

# Treatment of Acute Myocardial Infarction by Primary Angioplasty On-Site Compared With Treatment Following Interhospital Transfer: Short- and Long-Term Clinical Outcomes

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**Introduction and objectives.** Primary angioplasty is the treatment of first choice for patients with ST-segment elevation acute myocardial infarction. However, its use is limited as the majority of patients present at hospitals without a catheterization laboratory. The objective of this study was to determine short- and long-term outcomes of systematically implementing a primary angioplasty program at 2 hospitals, one of which did not have a catheterization laboratory.

**Methods.** This prospective observational study involved consecutive patients with acute myocardial infarction and an indication for reperfusion therapy who were admitted to the two participating hospitals (hospital 1 had a catheterization laboratory, while hospital 2 did not) between January 2000 and April 2001. Clinical follow-up was performed at 1, 6, and 12 months.

**Results.** The study included 222 patients: 158 in hospital 1 and 64 in hospital 2. The median (interquartile range) delays from door to angiography at hospital 1 and hospital 2 were 49.5 min (30.0-88.0 min) and 62.5 min (53.5-93.7 min), respectively ( $P=0.001$ ), and from symptoms to angiography, 162.5 min (105.0-247.5 min) and 187.5 min (131.2-288.7 min), respectively ( $P=0.04$ ). In-hospital and 1-year mortality rates were 12.2% and 15.3%, respectively, with no difference between the hospitals. The hospital of origin was not a determinant of either in-hospital mortality (odds ratio [OR]=1.42, 95% confidence interval [CI], 0.3-7.8) or 1-year mortality (HR, 2.04, 95% CI, 0.74-5.61).

**Conclusions.** Patients with ST-segment elevation acute myocardial infarction who require interhospital transfer for primary angioplasty have a similar clinical outcome to those who are admitted to a hospital at which the procedure is available, provided transfer is undertaken under optimal conditions (ie, with a suitable means of transport and a short transfer time).

**Key words:** Coronary angioplasty. Myocardial infarction. Prognosis. Reperfusion.

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Received October 16, 2006.

Accepted for publication April 11, 2007.

## Tratamiento del infarto agudo de miocardio con angioplastia primaria in situ frente a una transferencia interhospitalaria para su realización: resultados clínicos a corto y largo plazo

**Introducción y objetivos.** La angioplastia primaria es la estrategia de primera elección en el tratamiento de los pacientes con infarto con elevación del segmento ST. Sin embargo, su aplicación es reducida, ya que la mayoría de los pacientes acude a hospitales sin laboratorio de hemodinámica. Estudiamos los resultados clínicos a corto y largo plazo de un programa de aplicación sistemática de angioplastia primaria en 2 hospitales, uno de ellos sin laboratorio de hemodinámica.

**Métodos.** Estudio prospectivo, observacional, de pacientes con infarto e indicación de reperusión, ingresados de forma consecutiva en 2 hospitales entre enero de 2000 y abril de 2001 (hospital 1 con sala de hemodinámica y hospital 2 sin ésta). Se realizó seguimiento clínico al mes y a los 6 y 12 meses.

**Resultados.** Se incluyó a 222 pacientes, 158 en el hospital 1 y 64 en el hospital 2. Las medianas (percentiles 25-75) de retraso en minutos en el hospital 1 frente al hospital 2 fueron: tiempo «puerta-angiografía» 49,5 (30-88) frente a 62,5 (53,5-93,7),  $p = 0,001$ ; tiempo «síntomas-angiografía» 162,5 (105-247,5) frente a 187,5 (131,2-288,7),  $p = 0,04$ . La mortalidad hospitalaria y al año de seguimiento fue del 12,2 y el 15,3%, respectivamente, sin diferencias entre los hospitales. El hospital de procedencia no resultó un determinante de mortalidad hospitalaria (odds ratio = 1,42; intervalo de confianza [IC] del 95%, 0,3-7,8) ni al año de seguimiento (riesgo relativo = 2,04; IC del 95%, 0,74-5,61).

**Conclusiones.** Los pacientes con infarto agudo de miocardio con elevación del segmento ST que precisan traslado interhospitalario para recibir angioplastia primaria tienen una evolución clínica similar a la de los pacientes que ingresan en hospitales con disponibilidad para esa técnica, si ésta se aplica en condiciones óptimas (medio de transporte adecuado y tiempo corto de traslado).

**Palabras clave:** Angioplastia coronaria. Infarto de miocardio. Pronóstico. Reperusión.

**ABBREVIATIONS**

ICU: intensive care unit  
 STEAMI: ST-segment elevation acute myocardial infarction

**INTRODUCTION**

Primary angioplasty has shown better clinical outcomes than fibrinolysis in patients with ST-segment elevation acute myocardial infarction (STEAMI) when specific conditions are met.<sup>1,2</sup> Numerous clinical trials show its benefits, both when performed in the hospital where the patient presents with STEAMI<sup>1</sup> and when undertaken after transfer to another center.<sup>3-7</sup> Despite these results and current clinical practice guideline recommendations,<sup>8</sup> fibrinolysis continues to be the most widely-used reperfusion strategy. In Spain, with >40 000 infarctions per year,<sup>9</sup> only 5101 primary angioplasties were performed in 2005.<sup>10</sup>

The most important limitation of primary angioplasty is the need for an adequate infrastructure. Few Spanish hospitals have a catheterization laboratory and 43% of those that do lack a 24-hour emergency team.<sup>10</sup> Clinical trials have demonstrated the benefits of primary angioplasty following interhospital transfer but results in clinical practice differ from those of trials. The unavoidable delay of transfer and concomitant risks make it a controversial strategy when compared to on-site, out-of-hospital fibrinolysis or pharmacologic facilitation and deferred angioplasty.<sup>1-14</sup> Some authors suggest the clinical benefit of primary angioplasty over fibrinolysis is only a function of the delay.<sup>15</sup>

Conducting adequately structured and controlled programs with a follow-up of delays and rationalization of resources could reproduce, in clinical practice, the clinical trial results for primary angioplasty and extend its benefits to a greater number of patients than those currently receiving them.<sup>16,17</sup> In Spain, data on the results of primary angioplasty, whether performed at the admitting hospital or following interhospital transfer, are currently limited.<sup>18</sup>

In the present study, we describe and compare the short- and long-term results of a systematic, primary angioplasty program in patients with STEAMI in 2 hospitals, one with a catheterization laboratory and the other needing interhospital transfer for patients to undergo catheterization.

**METHODS****Design**

A prospective, observational study of 2 consecutive cohorts of patients admitted to 2 hospitals, one with and one without a catheterization laboratory.

**Patients**

We enrolled patients from 2 hospitals (hospital 1, with a catheterization laboratory, 881 beds; and hospital 2, 10 km from hospital 1, without a catheterization laboratory, 444 beds), consecutively indicated for primary angioplasty from January 1, 2000 thru April 30, 2001.

Since 2000, primary angioplasty has been the treatment of choice for STEAMI in these 2 centers. In both hospitals, primary angioplasty is considered to be indicated when 2 criteria are simultaneously fulfilled: *a*) symptoms compatible with myocardial ischemia lasting >30 min despite administration of antianginal treatment, and *b*) electrocardiographic ST-segment elevation  $\geq 0.1$  mV in at least 2 contiguous leads, lasting >30 min (or presence of new, complete left bundle-branch block), within 12 hours after onset of symptoms or later if symptoms of myocardial ischemia persist.

During the period included in this study, exceptionally, primary angioplasty was not performed in some of the following situations: patient refusal to undergo catheterization; prior knowledge of highly unfavorable coronary anatomy; absence of percutaneous arterial access; involvement of the interventional cardiology team in another procedure that could not be postponed; explicit decision of the physician responsible; lack of an available mobile intensive care unit (ICU) to transfer the patient to hospital 2.

**Inclusion and Exclusion Criteria in This Study***Inclusion Criteria*

We followed the principle of intention to treat and excluded all patients for whom the interventional cardiologist responsible for performing primary angioplasty had been contacted.

*Criteria of Exclusion*

1. Prior administration of fibrinolytic agents to treat current infarction.
2. Patients previously included in the study.
3. Patients indicated for primary angioplasty proceeding from a hospital other than the 2 previously-mentioned centers.

**Strategy of Applying for Urgent Catheterization**

In hospital 1, patients with suspected STEAMI were immediately attended by the duty cardiologist. After clinical examination and initial electrocardiogram, the duty cardiologist telephoned the interventional cardiologists, present in the catheterization laboratory during working hours (08.00-15.00), or the emergency

team on call outside of working hours. The team had 6 interventional cardiologists available for this procedure.

In hospital 2, the duty intensive care specialist indicating the procedure established contact with the duty cardiologist of hospital 1 and the latter contacted the catheterization team. When the transfer took place outside of working hours, patient transfer to the catheterization laboratory in a mobile ICU was simultaneous with the duty team's journey to the hospital.

To avoid delays, the program recommended patient transfer from the place of diagnosis (generally, the emergency room entrance) to the catheterization laboratory.

The procedural technique and later treatment remained at the discretion of the interventional cardiologist responsible in each case, in line with clinical practice guidelines current at the time.

## Variables

At admission, clinical variables were taken from the clinical record and the catheterization laboratory register by an assistant cardiologist and a trainee cardiologist. We conducted clinical follow-up of patients during hospitalization and later at 1, 6, and 12 months post-AMI, through medical visits or telephone contact. We defined 3 time intervals:

1. "Door-to-angiography" time: from the arrival of the patient at the first hospital to the start of the angiography.
2. "Door-to-artery open" time: from the arrival of the patient at the hospital to the opening of the artery.
3. "Onset of symptoms-to-angiography" time: from the onset of symptoms to the start of the angiography.

Cardiogenic shock was defined as maintained arterial hypotension (invasive systolic arterial pressure <90 mmHg during at least 30 min despite administration of fluids), accompanied by signs of tissue hypoperfusion secondary to cardiac dysfunction. We considered the procedure successful when it ended with residual stenosis  $\leq 20\%$  and TIMI (thrombolysis in myocardial infarction) flow 3 in the artery causing the infarction, without more severe complications in the catheterization laboratory (death, worsening of initial Killip class, or stroke).

## Statistical Analysis

Qualitative variables are expressed as number of cases and percentage and compared using  $\chi^2$  or the Fisher exact test when criteria for applying the former were not met.

Quantitative variables are expressed as mean (SD) or median and 25% and 75% percentiles if distributions were asymmetric. Comparison of these variables was by Student *t* test for independent means or the nonparametric

Mann-Whitney *U* test for variables with non-normal distribution.

Analysis of factors determining in-hospital mortality present at admission or after performing primary angioplasty was by logistic regression. Follow-up was with Kaplan-Meier survival analysis, and survival curves were compared with the log rank test. We used the Cox proportional risk logistic regression method to determine the factors present at admission or after performing primary angioplasty that associated independently with long-term mortality. In the 2 multivariable analyses, the selection of variables in the final model was conducted after exploring the different models obtained with the forward stepwise method of sequential inclusion and the backward stepwise exclusion of those variables that had shown a different distribution between the hospitals or that, in the literature, associate with a different prognosis after primary angioplasty. In both final models we confirmed their assumed applicability (residual analysis and fulfillment of criteria of proportionality, and log-linear, respectively). In all cases we considered  $P < .05$  significant. Statistical analysis was with SPSS® 12.02 and STATA® 8.2.

## RESULTS

From January 1, 2000 thru April 30, 2001, in hospital 1 or hospital 2, 245 patients who were diagnosed with STEAMI met reperfusion criteria. Hospital 1 admitted 172 patients, indicating primary angioplasty in 158 (92% of patients admitted had STEAMI and met criteria to undergo reperfusion treatment). The remaining 14 patients were not indicated for primary angioplasty because: *a*) the interventional cardiology team were involved with another infarction patient (2 patients); *b*) the patient refused treatment (1); *c*) highly unfavorable coronary anatomy was known (2); *d*) the physician responsible decided against the procedure (2); and *e*) the patient presented a very poor baseline situation prior to infarction (7). Six of these 14 patients received fibrinolysis (3.5%).

Hospital 2 admitted 73 patients with STEAMI who met reperfusion criteria. Primary angioplasty was indicated in 64 (88%). Non-indication for primary angioplasty in the remaining 9 patients was because: *a*) a mobile ICU was not available for the transfer (2 patients); *b*) the interventional cardiology team were involved with another infarction patient with (1); and *c*) the physician responsible decided against the procedure (6). Four of these 9 patients received fibrinolysis.

The final sample consisted of 222 patients which represents 90.6% of admissions with STEAMI and indication for reperfusion treatment in one or the other hospital.

The baseline characteristics of patients appear in Table 1. Patients from hospital 2 showed a more favorable cardiovascular profile, with less frequency of dyslipidemia,

prior AMI and prior coronary revascularization. They tended to be younger, with lower incidence of diabetes and other known, modifiable cardiovascular risk factors.

We found no differences between hospitals in characteristics of presentation of the infarction (Table 2).

In 79.9% of patients, onset of symptoms-to-angiography time was <6 h (Figure 1). We only found significant differences between the hospitals in the intervals that included interhospital transfer time (Table 3).

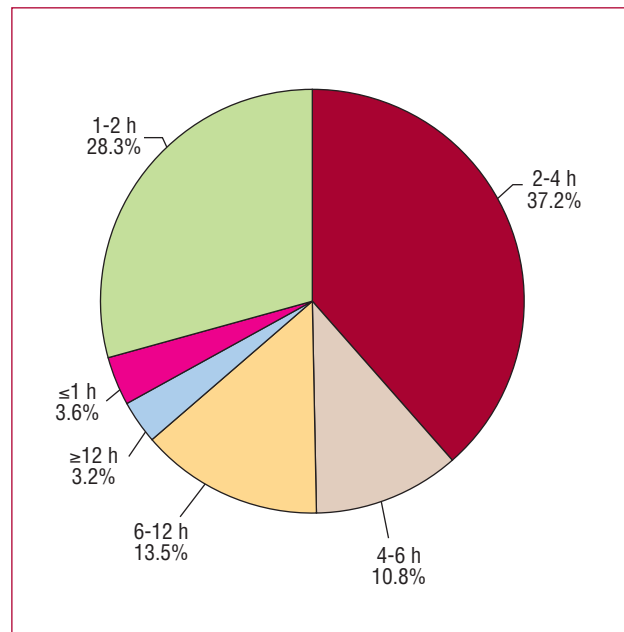
Two patients at hospital 2 died prior to starting the diagnostic procedure leaving 220 who underwent diagnostic coronary angiography. Of these, 192 finally underwent coronary intervention. The reasons why primary angioplasty was not performed in the remaining 28 patients appear in Figure 2. Table 4 summarizes baseline angiographic characteristics and interventional procedures.

### In-Hospital Evolution

Table 5 shows in-hospital results. Estimated incidence of more severe complications was 24.3%, fundamentally due to the presence of cardiogenic shock. Ventricular function at discharge, quantified through echocardiography in the first days after the acute episode, was evaluated in 192 patients and proved to be >40% in >75% of patients. In the remaining 14.1% ventricular function is unknown, fundamentally due to early death before echocardiography. Overall in-hospital mortality was 12.2%; 5.4% of patients died in the catheterization laboratory and the remaining 6.8% in-hospital. In 85.2% of deaths, the cause was cardiac, principally cardiogenic

shock (70.4%). In the 14.8% of non-cardiac deaths, the cause was multiorgan failure once the shock situation had been overcome, digestive hemorrhage and ischemic stroke (2 patients).

In the final logistic regression model, factors independently associated with greater in-hospital mortality were advanced age, female gender, presence of cardiogenic shock at admission, and procedure failure



**Figure 1.** Distribution of patients as a function of onset of symptoms-to-angiography time.

**TABLE 1. Demographic and Cardiovascular Antecedents\***

Variable	Overall (n=222)	Hospital of Origin		P
		Hospital 1, n=158 (71.2%)	Hospital 2, n=64 (28.8%)	
Age, years	67 (56.5-73.5)	67.5 (57.5-73.5)	64.5 (54.0-75.0)	.579
Age ≥75 years	51 (23)	35 (22.1)	16 (25)	.583
Gender, women	58 (21.6)	43 (27.2)	15 (23.4)	.562
Risk factors				
HBP	109 (49.1)	80 (50.6)	29 (45.3)	.473
DM	67 (30.2)	53 (33.5)	14 (21.9)	.086
Dyslipidemia	82 (36.9)	65 (41.1)	17 (26.6)	.042
Smoking	120 (54.1)	89 (56.3)	31 (48.4)	.285
Cardiovascular record				
Previous AMI	52 (23.4)	43 (27.2)	9 (14.1)	.036
Coronary revascularization	24 (10.8)	23 (14.6)	1 (1.6)	.005
Previous PTCA	20 (9)	19 (12)	1 (1.6)	.014
CVS	7 (3.2)	7 (4.4)	0	.087
Recent angina	87 (40.7)	68 (43)	19 (31.7)	.095

\*PTCA indicates percutaneous transluminal coronary angioplasty; CVS, cardiovascular surgery; DM, diabetes mellitus; HBP, high blood pressure; AMI, acute myocardial infarction.

Categorical variables are expressed in absolute values (percentage) and quantitative variables as median (percentiles 25-75).

**TABLE 2. Characteristics of Presentation of Acute Myocardial Infarction\***

Variable	Overall (n=222)	Hospital of Origin		P
		Hospital 1 (n=158)	Hospital 2 (n=64)	
Working hours	54 (24.3)	37 (23.4)	17 (26.6)	.621
Killip class				
I	162 (73)	113 (71.5)	49 (76.6)	.443
II	23 (10.4)	18 (11.4)	5 (7.8)	.428
III	7 (3.2)	5 (3.2)	2 (3.1)	1
IV	30 (13.5)	22 (13.9)	8 (12.5)	.779
ECG location				
Anterior	105 (47.3)	74 (46.8)	31 (48.4)	.829
Inferior	95 (42.8)	68 (43)	27 (42.2)	.908
Lateral	10 (4.5)	8 (5.1)	2 (3.1)	.728
Indeterminate	12 (5.4)	8 (5.1)	4 (6.3)	.747
LBBB	15 (6.8)	11 (7)	4 (6.3)	1
Ventricular arrhythmia	9 (4.1)	5 (3.2)	4 (6.3)	.284
RV Infarction	25 (11.3)	16 (10.1)	9 (14.1)	.401
CI fibrinolysis	20 (9)	16 (10.1)	4 (6.3)	.361

\*LBBB indicates left bundle-branch block; CI, contraindication for fibrinolysis; ECG: electrocardiogram; RV, right ventricle. Categorical variables are expressed in absolute values (percentage).

**TABLE 3. Times\***

Time, min	Hospital of Origin		P
	Hospital 1 (n=158)	Hospital 2 (n=64)	
Symptoms-to-hospital	90.0 (45.0-150.0)	119.0 (51.0-180.0)	.284
Hospital-to-angiography	49.5 (30.0-88.0)	62.5 (53.5-93.8)	.001
Hospital-to-artery open	70.0 (46.8-105.3)	85.0 (67.5-110.0)	.019
Symptoms-to-angiography	162.5 (105.0-247.5)	187.5 (131.3-288.8)	.040

\*Quantitative variables are expressed as median (percentiles 25-75).

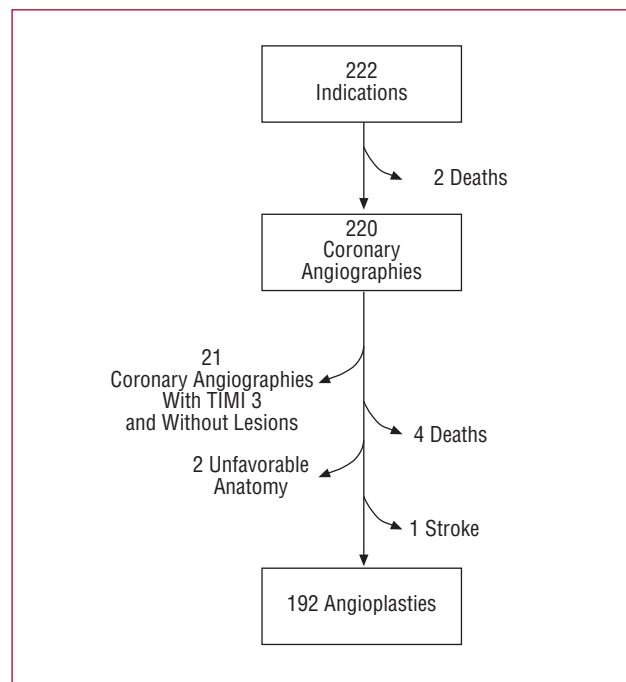
(Table 6). The hospital of origin did not associate significantly with greater mortality (odds ratio [OR], 1.42; 95% confidence interval [CI], 0.3-7.8).

### Follow-Up Phase

A total of 195 patients survived the in-hospital phase. We obtained a complete follow-up at 1 month and 1 year of 97.4% and 96.4%, respectively, with a mean follow-up time of 362.2 days (95% CI, 356.8-369.5 days). During follow-up, 7 patients died (5 of cardiac cause), and accumulated mortality was 3.1% (3.7% of patients discharged alive). Total mortality at 1-year follow-up, including the in-hospital phase, was 15.3%.

We found no significant differences in mortality or in frequency of other adverse cardiovascular events during follow-up (Table 7). The log rank test was nonsignificant when comparing the 2 hospitals for mortality, both on including ( $P=.49$ ) and excluding ( $P=.39$ ) the hospitalization phase (Figure 3).

In the Cox model study, of the variables present at admission or following performance of primary angioplasty and influencing long-term survival, only advanced age, presence of diabetes, shock at admission



**Figure 2.** Patients undergoing coronary angiography and primary angioplasty. Reasons for not performing the procedure.

**TABLE 4. Angiographic Characteristics\***

Variable	Overall (n=220)	Hospital of Origin		P
		Hospital 1 (n=158)	Hospital 2 (n=62)	
Artery causing the infarction				
LCA	2 (0.9)	1 (0.6)	1 (1.6)	.485
LAD	99 (45)	72 (45.6)	27 (43.5)	.786
RCA	73 (33.2)	55 (34.8)	18 (29)	.413
Cx	20 (9.1)	14 (8.9)	6 (9.7)	.850
Graft	2 (0.9)	2 (1.3)	0 (0)	1
Unknown	4 (1.4)	4 (2.5)	0 (0)	.579
None	20 (9.1)	10 (6.3)	10 (16.1)	.023
TIMI flow in ACI				
TIMI 0	146 (74.5)	107 (74.3)	39 (75)	.980
TIMI 1	28 (14.3)	18 (12.5)	10 (19.2)	.242
TIMI 2	18 (9.2)	17 (11.8)	1 (1.9)	.046
TIMI 3	4 (2)	2 (1.4)	2 (3.8)	.174
Multivessel disease	82 (37.3)	68 (43)	14 (22.6)	.005
IABP	21 (9.5)	16 (10.1)	5 (8.1)	.693
Treatment of ACI†				
Use of stent	178 (94.2)	131 (94.2)	47 (94)	1
Number of stents/lesion	1.3 (0.8)	1.3 (0.8)	1.2 (0.6)	.581
Thrombectomy devices	17 (9)	14 (10.1)	3 (6)	.566
GP IIb/IIIa antagonists	136 (72)	96 (69.1)	40 (80)	.140
Final TIMI flow				
TIMI 0	6 (3.2)	3 (2.2)	3 (6)	.190
TIMI 1	4 (2.1)	4 (2.9)	0 (0)	.575
TIMI 2	6 (3.2)	5 (3.6)	1 (2)	1
TIMI 3	173 (91.5)	127 (91.4)	46 (92)	1
Successful procedure	171 (90.5)	125 (89.9)	46 (92)	.785
Transfer hospital of origin	182 (94.8)	142 (100)	40 (80)	

\*ACI indicates artery causing the infarction; IABP, intraaortic balloon pump; RCA, right coronary artery; Cx, circumflex artery; LAD, left anterior descending coronary artery; GP, glycoprotein; LCA, left coronary artery; TIMI, thrombolysis in myocardial infarction.

Categorical variables are expressed in absolute values (percentage). Continuous variables are expressed as mean (SD).

†Patients who underwent primary angioplasty and the artery causing the infarction was known (n=189).

and procedure failure associated independently and significantly with greater mortality at 1-year follow-up (Table 8). The hospital of origin did not associate significantly with greater mortality in 1-year follow-up (relative risk [RR], 2.04; 95% CI, 0.74-5.61).

## DISCUSSION

The present study indicates results of systematic primary angioplasty in STEAMI in a hospital without a catheterization laboratory can be similar to those in a hospital with a laboratory despite the need to transfer patients, if the transfer is conducted so as to minimize delays and guarantee safety.

Five clinical trials<sup>3-7</sup> and 1 metaanalysis<sup>19</sup> have shown that transfer of patients with STEAMI from hospitals without a catheterization laboratory for them to undergo primary angioplasty is feasible, safe, and offers greater clinical benefits than on-site fibrinolysis. Despite these results, primary angioplasty remains an infrequently used treatment for STEAMI, probably because it is difficult to reproduce these results in clinical practice. The

motivation to participate in a clinical trial, geographic, and economic characteristics of countries, infrastructure, stimulation, and resources for the transfer and treatment of patients favored results in these studies—results that may be considered ideal. Despite distances of >100 km in the 2 principal studies (PRAGUE II<sup>5</sup> and DANAMI 2<sup>7</sup>), mean delays were optimal and complications during transfers, practically non-existent. In contrast, studies evaluating results of real-world primary angioplasty in centers without a catheterization laboratory have reported very different results and conclude that the recommendation to guarantee the potential benefits of primary angioplasty (arrival at the first hospital to start of revascularization time <90 min)<sup>8</sup> was seldom achieved.<sup>20</sup>

In our series, with non-selected patients in optimal condition for interhospital transfer, the median delay times observed in patients from hospital 2 were <65 min for admission-to-angiography, 85 min for admission-to-artery open, and <190 min from onset of symptoms-to-angiography. These are all lower than the times reported in clinical trials<sup>3-7</sup> and far below those in registers.<sup>20-22</sup>

**TABLE 5. In-Hospital Evolution. Complications\***

Variable	Overall (n=222)	Hospital of Origin		
		Hospital 1 (n=158)	Hospital 2 (n=64)	P
Cardiac complications				
Killip class IV	35 (15.8)	25 (15.8)	10 (15.6)	1
Mechanical complication	2 (0.9)	1 (0.6)	1 (1.6)	.494
Ventricular arrhythmia	11 (5)	7 (4.4)	4 (6.3)	.733
CAVB	14 (6.3)	12 (7.6)	2 (3.1)	.360
Re-AMI	4 (1.8)	4 (2.5)	0	.580
RVT	3 (1.4)	3 (1.9)	0	.560
Death	27 (12.2)	20 (12.7)	7 (10.9)	.823
In the catheterization laboratory	12 (5.4)	8 (5.1)	4 (6.3)	.747
Stay	15 (6.8)	12 (7.6)	3 (4.7)	.563
Cause of death				
Cardiac	23 (85.2)	17 (85)	6 (85.7)	1
Non-cardiac complications				
Vascular	10 (4.5)	9 (5.7)	1 (1.6)	.288
Major hemorrhage	6 (2.7)	5 (3.2)	1 (1.6)	.676
Minor hemorrhage	6 (2.7)	3 (1.9)	3 (4.7)	.358
Kidney failure	9 (4.1)	8 (5.1)	1 (1.6)	.218
Stroke	4 (1.8)	3 (1.9)	1 (1.6)	1
CK-MB peak†	181 (89.8-333)	189 (89.3-332.5)	170.5 (88.8-334.5)	.906
LVEF at discharge†				
<30%	7 (3.6)	5 (3.7)	2 (3.5)	1
30%-40%	37 (19.3)	28 (20.7)	9 (15.8)	.549
40%-55%	70 (36.5)	46 (34.1)	24 (42)	.326
≥55%	78 (40.6)	56 (41.5)	22 (38.6)	.750
Days stay				
ICU	2 (2-3)	3 (2-3)	2 (1-3)	.008
Total	7 (5-10)	8 (5.3-11)	6 (4-9)	.029

\*CAVB indicates complete atrioventricular block; CK-MB, MB isoenzyme of creatin kinase; FEVI, left ventricular ejection fraction; AMI, acute myocardial infarction; RVT, new urgent revascularization of the treated vessel; ICU, intensive care unit.

Categorical variables are expressed in absolute values (percentage). Quantitative variables are expressed as median (percentiles 25-75).

†Only patients discharged to home.

When comparing the 2 hospitals in our study, we found differences in door-to-angiography, door-to-artery open, and symptoms-to-angiography times, of only 13, 15, and 25 min, respectively. Such short delays, together with the few events associated with transport probably justify the absence of differences in the success of the procedure, infarction size, or the rate of clinical events.

Two factors may have conditioned these reduced delays: a) the design of an infrastructure to favor interhospital transfer, including a mobile ICU almost always immediately available; an experienced interventional cardiology team, on call 24 hours a day, mobilized immediately on establishing the indication in hospital 2; and a system of direct transfer of patients to the

**TABLE 6. Logistic Regression Model. Factors Determining Intrahospital Mortality\***

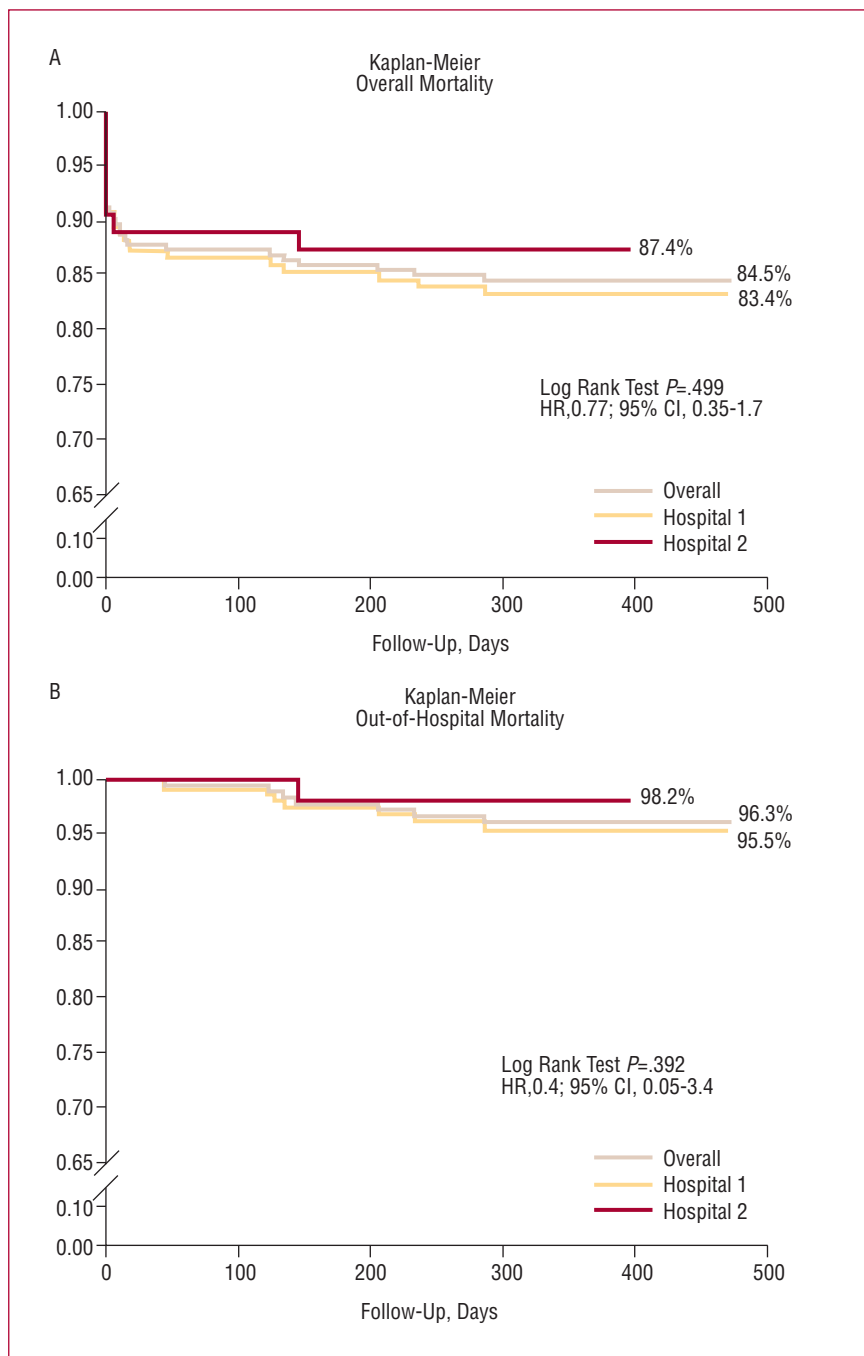
Variable	OR	P	95% CI
Age, by decades	3.18	.006	1.4-7.19
Gender, women	5.23	.022	1.26-5.58
Shock at admission	46.14	<.001	8.4-253.51
Procedure failure	17.22	<.001	4.04-73.33
Multivessel disease	1.46	.581	0.38-5.58
Hospital 1	1.42	.684	0.26-7.78
Log, symptoms-to-angiography time	1.68	.290	0.64-4.46

\*CI indicates confidence interval; Log, natural log; OR, odds ratio.

**TABLE 7. Mortality and Other Adverse Outcomes at 1-Year Follow-Up\***

	Overall	Hospital of Origin		
		Hospital 1	Hospital 2	P
Death	34 (15.3)	26 (16.5)	8 (12.5)	.459
Reinfarction	8 (3.6)	7 (4.4)	1 (1.6)	.444
RVT	4 (1.8)	4 (2.5)	0 (0)	.327
Stroke	4 (1.8)	3 (2.9)	1 (1.6)	1

\*RVT indicates urgent revascularization of the vessel treated.



**Figure 3.** Follow-up survival curves (days) for total mortality, including (upper) and excluding (lower) the in-hospital phase. HR indicates hazard ratio; CI, confidence interval.

**TABLE 8. Cox Analysis. Factors Determining Long-Term Mortality\***

Variable	RR	P	95% CI
Age, by decades	2.3	<.001	1.53-3.46
Gender, women	2.04	.053	0.99-4.21
Diabetes	2.1	.049	1.01-4.39
Shock at admission	9.37	<.001	3.87-22.68
Procedure failure	7.89	<.001	3.4-18.3
Multivessel disease	1.13	.761	0.51-2.52
Hospital 1	2.04	.167	0.74-5.61

\*CI indicates confidence interval; RR, relative risk.

catheterization laboratory from the service where the diagnosis was made avoiding the delay produced by the intermediate stages in the diagnosis and decision-making chain<sup>23</sup>; and *b*) the distance of just 10 km separating hospital 2 from the reference hospital making interhospital transfer time similar to that needed for the interventional cardiology team to arrive at the hospital of reference, meaning delays are practically identical in both hospitals.

The risk profile of patients included in this study is typical of STEAMI in daily clinical practice. In DANAMI 2,<sup>7</sup> patients with diabetes represented 7.5% versus 22% in



our series; 8.1% had a history of myocardial infarction versus 14%; and, especially, patients with cardiogenic shock represented 0% versus 12.5%. The selection bias of clinical trials may explain how, despite shorter delays and greater availability of technical advances in the treatment of STEAMI, in-hospital mortality in our series is twice that of these studies (6%-8% vs 12.2%) and highlights the need to know the results of applying scientific tests to the specific context in which clinical activity is undertaken. Despite the fact that 12.5% of patients transferred were in cardiogenic shock, interhospital transport was safe, with only 1 case of severe complications (1.5%), consisting of primary ventricular fibrillation, electrically cardioverted efficiently. On concluding the procedure, 80% of patients from hospital 2 who underwent a coronary intervention returned to the ICU of their hospital without incidents during the transfer.

After adjustment for the remaining variables, hospital 2 did not associate significantly with either in-hospital or mid-term mortality. In hospital 1, we even found a higher (but non-significant) rate of mortality, both absolute and of risk indicators that, given the sample size, may be due to chance or to the fact we are dealing with a reference hospital where the population attending may present a worse clinical profile than that attending hospital 2.

In Spain, relatively few hospitals have a catheterization laboratory and even the centers that do are not equipped with the resources needed to offer the procedure to patients with STEAMI on a 24-hour basis.<sup>10</sup> Studies such as ours encourage both transfer from centers without central catheterization laboratories and the development of plans for various centers with this facility but unable to offer it continuously, to implement a transfer system to rationalize efforts and resources, with shift-work systems in laboratories or other possible approaches, in order to offer each patient the best treatment possible.

### Limitations

The inclusion of a much greater number of patients may have produced significant differences in some of the variables analyzed, although the minimal differences found minimize the clinical importance of these possible differences. The tendency towards greater mortality found in hospital 1 indicates a larger sample size would be unlikely to invert the direction of the prognostic association, thus maintaining the idea that primary angioplasty in centers without catheterization laboratories is safe when certain conditions can be met. The conclusions of the present study are only applicable to centers close to a catheterization laboratory with strictly organized programs and sufficient resources similar to the ideal situation of the study. These data do not enable us to generalize that results obtainable in daily clinical practice in more distant centers might be superimposed

on those of hospitals with a catheterization laboratory. However, the conclusions could be extended to many Spanish urban hospitals located in areas near centers able to perform primary angioplasty and which could do so if they made the necessary structural modifications.

### CONCLUSIONS

In order to perform primary angioplasty, interhospital transfer from a center without a catheterization laboratory, to a nearby center, with adequate transport available and within a highly structured program, is feasible and meets the time requirements for the intervention established by the scientific societies. Under these conditions, in-hospital mortality and 1-year follow-up of patients undergoing transfer presented no differences by comparison with patients admitted to a hospital with a catheterization laboratory. The transfer of patients from a nearby hospital to the catheterization laboratory did not associate with greater mortality in any phase of follow-up.

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