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Outcomes Among ST-Elevation Myocardial Infarction (STEMI) Patients with Cardiogenic Shock and COVID-19: A Nationwide Analysis

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Research paper

Outcomes among ST-Elevation Myocardial Infarction (STEMI) patients with cardiogenic shock and COVID-19: A nationwide analysis

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A R T I C L E I N F O

Keywords:
STEMI
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A B S T R A C T

Background: There is paucity of data regarding the characteristics and outcomes of patients admitted for ST Elevation Myocardial Infarction (STEMI) complicated by cardiogenic shock (CS) with concomitant Coronavirus Disease 2019 (COVID-19) infection.
Methods: Using the National Inpatient Sample (NIS) Database for the year 2020, we conducted a retrospective cohort study to investigate the outcomes of patients who sustained STEMI-associated cardiogenic shock (STEMI-CS) with concomitant COVID-19 infection looking at its impact on in-hospital mortality and secondarily at the in-hospital procedure and intervention utilization rates as well as hospital length of stay.
Results: We identified a total of 22,775 patients with STEMI-CS, of which 1.71 % (n = 390/22,775) had COVID-19 infection. Using a stepwise survey multivariable logistic regression model that adjusted for patient and hospital level confounders, concomitant COVID-19 infection among STEMI-CS patients was found to be an independent predictor of overall in-hospital mortality compared to those without COVID-19 (adjusted OR 2.10; 95 % confidence interval [CI], 1.30–3.40). STEMI-CS patients with concomitant COVID-19 infection had similar in-hospital utilization rates for percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), extracorporeal membrane oxygenation (ECMO), percutaneous and durable left ventricular device, intra-arterial aortic balloon pump (IABP), renal replacement therapy (RRT), mechanical ventilation, as well as similar hospital lengths of stay.
Conclusion: Concomitant COVID-19 infection was associated with higher in-hospital mortality rates among patients with cardiogenic shock related to STEMI but had similar in-hospital procedure and intervention utilization rates as well as hospital length of stay.

1. Introduction

Cardiogenic shock (CS) remains to be one of the major complications associated with ST-Elevation Myocardial Infarction (STEMI) [1], and is a leading cause of in-hospital mortality after sustaining an acute myocardial infarction [2]. The emergence of Coronavirus Disease 2019 (COVID-19) infection, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has brought about global concern [3] due to its associated increased morbidity especially in those with severe disease [4]. COVID-19 affects the cardiovascular system through various mechanisms and can bring about acute myocardial injury, myocarditis, acute coronary syndrome, heart failure, arrhythmias, and venous thromboembolism [5]. This potentially places patients with COVID-19 and STEMI complicated by CS (STEMI-CS) at higher risk for increased morbidity and mortality. Although previous studies have shown that COVID-19 infection increases the risk of morbidity and mortality among STEMI-CS patients [6,7], there is still a paucity of data regarding the outcomes of hospitalized STEMI-CS patients with COVID-19 infection. Further, at the height of the pandemic, there were delays in the presentation of STEMI since patients were more cautious in going to the hospital due to the fear of being exposed to COVID-19. Likewise, there was a decrease in the procedure utilization rates including that of percutaneous coronary intervention (PCI) due to COVID-19 restriction protocols [8]. With this, we aim to investigate the impact of concomitant COVID-19 infection among patients admitted for STEMI-CS in terms of their outcomes including in-hospital mortality, interventional procedure utilization rates as well as hospital length of stay by utilizing a large nationwide database.

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2. Methods

We conducted a retrospective cohort study utilizing the 2020 National Inpatient Sample (NIS) database. Briefly, the publicly available NIS of the Health Care Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ), is the largest all-payer inpatient database in the United States that approximates 20-percent stratified sample of all discharges from US community hospitals. The NIS is an annual sample of hospital discharges that provides national estimates of the characteristics of the patients, diagnoses, and hospital-based procedures performed in US acute-care hospitals. All discharges from these hospitals are recorded and weighted to ensure that they are nationally representative. It is estimated to represent >97 % of the US population due to its multistate nature [9].

In our study sample of interest, all patients aged 18 and older who were admitted with a principal diagnosis of STEMI that was complicated by cardiogenic shock during the index hospitalization between January 2020 and December 2020 were included in the analysis. All eligible discharge records that had STEMI and cardiogenic shock as the diagnoses were identified using the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM). Patients were divided according to the presence or absence of COVID-19 infection. Sociodemographic variables were included. Further, patient comorbidities and medical history were retrieved based on the discharge records containing ICD-10 CM codes for the patient's diagnoses during the index hospitalization and were recorded accordingly. Procedural and interventional variables including PCI, coronary artery bypass graft (CABG), extracorporeal membrane oxygenation (ECMO), percutaneous and durable left ventricular assist device (LVAD), intra-aortic balloon pump (IABP), renal replacement therapy (RRT) and mechanical ventilation were identified using their respective procedure and intervention codes. (See Supplementary Table 1 for ICD-10-CM codes used in this study.)

The main clinical outcome of interest in this study was to investigate the impact of COVID-19 infection on in-hospital mortality. Secondary outcomes included other factors associated with inpatient mortality among patients with STEMI-CS, the influence of COVID-19 infection on the utilization rates of in-hospital interventions and procedures (coronary intervention rates, mechanical circulatory support rates, renal replacement therapy rates and mechanical ventilation rates), and length of stay among patients with STEMI-CS.

All data analyses were performed using StataBE 17.0 (StataCorp, College Station, Texas). The NIS is based on a complex sampling design that includes stratification, clustering, and weighing. This facilitates analysis to produce nationally representative results, variance estimates, and p values. Continuous variables were presented as median and interquartile range (IQR) as well as mean ± standard error (SE) where appropriate. Categorical variables were presented as numbers and/or percentages. Proportions were compared using the chi-square test, and continuous variables were compared using the student *t*-test. Survey univariable and multivariable logistic and linear regression analysis were used to calculate both adjusted and unadjusted odds ratios (ORs) for the primary and secondary outcomes. Outcomes were adjusted for potential patient and hospital level confounders, including age, gender, race, Charlson Comorbidity Index, median income, hospital bed size, hospital location, and teaching status, insurance type, and comorbidities. The variables were entered into the multivariable model were chosen based on the possible association with the outcome of interest on univariate regression analysis with p value <0.2. Survey multivariate linear regression analysis was used for the secondary outcome of hospital length of stay to adjust for possible patient and hospital level confounders as above. Variables were tested for collinearity, odds ratios and beta coefficients with 95 % confidence intervals were provided as appropriate. A p value of <0.05 was considered statistically significant.

3. Results

There were a total of 160,515 hospitalizations with a principal diagnosis of STEMI identified in the NIS database in the year 2020, of which 23,405 had cardiogenic shock during the index hospitalization.

Table 1
Baseline characteristics of the study population.

Patient characteristics	With COVID	Without COVID	p-Value
Number of patients	390	22,385	
Age at index admission, years (IQR)	63 (57–73)	66 (58–75)	
Women, no. (%)	34.62	33.37	0.82
Race/ethnicity, no. (%)			0.00
White	35.9	69.6	0.00
Black	14.1	8.09	0.06
Hispanic	29.49	8.91	0.00
Asian or Pacific Islander	6.41	4	0.29
Native American	0	0.51	0.54
Others	7.69	4.49	0.17
Comorbidities (%)			
Hypertension	15.38	23.97	0.10
Hyperlipidemia	43.59	55.17	0.05
Heart failure	51.28	54.72	0.56
Diabetes mellitus	12.82	9.67	0.35
Obesity	14.1	16.82	0.52
COPD	8.97	11.64	0.47
CAD	66.67	77.64	0.02
CKD, stage 1–4	17.95	20.75	0.53
ESRD	3.85	3.57	0.90
Tobacco use	0	1.61	0.29
Interventions/procedures (%)			
PCI	42.31	42.71	0.94
CABG	5.13	10.52	0.12
Percutaneous left ventricular assist device	11.54	19.16	0.07
Durable left ventricular assist device	0	0.36	0.60
ECMO	2.56	3.82	0.56
IABP	37.18	32.97	0.44
RRT	10.26	5.94	0.10
Mechanical ventilation	60.26	44.72	0.01
Charlson Comorbidity Index score, no. (%)			
1	15.38	13.78	0.69
2	17.95	28.5	0.04
3	66.67	57.72	0.12
Median annual income in patient's zip code, US$, no. (%)			0.00
$1–$49,999	39.74	26.87	0.01
$50,000–$64,999	34.62	27.54	0.15
$65,000–85,999	14.1	23.43	0.05
≥$86,000	8.97	2.01	0.01
Insurance type, no. (%)			0.20
Medicaid	52.56	53.63	0.85
Medicare	16.67	10.32	0.06
Private	20.51	26.58	0.21
Uninsured	3.85	5.56	0.52
Hospital characteristics			
Hospital region, no. (%)			0.80
Northeast	15.38	17.09	0.71
Midwest	25.64	21.85	0.43
South	34.62	38.51	0.49
West	24.36	22.56	0.71
Hospital bed size, no. (%)			0.61
Small	19.23	15.17	0.32
Medium	28.21	29.08	0.87
Large	52.56	55.75	0.58
Location and teaching status of the hospital (%)			0.42
Rural	2.56	4.18	0.47
Urban non-teaching	20.51	15.64	0.25
Urban teaching	76.92	80.19	0.48

COPD: chronic obstructive pulmonary disease, CAD: coronary artery disease, CKD: chronic kidney disease, ESRD: end-stage renal disease, PCI: percutaneous coronary intervention, CABG: coronary artery bypass grafting, ECMO: extracorporeal membrane oxygenation, IABP: intra-aortic balloon pump, RRT: renal replacement therapy.

Of these, 22,775 met our inclusion criteria. Table 1 summarizes the baseline characteristics of the study population. Patients with concomitant COVID-19 infection accounted for 1.71 % (n = 390/22,775) of the total study population. Further, the median age for those with and without COVID-19 were 63 years (IQR, 57–73 years) and 66 years (IQR, 58–75 years), respectively. Compared to patients admitted without COVID-19 infection, admitted STEMI patients with cardiogenic shock and concomitant COVID-19 infection had similar proportion of females, insurance type, characteristics of admitting hospitals, and prevalence of hypertension, heart failure, obesity, diabetes mellitus, COPD, chronic kidney disease (stage 1–5) and tobacco use (see Table 1). On the contrary, patients admitted with COVID-19 infection were less likely to be white (35.9 % vs 69.6 %, p = 0.00), and had a lower median annual income (39.74 % vs 26.87 %, p = 0.01).

The overall mortality rate among patients admitted for STEMI complicated by cardiogenic shock was 32.76 % (n = 7460/22,775). Among those with concomitant COVID-19 infection, the mortality rate was significantly higher at 52.56 % (205/390) (p = 0.00). On univariate and multivariate analyses that adjusted for patient and hospital level confounders, concomitant COVID-19 infection was found to be an independent predictor of overall in-hospital mortality (adjusted OR 2.11; 95 % confidence interval [CI], 1.32–3.38). Further, age, female sex, Charlson comorbidity index, lack of insurance, use of LVAD, RRT and ECMO, were significantly associated with increased inpatient mortality in patients with STEMI-CS (see Table 2).

For patients admitted with STEMI complicated by cardiogenic shock, the overall utilization rates were as follows: PCI rate was 42.7 %, while the CABG rate of 10.43 %. In addition, ECMO was required in 3.8 % of admitted patients whereas percutaneous and durable LVAD were utilized in 19.03 % and 0.35 % of total admissions, respectively. Additionally, the IABP utilization rate was 33.04 %. Moreover, RRT was required for 6.02 % of admissions. It was found that there was a significantly higher rate of mechanical ventilation among patients with concomitant COVID-19 infection (60.26 % vs 44.72 %) (p = 0.01), however, after adjusting for patient and hospital level confounders, it showed that COVID-19 infection was not a predictor of mechanical ventilation utilization (adjusted OR 1.57; 95 % confidence interval [CI] 0.95–2.57) (see Supplementary Table 2). Overall, there were no significant differences in the rates of PCI, CABG, ECMO, percutaneous and durable left ventricular assist device, IABP, and RRT utilization (see Table 1).

The mean length of stay for admitted patients with STEMI-CS and concomitant COVID-19 infection was significantly longer at 13.33 days (95 % confidence interval [CI] 7.53–19.13) in contrast to 7.47 days (95 % confidence interval [CI] 7.15–7.80) in those without COVID-19 infection (p = 0.05). After a sensitivity analysis, this time excluding the ones with in-patient mortality, the results showed the same significant increase (but longer mean length of stay) in the hospital LOS among those with concomitant COVID-19 infection (22 days [95 % confidence interval [CI] 9.70–34.30]) compared to those without COVID-19 infection (9.12 days [95 % confidence interval [CI] 8.66–9.59]). However, after adjusting for patient and hospital level confounders, this was no longer statistically significant (p = 0.10). Instead, age, female gender, higher number of comorbidities, insurance type (Medicare and uninsured), and being admitted to a large urban teaching hospital were significantly associated with longer length of stay (please see Table 3).

Table 2
Multivariable logistic regression table of factors associated with in-hospital mortality among patients with STEMI complicated by cardiogenic shock.

Variable	Adjusted odds ratio	95 % confidence interval [CI]	p value
COVID-19	2.11	1.32–3.38	0.00
Age	1.05	1.04–1.06	0.00
Male, sex	Reference		
Female, sex	1.22	1.05–1.40	0.01
Charlson Comorbidity Index	1.11	1.05–1.17	0.00
Hospital bed size			
Small-sized	Reference		
Medium-sized	1.24	0.99–1.58	0.06
Large-sized	1.19	0.96–1.48	0.12
Insurance type			
Medicaid	Reference		
Medicare	0.96	0.73–1.26	0.75
Private	0.81	0.66–1.00	0.05
Uninsured	1.71	1.20–2.44	0.00
Comorbidities			
Hypertension	1.15	0.93–1.41	0.20
Hyperlipidemia	0.72	0.62–0.83	0.00
Heart failure	0.50	0.42–0.61	0.00
CAD	0.78	0.66–0.92	0.00
Obesity	0.87	0.71–1.07	0.20
COPD	0.83	0.65–1.06	0.14
CKD, stage 1–4	0.88	0.55–1.42	0.60
ESRD	1.06	0.85–1.32	0.61
Tobacco use	0.67	0.35–1.29	0.23
Procedures and interventions			
PCI	0.69	0.59–0.80	0.00
CABG	0.41	0.31–0.56	0.00
Percutaneous left ventricular assist device	2.08	1.73–2.51	0.00
ECMO	2.02	1.33–3.06	0.00
IABP	0.98	0.84–1.15	0.83
RRT	2.09	1.52–2.87	0.00
Mechanical ventilation	3.86	3.30–4.51	0.00

COPD: chronic obstructive pulmonary disease, CAD: coronary artery disease, CKD: chronic kidney disease, ESRD: end-stage renal disease, PCI: percutaneous coronary intervention, CABG: coronary artery bypass grafting, ECMO: extracorporeal membrane oxygenation, IABP: intra-aortic balloon pump, RRT: renal replacement therapy.

4. Discussion

This study is, to the best of our knowledge, the first observational report from a nationally representative database on the clinical outcomes among patients hospitalized for STEMI complicated by cardiogenic shock (STEMI-CS) and with concomitant COVID-19 infection. Investigated outcomes include in-hospital mortality, in-hospital procedure and intervention utilization rates, and impact on hospital length of stay. Our analysis suggests that COVID-19 infection is independently associated with increased odds for in-hospital mortality among patients with STEMI-CS. However, there were no significant differences in in-hospital procedure and intervention utilization rates as well as hospital length of stay regardless of COVID-19 status.

A previous study by Kolte et al. [10] showed that the incidence of STEMI-CS in 2010 was 10.1 % which increased to 14.58 % in 2020 based on our findings. This is likely partly due to the delayed presentation of STEMI patients to the hospital in fear of contracting COVID-19 infection [11] which increases their risk for sustaining complications including cardiogenic shock. Further, a recent study by Vallabhajosyula et al. [12] showed that the in-hospital mortality rates decreased from 49.6 % in 2000 to 32.7 % in 2017, owing in part due to the advances in revascularization techniques, evolution of mechanical circulatory support, and the development of protocols for STEMI-CS. However, according to a study by Varshney et al. [7], among STEMI-CS patients with concomitant COVID-19 infection, the mortality rate was noted to be 63 %. Our analysis concurs with previous studies and further highlights the influence of COVID-19 infection on the mortality rate of patients with STEMI-CS. This significant increase in the in-hospital mortality rate among patients with concomitant COVID-19 infection is likely due to the implicating mechanisms of the SARS-CoV-2 virus causing cardiac injury beyond acute coronary syndromes, including stress-induced cardiomyopathy, myocarditis, microvascular dysfunction and thrombosis, and acute decompensation of a known heart failure [13]. Mechanistically, similar to an influenza infection, myocardial injury due to COVID-19 may be related to increased viscosity, enhanced coagulation cascade, proinflammatory effects or direct cytopathic effects of the SARS-CoV-2

Table 3
Multivariable logistic regression table of factors associated with hospital length of stay (LOS) among patients with STEMI complicated by cardiogenic shock.

Variable	Coefficient	95 % confidence interval [CI]	p value
COVID-19	4.11	−0.85–9.07	0.10
Age	−0.6	−0.09 to −0.03	0.00
Male	Reference		
Female	−0.78	−1.35 to −0.20	0.01
Race/ethnicity			
White	Reference		
Black	0.36	−0.82–1.53	0.55
Hispanic	−0.13	−1.27–1.02	0.83
Asian or Pacific Islander	−0.83	−2.01–0.35	0.17
Native American	−1.90	−3.90–0.11	0.06
Others	−0.36	−1.52–2.24	0.71
Comorbidities			
Hypertension	0.30	−0.34–0.95	0.35
Hyperlipidemia	−0.83	−2.37 to −1.28	0.00
Heart failure	3.93	3.25–4.61	0.00
Diabetes mellitus	−2.07	−2.85 to −1.29	0.00
Obesity	0.89	−1.52 to −0.25	0.01
COPD	−2.00	−2.67 to −1.33	0.00
CAD	−1.79	−2.69 to −0.88	0.00
CKD, stage 1–4	−0.08	−1.32–1.16	0.90
ESRD	2.46	−0.38–5.30	0.09
Tobacco use	−1.61	−3.29–0.07	0.06
Charlson Comorbidity Index score	0.49	0.20–0.79	0.00
Median annual income in patient's zip code, US$			
$1–$49,999	Reference		
$50,000–$64,999	0.85	0.07–1.63	0.03
$65,000–85,999	0.33	−0.44–1.09	0.41
≥$86,000	0.29	−0.59–1.18	0.52
Insurance type			
Medicaid	Reference		
Medicare	2.52	1.04–4.00	0.00
Private	0.57	−0.20–1.33	0.15
Uninsured	−1.40	−2.53 to −0.27	0.02
Hospital characteristics			
Hospital region			
Northeast	Reference		
Midwest	−0.81	−1.97–0.36	0.18
South	−0.31	−1.37–0.75	0.56
West	−0.96	−2.12–0.21	0.11
Hospital bed size			
Small	Reference		
Medium	0.89	0.15–1.64	0.02
Large	2.57	−2.12–0.21	0.00
Location and teaching status of the hospital			
Rural	Reference		
Urban non-teaching	−0.16	−1.26–0.95	0.78
Urban teaching	1.74	0.71–2.77	0.00

COPD: chronic obstructive pulmonary disease, CAD: coronary artery disease, CKD: chronic kidney disease, ESRD: end-stage renal disease.

virus [14,15]. Among patients who suffered from STEMI, in addition to the myocardial injury caused by an ischemic event during an acute myocardial infarction, the increased cytokine level during a COVID-19 infection cause further depression of myocardial function leading to the development or worsening of cardiogenic shock [16]. Further, a significant time delay between the diagnosis and intervention of STEMI-CS may occur among COVID-19 patients because the supposed interventions such as primary PCI may entail logistical delays due to protocols imposed for possible transmission to staff and other patients [17]. Moreover, similar to the results of previous studies that were conducted in a pre-COVID-19 era, our study showed that age [18–21], female gender [19,22] and being uninsured [23] are still significant predictors of increased mortality among patients with STEMI-CS. This is likely due to the inherent nature of these risk factors related to disparity in healthcare delivery that are prevalent even before the COVID-19 pandemic. Finally, hyperlipidemia, CAD and pre-existing heart failure are the usual traditional risk factors for STEMI and cardiogenic shock. The seemingly paradoxical association with decreased mortality seen in our study might be something related to COVID-19 infection and non-traditional mechanisms leading to cardiogenic shock including COVID-19 associated myopericarditis. COVID-19 associated cardiogenic shock can be very rapid in onset and may be potentially fatal [24]. Also shock states with COVID-19 might be associated with mixed mechanisms of shock including distributive shock [7]. This might translate to those with COVID-19 having higher rates of mortality as opposed to the ones with traditional cardiometabolic risk factors. However, these findings should be interpreted with caution as these are to be considered observational and hypothesis generating.

Various treatment options exist for STEMI-CS patients, and the utilization rates for these procedures and interventions depend on specific patient indications and institutional capability. In a study by Varshney et al. looking at the epidemiology of cardiogenic shock among COVID-19 patients, the PCI rate was 8 % and the total mechanical circulatory support rate was 11 %, of which 7 % had IABP, 6 % had PVAD, and 8 % had ECMO. Further, 19 % of patients underwent RRT and 90 % were mechanically ventilated [7]. Compared to our analysis, except for the mechanical ventilation rate, in-hospital procedure utilization rates were much higher compared to the previous analysis of Varshney et al. [7], and the overall procedure utilization rate was not much different in patients regardless of COVID-19 status. This is likely since STEMI-CS patients would still likely require the same procedures and interventions regardless of their COVID-19 status – in accordance to the true medical need. The differences can also be explained as we specifically only looked at cardiogenic shock per se in a specific subset of patients (with STEMI) while their study also included other forms of combined shock and undetermined shock. Lastly, there could be some degree of underestimation of the outcomes of interest in patients with COVID-19 infection and concomitant STEMI-CS since those who have STEMI-CS may have been too critically ill to be labeled as severe COVID-19 infection, hence, the utilization of certain interventions such as mechanical ventilation among those with COVID-19 may have been underestimated.

Among STEMI-CS patients, the hospital length of stay is determined by several factors including age, severity of the myocardial infarction, and number of significant comorbidities [25]. In a study by Swaminathan et al. [26], STEMI-CS patients had a significantly longer length of stay as compared to those with no cardiogenic shock. Further, patients were generally older, of the female gender and had more comorbidities. Additionally, according to Saad et al., patients with concomitant COVID-19 infection had longer lengths of stay compared to those without COVID-19 [27]. Interestingly, although our study confirmed that age, female gender and higher number of comorbidities lead to longer length of stay, our analysis showed that COVID-19 infection is not a predictor of a longer LOS. However, our study is limited by its ability to infer the severity of both cardiogenic shock and concomitant COVID-19 infection, since an asymptomatic or mild COVID-19 infection may not impact the overall prognosis of STEMI-CS patients, hence will also have little to no impact in the hospital LOS.

Our study has several limitations owing to the use of an administrative dataset and the cross-sectional nature of our study design thereby limiting the ability to capture patient level data including the time to first medical contact, door to device time and time from presentation to the development of cardiogenic shock, all of which could confound the independent association of COVID-19 to the outcomes of interest. Additionally, the database lacks the information regarding the disease severity indicator whether a condition is present on admission or not, and non-availability of a disease state relevant to the outcome of interest. Moreover, underreporting and coding errors might be a source of bias in our analysis [26]. Further, in the absence of radiographic, echocardiographic, and angiographic data, it's not possible to further stratify the severity of cardiovascular illness and the extent of myocardial injury. Moreover, the ICD-10 code for COVID-19 infection was released on April 1, 2020 which potentially missed a significant number of true COVID-19 cases since the pandemic started several months prior. In addition, there could be some underestimation of certain in-hospital events including morbidity indicators such as utilization of invasive ventilation likely due to the challenge of correctly attributing the severity of STEMI-CS or COVID-19 infection to certain disease severity indicators. Furthermore, the seemingly paradoxical association of CAD, heart failure and hyperlipidemia with less mortality and COPD with less mechanical ventilation utilization should be interpreted with caution. Lastly, the study was limited to in-hospital events only, thereby certain complications that may have occurred after hospitalization could have been missed.

5. Conclusion

This study showed that STEMI-CS patients with concomitant COVID-19 infection have higher odds of inpatient mortality compared to those who do not have COVID-19, but they have similar in-hospital procedure and intervention utilization rates as well as hospital lengths of stay.

CRediT authorship contribution statement

Bruce Adrian Casipit: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration. **Zurab Azmaiparashvili:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing – review & editing, Visualization, Supervision. **Kevin Bryan Lo:** Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization, Supervision. **Aman Amanullah:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing – review & editing, Visualization, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ahjo.2022.100243.

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