

OUT-OF-HOSPITAL CARDIAC ARREST IN YOUNG ADULTS AGED 45 YEARS OR YOUNGER

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Abstract

Introduction: We know about factors that influence survival following out-of-hospital cardiac arrest. Nevertheless, most studies describe the treatment of victims of OHCA in general. We therefore initiated this study to determine whether there are special features of the post-resuscitation treatment of young adults.

Material and methods: All victims of OHCA (age 17–45 years) who were admitted to our intensive care unit between January 1st 2008 and December 31st 2013 were registered and their medical reports were stored in a central database.

Results: There were 15 victims of nontraumatic OHCA aged 45 years or younger: seven men (46.7%) and eight women (53.3%). Return of spontaneous circulation (ROSC) prior to hospital admission was achieved in nine patients (60.0%), five patients (33.3%) received mild therapeutic hypothermia (MTH), and six patients received percutaneous coronary intervention (PCI). Myocardial infarction was the most common cause of death (40.0%), including in two patients following prior heart operations. The survival rate was 53.3%; seven out of eight patients discharged alive had a good neurological state (CPC 1).

Discussion: The prevalence of nontraumatic OHCA in patients aged 45 years or younger is rare and we could not find any relevant differences between the post-resuscitation findings in young adults and those described for victims of OHCA in general beside a higher rate of application of MTH among the younger patients.

The main finding of our study was the surprisingly high prevalence of cardiac causes of OHCA with myocardial infarction as the most common cause of death despite the young age of our patients collective.

Conclusion: As cardiac causes of OHCA were the most common finding in our study of young victims from OHCA, we recommend that especially young victims from OHCA should be transported in a cardiac centre with PCI readiness on a 24/7 basis.

Keywords: sudden cardiac arrest, resuscitation, out-of-hospital cardiac arrest, young adults, mild therapeutic hypothermia

INTRODUCTION

Several factors have been reported to influence survival following out-of-hospital cardiac arrest (OHCA): witnessed events, bystander cardiopulmonary resuscitation (CPR), an initial shockable rhythm and the return of spontaneous circulation (ROSC) before hospital admission [1, 2]. However, as all these results refer to the population in general, previous investigations have recommended the need for further studies in more homogenous subgroups to assess more individual risk profiles and maybe achieve even better post-resuscitation treatments.

Following these recommendations, we initiated this study with the aim of gaining more insight into the post-resuscitation treatment of young adults.

MATERIAL AND METHODS

All patients who were admitted to our intensive care unit following OHCA between January 1st 2008 and December 31st 2013 were registered and their data were stored in a central database. Patients aged 45 years or younger were identified and their medical reports were included in further investigations. Children and adolescents younger than 16 years old were excluded as they were immediately transferred to a special center.

All data were stored in a central database. Statistical analysis was performed with the Statistical Package of Social Science (SPSS 22.0, IBM, Armonk, NY, USA). Continuous variables are

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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.

RESULTS

Data from out-of-hospital resuscitation

Fifteen patients aged 45 years or younger were admitted to our hospital between January 1st 2008

and December 31st 2013 following nontraumatic OHCA: seven men (46.7%) and eight women (53.3%). Their age ranged from 17 to 45 years (Table 1).

On the basis of there being 156,000 inhabitants in the city of Herne, 15 OHCA among young adults aged 45 years or younger is equivalent to an incidence of 1.6 OHCA per 100,000 inhabitants per year.

Twelve events were witnessed (80.0%), and lay resuscitation was performed in four cases (26.7%); in two further cases (13.3%) cardiac arrest did not

Table 1: patient data from out-of-hospital resuscitation and survival during follow-up

No	Gender /age (years)	Patient's characteristics	Witnessed	First rhythm	Lay resuscitation	Duration of resuscitation (minutes)	ROSC before arrival	Discharged alive	Time to death (hours)	CPC
1	m 17y	Uncertain	yes	Asystolic	no	n.a.	Resuscitation	no	2	
2	m 20y	myocardial infarction following Rashkind procedure and Mustard atrial switch operation transposition of the great arteries, ventricular septal defect and ductus arteriosus Botalli	yes	VT	no	n.a.	Resuscitation	no	1	
3	m 27y	hypoxemia due to aspiration following measles encephalitis	no	Asystoly	no	65	Resuscitation	no	96	
4	m 31y	Myocarditis	yes	VF	no	n.a.	ROSC	yes		1
5	m 34y	hypoxemia due to aspiration following drug intoxication	no	Asystoly	no	40	ROSC	yes		4
6	f 34y	Uncertain	no	Asystoly	no	n.a.	Resuscitation	no	24	
7	f 35y	long QT syndrome	yes	VF	yes	10	ROSC	yes		1
8	f 37y	myocardial infarction following heart lung transplantation	yes	Asystoly	no	55	Resuscitation	no	96	
9	m 40y	hypertrophic cardiomyopathy	yes	Asystoly	no	n.a.	ROSC	no	96	
10	f 40y	Lungembolia	yes	Asystoly	yes	15	Resuscitation	no	21	
11	m 41y	myocardial infarction	yes	VF	yes	n.a.	ROSC	yes		1
12	f 42y	myocardial infarction	yes	VF	no	20	ROSC	yes		1
13	f 42y	myocardial infarction	yes	VF	EMT	30	ROSC	yes		1
14	f 45y	myocardial infarction	yes	VF	EMT	n.a.	ROSC	yes		1
15	f 45y	Myocarditis	yes	VF	yes	10	ROSC	yes		1

m: male, f: female, y: years, VT: ventricular tachycardia, VF: ventricular fibrillation, EMT: emergency medical team, ROSC: return of spontaneous circulation, n.a.: not available, CPC: cerebral performance category

occur until after the emergency medical team (EMT) had arrived.

The first documented rhythm was asystolic in seven (46.7%) and ventricular tachycardia or ventricular fibrillation in the other eight patients (53.3%).

ROSC prior to hospital admission was achieved in nine patients (60.0%); six patients (40.0%) were admitted to our intensive care unit under continued resuscitation efforts (Table 1).

Mild therapeutic hypothermia (MTH)

Five patients (33.3%) were treated with mild therapeutic hypothermia (MTH), but ten patients (66.6%) were not treated for the following reasons. Patient 1 and 2 never reached clinical stability and died within the first 2 hours after hospital admission. The resuscitation of patients 7 and 15 lasted no longer than 10 minutes and previous data suggested a benefit from MTH in comatose survivors of cardiac arrest with an OHCA-to-ROSC interval greater than 15 minutes [3]. Patient 6 showed established multiple organ

failure at admission and was therefore excluded from MTH [4]. Patients 4, 11 and 14 were not treated with MTH as they were no longer comatose but were breathing spontaneously when they reached our hospital.

Patients 3 and 8 were not treated with MTH as the initial rhythm was asystolic and the guidelines at that time [5] suggested a benefit of MTH only for survivors following OHCA due to ventricular tachycardia or ventricular fibrillation (Table 2).

Coronary angiography

The guidelines of the European Resuscitation Council underline the potential benefit of early percutaneous coronary intervention (PCI) in patients following OHCA and estimated cardiac cause of death [6]. Ten patients in our collective (66.6%) received coronary angiography, six of them PCI (40.0%). Those who did not receive coronary angiography or equivalent either never reached clinical stability (Patients 1 and 2), or had a more likely non-cardiac cause of death (Patients 3, 6 and 10) (Table 2).

Table 2: patient's data containing in-hospital diagnostic

No	Patient's gender/age	First pH	First pCO ₂ (mm Hg)	First pO ₂ (mm Hg)	First Lactate (mmol /l)	Potassium (mmo l/l)	NSE (ng/ml)	Coronary angiography	Percutaneous coronary intervention	Mild therapeutic hypothermia (MTH)	Implantable Cardioverter Defibrillator or (ICD)	ICD 6 month follow-up
1	m 17y	<6.8	>115	6	>15	6.4	-	no		no		
2	m 20y	-	-	-	-	-	-	no		no		
3	m 27y	6.83	75	1	14.6	5.2	-	no		no		
4	m 31y	7.32	52	71	0.5	3.8	-	yes		no	yes	0
5	m 34y	<6.8	>150	63	13.3	6.8	326	yes	RIVA	yes		
6	f 34y	-	-	-	-	-	-	no		no		
7	f 35y	-	-	-	-	-	23.5	yes		no	yes	1 non-sustained VT
8	f 37y	<6.8	66	324	14.2	4.3	94.4	yes	RPLD	no		
9	m 40y	6.95	26	408	>15	2.8	500	yes		yes		
10	f 40y	7.42	40	83	>15	2.7	82	no		yes		
11	m 41y	-	-	-	-	-	14.1	yes	RCX	no		
12	f 42y	-	-	-	-	-	29.3	yes	RIVA + RCA	yes		
13	f 42y	-	-	-	-	-	-	yes	RIVP	yes	yes	10 non-sustained VT
14	f 45y	-	-	-	-	-	-	yes	RIVA + RCX	no		
15	f 45y	7.13	38	77	12.3	3.2	-	yes		no	yes	0

m: male, f: female, y: years, NSE: neuron-specific enolase, RIVA: Ramus interventricularis anterior, RPLD: Ramus posterolateralis dexter, RCX: Ramus circumflexus, RIVP: Ramus interventricularis posterior

Data from further in-hospital diagnostics

Arterial blood gas analysis following admission was performed in eight patients (53.3%). The first pH ranged from <6.8 to 7.42, first pCO₂ from 26 to >150 mmHg, first pO₂ from 1 to 408 mmHg. The first lactate ranged from 0.5 to >15 mmol/l, first potassium from 2.7 to 6.8 mmol/l. The highest NSE levels during follow-up ranged from 14.1 to 500.0 ng/ml (Table 2).

OHCA was caused either by myocardial infarction (six patients, 40.0%), myocarditis (two patients, 13.3%), asphyxia (two patients, 13.3%), lung emboli (one patient, 6.7%), long QT syndrome (one patient, 6.7%), or hypertrophic cardiomyopathy (one patient, 6.7%) or the cause remained uncertain (two patients, 13.3%). Diagnosis was confirmed by clinical diagnostics, autopsy, or both.

Two patients who died from myocardial infarction had had prior heart operations; one patient the Rashkind procedure and Mustard atrial switch operation before his first birthday, and the other patient heart lung transplantation due to pulmonary hypertension 3 years before the cardiac arrest occurred (Table 1).

Data from patients' follow-up

Eight patients (53.3%) were discharged alive, and seven patients (46.7%) died between the first and fourth day after hospital admission. Almost all patients (87.5%) who survived were discharged in a good neurological state (CPC 1); only one patient was discharged in a vegetative state (CPC 4).

Four patients (20.0%) received an implantable cardioverter defibrillator (ICD) during follow-up. Two of these had had no further rhythm events at the 6-month follow-up, one patient had had a single non-sustained ventricular tachycardia (nsVT) and one patient ten nsVT. None of them received ICD therapies (Table 1).

DISCUSSION

With an incidence of 1.6 OHCA per 100,000 inhabitants per year, the need for resuscitation of young adults aged 45 years or younger is rare but not so low that it can be ignored. However, there were few differences between our findings and former findings following OHCA in general.

Similarities between young victims of OHCA and victims of OHCA in general

Comparison of our findings with previous data revealed several similarities between the resuscitation of young victims of OHCA and the resuscitation of victims of OHCA in general.

First, although most events were witnessed, there were poor rates of bystander CPR [1]. Second, survival rates were higher in patients with witnessed events (58.3%), patients who received immediate CPR from a layperson or EMT (83.3%) and those who presented an initial shockable rhythm (87.5%) [1, 7]. Third, cardiac causes were the most common cause of death [8], which underlines the notion that the number of cardiac deaths in the young is sufficiently high to command attention [9]. Fourth, 40% of PCI in our group was similar to that described among all victims of OHCA [10]. Fifth, survival rates among patients who did not achieve ROSC prior to hospital admission were extremely poor [2, 10]. Sixth, survival rates following OHCA were generally poor [1, 10, 11, 12, 13] with better rates following ventricular fibrillation [14]. Among patients who reached the hospital alive, every second victim of OHCA died [15, 16]; in our investigation the survival rate of young adults was 53.3%.

Differences between young victims of OHCA and victims of OHCA in general

Beside those similarities, we observed only one difference between young victims of OHCA and victims of OHCA in general. To our knowledge, only a few studies have systematically recorded the use of mild therapeutic hypothermia in intensive care units following OHCA. There are data that describe the poor availability of MTH [17, 18], with logistic problems being the leading cause of non-adoption [18], and there are data that described the rate of application of MTH as only 25.6% [10] but of course especially the choice of admitting hospital for patients suffering OHCA significantly influences treatment and outcome [19].

In our trial, MTH was available and the motivation for its use was high, especially as the post-resuscitation treatment of young adults was associated with great effort on the part of all staff. As a consequence, the rate of MTH application in our sample was higher than that reported for the population in general [10]; even so, only one third of all patients were treated with this method.

Causes of death in young victims of OHCA

Probably the most important finding of this study is the high prevalence of cardiac causes of death that were found in at least two third of our patients aged 45 years or younger (table 1). Despite the young age of these patients, myocardial infarction was the most common cause of death with comparable rates to those described previously [2]. However, we could observe diverse other cardiac causes of death like myocarditis, hypertrophic cardiomyopathy and QT prolongation. We therefore recommend that especially young victims from OHCA should be transported in a cardiac centre with PCI readiness on a 24/7 basis.

Conflict of Interest

All authors declare no conflict of interest.

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