Original articles

# Primary coronary angioplasty in ST-elevation myocardial infarction: prediction of the thirty-day mortality risk in an unselected population of patients

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*Key words:*
**Cardiogenic shock; Coronary angioplasty; Myocardial infarction.**

*Background.* **The 30-day mortality in catheter-based reperfusion therapy in patients with acute myocardial infarction varies widely in the literature and only some factors, such as cardiogenic shock, are clearly associated with the risk. This non-randomized, single center study investigates the potential factors influencing the 30-day mortality in 586 consecutive patients with ST-elevation myocardial infarction, treated with primary coronary angioplasty (PTCA).**

*Methods.* **In the whole series and in two subgroups (with and without cardiogenic shock) the clinical, angiographic and procedural variables were used to develop multivariate statistical models for the prediction of the endpoint.**

*Results.* **The overall 30-day mortality was 7.3%: 35.8 and 4.5% in patients with and without cardiogenic shock, respectively ($p < 0.001$). Independent predictors of the 30-day mortality included: a) in the entire series: shock, PTCA angiographic success, time to treatment, age, and coronary artery disease extension; b) in patients with cardiogenic shock: PTCA angiographic success, time to treatment, coronary artery disease extension, and use of abciximab; c) in patients without cardiogenic shock: time to treatment, age, and coronary artery disease extension.**

*Conclusions.* **In patients with ST-elevation myocardial infarction submitted to primary PTCA, the 30-day mortality rate is a highly predictable endpoint. The role of abciximab therapy and of other independent predictors varies according to the presence or otherwise of cardiogenic shock.**

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## Introduction

Primary percutaneous transluminal coronary angioplasty (PTCA) of the infarct-related artery is a valuable tool to achieve reperfusion and salvage of the myocardium in ST-elevation myocardial infarction (STEMI)[1] and its results may be further improved by coronary stent implantation[2,3]. Among the predictors of procedural success and short-term results of primary PTCA, the role of cardiogenic shock has been well defined. Conversely, conflicting results have been reported on the impact of other factors[4-6] and particularly debated is the impact of adjunctive abciximab therapy on mortality[7-10].

For this reason, we reviewed an unselected series of consecutive patients with STEMI submitted to routine primary PTCA and evaluated the impact of the clinical, angiographic and procedural factors which may affect the 30-day mortality risk, both in the whole cohort and in the subgroups of patients with and without cardiogenic shock.

## Methods

**Study population and treatment protocol.** The study population consisted of 586 consecutive patients with STEMI submitted to primary PTCA between January 1998 and October 2002. Our institution is a tertiary cardiac care unit in which primary PTCA has been the reperfusion strategy for all STEMI patients since 1996. The inclusion criteria were: 1) chest pain lasting > 30 min associated with ST-segment elevation ≥ 1 mV in ≥ 2 contiguous leads plus 2) symptom onset ≤ 12 hours. Patients with a symptom onset > 12 hours but with persisting chest pain and ST-segment elevation were also included.

PTCA of the infarct-related artery was performed with the standard technique. All patients received 5000 to 10 000 IU of heparin and 500 mg of aspirin intravenously. Coronary stents were routinely implanted, with a restricted use in those patients with a vessel diameter < 2.5 mm and in case of a coronary anatomy unsuitable for stent implantation. A variety of guidewires, low profile coronary angioplasty balloons and stents were used. Abciximab therapy (0.25 mg/kg bolus plus 12-hour infusion at 0.125 γ/kg/min) was administered at the discretion of the operators; its use was considered contraindicated in patients considered at higher risk of bleeding complications: peptic ulcer, history of stroke or transient ischemic attacks, major surgery within 30 days, cardiac arrest, and hemorrhagic diathesis. Abciximab was administered immediately before PTCA. After the PTCA procedure, all patients were treated with aspirin 100 mg daily indefinitely and with thienopiridin (ticlopidine 500 mg or clopidogrel 75 mg daily following a 300 mg loading dose) for 1 month, if a coronary stent had been implanted. All in-hospital survivors were clinically evaluated at 1 month.

**Endpoint and variable definitions.** The endpoint of the study was the 30-day mortality due to any cause.

Primary PTCA was defined as percutaneous coronary revascularization without previous thrombolytic therapy.

Patients receiving oral hypoglycemic drugs or insulin were considered diabetics. Cardiogenic shock was identified in the presence of persistent hypotension (systolic blood pressure ≤ 85 mmHg) associated with clinical signs of systemic hypoperfusion (cold skin and oliguria). Multivessel coronary artery disease was defined if a stenosis > 50% was present in more than one main coronary vessel.

The time to treatment (T-t-T) was considered as the time interval from symptom onset to vessel patency restoration; in patients with pre-PTCA TIMI flow grade 2-3 in the culprit vessel and symptom resolution (22% of patients), the T-t-T was considered as the interval between the onset and the resolution of the symptoms; four subgroups of T-t-T were identified on clinical and statistical bases: within 6 hours, > 6 and ≤ 9 hours, > 9 and ≤ 24 hours, > 24 hours.

PTCA angiographic success was defined as TIMI flow grade 3 in the culprit vessel with residual stenosis ≤ 30%. Quantitative coronary angiography was performed with the use of an automatic edge detection system (CASS II).

**Statistical analysis.** Non-parametric data were reported as absolute numbers and relative frequencies; continuous data were summarized as mean values ± SD. At univariate analyses, the unpaired Student's t-test for parametric variables or the $\chi^2$ test with Yates correction (or Fisher's exact test when appropriate) for non-parametric variables were calculated. For non-parametric variables coded in more than two levels, a test for the linear trend was also elaborated. The statistical significance level was set at 5%. Multivariate analysis was performed using the logistic regression model to identify the independent predictors (BMDPLR software). The areas below the ROC curves were calculated for the final multivariate statistical models and a 30-day mortality probability score was elaborated. The scores were developed using the variables' coefficients (natural logarithm of the odds ratios) calculated by the logistic models.

## Results

The baseline characteristics of the entire cohort (586 patients) are summarized in table I. More than 80% of patients were treated within 6 hours of symptom onset; 62.3% had an anterior STEMI and in 63.2% the pre-PTCA TIMI flow grade was 0.

Fifty-three patients (9%) had cardiogenic shock and constituted group 1, while group 2 comprised the remaining 533 patients (Table II).

**Table I.** Clinical, angiographic baseline and procedural characteristics of the patients.

| | |
|---|---|
| Age (years) | 63.2 ± 11.9 (range 25-92) |
| Male gender | 473 (80.7%) |
| Diabetes | 87 (14.8%) |
| CK max (U/l) | 2410.7 ± 2146.3 |
| CK-MB max (U/l) | 305.2 ± 430.8 |
| Cardiogenic shock | 53 (9%) |
| Time to treatment (hours) | |
| Within 6 | 480 (81.9%) |
| > 6 ≤ 9 | 47 (8%) |
| > 9 ≤ 24 | 41 (7%) |
| > 24 | 18 (3.1%) |
| Anterior STEMI | 365 (62.3) |
| No. vessels | |
| One-vessel disease | 334 (57%) |
| Two-vessel disease | 156 (26.6%) |
| Three-vessel disease | 96 (16.4%) |
| Vessel treated | |
| Right coronary artery | 176 (30%) |
| Left circumflex artery | 46 (7.8%) |
| Left anterior descending artery | 354 (60.4%) |
| Bypass graft/left main | 10 (1.7%) |
| Coronary segment | |
| Proximal | 282 (48.1%) |
| Mid | 265 (45.2%) |
| Distal | 39 (6.7%) |
| Pre-PTCA TIMI flow grade | |
| 0 | 370 (63.2%) |
| 1 | 81 (13.8%) |
| 2 | 61 (10.4%) |
| 3 | 68 (11.6%) |
| Abciximab use | 323 (55.1%) |
| IRA stenting (successful PTCA only) | 471 (85.6%) |
| IABP (only patients with shock)* | 43 (81.1%) |

CK = creatine kinase; IABP = intra-aortic balloon pump; IRA = infarct-related artery; PTCA = percutaneous transluminal coronary angioplasty; STEMI = ST-elevation myocardial infarction.

**Table II.** Group 1 (cardiogenic shock) and group 2 (no cardiogenic shock) description (absolute number, rate).

| | Group 1 | Group 2 | Statistics |
|---|---|---|---|
| No. patients | 53 (9%) | 533 (91%) | |
| 30-day mortality | 19 (35.8%) | 24 (4.5%) | $\chi^2 = 65.13$; $p < 0.0001$ |
| Time to treatment (hours) | | | |
| ≤ 3 | 21 (39.6%) | 278 (52.2%) | |
| ≤ 6 | 18 (34%) | 163 (30.6%) | $\chi^2 = 7.47$ |
| ≤ 9 | 4 (7.5%) | 43 (8.1%) | $p < 0.005$ |
| ≤ 12 | 3 (5.7%) | 20 (3.8%) | |
| ≤ 24 | 1 (1.9%) | 17 (3.2%) | |
| > 24 | 6 (11.3%) | 12 (2.3%) | |
| Diabetes | 7 (13.2%) | 80 (15%) | $\chi^2 = 0.02$; p = NS |
| Abciximab | 20 (37.7%) | 303 (56.8%) | $\chi^2 = 6.37$; $p < 0.025$ |
| PTCA angiographic success | 41 (77.4%) | 509 (95.5%) | $\chi^2 = 24.45$; $p < 0.0001$ |
| Pre-PTCA TIMI flow grade | | | $\chi^2 = 1.41$; p = NS |
| 0 | 38 (71.7%) | 338 (63.4%) | |
| 1 | 7 (13.2%) | 74 (13.9%) | |
| 2 | 5 (9.4%) | 56 (10.5%) | |
| 3 | 3 (5.7%) | 65 (12.2%) | |
| IRA | | | $\chi^2 = 7.709$; $p < 0.06$ |
| RCA | 20 (37.7%) | 156 (29.3 %) | |
| LCx | 3 (5.7%) | 43 (8.1%) | |
| LAD | 27 (50.9%) | 327 (61.4%) | |
| Graft/left main | 3 (5.7%) | 7 (1.3%) | |
| Vessel segment | | | $\chi^2 = 1.998$; p = NS |
| Proximal | 31 (58.5%) | 251 (47.1%) | |
| Mid | 19 (35.8%) | 246 (46.1%) | |
| Distal | 3 (5.7%) | 36 (6.8%) | |
| No. diseased vessels | | | $\chi^2 = 0.453$; p = NS |
| 1 | 30 (56.6%) | 304 (57%) | |
| 2 | 11 (20.8%) | 145 (27.2%) | |
| 3 | 12 (22.6%) | 84 (15.8%) | |
| Age < 76 years | 41 (77.4%) | 449 (84.2%) | $\chi^2 = 3.03$; p = NS |
| Male gender | 39 (73.6%) | 421 (79%) | $\chi^2 = 1.43$; p = NS |
| STEMI location anterior | 29 (54.7%) | 336 (63%) | $\chi^2 = 1.09$; p = NS |
| IRA stented (successful PTCA only) | 33 (80.5%) | 438 (86.1%) | $\chi^2 = 0.56$; p = NS |

IRA = infarct-related artery; LAD = left anterior descending artery; LCx = left circumflex artery; PTCA = percutaneous transluminal coronary angioplasty; RCA = right coronary artery; STEMI = ST-elevation myocardial infarction.

No patient was lost to follow-up. The 30-day mortality was 7.3% (43/586) in the entire series: 35.8% (19/53) and 4.5% (24/533) in group 1 vs group 2, respectively ($p < 0.001$). Twenty-one patients died within the first 24 hours and 22 within the first month. One patient with an unsuccessful PTCA and acute post-infarction interventricular septal defect died after cardiac surgery; no other patient was submitted to cardiac surgery.

PTCA angiographic success was obtained in 550 patients (93.4%): 77.4 and 95.5% in group 1 and 2 respectively ($p < 0.0001$). Procedural failures were mainly due to the impossibility of crossing the occlusion with the guide-wire.

Infarct-related artery stenting was performed in 471 (85.6%) out of the 550 successfully treated patients: 80.5 and 86.1% in group 1 and 2 respectively (p = NS), while the remaining 14.4% received only balloon angioplasty, mainly because of small vessel reference diameter or excessive vessel tortuosity.

Abciximab therapy (Table III) was administered in 323 patients (55.1%): 56.8% in group 2 vs 37.7% in group 1 respectively ($p < 0.025$), while it was considered not indicated in the remaining 263 patients. The drug was more frequently used in patients with T-t-T ≤ 12 vs > 12 hours, in non-anterior STEMI and in stented patients.

Two patients developed neurological symptoms during abciximab infusion; the drug was promptly stopped and in both cases brain computed tomography did not reveal any significant lesion; in both patients neurological symptoms spontaneously and completely disappeared within a few hours. Three major vascular complications requiring surgical repair (femoral arterial pseudoaneurysm) occurred, all in patients not treated with abciximab. Minor bleeding (groin hematoma, gingival bleeding) occurred in 3.5 and 2.9% (p = NS) for abciximab vs no abciximab respectively.

**Predictors of the 30-day mortality.** *Entire series (586 patients).* Table IV shows the univariate predictors of

**Table III.** Analysis of abciximab use.

| Variable | Abciximab | No abciximab | % | RR | Statistics |
|---|---|---|---|---|---|
| Time to treatment (hours) | | | | | |
| ≤ 3 | 169 | 130 | 56.5 | 1 | |
| ≤ 6 | 105 | 76 | 58 | 1.03 | $\chi^2 = 12.556$ |
| ≤ 9 | 25 | 22 | 53.2 | 0.94 | $p < 0.05$ |
| ≤ 12 | 14 | 9 | 60.9 | 1.08 | Test for linear trend $p < 0.025$ |
| ≤ 24 | 6 | 12 | 33.3 | 0.59 | |
| > 24 | 4 | 14 | 22.2 | 0.39 | |
| Shock | 20 | 33 | 37.7 | 1 | $\chi^2 = 6.37$; $p = 0.25$ |
| No shock | 303 | 230 | 56.8 | 0.66 | |
| Diabetes | | | | | p = NS |
| Yes | 46 | 41 | 52.9 | 1 | |
| No | 277 | 222 | 55.5 | 1.05 | |
| PTCA angiographic success | | | | | p = NS |
| Yes | 308 | 242 | 56 | 1 | |
| No | 15 | 21 | 41.7 | 0.74 | |
| Pre-PTCA TIMI flow grade | | | | | p = NS |
| 0 | 203 | 173 | 54 | 1 | |
| 1 | 48 | 33 | 59.3 | 1.1 | |
| 2 | 39 | 22 | 63.9 | 1.18 | Test for linear trend p = NS |
| 3 | 33 | 35 | 48.5 | 0.9 | |
| IRA | | | | | $\chi^2 = 9.166$; $p < 0.025$ |
| RCA | 112 | 64 | 63.6 | 1 | |
| LCx | 30 | 16 | 65.2 | 1.02 | |
| LAD | 176 | 168 | 51.2 | 0.8 | |
| Graft/left main | 5 | 5 | 50 | 0.79 | |
| Vessel segment | | | | | p = NS |
| Proximal | 162 | 120 | 57.4 | 1 | |
| Mid | 132 | 133 | 49.8 | 0.87 | Test for linear trend p = NS |
| Distal | 29 | 10 | 74.4 | 1.29 | |
| No. diseased vessels | | | | | |
| 1 | 177 | 157 | 53 | 1 | $\chi^2 = 1.548$; p = NS |
| 2 | 89 | 67 | 57.1 | 1.08 | Test for linear trend p = NS |
| 3 | 57 | 39 | 59.4 | 1.02 | |
| Age (years) | 72.4 ± 8.8 | 62.6 ± 11.8 | | | |
| < 76 | 276 | 229 | 54.7 | 1 | $p < 0.001$ |
| ≥ 76 | 47 | 34 | 58 | 1.06 | p = NS |
| Sex (M/F) | 263/60 | 210/53 | 55.6/53.1 | 1/0.95 | p = NS |
| STEMI location | | | | | |
| Anterior | 180 | 185 | 49.3 | 1 | |
| Non-anterior | 143 | 78 | 64.7 | 1.31 | $\chi^2 = 12.57$; $p < 0.005$ |
| Stent (successful PTCA only) | 298 | 178 | 62.6 | 1 | |
| POBA | 25 | 85 | 22.7 | 0.36 | $\chi^2 = 55.84$; $p < 0.0001$ |
| CK (U/l) | 2562.8 ± 7255.7 | 2548.9 ± 2561.6 | | | p = NS |
| CK-MB (U/l) | 328.3 ± 326.2 | 291.2 ± 444.2 | | | p = NS |

CK = creatine kinase; IRA = infarct-related artery; LAD = left anterior descending artery; LCx = left circumflex artery; POBA = plain old balloon angioplasty; PTCA = percutaneous transluminal coronary angioplasty; RCA = right coronary artery; RR = relative risk; STEMI = ST-elevation myocardial infarction.

the 30-day mortality: shock, T-t-T, PTCA angiographic success, age, coronary artery disease extension, and use of abciximab. The T-t-T and mortality showed a statistically significant increasing linear relationship. Tables V and VI show the final multivariate logistic model results with a score for an easy and prompt estimate of the mortality risk in new patients with or without shock. Shock exposes the patients to a mortality risk 8.7 times higher than that observed in subjects with no shock. Unsuccessful PTCA exposes to a risk 5.3 (1/0.187) times higher in comparison with successful PTCA. T-t-T up to 9, 24 and > 24 hours respectively expose to a risk 1.81, 6.21 and 7.09 times higher than that observed for a T-t-T up to 6 hours. In comparison with an age < 75 years, an age ≥ 75 years exposes to a risk 2.92 times higher. In comparison with single-vessel disease, two- and three-vessel disease respectively expose to a risk 1.11 and 2.58 times higher. The multivariate model conveys 96 different patterns of the variables: the highest expected 30-day mortality is 93.2% for patients with the worst pattern (shock, T-t-T > 24 hours, unsuccessful PTCA, age ≥ 75 years, three-vessel disease); conversely the best pattern (no shock, T-t-T ≤ 6 hours, successful PTCA, age < 75 years, single-vessel disease) conveys

**Table IV.** Global cohort: univariate analysis of the 30-day mortality in primary percutaneous transluminal coronary angioplasty (PTCA) (586 patients).

| Variable | Death | Survival | % | RR | Statistics |
|---|---|---|---|---|---|
| Time to treatment (hours) | | | | | |
| ≤ 3 | 12 | 287 | 4 | 1 | $\chi^2 = 39.979$ |
| ≤ 6 | 10 | 171 | 5.5 | 1.38 | $p < 0.0001$ |
| ≤ 9 | 5 | 42 | 10.6 | 2.65 | Test for linear trend $p < 0.0001$ |
| ≤ 12 | 5 | 18 | 21.7 | 5.42 | |
| ≤ 24 | 4 | 14 | 21.2 | 5.54 | |
| > 24 | 7 | 11 | 38.9 | 9.69 | |
| Diabetes | | | | | $\chi^2 = 0.16$; p = NS |
| Yes | 5 | 82 | 5.7 | 1 | |
| No | 38 | 461 | 7.6 | 1.33 | |
| Abciximab | | | | | $\chi^2 = 6.82$; $p < 0.01$ |
| Yes | 15 | 308 | 4.6 | 1 | |
| No | 28 | 235 | 10.6 | 2.3 | |
| PTCA angiographic success | | | | | $\chi^2 = 42.3$; $p < 0.0001$ |
| Yes | 30 | 520 | 5.5 | 1 | |
| No | 13 | 23 | 36.1 | 6.62 | |
| Cardiogenic shock | | | | | $\chi^2 = 66.77$; $p < 0.0001$ |
| Yes | 19 | 34 | 35.8 | 8 | |
| No | 24 | 509 | 4.5 | 1 | |
| Pre-PTCA TIMI flow grade | | | | | $\chi^2 = 11.35$; $p < 0.001$ |
| 0 | 30 | 346 | 8 | 1 | Test for linear trend p = NS |
| 1 | 2 | 79 | 2.5 | 0.3 | |
| 2 | 8 | 53 | 13.1 | 1.64 | |
| 3 | 3 | 65 | 4.1 | 0.4 | |
| IRA | | | | | $\chi^2 = 8.046$; $p < 0.05$ |
| RCA | 13 | 163 | 7.4 | 1 | |
| LCx | 4 | 42 | 8.7 | 1.17 | |
| LAD | 23 | 331 | 6.5 | 0.88 | |
| Graft/left main | 3 | 7 | 30.0 | 4 | |
| Vessel segment | | | | | $\chi^2 = 0.82$; p = NS |
| Proximal | 22 | 260 | 7.8 | 1 | Test for linear trend p = NS |
| Mid | 17 | 248 | 6.4 | 0.58 | |
| Distal | 4 | 35 | 10.3 | 0.93 | |
| No. diseased vessels | | | | | $\chi^2 = 7.4$; $p < 0.05$ |
| 1 | 19 | 315 | 5.7 | 1 | Test for linear trend $p < 0.05$ |
| 2 | 9 | 147 | 5.8 | 1 | |
| 3 | 15 | 81 | 15.6 | 2.7 | |
| Stent (only successful PTCA) | 22 | 449 | 4.7 | 1 | $\chi^2 = 2.92$; p = NS |
| POBA | 8 | 71 | 10.1 | 2.17 | |
| Age (years) | 70 ± 10.9 | 62.7 ± 11.8 | | | |
| < 76 | 30 | 475 | 5.9 | 1 | $p < 0.01$ |
| ≥ 76 | 13 | 68 | 16 | 2.7 | $\chi^2 = 9.06$; $p < 0.005$ |
| Sex (M/F) | 31/12 | 442/101 | 6.6/10.6 | 1/1.61 | $\chi^2 = 1.66$; p = NS |
| STEMI location | | | | | $\chi^2 = 0.05$; p = NS |
| Anterior | 27 | 338 | 7.4 | 1 | |
| Non-anterior | 16 | 205 | 7.2 | 0.98 | |
| CK (U/l) | 2468.8 ± 2718.1 | 2385.3 ± 2151.3 | | | p = NS |
| CK-MB (U/l) | 317.5 ± 315.4 | 293.0 ± 456.7 | | | p = NS |

CK = creatine kinase; IRA = infarct-related artery; LAD = left anterior descending artery; LCx = left circumflex artery; POBA = plain old balloon angioplasty; RCA = right coronary artery; RR = relative risk; STEMI = ST-elevation myocardial infarction.

the lowest expected 30-day mortality (1.58%). The area below the ROC curve (0.8312), constructed with the final multivariate model, was found to be highly significant ($p < 0.00001$).

*Series with cardiogenic shock (53 patients).* In this series, the mortality was 35.8%. Table VII shows the results of univariate analysis: the T-t-T (two subgroups, cut-off 6 hours), PTCA angiographic failure and no abciximab administration were significantly associated with the endpoint. Table VIII shows the results of multivariate analysis: the model conveys 16 different patterns of the variables; the highest expected 30-day mortality is observed in patients with the worst pattern (T-t-T > 6 hours, unsuccessful PTCA, three-vessel disease, no abciximab); conversely, the best pattern (T-t-T < 6 hours, successful PTCA, single-vessel disease, abciximab use) conveys the lowest expected 30-day mor-

**Table V.** Global cohort: multivariate analysis results and related score for the 30-day mortality prediction in primary percutaneous transluminal coronary angioplasty (PTCA) (586 patients).

| Independent predictor | Coefficient | Odds ratio | p |
|---|---|---|---|
| Shock | 0 | 1 | < 0.00001 |
| No shock | -2.166 | 0.115 | |
| Successful PTCA | -1.674 | 0.187 | < 0.0007 |
| Unsuccessful PTCA | 0 | 1 | |
| Time to treatment (hours) | | | < 0.0005 |
| ≤ 6 | 0 | 1 | |
| ≤ 9 | 0.592 | 1.81 | |
| ≤ 24 | 1.826 | 6.21 | |
| > 24 | 1.959 | 7.09 | |
| Age < 75 years | 0 | 1 | < 0.0139 |
| Age ≥ 75 years | 1.070 | 2.92 | |
| Single-vessel disease | 0 | 1 | < 0.0857 |
| Two-vessel disease | 0.1061 | 1.11 | |
| Three-vessel disease | 0.949 | 2.58 | |

Adding the single coefficient values to the constant (-0.2908) one may calculate the logit of the expected risk of 30-day mortality (see Table VI). Example: time to treatment up to 6 hours 0, successful PTCA -1.674, shock = 0, three-vessel disease = 0.949, age < 75 years = 0, constant = -0.2908, sum (logit) = -1.0158 → expected mortality rate < 30%. For the exact estimation, use the following formula: expected mortality rate = 1/[1 + (exp(-logit)].

**Table VI.** Thirty-day expected mortality score in primary percutaneous transluminal coronary angioplasty.

| Score | 30-day expected mortality (%) |
|---|---|
| Lower than -3.8918 | < 2 |
| Lower than -2.9444 | < 5 |
| Lower than -2.1972 | < 10 |
| Lower than -1.3863 | < 20 |
| Lower than -0.8473 | < 30 |
| Lower than -0.4055 | < 40 |
| Lower than 0 | < 50 |
| Lower than 0.4055 | < 60 |
| Lower than 0.8473 | < 70 |
| Lower than 1.3863 | < 80 |
| Lower than 2.1972 | < 90 |

tality rate. The area below the ROC curve (0.9652) was highly significant (p < 0.00001).

*Series without cardiogenic shock (533 patients).* In this series, the mortality was 4.5%. Tables IX and X show the results of univariate and multivariate analysis: the T-t-T (four subgroups), age and coronary artery disease extension were significantly associated with the endpoint. The multivariate model conveys 16 different patterns of the variables: the highest expected 30-day mortality rate is 51.3% for patients with the worst pattern (T-t-T > 12 hours, age > 75 years, three-vessel disease); conversely, the best pattern (T-t-T up to 12 hours, age ≤ 75 years, single- or two-vessel disease) conveys the lowest expected 30-day mortality rate (1.43%). The area below the ROC curve (0.7502) was highly significant (p < 0.0001).

## Discussion

This study describes a large series of unselected patients with STEMI undergoing primary PTCA within 12 hours of symptom onset in a single tertiary cardiac care unit.

The 30-day mortality, the endpoint of the study, was 7.3%, which is comparable to the rates of other series, ranging from 2 to 10%[5]. The 30-day mortality appeared strongly related to several factors identified and weighted by logistic multivariate analysis: a) five independent predictors in the entire cohort: cardiogenic shock, T-t-T, PTCA angiographic success, age, coronary artery disease extension; b) four independent predictors in the shock cohort: T-t-T, PTCA angiographic success, coronary artery disease extension, abciximab use; c) three independent predictors in the cohort without shock: T-t-T, age, coronary artery disease extension.

Applying these results and following the examples shown in tables V, VIII and X, it is possible to obtain an *a priori* estimate of the procedure outcome in new patients.

Many of these observations confirm previous reports. Pre-procedural cardiogenic shock has been uniformly described as the single major predictor of mortality in primary PTCA. In previous series, the range of in-hospital mortality for primary PTCA has varied from 2.0 to 5.2% for no-shock patients and from 32 to 45% for shocked patients[11,12].

Also well documented is the role of other predictors which emerged in our study: a) age: a recent pooled analysis of primary PTCA reported a 5-time higher in-hospital mortality rate for patients > 75 years than their younger counterparts[13]; b) PTCA failure: it is a well known powerful predictor of mortality[4,5] probably because it is associated with a higher clinical and angiographic risk profile (three-vessel disease, severely impaired left ventricular function, large amount of thrombus, multiple stenoses)[14]; c) multivessel disease: in previous studies, in-hospital mortality for primary PTCA has been only 1% for patients with single-vessel disease compared with 12% in cases with multivessel disease[15,16]; d) T-t-T: a significant correlation with clinical endpoints has been formerly described[17]; our data show a linear trend (evident both at univariate and multivariate analysis) between T-t-T and 30-day mortality; T-t-T is maximally crucial in patients with cardiogenic shock in whom a T-t-T > 6 hours exposes to a marked increase in the mortality risk.

**Table VII.** Group 1 (patients with cardiogenic shock): univariate analysis of the 30-day mortality in primary percutaneous transluminal coronary angioplasty (PTCA) (53 patients).

| | Death | Survival | % | RR | Statistics |
|---|---|---|---|---|---|
| Time to treatment (hours) | | | | | |
| ≤ 3 | 3 | 18 | 14.3 | 1 | $\chi^2 = 21.768$ |
| ≤ 6 | 4 | 14 | 22.2 | 1.56 | $p < 0.001$ |
| ≤ 9 | 4 | 0 | 100 | 7 | Test for linear trend $p < 0.001$ |
| ≤ 12 | 2 | 1 | 66.7 | 15.2 | |
| ≤ 24 | 1 | 0 | 100 | 7 | |
| > 24 | 5 | 1 | 83.3 | 5.83 | |
| Diabetes | | | | | p = NS |
| Yes | 2 | 5 | 28.6 | 1 | |
| No | 17 | 29 | 37.0 | 1.3 | |
| Abciximab | | | | | $\chi^2 = 4.7$; $p < 0.05$ |
| Yes | 3 | 17 | 15 | 1 | |
| No | 16 | 17 | 48.5 | 3.23 | |
| PTCA angiographic success | | | | | $\chi^2 = 17.995$; $p < 0.0001$ |
| Yes | 8 | 33 | 19.5 | 1 | |
| No | 11 | 1 | 91.7 | 4.7 | |
| Pre-PTCA TIMI flow grade | | | | | $\chi^2 = 7.346$; $p > 0.06$ |
| 0 | 14 | 24 | 36.8 | 1 | Test for linear trend p = NS |
| 1 | 1 | 6 | 14.3 | 0.4 | |
| 2 | 4 | 1 | 80 | 2.17 | |
| 3 | 0 | 3 | 0 | 0 | |
| IRA | | | | | $\chi^2 = 2.55$; p = NS |
| RCA | 5 | 15 | 25 | 1 | Test for linear trend p = NS |
| LCx | 1 | 2 | 33.3 | 1.1 | |
| LAD | 11 | 16 | 40.7 | 0.8 | |
| Graft/left main | 2 | 1 | 66.7 | 3.8 | |
| Vessel segment | | | | | |
| Proximal | 12 | 19 | 38.7 | 1 | |
| Mid | 6 | 13 | 31.6 | 0.82 | p = NS |
| Distal | 1 | 2 | 33.3 | 0.86 | Test for linear trend p = NS |
| No. diseased vessels | | | | | |
| 1 | 10 | 20 | 33.3 | 1 | |
| 2 | 2 | 9 | 18.2 | 0.55 | p = NS |
| 3 | 7 | 5 | 58.3 | 1.75 | Test for linear trend p = NS |
| Age (years) | 70 ± 12.5 | 62.4 ± 12 | | | |
| < 76 | 14 | 27 | 34.1 | 1 | p = NS |
| ≥ 76 | 5 | 7 | 41.7 | 1.2 | p = NS |
| Sex (M/F) | 13/6 | 26/8 | 33.3/42.9 | 1/1.29 | p = NS |
| STEMI location | | | | | |
| Anterior | 13 | 16 | 44.8 | 1 | |
| Non-anterior | 6 | 18 | 25 | 0.56 | p = NS |
| Stent (successful PTCA only) | 5 | 28 | 15.2 | 1 | p = NS |
| POBA | 3 | 5 | 37.5 | 2.48 | |
| CK (U/l) | 2258.4 ± 2161.1 | 2473.3 ± 2055.7 | | | p = NS |
| CK-MB (U/l) | 307.8 ± 298.3 | 298.3 ± 396.4 | | | p = NS |

CK = creatine kinase; IRA = infarct-related artery; LAD = left anterior descending artery; LCx = left circumflex artery; POBA = plain old balloon angioplasty; RCA = right coronary artery; RR = relative risk; STEMI = ST-elevation myocardial infarction.

Conversely more conflicting results have been reported in the literature on the role of other variables and particularly debated is the impact of adjunctive abciximab therapy on the 30-day mortality. In our series, abciximab reduced the incidence of the endpoint at univariate analysis of the entire series (relative risk of death 2.2 times higher in case of no use) and in patients with cardiogenic shock (relative risk of death 3.2), in whom the drug is also an independent predictor of survival (odds ratio of mortality abciximab no/abciximab yes = 13).

Thus, it appears that abciximab therapy gives its best results in the highest risk patients and this different level of benefit according to the patient risk profile might account for the disparity existing in the literature about the clinical efficacy of this drug. Clinical trials such as RAPPORT[18] and ADMIRAL[8] excluded patients with cardiogenic shock and showed a substantial

**Table VIII.** Group 1 (patients with shock): multivariate analysis results and related score for the 30-day mortality rate prediction in primary percutaneous transluminal coronary angioplasty (PTCA) (53 patients).

| Independent predictor | Coefficient | Odds ratio | p |
|---|---|---|---|
| Successful PTCA | -5.283 | 0.00507 | < 0.0008 |
| Unsuccessful PTCA | 0 | 1 | |
| Time to treatment (hours) | | | < 0.0022 |
| ≤ 6 | 0 | 1 | |
| > 6 | 3.840 | 46.5 | |
| One- or two-vessel disease | 0 | 1 | < 0.0178 |
| Three-vessel disease | 3.535 | 34.3 | |
| Abciximab | 0 | 1 | < 0.0449 |
| No abciximab | 2.565 | 13 | |

Adding the single coefficient values to the constant (-0.3143) one may calculate the logit of the expected risk of the 30-day mortality. Example: time to treatment ≤ 6 hours = 0, successful PTCA = -5.283, three-vessel disease = 3.535, no abciximab = 2.565, constant = -0.3143, sum (logit) = 0.5027 → expected 30-day mortality < 70% (exact estimation 62.3%); with use of ReoPro: < 20% (exact estimation 11.3%).

**Table IX.** Group 2 (patients without cardiogenic shock): univariate analysis of the 30-day mortality in primary percutaneous transluminal coronary angioplasty (PTCA) (533 patients).

| Variable | Death | Survival | % | RR | Statistics |
|---|---|---|---|---|---|
| Time to treatment (hours) | | | | | |
| ≤ 3 | 9 | 269 | 3.2 | 1 | $\chi^2 = 17.85$ |
| ≤ 6 | 6 | 157 | 3.7 | 1.14 | p < 0.005 |
| ≤ 9 | 1 | 42 | 2.3 | 0.72 | Test for linear trend p < 0.005 |
| ≤ 12 | 3 | 17 | 15 | 4.63 | |
| ≤ 24 | 3 | 14 | 17.6 | 5.45 | |
| > 24 | 2 | 10 | 16.7 | 5.15 | |
| Diabetes | | | | | p = NS |
| Yes | 3 | 77 | 3.8 | 1 | |
| No | 21 | 432 | 4.6 | 1.2 | |
| Abciximab | | | | | p = NS |
| Yes | 12 | 291 | 3.8 | 1 | |
| No | 12 | 218 | 4.6 | 1.24 | |
| PTCA angiographic success | | | | | p = NS |
| Yes | 22 | 487 | 4.3 | 1 | |
| No | 2 | 22 | 8.3 | 1.93 | |
| Pre-PTCA TIMI flow grade | | | | | p = NS |
| 0 | 16 | 322 | 4.7 | 1 | Test for linear trend p = NS |
| 1 | 1 | 73 | 1.4 | 0.3 | |
| 2 | 4 | 52 | 7.1 | 1.51 | |
| 3 | 3 | 62 | 4.6 | 0.98 | |
| IRA | | | | | p = NS |
| RCA | 8 | 148 | 5.1 | 1 | Test for linear trend p = NS |
| LCx | 3 | 40 | 7 | 1.36 | |
| LAD | 12 | 315 | 3.7 | 0.72 | |
| Graft/left main | 1 | 6 | 14.1 | 2.79 | |
| Vessel segment | | | | | p = NS |
| Proximal | 10 | 241 | 4 | 1 | Test for linear trend p = NS |
| Mid | 11 | 235 | 4.5 | 1.12 | |
| Distal | 3 | 33 | 8.3 | 2.09 | |
| No. diseased vessels | | | | | $\chi^2 = 6.642$; p < 0.05 |
| 1 | 9 | 295 | 3 | 1 | Test for linear trend p < 0.025 |
| 2 | 7 | 138 | 4.8 | 1.63 | |
| 3 | 8 | 76 | 9.5 | 3.22 | |
| Age (years) | 72.4 ± 8.8 | 62.6 ± 11.8 | | | |
| < 76 | 16 | 448 | 3.4 | 1 | p < 0.001 |
| ≥ 76 | 8 | 61 | 11.6 | 3.4 | $\chi^2 = 7.742$; p < 0.01 |
| Sex (M/F) | 18/6 | 416/93 | 4.1/6.1 | 1/1.46 | p = NS |
| STEMI location | | | | | p = NS |
| Anterior | 14 | 322 | 4.2 | 1 | |
| Non-anterior | 10 | 187 | 5.1 | 1.22 | |
| Stent (successful PTCA only) | 17 | 425 | 3.8 | 1 | |
| POBA | 7 | 84 | 7.7 | 2 | p = NS |
| CK (U/l) | 2562.8 ± 7255.7 | 2548.9 ± 2561.6 | | | p = NS |
| CK-MB (U/l) | 328.3 ± 326.2 | 291.2 ± 444.2 | | | p = NS |

CK = creatine kinase; IRA = infarct-related artery; LAD = left anterior descending artery; LCx = left circumflex artery; POBA = plain old balloon angioplasty; RCA = right coronary artery; RR = relative risk; STEMI = ST-elevation myocardial infarction.

**Table X.** Group 2 (patients without cardiogenic shock): multivariate analysis results and related score for the 30-day mortality prediction in primary percutaneous transluminal coronary angioplasty (533 patients).

| Independent predictor | Coefficient | Odds ratio | p |
|---|---|---|---|
| Time to treatment (hours) | | | < 0.0042 |
| ≤ 6 | 0 | 1 | |
| ≤ 9 | -0.4318 | 0.649 | |
| ≤ 12 | 1.441 | 4.23 | |
| > 24 | 1.727 | 5.62 | |
| Age < 76 years | 0 | 1 | < 0.006 |
| Age ≥ 76 years | 1.24 | 3.45 | |
| One- or two-vessel disease | 0 | 1 | < 0.0503 |
| Three-vessel disease | 0.8856 | 2.42 | |

Adding the single coefficient values to the constant (-3.801) one may calculate the logit of the expected risk of 30-day mortality. Example: time to treatment up to 9 hours = -0.4318, one- or two-vessel disease = 0, age ≥ 76 years = 1.24, constant = -3.801, sum (logit) = -2.9928. Expected 30-day mortality < 5%.

benefit of abciximab administration in terms of the 30-day urgent target vessel revascularization rate, but no effect on the in-hospital and 30-day mortality rates. On the other hand, in an unselected series comprising high-risk patients (10.5% of patients in cardiogenic shock) treated with primary PTCA and routine infarct-related artery stenting, Antoniucci et al.[10] reported that abciximab administration turned out to be an independent predictor of the 30-day mortality (plus cardiogenic shock and elderly), with a 73% relative reduction in mortality for the overall patient population. A further report from the same group showed that administration of the drug as an adjunct to infarct-related artery stenting was associated with a 57% relative reduction in the 1-month mortality in a consecutive series of patients with cardiogenic shock complicating an acute myocardial infarction[19]. Further support has recently been provided for the short- and long-term benefits of abciximab therapy in primary PTCA of STEMI complicated by severe heart failure[20,21].

There are several potential beneficial mechanisms of adjunctive abciximab therapy in primary PTCA[22,23] and we hypothesize that their role is crucial in patients with the worst conditions.

Interestingly, in our study abciximab was administered only in 37.7% of patients with shock in comparison to 56.8% of patients without shock ($p < 0.025$), due to the concern that the association of an intra-aortic balloon pump with the drug could have exposed the patients to major bleeding risk. However, this was not the case (no major vascular complications occurred) and, as a matter of fact, the use of abciximab was reduced in patients who would have benefited most from the drug.

**Study limitations.** This study is limited by its observational nature and by the fact that abciximab was given is a non-randomized fashion. Moreover, the analytical model does not take in account relevant clinical indices of risk assessment (such as, for example, the ejection fraction and previous myocardial infarction), which could have strongly influenced the patients' outcome. Another potential limitation could be the heterogeneity of the data collected which reflects the continuous evolution of the PTCA techniques of revascularization over the nearly 5 years of the study.

In spite of these limitations, the study is effectively representative of the "real world" because it involved all STEMI patients referred to our center, without any exclusion criteria such as age or clinical status. The selected parameters, although incomplete, are easy to collect, fairly comprehensive and allow a definite prognostic stratification of the single patient. Abciximab therapy was administered at the discretion of the operator, but its independent predictive role of death could be clearly validated by logistic multivariate analysis, even in the small sample size of patients with shock.

In conclusion, the short-term results of primary PTCA are highly predictable: besides coronary stenting (the role of which was not investigated in this study but has been largely previously demonstrated), other variables are strongly related to the 30-day mortality. These factors may be identified and weighted in order to estimate the risk profile of the single patient and may also be modified (shortening T-t-T, administering abciximab especially in high-risk patients) in order to optimize myocardial reperfusion.

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