-Hospital Treatment Stratified by the Initial Findings of Myocardial Infarction or Shockable Rhythm

100.0% of the young patients who fulfilled the criteria of STEMI [12], 33.3% of the young patients who fulfilled the criteria of NSTEMI [13] and 57.1% of the young patients without myocardial infarction received coronary angiography.

In elderly, 33.3% of the patients with STEMI, 40.0% of the patients with NSTEMI and 13.3% of the patients without myocardial infarction received coronary angiography (Table 2, Figure 1).

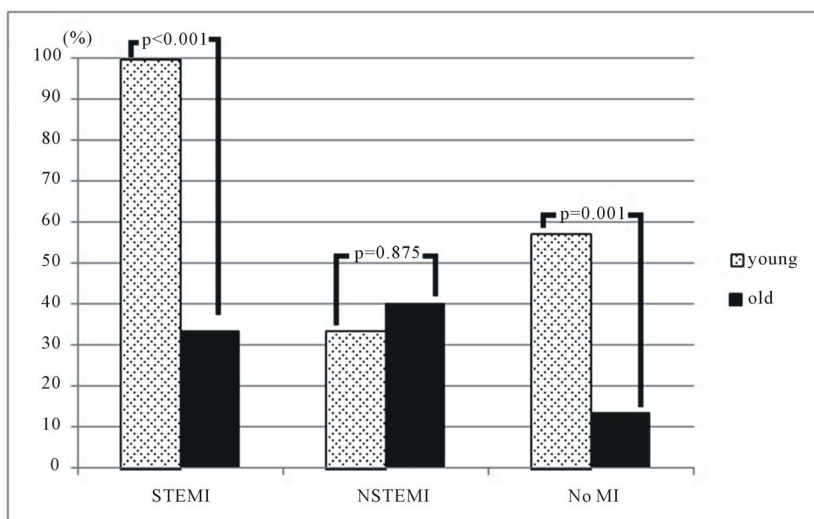
Mild therapeutic hypothermia was applied in 93.8% of the young patient with initial shockable rhythm and 68.8% of the young patients without initial shockable rhythm. In elderly, MTH was used in 37.5% of the patients with initial shockable rhythm and 10.0% of the patients without initial shockable rhythm (Table 2, Figure 2).

## 4. Discussion

Our data are in line with previously published studies that described better surviving rates in younger than in elderly victims from OHCA (Table 1) [6]-[11]. Possible reasons for these differences might be estimated in the pre-hospital but also the intra-hospital findings.

### 4.1. Pre-Hospital Findings

It has been argued that a presumably higher rate of nursing home residencies in the elderly patients might influence survival from OHCA. Of course, the most common incident locations of cardiac arrest are either the



**Figure 1.** Percentage of the old and young patients who received coronary angiography following OHCA depending on their initial presentation with myocardial infarction or not.

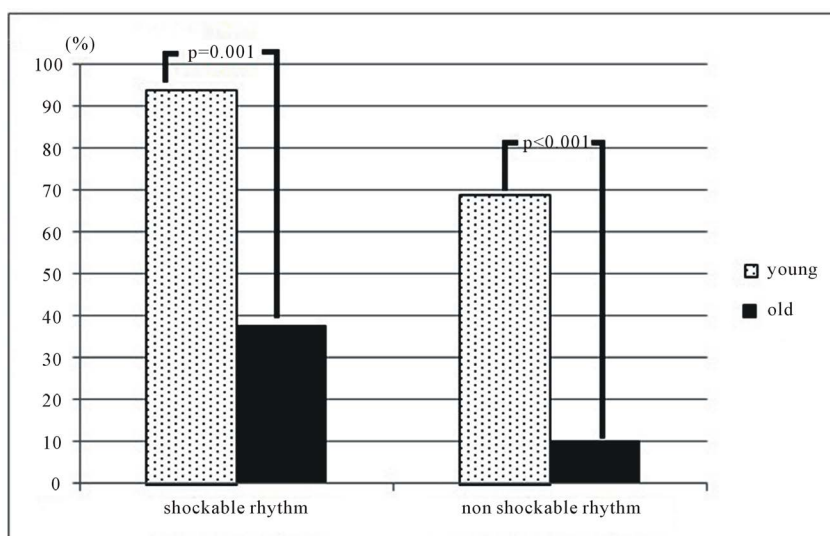
**Table 2.** Coronary angiography and application of mild therapeutic hypothermia in old and young victims from OHCA depending on first laboratory and electrocardiographic findings.

	Young (n = 32)	Old (n = 38)
<u>STEMI</u>	8	3
Coronary angiography	8 (100.0%)	1 (33.3%)
No coronary angiography	0 (0.0%)	2 (66.6%)
<u>NSTEMI</u>	3	5
Coronary angiography	1 (33.3%)	2 (40.0%)
No coronary angiography	2 (66.6%)	3 (60.0%)
<u>No myocardial infarction</u>	21	30
Coronary angiography	12 (57.1%)	4 (13.3%)
No coronary angiography	9 (42.9%)	26 (86.7%)
<u>Initial shockable rhythm</u>	16	8
Mild therapeutic hypothermia	15 (93.8%)	3 (37.5%)
No mild therapeutic hypothermia	1 (6.2%)	5 (62.5%)
<u>Initial non-shockable rhythm</u>	16	30
Mild therapeutic hypothermia	11 (68.8%)	3 (10.0%)
No mild therapeutic hypothermia	5 (31.2%)	27 (90.0%)

STEMI: ST elevation myocardial infarction; NSTEMI: non ST elevation myocardial infarction.

patient’s home or—especially in elderly—the nursing homes [14] [15]. However, by now, there are discrepant findings about the influence of nursing home residencies on patient’s survival following OHCA; some authors reported a predictive value of nursing home residency for decreased survival to discharge following OHCA [16]-[18] whereas there were similar survival rates in another study [19].

The findings of the present study cannot support the theory of a relevant influence of nursing home residencies on patient’s survival. In fact, there was just one difference between young and old victims from OHCA in the pre-hospital setting: a lower rate of initial shockable rhythm in elderly (Table 1) [20]-[22].



**Figure 2.** Percentage of the old and young patients who were treated with mild therapeutic hypothermia following OHCA depending on whether they initially present with a shockable rhythm.

Physiological data, such as first pH, first pO<sub>2</sub>, first pCO<sub>2</sub>, first lactate and the initial body temperature were all similar in young and old victims from OHCA (**Table 1**).

#### 4.2. In-Hospital Findings

The current guidelines for the management of patients following OHCA recommend two main techniques in the post-resuscitation treatment: mild therapeutic hypothermia and early coronary angiography—at least in patients with suspected cardiac cause of death [23]. The combination of mild therapeutic hypothermia (MTH) and early coronary angiography—inclusive PCI if necessary—is feasible and safe [11] [24]-[27] and has been shown to improve surviving rates from OHCA [7] [28] [29].

However, in our data, only 18.4% of the elderly patients received coronary angiography and only 15.8% were treated with MTH whereas we observed a broad use of both techniques in young patients (**Table 1**).

It might be hypothesized, that a higher prevalence of severe comorbidities in elderly patients contradicts invasive techniques but to our knowledge, there are no studies that really record either the pre-arrest comorbidities or the functional status of victims from OHCA and clarify their influence on survival, neither in the victims from OHCA in general, nor in elderly in particular. Furthermore, previous studies confirmed that the use of mild therapeutic hypothermia is safe [11] [30], complicative infections during therapeutic hypothermia do not impact mortality or neurological recovery [31] and a limitation of post-resuscitation MTH based on age alone is not justified [32].

Taking into account that especially the early induction of MTH during cardiac arrest improves neurological outcomes [33], we doubt that relevant differences in the patient's advance directives caused the rare use of MTH or coronary angiography in elderly.

At last, it might be discussed that a lower rate of an initial shockable rhythm in old patients (**Table 1**) led to lower application rates of MTH in elderly as the current guidelines recommend the use of MTH in patients with an initial shockable rhythm [23].

However, subgroup analysis yielded that the application of mild therapeutic hypothermia was also rare in elderly with an initial shockable rhythm (**Table 2, Figure 2**) and also coronary angiography was infrequently used in elderly patients, even in those who presented with STEMI following OHCA (**Table 2, Figure 2**).

Therefore, in summary, we interpret our data as an expression of age-related differences in the post-resuscitation treatment with a worse therapy in elderly.

Of course, this is a single center study and our findings must be confirmed in further investigations but our data are also in line with further descriptions of less commitment on the treatment of old patients; an obviously frequent finding in cardiovascular disease. For example, there was a rare secondary cardiovascular preventive

therapy in elderly [34] an undertreatment with oral anticoagulation [35] [36], the finding that advancing age was inversely associated with receipt of evidence-based cardiac therapies following acute myocardial infarction [37] and the observation that elderly patients were less likely to receive evidence-based treatments in heart failure [38].

### 4.3. Limitations

The present study is a single center study and we did not adjust for confounding factors, but however, the characteristics of our patient's are comparable to those described previously in other studies [11] [24] [28] and the observation of less commitment on the treatment of old patients was frequent in diverse other cardiovascular disease [34]-[38]. However, further investigations should verify our data.

### 5. Conclusions

In summary, our data suggest that age-related differences in survival following OHCA might be caused by age-related differences in the in-hospital treatment.

Expecting an increasing number of elderly victims from OHCA during the next years, we see the need for further studies with larger sample sizes to confirm our findings.

### Conflict of Interest

All authors declare: no conflict of interest.

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