

## Primary Percutaneous Coronary Intervention after Out-of-Hospital Cardiac Arrest: Patients and Outcomes

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### Abstract

**Background:** The decision to perform primary percutaneous coronary intervention in unconscious patients resuscitated after out-of-hospital cardiac arrest is challenging because of uncertainty regarding the prognosis of recovery of anoxic brain damage and difficulties in interpreting ST segment deviations. In ST elevation myocardial infarction patients after OHCA, primary PCI is generally considered the only option for reperfusion. There are few published studies and no randomized trial has yet been performed in this specific group of patients.

**Objectives:** To define the demographic, clinical and angiographic characteristics, and the prognosis of STEMI patients undergoing primary PCI after out-of-hospital cardiac arrest.

**Methods:** We performed a retrospective analysis of medical records and used the prospectively acquired information from the Rambam Primary Angioplasty Registry (PARR) and the Rambam Intensive Cardiac Care (RICCa) databases.

**Results:** During the period March 1998 to June 2006, 25 STEMI patients (21 men and 4 women, mean age  $56 \pm 11$  years) after OHCA were treated with primary PCI. The location of myocardial infarction was anterior in 13 patients (52%) and non-anterior in 12 (48%). Cardiac arrest was witnessed in 23 patients (92%), but bystander resuscitation was performed in only 2 patients (8%). Eighteen patients (72%) were unconscious on admission, and Glasgow Coma Scale  $> 5$  was noted in 2 patients (8%). Cardiogenic shock on admission was diagnosed in 4 patients (16%). PCI procedure was successful in 22 patients (88%). In-hospital, 30 day, 6 month and 1 year survival was 76%, 76%, 76% and 72%, respectively. In-hospital, 30 day, 6 month and 1 year survival without severe neurological disability was 68%, 68%, 68% and 64%, respectively.

**Conclusions:** In a selected group of STEMI patients after out-of-hospital cardiac arrest, primary PCI can be performed with a high success rate and provides reasonably good results in terms of short and longer term survival.

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Results of the Thrombolysis in Cardiac Arrest (TROICA) study [1] presented at the World Congress of Cardiology in 2006 suggest that thrombolytic therapy may not improve prognosis in patients after OHCA, which leaves primary PCI as the only option for prompt reperfusion. Few studies investigating results of primary PCI in ST segment elevation myocardial infarction patients resuscitated after OHCA have been published [2-5] and no randomized trial has yet been performed in this specific group of patients. The aim of the present study was to define the demographic, clinical and angiographic characteristics and a prognosis of patients undergoing primary PCI after OHCA.

### Patients and Methods

The Rambam Medical Center is a university hospital with a high volume intensive cardiac care unit and intervention cardiology as well as cardiac surgery facilities. The study was performed by retrospective analysis of medical records, and by using the prospectively acquired information from the hospital's Primary Angioplasty Registry Rambam (PARR) and from the Rambam Intensive Cardiac Care (RICCa) databases. Follow-up for a minimum of 1 year was performed in all studied patients.

### Results

Twenty-five STEMI patients (21 men and 4 women, mean age  $56 \pm 11$  years, range 37–77), resuscitated after out-of-hospital cardiac arrest were treated with primary PCI during the period March 1998 to June 2006. Myocardial infarction location was anterior in 13 patients (52%) and non-anterior in 12 (48%). Prior to the index infarction diabetes mellitus was present in 8 patients (32%), hyperlipidemia in 12 (48%), hypertension in 12 (48%), smoking in 18 (64%) and a family history of coronary disease in 7 (28%) [Table 1]. A history of MI was noted in 6 patients (24%) and a history of PCI in 6 (24%) – 3 in the present infarct-related artery and 3 in another artery.

\* The first two authors contributed equally to the study.

OHCA = out-of-hospital cardiac arrest

PCI = percutaneous coronary intervention

STEMI = ST elevation myocardial infarction

The decision to perform primary percutaneous coronary intervention in an unconscious patient resuscitated after out-of-hospital cardiac arrest is a challenging one. The main dilemma is the uncertainty in predicting prognosis of recovery after anoxic brain damage in a specific patient. Another concern regards problems in the interpretation of ST segment deviations in a patient shortly after cardiac arrest and resuscitation.

**Table 1.** Coronary risk factors in patients treated with primary PCI after out-of-hospital cardiac arrest

	No. of patients (%)
Diabetes mellitus	8 (32)
Hyperlipidemia	12 (48)
Hypertension	12 (48)
Smoking	18 (64)
Family history of coronary artery disease	7 (28)

Co-morbidities that could possibly influence outcome such as aortic stenosis, congestive heart failure, chronic renal failure, peripheral vascular disease, hyperthyroidism and allergy to iodine were noted in 8 patients (32%). These co-morbidities were not always known at the time of the decision to perform PCI.

#### Cardiac arrest

Cardiac arrest occurred at home in 7 patients (28%), in a primary care facility in 7 (28%), in the ambulance in 1 (4%) and outdoors in 10 (40%). Cardiac arrest was witnessed in 23 patients (92%), but bystander resuscitation was initiated in only 2 of these patients. Ventricular fibrillation was the initial rhythm recorded in 19 patients (76%), asystole in 2 (8%), ventricular tachycardia in 2 (8%) and in 2 patients no malignant arrhythmia was noted at the first electrocardiograph recording.

#### Status on admission to the ICCU

Eighteen patients (72%) were unconscious, Glasgow Coma Score above 5 was noted in 2 patients (8%). The mean score in the group was 4. Fifteen patients (60%) were on mechanical ventilation and sedated prior to admission, which contributed to the difficulties in assessing their neurological status. Cardiogenic shock on admission was diagnosed in 4 patients (16%).

#### Coronary angiography and primary PCI procedure

Single, double and triple-vessel disease was found in 11 (44%), 8 (32%) and 6 (24%) patients, respectively. The infarct-related artery was the left anterior descending, circumflex and right coronary artery (or their major branches) in 13 (52%), 6 (24%) and 6 (24%) patients, respectively [Table 2].

Successful PCI defined as residual stenosis < 50% and TIMI flow 3 at the end of the procedure was noted in 22 patients (88%). Stenting of the infarct-related artery was performed in 23 patients (92%) and 13 (52%) were treated with an IIb/IIIa inhibitor. Median door-to-balloon time was 106 minutes (interquartile range 81–151).

#### In-hospital management

Therapeutic hypothermia was used in 2 patients (8%). Fifteen patients (60%) were ventilated for 2–13 days (mean  $5 \pm 4.4$ ). Intraaortic balloon pump was required for hemodynamic support in 4 patients (16%), and 5 patients (20%) were initially treated

**Table 2.** Coronary angiography data in patients treated with primary PCI after OHCA

	No. of patients (%)
<b>No. of vessels with significant stenosis</b>	
Single	11 (44)
Double	8 (32)
Triple	6 (24)
<b>Infarct-related artery</b>	
Left anterior descending	13 (52)
Circumflex	6 (24)
Right coronary artery	6 (24)

with dopamine. During the index hospitalization 91% of patients were treated with beta-blocker, 83% with angiotensin-converting enzyme inhibitors and 29% with aldosterone antagonist. All received aspirin and clopidogrel.

#### Outcome

In-hospital, 30 day, 6 month and 1 year survival was 76%, 76%, 76% and 72%, respectively. In-hospital, 30 day, 6 month and 1 year survival without severe disability was 68%, 68%, 68% and 64%, respectively.

#### Discussion

The decision to perform primary PCI in STEMI patients resuscitated after cardiac arrest is a difficult one. This decision takes into consideration factors such as the reversibility of anoxic brain damage, and the likelihood of a significant improvement in outcome (cardiac mortality and morbidity) by PCI. Other considerations include the logistic difficulties in transporting an unconscious ventilated patient to and from the catheterization unit.

In 1995 Kahn et al. [2] reported on 11 patients who were treated with primary PCI after out-of-hospital cardiac arrest. PCI was successful in 7 patients (64%) and 6 (55%) survived to hospital discharge. They suggested that "reperfusion therapy with emergency catheterization, adjunctive hemodynamic support, and catheter-based mechanical reperfusion therapies is a therapeutic option in patients with out-of-hospital cardiac arrest surviving to emergency center admission, even in the presence of depressed sensorium." They limited this therapeutic option to patients with electrocardiographic evidence of ST elevation MI.

Spaulding and co-workers [3] performed coronary angiography in 84 successfully resuscitated OHCA patients with no obvious non-cardiac cause of cardiac arrest. According to inclusion criteria these patients were 30–75 years old, had cardiac arrest within 6 hours of symptom onset, and were previously leading a normal life. Significant coronary disease was found in 60 patients including coronary occlusion in 40. PCI was performed in 37 patients, and was successful in 28 (76%). In-hospital survival (for the whole cohort) was 38%. Multivariate logistic regression analysis revealed that successful angioplasty was an independent predictor of survival.

Bendz et al. [4] reported on 40 STEMI patients after successful out-of-hospital cardiopulmonary resuscitation who were treated

ICCU = intensive cardiac care unit

with primary PCI. Inclusion criteria were: ST segment elevation indicative of an acute MI and successful out-of-hospital CPR, i.e., return of spontaneous circulation prior to admission to hospital. There was no age limit, but patients were excluded if the interval from cardiac arrest to initiation of CPR was more than 10 minutes. In-hospital and 2 year mortality was 27.5% (survival 72.5%). The authors conclude that long-term prognosis is good in a selected group of patients after successful out-of-hospital CPR treated with primary PCI. In another study [5], a higher rate of diagnostic and therapeutic procedures – such as echocardiography, graded exercise test, coronary angiography, electrophysiological studies, PCI, and implantable cardioverter defibrillator – was associated with better prognosis. Higher socio-economic status was also associated with better prognosis in this study. On the other hand, in a study by Bulut and colleagues [5], in-hospital outcome did not differ significantly in STEMI patients after out-of-hospital cardiac arrest treated with primary PCI (10 patients, mortality 60%), thrombolytic therapy (7 patients, mortality 57%), or in those who did not receive any reperfusion therapy (20 patients, mortality 65%). In-hospital survival rates were 40%, 43% and 35%, respectively, which is lower than in other studies [2,4]. The strongest independent predictor for in-hospital death in this study was Glasgow Coma Score ( $r = 0.76$ ,  $P < 0.001$ ), but not specific therapy.

The results of our study as well as our patients' characteristics are very similar to those in the study reported by Bendz et al. [4]. Our data support the concept that the outcome in selected patients treated with primary PCI after OHCA is reasonably good. Our findings undoubtedly reflect a selection bias: patients thought to have a poor neurological prognosis probably were not referred for primary PCI but were treated more conservatively. In addition, it is very possible that primary PCI has a beneficial role. We suggest that the option of primary PCI should be considered in all patients after OHCA and STEMI, unless there is compelling evidence of an end-stage cardiac or other disease, or signs strongly suggesting a poor neurological prognosis. The real challenge is the proper selection of patients for primary PCI

CPR = cardiopulmonary resuscitation

in order not to miss an opportunity for reperfusion in patients who may benefit from it on the one hand, and not waste human and material resources on interventions that will not improve outcome on the other. We suggest that the results of this study could be helpful in solving this problem.

#### Study limitations

The major limitations of the study were twofold: first was the retrospective nature of the study; second was the non-randomized selection for primary PCI, which was performed at the discretion of the attending cardiologist. This, of course, introduces significant selection bias. On the other hand, in view of the relatively good outcome in this group of patients, it could be interpreted as evidence of proper patient selection.

#### Conclusions

In a selected group of STEMI patients after out-of hospital cardiac arrest, primary PCI, being the only option for reperfusion, could be performed with a high success rate and provides reasonably good results in terms of short and longer-term survival.

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## Capsule

### NF-κB and breast cancer

Advanced breast cancers frequently metastasize to bone, resulting in osteolytic lesions, yet the underlying mechanisms are poorly understood. Park et al. report that nuclear factor-κB (NF-κB) plays a crucial role in the osteolytic bone metastasis of breast cancer by stimulating osteoclastogenesis. Using an in vivo bone metastasis model, the researchers found that constitutive NF-κB activity in breast cancer cells is crucial for the bone resorption characteristic of osteolytic bone metastasis. They identified the gene encoding granulocyte macrophage-colony stimulating factor (GM-CSF) as a key target of NF-κB and found

that it mediates osteolytic bone metastasis of breast cancer by stimulating osteoclast development. Moreover, they observed that the expression of GM-CSF correlated with NF-κB activation in bone-metastatic tumor tissues from individuals with breast cancer. These results uncover a new and specific role of NF-κB in osteolytic bone metastasis through GM-CSF induction, suggesting that NF-κB is a potential target for the treatment of breast cancer and the prevention of skeletal metastasis.

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