

Influence of the Second Wave of the COVID-19 Pandemic on the Management of Patients with ST-T Segment Elevation Myocardial Infarction

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The ongoing coronavirus disease 2019 (COVID-19) has caused a global health crisis. This prospective, observational, single-centre, cohort study investigated the influence of the second wave of the pandemic on the treatment of ST-segment elevation myocardial infarction (STEMI) patients admitted to the largest tertiary centre in Nicosia, Cyprus. We measured onset-to-door (O2D) time, door-to-balloon (D2B) time, onset-to-balloon (O2B) time, and 30-day mortality for 250 consecutive patients who presented directly or were transferred to Nicosia General Hospital from 1 January 2021, to 31 December 2021, during the second wave of the pandemic in Cyprus. We compared a control group of patients with similar clinical characteristics admitted before the COVID-19 outbreak. Median O2D time was increased from 89 min to 120 min (p-value=0.094). D2B time was not increased significantly (85.5 vs. 87 min, p-value=0.137). The total ischemic time (O2B time) was increased from 173.5 min to 232.5 min, respectively (173.5 vs. 232.5, p=0.001). During the pandemic, more patients presented with cardiogenic shock (3.94 vs. 13.6, p=0.001) and with cardiac arrest (9.85 vs. 17.2, p=0.035,) while there was an increase in 30-day mortality (4.43% vs. 8.8%, p-value=0.100). Patients with STEMI during the second wave of the COVID-19 pandemic seem to have presentation delays with increased total ischaemic times, presented more commonly in cardiogenic shock or cardiac arrest, increasing 30-day mortality.

Key Words: COVID-19; Myocardial Reperfusion; ST Elevation Myocardial Infarction

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INTRODUCTION

The ongoing coronavirus disease 2019 (COVID-19) pandemic has caused a global health crisis with a significant impact on healthcare systems. Among its serious implications, COVID-19 appears to have had a substantial indirect effect on the treatment of cardiovascular diseases.^{1,2} Specifically, COVID-19 seems to have negatively influenced the management of patients with ST-segment elevation myocardial infarction (STEMI).³

Data from many registries have shown that the number of patients presenting with STEMI declined substantially during the pandemic, ranging from 39 to 50%.¹⁻³ Additio-

nally, there are mixed data regarding the impact of the pandemic in reperfusion times around the world. Some studies have shown that the COVID-19 pandemic did not influence the treatment of STEMI patients with no specific rise in reperfusion times.^{4,5} However, other studies have shown that during the pandemic, the reperfusion times in STEMI increased.⁶⁻¹² Nevertheless, some of these studies pointed out that the delays were pre-hospital, mainly driven by hospital presentation delays.^{6,7} In contrast, others showed that also, an in-hospital treatment delay component contributed to the overall picture.⁸⁻¹² The above mixed data urge more research on this topic.

This study aimed to investigate the impact of the second wave of the COVID-19 pandemic on the management of

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STEMI patients treated in the largest tertiary centre in Nicosia, Cyprus. First, the study examines the hypothesis of whether, during the second wave of the pandemic, STEMI patients experienced longer reperfusion times. Furthermore, it analyzes all the components of the total ischemic time, evaluating both the pre-hospital and the in-hospital components of delay. Finally, it investigates the influence of the second wave of the pandemic on the 30-day mortality of STEMI patients.

MATERIALS AND METHODS

1. Study design and demographics

We conducted an observational, retrospective cohort study of all consecutive patients who activated the primary percutaneous intervention (pPCI) service and were admitted to the tertiary hospital due to STEMI from January 2021 to December 2021. The above time frame was the period of the second wave of COVID-19 in Cyprus. We compared the clinical characteristics, patient and system delays, and clinical outcomes of these patients with clinical outcomes of patients with similar baseline and demographic characteristics admitted before the COVID-19 outbreak response. We defined two time periods for comparison: (1) before the COVID-19 period (Pre COVID-19 group, control group), from 1 June 2016 to 31 December 2017, and (2) during the second wave of the COVID-19 pandemic (During COVID-19 group) from 1 January 2021 to 31 December 2021. We had chosen the above before the COVID-19-time interval as the control group because the STEMI patients in this time interval had similar baseline and demographic characteristics to the STEMI patients in the during-COVID-19 group. In order to predict the required sample size for our study, we have used the PWR package developed by Champely,¹³ which implements power analysis, as outlined by Cohen.¹⁴ All of our statistically significant outcomes fall into the range of high or moderate effect size, according to Cohen.¹⁴ Given that assumption, a 90% of statistical power is achieved with at least 85 subjects in the cohort when comparing two-scale (unpaired) distributions, and with at least 141 subjects in the cohort, when associating two discrete (dichotomous) distributions. Moreover, generalized regression analysis within the same context requires a number of 190 subjects in the cohort to achieve a statistical power of 90%, under the presence of 15 predictors.

Nicosia General hospital is the largest tertiary centre in Cyprus, serving as the pPCI centre for three major districts: Nicosia, Larnaca, and Ammochostos districts, an area with more than 500.000 inhabitants. Approximately 350 pPCI are performed per year. Patients from the Nicosia district usually present directly to the hospital. Patients from the other two districts usually present to the local hospitals. The district hospitals of Larnaca (42 km, 30 min distance from pPCI centre) and Ammochostos (84 km, 55 min distance from pPCI centre), refer patients with STEMI requiring primary PCI, providing that they can offer the

reperfusion in less than 120 minutes, based on the current guidelines.¹⁵ Of note, Ammochostos General Hospital (GH) was placed as the COVID-19 national reference hospital in Cyprus for COVID-19 patients during the pandemic. STEMI diagnosis was given according to the Fourth Universal Myocardial Infarction Definition, meaning concomitant raised cardiac troponin levels with at least one value >99th percentile of the upper reference limit, and at least 1 of the following: symptoms of angina, electrocardiographic changes (new ST-elevation in 2 contiguous leads, measuring >0.2mV in leads V1-3 or 0.1mV in all other leads, or new-onset left bundle branch block) or cardiac imaging suggestive of MI (regional wall motion abnormality).¹⁶ This project was approved by the local Institutional Review Board and was in ethical compliance with the Declaration of Helsinki.

2. Study variables

We collected data on patients' clinical characteristics, patient and system delays, and outcomes. We defined onset time as the time of the symptom onset based on the patient interview. Door time was when the patient presented to the hospital emergency department of the recipient's primary PCI-capable hospital. Door star time (D*) was when the patient presented to the recipient district non-PCI capable hospital. Balloon time was defined as the time of the first balloon inflation, direct stenting, or manual aspiration during primary PCI.

Subsequently, we defined the following time intervals. First, the onset-to-door time (O2D time) was defined as the time interval from the onset of pain to hospital admission in the primary PCI centre. Second, the onset-to-door star time (O2D* time) was defined as the time interval from onset of pain to hospital admission in the district (non-PCI capable) hospital. Third, the door-to-balloon time (D2B time) was defined as the time interval from hospital admission to pPCI capable hospital to first device deployment. Fourth, the star door-to-balloon time (D*2B time) was defined as the interval from arrival at the referring (non-PCI capable) hospital to the time of first device deployment at the receiving hospital. Finally, the symptom onset-to-balloon (O2B) time was defined as the time interval from onset of pain to first device deployment and reflected the total ischemic time.¹⁷ The responsible physician who performed the procedure recorded all the above time frames.

3. Statistical analysis

A mixed dataset, with both scale and categorical variables, was available for analysis. All scale variables were tested for composite normality with the Shapiro-Wilk test, and excluding age, they were found to be non-normal. Age was reported with its mean±standard deviation, while all other scale variables with their median (Q1-Q3). Categorical variables include sex, smoking history, history of hyperlipidemia, history of hypertension, history of diabetes mellitus, family history of coronary heart disease, history of previous myocardial infarction, history of previous angio-

plasty, history of CABG, and history of in-hospital transfer were reported as count (%). Hypothesis testing to compare variable values/levels of the two distinct populations involved the Student's t-test for parametric scale variables, Wilcoxon's rank-sum test for the non-parametric scale variables, and Pearson's chi-squared test of independence for the categorical variables (along with the Yates' continuity correction). We also performed Fisher's exact test to accompany Pearson's chi-squared test of independence for the scenario of rare counts in categorical variables' associations. Moreover, comparing scale values of more than two populations involved the Kruskal-Wallis test. Finally, a multivariate analysis was done via logistic regression and the extraction of a set of estimates, p-values, and odds ra-

tios (ORs) (the latter ones and their 95% confidence intervals). All statistical tests were two-sided, and statistical significance was determined when $p < 0.05$. The data analysis, processing, and visualization were held with the R language for statistical computing and the assistance of the RStudio IDE (both open source).

RESULTS

A total of 377 cases activated the primary PCI service during the above studied COVID-19 period, considered the period of the second wave of the pandemic. Of these, 250 (66%) were STEMI and included in the analysis, and the remaining 127 (33%) were non-ST-elevation myocardial

TABLE 1. Baseline demographic and clinical characteristics among patients admitted for STEMI, before and during COVID-19

	Pre COVID-19 (n=203)	During COVID-19 (n=250)	p-value
Demographics			
Age	60.4±11.18	61.38±11.76	0.367
Sex, male	179 (88.18%)	218 (87.2%)	0.864
Medical history			
Hypertension	38 (47.5%)	111 (44.4%)	0.722
Diabetes mellitus	16 (19.28%)	49 (19.6%)	1.000
Hyperlipidemia	42 (51.22%)	95 (38%)	0.048
Current smoker	56 (70%)	145 (58%)	0.075
Family history of CAD	22 (30.99%)	49 (19.6%)	0.060
Previous MI	18 (22.22%)	26 (10.4%)	0.011
Previous PCI	21 (24.71%)	40 (16%)	0.102
Previous CABG	6 (2.96%)	5 (2.01%)	0.731
Presenting characteristics			
Anterior STEMI	103 (50.74%)	114 (45.6%)	0.320
Lateral STEMI	33 (16.26%)	48 (19.2%)	0.490
Inferior STEMI	91 (44.83%)	109 (43.6%)	0.868
Posterior STEMI	14 (6.9%)	22 (8.8%)	0.569
Right ventricular STEMI	19 (9.36%)	27 (10.8%)	0.728
Cardiogenic shock	8 (3.94%)	34 (13.6%)	0.001
Cardiac arrest	20 (9.85%)	43 (17.2%)	0.035
Culprit vessel			
Left main stem	3 (1.48%)	5 (2.12%)	0.951
Left anterior descending artery	105 (51.72%)	109 (46.19%)	0.103
Circumflex	27 (13.3%)	40 (16.95%)	0.501
Right coronary artery	63 (31.03%)	78 (33.05%)	0.948
Graft	5 (2.46%)	4 (1.69%)	0.751
Procedural characteristics			
Radial access	173 (85.22%)	222 (88.8%)	0.321
Adjunct devices			
DES	162 (83.94%)	226 (90.4%)	0.057
Use of glycoprotein IIb/IIIa inhibitors	67 (35.26%)	70 (28%)	0.127
Aspiration thrombectomy	139 (68.47%)	61 (24.4%)	<0.001
IVUS	2 (0.99%)	22 (8.8%)	<0.001
IABP	4 (1.97%)	15 (6%)	0.058
Temporary pacemaker	10 (4.93%)	10 (4%)	0.805
Clinical outcome			
30-day mortality	9 (4.43%)	22 (8.8%)	0.100

CAD: coronary artery disease, CABG: coronary artery bypass graft, COVID-19: coronavirus disease 2019, DES: drug eluting stent, IABP: intra-aortic balloon pump, IVUS: intravascular ultrasound, MI: myocardial infarction, PCI: percutaneous coronary intervention, STEMI: ST-segment elevation myocardial infarction.

infarction (NSTEMI) cases. We compared the 250 STEMI patients with 215 STEMI cases of the control group admitted in the pre-COVID-19 period. Demographic and epidemiological characteristics of patients with STEMI (age, gender, smoking, history of hypertension, history of diabetes mellitus, history of hyperlipidemia, history of heart failure, family history of coronary heart disease, previous myocardial infarction, previous angioplasty) were analyzed. The baseline demographic, clinical, and procedural characteristics among patients in the study are presented in Table 1.

There were statistically significantly more patients presented with cardiac arrest (9.85% vs. 17.2%, p-value=0.035)

and cardiogenic shock (3.94% vs. 13.6%, p-value=0.001) during the second wave of the COVID-19 pandemic. During the COVID-19 period, there was more use of intravascular imaging with intravascular ultrasound (IVUS) (0.99% vs. 8.8%, p-value<0.001) and less use of aspiration thrombectomy (68.47% vs. 24.2%, p-value<0.001). The decreased use of aspiration thrombectomy most likely reflects recent guideline-derived changes in the primary PCI practice. The increased IVUS use is possibly related to recent alterations of the local reimbursement policies and to the increased experience of the operators making them more confident to use intracoronary imaging in the acute phase of a STEMI.

TABLE 2. Comparison of symptom onset-to-door time (O2D), door-to-balloon time (D2B), and symptom onset-to-balloon time (O2B) for patients with STEMI undergoing primary PCI, before and during COVID-19

	Pre COVID-19 (n=203)	During COVID-19 (n=250)	p-value
O2D	89 (60-134)	120 (60-204)	0.094
D2B	85.5 (62.75-102)	87 (69-132)	0.137
D2B less than 60	12 (20%)	15 (14.29%)	0.462
O2B	173.5 (131.25-258.75)	232.5 (172.25-373)	0.001
O2B less than 720	55 (94.83%)	211 (91.74%)	0.607

All times are measured in minutes. COVID-19: coronavirus disease 2019, D2B: door-to-balloon, O2B: symptom onset-to-balloon, O2D: symptom onset-to-door, PCI: percutaneous coronary intervention.

TABLE 3. Symptom onset-to-door time (O2D*), door-to-balloon time (D*2B), symptom onset-to-balloon time (O2B) and 30-day mortality for patients with STEMI presenting in non-PCI capable hospital, requiring intrahospital transfer and undergoing primary PCI in PCI capable hospital during COVID-19; overall and comparing different centers

	Patients requiring intrahospital transfer (n=135)	Ammochostos general hospital (n=46)	Larnaca general hospital (n=78)	Other district hospitals (n=8)	p-value
O2D*	107 (55.25-214.5)	100.5 (56.75-243.5)	102 (54-152.5)	237 (125-332)	0.248
D*2B	142 (115-187)	147 (125.5-187.75)	138 (102-167.5)	229 (170-311)	0.008
D*2B less than 120	38 (28.15%)	8 (19.05%)	29 (40.85%)	1 (14.29%)	0.033
O2B	249 (195-395)	238 (191.25-429.75)	235 (192.5-326)	409 (277-622.75)	0.041
O2B less than 720	113 (83.7%)	37 (88.1%)	68 (95.77%)	6 (75%)	0.074
30-day mortality	11 (8.15%)	2 (4.35%)	8 (10.26%)	0 (0%)	0.343

All times are measured in minutes. COVID-19: coronavirus disease 2019, D*2B: door-to-balloon time interval from the time of arrival at the referring (non-PCI capable) hospital to the time of first device deployment at the receiving primary PCI capable hospital, O2B: symptom onset-to-balloon, O2D*: symptom onset-to-door in the district (non-PCI capable) hospital, PCI: percutaneous coronary intervention.

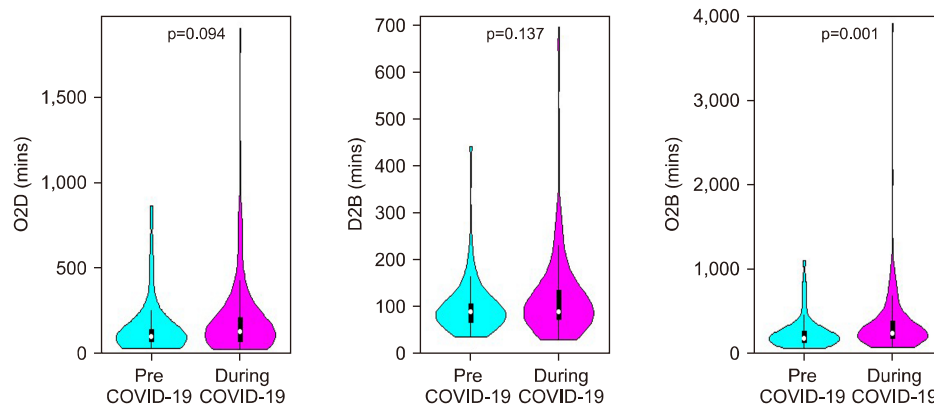


FIG. 1. Side-by-side violin plots illustrating the comparison between the O2D, D2B and O2B times (in minutes) before and during COVID-19. COVID-19: coronavirus disease 2019, D2B: door-to-balloon, O2B: symptom onset-to-balloon, O2D: symptom onset-to-door.

With regards to the time intervals, the median O2D, D2B, O2D*, D*2B, and O2B times are illustrated in Tables 2 and 3 and Fig. 1. O2D time was increased during the second wave of the COVID-19 pandemic (89 min vs. 120 min, p-value=0.094). On the other hand, D2B time was not increased significantly during the second wave of the COVID-19 pandemic (85.5 min vs. 87 min, p-value=0.137). However, the O2B time, which reflects the total ischaemic time, increased statistically significantly during the second wave of the COVID-19 pandemic (173.5 vs. 232.5 min, p-value=0.001). Concerning the patients who presented in non-PCI-capable hospitals and were referred for pPCI to the pPCI-capable hospital, O2D* time was calculated at 107 min, and D*2B time was calculated at 142 min [see Table 3]. Of note, patients who presented in Ammochostos

GH, which was defined as the reference hospital for COVID-19 during the pandemic, showed longer reperfusion times when compared with Larnaca GH, the other central district referring centre (D*2B Ammochostos vs. D*2B Larnaca=147 min vs. 138 min, p-value 0.032).

Finally, concerning the clinical outcomes, there was an increase in 30-day mortality (4.43% vs. 8.8%, p-value=0.100) during the second wave of the pandemic. The Fisher’s test for the same task returned a p-value of 0.091. Multivariable logistic regression analysis revealed that independent predictors of 30-day mortality included older age (OR 1.089, 95% CI 1-1.186, p-value=0.050), cardiac arrest on presentation (OR 11.003, 95% CI 1.655-73.137, p-value=0.013), cardiogenic shock (OR 23.17, 95% 3.756-142.928, p-value=0.001), prolonged O2B time (OR 1.003,

TABLE 4. Multivariate logistic regression analysis for the 30-day mortality (as target) of patients with STEMI treated with primary PCI during the COVID-19 period

	Estimate	p-value	OR (95% CI)
Age	0.085	0.050	1.089 (1-1.186)
Sex, female	-1.645	0.266	0.193 (0.011-3.508)
Cardiogenic shock	3.143	0.001	23.17 (3.756-142.928)
Cardiac arrest	2.398	0.013	11.003 (1.655-73.137)
Use of glycoprotein IIb/IIIa inhibitors	1.04	0.284	2.828 (0.422-18.974)
O2B	0.003	0.044	1.003 (1-1.006)
Hyperlipidemia	-0.9	0.383	0.406 (0.054-3.074)
Family history of CAD	0.156	0.904	1.169 (0.092-14.828)
Hypertension	2	0.091	7.388 (0.726-75.18)
Diabetes mellitus	-0.986	0.426	0.373 (0.033-4.239)
History of heart failure	4.477	0.019	87.936 (2.097-3687.155)
Previous MI	1.265	0.506	3.543 (0.085-146.843)
Previous PCI	0.076	0.965	1.079 (0.037-31.238)
Previous CABG	-0.511	0.815	0.6 (0.008-43.478)

CAD: coronary artery disease, CABG: coronary artery bypass graft, CI: confidence interval, COVID-19: coronavirus disease 2019, MI: myocardial infraction, O2B: symptom onset-to-balloon time, OR: odds ratio, PCI: percutaneous coronary intervention, STEMI: ST-segment elevation myocardial infarction.

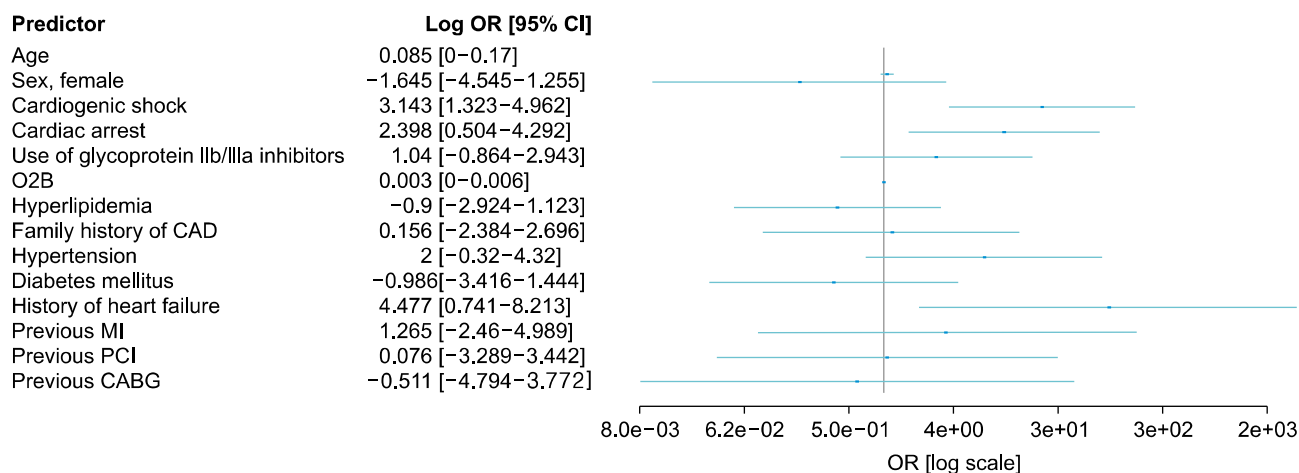


FIG. 2. A forest plot corresponding to the multivariate logistic regression model for the 30-day mortality (as target) of patients with STEMI treated with primary PCI during the COVID-19 period. CAD: coronary artery disease, CABG: coronary artery bypass graft, COVID-19: coronavirus disease 2019, MI: myocardial infraction, O2B: symptom onset-to-balloon time, OR: odds ratio, PCI: percutaneous coronary intervention, STEMI: ST-segment elevation myocardial infarction.

95% CI 1-1.006, p-value=0.044) and history of heart failure (OR 87.936, 95% CI 2.097-3687.155, p-value=0.019) (Table 4 and Fig. 2). All the above statistical outcomes achieved a statistical power higher than 90%.

DISCUSSION

The primary purpose of our study was to assess the impact of the second wave of the COVID-19 pandemic on STEMI management in the largest tertiary centre of Nicosia, Cyprus. There were several findings according to our study. Firstly, there was an increase in the total ischaemic time (onset-to-balloon time) compared with the average of the pro-COVID-19 interval we used as reference. Secondly, there was an increase of patients presenting with cardiac arrest and cardiogenic shock, which might be related to longer reperfusion times. Thirdly, there was an increase in the reperfusion time for STEMI patients presented in the reference for COVID-19 hospital in Cyprus. Finally, our study confirmed data from other studies that elevated reperfusion time, alongside older age, cardiac arrest, cardiogenic shock, and history of pre-existing heart failure are correlated with increased 30-day mortality.

In the literature, there are mixed data regarding the impact of the COVID-19 pandemic in reperfusion times in STEMI. Some studies showed no direct impact of the pandemic on reperfusion time. In contrast, others showed a more prolonged delay in O2D time, indicating that patients waited significantly longer during the pandemic to seek medical treatment for MI than before the pandemic. Finally, some studies showed longer delays in both O2D and D2B times, meaning that both pre-hospital and inter-hospital time intervals increased during the pandemic.

Hammad et al.⁴ found in their study that average D2B times were not significantly different between the pre-and post-COVID-19 cohorts (59 minutes vs. 58 minutes). The authors interestingly described that STEMI patients who presented 12 hours after the onset of symptoms had significantly higher D2B time and peak troponins. Similarly, Tan et al.⁵ found that the COVID-19 pandemic had no significant impact on reperfusion time. In their study, the DTB times (80.6 min vs. 79.3 min, p-value=0.470) and overall mortality (14% vs. 13%, p-value=0.900) remained similar before and during the COVID-19 era.

Aldujeli et al.⁶ presented that during the pandemic, there was a significant increase in onset-to-door times with no effect on door-to-balloon time. The median onset-to-door time during the pandemic was significantly more extensive than that of the pre-pandemic (O2D time 620 vs. 349 min, p-value=0.014); however, there was not a significant delay in door-to-balloon time (D2B time 86 vs. 76 min, p-value=0.983). Similarly, Erol et al.⁷ found that the median time from symptom onset to hospital arrival increased from 150 min to 185 min in patients with STEMI (O2D time 150 vs. 185 min, p-values<0.001) with no effect in D2B times (37 vs. 40 min, p-value=0.448).

In contrast, other studies revealed a significant impact

of the COVID-19 pandemic in both O2D and D2B times with longer treatment delays in STEMI patients. De Luca et al.⁸ in a retrospective registry in Europe, assessing patients with STEMI treated with pPCI, showed that the pandemic was associated with a significant increase in door-to-balloon and total ischemia times [DTB time 34 (921-30) min vs. 36 (24-60) min, p-value=0.007, O2B time 181 (120-301) min vs. 200 (127-357) min, p-value=0.004]. Gong et al.⁹ found that during the pandemic the delay in symptom-to-FMC was significantly longer (180 [68.75-342] vs. 120 [60-240] min, p-value=0.003), and the D2B times increased significantly (148 [115-190] vs. 84 [70-120] min, p-value<0.001). However, among patients with STEMI, MACE was similar in both time periods (18.3% vs. 25.7%, p-value=0.168). Garcia et al.¹⁰ found that the COVID-19 pandemic has adversely affected many aspects of STEMI care, including timely access to the cardiac catheterization laboratory for pPCI. According to the authors, after COVID-19 the D2B times increased on average by 20%, 95%CI (-0.2 to 44, p-value=0.050). Similarly, in a large retrospective cohort study including a total of 34,127 patients with STEMI, the median time from symptom to hospital showed an increase after the lockdown (O2D time 150 (99-270) vs. 135 (89-250) min, p-value=0.004) and a longer door-to-balloon time after the lockdown (D2B time 48 (21-112) vs. 37 (16-94) min, p-value<0.001).¹¹

An interesting pattern of higher prevalence of cardiogenic shock cases and cardiac arrest cases during the pandemic has been described in many studies. Gramegna et al.¹⁸ found that cardiogenic shock cases were numerically increased during the pandemic (19.2% vs. 9.5%, p-value=0.440). Similarly, Rangé et al.¹⁹ in their registry, found that cardiogenic shock cases were higher during the pandemic (5.7% vs. 2.9%, p-value=0.070). Chew et al.²⁰ found that the prevalence of out-of-hospital cardiac arrest was also higher during COVID than before (9.5% vs. 1.9%, p-value=0.003). It is unclear if COVID-19 and the associated delays are responsible for the increase of cardiogenic shock and cardiac arrest cases in these studies and our study. Therefore, the reasons for the increased incidence of out-of-hospital cardiac arrest and cardiogenic shock remain hypothetical. The fear of patients visiting a hospital or the reduced threshold and clinical judgment among clinicians to provide prompt diagnosis and timely patient admission during the pandemic could be a reason for these findings.

There are many possible explanations for the delayed reperfusion during the COVID-19 pandemic. Some of the following reasons may be relevant also to our study. First, regarding the pre-hospital delay (O2D time interval), many patients may have feared exposure to COVID-19 infection and avoided visiting the hospital despite having acute chest pain.²¹ The second explanation is that the necessary triage of patients with acute chest pain was very slow during the pandemic.²² Thirdly, delays might also occur at the emergency medical services level responsible for transferring patients with STEMI in the COVID-19 pandemic. During the pandemic, many ambulances might be needed

in COVID-related cases, while with the emergency departments are busy and crowded, ambulance services might have been increasingly delayed.^{22,23}

Regarding the in-hospital component of delay (D2B time interval), some possible explanations include the demand for precise screening for respiratory symptoms, identification of possible sick contacts, and the performance of nasopharynx screening for COVID-19 before transfer to the catheterization laboratory.²⁰⁻²² Also, there might be a degree of delayed diagnosis in the emergency department due to the massive volume of cases. In addition, significant delays could also have resulted from slower patient admission and slower delivery of the patient in the cath lab due to a lack of the necessary staff. Finally, we cannot ignore the challenges and the delay that might add the extra personal protective equipment of the cath lab staff in STEMI cases with possible COVID-19 infection.²²

Our study has several limitations. The first limitation is that study results are based on single centre data from a specific geographic region and probably could not be extracted from other areas. Secondly, the data collection has not been performed by an independent body rather than the interventional cardiologist of the service. The concealment, falsification, or beautification of the times to improve the times of each operator cannot be excluded. Thirdly, strict estimation of the time from the onset of symptoms to hospitalization (O2D time) can be problematic, as these times are based on patient reports and therefore cannot be verified independently. In contrast, D2B times are probably recorded more accurately. Fourthly, despite our efforts to compare with patients from previous years with similar demographic and clinical characteristics, the two groups were not homogenous in some variables (e.g., hyperlipidemia, previous MI). Furthermore, we did not have pre-COVID cohort patients presenting to district non-PCI-capable hospitals who were transferred for primary PCI to compare. During this chronological period, STEMI cases from these two district hospitals received intravenous thrombolysis, and staged PCI was performed 24-48 hours post thrombolysis. Fifth, we cannot ignore that other factors could contribute to the increase of the reperfusion times. Finally, we must not forget that this is an observational study with all the limitations of this type of data analysis. Due to the data's synchronic nature, it is impossible to prove the causal relationship between the variables, and the correlations observed may not be causal. Of course, an attempt has been made to mitigate this effect by adjusting the risk. However, we cannot rule out the possibility of residual confusion from other unmeasured factors related to the final reperfusion time.

In conclusion, our departmental evaluation demonstrates that patients with STEMI during the second wave of the COVID-19 pandemic seem to have presentation delays with increased total ischaemic times, presented more common in cardiogenic shock or cardiac arrest increasing overall 30-day mortality.

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CONFLICT OF INTEREST STATEMENT

None declared.

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