



Original article

Impact of the COVID-19 pandemic on ST – elevation myocardial infarction management in a referral center of northern Peru

Jean Pierre Carrión Arcela^{1,a}, Piero Custodio-Sánchez^{2,a}, Tatiana Gisell Coca Caycho^{2,a}

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Author's affiliation

¹ Cardiology Service. Hospital Luis Heysen Incháustegui. EsSalud. Chiclayo. Perú.

² Cardiology Service. Hospital Nacional Almazor Aguinaga Asenjo. EsSalud. Chiclayo. Perú.

^a Attending cardiologist

***Correspondence**

Jean Pierre Carrión Arcela
+51 914755876

Email

jeancarrionarcela@gmail.com

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ABSTRACT

Objective. To evaluate the impact of the COVID-19 pandemic on the ST-Elevation myocardial infarction (STEMI) management in a referral center of northern Peru. **Methods.** This was an observational, analytical, retrospective cohort-type study, that used information from the Acute Coronary Syndrome registry of the Hospital Nacional Almazor Aguinaga Asenjo. The characteristics of the patients with STEMI and their 30-day outcomes were compared in two cohorts according to the time of medical care: prior to the pandemic or during the pandemic. **Results.** During the COVID-19 pandemic, hospitalizations due to STEMI decreased by 53%, there was a greater use of fibrinolysis to the detriment of primary angioplasty, with increases in the time of first medical contact (100 vs. 240 minutes, $p = 0.006$) and ischemic time to percutaneous coronary intervention (900 vs. 2880 minutes, $p < 0.001$). This produced a higher frequency of post-infarction heart failure (21.1% vs. 46.7%, $p = 0.002$) and a lower left ventricular ejection fraction at discharge (49.2 +/- 8.6 vs 44.8 +/- 9.3, $p = 0.009$), without an increase in in-hospital cardiovascular mortality. **Conclusions.** The COVID-19 pandemic has had a negative impact on the treatment of patients with STEMI. We found less hospitalizations, longer reperfusion times, and higher frequency of post-infarction heart failure and lower left ventricular ejection fraction at discharge.

Keywords: Myocardial infarction; COVID-19; Myocardial reperfusion (source: MeSH NLM).

Introduction

The COVID-19 pandemic caused changes both in the care provided by hospitals, which directed most of their efforts toward this new disease, and in the population, which avoided health services for fear of contagion. In this context, the number of hospitalizations due to ST-segment elevation myocardial infarction (STEMI) decreased in many healthcare centers and countries. Tomasoni *et al.* reported a 33% decrease in Italy ⁽¹⁾; Rodriguez *et al.* reported a 27.6% decrease in Spain ⁽²⁾ and Custodio *et al.* reported a 59% decrease ⁽³⁾ in Peru; likewise, lower reperfusion rates, lower frequency of primary percutaneous coronary intervention (PCI) have been reported, as well as an increase in the time to first medical contact and total ischemic time ⁽⁴⁾. This has been associated with increased mortality and post-infarction complications in these patients ^(5,6).

Because of the above, and because of the impact that this pandemic has had on the Peruvian context, where the rate of non-reperfusion is high and usually with door-to-balloon times far from international standards ^(7,8), we set out to evaluate the repercussion of the COVID-19 pandemic on reperfusion strategies for acute myocardial infarction with ST-segment elevation in a referral center in northern Peru.

Materials and methods

This is an analytical observational retrospective cohort study. Patients were selected from the acute coronary syndrome registry of the Hospital Nacional Almanzor Aguinaga Asenjo, a referral center in the northern macro-region of Peru (Lambayeque, Piura, Cajamarca, Tumbes and Amazonas). We conducted a census sampling and then compared the characteristics of patients with STEMI and their 30-day outcomes between two groups: April - December 2019 (pre-pandemic) and April - December 2020 (during the pandemic). The inclusion criteria were: over 18 years of age, of both sexes, with clinical angina and/or anginal equivalent associated with persistent ST-segment elevation ≥ 2.5 mm in males under 40 years of age; ≥ 2 mm in males aged 40 or older, or ≥ 1.5 mm in females in leads V2-V3, or ≥ 1 mm in other leads ⁽⁷⁾, regardless of the time of disease progression, or with a complete de novo left bundle branch block; patients with a diagnosis of acute myocardial infarction without coronary lesions, coronary dissection, or coronary embolism were excluded.

We evaluated and compared sociodemographic characteristics, cardiovascular history, reperfusion strategies, reperfusion therapy times, in-hospital complications, and 30-day outcomes between both groups.

For statistical analysis, measures of central tendency and their respective measures of dispersion, the student's t-test, Chi-square and the Wilcoxon rank test were used, as appropriate. A p-value of <0.05 was considered to be statistically significant. All statistical analyses were conducted using SPSS version 25.

Results

The study included 96 patients diagnosed with STEMI during the months of April-December 2019 and 45 patients diagnosed during the months of April-December 2020. A 53% decrease in the total number of hospitalizations was found between both periods (**Figure 1**).

Male sex predominated in both groups; the most frequent cardiovascular risk factors were arterial hypertension, diabetes *mellitus*, and dyslipidemia; no significant differences were found between the groups. In both groups, typical angina was the most frequent symptom at admission (90%), followed by dyspnea; atypical angina was proportionally more frequent during the pandemic period ($p = 0.019$), and the most frequent infarct location was the anterior surface, followed by the inferior surface (**Table 1**).

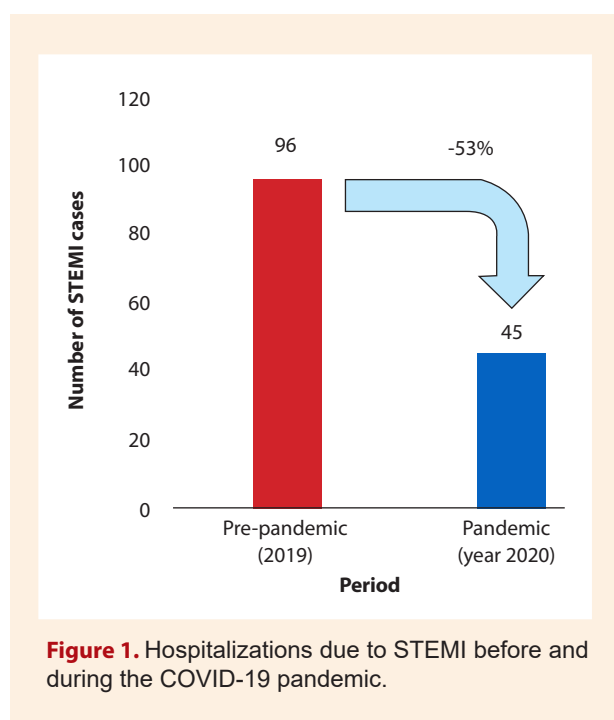


Figure 1. Hospitalizations due to STEMI before and during the COVID-19 pandemic.

Table 1. Characteristics of STEMI patients before and during the COVID-19 pandemic.

Baseline characteristics	Pre-COVID (N=96)	COVID (N=45)	P
Age (mean ± SD)	64.68 (±11.4)	66.09 (±13.8)	0.551
Male sex	82 (85.4%)	36 (80%)	0.417
Risk factors			
Arterial hypertension	59 (61.5%)	26 (57.8%)	0.677
Diabetes mellitus	30 (31.3%)	14 (31.1%)	0.987
Dyslipidemia	41 (42.7%)	14 (31.1%)	0.188
Chronic kidney disease	13 (13.5%)	5 (11.1%)	0.687
Initial clinical presentation			
Typical angina	92 (95.8%)	40 (88.9%)	0.116
Atypical chest pain	4 (4.2%)	7 (20%)	0.019
Dyspnea	23 (23.96%)	13 (28.9%)	0.531
Cardiac arrest	1 (1.04%)	1 (2.22%)	0.581
Syncope	2 (2.08%)	4 (8.88%)	0.062
Presentation rhythm			
Sinus	92 (95.8%)	44 (97.78%)	0.813
Atrial fibrillation	1 (1.05%)	0	
AVB	2 (2.10%)	1 (2.22%)	
LBBB	1 (1.05%)	0	
Killip Kimball class at admission			
I	66 (68.7%)	27 (60%)	0.489
II	16 (16.7%)	12 (26.6%)	
III	7 (7.3%)	3 (6.7%)	
IV	7 (7.3%)	3 (6.7%)	
Location of the infarct			
Anterior	44 (45.8%)	28 (62.2%)	0.030
Inferior	43 (44.8%)	12 (26.7%)	
Inferoposterior	9 (9.4%)	3 (6.7%)	
Lateral	0	2 (4.4%)	

AVB: Atrioventricular block, LBBB: Left bundle branch block

Regarding reperfusion therapies, we observed that nearly 50% of patients did not access timely reperfusion therapy (< 12 h from symptom onset) before and during the COVID-19 pandemic, with a slightly higher percentage in the latter period without statistical significance. Fibrinolysis was used in greater proportion during the pandemic period with a success rate of 80%, and a decreased use of primary angioplasty, without achieving a statistically significant difference between the two groups (Table 2).

More than 90% of patients who underwent percutaneous revascularization had a final TIMI grade 3 flow. A lesion of the anterior descending artery was the cause of infarction in most patients from both groups, but there was a greater frequency

Table 2. Reperfusion strategies

	Pre - COVID (N=96)	COVID (N=45)	P
Fibrinolysis	33 (34.38%)	19 (42.2%)	0.915
Successful	23 (69.7%)	15 (80%)	0.368
Coronarography	87 (90.6%)	41 (91.1%)	0.926
PCI			
Primary	15 (15.6%)	3 (6,7%)	0.137
Pharmacoinvase	19 (19.8%)	11 (24.4%)	0.622

PCI: Percutaneous coronary intervention

of multivessel arterial disease during the pandemic period, with a statistically significant difference (92% vs. 58%, $p = 0.021$). Likewise, these non-culprit coronary lesions were treated more frequently in hospitalization during the pandemic period ($p = 0.016$) (Table 3).

One of the most important findings was the increased reperfusion time; the time from ischemia to percutaneous coronary intervention (PCI) was longer during the pandemic (2880 vs. 900 min, $p < 0.001$), this increase being the sum of a longer delay to first medical contact (240 vs. 100 min, $p = 0.006$) and an increase in door-to-balloon time (945 vs. 610 min, $p = 0.073$) (Figure 2).

The pharmacological therapy used in both groups was similar; the most frequent in-hospital complication was heart failure, although with a higher frequency during the COVID-19 pandemic period, with a statistically significant difference (46.7% vs. 21.1%, $p = 0.002$); additionally, the ejection fraction at discharge was lower during the pandemic (49.2 ± 8.6 vs. 44.8 ± 9.3 , $p = 0.009$) (Table 4).

These findings were not associated with an impact on in-hospital or 30-day cardiovascular mortality. Finally, it should be

noted that in the cohort during the pandemic, ten patients were diagnosed with COVID-19 and during their evolution two died at 30 days, which increased mortality from non-cardiovascular causes ($p = 0.046$) (Table 4).

Discussion

Our study evaluated the impact of the COVID-19 pandemic on the management of STEMI in the northern macro-region of Peru. We found it had a negative impact, reducing the number of hospitalizations by more than 50%, delaying and even reducing reperfusion therapy with a consequent increase in acute complications such as heart failure and a lower ejection fraction at discharge.

The decrease in the number of hospital admissions for STEMI has been a constant in different studies with a variation between 20-60% (2,3); in accordance with this, our study also showed an important reduction in hospitalizations in the north of the country. This may be motivated by different reasons, among which Perrin Nils *et al.* highlight the fear of contagion or spread of COVID-19 after hospital admission or not wanting to add a

Table 3. Coronary angiography characteristics in both groups.

	Pre-COVID (N=34)	COVID (N=14)	P
Culprit artery involved in the infarction			
Anterior descending artery	18 (52.9%)	9 (64.3%)	0.314
Right coronary artery	5 (14.7%)	0	
Circumflex artery	11 (32.4%)	5 (35.7%)	
Initial TIMI score			
TIMI 0	13 (38.2%)	1 (7.1%)	0.025
TIMI 1	8 (23.5%)	1 (7.1%)	
TIMI 2	11 (32.4%)	11 (78.6%)	
TIMI 3	2 (5.9%)	1 (7.1%)	
Final TIMI score			
TIMI 0	0 (0.0%)	0 (0.0%)	0.803
TIMI 1	1 (2.9%)	0 (0.0%)	
TIMI 2	2 (5.9%)	1 (7.1%)	
TIMI 3	31 (91.2%)	13 (92.9%)	
Multivessel disease	20 (58.82%)	13 (92.85%)	0.021
PCI of NCA	4 (11.76%)	6 (42.85%)	0.016

PCI: Percutaneous coronary intervention, NCA: Non-culprit arteries

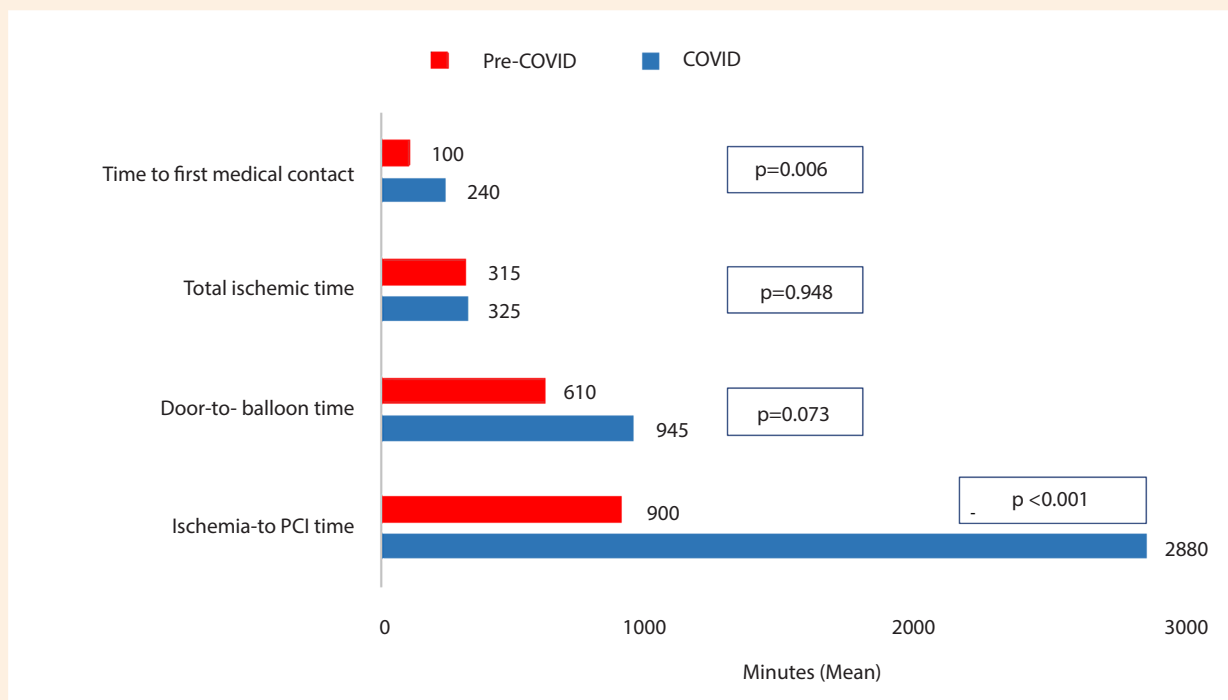


Figure 2. Reperfusion times before and during the COVID-19 pandemic.

PCI: Percutaneous coronary intervention

Table 4. Pharmacological therapy, in-hospital complications and 30-day outcomes

	Pre-COVID (N=96)	COVID (N=45)	p
Pharmacological therapy			
Vasopressors	15 (15.6%)	17 (37.8%)	0.747
Inotropics	20 (20.8%)	15 (33.3%)	0.109
Nitrates	39 (40.6%)	19 (42.2%)	0.857
In-hospital complications			
Heart failure	20 (21.1%)	21 (46.7%)	0.002
Cardiogenic shock	16 (16.7%)	7 (15.6%)	0.868
CVD	1 (1.1%)	0 (0%)	0.490
Major bleeding	3 (3.2%)	0 (0%)	0.228
Cardiac arrest	5 (5.2%)	6 (13.3%)	0.094
Cardiovascular death	12 (12.5%)	3 (6.7%)	0.295
Non-cardiovascular death	3 (3.2%)	0 (0%)	0.226
LVEF at discharge	49.23 (±8.59)	44.77 (±9.28)	0.009
30-day outcomes			
Rehospitalization	6 (7.3%)	2 (4.8%)	0.584
Reinfarction	1 (1.2%)	0	0.472
Cardiac death	0	0	
Non-cardiac death	0	2 (4.8%)	0.046

Figure 3. Central figure: Impact of the COVID-19 pandemic on the management of ST-segment elevation myocardial infarction.

Objectives



To evaluate the impact of the COVID-19 pandemic in the management of STEMI in a referral center in northern Peru (Hospital Nacional Almanzor Aguinaga Asenjo, Chiclayo Peru).

Study design



Retrospective cohort

Patients with STEMI

Apr-Dec 2019

96 patients

Apr-Dec 2020

45 patients

30-day follow up

Results



Longer time to first medical contact	100 > 249 min	(p=0.006)
Longer time to PCI	900 > 2880 min	(p<0.001)
Increased incidence of post-infarction failure	21.1% > 46.7%	(p=0.002)
Lower LVEF at discharge	49.2% (+-8.6) > 44.8% (+-9.3)	(p=0.009)
No apparent change in hospital mortality		

Conclusiones



The COVID-19 pandemic has had a negative impact in the management and progression of patients with STEMI, highlighting longer ischemic times and increased post-infarction failure.

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burden to the health system ⁽⁹⁾. In addition, we must consider the possibility of underdiagnosis of acute coronary syndrome ⁽¹⁰⁾ and the increase in out-of-hospital mortality due to a delay in timely care during the pandemic ⁽¹¹⁾.

On the other hand, although time is considered the greatest limiting factor for achieving optimal results in reperfusion therapy ^(12,13), our country is still far from meeting the international recommendations since even before the pandemic. The pandemic worsened this situation by increasing not only the time of first medical contact, but also the ischemia-to-PCI time and the total ischemic time. The sanitary measures taken by the government may explain these findings. These measures delayed the transfer of patients within or outside the region; the information provided regarding the management of the pandemic in the hospitals strengthened the fear of contagion during hospitalization; there was a lack of space in the emergency

rooms for the care of cardiovascular emergencies; there was a lack of fibrinolytics, and there was a need for spending more time on protective measures prior to the procedures. Thus, the access to reperfusion therapy was limited, increasing the possibility of non-reperfusion. This study found that 50% of patients did not receive reperfusion, a value higher than that reported in our country a few years ago (33%); this demonstrates the national context outside the capital ⁽⁸⁾, with figures that are higher in the more distant regions and in healthcare centers without supplies or timely referral capacity. This gives an idea of the fragility of the organization of our health system, which failed to adapt to this adverse scenario, neglecting the approach to this and other cardiovascular pathologies with high morbidity and mortality ⁽¹⁴⁾.

The purpose of the management of STEMI is to achieve reperfusion in the shortest possible time following the premise "time is muscle" ⁽¹⁵⁾. In the early days of the pandemic, the use

of fibrinolysis as the main reperfusion strategy was encouraged from China⁽¹⁶⁾ to the detriment of primary angioplasty. Fibrinolysis was preferred because it had greater feasibility regarding infrastructure and equipment, even more so in a context where the diagnosis of SARS-CoV-2 infection had to be ruled out and biosafety equipment had to be provided as a requirement for admission to the catheterization laboratory. Later, however, the consensus of the Society for Cardiovascular Angiography and Interventions (SCAI) and the American College of Cardiology (ACC)⁽¹⁷⁾ confirmed primary angioplasty as the preferred reperfusion strategy of choice, provided it is conducted at the appropriate time, since its use is associated with lower mortality, reinfarction and stroke rates both in the short and long term^(18,19). Despite these recommendations, our study showed a decrease in the practice of primary angioplasties, the ISACS-STEMI COVID registry in Italy also showed a 19% reduction in primary angioplasties⁽²⁰⁾; and Kwok *et al.* reported that in England there was a 43% reduction in angioplasties compared with previous monthly averages⁽²¹⁾.

It is important to note that patients admitted during the COVID-19 pandemic showed a higher frequency of multivessel disease, a finding also reported in other studies such as the one by Rodríguez-Leor *et al.*⁽²⁾. One possible explanation for this is that the patients who sought medical attention were those with the greatest ischemic burden. The approach provided to these patients was the most appropriate, as a large percentage received complete revascularization before discharge.

The consequences of delayed and decreased reperfusion therapies during the COVID-19 pandemic are reflected in a higher frequency of heart failure and lower left ventricular ejection

fraction at discharge, which correlate with the results obtained by Primessnig *et al.* in Germany⁽²¹⁾ and De Rosa *et al.* in Italy⁽⁴⁾.

Finally, the negative impact of the COVID-19 pandemic was observed even in the 30-day follow-up, as all-cause mortality increased, mainly at the expense of non-cardiovascular causes, due to mortality factors inherent to patients diagnosed with COVID-19 such as age > 55 years, arterial hypertension, diabetes *mellitus*, among others^(23,24).

Limitations

Despite our study taking place in a referral hospital in the northern macro-region of Peru, our sample size is small when compared to previous studies, and since it is a regional study with its own sociodemographic and territorial characteristics, it does not allow us to understand the national context in its entirety.

Conclusions

The COVID-19 pandemic produced the following in the studied population: a lower number of hospitalizations; delays regarding reperfusion time; higher frequency of post-infarction heart failure; lower left ventricular ejection fraction; and higher all-cause mortality in the first 30 days after discharge. These results should draw the attention of our health authorities to strengthen and prioritize timely medical care of acute myocardial infarction, in order to achieve better short- and long-term outcomes.

Authors' contribution

The authors of this study declare that they entirely participated in the preparation, revision and writing of this scientific article.

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