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Review Article

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Incidence Rates and Frequency of Instrumental and Drug Treatments in Hospitalized Patients with Covid-19 And St-Segment Elevation Myocardial Infarction (Stemi)

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ABSTRACT

By E.M. Evsikov et al. "Incidence rates and frequency of instrumental and drug treatments in hospitalized patients with COVID-19 and ST-segment elevation myocardial infarction (STEMI)"

Relevance of the topic

Policy reviews on this issue have noted that acute myocardial injury with elevated cardiac troponin (cTn) levels is associated with worse outcomes in patients with SARS-CoV-2 infections. In meta-analyses, the cumulative prevalence of acute myocardial injury according to diagnostic biochemical markers of myocardial damage varied in patients with covid-19 from 5% to 38%, depending on the criteria used, and exceeded an average of 20%.

Goal of the work: To study the features of providing medical care and conducting instrumental and drug treatment for patients COVID-19 hospitalized with acute coronary syndrome and myocardial infarction (AMI). To assess how the COVID-19 pandemic has impacted systems of care for patients with UTI and timely access to reperfusion therapy in different regions of the world. To determine the significance of the leading mechanisms of myocardial damage during COVID-19, such as hypercoagulation and the development of coronary microvascular thrombosis; diffuse endothelial damage and "endotheliitis" in multiple organs including the heart, inflammation and/or stress causing coronary plaque rupture or supply and demand imbalance leading to myocardial ischemia/infarction.

Keywords: Acute Myocardial Infarction with ST Segment Elevation, Myocardial Reperfusion, Covid-19, Viral Pneumonia

As the consequences of the COVID-19 pandemic have been studied, more and more information has begun to emerge about the non-respiratory effects of coronavirus infection. Controlled studies have found that the COVID-19 virus, SARS-CoV-2, is more likely to infect multiple organ systems, especially the human lungs and heart [1].

Signs of myocardial injury, as measured by elevated cardiac biomarkers, especially high-sensitivity troponin and/or creatine kinase MB, are common in patients with COVID-19 infection. In a meta-analysis by cardiologists from the American cardiology Brown University (Providence, USA), which included 26 studies in 11,685 patients with verified covid-19, the cumulative prevalence of acute myocardial damage according to the diagnosis of biochemical markers of myocardial damage ranged from 5% to 38%, depending from the criteria used and exceeded an average of 20% [2].

Similar data are provided in a retrospective study cardiologists from the St. Luke's Heart Institute and the University of Missouri-Kansas City, (Missouri, USA). In the work of Sammour YM et.al [3]. data were analyzed 32,636 patients with covid-19 from the American Heart Association's cardiovascular disease

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registry. The authors included in the sample 6234 (19.4%) patients with venous blood sampling from the antecubital vein (age 68.7 ± 16.0 years, 56.5% men, 51.5% Caucasians), of which 1365 (21.0%) 6%) an increase in CTN (troponin) of more than 5 times was noted. In patients studied at 55 centers, the average rate of invasive coronary angiography was 0.1%, with an adjusted MOR (ratio odds) 1.5, the average frequency of echocardiography assessing left ventricular ejection fraction (LVEF) was 25.5% (MOR 3.0), the number of hospitalizations in intensive care units was 41.7% (MOR 2.2), and the rate of in-hospital deaths was 20.9% (MOR 1.7).

Policy reviews on this issue have noted that acute myocardial injury with elevated cardiac troponin (cTn) levels is associated with worse outcomes in patients with SARS-CoV-2 infections [4].

Possible causes of cardiac injury in these settings may include myocarditis, acute myocardial infarction (MI), stress cardiomyopathy, cardiac arrhythmia, sepsis-associated myocardial injury, pulmonary embolism, endothelial and systemic inflammation [5]. Among them, acute MI is a critical diagnosis that needs to be diagnosed promptly to optimize treatment and outcomes. Acute type 1 MI is a diagnosis that uses established care pathways, including invasive treatment with coronary angiography and potential revascularization to optimize outcomes, particularly for ST-elevation MI (STEMI) and non-STEMI (NSTEMI). with high-risk features [6]. Patients with COVID-19 who have only suspected acute MI present an additional challenge due to the risk of possible inappropriate actions by healthcare providers and conditions that can mimic BMI without the presence of obstructive coronary disease [7].

In studies of morphologists during the covid period, it was found that in patients with ACS, in addition to rupture and thrombosis of the atheroscleral plaque, other pathogenetic factors also take part in the development of acute myocardial damage during covid-19. According to the European Heart Association (ESC) Working Group on Cellular Biology of the Heart, the main causes of heart damage in COVID-19 are:

a) coagulopathy with micro- (and to a lesser extent macro-) vascular occlusion,
b) direct infection of myocardial cells,
c) effects of cytokine storm
d) mechanisms associated with increased coagulopathy [8].

The likely mechanisms of myocardial injury in COVID-19 are multifactorial and include:

1) hyperinflammation and cytokine storm mediated by pathological T cells and monocytes, leading to myocarditis;
2) respiratory failure and hypoxemia, leading to damage to cardiomyocytes;
3) downregulation of ACE2 expression and subsequent protective signaling pathways in cardiomyocytes;
4) hypercoagulation and development of coronary microvascular thrombosis;
5) diffuse endothelial damage and "endotheliitis" in several organs, including the heart,
6) inflammation and/or stress causing coronary plaque rupture or supply and demand imbalance leading to myocardial ischemia/infarction [2].

The development of acute myocardial infarction with ST segment elevation (STEMI) in patients with COVID-19, according to Iranian specialists from the Center for Interventional Cardiology, is represented by a characteristic angiographic variant in the form of extensive and multivessel thrombosis, independent of atherosclerotic plaques, and is a significant factor in patient mortality, representing a new therapeutic challenge [9].

Baseline demographic, clinical, and procedural data on this disease were obtained, including from national COVID-19 myocardial infarction registries. Yes, according to data The North American COVID-19 Myocardial Infarction Registry collected baseline patient demographic, clinical, and procedural data. Univariate logistic regression was performed using candidate predictor variables, and multivariate logistic regression was performed using backward stepwise selection to identify independent predictors of in-hospital mortality. In-hospital mortality occurred in 118 of 425 (28%) patients [10]. Eight variables present at the time of STEMI diagnosis (respiratory rate >35 breaths/min, cardiogenic shock, oxygen saturation <93%, age >55 years, chest X-ray infiltrates, kidney disease, diabetes, and dyspnea) were assigned a weighted integer. In-hospital mortality increased exponentially with increasing integer risk score (Cochran-Armitage), and the model demonstrated good discriminant power (c-statistic = 0.81) and calibration (Hosmer-Lemeshow).

Increasing risk scores were strongly associated with in-hospital mortality (3.6% - 60% mortality in low and very high-risk categories, respectively), [10].

Canadian cardiologists from the Department of Cardiology, Faculty of Medicine, University of Saskatchewan, analyzed data from the North American COVID-19 Myocardial Infarction Registry (Shavadia JS, EA), including 853 STEMI-COVID patients in the US and Canada, 112 (13 %) of which were registered in Canada. The registry included adult (≥ 18 years) patients hospitalized from March 1, 2020 to December 31, 2021, who met the following inclusion criteria: (1) ST-segment elevation in at least 2 contiguous leads (or new left bundle branch block), (2) clinical equivalent of myocardial ischemia, and (3) confirmed or suspected COVID-19 infection. Model covariates included year of enrollment, country, sex, age <66 years, body mass index-based overweight/obesity score, Caucasian race score, current smoking status, hypertension, diabetes mellitus, previous myocardial infarction, previous stroke or transient ischemic attack, signs of congestive heart failure, pulmonary infiltrates and development of shock during percutaneous coronary intervention (PCI). Clinical outcomes of patients enrolled in the study in the United States (n = 741) versus Canada (n = 112) were as follows: mortality was 28% (n = 209) versus 16% (n = 18); stroke was 1.8% (n = 13) versus 0% (n = 0); re-infarction - 2% (n = 15) compared with 0% (n = 0); cumulative mortality, stroke or reinfarction - 30% (n = 225) compared with 16% (n = 18) [11].

In the analysis, the risk of in-hospital mortality was significantly higher in unvaccinated compared with vaccinated STEMI-COVID patients (RR 4.7). In both countries, as well as throughout the world, the COVID-19 pandemic has significantly impacted systems of care for patients with UTI, threatening

timely access to reperfusion therapy. Primary percutaneous coronary intervention was the dominant reperfusion strategy, with no difference in time from onset to balloon (see table).

Table Clinical Outcomes of Patients Enrolled in the Study in the United States Versus Canada

Reperfusion in patients undergoing angiography	Canada	USA
Primary PCI	78 (80%)	415 (70%)
Emergency PCI	9 (9.2%)	24 (4.0%)
Thrombolytics	3 (3.1%)	22 (3.7%)
Drug therapy	7 (7.1%)	122 (21%)
CABS (aorto-coronary bypass surgery)	1 (1%)	10 (1.8%)

Fibrinolysis was used less frequently in the United States than in Canada. Data are presented as n (%) and compared using appropriate Pearson $\chi 2$ and Fisher exact tests. The authors concluded that there are marked differences in morbidity and reperfusion strategies in patients with STEMI-COVID in the United States compared to Canada. No differences in hospital mortality were noted. Vaccination, regardless of region, appeared to be strongly associated with a reduced risk of in-hospital mortality [11].

In an analysis by members of the Levine Cardiac Intensive Care Unit Thrombolysis in Myocardial Infarction (TIMI) Study Group, Cardiovascular Division of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston (Massachusetts, USA), Bhatt AS et al. [12]. used data from the American Heart Association COVID-19 Cardiovascular Registry from January 14, 2020 to November 30, 2020 from 105 sites. Patient characteristics, resource utilization, and clinical outcomes were summarized and compared according to the presence or absence of IMI ST. Of the 15,621 COVID-19 cases, 54 (0.35%) patients with BMI were hospitalized. Among patients with IMI ST, the majority (n=40.7%) underwent transthoracic echocardiography, but only half (n=27.5%) underwent coronary angiography. Half of all patients with COVID-19 and STEMI (n=27, 5%) did not receive any primary reperfusion therapy. The incidence of shock from all causes was 47% versus 14%, cardiac arrest 22% versus 4.8%, acute heart failure 17% versus 1.4%, and the need for renal replacement therapy 11% versus 4.3%, were many times higher in patients with ST UTI compared with patients without ST UTI (significant for all comparisons). The rate of in-hospital death was 41% in patients with ST BMI compared with 16% in patients without ST BMI (significant). The authors concluded that ST BMI in hospitalized patients with COVID-19 is rare but is associated with adverse in-hospital outcomes. [12].

An initial analysis of data from the North American COVID-19 Myocardial Infarction Registry was presented in a report from the Minneapolis Heart Institute Foundation. Minneapolis, (Minnesota, USA) Santiago Garcia et.al. [13]. It included patients with BMI ST with confirmed COVID+ infection (group 1) or suspected (group 2) of COVID-19 infection. An age- and sex-matched group of BMI ST patients (matched to COVID+ patients in a 2:1 ratio) treated pre-COVID (2015 to 2019) serves as a control group to compare treatment strategies and outcomes (group 3). The primary outcome was in-hospital death, stroke, reinfarction, or repeat unplanned revascularization. As of December 6, 2020, the NACMI registry included 1,185 patients (230 COVID+, 495 PUI, and 460 controls). COVID+ patients were more likely to be from minority ethnic groups (Hispanic 23%, Black 24%) and had a higher prevalence of diabetes mellitus (46%). COVID+ patients were more likely to experience cardiogenic shock (18%) but less likely to undergo invasive angiography (78%) (all $p < 0.001$ compared with control patients). Among COVID+ patients who underwent angiography, 71% underwent PCI (PPCI) and 20% received medical therapy (significantly compared with control patients). The primary outcome occurred in 36% of COVID+ patients, 13% of PUI, and 5% of control patients ($p < 0.001$ vs. control patients). The researchers concluded that patients with COVID+ and BMI ST represent a high-risk group with unique demographic and clinical characteristics. PPCI for this infection is technically feasible and remains the predominant reperfusion strategy, supporting current recommendations.

Data from the Swiss Cardiovascular SARS-CoV-2 Consortium were analyzed in the work of employees of the Department of Cardiology of the Bern University Hospital Inselspital, Bern, Switzerland, Koskinas KC et al. [14]. Between March 2020 and February 2022, 538 patients were enrolled in the study, including 122 acute cardiac events and 416 controls. The mean age was 68.0 ± 14.7 years, and 75% were male. Compared with controls, SARS -COV-2-positive patients were more likely to have acute heart failure (35% vs. 17%) or sustained arrhythmia (31% vs. 9%), but less likely to have acute coronary syndrome (26% vs. 53%) or severe aortic stenosis (4% vs. 18%).

Mortality was significantly higher in cases compared with inpatient controls (16% vs. 1%), at 30 days (19.0% vs. 2.2%), and at 1 year (28.7% vs. 7.6%); this was driven primarily (up to 30 days) and exclusively (at 1-year follow-up) by higher non-CVD mortality and was accompanied by a higher incidence of worsening renal function. The researchers concluded that patients hospitalized for acute heart disease with SARS-COV-2 infection had higher all-cause mortality throughout the 1-year follow-up period. The study results highlight the need for effective, multifaceted management of both cardiac and non-cardiac disease and long-term follow-up of patients with acute cardiac disease complicated by SARS-COV-2 infection.

Impact of COVID-19 on mortality in patients with ST-segment elevation myocardial infarction hospitalized during a national outbreak in Italy was analyzed from a nationwide, universal administrative database of re-examined patients with BMI ST hospitalized during the COVID-19 quarantine (March 11–May 3, 2020) and similar periods over the previous 5 years in Italy in a staff study Department of Cardiothoracic and Vascular Medicine and Surgery AO San Camillo-Forlanini (Rome, Italy), [15]. The study found that the observed rate of 30-day and 6-month all-cause mortality in patients with BMI ST with and without COVID-19 infection during quarantine was compared with the expected mortality rate according to the trend of the previous 5 years. During the study period, 32,910 hospitalizations of patients with ST-segment elevation BMI were recorded in Italy. Among them, 4048 patients with BMI ST were hospitalized during the 2020 outbreak: 170 (4.2%) with a diagnosis of COVID-19 and 3878

(95.8%) without a diagnosis of COVID-19. Based on the 5-year trend, the 2020 expected 30-day and 6-month all-cause mortality rates were 9.2% and 12.6%, while observed deaths were 10.8% and 14.4%, respectively. Excluding BMI ST patients diagnosed with COVID-19, the mortality rate was consistent with the previous 5-year trend. After multiple adjustments, having a COVID-19 diagnosis was an independent predictor of all-cause mortality at 30 days [adjusted odds ratio (OR) 4.5] and 6 months (OR 3.6). The authors concluded that during the 2020 national outbreak in Italy, COVID-19 infection significantly increased the mortality trend in patients with BMI ST.

The study by the Paris Cardiovascular Research Center PARCC (Paris, France, 2021) used data from a national survey in France and analyzed data from follow-up examinations of patients with BMI ST from 65 centers referred for urgent revascularization between March 1 and May 31 2020 and from March 1 to May 31, 2019. The primary outcome was in-hospital death or nonfatal mechanical complications of acute myocardial infarction. A total of 6306 patients were included in the analysis. It was found that during the peak of the pandemic there was a decrease in the number of hospitalizations with STEMI by 13.9 ± 6.6% per week. Delays between symptom onset and percutaneous coronary intervention were longer in 2020 compared to 2019 (270 [IQR 150–705] vs. 245 [140–646] minutes), driven by increased time from symptom onset to first presentation.

physician (121 [60-360] vs. 150 [62-420] minutes. More mechanical complications were observed during 2020 (0.9% vs. 1.7%), resulting in a significant difference in the primary outcome (112 patients [5.6%] in 2019 versus 129 [7.6%] in 2020 There was no significant difference in the incidence of orotracheal intubation, in-hospital cardiac arrest, ventricular arrhythmias, and cardiogenic shock. The researchers concluded that during the former. During the peak of the COVID-19 pandemic in France, there was a decrease in the number of hospitalizations with BMI associated with increased ischemic time, solely due to increased delays associated with patient treatment and increased mechanical complications. The results indicate the need to encourage the population to seek medical attention when cardiac arrest occurs. vascular symptoms [16].

In a study by members of the American Department of Cardiology, Westchester Medical Center, New York Medical College (Valhalla, New York, USA), the 2020 national inpatient sample database was queried to identify all hospitalizations among adults with a primary diagnosis of ST UTI, with with and without concomitant COVID-19. Data on 159,890 hospitalizations were presented and analyzed patients with ST-segment elevation myocardial infarction (ST-BMI), of which 2210 (1.38%) had concomitant COVID-19. After propensity matching, BMI ST patients with comorbid COVID-19 had significantly higher mortality (17.8% vs. 9.1%, or 1.96), and a lower likelihood of receiving same-day percutaneous coronary intervention (PCI) (63.6% vs. 70.6%, with a trend toward lower overall PCI rates (74.9% vs. 80.2%) and significantly fewer coronary artery bypass grafting procedures: 3.0% vs. 6.8%) before discharge, compared to patients with BMI ST without COVID-19. The incidence of cardiogenic shock, need for mechanical circulatory support, extracorporeal membrane oxygenation, cardiac arrest, acute kidney injury (AKI), dialysis, major bleeding, and stroke did not differ significantly between groups. Patients with COVID-19-positive BMI ST who underwent same-day PCI had significantly lower odds of in-hospital mortality (adjusted OR 0.42). The authors concluded that patients with ST UTI with co-infection with COVID-19 had significantly higher (almost 2-fold) in-hospital mortality and lower odds of undergoing same-day PCI, total (any day) PCI, and on-time CABG. hospitalization compared to patients with ST UTI without COVID-19 [17].

The coronavirus disease 2019 (COVID-19) pandemic has had a significant impact on global health systems. A number of studies have reported a negative impact of COVID-19 on the prognosis of patients with ST-segment elevation myocardial infarction (IMI ST), including a study by the Cardiovascular Intensive Care Unit, Japan Medical School Hospital assessing the impact of the COVID-19 pandemic on patients with BMI ST admitted to an academic tertiary care center in Tokyo, Japan. This retrospective observational cohort study included data from 398 consecutive patients admitted from January 1, 2018 to March 10, 2021, and compared hospitalization rates, clinical characteristics, course, management, and outcomes before and after March 11, 2020, the date on which the World Health Organization The health organization has declared COVID-19 a pandemic. According to the data obtained by the authors, the number of hospitalizations of patients with BMI ST during the COVID-19 pandemic decreased by 10.7% compared to the previous year (117 cases versus 131 cases). During the COVID-19 pandemic, the incidence of late onset was significantly higher (26.5% versus 12.1%) and early onset [241 (IQR: 70-926) versus 128 (IQR: 66-493) minutes] and door-to-balloon time [72 (IQR: 61-128) vs. 60 (IQR: 43-90) minutes, $p<0.001$] were significantly longer than the previous year. In addition, in-hospital mortality was higher, but the difference was not significant (9.4% vs. 5.0%). In conclusion, the authors noted that the COVID-19 pandemic had a significant impact on patients with BMI ST in Tokyo and resulted in a small decrease in hospitalizations, a significant increase in late presentations and delays in treatment, and a slight increase in mortality. During the COVID-19 pandemic, the emergency treatment system for ST UTI in Japan should be reorganized [18].

In an Israeli retrospective cohort study of Clalit Health Services patients treated for AMI at multiple hospitals, authors from the Department of Planning and Strategy, Tel Aviv, Ruth and Bruce Rappaport Faculty of Medicine, Technion, Israel Institute of Technology (Haifa, Israel). examined patient characteristics and 30-day mortality during three 5-week phases of the first wave of the COVID-19 pandemic in Israel: before quarantine (N = 702), during quarantine (N = 584), and after quarantine was lifted (N = 669). They compared data for the same period in 2018 and 2019. Patient diagnoses were stratified by ST-segment elevation myocardial infarction (ST-segment elevation myocardial infarction) and non-ST-segment elevation myocardial infarction (ST-BMI). It was found that the number of hospitalizations for AMI during quarantine was 17% lower than in the period before quarantine (frequency rate - 0.83), and 22% and 31% lower than in the corresponding periods of 2018 and 2019, respectively. The decline was mainly due to non-STEMI hospitalizations (26% lower than pre-lockdown 2020). The number of hospitalizations for both ST and non-STI UTIs was moderately reduced in the

post-lockdown period compared to the corresponding periods in 2018 and 2019. The 30-day mortality rate was similar in all periods assessed. The researchers concluded that the number of hospitalized patients with AMI during the first COVID-19 lockdown and post-lockdown was significantly reduced, without significant changes in 30-day mortality rates [19].

A US cross-sectional study retrospectively analyzed AMI hospitalizations occurring between December 30, 2018 and May 16, 2020 at 49 Providence Saint Joseph Health System hospitals located in 6 states (Alaska, Washington, Montana, Oregon, California and Texas). The cohort included patients aged 18 years or older who had a primary diagnosis of AMI at discharge (ST-segment elevation myocardial infarction [STEMI] or non-ST-segment elevation myocardial infarction [NSTEMI]). Segmented regression analyzes were performed to assess changes in weekly case counts. Cases were grouped into 1 of 3 periods: pre-COVID-19 (December 30, 2018 to February 22, 2020), early COVID-19 (February 23, 2020 to March 28, 2020), and post-COVID -19 (from March 29, 2020 to May 16, 2020). In-hospital mortality was risk-adjusted using the observed-to-expected (O/E) ratio and a covariate-adjusted multivariate model. The cohort included 15,244 hospitalizations for AMI (of which 4,955 were hospitalized for ST UTI [33%] and 10,289 for NST UTI [67%]) involving 14,724 patients (mean age 68 [13] years and 10 019 men [66%]). It was found that starting February 23, 2020, the number of AMI-related hospitalizations decreased at a rate of -19.0 cases per week for 5 weeks (early COVID-19 period). Thereafter, AMI-related hospitalizations increased by +10.5 cases per week (later COVID-19 period). There were no significant differences in patient demographics, cardiovascular comorbidities, or treatment approaches between periods. The mortality rate from AMI increased in the early period (odds ratio, 1.27), which was disproportionately associated with patients with ST BMI (OR, 1.96). Although the O/E mortality ratio for AMI was not statistically different in the later period (1.23), an increase in the O/E mortality ratio was noted in patients with BMI ST (2.40) and after risk adjustment (odds ratio 1.52). The observed (overall) in-hospital mortality rate was similar across time periods for all groups. However, compared with the pre-COVID-19 period, patients with IMI ST had a statistically higher risk of mortality in the later COVID-19 period after adjusting for patient demographics and comorbidities (OR, 1.52). Using the PSJH model, the ratio of observed to expected in-hospital mortality (O/E) for patients with AMI was statistically increased in the early period of COVID-19 (O/E ratio 1.27), with consistent results in the later period (O/E ratio E 1.23). However, these results differed in patients with ST UTI compared with patients with NSTEMI UTI. In patients with ST UTI, the O/E mortality ratio was significantly higher in all 3 COVID-19 periods. In these patients, there was a gradual increase in the O/E mortality ratio from the earlier period (O/E ratio 1.48) to the early (O/E ratio 1.96) and later (O/E ratio 2.40) periods. The BMI ST/E mortality ratio in the later period was statistically higher than in the earlier period. In contrast, patients with NSTEMI had a consistently lower O/E mortality ratio across all 3 periods (pre: O/E ratio, 0.80); in the early stages: O/E ratio 0.91; in later stages: O/E ratio 0.71). There were notable differences in risk-adjusted mortality over the periods analyzed. Patients hospitalized for AMI in the early period of COVID-19 had an increased O/E mortality ratio, disproportionately associated with patients with BMI ST. In this population, O/E ratios and risk-adjusted mortality rates were even higher in the later COVID-19 period. Based on the results of the analysis, it was concluded that changes in AMI hospitalization rates and worse outcomes were observed during early and late periods of COVID-19 [20].

The nature of the main trends and changes in the provision of emergency care to patients with covid-19 and ACS in several regions of the world was analyzed in a meta-analysis by German authors from the Department of Cardiology and Angiology, Robert-Bosch-Krankenhaus (Stuttgart, Germany) [21]. According to them, in the cardiology community, the care of patients with acute coronary syndrome in general and ST-segment elevation myocardial infarction (ST-segment elevation myocardial infarction) in particular has undergone very important changes during the pandemic. Several studies have shown that the number of patients with acute coronary syndrome has decreased during the pandemic compared to pre-pandemic periods [22]. A pan-European study found that patients with BMI often present to hospitals so late that the optimal time frame for emergency primary percutaneous coronary intervention has already passed [23]. In an analytical review, Italian researchers from the Department of Experimental and Clinical Medicine, University of Florence (Florence, Italy). assessed how the SARS-CoV2 pandemic affected health care for patients with BMI ST [24]. When comparing the number of hospitalizations of more than 111,000 patients with BMI in different countries, it was shown that their number decreased by 20% [21].

Thus, in patients with a verified diagnosis of covid-19, the prevalence of acute myocardial damage according to the diagnosis of biochemical markers of myocardial damage varied from 5% to 38%, depending on the criteria used. The COVID-19 pandemic has significantly impacted systems of care for patients with UTI worldwide, threatening timely access to reperfusion therapy. According to several national registries in the cardiology community, medical care for patients with acute coronary syndrome in general and with ST-segment elevation myocardial infarction (ST-segment elevation myocardial infarction) has undergone very important changes during the pandemic.

Several studies have shown that the number of patients with acute coronary syndrome has decreased during the pandemic compared to pre-pandemic periods and that hospitalizations and care for these patients have decreased by 20%. Based on the results of the analysis, it was noted that There were changes in the rate of hospitalization of patients with AMI and worsening outcomes in the early and late periods of COVID-19. Primary percutaneous coronary intervention remained the dominant reperfusion strategy during this period, with no difference in time from onset of first symptoms to balloon compared with the pre-Covid period.

Features of Providing Medical Care and Conducting Instrumental and Drug Treatment for Patients Covid-19 Hospitalized with Acute Coronary Syndrome and Myocardial Infarction (AMI)

Possible impact of infection COVID-19 on treatment patterns and outcomes of hospitalized patients with acute myocardial infarction (AMI) has been assessed in a number of controlled studies. One of these, an English study by authors from the

University of Leeds (UK), was analyzed to determine whether the COVID-19 pandemic changed the response of patients to hospital treatment and mortality from AMI [25]. Based on an analysis of hospitalizations of patients with acute myocardial infarction (AMI) and COVID-19 in 99 hospitals in England, a study was conducted as part of the National Myocardial Ischemia Audit Project to assess the nature and effectiveness of treatment provided. Hospitalizations were classified as non-ST-segment elevation myocardial infarction (NSTEMI) or real-time STEMI between January 1, 2019, and May 22, 2020. Time series plots were evaluated using a seasonally adjusted 7-day simple moving average. It found that since 23 March 2020 (UK lockdown), median daily hospital admissions have fallen more for NSTEMI [from 69 to 35; incidence-risk ratio (IRR) 0.51 than STEMI (35 to 25; IRR 0.74) to the April 19, 2020 low.

Patients treated during quarantine were younger (mean age 68.7 vs. 66.9 years), less likely to have diabetes (24.6% vs. 28.1%) or have cerebrovascular disease (7.0% vs. 8.6%). In ST-segment elevation myocardial infarction, primary percutaneous coronary intervention was performed more often (81.8% vs. 78.8%), the proportion of thrombolysis was insignificant (0.5% vs. 0.3%), and the average duration of coronary angiography for NSTEMI decreased (26 .2 versus 64.0 hours), the average length of hospitalization decreased (from 4 to 2 days), the frequency of prescription of pharmacotherapy for secondary prevention remained unchanged (in > 94.7% of patients). Mortality at 30 days increased with NSTEMI [5.4% to 7.5%; odds ratio (OR) 1.41], but decreased in STEMI (from 10.2% to 7.7%; OR 0.73). Based on the results of the analysis, the authors concluded that During the COVID-19 pandemic, there was a significant decrease in the number of hospitalizations with AMI, those who went to the hospital were younger, with fewer comorbidities, but with NSTEMI they had a higher 30-day mortality rate.

Using data from a Spanish multicenter, nationwide, retrospective observational registry of consecutive patients followed in 75 specialized centers for the treatment of ST-elevation AMI in different regions of Spain, researchers from the Institut del Cor, Hospital Universitari Germans Trias i Pujol, Badalona, Barcelona (Spain), [26]. compared patient and procedure characteristics and hospitalization outcomes in 2 different cohorts with 30-day follow-up, depending on whether patients received treatment before or after COVID-19. In the analysis, there were no differences in reperfusion strategy (more than 94% of patients were treated with primary percutaneous coronary intervention in both groups). Patients receiving primary percutaneous coronary intervention during the COVID-19 outbreak had longer cardiac ischemia time (233 [150–375] vs. 200 [140–332] minutes, but there was no difference in time from first presentation to reperfusion. The number of patients with suspected ST UTI treated in ST IMS networks decreased by 27.6%, and the number of patients with confirmed ST UTI decreased from 1305 to 1009 (22.7%). In-hospital mortality was higher during COVID-19 (7.5% vs. 5.1%; unadjusted RR, 1.50); this association remained after adjustment for risk factors (risk-adjusted HR, 1.88). In the 2020 cohort, the rate of confirmed SARS-CoV-2 infection during hospitalization was 6.3%. The researchers concluded that the number of patients with BMI ST treated during the current COVID-19 outbreak decreased compared to the previous year, while the mean time from symptom onset to reperfusion increased and the in-hospital mortality rate doubled. There were no changes in reperfusion strategy, and the vast majority of patients underwent primary percutaneous coronary intervention. The combination of IMI ST and SARS-CoV-2 infection was relatively rare.

US authors from the Department of Anesthesiology and Perioperative Medicine, University of Rochester School of Medicine, (Rochester, New York, USA), in a cross-sectional study, attempted to assess whether the COVID-19 pandemic was associated with increased disparities in treatment and outcomes among Medicare patients. hospitalized with AMI [27]. They analyzed data on patients hospitalized with AMI between January 2016 and November 2020. Of the 1,319,273 hospitalizations for AMI (579,817 women [44.0%]; 122,972 blacks [9.3%], 117,668 Hispanics [8.9%], and 1,078,633 whites [81.8%] were included; mean age 77 [8.4] years). In patients with non-ST-segment elevation MI (NSTEMI), the overall adjusted odds of mortality and hospital discharge increased by 51% (adjusted odds ratio [aOR 1.51] and 32% (aOR 1.32), respectively, and the odds of revascularization decreased by 27% (aOR, 0.73) among patients hospitalized during weeks with high COVID-19 hospital burden (>30%), compared with patients hospitalized before the pandemic. Black patients with NSTEMI experienced a clinically nonsignificant increase in the odds of mortality. 7% (aOR, 1.07) for every 10% increase in hospital caseload for COVID-19, but no increase in readmissions or community discharges, or the rate of revascularization decreased compared to white patients. The authors concluded that the increase in COVID-19 burden in Rochester hospitals in the United States was not associated with changes in outcomes or use of revascularization by BMI ST overall or by racial or ethnic group.

Initial data from the North American COVID-19 Myocardial Infarction Registry (NACMI) were presented in a report from the Minneapolis Heart Institute Foundation. Minneapolis (Minnesota, USA) Santiago Garcia et.al. [13]. Patients with BMI ST and confirmed COVID+ infection (group 1) or suspected (group 2) of COVID-19 infection (PUI) were included. A group of age- and sex-matched BMI ST patients (matched to COVID+ patients in a 2:1 ratio) treated pre-COVID (2015 to 2019) served as a control group to compare treatment strategies and outcomes (group 3). The primary outcome was in-hospital death, stroke, reinfarction, or repeat unplanned revascularization.

As of December 6, 2020, 1185 patients (230 COVID+, 495 PUI, and 460 control patients) were enrolled in the NACMI registry. COVID+ patients were more likely to be from minority ethnic groups (Hispanic 23%, Black 24%) and had a higher prevalence of diabetes mellitus (46%). Patients with COVID+ were more likely to experience cardiogenic shock (18%), but less likely to undergo invasive angiography (78%) (all differences were significant compared to control patients). Among COVID+ patients who underwent angiography, 71% underwent PCI (PPCI) and 20% received medical therapy (significantly compared with control patients). The primary outcome occurred in 36% of COVID+ patients, 13% of PUI and 5% of control patients (significant compared with control patients). The researchers concluded that patients with COVID+ and BMI ST represent a high-risk group with unique demographic and clinical characteristics. PCI (PPCI) for this infection is

technically feasible and remains the predominant reperfusion strategy, supporting current US guidelines [7].

In a study by Turkish specialists from the Department of Cardiology, Turkish University of Medical Sciences, Sisli Hamidiye Etfal Teaching and Research Hospital, (Istanbul, Turkey), [28]. angiographic data after mechanical revascularization and troponin levels were compared in one hundred and sixty-five patients with ACS (infarction myocardium with ST elevation in 6 of 2.4% of cases) who underwent percutaneous coronary intervention between March 1 and June 30, 2020. A polymerase chain reaction test was performed in case of suspicious symptoms or typical CT scan findings. Twenty-six patients (15.7%) tested positive for COVID-19. Angiographic parameters of thrombolysis were assessed by the number of frames after myocardial infarction (TFC) and the degree of myocardial redness (MBG), in myocardial infarction (TIMI), which are indicators of successful angiographic reperfusion. The Thrombolysis in Myocardial Infarction (TIMI) frame counting method was developed as a continuous measure of coronary blood flow, allowing for objective and reproducible assessment and thus overcoming the limitations of the traditional TIMI flow scoring system. The MBG score was developed as a more direct way to assess myocardial perfusion and has proven to be a useful parameter in predicting mortality after primary percutaneous coronary intervention (PCI), [29]. COVID-19 has previously been shown to be associated with arterial and venous complications. However, there is still insufficient data on the effect of the disease on coronary microcirculation. In the cited study, the authors sought to evaluate the nature and severity of microvascular abnormalities after primary PCI in COVID-19 patients with ACS using angiographic TFC-corrected (cTFC) and MBG indices. Higher TFC values were observed in patients with COVID-19, but significantly lower MBGs parameters (grades 0 and 1).

Peak troponin-I values were also higher in the COVID-19 group (27,335 vs. 15,959 ng/dL). Patients with COVID-19 were more likely to have pathologically low left ventricular ejection fraction values (37.5% vs. 50.6%). Case fatality rates were higher in patients with COVID-19 (38.4% vs 7.2%). According to the authors, T FC values and ejection fraction may be associated with in-hospital mortality rates among COVID-19 patients with ACS, according to the results of logistic regression. In correlation analysis, TFC was positively correlated with C-reactive protein level (r=0.340) and peak troponin-I value (r=0.369). The researchers concluded that COVID-19 is associated with slowing coronary blood flow and impaired microvascular circulation in patients with ACS.

The Society of Cardiac Angiography and Interventions (SCAI) and the European Association of Percutaneous Cardiovascular Interventions (EAPCI) have considered PCI as the standard treatment for patients with ST UTI during the COVID-19 pandemic [30,31]. In-hospital outcomes of patients with BMI who underwent PCI during the quarantine period from January 15, 2019 to April 14, 2020 according to the France PCI registry were analyzed in a report by Rangé G. et al. [32]. In analysis 2064 patients with ST UTI who underwent PCI were included: 1942 in the pre-quarantine group and 122 in the quarantine group. A significant reduction (12%) in the average number of UTIs per month was observed in the quarantine group compared with the pre-quarantine group (139 versus 122). The researchers noted a significant increase in the delay from the onset of symptoms to the first visit to the doctor for patients who went directly to the emergency department (ED) (238 minutes vs. 450 minutes). The quarantine group had higher rates of hospitalization and in-hospital major adverse cardiovascular events (MACE: death, stent thrombosis, myocardial infarction, unplanned coronary revascularization, stroke, and major bleeding), (7.7% vs. 12.3%) and mortality (4.9% vs. 8.2%), but the differences were not statistically significant. The researchers concluded that from a multicenter PCI registry, the COVID-19 outbreak in France was associated with a significant reduction in ST UTIs during PCI and longer transfer times for patients presenting directly to those presenting directly to the emergency department (ED). Death rates doubled, but the difference was not statistically significant.

Patients with ST-segment elevation myocardial infarction (ST-segment elevation myocardial infarction) treated during the COVID-19 pandemic may require longer time to reperfusion. Delayed reperfusion may potentially increase the risk of out-of-hospital cardiac arrest (OHCA) in these patients. Limited access to health care, greater reluctance to seek care, and willingness of bystanders to provide life-saving interventions may further contribute to the perceived variation in OHCA risk in ST UTI. Polish cardiologists from the Center for Invasive Cardiology, Electrotherapy and Angiology (Nowy Sacz, Poland) studied the impact of the COVID-19 outbreak on the timeliness of cardiac treatments and clinical outcomes of patients with BMI ST with OHCA [33].

A total of 5,501 patients with ST UTI complicated by OHCA who underwent primary percutaneous coronary intervention with stent implantation were included in the study. Propensity score matching was used to exclude the possible influence of non-randomized design. A total of 740 pairs of patients with IMI ST and OHCA treated before and during the COVID-19 pandemic were compared. It was found that both groups had similar mortality rates and the prevalence of periprocedural complications. However, patients treated during the COVID-19 outbreak experienced a longer delay from first presentation to angiography (88.8 ± 61.5 versus 101.4 ± 109.8 minutes). There was also a trend toward an increase in the time from the onset of a painful attack to angiography in patients admitted to the hospital during the pandemic era (207.3 ± 192.8) versus 227.9 ± 231.4 minutes). The authors concluded that periprocedural outcomes for BMI ST complicated by OHCA were comparable before and during the COVID-19 pandemic. However, treatment during the COVID-19 outbreak was associated with a longer time period from first presentation to reperfusion.

In a Chinese-American study of specialists from the Department of Global Health, School of Public Health, Peking University (Beijing, China) and the Department of Health Policy and Management, University of Maryland at College Park (Maryland, USA), the results of hospitalization and specialized medical care were assessed. help [34]. The authors assessed primary and secondary indicators. The primary outcome was the rate of BMI readmissions at the end of the month, and secondary outcomes were measures of quality of care for BMI patients. The number of daily hospitalizations during and after the outbreak fell by

53% and 38%, respectively, compared to the corresponding period in 2019. There remained a gap in the actual number of breakthrough hospitalizations at 306 and the predicted number at 497. 26 deaths due to ST UTI were associated with failure to seek care. The researchers concluded that in the postoperative period of 2020, compared with the corresponding period in 2019, the percentage of cases of hospitalized patients with UTI ST and COVID-19 by ambulance decreased from 9.3% to 4.2%, the average door-to-balloon time increased from 17.5 to 34.0 minutes, and the rate of percutaneous coronary interventions (PCI) decreased from 71.3 % to 60.1%.

In a study by American cardiologists from the Levine Cardiac Intensive Care Unit on Thrombolysis in Myocardial Infarction (TIMI), the Cardiovascular Department of Medicine, Brigham and Women's Hospital and Harvard Medical School (Boston, Massachusetts), an analysis of data from patients included in the American Association of Cardiovascular Diseases Registry was conducted.

COVID-19 hearts based on ST-segment elevation myocardial infarction (STEMI) statistics hospitalized for COVID-19 from January 14, 2020 to November 30, 2020 from 105 sites [12].

Patient characteristics, resource utilization, and clinical outcomes were summarized and compared according to the presence or absence of IMI ST. Among 15,621 COVID-19 hospitalizations, 54 (0.35%) patients had a BMI. Of patients with IMI ST, the majority (n=40.7%) underwent transthoracic echocardiography, but only half (n=27.5%) underwent coronary angiography. A minority of patients with COVID-19 and STEMI (n=27.5%) did not receive any primary reperfusion therapy. The incidence of shock from all causes was (47% vs 14%), cardiac arrest (22% vs 4.8%), acute heart failure (17% vs 1.4%) and need for renal replacement therapy (11% vs 4.8%). 3%) were many times higher in patients with ST UTI compared to patients without ST UTI (the difference was significant for all indicators). The rate of in-hospital death was 41% in patients with BMI ST compared with 16% in patients without BMI ST. The researchers concluded that ST BMI in hospitalized patients with COVID-19 is rare but is associated with adverse in-hospital outcomes.

Rates of coronary angiography and primary reperfusion were low in this population of patients with ST BMI and COVID-19, and adaptation of health care systems is necessary to provide timely, modern treatment to this population.

In a Polish study of employees from the Rheumatology Department of a provincial hospital (Kunsk, Poland), The authors analyzed the course of the disease in 29,915 patients with BMI ST, of which 3,139 (10.5%) underwent thrombectomy. COVID-19 (+) infection was reported in 311 (10.8%).

The analysis compared the clinical characteristics and features of management of BMI ST in patients with COVID-19 (+) and COVID-19 (-). Multivariate logistic regression analysis was performed to search for factors influencing thrombectomy outcomes. The results showed that patients with COVID-19 (+) had a higher Killip heart failure class (Class IV; n = 33 (12.3%) vs. n = 138 (5.8%). Arrest heart disease at baseline was more common in this group (n = 25 (8.0%) vs. n = 137 (4.8%). Thrombolysis in myocardial infarction (TIMI) 3 after percutaneous coronary intervention was performed less frequently (n = 248 (80.5%) compared to n = 2388 (87.1%) in the COVID-19 (-) group. Periprocedural mortality was similar in both groups (n = 28 (0.99%) vs n = 4 (1.29%). In multivariate regression analysis, COVID-19 was found to increase the risk of thrombectomy (OR = 1.23; relative risk) The researchers concluded that patients with BMI ST who underwent aspiration thrombectomy and had COVID-19 (+) were more likely to be in severe clinical condition (higher Killip class, more frequent episodes of asystole before the procedure than those with COVID-19). patients with COVID-19 (-) Despite more intensive antiplatelet and anticoagulant treatment, PCI procedures were less likely to result in optimal response TIMI-3 is an independent strong predictor in patients to undergo aspiration thrombectomy for BMI ST [35].

A high incidence of stent thrombosis in COVID-19-positive patients with ST BMI in a multicenter retrospective case series study spanning 4 countries was noted by authors from Baylor University Medical Center, Dallas, Texas (USA), [36]. Researchers analyzed the records of patients admitted with symptomatic COVID-19 infection and STEMI in hospitals in Italy, Lithuania, Spain and Iraq from February 1, 2020 to April 15, 2020. A total of 78 patients were included in this study, 49 (63%) of whom were men, with a mean age of 65 [58,71] years and high comorbidity. During hospitalization, 8 (10%) developed acute respiratory distress syndrome and 14 (18%) required mechanical ventilation. 19 (24%) patients underwent primary percutaneous coronary intervention (PCI) and 59 (76%) received fibrinolytic therapy. 13 (17%) patients required cardiac resuscitation and 9 (11%) died. Of the 19 patients who received primary PCI, 8 (42%) required intubation and 8 (42%) required cardiac resuscitation. Stent thrombosis was diagnosed in 4 patients (21%). A total of 5 patients (26%) died during hospitalization. Fifty (85%) of 59 patients initially treated with fibrinolytic therapy had successful fibrinolysis. The average time to reperfusion was 27 minutes.

Hemorrhagic stroke occurred in 5 patients (9%). Six patients (10%) required invasive mechanical ventilation; 5 (9%) required cardiac resuscitation and 4 (7%) died. In conclusion, the authors noted the high incidence of stent thrombosis and the possible need to adapt antithrombotic therapy in patients with COVID-19 and STEMI.

Efficiency and safety of primary percutaneous coronary intervention in the hospital in patients with BMI ST, against the background of concomitant infection with COVID-19 were analyzed by staff at the British Heart Center Barts between 1 March 2020 and 20 May 2020 in English a single-centre observational study by interventionists at St Bartholomew's Hospital (London), [37]. In 115 consecutive patients with confirmed BMI ST, there were significantly higher rates of multivessel thrombosis, stent thrombosis, modified post first thrombus removal device use, followed by increased use of glycoprotein IIb/IIIa inhibitors and thrombus aspiration. At their receipt higher levels of troponin T and lower lymphocyte counts, but increased levels of D-dimer and C-reactive protein were found. The degree of myocardial redness and left ventricular function were significantly lower in COVID-19 patients with BMI ST. The analysis also noted

the use of higher doses of heparin to achieve therapeutic partial activated thromboplastin clotting times. Patients with BMI ST who had COVID-19 infection had longer hospital stays and were more likely to receive intensive care. The authors concluded that in patients with BMI ST and concomitant COVID-19 infection, there is a clear shift in the hemostatic system towards a higher thrombotic load and worse outcomes. This confirmed the need to assess the status of patients with COVID-19 in all cases of BMI ST and conduct further research to more fully understand the main risk factors and mechanisms of increased risk of arterial thrombosis, as well as the development of aggressive antithrombotic therapy in individual cases.

The main results and conclusions from the work of this group of English angiologists were discussed in several thematic reviews and in a journal, editorial Am Coll Cardiol September 2020 Magazine editor Dauerman HL [38]. from the University of Vermont Larner College of Medicine Burlington, Vermont (USA), suggested that There are unique features of the PCI procedure in patients with acute lesions caused by a virus that require caution and additional techniques when performing it. He noted that in a detailed angiographic comparison with a control group with a negative COVID-19 result, the authors a sharp increase in thrombotic load was observed, which may complement previous understanding of the pathophysiology of coronary injury in patients during the COVID-19 pandemic. The conclusion drawn from this study of ST BMI associated with COVID-19 suggests that performing primary PCI is technically more difficult in the setting of acute coronavirus infection [3,7]. High thrombus burden (modified thrombus grade 4/5) was twice as common in patients with COVID-19 and STEMI compared to patients without COVID-19 (75.0% vs. 31.4%). Multivessel thrombosis was observed in 17.9% of COVID-19 patients with BMI ST and none in the COVID-19 negative group, and stent thrombosis as the initial presentation was also 10 times more likely for both comparisons [3,9]. The difficulty of performing angiography has led operators to increasingly use glycoprotein IIb/IIIa inhibitors and thrombectomy to treat these difficult lesions [39]. IN in contrast to the data of the authors from New York and Lombardy [40,41], hospital mortality in patients with COVID-19–positive STEMI was not in the range from 40% to 75%; a was slightly higher than in the COVID-19-negative group (by 17.9% in COVID-19-positive compared to 6.5% in COVID -19 negative). These mortality data were consistent with the severity of cardiac damage in this category of patients , given that approximately one-quarter of COVID-19-positive patients experienced cardiac arrest. And studies of primary PCI in patients IC ST in the pre-Covid period demonstrated increased mortality among patients with a large number of coronary thrombi [42]. The experience of London interventionists, with reasonable procedural time parameters and pathology-appropriate outcomes, supports proposals recommending effective primary PCI programs as a routine strategy for patients with ST BMI during the COVID-19 pandemic [7,41]. The peculiarity of this coronary defeats is that t three quarters of patients with COVID-19-positive STEMI have a high burden of coronary thrombi. It is associated with a pronounced inflammatory reaction that occurs against the background of COVID-19 infection [43].

This inflammatory response to the virus can be assessed using a number of serological parameters, including C -reactive protein a and D-dimer a [44]. The connection between inflammation and thrombosis has been established previously and occurs through the activation of leukocytes, platelets, endothelium and smooth muscle cells [45]. The association of viral infection and increased risk of myocardial infarction has previously been described for influenza, and an inflammatory risk factor is likely [46,47]. Infection with the COVID-19 virus causes an intense inflammatory response that promotes thrombosis in multiple vascular beds , with large numbers of STEM-associated thrombi being one of many potential manifestations. The development of a hypercoagulable state in critically ill patients with COVID-19 has been demonstrated using thromboelastography [48]. The clinical manifestations of the inflammation-thrombosis-hypercoagulation cascade are supported by research data identifying an increased risk of inflammation in the venous bed with the development of deep vein thrombosis, pulmonary embolism, disseminated intravascular coagulation and stroke among patients with COVID-19 [44].

A comparison of the incidence of ischemic strokes in patients with COVID-19 compared with data from patients with influenza infection revealed an increased incidence of ischemic strokes associated with COVID-19 (odds ratio: 7.6) [49]. Although an increased risk of myocardial infarction with viral infection has been described previously [46], COVID-19 may be a particularly aggressive viral infection. A Coronavirus causes an intense inflammatory reaction with the development of thrombosis in several vascular beds. This data may lead to changes in antithrombotic treatment strategies in critically ill patients with COVID-19 [50].

In the comments of French authors from the European Hospital Georges Pompidou, Department of Cardiology, (Paris, France), [51]. in the nature of those cited in the publications of Choudry FA et.al. (2020) data suggest that the optimal anticoagulation regimen in patients with ST BMI with COVID-19 undergoing PCI remains unknown. Of the drugs of this type of action used in international angiological practice, intravenous low molecular weight heparin enoxaparin has a more predictable dose-effect relationship than UFH, provides more stable anticoagulant therapy and does not require monitoring or dose adjustment. This makes it an interesting alternative to UFH in combination with dual antiplatelet therapy, especially as it is consistent with recommendations for the treatment of STEMI [7,52,78] and supported by the effectiveness of low molecular weight heparin in the prevention of venous thrombosis in patients with COVID-19 [44].

Difficulties in choosing tactics and method of revascularization in the treatment of STEMI with COVID-19 were analyzed in detail in a review by American authors Yerasi C, et al. [53]. (53), employees of the Section of Interventional Cardiology, MedStar Washington Hospital Center, Washington, DC, United States of America) from 2020. It was noted that at that time there were no published studies in the literature evaluating various treatment strategies for IMI ST during the pandemic. The reference point could have been the information available at that time from Chinese authors from the People's Hospital of Sichuan Province, Zeng et al. [54]. according to the results of performing thrombolysis in patients with BMI ST, with the onset of symptoms less than 12 hours, and performing PCI only

after the patient has tested negative for COVID-19. The authors recommended a detailed assessment of the risk of spread of infection in comparison with the benefits of PCI, and in unstable patients, conservative treatment until the pneumonia resolves.

However, this approach was difficult to implement for a number of reasons. Many patients had contraindications for thrombolysis (previous stroke or hemorrhagic stroke, active bleeding, advanced age, multiple organ failure, cytokine storm in patients with COVID-19 [43]), inability to identify acute vascular lesions causing coronary syndrome, despite signs STEMI according to ECG data, increased detection of Takotsubo syndrome, myopericarditis, spontaneous dissection of the coronary arteries during acute infections [55,56]. In a pandemic environment, it is inevitable that resource utilization will increase due to the length of stay of patients and complications arising from in the management of thrombolytics. The benchmark was pre-Covid data obtained from an analysis of 29,190 patients with BMI ST from 229 hospitals participating in the Get Using the Guidelines—coronary heart disease (GWTG-CAD) database. In-hospital mortality (fibrinolysis 4.6% vs. primary PCI 3.3%), length of stay (fibrinolysis 4 days vs. primary PCI 3 days) and hospital stay >4 days (fibrinolytics 39% vs. with primary PCI 28%) were significantly higher in the group in which thrombolytics were used [57]. Data obtained during the pandemic showed that approximately 31% of patients with symptoms of COVID-19 may develop acute respiratory distress syndrome [43] and this may be exacerbated by the existing increased risk of alveolar hemorrhage with thrombolytic agents [58].

In a literature review of American researchers from the Georgia Heart Institute, (Gainesville, USA), [59]. on the problem of choosing tactics and revascularization method for the treatment of STEMI with COVID-19, it has been noted that although primary PCI has been the first-line reperfusion strategy for patients with BMI ST in the United States, the incidence of reperfusion strategies targeting fibrinolysis remains approximately 2–13% [60]. Longer reperfusion delays have been reported during the COVID-19 pandemic than in the pre-Covid period. Delayed presentations, lack of adequate early COVID-19 testing, potential hazard to staff, longer assessment times in emergency departments leading to increased D2B time and therefore potential loss of benefit from primary PCI have led to updated proposals for the need for increasing the possibility of using the fibrinolytic method of reperfusion, primarily in selected patients with BMI ST [61].

In a review of English interventionists from Manchester Heart Centre, Manchester Royal Infirmary, Manchester University NHS Foundation Trust, UK (MJD), [62], states that fibrinolytic therapy (FT) was the first effective reperfusion treatment that was systematically used in ST BMI. PCI (PPCI) was subsequently shown to be superior to FT, becoming the standard of care for BMI ST throughout the Western world. However, in geographically isolated areas with low population density, fibrinolytic-based reperfusion strategies persist (2% to 13% of STEMIs in current US practice), [60] as in much of the developing world. This issue was extensively studied in the randomized, controlled STREAM (Strategic Reperfusion Early After Myocardial Infarction) trial, a modern fibrinolytic trial that enrolled patients with BMI ST less than 3 hours after symptom onset who were unable to access PPCI less than 1 hour after the first visit to the doctor. Patients were randomized to FT with PCI at 6–24 hours or PPCI (median difference between fibrinolytic administration and PCI ≥78 minutes). Outcomes of FT compared with PPCI were similar with regard to the incidence of death, shock, heart failure, or reinfarction. The need for emergency angiography in the fibrinolytic sector was 36%; mortality <5% in both groups. Intracranial hemorrhage was higher in FT (1.0% vs. 0.5%). The researchers concluded that when delays in PPCI are unavoidable, the pharmacoinvasive approach is no worse than PPCI in the P2Y12 inhibitor era [63].

Thus, delay in presentation of patients with BMI ST to health care facilities, lack of adequate testing for COVID-19 at an early stage, potential danger to clinic and hospital staff, longer assessment times in emergency departments, accompanied by increased D2B time and, consequently, the potential loss of benefit from primary PCI has led to some preference for the use of fibrinolytic therapy (FT) over primary percutaneous coronary intervention (PCI) for BMI ST. The Sichuan Provincial People's Hospital protocol (2020) prescribed the use of thrombolysis in patients with ST BMI if the onset of symptoms was less than 12 hours, and the use of PCI only after the patient tested negative for COVID-19. The authors also recommended carefully weighing the risk of spreading the infection against the benefit of PCI, and in unstable patients, conservative treatment until the pneumonia resolves. Controlled studies have found that when delays in PPCI are unavoidable, the pharmacoinvasive approach is no worse than the PPCI procedure in the era of P2Y12 inhibitors. PPCI was subsequently shown to be superior to FT, becoming the standard of care for BMI ST throughout the Western world. During the pandemic, interventionalists have found a high incidence of coronary stent thrombosis when using revascularization techniques, indicating a possible need to adapt the ST implantation technique for patients with COVID-19. Despite more intensive antiplatelet and anticoagulant treatment, PCI procedures in patients with ST BMI and COVID-19 were less likely to result in optimal TIMI-3 response than in patients without Covid infection.

Features of Antithrombotic Therapy and Secondary Drug Prevention in Patients with COVID-19 with NSTEMI and STEMI

Coronavirus disease 2019 (COVID-19) may predispose patients to an increased incidence of thrombotic disease in both the venous and arterial circulation due to excessive inflammation, platelet activation, endothelial dysfunction, and congestion. Changes in the hemostatic system in patients associated with COVID-19 suggest the presence of a hypercoagulable state, which may increase the risk of thromboembolic complications [64]. In addition, many patients receiving antithrombotic therapy for thrombotic diseases may develop COVID-19, which impacts the selection, dosing, and laboratory monitoring of antithrombotic therapy. Antithrombotic therapy and prevention is a mandatory component in the treatment of inpatients with covid-19, prescribed by national recommendations of the Russian Federation and in the USA [7,65]. The feasibility of its use is based on the idea of the role of thrombotic disorders in the pathogenesis of organ damage in this pathology.

Many patients with severe COVID-19 exhibit coagulation abnormalities that mimic other systemic coagulopathies

associated with severe infections, such as disseminated intravascular coagulation (DIC) or thrombotic microangiopathy [66]. But COVID-19 has distinctive features. The combination of thrombocytopenia, increased prothrombin time and increased D-dimer indicates DIC, although the pattern is clearly different from the DIC observed in sepsis [67]. In sepsis, thrombocytopenia is usually more severe, and D-dimer concentrations do not reach the high levels observed in patients with COVID-19. In fact, most patients with COVID-19 would not be classified as having DIC according to the International Society of Thrombosis and Haemostasis assessment of DIC [68].

A significant proportion of patients with severe COVID-19 develop, sometimes unrecognized, venous and arterial thromboembolic complications [67,68]. Initial cohort studies indicate that the incidence of thromboembolic complications in patients with COVID-19 is 35-45%. At the same time, the development of coagulopathy in patients with COVID-19 is associated with an increased risk of death [69].

Many controlled studies have shown that the typical manifestation in patients with COVID-19 and coagulopathy is an increased concentration of D-dimer, a relatively mild decrease in platelet count and a prolongation of prothrombin time [70,71]. Patients admitted to the intensive care unit (ICU) had significantly higher median D-dimer concentrations (2.4 mg/L, IQR 0.6–14.4) than patients who did not receive ICU care (0.5 mg/L, 0.3-0.8), [71]. A D -dimer level of more than 1 mg/l was associated in patients with covid-19 with an 18-fold increase in the risk of death [43].

Coronavirus infection is also associated with marked activation of the fibrinolytic system. Endothelial cell damage caused by inflammation can lead to massive release of plasminogen activators, which may explain the high concentrations of D-dimer and fibrin breakdown products in patients with severe COVID-19 [64].

Moderate thrombocytopenia (platelet count <150 × 10 cells per L) can be found in 70-95% of patients with severe COVID-19. Thrombocytopenia in COVID-19 was not found to be a significant predictor of disease progression or adverse outcome [66,71]. Studies conducted over time in patients with COVID-19 have shown that only about 5% of patients have a platelet count of less than 100 × 10 9 cells per liter [70,71].

Mean fibrinogen concentrations in patients with COVID-19 are at the upper limits of normal, presumably as an acute phase response. However, shortly before death, a sudden decrease in plasma fibrinogen levels to a concentration of less than 1.0 g/L was observed in a number of patients with COVID-19 in China. [69].

Thrombotic microangiopathy is usually caused by pathologically increased interaction of platelets with the vessel wall due to ultra-large von Willebrand factor multimers. These multimers are released from damaged endothelial cells and are under normal circumstances cleaved by ADAMTS13 (thrombospondin type 1 repeat disintegran and metalloprotease member 13). In many severe inflammatory conditions, systemic infection results in secondary deficiency of ADAMTS13. There are currently no data on ADAMTS13 concentrations in patients with ACS, MI, and severe COVID-19 infection [64].

Experts suggest that measures for the prevention and treatment of coagulopathies with heparins in patients with ACS, MI and severe infection COVID-19 may have a positive effect on the outcome of the disease. A retrospective study conducted in China included 449 patients admitted to hospital with severe COVID-19 infection. showed lower mortality in patients with COVID-19-associated coagulopathy who received prophylactic heparin than in patients who did not receive anticoagulant treatment (40 [40%] of 99 patients vs. 224 [64%] of 350 patients) in a subgroup patient with a high rate of coagulopathy caused by sepsis [69]. In particular, in patients with elevated D-dimer concentrations (6 times the upper border norms) mortality was lower in patients receiving heparin than in patients not receiving heparin [69].

There is evidence to support the use of low molecular weight heparin (LMWH) at prophylactic doses for the prevention of venous thromboembolism in critically ill patients. [72]. Given the hypercoagulable state of patients with severe COVID-19 and the potential increased risk of thrombosis, it is suggested that all patients with COVID-19 admitted to the hospital receive this prophylactic treatment unless medically contraindicated. If LMWH is not available, unfractionated heparin can be used, although this requires more frequent injections; an alternative is fondaparinux, but whether this drug has the postulated anti-inflammatory properties of heparin is unclear [64].

Patients with severe COVID-19 may require thromboprophylaxis at higher doses than usual due to their hypercoagulable state [73]. and this hypothesis will be tested in several multicenter randomized controlled trials (NCT04372589 , NCT04345848 and NCT04366960).

The nature of coagulation disorders and their role in coronary thrombus formation in patients with covid-19 with confirmed BMI ST were assessed in the above-cited English study by employees of the Department of Cardiology of the Barts Heart Center, St. Bartholomew's Hospital (London, England) [37]. Patients with BMI ST with co-infection with COVID-19 had higher troponin T levels and lower lymphocyte counts, but increased D-dimer and C-reactive protein levels. There were significantly higher rates of multivessel thrombosis, stent thrombosis, higher modified post first thrombus removal device followed by increased use of glycoprotein IIb/IIIa inhibitors and thrombus aspiration. They used higher doses of heparin to achieve therapeutically activated clotting times. The researchers concluded that patients with ST UTI and concomitant COVID-19 infection have a shift in the body's coagulation system toward a higher thrombus burden and worse outcomes.

This confirms the need to establish COVID-19 status in all cases of BMI ST. Further studies are required to clarify the mechanisms of coronary thrombosis and the benefit of aggressive antithrombotic therapy in selected cases of this infection.

Coronavirus disease 2019 (COVID-19) may predispose patients to thrombotic disease in both the venous and arterial circulation due to excessive inflammation, platelet activation, endothelial

dysfunction, and congestion. In addition, many patients receiving antithrombotic therapy for thrombotic diseases may develop COVID-19, which may affect the selection, dosing, and laboratory monitoring of antithrombotic therapy. Moreover, at a time when much attention is focused on COVID-19, it is critical to consider how to optimize available technologies to care for non-COVID-19 patients who have thrombotic diseases, including ACS and acute MI. In a literature review, authors from Columbia University (NewYork-Presbyterian Hospital/ Columbia University, USA) review the current understanding of the pathogenesis, epidemiology, management, and outcomes of patients with COVID-19 who develop venous or arterial thrombosis, patients with pre-existing thrombotic diseases who develop COVID-19, or those who require prevention or treatment of thrombotic diseases during during the COVID-19 pandemic [44]. According to preliminary reports, hemostatic disturbances, including disseminated intravascular coagulation (DIC), have been observed in patients with COVID-19 [74]. In addition, severe inflammatory response, critical illness, and underlying traditional risk factors may predispose to thrombotic complications similar to previous outbreaks of virulent zoonotic coronavirus [75,76]. The authors suggest that the methods used for the treatment of COVID-19 and secondary drug prevention of its complications may have adverse drug interactions with antiplatelet agents and anticoagulants [44,78].

The frequency of prescription of pharmacotherapy for secondary prevention and its effect on the course of MI in selected groups of patients with covid-19 were analyzed in the above-cited study by cardiologists from the Leeds Institute for Data Analysis and the University of Leeds (UK). The authors assessed the impact of the COVID-19 pandemic on patient response, inpatient care patterns and mortality from AMI in 99 hospitals in England as part of the National Myocardial Ischemia Audit Project [25]. The reason for hospitalization was classified as the need for emergency treatment of non-ST segment elevation myocardial infarction (NSTEMI). The researchers found that the frequency of prescription of pharmacotherapy for secondary prevention in the selected groups of patients remained unchanged (exceeding 94% in each). Mortality at 30 days increased with NSTEMI [5.4% to 7.5%; odds ratio (OR) 1.41], but decreased in STEMI (from 10.2% to 7.7%; OR 0.73). The analysis concluded that during COVID-19, patients with NSTEMI had a higher 30-day mortality rate [25].

National standards used in the treatment of patients with complicated forms of Covid-19 provide for a complex of antiviral, antibacterial, antithrombotic, hormonal, anti-inflammatory and symptomatic therapy to improve the prognosis and treatment of hospitalized patients. The possible influence of the nature of the pathogenetic and symptomatic therapy on the course and outcomes of ACS and AMI in patients with covid-19 was analyzed during the period under review only in a small number of clinical studies. Thus, in a prospective study conducted by the Regional Center of Public Health in Milan, the frequency of use of angiotensin-converting enzyme inhibitors and angiotensin receptor blockers for the treatment of arterial hypertension was analyzed [77]. All patients with IMI ST admitted to the institute from February 21 to April 1, 2020 (during the COVID-19 pandemic) were included in the analysis. Patient data were compared with a historical cohort of patients admitted for ST UTI during a similar time period (February 21 to April 1) in 2018 and 2019, in terms of time from symptom onset to hospitalization, clinical characteristics, and in-hospital outcomes. A total of 26 patients were hospitalized for ST UTI during the study period, and 7 (26.9%) of these patients tested positive for coronavirus. At admission, the incidence of symptomatic drug therapy, including the use of angiotensin-converting enzyme inhibitors and angiotensin receptor blockers, was similar between cohorts. The median (interquartile range) time from symptom onset to hospitalization was significantly longer in 2020 compared with the historical cohort (15.0 [2.0-48.0] vs. 2.0 [1.0-3.0] hours). At the same time, in 2020 there was a significantly higher proportion of patients with late ST IMS compared with the historical cohort (50.0% versus 4.8%). Primary percutaneous coronary the intervention was performed in 80.8% of patients in 2020 compared to 100% in the historical cohort. In-hospital mortality, thromboembolism, mechanical ventilation, or hemodynamic decompensation requiring inotropic or mechanical support were similar during the periods compared. The researchers concluded that preliminary results demonstrate a significantly longer time from symptom onset to hospitalization in patients with ST UTI during the COVID-19 pandemic compared with the previous similar time period and similar rates of symptomatic drug therapy, including the use of angiotensin-converting enzyme inhibitors and blockers. angiotensin receptors in different cohorts [78].

Consequently, many patients with severe COVID-19 exhibit coagulation disorders that mimic other systemic coagulopathies, including disseminated intravascular coagulation. Patients with BMI ST with co-infection with COVID-19 had higher levels of troponin T and lower lymphocyte counts, but increased levels of D-dimer and C-reactive protein. They had significantly higher rates of multivessel thrombosis, stent thrombosis, modified post first thrombus removal device use, followed by increased use of glycoprotein IIb/IIIa inhibitors and thrombus aspiration. During their treatment, higher doses of heparin were used to achieve therapeutic values of thromboplastin activated clotting time. It is assumed that some drugs recommended for drug treatment and secondary prevention in patients with COVID-19 and ST UTI may enter into adverse drug interactions with antithrombotic agents and anticoagulants. The principles of secondary drug therapy and prevention in the treatment of patients with late STMI have remained unchanged during the COVID-19 pandemic. Rates of symptomatic drug therapy, including the use of angiotensin-converting enzyme inhibitors and angiotensin receptor blockers, were not significantly associated with disease outcomes in separate controlled trials.

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