Six-Month Outcome of Emergency Percutaneous Coronary Intervention in Resuscitated Patients After Cardiac Arrest Complicating ST-Elevation Myocardial Infarction

Philippe Garot, MD; Thierry Lefevre, MD; Hélène Eltchaninoff, MD, PhD; Marie-Claude Morice, MD; Fabienne Tamion, MD; Bernard Abry, MD; Pierre-François Lesault, MD; Jean-Yves Le Tarnec, MD; Claude Pouges, MD; Alain Margenet, MD; Mehran Monchi, MD; Ivan Laurent, MD; Pierre Dumas, MD; Jérôme Garot, MD, PhD; Yves Louvard, MD

Background—The outcome of resuscitated patients after cardiac arrest complicating acute myocardial infarction remains poor, primarily because of the relatively low success rates of cardiopulmonary resuscitation management. Existing data suggest potential beneficial effects of early myocardial reperfusion, but the predictors of survival in these patients remain unknown.

Methods and Results—From 1995 to 2005, 186 patients (78% men; mean age, 60.4±13.8 years) underwent immediate percutaneous coronary intervention after successful resuscitation for cardiac arrest complicating acute myocardial infarction. Prompt prehospital management was performed by mobile medical care units in 154 of 186 patients, whereas 32 had in-hospital cardiac arrest. Infarct location was anterior in 105 patients (56%), and shock was present on admission in 96 (52%). Percutaneous coronary intervention (stenting rate 90%) was successful in 161 of 186 patients (87%). Six-month survival rate was 100 of 186 (54%), and 6-month survival free of neurological sequelae was 46%. By multivariate analysis, predictors of 6-month survival were a shorter interval between the onset of cardiac arrest and arrival of a first responder (odds ratio, 0.67; 95% CI, 0.54 to 0.84), a shorter interval between the onset of cardiac arrest and return of spontaneous circulation (odds ratio, 0.91; 95% CI, 0.87 to 0.96), and absence of diabetes (odds ratio, 7.30; 95% CI, 1.80 to 29.41).

Conclusions—In patients with resuscitated cardiac arrest complicating acute myocardial infarction, prompt prehospital management and early revascularization were associated with a 54% survival rate at 6 months. A strategy including adequate prehospital management, early revascularization, and specific care in dedicated intensive care units should be strongly considered in resuscitated patients after cardiac arrest complicating acute myocardial infarction. **(*Circulation*. 2007;115:1354-1362.)**

Key Words: angioplasty ■ cardiopulmonary resuscitation ■ heart arrest ■ myocardial infarction ■ shock

Immediate coronary angiography has been proposed as a triage method in patients with resuscitated cardiac arrest to select candidates suitable for emergent percutaneous coronary intervention (PCI) because this strategy may improve their outcome.[1] Indeed, emergent PCI has been validated in high-risk patients with acute myocardial infarction (AMI), especially in those presenting with cardiogenic shock.[2] Among patients with AMI referred to the cardiac catheterization laboratory, those with resuscitated cardiac arrest before admission are relatively rare, accounting for <5% of all AMI patients. Accordingly, resuscitated cardiac arrest represents a common criterion for exclusion in the vast majority of clinical trials. Consequently, data on the outcome of PCI in these patients are scarce and, when available, are usually obtained from small sample size populations.[1,3–7] Although recent reports point to the beneficial effects of successful prompt reopening of the infarct-related artery in patients with AMI and resuscitated cardiac arrest,[1] the clinical outcome of these patients and the predictors of survival are still unknown.

To address this issue, we collected data from consecutive patients undergoing emergency PCI after resuscitated cardiac arrest complicating AMI from 1995 to 2005 in 5 centers with high PCI volume.

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From Institut Cardiovasculaire Paris-Sud, Massy and Quincy (P.G., T.L., M.-C.M., B.A., M.M., I.L., P.D., Y.L.); Cardiologie, Centre Hospitalier Charles Nicolle, Rouen (H.E., F.T., P.-F.L.); Service Aide Médicale d'Urgence Seine-et-Marne, Melun (J.-Y.L.T.); Service Aide Médicale d'Urgence Essonne, Corbeil-Essonnes (C.P.); Service Aide Médicale d'Urgence Val-de-Marne, Créteil (A.M.); and Cardiologie, Centre Hospitalier Henri Mondor, Créteil (J.G.), France.

Correspondence to Philippe Garot, MD, Institut Cardiovasculaire Paris-Sud, Centre Hospitalier Claude Galien, 20 Route de Boussy, 91480 Quincy, France. E-mail p.garot@icps.com.fr

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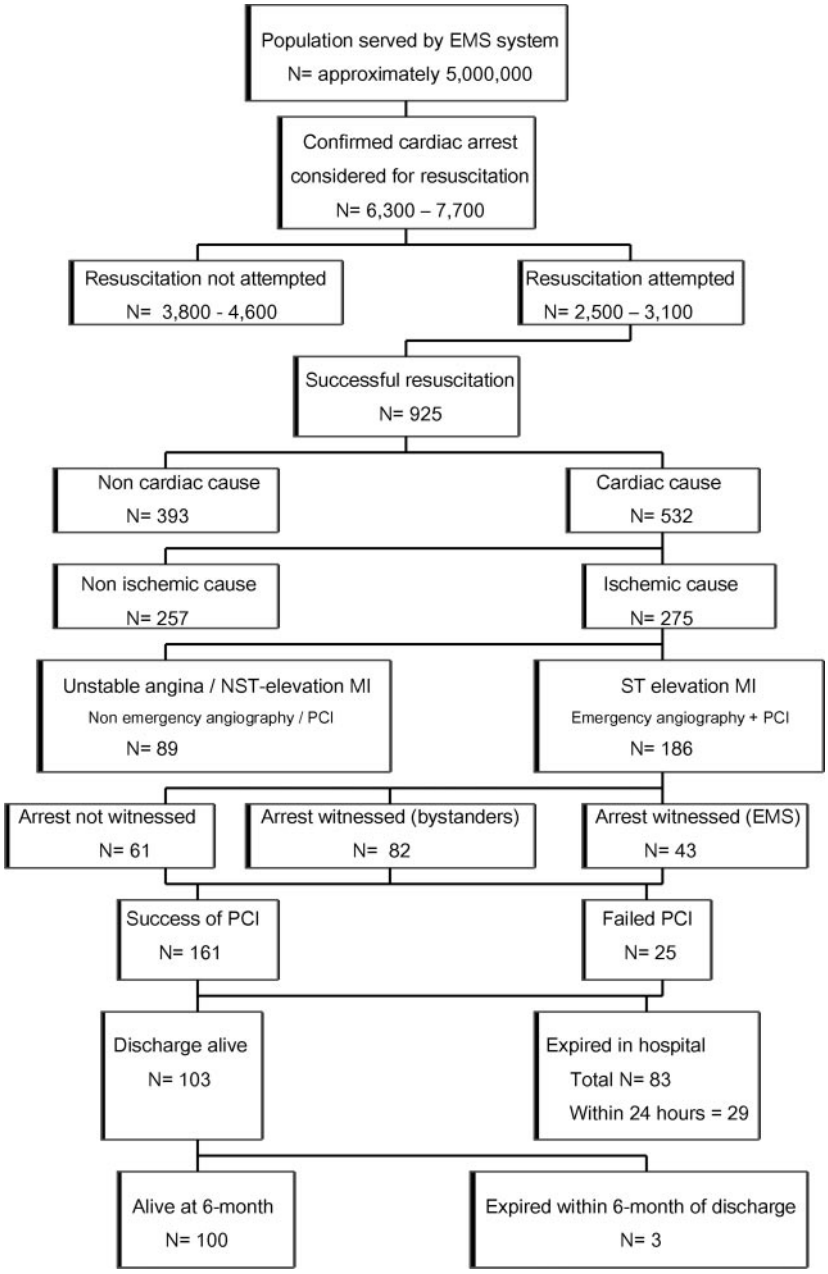

Figure 1. Flow diagram of the study population and outcome. NST indicates non-ST.

Methods

Patient Population

We retrospectively collected data from consecutive patients undergoing emergency PCI after resuscitated cardiac arrest complicating AMI from 1995 to 2005 in 5 centers with high PCI volume (≈45 000 PCIs during the study period) including 4 in the south county of Paris (Institut Jacques Cartier [Massy], Hopital Claude Galien [Quincy], Clinique du Bois de Verrières [Antony], Centre hospitalier Henri Mondor [Creteil]) and 1 in Normandy (Centre hospitalier Charles Nicolle [Rouen]). Because the data from emergency medical service (EMS) interventions were not fully computerized until recently, it was impossible to provide accurate statistics concerning the number and outcome of all patients with cardiac arrest from whom the study population was derived. Data were extracted from existing databases (EMS, cardiac catheterization laboratory, and intensive care unit/cardiac care unit) and from the CARDIO Agence Regionale d' Hospitalisation d'Ile de France (CARDIO-ARHIF) registry conducted by the government agency in the greater Paris area. These databases and official registry were able to provide rough estimations but not accurate numbers of patients and alerts received during the study period. The margin of error has been estimated to be ≈±10%. Cardiac arrest was the cause of EMS alert in ≈7000 cases (6300 to 7700). The patient population is depicted in Figure 1, according to the guidelines for uniform reporting of data from out-of-hospital cardiac arrest.[8] A decision was made to provide EMS assistance in ≈90% of them, excluding 10% for whom the interval for assistance was considered to exceed reasonable limits. Cardiopulmonary resuscitation was finally initiated in 2500 to 3100 patients, excluding 3100 to 3900 patients presenting irreversible symptoms of death at the time of EMS arrival. A total of 925 patients underwent successful resuscitation. Among them, cardiac arrest was considered of noncardiac cause in 393 patients (42%) and of cardiac cause in 532 of 925 (58%). Noncardiac causes of cardiac arrest were acute respiratory failure (56%), stroke (9%), related to medications or consequences of renal failure (8% for both), or unknown (19%). Cardiac causes were related to nonischemic causes in 257 patients and myocardial ischemia in 275, including 186 presenting with ST-elevation MI and

89 with unstable angina or non–ST-elevation MI. The present study focused on 186 patients who were resuscitated from cardiac arrest complicating acute ST-elevation MI and were referred to the cardiac catheterization laboratory to undergo immediate PCI.

Prehospital Management

Before hospital admission, prehospital medical care was performed by EMS that comprised 4 mobile medical care units including 3 in the south county of Paris (Seine-et-Marne, Essonne, Val-de-Marne) and 1 in the county of Rouen (Seine-maritime), covering a population of ≈5 000 000. Each mobile medical care unit involves a dispatching center and ambulances with resuscitation equipment, staffed by physicians trained in emergency medicine. Reaching the medical referent of each dispatching center requires the use of a nationwide free-access dedicated phone number (#15). Thanks to a trained medical network, the EMS was able to reach the scene within a mean of 10 minutes after the alert. In the present experience, cardiopulmonary resuscitation was initiated by the first responder and followed by the mobile medical team according to standard procedures. At least 1 prehospital 12-lead ECG was performed in all patients. External defibrillation was required for resuscitation in all patients. Medical care comprised tracheal intubation and mechanical ventilation in the vast majority of patients. Paralytics and anesthetics were administered routinely in these patients and interfered with initial neurological status evaluation because most of the patients had low muscular tone and papillary myosis. After hemodynamic recovery and stabilization, patients were emergently transported to the cardiac catheterization laboratory of the nearest hospital equipped with PCI facilities and dedicated intensive care units under the permanent monitoring of ECG record.

In-Hospital Evaluation and Treatment

Patients were admitted directly to the cardiac catheterization laboratory and had a rapid complete clinical workup as well as a surface 12-lead ECG just before cardiac catheterization. Hemodynamics (heart rate, blood pressure) were evaluated carefully. Shock on admission was defined as a drop in systolic blood pressure <90 mm Hg lasting >30 minutes despite fluid administration and after excluding right ventricular infarction and requiring the administration of inotropic drugs along with heart rate >100 bpm. Cardiac catheterization and coronary angiography were performed in all patients at the time of hospital admission. Patients were selected for the present analysis after prompt coronary angiography if they had been resuscitated from cardiac arrest, with >2 mm ST-segment elevation in >2 contiguous leads or a left bundle-branch block and/or at least 1 culprit lesion on angiography. Emergency PCI of the infarct-related artery was performed in all patients with the use of standard balloon and stent techniques. Heparin was administered at a dose of 1 mg/kg body wt before PCI, and additional injections were guided by measurement of the activating clotting time to obtain an activating clotting time between 275 and 325. Aspirin was given intravenously at a dose of 250 to 500 mg, and a loading dose of ticlopidine (1995–2001) or clopidogrel (2001–2005) 300 to 600 mg was given during or immediately after the procedure, through a nasogastric tube in unconscious patients. PCI success was defined as a residual stenosis <50% with a Thrombolysis in Myocardial Infarction (TIMI) grade 3 flow in the infarct-related artery. Intra-aortic balloon pump was inserted via the femoral access when indicated. The use of glycoprotein IIb/IIIa inhibitors was left to the operator's judgment. After the procedure was completed, continuous medical care was performed in the intensive care unit. According to the International Liaison Committee on Resuscitation guidelines,[9] mild therapeutic hypothermia was achieved in the majority of patients since 2003. Cooling was initiated within the first 2 hours after patient admission to the intensive care unit with attainment of a core temperature of 32°C to 34°C and was scheduled to be maintained for 24 hours.

Follow-Up

During the hospital course, major adverse events, including death from any cause, recurrent cardiac arrest, early reocclusion of the infarct-related artery, early reintervention, and stroke, were recorded. Left ventricular ejection fraction was evaluated by echocardiography within the first days after PCI in 147 patients (79%). A left ventricular angiography was performed rarely (<10% of the patients). Neurological recovery and overall performance of the patients were estimated at the time of discharge according to current available scales.[10,11] Briefly, cerebral performance was graded from 1 (good cerebral performance, conscious, alert, able to work and lead a normal life despite possible minor psychological or neurological deficits) to 4 (coma, vegetative state, not conscious, no verbal or psychological interactions with environment) according to Glasgow-Pittsburgh cerebral performance categories. Clinical follow-up was obtained in all survivors at a mean of 6.2±2.1 months after hospital discharge, including evaluation of hemodynamics and clinical data.

Statistical Analysis

Continuous data are expressed as mean±SD, and discrete data are presented as percentages. Factors relevant to survival were assessed by univariate analysis with the use of χ^2 tests for categorical variables and t tests for continuous variables. A nonparametric Mann-Whitney test was used for variables with a nonnormal distribution (time elapsed between the onset of cardiac arrest and both arrival of first responder and return of spontaneous circulation, and creatine kinase and troponin peak values). All demographic (including risk factors and intervals between the onset of cardiac arrest and medical management), angiographic, and procedural characteristics were assessed by univariate analysis. The primary goals of this analysis were to assess the clinical outcome and the predictors of survival in patients with AMI and resuscitated cardiac arrest, and factors with a probability value <0.10 were included in a multiple stepwise logistic regression model to identify the independent predictors of 6-month survival in the study population. Statistical analysis was performed with the use of Abacus Statview (SAS Institute, Inc, Cary, NC) and Statacorp (College Station, Tex) Stata 9.1 software.

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results

Prehospital Management

The baseline characteristics of the study population are described in Table 1. Cardiac arrest was witnessed in 125 of 186 patients (67%) and was out of hospital in 157 of 186 (84%). Circumstances of cardiac arrest were as follows: at the patient's home in 33%, during transportation to cardiac catheterization laboratory in 23%, in the city/streets in 21%, in hospital in 16%, and during business or sport activities in 4% and 3%, respectively. Cardiac arrest was preceded by a known typical chest pain in 66% of patients. It is noteworthy that 56% of patients had anterior AMI and that 12% of the whole population was treated by prehospital thrombolysis. The mean interval between the onset of cardiac arrest and arrival of a first responder was 6.2±7.5 minutes, whereas external defibrillation was performed within 12.6±12.0 minutes after cardiac arrest. Finally, return of spontaneous circulation was obtained within 20.8±17.5 minutes after cardiac arrest, and the mean interval between the onset of AMI and admission to the cardiac catheterization laboratory was 190.7±196.4 minutes.

Admission to and Management in the Cardiac Catheterization Laboratory

Shock was present on admission in 96 patients (52%), and mechanical ventilation was required in 171 (92%). Cardiac

TABLE 1. Baseline Clinical and Angiographic Characteristics of the Study Population

Variable	Study Population (N=186)
Age, y, mean±SD	60.4±13.8
Male	146 (78)
Hypertension	51 (27)
Dyslipidemia	71 (38)
Diabetes mellitus	37 (20)
Prior AMI	36 (19)
Prior CABG	6 (3)
Prior PCI(s)	17 (9)
Cardiac arrest to arrival of first responder, min (range)	2 (1 to 45)
Cardiac arrest to return of spontaneous circulation, min (range)	15 (1 to 90)
Onset of AMI to admission, min (range)	130 (30 to 1140)
Known preceding chest pain	123 (66)
Anterior AMI	105 (56)
Shock on admission	96 (52)
Ejection fraction, %, mean±SD	36.1±11.2
Prehospital thrombolytics	22 (12)
Multivessel disease	109 (59)
Coronary arteries with >60% stenosis, mean±SD	1.8±0.8
Left main (culprit lesion)	11 (6)
Graft (culprit lesion)	3 (2)
Percent stenosis, mean±SD	95±18
Pre-PCI TIMI grade 0 to 2	167 (90)
Thrombus-containing lesion	148 (80)

Values are expressed as mean with percentages of the total in parentheses, except where indicated otherwise. CABG indicates coronary artery bypass grafting.

catheterization and coronary angiography were performed after a mean interval of 199±192 minutes after the onset of AMI symptoms. Coronary angiography showed a recent coronary occlusion (TIMI grades 0 and 1) in 138 patients or a severe coronary lesion (>75% stenosis) in the 48 remaining patients. The mean ejection fraction on admission was 36.1±11.2%. Stenting was used in 90% of cases (Table 2), and an intra-aortic balloon pump was inserted in 43%. Glycoprotein IIb/IIIa inhibitors were administered as an adjunct to PCI in 17% of patients. Finally, PCI was successful in 87% of patients.

Intensive Care Unit Management and Hospital Outcome

Mild therapeutic hypothermia was induced in 34 patients (18%) and was maintained during 18.7±12.2 hours. When implanted, the support of intra-aortic balloon pump was maintained for 2.5±2.2 days, and inotropic drugs were progressively discontinued when spontaneous hemodynamics were restored and stabilized. Forty-one patients (22% of the whole population, 43% of patients with shock) had refractory cardiogenic shock despite prompt coronary reopening, intra-aortic balloon pump, and inotropes. A temporary biventricular assist device was implanted in 2 of them, whereas the

TABLE 2. Outcome of PCI in the Study Population

Variable	Study Population (N=186)
Stenting	168 (90)
Direct stenting	72 (43)
Stents per patient, mean±SD	1.4±1.0
Mean stent length, mm, mean±SD	26±18
Mean stent diameter, mm, mean±SD	3.3±0.5
Intra-aortic balloon pump	80 (43)
IIb/IIIa inhibitors	31 (17)
No reflow	10 (5)
Final TIMI grade 3 flow	164 (88)
Residual stenosis <50%	171 (92)
Thrombus distal emboli	7 (4)
Side branch occlusion	2 (1)
PCI success	161 (87)
Attempted PCI >1 vessel	34 (18)
Post-PCI CK peak value, UI/L (range)	2072 (692–24882)
Post-PCI troponin Ic peak value, μg/L (range)	62 (3–1197)
In-hospital stay, d, mean±SD	13.1±14.3

Values are expressed as mean number with percentages of the total in parentheses, except where indicated otherwise. CK indicates creatine kinase.

remaining 39 patients died of severe hemodynamic instability and multiorgan failure. Thirty additional patients died of irreversible cerebral ischemia. Indeed, cerebral anoxia occurred with no difference ($P=0.77$) in patients treated by mild therapeutic hypothermia (6/34; 18%) and in those treated conventionally (24/154; 16%). Recurrent severe ventricular arrhythmia occurred in 41 patients and was fatal in 10 of them. During intensive care unit management, 60 patients had ventilator-associated pneumonia, which was fatal in 4 of them.

Finally, a total of 103 patients (55% of the population) were discharged alive 18.2±14.1 days after admission. More than two thirds of them (n=72) had New York Heart Association class I or II status. Eighty-nine survivors (86%) had good cerebral (cerebral performance category 1) and overall performance and were leading a normal life. Moderate cerebral disability (cerebral performance category 2) was present at discharge in 10 survivors, characterized by either permanent memory or mental changes (n=9) or dysphasia, hemiplegia, and ataxia (n=2). Finally, 4 patients (4%) had severe postischemic cerebral dysfunctions (cerebral performance category 3 and 4) and were severely disabled.

Six-Month Outcome

All patients were followed up for at least 6 months. Three additional patients died at day 45, 99, and 120 from the complications of heart failure. These patients had shock on admission and had undergone successful PCI of the culprit artery. They were discharged at a mean of 17±2 days after admission, and their mean ejection fraction was 31±8%. The remaining patients (100/186; 54%) were still alive at 6-month follow-up. The distribution of surviving patients (in percentage of the total) within the follow-up period is depicted in

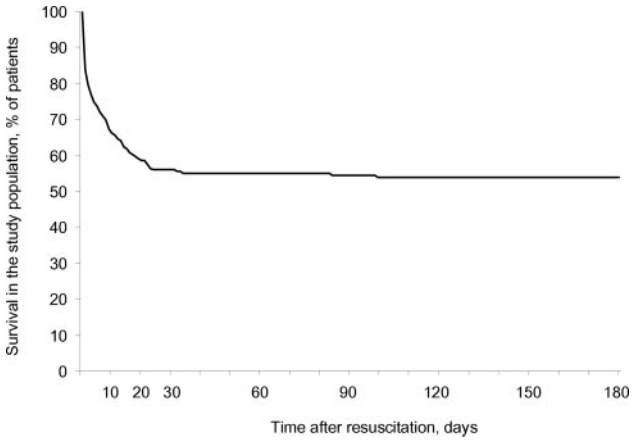

Figure 2. Evolution of survival in the study population between successful resuscitation and 6-month follow-up.

Figure 2. The vast majority of them recovered satisfactory quality of life under subsequent medication including angiotensin-converting enzyme inhibitors and low doses of β-blockers, when tolerated. None of the survivors had recurrent cardiac arrest during follow-up.

Compared with patients who died (Table 3), 6-month survivors had shorter intervals between the onset of cardiac arrest and arrival of first responder, external defibrillation, and return of spontaneous circulation ($P<0.0001$ for all) and were less likely to have a prior AMI ($P=0.041$) or a prior PCI ($P=0.009$). Similarly, 6-month survivors were more frequently in a public place at the time of cardiac arrest ($P<0.0001$) and had lower rates of shock on admission ($P<0.0001$). In contrast, neither the procedural characteristics nor the rates of PCI success were different between patients who survived and those who died within the follow-up period (Table 4). It is also noteworthy that mild therapeutic hypothermia was not associated with any differences in 6-month survival rate. Although variables associated with 6-month survival were identified clearly with the use of univariate statistical analysis, multivariate models showed (Figure 3) that absence of shock on admission, of diabetes, and of prior PCI, as well as mean intervals between the onset of cardiac arrest and both arrival of first responder and return of spontaneous circulation, were independently associated with 6-month survival in these patients. Because shock appeared as the main variable driving the outcome of patients, a reanalysis was conducted excluding shock (Figure 4). This analysis emphasized the role of severe recurrent ventricular arrhythmias in hampering the outcome of the study population.

The distribution of mean intervals between the onset of cardiac arrest and both arrival of first responder and return to circulation is depicted (Figure 5) in the study population stratified on the basis of survival or death within the 6-month follow-up period, highlighting the crucial importance of

TABLE 3. Baseline Clinical and Angiographic Characteristics of the Population According to Survival or Death at 6-Month Follow-Up

Variable	Survival (n=100)	Death (n=86)	P
Age, y, mean±SD	59.3±14.2	61.3±13.2	0.33
Male	81 (81)	65 (76)	0.37
Hypertension	24 (24)	27 (31)	0.24
Dyslipidemia	40 (40)	31 (36)	0.62
Diabetes mellitus	15 (15)	22 (26)	0.065
Prior AMI	14 (14)	22 (26)	0.041
Prior PCI(s)	4 (4)	13 (15)	0.0087
Out-of-hospital cardiac arrest	83 (83)	74 (86)	0.70
Cardiac arrest in public place	73 (73)	40 (47)	<0.0001
Cardiac arrest to arrival of first responder, min, mean±SD	2.1±2.4	10.5±8.6	<0.0001
Cardiac arrest to defibrillation, min, mean±SD	5.4±5.0	20.5±12.4	<0.0001
Cardiac arrest to return of circulation, min	9.6±9.2	32.9±16.3	<0.0001
Onset of AMI to admission, min, mean±SD	179.9±185.8	202.8±208.2	0.45
Anterior AMI	55 (55)	50 (58)	0.67
Shock on admission	32 (32)	64 (74)	<0.0001
Ejection fraction, %, mean±SD	40.3±11.6	31.3±8.6	<0.0001
Prehospital thrombolysis	12 (12)	10 (12)	0.88
Multivessel disease	57 (57)	52 (60)	0.56
Left main (culprit lesion)	6 (6)	5 (6)	0.96
TIMI grade 3 flow on admission	9 (9)	7 (8)	0.83
Thrombus-containing lesion	76 (76)	72 (84)	0.92

Values are expressed as mean number with percentages of the total in parentheses, except where indicated otherwise.

TABLE 4. In-Hospital Care and PCI Outcome of the Population According to Survival or Death at 6-Month Follow-Up

Variable	Survival (n=100)	Death (n=86)	P
Inotropic drugs on admission	42 (42)	66 (77)	<0.0001
Stenting	91 (91)	77 (90)	0.92
Direct stenting	44 (48)	28 (36)	0.36
Stents per patient, mean±SD	1.4±1.0	1.4±1.0	0.81
Mean stent length, mean±SD	24.8±18.2	26.1±16.9	0.75
Mean stent diameter, mean±SD	3.3±0.6	3.3±0.4	0.94
Intra-aortic balloon pump	29 (29)	51(59)	<0.0001
IIb/IIIa inhibitors	16 (16)	15 (17)	0.80
No reflow	5 (5)	5 (6)	0.81
Side branch occlusion	1 (1)	1 (1)	0.90
Distal emboli	3 (3)	4 (5)	0.53
Post-PCI CK peak value, UI/L, mean±SD	3343±3630	3929±4952	0.50
Post-PCI troponin Ic peak value, μg/L, mean±SD	126±319	127±200	0.98
Multivessel PCI	19 (19)	15 (17)	0.81
PCI success	89 (89)	72 (84)	0.29
Complete coronary revascularization by PCI	53 (53)	41 (48)	0.52
Mild therapeutic hypothermia	15 (15)	18 (21)	0.29

Values are expressed as mean number with percentages of the total in parentheses, except where indicated otherwise. CK indicates creatine kinase.

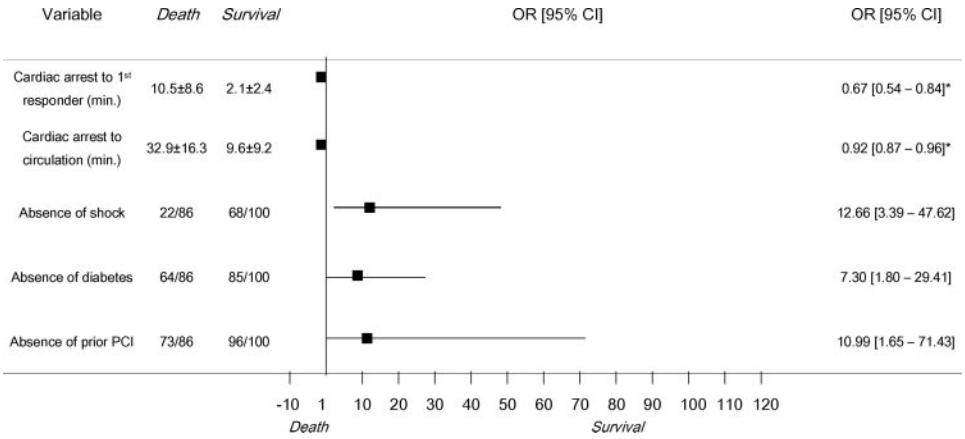

Figure 3. Predictors of 6-month survival after emergency PCI in resuscitated patients after cardiac arrest complicating AMI. Long intervals between the onset of cardiac arrest and arrival of first responder and return of circulation are associated with increased death rate, whereas absence of shock, of diabetes, and of history of prior PCI were associated with increased survival rate at follow-up. OR indicates odds ratio. *For each additional minute.

immediate cardiopulmonary resuscitation maneuvers and of prehospital medical care.

Discussion

The present study shows that adequate management of patients admitted for resuscitated cardiac arrest complicating AMI, including prompt prehospital medical management, emergency PCI of the culprit artery, and specific care in the intensive care unit, is associated with a 54% survival rate at 6-month follow-up and a 48% survival rate without neurological sequelae. Additionally, absence of shock on admission, of diabetes, and of prior PCI as well as a shorter interval between the onset of cardiac arrest and both arrival of first responder and return of spontaneous circulation were independent predictors of 6-month survival in these patients.

Prehospital Management of AMI Patients With Cardiac Arrest

Despite wide use of emergency PCI for AMI, cardiac arrest remains a significant clinical issue with a low survival rate.[12,13] Sudden cardiac death was estimated to be the cause of ≈300 000 deaths in the United States annually and the cause of >50% of all cardiovascular deaths.[14] Patient outcome has been improved by community-based interventions including widespread public awareness programs and the increased availability of semiautomatic cardiac defibrillators in public areas (eg, airports, shopping centers) associated with organized healthcare in dedicated networks (mobile medical care units).[14,15] Recent studies have pointed out the crucial role of the French mobile medical network (Service d'Aide Medicale Urgente [SAMU]) in the prehospital management of acute cardiovascular diseases.[16] The present report emphasizes its role because it demonstrates that the interval between the onset of cardiac arrest and return of spontaneous circulation, reflecting prompt arrival at the scene and adequate out-of-hospital medical care, is one of the key determinants in patient survival. Although their role is crucial in patients' outcome, it is noteworthy that the first key determinant consists of the ability of the first responder to provide first assistance and to alert the EMS. Frequently, the determi-

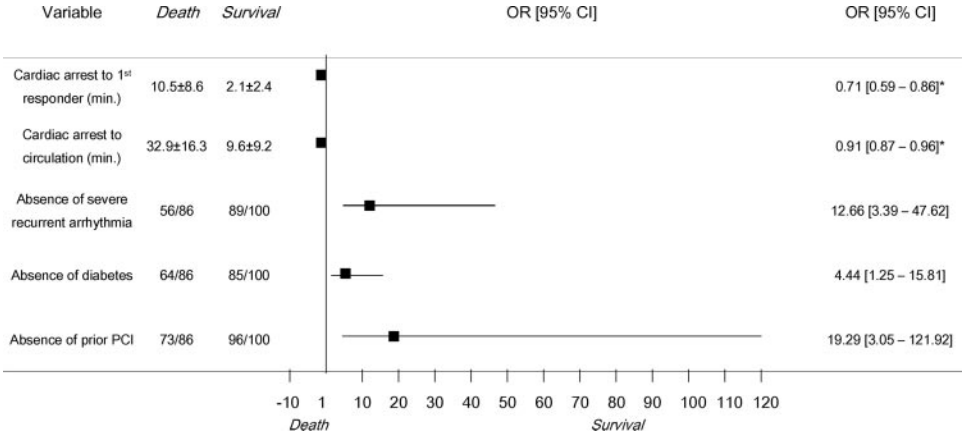

Figure 4. Predictors of 6-month survival after emergency PCI in resuscitated patients after cardiac arrest complicating AMI. All variables are shown with the exclusion of shock. OR indicates odds ratio. *Accounting for each additional minute. Long intervals between the onset of cardiac arrest and arrival of first responder and return of circulation are associated with increased death rate, whereas absence of shock, of diabetes, and of history of prior PCI were associated with increased survival rate at follow-up.

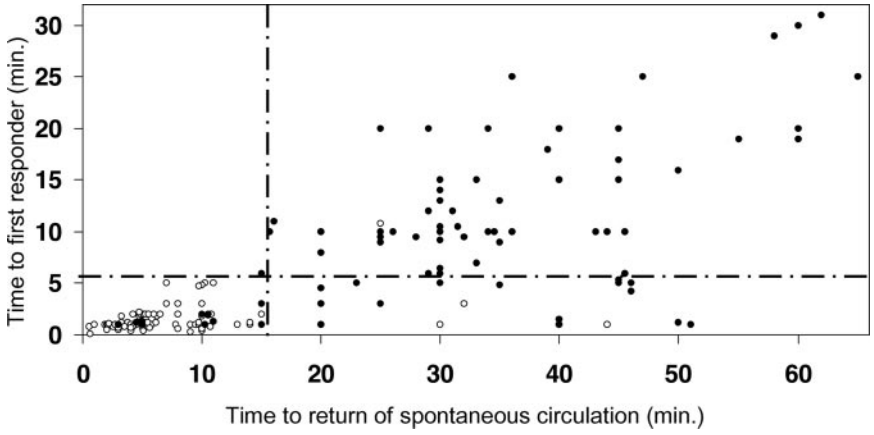

Figure 5. Distribution of mean intervals between the onset of cardiac arrest and both arrival of first responder and return of spontaneous circulation in the study population. Intervals between the onset of cardiac arrest and both arrival of first responder and return to circulation are depicted for survivors (open circles) and for patients who died (closed circles) within follow-up, highlighting that most of survivors underwent CPR initiation within 6 minutes after the onset of cardiac arrest and recovered spontaneous circulation within 16 minutes after sudden death.

nation of intervals between cardiac arrest and arrival of first responder, defibrillation, and return of circulation is a rough estimate, especially in unwitnessed cardiac arrest circumstances.[17] We speculated that this approximation was not responsible for significant mistakes and inappropriate conclusions in the study population. Approximately two thirds of the cardiac arrests occurred in a public place, which is unusual because cardiac arrest occurs most frequently at home in many countries. However, our population consisted of survivors of out-of hospital cardiac arrest who had been resuscitated and transported to the hospital. These patients were more likely to receive cardiopulmonary resuscitation in public places than at home. Indeed, patients who received bystander cardiopulmonary resuscitation were reported to have significantly higher rates of successful resuscitation and were more frequently discharged from the hospital.[18]

Out-of-hospital triage of patients with cardiac arrest has several inherent limitations that may hamper the diagnosis and delay adequate management. On arrival at the scene, the medical staff must rapidly recognize cardiac arrest and determine its cause and prognosis. In this setting, CPR requires prompt intravenous administration of adrenergic and inotropic drugs, as well as anesthetics and paralytics that modify the baseline muscular tone and papillary reflex. For this reason, neurological examination may not properly evaluate the potential postischemic lesions of the brain in these patients. In addition, post–cardiac arrest ECG changes are frequent and nonspecific for AMI.[19] Given the rough determination of the time of cardiac arrest and the confounding interpretation of neurological examination and ECG changes, the strategy of prehospital medical care was prompt transportation to the nearest hospital equipped with cardiac catheterization laboratory and intensive care unit facilities. For the same reasons, emergency PCI was performed irrespective of the neurological status on arrival in the cardiac catheterization laboratory.

Impact of Emergency PCI in Cardiac Arrest Complicating AMI

The role of emergency PCI in AMI patients resuscitated from cardiac arrest has been reported in small population samples. Existing data support a strong benefit of successful PCI, which has been reported to improve survival in these patients. However, these results have been obtained from studies in which emergency coronary reopening was attempted in series of only 10 to 37 patients and succeeded in ≈75% of them.[1,4–7] In the present study, the in-hospital survival rate was very similar to that observed in patients presenting with AMI complicated by cardiogenic shock.[2] Indeed, the SHOCK (SHould we emergently revascularize Occluded Coronaries for cardiogenic shocK?) study showed that early revascularization was related to 6-month survival but was not associated with any differences in 30-day survival, pointing out the role of myocardial reperfusion in improving myocardial function in patients with large infarcts and shock. Accordingly, the present data indicate that early revascularization was achieved with similar rates in patients who died and in those who were discharged alive. The rate of PCI success was 87%, which is similar to that of patients treated for AMI and shock but inferior to that of patients presenting with AMI, which reaches >95% in recent published series.[20] Although successful PCI could have played an important role in improving survival in these patients, the present data indicate that it was not sufficient in itself to show any differences in both 30-day and 6-month mortality rates. This may be explained by the relatively small number of patients. Nevertheless, resuscitation after cardiac arrest complicating AMI is relatively rare, and even high-volume PCI centers have reported small series of patients in the literature.

New Concepts in the Management of Resuscitated Patients After Cardiac Arrest

Postischemic cerebral lesions are one of the key determinants of prolonged circulatory arrest. It has been hypothesized that mild therapeutic hypothermia may have protective effects in resuscitated patients by limiting the effect of both postischemic myocardial no-reflow[21–23] and postischemic cerebral injury after cardiac arrest.[24] Indeed, early mild therapeutic hypothermia has been recommended in survivors of cardiac arrest since 2003.[9] In the present study conducted from 1995 to 2005, cooling was induced in only 33 of 186 patients (18%) and was not associated with any differences in mortality rates. More surprisingly, it was associated with a trend toward higher mortality rates in patients with shock. This may be the consequence of a

selection bias because patients treated by mild hypothermia had worse clinical characteristics, including longer intervals between the onset of cardiac arrest and return of spontaneous circulation. Pharmacological agents have been postulated to have neuroprotective properties, but few have been evaluated in humans, and none has demonstrated favorable effects in the prevention of postischemic human cerebral injury.[25] Indeed, none of the agents were used in the present population. Implantable cardiac defibrillators have shown favorable results in resuscitated patients after cardiac arrest, including those presenting with AMI. However, only 9 patients of the present study were treated with these devices. Recently, the Defibrillator in Acute Myocardial Infarction (DINAMIT) Trial suggested that systematic implantation of a defibrillator is not associated with reduced mortality[26] in high-risk AMI patients. It is therefore notable that no survivor of the present population had recurrent cardiac arrest during the first 6 months after AMI. Actually, 4 of them died from recurrent ventricular arrhythmia that occurred within the first days after myocardial reperfusion, which is commonly not a recommended period for implantation of defibrillators. Indeed, it is noteworthy that the postdischarge mortality rate was low in these patients (3%), very similar to that observed in patients with shock.[2]

Limitations

The present study is a nonrandomized, observational registry, which implies the absence of both a data safety monitoring board and a blinded core laboratory. The present analysis focuses on survivors of cardiac arrest undergoing emergency PCI and subsequent care in an intensive care unit. Therefore, all patients who died before arrival in the cardiac catheterization laboratory were not included in the present study. Absence of shock and absence of prior PCI were independent predictors of 6-month survival; however, CIs for these 2 variables were wide, which may suggest that the analysis should focus on the univariate analysis and to a lesser extent on multivariate models.

Conclusions

In conclusion, adequate management of cardiac arrest complicating AMI, including prompt prehospital medical management, emergency PCI of the infarct, and adequate management in the intensive care unit, is associated with a 54% survival rate at 6 months. A short interval between the onset of cardiac arrest and arrival of a first responder and recovery of spontaneous circulation, absence of shock on admission, and absence of history of diabetes and of prior PCI are independently associated with increased survival in these patients. Even though the care of these patients is frequently eventful, the strategy, consisting of prompt prehospital hemodynamic stabilization followed by direct admission in the cardiac catheterization laboratory for emergency coronary reperfusion and specific care in intensive care units, is associated with favorable outcomes in half of them. Unfortunately, the vast majority of the patient population from whom the study population was derived died before EMS arrival or despite resuscitation. This emphasizes the role and importance of patient and family education about the warning signs of cardiovascular disease and lay person interventions such as cardiopulmonary resuscitation to ultimately improve survival in cardiac arrest.

Disclosures

None.

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Six-Month Outcome of Emergency Percutaneous Coronary Intervention in Resuscitated Patients After Cardiac Arrest Complicating ST-Elevation Myocardial Infarction

Philippe Garot, Thierry Lefevre, Hélène Eltchaninoff, Marie-Claude Morice, Fabienne Tamion, Bernard Abry, Pierre-François Lesault, Jean-Yves Le Tarnec, Claude Pouges, Alain Margenet, Mehran Monchi, Ivan Laurent, Pierre Dumas, Jérôme Garot and Yves Louvard

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