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ORIGINAL INVESTIGATIONS

Temporal Trends in Mechanical Complications of Acute Myocardial Infarction in the Elderly

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ABSTRACT

BACKGROUND Reperfusion therapy led to an important decline in mortality after ST-segment elevation myocardial infarction (STEMI). Because the rate of cardiogenic shock has not changed dramatically, the authors speculated that a reduction in the incidence or fatality rate of mechanical complications (MCs), the second cause of death in these patients, could explain this decrease.

OBJECTIVES This study sought to assess time trends in the incidence, management, and fatality rates of MC, and its influence on short-term mortality in old patients with STEMI.

METHODS Trends in the incidence and outcomes of MC between 1988 and 2008 were analyzed by Mantel-Haenszel linear association test in 1,393 consecutive patients ≥75 years of age with first STEMI.

RESULTS Overall in-hospital mortality decreased from 34.3% to 13.4% (relative risk reduction, 61%; $p < 0.001$). Although the absolute mortality due to MC decreased from 9.6% to 3.3% ($p < 0.001$), the proportion of deaths due to MC among all deaths did not change (28.1% to 24.5%; $p = 0.53$). The incidence of MC decreased from 11.1% to 4.3% (relative risk reduction 61%) with no change in their hospital fatality rate over time (from 87.1% to 82.4%; $p = 0.66$). The proportion of patients undergoing surgical repair decreased from 45.2% to 17.6% ($p = 0.04$), with no differences in post-operative survival (from 28.6% to 33.3%; $p = 0.74$).

CONCLUSIONS Although the incidence of MC has decreased substantially since the initiation of reperfusion therapy in elderly STEMI patients, this reduction was proportional to other causes of death and was not accompanied by an improvement in fatality rates, with or without surgery. MCs are less frequent but remain catastrophic complications of STEMI in these patients. (J Am Coll Cardiol 2018;72:959–66) © 2018 by the American College of Cardiology Foundation.

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ABBREVIATIONS AND ACRONYMS

AMI = acute myocardial infarction

CVD = cardiovascular disease

FWR = free-wall rupture

MC = mechanical complication

PMR = papillary muscle rupture

PPCI = primary percutaneous coronary intervention

STEMI = ST-segment elevation myocardial infarction

VSR = ventricular septal rupture

Short-term fatality rates after acute myocardial infarction (AMI) have decreased importantly in the last decades (1-3), particularly in the oldest patients, who constitute the majority of early AMI deaths (4,5), particularly those 75 years of age or older, who account for 25% of all AMI deaths (6). This improvement has been mostly driven by the increase in the use of reperfusion therapy, particularly primary percutaneous coronary intervention (PPCI) (7). The main mechanism for early death after AMI in elderly patients is cardiogenic shock, causing roughly one-half of initial deaths, followed by mechanical complications (MCs), accounting for approximately one-third of early deaths (8). Given that the incidence and fatality rate of cardiogenic shock has not varied significantly in the last decades (9-11), we speculate that either a decrease in the incidence or in the fatality rate of MCs might explain an important part of the improvement in short-term prognosis in older patients with AMI, particularly in those with ST-segment elevation myocardial infarction (STEMI). We, therefore, designed this study to assess the time trends in the incidence, management, and fatality rates of MCs, and their influence on short-term mortality in older patients with STEMI.

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METHODS

PATIENTS AND DATA ABSTRACTION. The population consisted of all patients ≥75 years of age admitted to the Coronary Care Unit of Hospital General Universitario Gregorio Marañón in Madrid, Spain, with a definitive diagnosis of first STEMI between October 1, 1988, and December 31, 2008. We abstracted variables related to baseline characteristics, infarction features, diagnostic procedures, treatment, and hospital course as previously described (7). Data were obtained directly from clinical records.

DEFINITIONS. MC was defined as any spontaneous rupture of the myocardium following AMI. This comprises 3 types, according to the area where the myocardial rupture happens: free-wall rupture (FWR), ventricular septal rupture (VSR), and papillary muscle rupture (PMR). Confirmed FWR was defined as the occurrence of electromechanical dissociation or severe and sudden hemodynamic compromise associated with at least 1 of the following: 1) pericardial effusion (>1 cm) with intrapericardial echoes and criteria of cardiac tamponade by 2-dimensional echocardiography; 2) hemopericardium by pericardiocentesis; or 3) anatomic confirmation (surgical or post-mortem). Suspected FWR included cases of death due to electromechanical dissociation after a course free of signs of pump failure but in whom none of the confirmation tests was available. VSR was diagnosed by Doppler echocardiography, step-up in oxymetric analysis >5% from right atrium to right ventricle, ventriculography, surgical closure of the ruptured site, or necropsy. PMR was diagnosed by transthoracic or transesophageal Doppler echocardiography, or by anatomic confirmation (surgery or necropsy). The causes of early death after AMI were classified as: shock or pump failure, MCs (any kind of cardiac rupture or electromechanical dissociation without prior evidence of left ventricular systolic dysfunction or heart failure), and other causes (7). Admission delay was defined as the time from symptoms onset to emergency room arrival.

STATISTICAL ANALYSIS. Continuous variables were assessed for normal distribution using the 1-sample Kolmogorov-Smirnov test and were expressed as mean ± SD or, if they do not fulfill this condition, as median and interquartile range. Categorical variables were expressed as frequencies and percentages. The prevalence of suspected FWR was calculated, but not considered for the rest of analysis.

For time-trend analyses, patients were divided into 4 consecutive 5-year periods according to year of admission: 1988 to 1993, 1994 to 1998, 1999 to 2003, and 2004 to 2008. Differences were assessed with the Mantel-Haenszel chi-square test of linear association for categorical variables. Analysis of variance and Kruskal-Wallis tests were used to compare means and medians. A logistic regression analysis for mortality was performed to assess the time trend in risk-adjusted mortality including age, risk factors, prior cardiovascular disease (CVD), delay to admission, and time period as covariates. A 2-tailed probability value of <0.05 was considered statistically significant for all these tests. Statistical analyses were performed with SPSS software version 21 (IBM, Armonk, New York).

RESULTS

A total of 1,393 patients were enrolled. They were split into four 5-year time period groups, which consisted of 280 (20.1%), 363 (26.0%), 356 (25.5%), and 394 (28.3%) patients, respectively. Baseline characteristics, infarction features, reperfusion therapy, mortality rates, and their temporal trends are shown in Table 1. The mean age of the patients was 80.7 ± 4.7 years, and 51% were women. The majority (84%) presented with at least 1 cardiovascular risk factor, and 33.9% had had prior CVD. Most patients (64.7%)

TABLE 1 Time Trends in Baseline Characteristics, Infarction Features, Reperfusion Therapy, and Mortality

	Total (N = 1,393, 100%)	1988–1993 (n = 280, 20.1%)	1994–1998 (n = 363, 26.0%)	1999–2003 (n = 356, 25.5%)	2004–2008 (n = 394, 28.3%)	p Value for Trend
Age, yrs	80.7 ± 4.7	79.9 ± 4.3	80.9 ± 4.8	80.7 ± 4.9	80.9 ± 4.6	**0.023**
Women	710 (51.0)	148 (52.9)	189 (52.1)	172 (48.3)	201 (51.0)	0.483
Risk factors	1169 (84)	217 (77.8)	294 (81.0)	311 (87.6)	347 (88.1)	**<0.001**
Hypertension	827 (59.6)	133 (47.8)	192 (53.0)	223 (62.8)	279 (71.0)	**<0.001**
Hyperlipidemia	391 (28.1)	60 (21.5)	91 (25.1)	109 (30.7)	131 (33.3)	**<0.001**
Diabetes mellitus	438 (31.5)	92 (33.0)	113 (31.2)	118 (33.2)	115 (29.3)	0.405
Smoking	296 (21.3)	60 (21.5)	63 (17.4)	92 (25.9)	81 (20.6)	0.533
Prior CVD	470 (33.9)	111 (39.9)	168 (46.3)	98 (27.7)	93 (23.7)	**<0.001**
Angina	243 (17.5)	65 (23.3)	96 (26.4)	50 (14.1)	32 (8.1)	**<0.001**
Heart failure	60 (4.3)	16 (5.7)	22 (6.1)	9 (2.5)	13 (3.3)	**0.028**
Cerebrovascular disease	138 (9.9)	18 (6.5)	52 (14.3)	30 (8.5)	38 (9.6)	0.852
PAD	148 (10.6)	33 (11.8)	52 (14.3)	25 (7.0)	38 (9.6)	0.058
Infarct features						
Admission delay, h	3 (1.5–8)	4 (2–12)	4 (2–8)	3 (1.5–7)	2 (0.5–5.5)	**<0.001**
Killip class						**<0.001**
I	859 (70.3)	183 (65.8)	236 (65)	254 (73.2)	186 (79.5)	
II–III	280 (24.9)	74 (26.6)	83 (22.8)	77 (22.2)	46 (19.6)	
IV	83 (6.8)	21 (7.6)	44 (12.1)	16 (4.6)	2 (0.9)	
STEMI location						0.191
Anterior	557 (40.0)	113 (40.4)	149 (41)	137 (38.5)	158 (40.2)	
Inferior	650 (46.7)	124 (44.3)	161 (44.4)	171 (48)	194 (49.9)	
Posterior/lateral	95 (6.8)	22 (7.8)	22 (6.1)	17 (7.6)	24 (6.1)	
LBBB/indeterminate	90 (6.5)	21 (7.5)	31 (8.5)	21 (5.9)	17 (4.3)	
Multivessel disease	436 (57.4)	29 (63.0)	90 (55.2)	127 (55.0)	190 (59.4)	0.711
LVEF ≤0.30	275 (21.9)	40 (18.0)	73 (22.3)	71 (21.1)	91 (24.5)	0.053
Reperfusion therapy	735 (52.8)	49 (17.5)	210 (57.9)	208 (58.4)	268 (68)	**<0.001**
PPCI	474 (34.1)	11 (22.4)	100 (47.6)	150 (72.5)	213 (79.8)	**<0.001**
Fibrinolysis	259 (18.7)	38 (77.6)	110 (52.4)	57 (27.5)	54 (20.2)	**<0.001**
Length of stay, days	10 (6–15)	12 (6–18)	10 (5–16)	10 (7–15)	7 (5–11)	**<0.001**
In-hospital mortality	346 (24.7)	96 (34.3)	122 (33.6)	75 (21.1)	53 (13.4)	**<0.001**
Deaths due to MC	97 (6.9)	27 (9.6)	37 (10.2)	20 (5.6)	13 (3.3)	**<0.001**
Cause of death						0.530
Shock/pump failure	203 (58.6)	52 (54.2)	75 (61.5)	43 (57.3)	33 (62.3)	
MC	97 (28.0)	27 (28.1)	37 (30.3)	20 (26.7)	13 (24.5)	
Other causes	46 (13.3)	17 (17.7)	10 (8.2)	12 (16.0)	7 (13.2)	

Values are mean ± SD, n (%), or median (interquartile range). **Bold** p values are statistically significant.

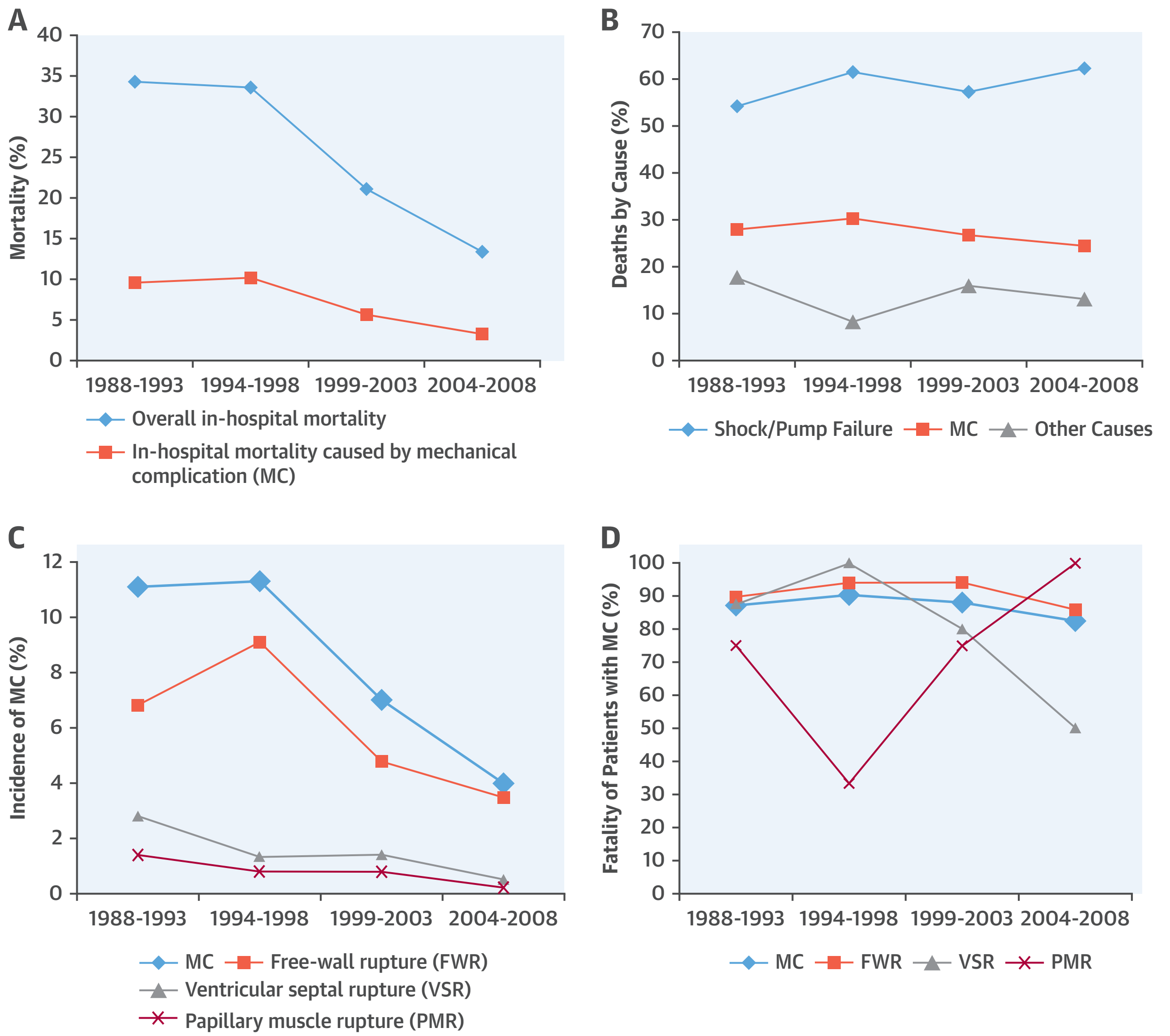
CVD = cardiovascular disease; LBBB = left bundle branch block; LVEF = left ventricular ejection fraction; MC = mechanical complication; PAD = peripheral arterial disease; PPCI = primary percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

arrived within the first 6 h from symptom onset with a median admission delay of 3 h (1.5 to 8 h). Cardiogenic shock at admission (Killip class IV) was present in 6.8%. Multivessel disease was found in 57.4% of patients who underwent coronary angiography, and 21.9% presented with left ventricular systolic dysfunction (left ventricular ejection fraction <0.30) at admission. Reperfusion therapy was performed in 52.8% of patients (PPCI 34.1% and fibrinolysis 18.7%). Overall in-hospital mortality was 24.7%, and 28% of deaths were due to MCs.

BASELINE CHARACTERISTICS, TREATMENT, AND MORTALITY OF AMI. Baseline characteristics changed significantly over the 20 years of enrollment (Table 1), with an increase in mean age and the prevalence of cardiovascular risk factors, and a decrease in the prevalence of prior CVD. There was a shortening in the median time to admission (from 4 to 2 h) with a reduction in the prevalence of advanced Killip class at admission. No significant differences were found in time trends for STEMI location, the prevalence of multivessel disease, or severe left ventricular systolic dysfunction.

The use of reperfusion therapy increased from 17.5% in 1988 to 1993, to 68% in 2004 to 2008, initially driven by the use of fibrinolysis but later by PPCI, which overtook fibrinolysis in the latest periods. The length of stay steadily decreased from 12 to 7 days ($p < 0.001$). In-hospital mortality declined 61% during the study period, from 34.3% in 1988 to 1993, to 13.4%

CENTRAL ILLUSTRATION Time Trends in Mechanical Complications After ST-Segment Elevation Myocardial Infarction



Puerto, E. et al. J Am Coll Cardiol. 2018;72(9):959-66.

Time trends in hospital all-cause and cause-specific mortality, and incidence and fatality rates of mechanical complications (MCs) in older patients after ST-segment elevation acute myocardial infarction. **(A)** Trends in overall in-hospital mortality and in-hospital mortality caused by MCs. **(B)** Trends in the main causes of hospital death. **(C)** Trends in the incidence of MCs as a whole, free-wall rupture, ventricular septal rupture and papillary muscle rupture. **(D)** Trends in hospital fatality rates for MCs as a whole, free-wall rupture, ventricular septal rupture and papillary muscle rupture. FWR = free-wall rupture; MC = mechanical complication; PMR = papillary muscle rupture; VSR = ventricular septal rupture.

in 2004 to 2008 (p for trend <0.001) (Table 1, Central Illustration, panel A). During that time, the number of deaths due to MCs decreased from 27 (9.6%) in 1988 to 1993, to 13 (3.3%) in 2004 to 2008, a relative reduction of 66% (p for trend <0.001) (Central Illustration, panel A). However, when the relative contribution of the different causes of death to in-hospital mortality was analyzed, the proportion of deaths caused by MCs did not change during the study period (28.1% in 1988 to 1993, 24.5% in 2004 to 2008; p for trend = 0.53) (Central Illustration, panel B). After adjustment for time variations in age, risk

TABLE 2 Time Trends in Outcomes and Therapies of MCs

	Total (N = 1,393, 100%)	1988–1993 (n = 280, 20.1%)	1994–1998 (n = 363, 26.0%)	1999–2003 (n = 356, 25.5%)	2004–2008 (n = 394, 28.3%)	p Value for Trend
Mechanical complications	114 (8.2)	31 (11.1)	41 (11.3)	25 (7.0)	17 (4.3)	**<0.001**
Survived	14 (12.3)	4 (12.9)	4 (9.7)	3 (12.0)	3 (17.6)	0.662
Surgical treatment	33 (28.9)	14 (45.2)	10 (24.4)	6 (24.0)	3 (17.6)	**0.040**
Survived after surgery	12 (36.4)	4 (28.6)	4 (40.0)	3 (50.0)	1 (33.3)	0.742
Free-wall rupture	83 (5.9)	19 (6.8)	33 (9.1)	17 (4.8)	14 (3.5)	**0.009**
Survived	7 (8.4)	2 (10.5)	2 (6.1)	1 (5.8)	2 (14.3)	0.753
Pericardiocentesis	37 (44.5)	8 (42.1)	12 (36.4)	9 (52.9)	8 (57.1)	0.250
Surgical treatment	21 (25.3)	7 (36.8)	8 (24.2)	3 (17.6)	3 (21.4)	0.253
Survived after surgery	6 (28.6)	2 (28.6)	2 (25.0)	1 (33.3)	2 (66.7)	0.843
Ventricular septal rupture	20 (1.4)	8 (2.8)	5 (1.3)	5 (1.4)	2 (0.5)	**0.019**
Survived	3 (15.0)	1 (12.5)	0 (0)	1 (20.0)	1 (50.0)	0.270
Surgical treatment	5 (25.0)	4 (50.0)	0 (0)	1 (20.0)	0 (0)	0.110
Survived after surgery	2 (40.0)	1 (25.0)	–	1 (100)	–	0.221
Papillary muscle rupture	11 (0.8)	4 (1.4)	3 (0.8)	3 (0.8)	1 (0.2)	0.108
Survived	4 (36.4)	1 (25.0)	2 (66.7)	1 (25.0)	0 (0)	0.827
Surgical treatment	7 (63.6)	3 (75.0)	2 (66.7)	2 (66.7)	0 (0)	0.326
Survived after surgery	4 (57.1)	1 (33.3)	2 (100)	1 (50.0)	–	0.628

Values are n (%). **Bold** p values are statistically significant.
MC = mechanical complication.

factors, prior CVD, and delay to admission, the time trend in risk-adjusted mortality remained statistically significant ($p < 0.001$).

INCIDENCE, MANAGEMENT, AND FATALITY OF MCs. During the study period, 114 patients (8.2%) developed a MC, FWR being the most frequent (n = 83, 5.9%), followed by VSR (n = 20, 1.4%) and PMR (n = 11, 0.8%) (Table 2, Central Illustration, panel C). There were 10 additional patients (0.7%) in whom FWR was suspected, but not confirmed, most of them (n = 5) in the first period (1988 to 1993) when echocardiography was not readily available. The incidence of MCs went down from 11.1% in 1988 to 1993, to 4.3% in 2004 to 2008, a relative reduction of 61% (Central Illustration, panel C), mainly due to a 48% relative reduction in the incidence of FWR (from 6.8% in 1988 to 1993 to 3.5% in 2004 to 2008; p for trend = 0.009) and, to a lesser extent, because of a 82% relative reduction in the incidence of VSR (from 2.8% in 1988 to 1993 to 0.5% in 2004 to 2008; p for trend = 0.02).

Survival after any MC was very low at any time period (12.9% in 1988 to 1993, 17.6% in 2004 to 2008; p for trend = 0.66) (Central Illustration, panel D), with no significant improvement in survival for any specific MC (Table 2). Surgical repair was performed in 33 patients (28.9%) with MCs, 21 FWR (25.3%), 5 VSR (25.0%), and 7 PMR (63.6%), with a significant trend toward a lower proportion of MC patients treated surgically: from 14 (45.2%) in 1988 to 1993, to 3 (17.6%) in 2004 to 2008 (p for trend = 0.04). Survival after surgery did not change significantly over time: 28.6% in 1988 to 1993, 33.3% in 2004 to 2008 (p for trend = 0.74) (Table 2). Only 2 patients survived without surgery in the last period, one diagnosed with FWR and the other with VSR. Finally, there was no difference in the proportion of patients with FWR who underwent pericardiocentesis (42.1% in 1988 to 1993, 57.1% in 2004 to 2008; p for trend = 0.25).

DISCUSSION

Our study, one of the largest series focused on MCs after AMI, shows that during the 20 years of the study period, and parallel to the initiation and increased use of reperfusion therapy in the elderly, there was a dramatic reduction in hospital mortality and in the incidence of MCs in these patients, which was numerically more important for FWR, the most frequent MC. However, we did not find an improvement over time in the survival of patients who developed a MC, who still have a very poor prognosis. Moreover, the reduction in the incidence and mortality by MCs in our population ran in parallel with that of cardiogenic shock. Therefore, we did not observe a reduction in the contribution of MCs as a cause of death in this population that could specifically explain part of the reduction in absolute mortality of older patients with STEMI.

The progressive reduction in short-term mortality for older patients with STEMI has been previously described (4–7). This has been explained mainly by the increased use of reperfusion therapy and a general improvement in the quality of acute care (8,12). The increase in the use of PPCI rather than fibrinolysis is relevant because an excess mortality risk associated with fibrinolysis has been described in patients older than 75 years of age (13,14). Later on, we showed that, rather than intracerebral bleeding, most of this excess risk was explained by a significantly increase in the incidence of FWR among patients treated with fibrinolysis, especially beyond the first 12 h, which was not observed in older patients treated with PPCI (7). The trends for a progressive reduction in the treatment with fibrinolysis with the concomitant increase in PPCI made us predict a reduction in the incidence of MCs in general, and of FWR in particular. Given that MCs: 1) accounted for roughly one-third of early deaths in these patients (15); 2) that several studies have pointed out a lack of a significant reduction in the incidence of cardiogenic shock, the main cause of hospital death in patients with STEMI (16–18); and 3) that PPCI seems to be successful in preventing FWR in older STEMI patients (7) and in the general population (19), we speculated that a reduction in MCs could be expected and that this could account for a large proportion of the early mortality reduction observed in this population. Additionally, we speculated that an improvement in the short-term prognosis of MCs in these patients, driven by an earlier diagnosis and/or a more effective treatment, could also play a role.

Consistent with the first hypothesis, we found that there was a marked reduction during the study period in the incidence of the 3 MCs, and in the number of deaths caused by MCs. Actually, a reduction in the incidence of FWR in the general population with STEMI had been described previously (20,21). Interestingly, no reduction in the incidence of mortality or MCs between the first and second period was observed (**Central Illustration**, panels A and C), when the majority of reperfusion therapy was still done through fibrinolysis. This trend was driven by the increase in the incidence of FWR, a risk associated with fibrinolysis in older patients (7), whereas the reduction occurred mostly during the years when PPCI was the dominant therapy.

However, we did not find a reduction in the proportion of patients dying due to a MC as compared with other causes, suggesting that the benefit of reperfusion therapy (and of primary PCI in particular) is not specific, but rather general, reducing proportionally the main causes of death, cardiogenic shock, MCs, and others. In addition, we did not find any improvement either in the survival of all patients who developed a MC or in those who were surgically treated during the 20-year period. Moreover, we found a significant reduction in the proportion of patients who underwent surgery over time. Interesting enough, there was not a parallel decline in the use of pericardiocentesis for patients with FWR, which remained stable in the range of 40% to 60% throughout the study period. These results are consistent with some prior reports (22) but contrast with previous observations in the general population (20,21).

The reasons for the lack of improvement in outcomes and the trend in surgical treatment for MCs are unclear. The fact that we only analyzed the oldest patients may be relevant. It may have been due also to a more rapid clinical or hemodynamic instability in the latest time periods, which was not specifically recorded; a more strict patient selection, perhaps driven by an increased reluctance to operate on old patients with a very high surgical mortality risk that did not improve over time or other unmeasured factors. Age-related comorbidities could also have resulted in a poorer prognosis after surgery and in the global absence of improvement in the case-fatality rate in the present report.

Several case studies in the published reports have reported the use of extracorporeal membrane oxygenation support to stabilize patients with MCs, especially VSR, until surgery can be performed. In the future, given that this delay would probably allow a stronger stability of the myocardial tissue around the infarct area and, consequently, a more effective repair, the surgery rate could be expected to increase and mortality to reduce conspicuously. In addition to the increased use of circulatory support systems, the high lethality of MCs should encourage the investigation of alternative approaches such as expanding the use of percutaneous devices for the treatment of VSR (22), especially for patients with morbidity and an unacceptable surgical risk, such as the population described in this study.

STUDY LIMITATIONS. A number of limitations deserve consideration. This is an observational study, and therefore, no causal relationship can be inferred. In particular, the relationship between the trends in revascularization rates, revascularization type, and incidence of MCs can only be hypothesis-generating. Although the database was prospectively designed, most of the information was collected retrospectively. Nevertheless, the proportion of missing values is very low (<0.5%) for baseline characteristics, reperfusion therapy, MCs, and mortality rates, with the exception of Killip class (10%). The reasons for several clinical decisions were not systematically recorded, and thus, explanations can only be speculative. The changes occurring during the 20 years of the study course included clinical practices and therapies but also diagnostic, technical, organizational, and cultural factors in several departments (cardiology, emergency, cardiac surgery), which may all have had an influence on the results and would be impossible to measure specifically. For instance, the rate of use of echocardiography increased from 79% to 97% in the global population and from 97% to 100% in patients with MCs. No MC was diagnosed by computerized tomography or magnetic resonance imaging, because these techniques were not available for emergency situations during the analyzed period. These factors could have led to small underestimation of MCs, especially in the first time periods. Although 10 years have passed between the last data collection and analysis, no major relevant changes in the incidence of MCs have occurred that would make our results invalid. If anything, the rate of PPCI may currently be higher than in our last observation period. Although the increased use of mechanical circulatory support in recent years may have increased the chance of survival in some patients with MCs, it may not be used as frequently in very old patients, and it would have not been recorded in this registry.

CONCLUSIONS

In parallel with the increasing use of reperfusion therapy, particularly PPCI, a progressive decline in the incidence of MCs occurred over a 20-year period, mainly associated with the reduction of FWR incidence in older STEMI patients. The significant decrease in MC mortality was due to a reduction in the incidence of these complications, but not in their fatality rate, which remains exceedingly high.

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PERSPECTIVES

COMPETENCY IN SYSTEMS-BASED PRACTICE: In parallel with increased use of reperfusion therapies, the incidence of MCs in elderly patients with STEMI decreased over the past several decades, but when MCs develop, the short-term prognosis is still poor.

TRANSLATIONAL OUTLOOK: Further research is needed to improve the outcome of MCs in elderly patients with STEMI.

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