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Out-of-Hospital Cardiac Arrests in Patients with Acute ST Elevation Myocardial Infarctions in the East Bohemian Region over the Period 2002–2004

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Key Words

Acute myocardial infarction · Cardiac arrest · Cardiac arrest, out-of-hospital · Percutaneous coronary intervention · ST segment elevation myocardial infarction · Cardiac death, sudden

Abstract

Background: Early reperfusion by direct percutaneous coronary intervention (PCI) in patients with ST segment elevation acute myocardial infarctions (STEMI) with an out-of-hospital cardiac arrest (OHCA) reduces hospital and long-term mortality. ***Aims:*** Evaluating the significance of direct PCI for the short-term (discharge from acute hospitalization) and 1-year survival in patients with acute STEMI after OHCA. ***Methods:*** In this prospective study, from April 1, 2002 up to August 31, 2004, a total of 26 hospitalized individuals (22 men, 4 women, aged 35–79 years, median 58.5) from the East Bohemian region with OHCA (primary group of 718 individuals) with acute STEMI were included. Urgent coronary angiography was performed in 20 individuals, and direct PCI was done in 19 of them. The remaining 6 patients did not undergo angiography. ***Results:*** Fifteen patients (57.7%) survived acute hospitalization, of whom 11 were without neurological deficits. In the subgroup with urgent coronary angiography 14 patients (70%) survived hospitalization, and in the subgroup without coronarography only 1 patient survived hospitalization (16.7%). In the subgroup with PCIs, 13 out of the 19 patients survived (68.4%). None of the patients died during the 1-year follow-up after being discharged from acute hospitalization. According to the urgent coronarography the artery most commonly responsible for the infarction was the left anterior descending artery (50%). Initial TIMI flow grade 0–I was found in 17 patients and grade II–III in 3 individuals. After PCI, irrespective of stent implantation, an optimal angiographic success (TIMI flow grade II–III) was obtained in 17 cases. ***Conclusion:*** Short-term survival of patients after OHCA with STEMI treated with direct PCI was found to be 68.4%. Out of 6 patients not receiving reperfusion therapy 1 survived (16.7%). Over the course of the 1-year follow-up none of the patients died.

Introduction

Most of the deaths from acute ST segment elevation myocardial infarction (STEMI) are caused by ventricular fibrillation [1, 2]. Survival of these patients in the field depends above all on the presence of a witness, immedi-

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ate initiation of bystander cardiopulmonary resuscitation (CPR) and timely electric defibrillation [3, 4]. An important prognostic factor in patients with STEMI is achieving timely reperfusion pharmacologically (thrombolysis) or mechanically by direct percutaneous coronary intervention (PCI) [1, 3, 5, 6]. The hospital mortality of patients with out-of-hospital cardiac arrest (OHCA) and direct PCI (mainly STEMI) ranges between 23 and 46% [7–12]. One year from acute hospitalization more than 90% of patients survive [7, 8, 10, 11].

The aim of our work was to evaluate the impact of direct PCI of STEMI in patients with OHCA on short-term (discharge from acute hospitalization) and long-term (1-year) survival.

Materials and Methods

Patient Selection

In this study we prospectively included (over the period between April 1, 2002 and August 31, 2004) a total of 718 individuals (511 men and 207 women) from the East Bohemian region [an area of 11,244 km^2 with 1,236,000 inhabitants served by 24 rescue service centers, 16 anesthesiology and resuscitation departments (ARD), 19 internal medicine departments, two cardiocenters: Hradec Kralove and Pardubice] (fig. 1). The patients were aged between 16 and 97 years (median 69) and OHCA were reported to the rescue center dispatch. We excluded individuals with cardiac arrest occurring in the presence of emergency medical services (EMS). Individuals in whom there were apparent toxic, traumatic or suicidal etiologies for unconsciousness, including drowning and terminal illnesses, were also excluded. Medical CPR was initiated in 574 cases. In 560 patients we considered the cardiac arrest to be of 'primary cardiac' cause. Out of these 149 individuals (all with return of spontaneous circulation in the field for over 5 min) survived till hospital admission. According to the clinical course and laboratory examinations the main cause of OHCA in these hospitalized individuals was found to be acute STEMI in 26 cases (fig. 2).

Procedure

In accordance with the Utstein Style protocol, we created a questionnaire that was sequentially filled by rescue service doctors, ARD, internal medicine departments and cardiocenters [13–15]. While filling in the questionnaire patient anonymity was maintained by giving each patient a unique numerical identification code. The questionnaire was predominantly formulated to allow for a clear (yes or no) response to the given questions. It included data of the patient's history, information regarding prehospital care, initial ECG rhythm, time intervals (arrival time = interval between the time when the event was reported to the rescue center and the beginning of emergency care by the EMS staff, length of CPR, intervals between symptom onset and treatment initiating upon hospital 'door' admission), and the distance from a cardiocenter (catheterization laboratory). Hospitalization data concerning diagnosis, clinical course and treatment of acute STEMI [artificial pulmonary ventilation, Glasgow Coma Scale (GCS) on admission, presence of cardiogenic shock, post-anoxic encephalopathy, coronarography details, reperfusion treatment with direct PCI] were recorded [16]. We registered information on short-term (death within 24 h, discharge from acute hospitalization) and 1-year survival of patients including evaluating the CNS state with the aid of cerebral performance categories using Glasgow-Pittsburgh Outcome Categorization (CPC) (table 1) [17].

Statistics

For the statistical evaluation of survival we used Fisher's test for the differences in two proportions (fig. 2).

Definitions

Acute STEMI. Acute STEMI is defined as dynamic ST segment elevations on the ECG along with a typical rise (a minimum of 3 times above the upper border of normal values) and fall in biochemical markers of myocardial necrosis [serum creatinine kinase (CK) and its MB fraction] with the consequent development of a pathologic Q wave on the ECG. Due to disputable interpretation of biochemical markers of myocardial necrosis following a CPR, as a diagnostic indicator, we took into consideration the coronary angiogram prior to direct PCI, myocardial wall kinetics (ultrasound) and in some cases even the autopsy report.

Optimal angiographic results after direct PCI were considered to be achieved when less than 30% of residual luminal stenosis remained in the target vessel, i.e. thrombolysis in myocardial infarction (TIMI) flow grade II and III [18].

Infarct-Related Artery. Infarct-related artery is defined as the coronary artery, whose luminal stenosis or occlusion led to the acute STEMI.

Clinical Significant Coronary Artery Disease (after Reperfusing the Infarct Arteries). Clinical significant coronary artery disease is defined as more than a 50% reduction in luminal diameter in $\geq$1 major epicardial artery [19, 20].

Treatment of Acute STEMI

The EMS system was structured as a one-tier system with doctor's participation in over 90% of OHCAs. From the field the destination of the patient transport was determined by the medical doctor based on clinical data and 3-lead or 12-lead ECG recordings. At the time of this study mostly 3-lead ECG records were used.

Prior to the transport to the cardiac catheterization laboratory (mostly from intensive care units) patients in the subgroup with urgent coronary angiography (n = 20) received 500 mg aspirin along with 5,000–10,000 units of unfractionated heparin intravenously. The subgroup of patients who were not transported to the catheterization laboratory (n = 6) was treated with intravenous unfractionated heparin without thrombolysis. Further treatment of the acute STEMI (β-blockers, nitroglycerine, sedatives, analgesia, angiotensin-converting enzyme inhibitors, statins) was similar in both subgroups. Ticlopidine/clopidogrel was administered in cases of stent implantation [1, 3].

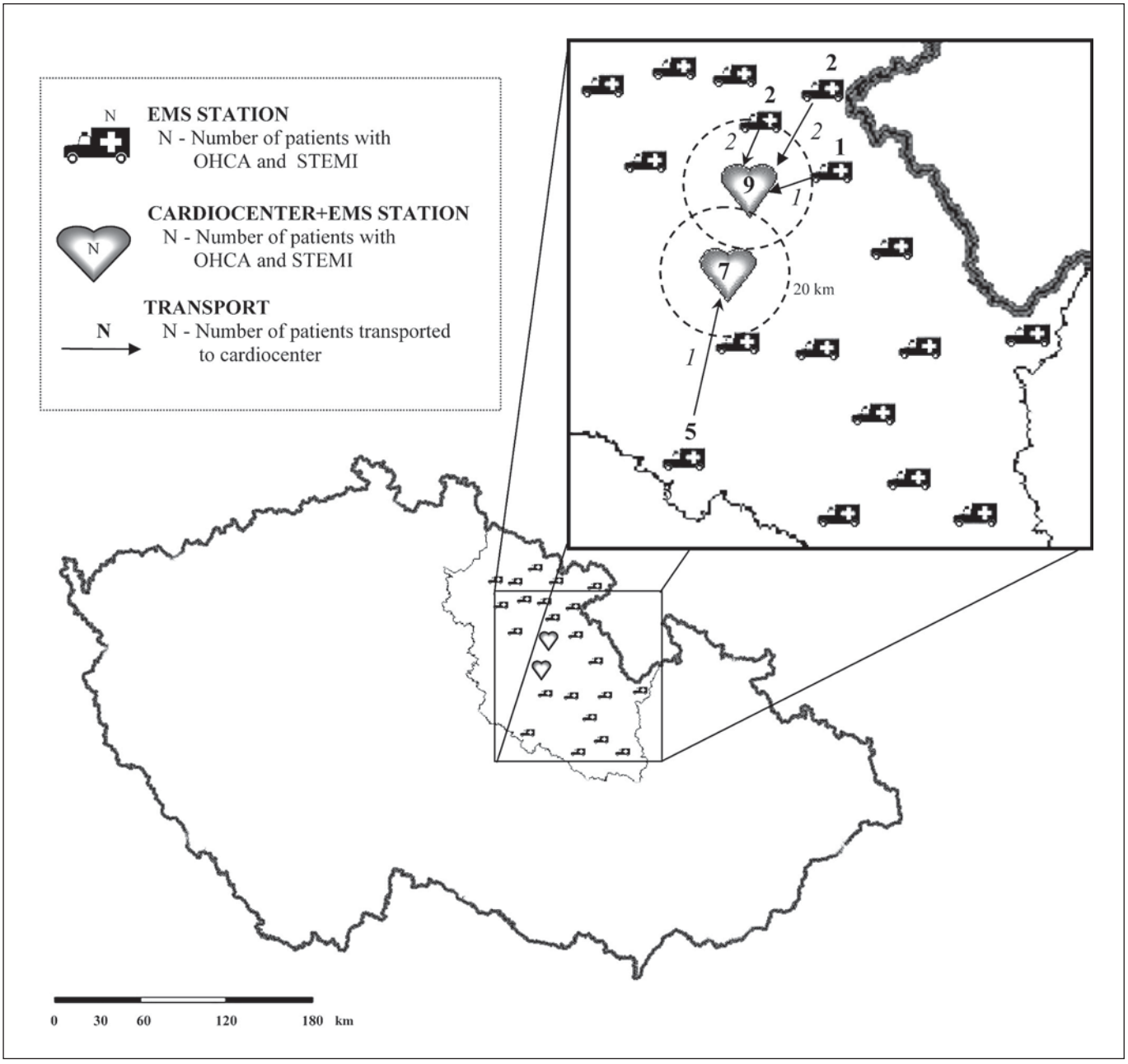

Fig. 1. Map of the East Bohemia region with two cardiocenters and location of all EMS stations.

Results

Of patients with acute STEMI after OHCA and medical CPR (n = 26; 22 men, 4 women; aged 35–79 years, median 58.5) urgent coronary angiography was performed in 20 cases, in 19 of which it was direct PCI. Urgent coronary angiography was not done in 6 cases.

Main Characteristics (table 2)

Ischemic heart disease (IHD) was documented in 13 (50%) patients prior to the actual OHCA. In 7 individuals (26.9%) we did not find IHD or the presence of primary risk factors for IHD. Initial cardiac rhythms most often recorded in the field were, i.e. in 23 cases (88.5%), ventricular fibrillation. Prior to admission to the intensive

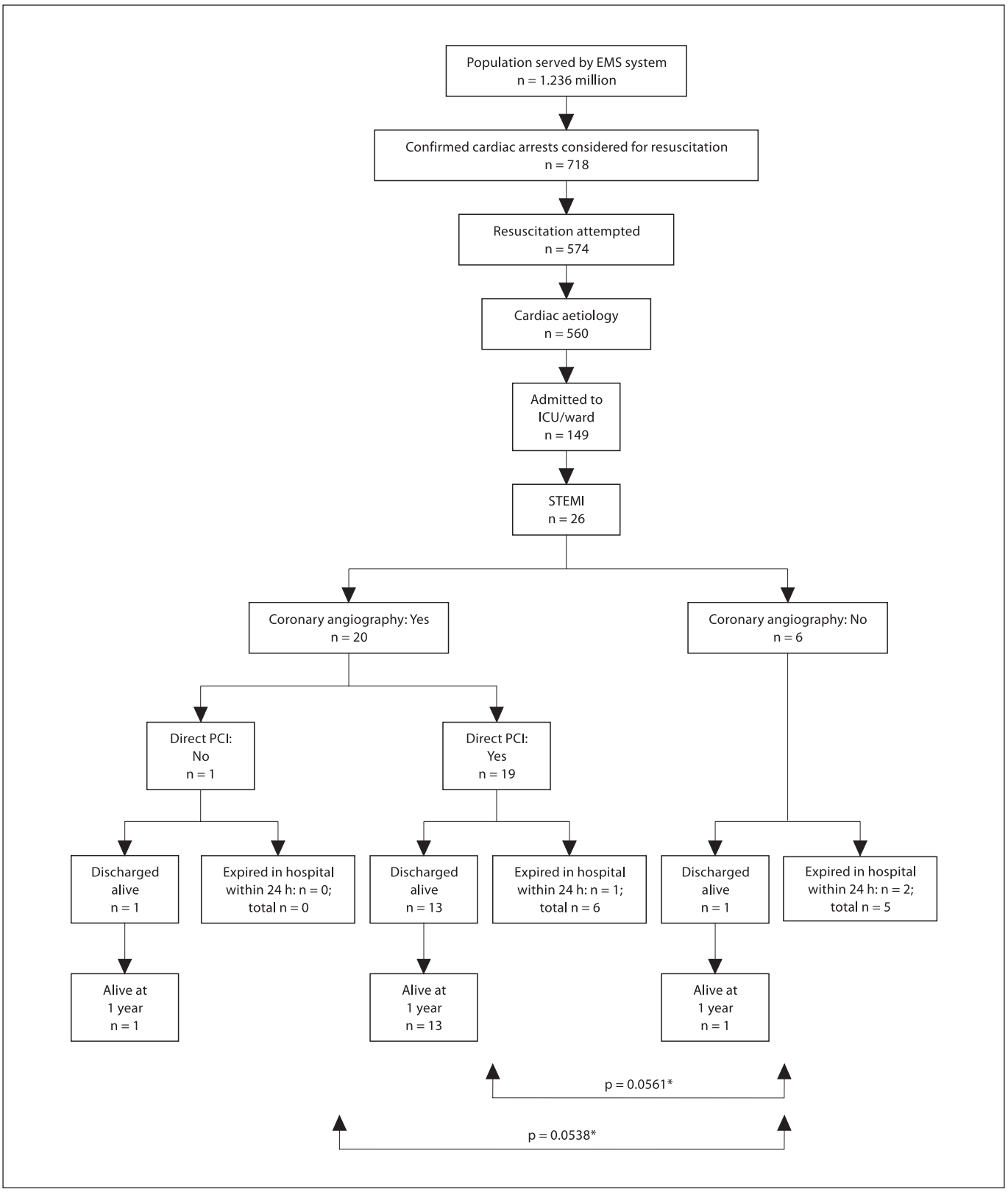

Fig. 2. Survival of hospitalized individuals with acute STEMI after OHCA. ICU = Intensive care unit. * Statistical analysis according to Fisher's test for the differences in two proportions.

Table 1. Glasgow-Pittsburgh Outcome Categorization (CPC) of brain injury in hospitalized individuals (n = 15)

CPC	With coronary angiography (n = 14), n	Without coronary angiography (n = 1), n
Discharged from acute hospital		
1 (good cerebral performance)	11[a]	0
2 (moderate cerebral disability)	1	1
3 (severe cerebral disability)	1	0
4 (coma/vegetative state)	1	0
After 1 year's follow-up		
1 (good cerebral performance)	13[a]	0
2 (moderate cerebral disability)	1	1
3 (severe cerebral disability)	0	0
4 (coma/vegetative state)	0	0

CPC = Cerebral Performance Categories [17]; n = number of patients.
[a] PCI was not performed in 1 individual (20% residual stenosis after spontaneous reperfusion).

care unit, 23 individuals (88.5%) had a conscious level of 3–5 according to GCS. Cardiogenic shock (evidence of tissue hypoperfusion induced by heart failure after correction of preload defined as systolic blood pressure <90 mm Hg or drop of mean arterial pressure >30 mm Hg and/or low urine output <0.5 ml/kg/h) was reported in 12 individuals (46.2%) and postanoxic encephalopathy in 11 patients (42.3%). The duration of hospitalization was 13.5 ± 14.9 days (median 15) in the group as a whole and 18.9 ± 12.3 days (median 14) in individuals who survived acute hospitalization, the longest being 57 days.

Distance and Time Intervals Concerning Prehospital Care

When the catheterization laboratory was within 20 km (including) from the site of OHCA urgent coronarography was performed in 16 out of 19 (84.2%) individuals and when it was over 20 km, 4 out of 7 individuals (57.1%) were immediately examined (table 2). A total of 17 patients were transported to the laboratory directly from the field and 3 were sent to the cardiocenter following primary examination at other hospitals (fig. 1). Table 3 shows an overview of time intervals during prehospital care in relation to surviving acute hospitalization. Arrival times within 10 min (including) were achieved in 21 individuals (80.8%). In all patients who underwent urgent coronarography the interval from the symptom onset to hospital admission did not exceed 180 min. In all patients examined in the catheterization laboratory 120 min were not exceeded in the time period from initiating treatment in the field up to hospitalization.

Angiographic Characteristics

According to the urgent coronarograms performed in 20 individuals, the most common artery involved was the left anterior descending coronary artery in 9 cases (45%) and the right coronary artery including the ramus posterolateralis dexter in 7 cases (35%) (table 4). An initial TIMI flow grade 0–I was found in 17 individuals and grade II–III in 3. After PCI (19 cases) with invariable stent implantations, an optimal angiography success (TIMI flow grade II–III) was achieved in 17 individuals. In 1 patient a TIMI flow III was found in the infarct artery (left anterior descending coronary artery) according to the initial angiogram but a stent was placed for the dissection of the atherosclerotic plaque. PCI was not performed in one case since the luminal stenosis diameter was over 20% (spontaneous reperfusion) with a primary TIMI flow III. Clinically significant residual stenosis of main coronary arteries after unblocking the infarct artery was observed in a total of 9 individuals (45%).

The relationship between TIMI flow according to angiography and the localization of the myocardial infarction according to ECG is illustrated in table 5.

Surviving Acute Hospitalization

A total of 15 patients (57.7%) survived acute hospitalization. Within the first 24 h 3 patients died (11.5%). In the subgroup with urgent coronary angiography (n = 20) 14 individuals survived hospitalization (70%), whereas in the subgroup without coronarography (n = 6) 1 patient survived hospitalization (16.7%; p = 0.0538). In the sub-

Table 2. Clinical, prehospital and hospital characteristics of hospitalized individuals (n = 26)

	With coronary angiography (n = 20)	Without coronary angiography (n = 6)
Age, years		
Median	55.5	61.5
Range	35–79	43–69
Mean	56.3 ± 10	56.7 ± 8.2
>70 years, n	2 (10%)	0
Males, n	18 (90%)	4 (67%)
Risk factors for coronary artery disease[a], n		
0	10 (50%)	0
1	7 (35%)	3 (50%)
2	3 (15%)	3 (50%)
Hypertension (diastolic pressure, >90 mm Hg), n	6 (30%)	2 (33%)
Diabetes mellitus, n	0	2 (33%)
Hypercholesterolemia (cholesterol >5.7 mmol/l), n	2 (10%)	2 (33%)
Smoking, n	7 (35%)	3 (50%)
Previous IHD, n	10 (50%)	3 (50%)
Initial cardiac rhythm, n		
Ventricular fibrillation	20 (100%)	3 (50%)
Asystole	0	1 (17%)
Pulseless electrical activity	0	1 (17%)
Atrioventricular block	0	1 (17%)
Distance from the location of cardiac arrest to cardiac catheterization laboratory, n		
≤20 km	16 (80%)	3 (50%)
>20 km	4 (20%)	3 (50%)
Infarct location (ECG) on admission, n		
Anterior	10 (50%)	4 (67%)
Inferior	9 (45%)	0
Lateral	1 (5%)	0
Others (combination)	0	2 (33%)
GCS at admission, n		
3–5	17 (85%)	6 (100%)
6–10	1 (5%)	0
11–15	2 (10%)	0
Cardiogenic shock, n	8 (40%)	4 (67%)
Postanoxic encephalopathy, n	7 (35%)	4 (67%)
Artificial pulmonary ventilation, n	17 (85%)	6 (100%)
Left ventricular ejection fraction ≤35% (Echo), n	8 (40%)	4 (67%)

Echo = Echocardiography.

[a] The following were considered risk factors: hypertension (diastolic pressure >90 mm Hg), diabetes mellitus, hypercholesterolemia (cholesterol >5.7 mmol/l), and smoking.

group with completed PCI 13 out of 19 individuals (68.4%) survived. The significance level when comparing with the group without urgent coronarography was 0.0561 (fig. 2).

During the course of hospitalization, 11 individuals died, of whom 3 were autopsied. The causes of death were cardiogenic shock (5 patients; 2 autopsied), septic shock (2 patients) and severe neurological consequences (4 patients; 1 autopsied).

According to the Glasgow-Pittsburgh Outcome Categorization (CPC) 11 out of 15 patients (73.3%) discharged from acute hospitalization were without neurological

Table 3. Time intervals and short-term survival in hospitalized individuals (n = 26)

	With coronary angiography (n = 20), n		Without coronary angiography (n = 6), n	
	total	surviving hospitalization	total	surviving hospitalization
Arrival times, min				
0–1	1	1	0	0
2–5	9[a]	6[a]	1	1
6–10	7	4	3	0
11–15	2	2	1	0
16–20	1	1	1	0
Duration of medical CPR, min				
0–10	4	3	2	1
11–20	5[a]	4[a]	3	0
21–30	7	5	0	0
≥31	4	2	1	0
Onset of symptoms to hospital (door), min				
≤60	9[a]	5[a]	1	0
61–120	9	8	4	1
121–180	2	1	0	0
181–240	0	0	0	0
241–360	0	0	0	0
361–720	0	0	1	0
From field treatment initiation to hospital (door), min				
≤30	1	1	1	0
31–60	13[a]	9[a]	2	0
61–90	4	4	3	1
91–120	2	0	0	0
Time intervals (median; range; mean ± SD), min				
Arrival time			6; 1–20; 6.9 ± 4.0	
Length of CPR			20; 1–60; 22.1 ± 12.6	
Onset of symptoms to hospital admission (door)			73; 25–668; 97.9 ± 118.1	
From field treatment initiation to hospital admission (door)			50; 19–107; 55.4 ± 21.2	

[a] PCI was not performed in 1 patient (20% residual stenosis after spontaneous reperfusion).

deficits (CPC 1) and after urgent coronary angiography. One patient remained in a coma (CPC 4) (table 1) [17].

It is worth noting that after undergoing CPR for 'primary cardiac' causes of OHCA (excluding acute STEMI) 123 individuals (90 men, 33 women; aged 21–90 years, median 67) were admitted to hospital, out of whom 38 (30.9%) survived acute hospitalization (table 6).

1-Year Follow-Up

During the 1-year follow-up of the patients discharged from acute hospitalization no death was reported (fig. 2). In the CPC categories the number of patients without neurological deficit (CPC 1) rose to 13 (table 1).

Discussion

OHCA was caused by IHD in 85% cases [21–24]. In the autopsy findings, signs of acute coronary syndromes (thrombosis/myocardial necrosis) were described in up to 95% of affected individuals [22, 25]. According to a few articles in the literature, revascularization methods, above all direct PCI, positively influence the acute hospitalization and long-term prognosis of such patients [7, 9, 11, 12, 19]. Between 55 and 77% individuals with primary PCI after OHCA survive acute hospitalization [7–11], whereas 88–100% of patients survive long-term, i.e. at least 1 year after discharge from acute hospitalization [7, 8, 10, 11]. When comparing our study to certain others,

Table 4. Angiographic data of hospitalized individuals (n = 20)

Infarct-related artery, n	
LAD	9 (45%)[a]
CABG (LAD)	1 (5%)
LCx	3 (15%)
RCA	6 (30%)
RPLD (RCA)	1 (5%)
TIMI flow, n	
Baseline	
0	14 (70%)
I	3 (15%)
II	1 (5%)
III	2 (10%)[a]
Final	
0	1 (5%)
I	1 (5%)
II	3 (15%)
III	15 (75%)[a]
Optimal angiographic result, n	18 (90%)[a]
Stenting of the infarct-related artery, n	17 (85%)
Coronary arteries with >50% luminal stenosis, n	
1	6 (30%)
2	2 (10%)
3	1 (5%)

LAD = Left anterior descending coronary artery; CABG (LAD) = aortocoronary bypass to the left anterior descending coronary artery; LCx = left circumflex coronary artery; RCA = right coronary artery; RPLD = ramus posterolateralis dexter; TIMI flow = thrombolysis in myocardial infarction flow [18].

[a] PCI was not performed in 1 patient (20% residual stenosis after spontaneous reperfusion).

Table 5. TIMI flow (angiography) and myocardial infarct location (ECG) (n = 20)

TIMI flow (baseline to final)	Infarct location (ECG)		
	anterior	inferior	lateral
0–III	3	5	1
0–II	1	2	0
0–I	1	0	0
0–0	0	1	0
I–III	2	1	0
II–III	1	0	0
III–III	2[a]	0	0

TIMI flow = Thrombolysis in myocardial infarction flow [18].

[a] PCI was not performed in 1 patient (20% residual stenosis after spontaneous reperfusion).

between 11 and 36% patients survived acute hospitalization after OHCA of 'primary cardiac' causes without considering the method of treatment [15, 26–29].

In our group of patients after OHCA and STEMI, survival of acute hospitalization in the subgroup of patients after direct PCI was observed in 13 of 19 individuals. On the other hand, in the subgroup of 6 patients without urgent coronary angiography and without direct PCI only 1 patient survived (16.7%). Direct PCI was not performed in 1 patient with STEMI due to the spontaneous reperfusion of the infarct artery. The level of significance with respect to survival when comparing subgroups with and without urgent coronarography was 0.0538. When comparing the subgroup with direct PCI with the group without urgent coronarography it was 0.0561. None of the patients who were discharged from acute hospitalization, independently of their primary treatment, died over the 1-year follow-up. In the literature we failed to find a similar prognostic comparison between direct PCI and not performing PCI.

According to the literature, patients after OHCA admitted to hospital have GCS 3–5 (up to 9) in 61–87% of cases [9, 10]. In our survey a GCS score of 3–5 was observed in 85% of the group. Postanoxic encephalopathy-induced neurological alterations have been reported in 18.2% [11], 50% [12] and according to our data in 42.3% patients. Sixty-seven to 94% of patients were discharged home from acute hospitalization without neurological deficits after direct PCI [8, 10, 12]. In our group, after undergoing a direct PCI, 76.9% patients (10/13 individuals) were discharged home without neurological deficits. During the 1-year follow-up of our subgroup of patients who had undergone direct PCI, the number of patients without neurological deficits rose to 92.3% (12/13 individuals).

During the urgent coronary angiography of patients after OHCA an initial TIMI flow 0–I was reported by Lee et al. [11] in 18 of 22 individuals. A similar incidence of flow was also observed in our group, i.e. 17 of 20 individuals. Coronary interventions led to optimal results in 7 of 11 individuals [8], in 28 of 37 individuals [12] and in 14 out of 16 infarcted arteries in another group [10]. Only the successful revascularizations, with the aid of PCI in a group of 24 individuals, were reported by Borger van der Burg et al. [19]; the unsuccessful ones were not evaluated and furthermore they did not assess direct PCI. In our case, an optimal angiographic result after direct PCI was achieved in 17 of 19 cases.

Table 6. Main diagnosis of patients admitted to hospital excluding those with STEMI (n = 123)

Diagnosis	Individuals n	Autopsy confirmed, n
Expired (n = 85)		
IHD without acute myocardial infarction	40	18
IHD-acute myocardial infarction	30	13
Aortic dissection	2	2
Dilated cardiomyopathy	2	1
Acute myocarditis	1	1
Aortic coarctation	2	1
Pulmonary embolism	5	1
Others	3	1
Discharged alive (n = 38)		
IHD without acute myocardial infarction	21	
IHD-acute myocardial infarction	6	
Dilated cardiomyopathy	3	
Aortic stenosis	1	
Arrhythmogenic dysplasia of the right ventricle	1	
Long QT syndrome	1	
Idiopathic arrhythmia	5	

For the effectiveness of direct PCI in acute STEMI, the time interval from the onset of symptoms to the arrival at the catheterization laboratory and infarct artery reperfusion plays a crucial role [1, 3]. Along with this time interval, when hauling to an OHCA, the delay prior to initiating CPR and thereby the related arrival times of the EMS are of further significance (enabling a timely electrical defibrillation) [3, 28]. Spaulding et al. [12]report a maximal interval from OHCA to hospital admission of 160 min. According to Keelan et al. [10], direct PCI was attempted up to 480 min from the OHCA. In our survey, admission to hospital was within 120 min from the beginning of OHCA in 88.5% of all patients and for the subgroup with urgent coronarography in up to 90% of patients. No angiographic examination was performed in any of the patients over a time interval of 180 min. The presented time intervals are in relation to having achieved prognostically crucial arrival times for patients with OHCA of under 10 min [28]. This limit of the arrival time was attained in 85% of our subgroup of patients with subsequent urgent coronary angiography. The distance from the catheterization laboratory influenced the reported time intervals. When the distance from the location of OHCA to the catheterization laboratory was 20 km and below, urgent coronarography was performed in 84.2% patients, and when it was further only 57.1% of patients were catheterized.

Advantages of our study include its prospective design and 1-year follow-up of the patients after discharge from acute hospitalization. For example, Lee et al. [11] evaluated his group of 22 patients retrospectively. The treatment of acute STEMI including direct PCI is precisely defined in the recommended procedures of specialist societies [1, 3]. We thus considered it advantageous to create groups with common inclusion criteria, i.e. STEMI in combination with OHCA. A similar approach was adopted by Bendz et al. [7] and Kahn et al. [8]. Other authors use more general terms for acute myocardial infarction [9], consequently evaluating only the relationship between OHCA and direct or elective PCI [10, 19]. When evaluating angiographic findings, e.g. in the article by Spaulding et al. [12], there was no differentiation in the interpretation between acute and chronic occlusions of coronary arteries. In our survey we only included patients with an acute occlusion of a coronary vessel. The present literature lacks information regarding short-term and long-term survival after OHCA and STEMI and comparing patients with and without direct PCI (without prior thrombolysis) including evaluation of the CNS state using Glasgow-Pittsburgh Outcome Categorization (CPC).

A limitation of our study is the low number of individuals used for the final evaluation, although the original group was large. Other authors have also published similarly sized groups with direct PCI and OHCA. The

number of individuals with varying group definitions ranges between 10 and 22 individuals [8–11]. The largest cohort (40 patients), concerning long-term follow-ups, was reported by Bendz et al. [7]. A further limitation of this work was the failure to perform urgent coronarography in 6 patients with acute STEMI (critical clinical states or distance from the cardiac catheterization laboratory). A shortfall in the interpretation of time intervals is the missing information about the interval between the admission to the hospital (door) and reperfusion of the infarct artery (balloon). However, this interval is included in the survey only by Bendz et al. [7] where it is reported to be ranging between 47 and 67 min.

In conclusion, irrespective of treatment modality, an overall acute hospitalization survival was observed in 57.7% out of the 26 individuals with STEMI following OHCA (from an original group of 718 individuals). After direct PCI, acute hospitalization was successfully completed in 13 of 19 individuals. Of the 6 patients who did not receive reperfusion therapy only 1 patient survived (16.7%). During the 1-year follow-up of patients discharged from hospitalization, none died.

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