

# Mortality Patterns in ST-Segment Elevation Myocardial Infarction Over 10 Years in Argentina. ARGEN-IAM-ST Registry

*Evolución de la mortalidad en el infarto agudo de miocardio con elevación del segmento ST durante 10 años en Argentina. Registro ARGEN-IAM-ST*

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## ABSTRACT

**Background:** Acute myocardial infarction (AMI) is the leading cause of preventable death in Argentina and in most developing countries. Publications evaluating cardiovascular mortality have shown a downward trend over the last 20 years, attributable to significant advancements in care.

**Objective:** The aim of this study is to evaluate mortality of ST-segment elevation MI (STEMI) in Argentina, time from symptom onset to presentation, and time to reperfusion over a 10-year period.

**Methods:** Cases registered in the ARGEN-IAM-ST registry with a date of chest pain onset between January 1, 2015, and December 31, 2024, were analyzed. The characteristics of the population, times to presentation, in-hospital mortality, and complications during hospitalization due to STEMI were explored.

**Results:** A total of 7690 cases were analyzed from 209 institutions. Mean age was  $61.1 \pm 12$  years, and 79% were male. The median time from the onset of pain to presentation was 120 minutes (interquartile range, IQR, 59-243), door-to-needle time was 55 minutes (IQR 30-120), total ischemic time for fibrinolytic therapy was 180 minutes (IQR 108-300), door-to-balloon time was 79 minutes (IQR 45-137), and total ischemic time for percutaneous coronary intervention was 315 minutes (IQR 190-607). These values did not present significant variations when compared individually over time. In-hospital mortality was 8.6%, over 10 years with no statistically significant variations when comparing annual periods ( $p = 0.927$ ), despite reperfusion rate was  $> 90\%$  in 8 of the 10 years evaluated.

**Conclusion:** Over the past 10 years, the ARGEN-IAM-ST registry showed absence of significant changes in in-hospital mortality, time to presentation and time to treatment. It is necessary to take specific actions to change the reality of STEMI in Argentina.

**Key words:** Myocardial infarction - Percutaneous coronary intervention - Mortality-Registry

## RESUMEN

**Introducción:** El infarto agudo de miocardio (IAM) es la principal causa de muerte prevenible en Argentina, así como en la mayoría de los países en desarrollo. Las publicaciones que evalúan la mortalidad de causa cardiovascular muestran una tendencia decreciente en los últimos 20 años gracias a los avances en la atención.

**Objetivo:** Evaluar la mortalidad del IAM con elevación del segmento ST en la Argentina durante 10 años. Evaluar los tiempos desde el inicio del dolor a la consulta y la reperusión en el mismo período.

**Material y métodos:** Se analizaron los casos ingresados con fecha de inicio del dolor desde el 1ero de enero de 2015 hasta el 31 de diciembre de 2024 en el registro ARGEN-IAM-ST. Se exploró las características de la población, los tiempos de consulta, mortalidad intrahospitalaria y complicaciones durante la internación por IAM.

**Resultados:** Se analizaron 7690 casos en 209 instituciones. La media de edad fue de  $61,1 \pm 12$  años, el 79 % era de sexo masculino. La mediana (rango intercuartílico, RIC) desde el inicio del dolor a la consulta fue de 120 minutos (59-243); el tiempo puerta-aguja fue 55 minutos (RIC 30-120), el tiempo total de isquemia para fibrinolíticos fue de 180 minutos (RIC 108-300), el tiempo puerta-balón 79 minutos (RIC 45-137) y el tiempo total de isquemia en angioplastia 315 minutos (RIC 190-607). Éstos valores no sufrieron variaciones significativas cuando se los comparó de forma individual a lo largo del tiempo. La mortalidad intrahospitalaria fue del 8,6 %, sin variaciones estadísticamente significativas cuando se compararon períodos anuales ( $p = 0,927$ ), a pesar de que la tasa de reperusión fue mayor del 90 % en 8 de los 10 años.

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**Conclusión:** En 10 años del registro ARGEN IAM-ST no se evidenciaron variaciones significativas en la mortalidad intrahospitalaria ni los tiempos de consulta y atención. Resulta necesario realizar acciones concretas que permitan cambiar la realidad del IAM en Argentina.

**Palabras clave:** Infarto de miocardio - Intervención coronaria percutánea - Mortalidad - Registro

## INTRODUCTION

Acute myocardial infarction (AMI) is the leading cause of preventable death in Argentina and in most developing countries. Timely treatment has a positive impact on short- and long-term prognosis. Therefore, it is of utmost importance to understand how treatment patterns and their outcomes evolve in the local population. To this end, various tools allow for the observation of how indicators evolve over successive periods, the evaluation of advances in care, and the identification of barriers and opportunities for improvement. (1)

Prevalent disease registries are effective tools for monitoring clinical care and its outcomes because they are inexpensive and simple to use. There are multiple publications of AMI registries from Europe, the United States, Asia, and Oceania. These publications provide insight into clinical evolution, the effects of treatments, and issues arising from delays in medical interventions. (2-5)

The ARGEN-IAM-ST registry is the only registry on ST-segment elevation MI (STEMI) in Argentina that has been active for more than a decade. In previous publications, the registry has been a reference for understanding the reality of STEMI nationwide. (6-9) It is important to create a timeline for summarizing information for a given period and, at the same time, defining how the most important parameters related to care, treatment, and prognosis have evolved.

## OBJECTIVE

The aim of this study is to evaluate mortality associated with STEMI in Argentina over recent years using data from the ARGEN-IAM-ST registry, and to evaluate time to presentation and time to reperfusion.

## METHODS

The ARGEN-IAM-ST registry is a prospective, multicenter, and nationwide study with voluntary participation, conducted in collaboration between the Argentine Society of Cardiology and the Argentine Federation of Cardiology. The protocol had been previously published. (6) The target population was made up of STEMI patients admitted within the first 36 hours of the event. Non-STEMI cases, secondary infarctions, aortic dissection, pericarditis, and myocarditis were excluded. Cases registered with a date of chest pain onset between January 1, 2015, and December 31, 2024, were analyzed. Centers that reported at least one case during the specified period were considered participants in the study.

The most relevant data collected included coronary risk factors, cardiovascular history, and comorbidities; clinical picture, treatment used (antiplatelet agents, reperfusion, and treatment at discharge), and in-hospital clinical outcome. Data related to delays until effective treatment were

achieved was also obtained.

The following times and delays were considered:

- 1) Time to presentation: time elapsed between the onset of symptoms suggestive of myocardial ischemia and first medical contact.
- 2) Time to reperfusion: time elapsed between arrival at a medical center and initiation of reperfusion treatment.
  - a) In case of fibrinolytic therapy:
    - Time window: time interval in minutes from the onset of symptoms to the start of infusion.
    - Door-to-needle time: time interval in minutes from arrival at the institution to the start of infusion.
  - b) In case of percutaneous coronary intervention:
    - Time window: time interval in minutes from the onset of symptoms to balloon inflation.
    - Door-to-balloon time: time interval in minutes from arrival at the institution to balloon inflation.

Data were collected on the REDCap platform. The protocol was registered in ClinicalTrials.gov with the number NCT2458885.

## Ethical considerations

The protocol design of the ARGEN-IAM-ST registry was approved by the Committee on Ethics of the Argentine Society of Cardiology.

## Statistical analysis

Qualitative variables are presented as frequencies and percentages. Quantitative variables are expressed as mean  $\pm$  standard deviation (SD), or median and interquartile range (IQR), according to their distribution.

A logistic regression analysis was performed to explore mortality during the analyzed periods (which were annual) and to identify statistical differences. A p value  $<$  0.05 was considered statistically significant. The analysis was performed using R statistical package.

## RESULTS

A total of 7690 cases were analyzed from 209 institutions; 42% of the participating centers corresponded to public institutions. Mean age was  $61.1 \pm 12$  years, and 78.8% were male. Fifty-four percent had hypertension, 27.2% had diabetes, 10.8% were active smokers, and 37.5% had dyslipidemia (Table 1). Over the past 10 years, the median time from the onset of chest pain to presentation was 120 minutes (IQR 59-243), door-to-needle time was 55 minutes (IQR 30-120), total ischemic time for fibrinolytic therapy was 180 minutes (IQR 108-300), door-to-balloon time was 79 minutes (IQR 45-137), and total ischemic time for percutaneous coronary intervention was 315 minutes (IQR 190-607). These values did not present significant interannual variations (Table 2).

In-hospital mortality was 8.6% over 10 years with

no statistically significant variations when comparing annual periods ( $p = 0.927$ ) (Figure 1). Reperfusion therapy was utilized in at least 90% of cases in 8 of the 10 years analyzed, except for 2015 (84.2%). There were no significant variations in the use of reperfusion therapy or in mortality (Figure 2).

Anterior wall MI was the most common presentation, accounting for 39.7% of cases. Cardiogenic shock was present on admission in 7.4% of patients, 11.5% had cardiopulmonary arrest at the time of presentation, and heart failure was the most common in-hospital complication, occurring in 13.2% of cases. With respect to a key safety indicator, 4.1% of patients experienced bleeding complications during hospitalization.

Participating physicians were asked to complete a brief survey about their perceptions of the causes of delayed reperfusion in MI. They reported the following causes: delays in medical consultation (38.4%); delays in referral to another center for percutaneous coronary intervention (20.5%); delays in transportation (19.3%); and delays in the emergency department (13.5%) (Table 4).

## DISCUSSION

This study presents data from 10 years of uninterrupted activity of the ARGEN-IAM-ST registry. This is the longest-running study on STEMI in Argentina. Despite the voluntary nature of registry participation and the absence of funding for on-site auditing and sampling planning, the registry has been widely accepted by institutions, with 42% being public hospitals and 58% being private institutions or managed by social security funds. Since its inception, subsequent papers have been published on the reality of

STEMI. In this publication, a timeline is presented to offer an overview of the most important aspects regarding STEMI care and outcomes, such as time to presentation, time to treatment, time to reperfusion, and overall in-hospital mortality. These are important indicators that help evaluate the management of STEMI cases. (6-9) Although the number of participating centers and the number of cases entered into the registry have declined over time, as seen in Table 2 (1699 cases in 2015 and 393 cases in 2024), there have been no significant variations in the most important indicators. This suggests that the decline in cases did not affect these indicators, possibly because the centers contributing the most records have remained constant over time.

Despite the high volume of cases achieving reperfusion, we have not observed a variation in in-hospital mortality. This is noteworthy because mortality is higher than in other registries, such as that of the European Society of Cardiology, where the 30-day mortality rate is 4.4%. The highest mortality rate was observed in Middle Eastern centers, which are not affiliated with the Society (5.9%). (5) In the ACI-SEC Infarction Code Registry conducted in Spain in 2019, Oriol Rodriguez-Leor et al. analyzed data from 5401 patients, reporting in-hospital mortality and 30-day mortality rates of 5.5% and 7.9%, respectively. The reperfusion therapy rate was 91.9%, and reperfusion was performed within 120 minutes of the first medical contact in more than half of these cases. (10) In our registry, despite times to fibrinolytic therapy or percutaneous coronary intervention being shorter, in-hospital mortality was higher. This could be explained by the fact that the time to presentation was 50% longer compared to the Spanish registry. In the ACI-SEC Infarction Code Registry, the median time to presentation was 60 minutes. In the ARGEN-IAM-ST Registry, the lowest median time to presentation was 90 minutes in 2016 and the overall median time doubled after 10 years of follow-up. This contributes to an extended total ischemic time, a crucial indicator that may be associated with this excess mortality.

Amini et al. investigated the trend in cardiovascular disease mortality from 1990 to 2017 and concluded that, with a few exceptions, there was an overall downward trend. (11) Conversely, the prevalence and incidence of cardiovascular disease are increasing globally, as evidenced by the publication by Khan et al., who also explored the period between 1990 and 2017 as a reference. This suggests that despite the rise in the prevalence and incidence of cardiovascular disease, different health systems have found ways to effectively treat this significant challenge. (12)

Over the past decade, there has been no significant progress in care times. When professionals were asked about this issue, their response was that they perceive delays in time to presentation, time to referral to another center, and in ambulance arrival as the main barriers to improving reperfusion times. This

**Table 1.** Baseline characteristics

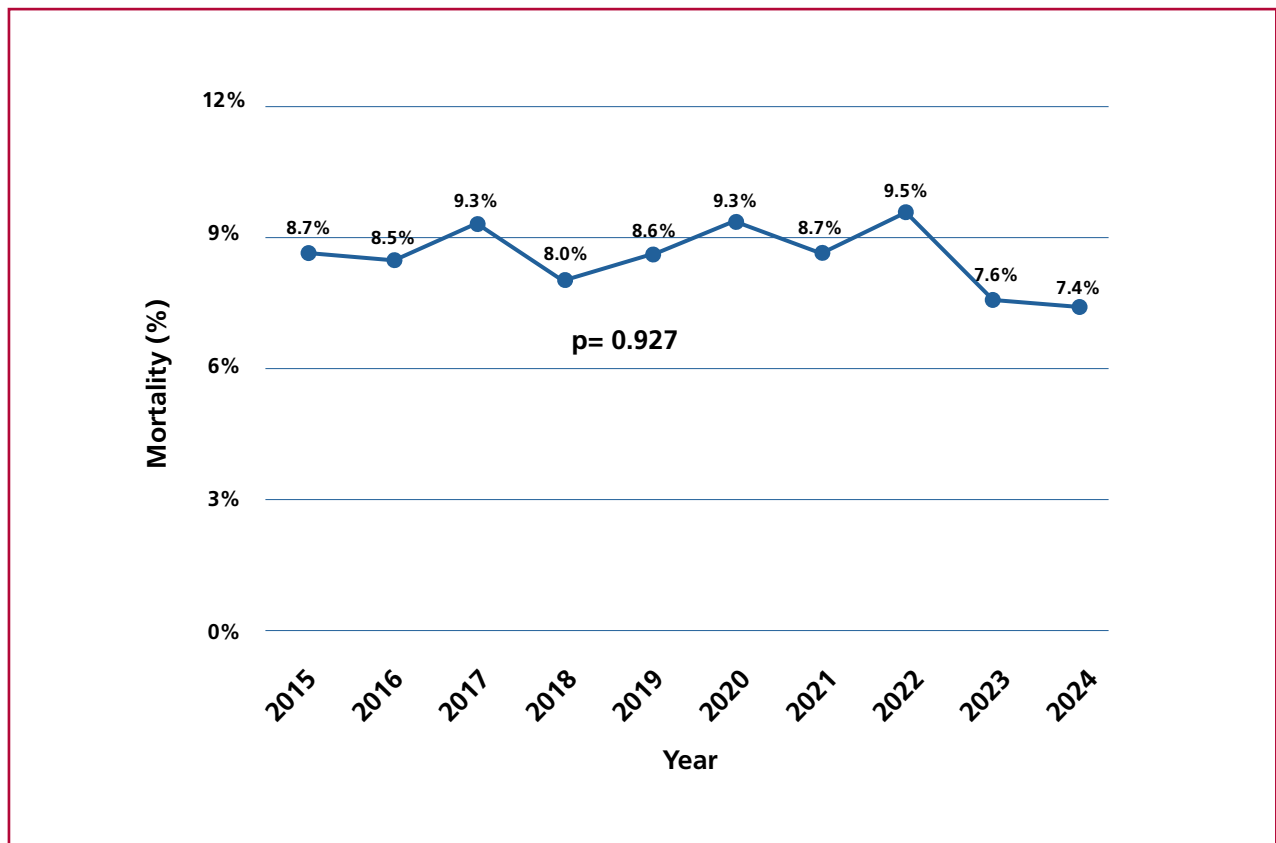
Variables	n = 7690
Age (years)	61.1 ± 12
Male	6059 (78.8%)
Hypertension	4153 (54.0%)
Diabetes mellitus	2092 (27.2%)
Current smoking	831 (10.8%)
Dyslipidemia	2882 (37.5%)
Family history	1129 (14.7%)
Previous coronary artery disease	955 (12.4%)
Previous heart failure	149 (1.9%)
COPD	232 (3.0%)
Chronic kidney disease	68 (0.9%)
Previous atrial fibrillation/atrial flutter	30 (0.4%)
Previous stroke	111 (1.4%)
Peripheral vascular disease	86 (1.1%)

Qualitative variables are presented as frequency and percentage and quantitative variables are expressed as mean and standard deviation  
COPD: chronic obstructive pulmonary disease

**Table 2.** Time intervals (in minutes) of the ARGEN-IAM-ST Registry [median (IQR)]

Year	N	Chest pain to presentation	Door-to-needle time	Time window to fibrinolysis	Door-to-balloon time	Time window to PCI
2015	1699	130 (60- 300)	49 (30- 90)	165(114- 297)	85 (53- 139)	301(190- 570)
2016	307	90 (40- 180)	45 (30- 120)	185(149- 315)	86 (53- 166)	280 (180- 533)
2017	688	97 (45- 190)	72 (30- 131)	200(124- 292)	88 (50- 150)	300(185- 571)
2018	911	102 (40- 240)	60 (30- 129)	190(120- 330)	75 (40- 140)	323(191- 616)
2019	1045	120 (60- 240)	60 (30- 101)	160 (110- 260)	74 (43- 135)	310(190- 600)
2020	674	120 (59- 240)	61 (40- 128)	180 (107- 295)	74 (38- 140)	315(190- 600)
2021	688	120 (56- 270)	45 (30- 177)	223 (133- 328)	70 (40- 120)	365 (190- 695)
2022	696	120 (60-270)	52 (30- 150)	200 (120- 300)	82 (45- 135)	335 (203- 679)
2023	488	112 (60- 240)	45 (15- 158)	185 (98- 271)	75 (40- 128)	325(192- 559)
2024	393	100 (48- 200)	40 (29- 105)	150 (90- 260)	70 (38- 120)	322(180- 646)
Total	7589	120 (59- 243)	55 (30- 120)	180 (108- 300)	79 (45- 137)	315(190- 607)

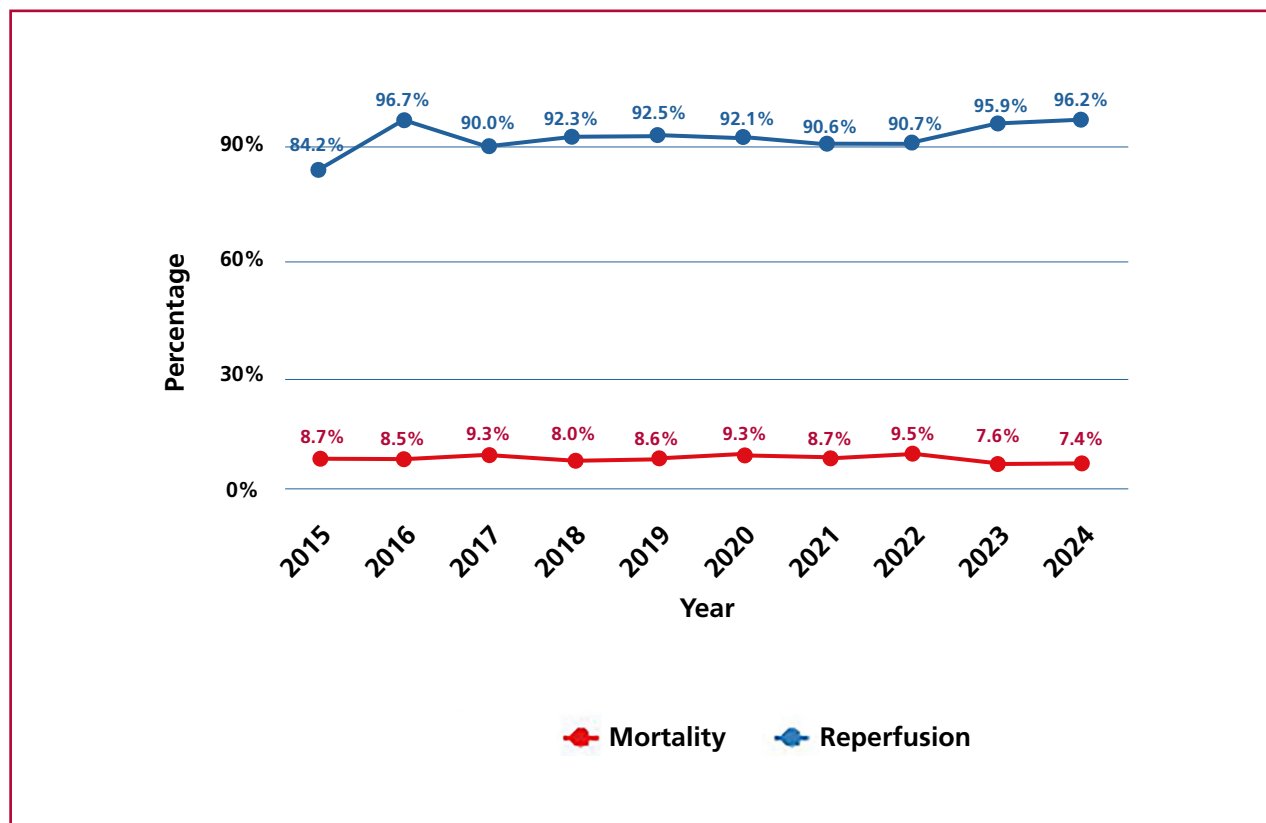
IQR: interquartile range; PCI: percutaneous coronary intervention

**Fig. 1.** STEMI mortality by year

has been a recurring issue in previous publications by the ARGEN-IAM-ST group, yet the issue remains unresolved. (6,7)

The most significant complication that occurred during hospitalization was heart failure, with an incidence of 13.2%, compared to 7.4% with cardiogenic

shock and 11.5% with cardiac arrest on presentation. The incidence of heart failure during hospitalization is higher than in other registries. For example, the GRACE registry reported a rate of 5.6% in 13 707 cases, Spencer et al. recorded a rate of 8.6% in 123,938 patients, and the US ACTION registry reported a rate

**Fig. 2.** Reperfusion and mortality from STEMI by year

of 3.6%. (13-15). Given that heart failure rates in this registry are more than double those in other registries, the prolonged total ischemic time could be the cause of this phenomenon despite the high reperfusion rates, as it was previously mentioned. (16)

The most significant indicators show an impact on in-hospital morbidity and mortality. As is well known, these indicators also suggest that the impact will occur during mid- and long-term follow-up, particularly for patients who develop heart failure. (17-20)

This exploratory analysis shows prolonged times to presentation, which is consistent with physicians' perceptions. Issues related to the organization of resources (delays in referral, ambulance arrival, and emergency care) are also reported. It is widely recognized that the logistics of transfers can lead to delays in reperfusion times. Therefore, the implementation of effective strategies in both prehospital and hospital settings is strongly recommended. (21)

Based on this information, it is necessary to educate and promote awareness among the population to prevent delays in cases of chest pain. Additionally, health systems must be organized to prevent delays in care and optimize human and technological resources. Implementing protocols and creating networks for AMI care could improve current outcomes and avoid another decade of stagnation. This approach would

avoid the economic and social impacts of being left behind by the improvements seen in other health systems.

In the case of Argentina, a country with a fragmented health system and different districts with their own demographic, geographic, and climatic characteristics, it is imperative to develop policies tailored to each reality.

#### CONCLUSION

Over the past 10 years, the ARGEN IAM-ST registry shows absence of significant changes in STEMI mortality despite high reperfusion rates. This could be due to prolonged times to presentation and treatment, which have not shown significant reductions. Analysis of delays suggests that logistics could be improved. It is imperative to implement policies designed to change the reality of AMI in Argentina to reduce the time between symptom onset and patient presentation, improve medical care, and optimize referral logistics. This will optimize both public and private healthcare resources.

#### Study limitations

The ARGEN IAM-ST registry is a voluntary registry, with no financial incentives and no data auditing at each institution. Data quality control is performed

**Table 3.** Characteristics and complications of STEMI

Characteristic	n=7690
ECG location (n = 7538)	
Anterior wall (V1-V6)	2989 (39.7%)
Inferior wall (LI - LII - VF)	2828 (37.5%)
Lateral wall (LI and VL or V5-V6 only)	256 (3.4%)
Anterolateral wall	710 (9.4%)
Anterior and inferior wall	81 (1.1%)
Inferolateral wall	626 (8.3%)
Undetermined (LBBB or cannot be located)	48 (0.6%)
Infarct-related artery (n= 6407)	
LMCA	85 (1.3%)
LAD	3052 (47.6%)
Diagonal	126 (2.0%)
LCx	830 (13%)
RCA	2201 (34.4%)
Venous graft	33 (0.5%)
Arterial graft	16 (0.2%)
None	47 (0.7%)
Unidentified	17 (0.3%)
Killip and Kimball class (n= 7533)	
KK I	5798 (77%)
KK II	1068 (14.2%)
KK III	113 (1.5%)
KK IV	554 (7.4%)
Bleeding (n= 7664)	
No bleeding	7348 (95.9%)
Minimal	191 (2.5%)
Minor	74 (1.0%)
Major	51 (0.7%)
Reinfarction	132 (1.7%)
PIA	160 (2.1%)
Cardiogenic shock *	728 (9.5%)
Intraaortic balloon pump	152 (2.0%)
Heart failure	1015 (13.2%)
Atrial fibrillation	341 (4.4%)
Electric cardioversion	365 (4.7%)
Pulmonary artery catheter	227 (3.0%)
Mechanical ventilation	646 (8.4%)
Ischemic stroke	67 (0.9%)

During the course of treatment (not applicable if on admission)  
 ECG: electrocardiogram; KK: Killip and Kimball; LAD: left anterior descending coronary artery; LBBB: left bundle branch block; LCx: left circumflex artery; LMCA: left main coronary artery; PIA: post-infarction angina; RCA: right coronary artery

through the REDCap platform. The contribution of researchers and participating institutions is vital to the project's sustainability. This registry model may

**Table 4.** Causes of delays in reperfusion

Cause of delay	n = 7690
Patient presentation	2954 (38.4%)
Ambulance	1483 (19.3%)
Emergency room care	1037 (13.5%)
Medical error in the diagnosis of infarction	860 (11.2%)
Catheterization laboratory team	632 (8.2%)
Referral to another center for primary PCI	1577 (20.5%)
Cardiac arrest	184 (2.4%)
Administrative error	296 (3.8%)
First ECG inconclusive	264 (3.4%)

PCI: percutaneous coronary intervention; ECG: electrocardiogram

be subject to reporting bias and does not have a sampling strategy.

#### Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web).

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