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Trends in Clinical Presentation, Management, and Outcomes of STEMI in Patients With COVID-19

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ABSTRACT

BACKGROUND We previously reported high in-hospital mortality for ST-segment elevation myocardial infarction (STEMI) patients with COVID-19 treated in the early phase of the pandemic.

OBJECTIVES The purpose of this study was to describe trends of COVID-19 patients with STEMI during the course of the pandemic.

METHODS The NACMI (North American COVID-19 STEMI) registry is a prospective, investigator-initiated, multicenter, observational registry of hospitalized STEMI patients with confirmed or suspected COVID-19 infection in North America. We compared trends in clinical characteristics, management, and outcomes of patients treated in the first year of the pandemic (January 2020 to December 2020) vs those treated in the second year (January 2021 to December 2021).

RESULTS A total of 586 COVID-19-positive patients with STEMI were included in the present analysis; 227 treated in Y2020 and 359 treated in Y2021. Patients' characteristics changed over time. Relative to Y2020, the proportion of Caucasian patients was higher (58% vs 39%; $P < 0.001$), patients presented more frequently with typical ischemic symptoms (59% vs 51%; $P = 0.04$), and patients were less likely to have shock pre-PCI (13% vs 18%; $P = 0.07$) or pulmonary manifestations (33% vs. 47%; $P = 0.001$) in Y2021. In-hospital mortality decreased from 33% (Y2020) to 23% (Y2021) ($P = 0.008$). In Y2021, none of the 22 vaccinated patients expired in hospital, whereas in-hospital death was recorded in 37 (22%) unvaccinated patients ($P = 0.009$).

CONCLUSIONS Significant changes have occurred in the clinical characteristics and outcomes of STEMI patients with COVID-19 infection during the course of the pandemic. (J Am Coll Cardiol 2022;79:2236-2244) © 2022 by the American College of Cardiology Foundation.

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The COVID-19 infection significantly increases the risk for both arterial and venous thromboembolic complications.[1] The risk of myocardial infarction (MI) doubles within a week of receiving a COVID-19 diagnosis and is associated with higher odds of mortality.[2,3] Patients presenting with ST-segment elevation myocardial infarction (STEMI) and COVID-19 constitute a high-risk subset with distinct clinical features, including preponderance of minority ethnicity, in-hospital presentation, cardiogenic shock, and very high in-hospital mortality.[4-7]

Despite an increased number of COVID-19 cases worldwide, significant progress has been made in both disease prevention and management during the course of the pandemic, which has contributed to a marked reduction in mortality in selected countries.[8-10] We previously reported very high (33%) in-hospital mortality for patients with STEMI and COVID-19 treated in North America during the early phase of the pandemic.[4]

The aim of this investigation is to examine trends in clinical characteristics, treatments, and outcomes of STEMI patients with COVID-19 infection using data from the NACMI (North American COVID-19 Myocardial Infarction) registry.

SEE PAGE 2245

METHODS

STUDY DESIGN. NACMI is a prospective, investigator-initiated, multicenter, observational registry of hospitalized STEMI patients with confirmed or suspected COVID-19 infection in North America. A detailed description of the study design has been previously published.[4,11] A total of 64 sites were approved by the local ethics committees (12 Canadian and 52 U.S. sites).

INCLUSION CRITERIA. NACMI included 3 groups of STEMI patients (COVID-19-positive group, contemporary COVID-19-negative group, and a historical control group). The present analysis on trends focused on the COVID-19-positive and contemporary COVID-19-negative group. The COVID-19-positive group comprised adult patients (age ≥18 years) with: 1) ST-segment elevation in at least 2 contiguous leads (or new-onset left bundle branch block); 2) a clinical correlate of myocardial ischemia (eg, chest pain, dyspnea, cardiac arrest, shock, mechanical ventilation); and 3) confirmed COVID-19-positive by any commercially available test during, or 4 weeks before, the index STEMI hospitalization.

The COVID-19-negative group comprised adult patients with STEMI who were suspected positive on presentation but subsequently tested negative for COVID-19 infection (person under investigation [PUI]). The definition of PUI was left to the discretion of local hospitals but in general included a combination of possible COVID-19 signs and symptoms (fever or respiratory symptoms such as cough, shortness of breath, sore throat), or exposure to a confirmed case or cluster of suspected COVID-19 cases. With advancements in rapid COVID-19 testing and streamlined STEMI protocols, we anticipated the designation of PUI would be less relevant in Y2021 but presented this information to serve as a reference group to compare trends.

NACMI was designed in early 2020 before the commercialization of vaccines against COVID-19.[12,13] Therefore, vaccine status was not routinely captured in the registry. However, once vaccines became commercially available in North America in 2021, the original protocol was amended to include immunization status including timing and type. The protocol amendment was approved by 20 enrolling sites at the time of this publication.

PRIMARY ENDPOINT. The primary endpoint for this analysis was in-hospital mortality. A composite of in-hospital death, stroke, or reinfarction was a secondary endpoint. Nonfatal events were defined using National Cardiovascular Data Registry (NCDR Cath PCI Registry version 4.4) definitions.

DATA COLLECTION. We used standardized data collection forms, modeled after the American College of Cardiology National Cardiovascular Data Registry definitions, and a secure web-based application (REDCap, Research Electronic Data Capture) for data capture. The data coordinating center at the Minneapolis Heart Institute Foundation had full access to the dataset and performed the statistical analysis. The protocol was approved by each local Institutional Review Board. Informed consent was waived.

STATISTICAL ANALYSIS. Discrete variables are summarized by counts (%), and continuous variables are summarized by mean ± SD if distributed

ABBREVIATIONS AND ACRONYMS

MI = myocardial infarction

PCI = percutaneous coronary intervention

STEMI = ST-segment elevation myocardial infarction

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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TABLE 1 Trends in Baseline Characteristics and Clinical Features at Presentation

	Y2020 (n = 227)	Y2021 (n = 359)	*P* Value[a]
Age <66 y	126 (56.0)	201 (56.0)	0.9
Male	163 (72.0)	268 (75.0)	0.4
History of CAD	51 (24.0)	88 (28.0)	0.3
Non-Caucasian	137 (61.0)	142 (42.0)	<0.001
Dyslipidemia	98 (45.0)	145 (46.0)	0.9
Diabetes mellitus	102 (46.0)	135 (42.0)	0.4
BMI, kg/m^2	29 ± 8	27 ± 10	0.5
Overweight/obese	156 (72.0)	253 (77.0)	0.2
Hypertension	165 (74.0)	223 (65.0)	0.025
History of heart failure	33 (16.0)	51 (16.0)	0.9
Aspirin on admission	88 (39.0)	127 (35.0)	0.4
Statin on admission	88 (39.0)	123 (34.0)	0.3
CVRF ≥3	43 (19.0)	77 (21.0)	0.5
Symptoms at presentation			
Dyspnea	126 (56.0)	152 (42.0)	0.002
Chest pain	115 (51.0)	212 (59.0)	0.046
Syncope	6 (2.6)	16 (4.5)	0.3
Infiltrates	106 (47.0)	120 (33.0)	0.001
Cardiac arrest pre-PCI	23 (11.0)	24 (7.9)	0.2
Shock pre-PCI	37 (18.0)	38 (13.0)	0.079
Ejection fraction, %	43 (35, 55)	45 (34, 55)	0.5
In-house presentation of MI	13 (5.7)	26 (7.4)	0.4

Values are n (%), mean ± SD, or median (25th percentile, 75th percentile). [a]Not adjusted for multiple comparisons.

BMI = body mass index; CAD = coronary artery disease; CVRF = cardiovascular risk factors; MI = myocardial infarction; PCI = percutaneous coronary intervention.

symmetrically, or as median (25th percentile, 75th percentile) if skewed.

COVID-19-positive patients were divided into 2 groups according to the year of the STEMI presentation during the pandemic, ie, Y2020 group from March 1, 2020, to December 31, 2020; and Y2021 group from January 1, 2021, to December 31, 2021. These periods coincided with the commercial introduction of vaccines against COVID-19 in North America. Demographic, clinical, and outcome variables were compared between the groups using Pearson's chi-square or Fisher exact test for categorical data and Student's *t*-test or Wilcoxon rank sum test for continuous variables, as appropriate.

Given a relatively short hospital length of stay, in-hospital mortality is modeled as a binary variable, and the relative risk of death for Y2021 vs Y2020 group is estimated from a multivariate robust Poisson regression with a canonical log-link and robust sandwich estimator of variance to allow for over-dispersion in the data. Model covariates include age, BMI, gender, race, diabetes, abnormal chest x-ray findings, and shock pre-percutaneous coronary intervention (PCI). More specifically, age originally collected as a 5-category variable is dichotomized as <66 or ≥66 years; and BMI categories are defined overweight/obese or not per Centers for Disease Control and Prevention definition. Furthermore, a proxy comorbidity index is defined to capture the pre-existing cardiovascular diseases/conditions as follows: a sum of indicators of hypertension and history of PCI, MI, coronary artery bypass graft, stroke, or CHF for each patient is dichotomized to index those with ≥3 pre-existing conditions. The choice of the variables and categories in the model is informed by existing literature, exploratory data analysis, sample size, and the number of adverse events considerations.[4,14]

Model parameters are estimated first from complete data, then using imputed data where missing values are approximated by sample medians that in case of categorical variables correspond to imputation by the most prevalent category. Model estimates are reported with their 95% CIs and *P* values.

COVID-19 vaccine data are available for 420 (71%) of patients in the study including 193 patients from the Y2021 cohort (54%). Of these 193 patients, only 22 (11%) were vaccinated against COVID-19 and 171 were unvaccinated. These data are described by summaries only, as in the previous text, because null number of adverse events did not allow for multivariate modeling.

Data were analyzed using R version 4.1.2 (R Foundation for Statistical Computing) in RStudio environment version 2021.09.1 (RStudio, PBC).

RESULTS

A total of 586 COVID-19-positive patients with STEMI were included in the present analysis; 227 treated in Y2020 (United States: 93%; Canada: 7%) and 359 treated in Y2021 (United States: 91%; Canada: 9%). The baseline characteristics and clinical features at presentation are presented in Table 1. Significant changes in patients' characteristics occurred over time. Relative to patients treated in 2020, patients treated in 2021 were more likely to be Caucasian (58% vs 39%; $P < 0.001$), more likely to present with chest pain (59% vs 51%; $P = 0.04$) rather than dyspnea (42% vs 56%; $P = 0.002$), and less likely to have shock pre-PCI (13% vs 18%; $P = 0.07$) or infiltrates on chest x-ray (33% vs 47%; $P = 0.001$).

INVASIVE ANGIOGRAPHY, REVASCULARIZATION STRATEGIES, AND TREATMENT TIMES. The use of invasive angiography increased over time from 77% in

2020 to 86% in 2021 (P = 0.004). Among patients undergoing invasive angiography, revascularization strategies are listed in Table 2. PCI (both primary and facilitated/rescue PCI) was the predominant revascularization modality used in >70% of cases with no significant differences between Y2020 and Y2021. Thrombolytics and coronary artery bypass graft surgery were infrequently used (<5% and 2%, respectively). Medical therapy alone was used in 19% of patients in Y2020 and 25% in Y2021 (P = 0.7) (primarily for patients with no culprit vessel).

Among patients undergoing primary PCI, the median door-to-balloon (D2B) time was 78 minutes (IQR: 50-122 minutes) in Y2020 and 70 minutes (IQR: 50-106 minutes) in Y2021 (P = 0.4). The proportion of patients meeting the metric of D2B time <90 minutes was 59% in Y2020 and 64% in Y2021 (P = 0.5).

CLINICAL OUTCOMES AND LENGTH OF STAY. A marked reduction in mortality from 33% in Y2020 to 23% in Y2021 (P = 0.008) was observed with a trend for reduction in the incidence of stroke (Y2020 2.6% vs Y2021 0.8%; P = 0.10) but no difference in reinfarction (Y2020 1.3% vs Y2021 2.2%; P = 0.5) rates (Figure 1). The composite outcome of death, stroke, or reinfarction occurred in 80 of 227 (35%) patients in Y2020 and 90 of 359 (25%) patients in Y2021 (P = 0.008).

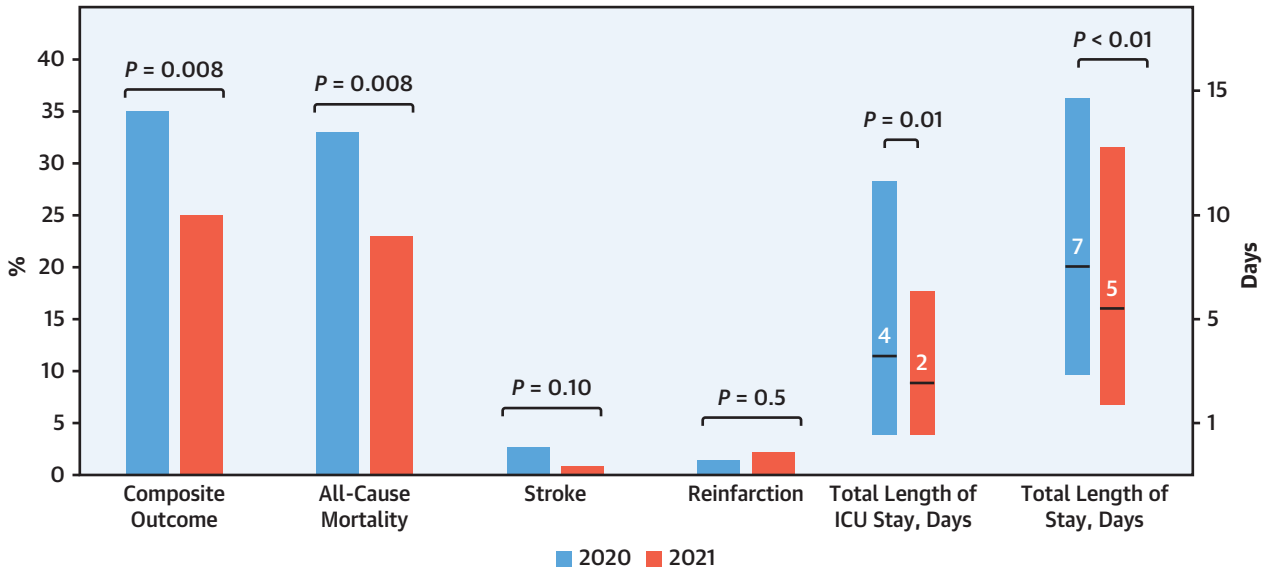
TABLE 2 Utilization of Invasive Angiography, Revascularization Strategies, and Antiplatelet Therapies at Discharge

	Y2020 (n = 227)	Y2021 (n = 359)	*P* Value[a]
No angiogram	52 (23.0)	49 (14.0)	0.004
Patients undergoing invasive angiography, n = 485			
Reperfusion strategy	175	310	0.7
CABG	3 (1.7)	5 (1.6)	
Facilitated/rescue PCI	7 (4.0)	11 (3.5)	
Medical therapy	34 (19.0)	78 (25.0)	
Primary PCI	125 (71.0)	206 (66.0)	
Thrombolytics	6 (3.4)	10 (3.2)	
Multivessel CAD	69 (49.0)	111 (49.0)	0.9
Primary PCI (survived to hospital discharge and complete antiplatelet data)	89 (73.0)	144 (73.0)	0.45
Clopidogrel	31 (34.0)	39 (27.0)	
Prasugrel	10 (11.0)	12 (8.0)	
Ticagrelor	48 (53.0)	93 (64.0)	

Values are n (%) or n. [a]Not adjusted for multiple comparisons.
CABG = coronary artery bypass graft surgery; other abbreviations as in Table 1.

Length of stay decreased from 7 days (IQR: 3-15 days) in Y2020 to 5 days (IQR: 2-12 days) in Y2021 (P = 0.01), and intensive care unit stay decreased from 4 days (IQR: 1-11 days) in Y2020 to 2 days (IQR: 1-6 days) in Y2021 (P < 0.001). From multivariate analysis of complete data, the risk of in-hospital

FIGURE 1 In-Hospital Events in Patients With STEMI and COVID-19 Infection



Proportion (%) of major adverse cardiovascular events and length of intensive care unit (ICU) and hospital stay in expressed as median and IQR in hospitalized patients with ST-segment elevation myocardial infarction (STEMI) and COVID-19 infection according to year of treatment. The composite outcome includes death, stroke, or recurrent myocardial infarction.

TABLE 3 Estimated Relative Risks of In-Hospital Mortality

	RR	95% CI Lower Bound	95% CI Upper Bound	*P* Value[a]
2021	0.751	0.534	1.055	0.101
Infiltrates on chest x-ray	1.721	1.224	2.434	0.002
Age ≥66 y	1.802	1.272	2.565	0.001
Male	1.089	0.757	1.589	0.652
Overweight/obese	1.069	0.737	1.585	0.731
African American	1.060	0.635	1.716	0.817
Asian	1.176	0.555	2.229	0.645
Hispanic	1.115	0.704	1.726	0.632
Indigenous	1.386	0.307	4.088	0.608
Other ethnicity	1.219	0.631	2.168	0.527
Shock pre-PCI	2.762	1.928	3.911	0.000
Diabetes	1.342	0.957	1.886	0.089
CVRF ≥3	1.098	0.718	1.642	0.656

Baseline categories are: year 2020, no infiltrates on chest x-ray, age <66 years, female sex, BMI category not overweight/obese, Caucasian race, no shock pre-PCI, no diabetes, CVRF <2. [a]Not adjusted for multiple comparisons.

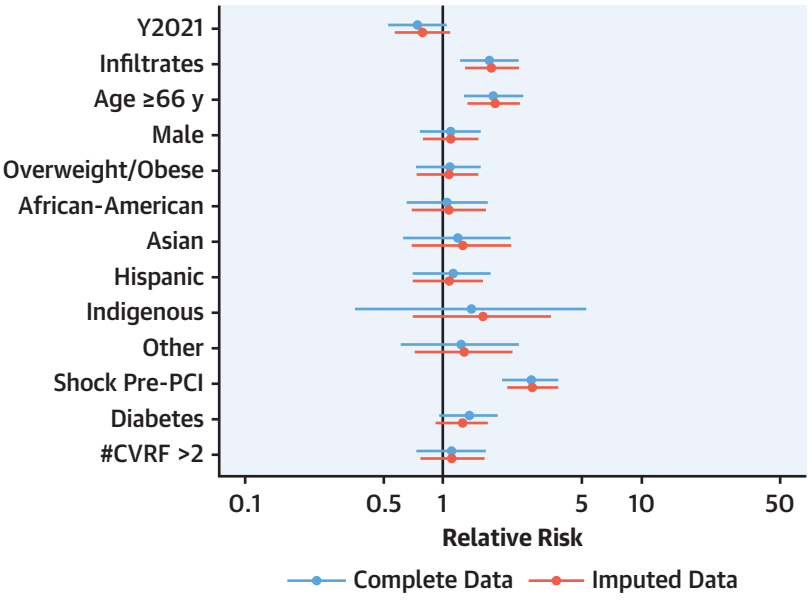
RR = relative risk; other abbreviations as in Table 1.

mortality for Y2021 patients was 25% lower (95% CI: −47 to 5; $P = 0.01$) than for Y2020. The risk of mortality was 1.7 (95% CI: 1.2-2.4; $P = 0.002$) times higher if infiltrates were observed and nearly 3 times higher (95% CI: 1.9-3.9; $P < 0.001$) if cardiogenic shock was present (Table 3, Figure 2). Similar estimates were derived from imputed data (Supplemental Table 1).

EFFECT OF COVID-19 VACCINES ON STEMI. Vaccine information was captured through a protocol amendment approved by the top 20 enrolling sites. These centers enrolled and provided vaccine data on 193 (54%) of 359 patients treated in Y2021. From these 193 patients hospitalized with STEMI and COVID-19, only 22 (11%) were vaccinated including 9 (45%) with BioNTech and Pfizer, 6 (30%) with Moderna, and 2 (10%) for each Johnson & Johnson and Janssen; in 3 patients, the vaccine type was unknown. The median time from vaccination to STEMI was 20 days (IQR: 6-132 days). The baseline characteristics and clinical features at presentation of vaccinated and unvaccinated patients in Y2021 are presented in Table 4. Vaccinated patients were less likely to present with respiratory symptoms or infiltrates on chest x-ray. In Y2021, none of the 22 vaccinated patients expired in hospital, whereas in-hospital death was recorded in 37 (22%) of unvaccinated patients.

COVID-19–NEGATIVE PATIENTS. Trends in clinical characteristics and outcomes for patients who were suspected of having COVID-19 but subsequently

FIGURE 2 Relative Risk of In-Hospital Death



Estimated relative risk of in-hospital mortality using original **(blue)** and imputed **(red)** data. Model covariates include age, body mass index, gender, race, diabetes, abnormal chest x-ray findings, and shock pre-percutaneous coronary intervention (PCI). Baseline categories are: Y2020, no infiltrates on chest x-ray, age <66 y, female gender, not overweight/obese, Caucasian race, no shock pre-PCI, no diabetes, cardiovascular risk factors (CVRF) <2.

tested negative (PUI) are presented in Table 5. Unlike COVID-19–positive patients, we observed no differences in the baseline characteristics or in-hospital outcomes for COVID-19–negative patients (mortality Y2020 11% vs Y2021 9.5%; $P = 0.231$).

DISCUSSION

We conducted an analysis of trends in clinical characteristics, management strategies, and outcomes of STEMI patients with COVID-19 infection using the NACMI registry, which represents the largest prospective dataset worldwide. There are several important findings (Central Illustration). First, in-hospital mortality decreased 25% (10 absolute points) in Y2021 compared with Y2020. Second, possible mediators of this reduction in mortality have been identified and include a lower risk profile of patients presenting with more typical ischemic symptoms, less cardiogenic shock, and pulmonary involvement. Third, a subgroup analysis of patients treated in Y2021 according to vaccination status revealed that vaccinated patients are significantly less likely to develop respiratory complications and none of them expired in the hospital, whereas in-hospital death was recorded in 22% of unvaccinated patients in Y2021. Finally, despite the logistical challenges imposed by the pandemic, PCI remains the dominant revascularization modality in North America with more than 70% of patients treated and 2 of 3 meeting the D2B time ≤90 minutes metric. In fact, we observed increased utilization of invasive angiography for risk stratification and management in Y2021 compared with Y2020. Taken together, our observations suggest that the clinical profile, management, and outcomes of STEMI patients with COVID-19 infection is evolving toward that of STEMI patients before the pandemic, although mortality remains high for unvaccinated patients.

Our group and others have previously reported that patients with STEMI and COVID-19 infection have very high in-hospital mortality.[3-7] Independent predictors of mortality in STEMI patients with COVID-19 infection are different than those without COVID-19.[14] Risk models have identified respiratory variables such as tachypnea, hypoxemia, use of mechanical ventilation, and infiltrates on chest x-ray as significant predictors of mortality in patients with COVID-19 infection.[15] In fact, respiratory variables accounted for ≥50% of the NACMI risk score.[15] The introduction of vaccines has significantly reduced hospitalizations and mortality caused by COVID-19 infection.[12,13,16-18] Our subgroup analysis according to vaccination status of STEMI patients treated in Y2021 suggests that prevention of severe respiratory illness is a likely mediator and provides additional support to current Centers for Disease Control and Prevention recommendations to vaccinate adults.[19] In addition to lung infiltrates, age ≥66 years and cardiogenic shock pre-PCI are also associated with in-hospital mortality.

TABLE 4 Baseline Clinical Characteristics and Outcomes of 2021 COVID-19–Positive STEMI Patients According to Vaccination Status

	Unvaccinated (n = 171)	Vaccinated (n = 22)	*P* Value[a]
Age <66 y	104 (61.0)	12 (55.0)	0.572
Overweight/obese	128 (78.0)	16 (89.0)	0.372
CVRF <3	137 (80.0)	19 (86.0)	0.579
Dyspnea	79 (46.0)	6 (27.0)	0.092
Chest pain	107 (63.0)	15 (68.0)	0.608
Syncope	6 (3.5)	1 (4.5)	0.577
Infiltrates on chest x-ray	64 (37.0)	4 (18.0)	0.075
Pleural effusion	11 (6.4)	2 (9.1)	0.647
Cardiomegaly	8 (4.7)	0 (0.0)	0.600
Cardiac arrest pre-PCI	8 (5.4)	1 (5.0)	1.0
Shock pre-PCI	20 (14.0)	2 (10.0)	1.0
Ejection fraction, %	45 (34, 55)	45 (44, 54)	0.404
In-house presentation of MI	19 (11.0)	0 (0.0)	0.137
Clinical outcomes			
Mortality	37 (22.0)	0 (0.0)	0.009
Stroke	1 (0.6)	0 (0.0)	1.0
Reinfarction	3 (1.8)	1 (4.5)	0.386
Composite endpoint	38 (22.0)	1 (4.5)	0.052

Values are n (%) or median (25th percentile, 75th percentile). [a]Not adjusted for multiple comparisons.
CVD = cardiovascular disease; STEMI = ST-segment elevation myocardial infarction; other abbreviations as in Table 1.

TABLE 5 Trends in Baseline Characteristics and Outcomes for COVID-19–Negative Patients (Person Under Investigation)

	Y2020 (n = 495)	Y2021 (n = 298)	*P* Value[a]
Age ≥66 y	200 (40.0)	137 (46.0)	0.124
History of CAD	127 (26.0)	80 (30.0)	0.275
Non-Caucasians	112 (24.0)	83 (29.0)	0.133
Dyslipidemia	277 (59.0)	160 (59.0)	0.976
Diabetes mellitus	151 (32.0)	94 (33.0)	0.675
BMI, kg/m^2	29 (25, 33)	28 (25, 32)	0.480
Hypertension	165 (74.0)	223 (65.0)	0.025
History of heart failure	45 (9.4)	34 (13.0)	0.118
Aspirin on admission	136 (27.0)	95 (32.0)	0.186
Statin on admission	172 (35.0)	93 (31.0)	0.306
Clinical outcomes			
Primary endpoint	62 (14.0)	29 (11.0)	0.231
Mortality	54 (11.0)	28 (9.5)	0.501
Stroke	7 (1.6)	2 (0.8)	0.497
Reinfarction	5 (1.1)	2 (0.8)	>0.099

Values are n (%) or median (25th percentile, 75th percentile). [a]Not adjusted for multiple comparisons.
Abbreviations as in Table 1.

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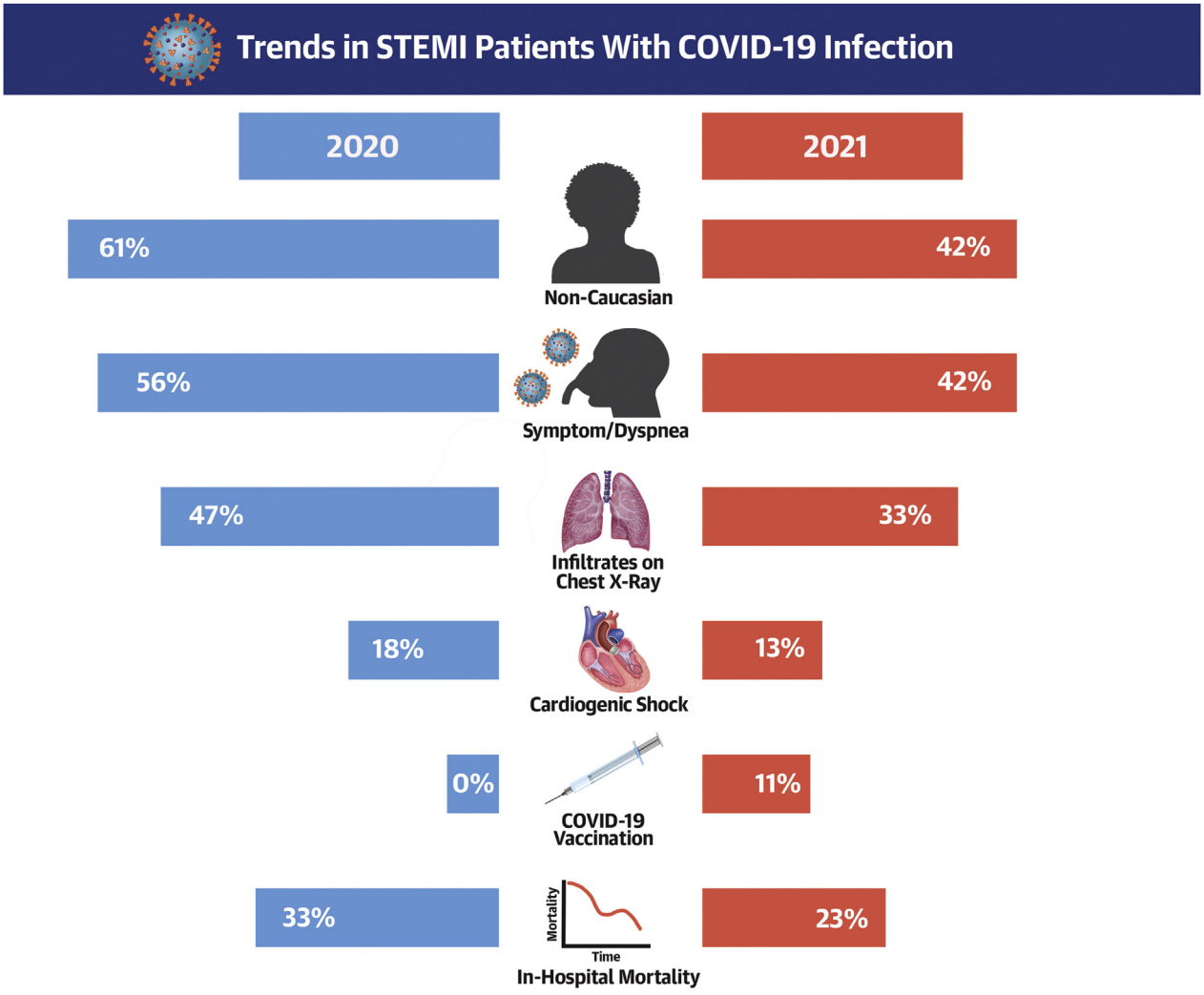
CENTRAL ILLUSTRATION **Summary of Key Findings of NACMI 2020-2021 Comparison**



Garcia S, et al. J Am Coll Cardiol. 2022;79(22):2236–2244.

Relative to Y2020, the proportion of Caucasian patients was higher, patients presented more frequently with typical ischemic symptoms, and were less likely to have shock pre-PCI or pulmonary manifestations of COVID-19 infection. In-hospital mortality decreased from 33% to 23%. Original created with BioRender.com.
NACMI = North American COVID-19 STEMI Registry; PCI = percutaneous coronary intervention.

During the first wave of the pandemic, we reported a preponderance of minority ethnicity in patients with STEMI and COVID-19 infection. Crowded living conditions, frontline employment, health disparities, and higher prevalence of comorbidities may explain these findings.[20] The present analysis demonstrates that, as the pandemic evolved, Caucasians became the predominant ethnic group in NACMI, which is consistent with prepandemic STEMI registries from North America.[21-23]

The NACMI registry was designed as a collaboration of 3 North American societies (Society for Cardiac Angiography and Interventions, Canadian Association of Interventional Cardiologists, and the American College of Cardiology Interventional Council) in response to an unprecedented reduction in cardiac catheterization laboratory activations and calls to deviate from the standard of care during the pandemic.[24-26] The NACMI registry is the largest, prospective data set of STEMI patients with COVID-19 treated in 2021 and continues to demonstrate that PCI is feasible during the pandemic, with the majority of patients being treated within guideline-recommended times despite expected delays caused

by testing and other logistical challenges posed by the pandemic. Educational efforts, such as the Society for Cardiac Angiography and Intervention's Seconds Still Count Patient Awareness campaign, are helping reverse these trends.[27,28]

STUDY LIMITATIONS. NACMI is the largest, prospective, multicentric STEMI COVID-19 registry to date. However, several limitations should be acknowledged. Common to observational registries, NACMI lacked independent event adjudication, core laboratory analysis, and pre-hospital data regarding total ischemic and transfer times for patients presenting to a non-PCI hospital. Angiographic and electrocardiographic core laboratory analysis are underway. Incomplete vaccination data as well as null number of deaths in vaccinated patients did not allow for estimating the association of vaccination with the risk of mortality while adjusting for underlying risk factors. The low proportion of vaccinated patients in a hospitalized cohort such as NACMI is consistent with the known protective effects against hospitalization, and other serious outcomes, of COVID-19 vaccines. Finally, our study did not capture information regarding COVID-19 variants. Omicron has shown signs of being less virulent than earlier variants, but it triggered record number of infections and a surge in deaths.[29] Omicron was first reported in the United States on December 1, 2021, which is the very end of our study period.

CONCLUSIONS

Significant changes have occurred in the clinical characteristics, management strategies, and outcomes of STEMI patients with COVID-19 infection during the course of the pandemic. Notably, mortality is 25% lower for patients treated in Y2021 relative to Y2020 but remains high for unvaccinated patients.

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PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: Significant changes have occurred in the clinical characteristics, management strategies, and outcomes of STEMI patients with COVID-19 infection during the course of the pandemic. Mortality has decreased 25% but remains high for unvaccinated patients.

TRANSLATIONAL OUTLOOK: Efforts to educate the public on the beneficial effects of COVID-19 vaccines must continue.

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KEY WORDS COVID-19, heart attack, outcomes, STEMI

APPENDIX For a supplemental table, please see the online version of this paper.