ELSEVIER

Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

STEMI and COVID-19 Pandemic in Saudi Arabia

Amin Daoulah, MD, Ahmad S. Hersi, MD,
Salem M. Al-Faifi, MD, Abdulaziz Alasmari, MD,
Alwaleed Aljohar, MD, Mohammed Balghith, MD,
Mohammed Alshehri, MD, Ali A. Youssef, MD,
Osama ElSayed, MD, Mohamed Nabil Alama, MD,
Wael A. Refaat, MD, Badr Alzahrani, MD,
Ziad Dahdouh, MD, Abdul Salim Khan, MD,
Mohamed A. Ghani, MD, Muhammad Adil Soofi, MD,
Mirvat Alasnag, MD, Hameedullah M. Kazim, MD,
Abdelmaksoud Elganady, MD, Taher Hassan, MD,
Ahmed Mahmoud Ibrahim, MD, Zainab Amellal, MD,
Faisal Alsmadi, MD, Abdulrahman M. Ghazi, MD,
Abdulaziz M. Alshehri, MD,
Mohammed S. Alhulayfi, MD, Ahmed A. Ghonim, MD,
Alaa S. Algazzar, MD, Turki A. AL Garni, MD,
Waleed AlHarbi, MD, Ahmed A. Jouda, MD,
Khaled Al-Shaibi, MD, Saleh Albasiri, MD,
Reda Abuelatta, MD, Wael Tawfik, MD,
Mohamed Magdy, MD, Sami Rashed Alasmari, MD,
Ehab Selim, MD, Mohamed Elramly, MD,
Mohammed A. Abufayyah, MD,

Saif S. Alshahrani, MD,
Abdulrahman H. Alqahtani, PhD,
Fatima Ali Ahmed, MD, Waleed A. Ahmed, MD, and
Amir Lotfi, MD

Abstract: The COVID-19 pandemic had significant impact on health care worldwide which has led to a reduction in all elective admissions and management of patients through virtual care. The purpose of this study is to assess changes in STEMI volumes, door to reperfusion, and the time from the onset of symptoms until reperfusion therapy, and in-hospital events between the pre-COVID-19 (PC) and after COVID-19 (AC) period. All acute ST-segment elevation myocardial infarction (STEMI) cases were retrospectively identified from 16 centers in the Kingdom of Saudi Arabia during the COVID-19 period from January 01 to April 30, 2020. These cases were compared to a pre-COVID period from January 01 to April 30, 2018 and 2019. One thousand seven hundred and eighty-five patients with a mean age 56.3 (SD $\pm$ 12.4) years, 88.3% were male. During COVID-19 Pandemic the total STEMI volumes was reduced (28%, $n = 500$), STEMI volumes for those treated with reperfusion therapy was reduced too (27.6%, $n = 450$). Door to balloon time $<$ 90 minutes was achieved in (73.1%, no $= 307$) during 2020. Timing from the onset of symptoms to the balloon of more than 12 hours was higher during 2020 comparing to pre-COVID 19 years (17.2% vs $<$3%, respectively). There were no differences between the AC and PC period with respect to in-hospital events and the length of hospital stay. There was a reduction in the STEMI volumes during 2020. Our data reflected the standard of care for STEMI patients continued during the COVID-19 pandemic while demonstrating patients delayed presenting to the hospital. (Curr Probl Cardiol 2021;46:100656.)

Introduction

Routine inpatient and outpatient health care has been greatly disrupted by the coronavirus (COVID-19) pandemic and in order to manage the crisis both equipment and personnel have been redeployed. There has been anecdotal and publications discussing the decrease in volume of the non-ST-segment elevation myocardial infarction (STEMI) and STEMI cases from around the world.[1-3] One explanation for the decrease includes patients are staying home due to fear of being infected by the coronavirus and other patients presenting late in their STEMI course due to the same concerns.

In patients presenting with STEMI, primary percutaneous coronary intervention (PPCI) is the accepted standard mode of treatment including during this pandemic. The Society for Cardiac Angiography and Interventions (SCAI) and American College of Cardiology continue to recommend PPCI as the standard treatment of STEMI patients during the current pandemic.[4]

The Saudi Heart Association has published guidance for acute coronary syndrome management for STEMI patients during the COVID-19 pandemic.[5]

In the Kingdom of Saudi Arabia (KSA) the first reported case of COVID-19 was March 2, 2020 with a world health organization declaring COVID-19 pandemic on March 11, 2020.[6,7]

The highest number of COVID-19 cases in the Arab world has been reported in KSA with a case fatality rate of 0.7.[8]

In this study, we assessed the STEMI volumes during the COVID-19 pandemic era (January, February, March, and April 2020) comparing to pre-COVID-19 era (January, February, March, and April 2018 and 2019). We also assessed door to reperfusion (balloon/needle) in order to better investigate hospital related system issues and symptom to reperfusion (balloon/needle) in order to better investigate delay in presentation.

Methods

Study design and population

This is a retrospective, multicenter, observational study that included all consecutive hospital admissions of patients with acute STEMI. Eligible patients were above the age of 18 years, hospitalized or presenting to emergency departments with ST segment elevation of more than 1mm in more than 2 contiguous leads lasting for more than 30 minutes, or new

left bundle branch block, or a clinical syndrome consistent with acute evolving transmural MI requiring immediate thrombolytic or interventional reperfusion therapy (PPCI).

All acute STEMI cases were identified in 16 high-volume (>100 PPCI per year) catheterization laboratories in the Kingdom of Saudi Arabia. All of which were in tertiary hospitals during the COVID-19 era from January 01 to April 30, 2020. These cases were compared to a pre-COVID era cohort from January 01 to April 30, 2018 and 2019.

Appendix 1 illustrates the total number of patients per hospital in addition to the number of Primary PCI, thrombolytic therapy, rescue PCI, and other causes of ST segment elevation who were taken to the catheterization laboratory for possible Primary PCI and had other diagnosis or those in whom the coronary anatomy was unfavorable or not feasible with percutaneous coronary intervention may undergo CABG per each hospital. No patients were excluded from this study.

Regional background regarding COVID 19 pandemic

On March 02, 2020 the Ministry of health announced the first case of coronavirus infection in a citizen who returned from Iran via the Kingdom of Bahrain.[6] WHO declares COVID 19 as a pandemic on March 11, 2020.[7] Social distancing and curfew was recommended by the Saudi Center for Disease Prevention and Control and the Saudi government respectively on March 23th.[9] The beginning of March, 2020 was identified as the beginning of the After COVID (AC) period. The first two months of 2020 (January 01 to February 29) were considered as "COVID era" in the current study due to the variable timing of screening measures for COVID 19 which were introduced by different centers in The Kingdom of Saudi Arabia [Jan (1 center), Feb (9 centers), March (6 centers)]. These measures followed The World Health Organization declaration that COVID was a public health emergency of international concern in Jan 30, 2020 following the outbreak that was first identified in Wuhan, China, in December 2019.[10] The Pre-COVID (PC) period for the current study was comprised of the eight months period, from Jan 1 to April 30, 2018 and 2019. A consensus statement from the cardiac services development team at the ministry of health of Saudi Arabia, recommended that all patients with acute STEMI should be considered COVID 19 positive until proven negative, that is, proper hand hygiene should be followed at all times, Personal Protective Equipment for the entire staff caring for the patient should be available, a negative pressure Cath Lab

should be used, all patients entering Cath Lab should be wearing a face mask if tolerated.[11]

The purpose of this study

To assess if there are any changes in STEMI volumes, door to balloon times, door to needle times, timing of presentation from the onset of symptoms until reperfusion therapy, in-hospital events, and length of hospital stay between the pre-COVID 19 and after COVID 19 period.

Study organization and clinical assessment

This Registry includes experienced cardiologists from all 16 tertiary hospitals from The Kingdom of Saudi Arabia.

Multiple variables and patient factors were measured. Baseline patient characteristics were obtained from hospital records (chart review and digital library). Information collected included, age, gender, BMI, history of smoking, diabetes, hyperlipidemia, hypertension, previous history of coronary artery disease, percutaneous coronary intervention, coronary artery bypass graft, peripheral vascular disease, stroke, hospital presentation, for example, presence of cardiogenic shock (defined as a systolic blood pressure of < 90 mmHg or requirement of inotropes to maintain a SBP > 90 mmHg), sudden cardiac arrest (VA or PEA or asystole), sustained VT, symptomatic bradyarrhythmia, electrocardiographic findings, echocardiographic findings, and laboratory results includes WBCC, hemoglobin, cardiac enzymes etc. COVID 19 screening for all patients undergoing cardiac catheterization in study hospitals was based on the case definition using visual triage checklist for acute respiratory illness. A score ≥ 5 prompted testing for COVID 19.[12] Angiographic and procedural details included identification of culprit vessels, segments and branches, other nonculprit vessels and number of stents. Timing variables were ascertained including time to presentation which is defined as the time from symptom onset until arrival at the hospital, door to balloon time, and door to needle time. In-hospital events are the events that the patient did not present with, but developed after hospitalization and included recurrent ventricular tachycardia/ventricular fibrillation (VT/VF), Symptomatic Brady-arrhythmia, congestive heart failure, cardiogenic shock, renal failure, death, stroke, recurrent MI, stent thrombosis, redo PCI, implantable cardioverter defibrillator implantation and permanent pacemaker implantation. In addition we measure duration of in-hospital stay for each patient. All data entry from each center were checked for data queries or

entry mistakes by the Principal Investigator prior to submission for final analysis. The study was approved by King Faisal Specialist Hospital and Research Center (Riyadh) Institutional Review Board and the institutional review board of each of the participating hospitals. Given the observational nature of the study and the fact that patient identities remained anonymous, the IRB did not require written informed consent.

Statistical analysis

The categorical data were presented as absolute numbers and percentages. The numerical data were presented as mean $\pm$ standard deviation or as median and interquartile range, depending on the data distribution. The categorical variables were compared using chi-squared or Fisher's exact tests where indicated, and the numerical data were compared using analysis of variance (ANOVA) and Kruskal-Wallis tests for normally distributed and skewed variables, respectively. A 2-sided P value of <0.05 was considered statistically significant. The statistical analyses were performed using SPSS, version 21 (IBM Corp., Armonk, NY).

Results

Enrolled hospitals and study population

We invited a total of 16 hospitals from the 5 provinces in The Kingdom of Saudi Arabia (Makkah, Madinah, Riyadh, Asir, Eastern province). One thousand seven hundred and eighty-five patients with acute STEMI were enrolled in the study. Cases during the COVID-19 era from January 01 to April 30, 2020 were compared to a pre-COVID era cases from January 01 to April 30, 2018 and 2019. Of these patients, 1499 (84%) had Primary PCI, 134 (7.5%) thrombolytic therapy (alteplase 104, Tenecteplase 29, streptokinase 1), 94 (5.3%) rescue PCI, and 58 (3.2%) other causes of ST segment elevation who were taken to the catheterization laboratory for possible PPCI and either had normal coronary (pericarditis 4, myocarditis 3, unknown cause 3) or coronary anatomy that was unfavorable or untreatable with percutaneous coronary intervention. This latter group were treated with surgery, CABG (18) or treated medically (diffuse multivessel disease 3, distal disease 6, small vessel disease 2, nonobstructive lesion 5, failed PCI 2, SCAD 2, ecstatic disease 1, coronary spasm 1, heavy thrombus 2, awaiting COVID 19 results 6). Figure 1A Weekly rates of hospitalization for acute ST-segment elevation myocardial infarction among 1785 patients enrolled in the study between
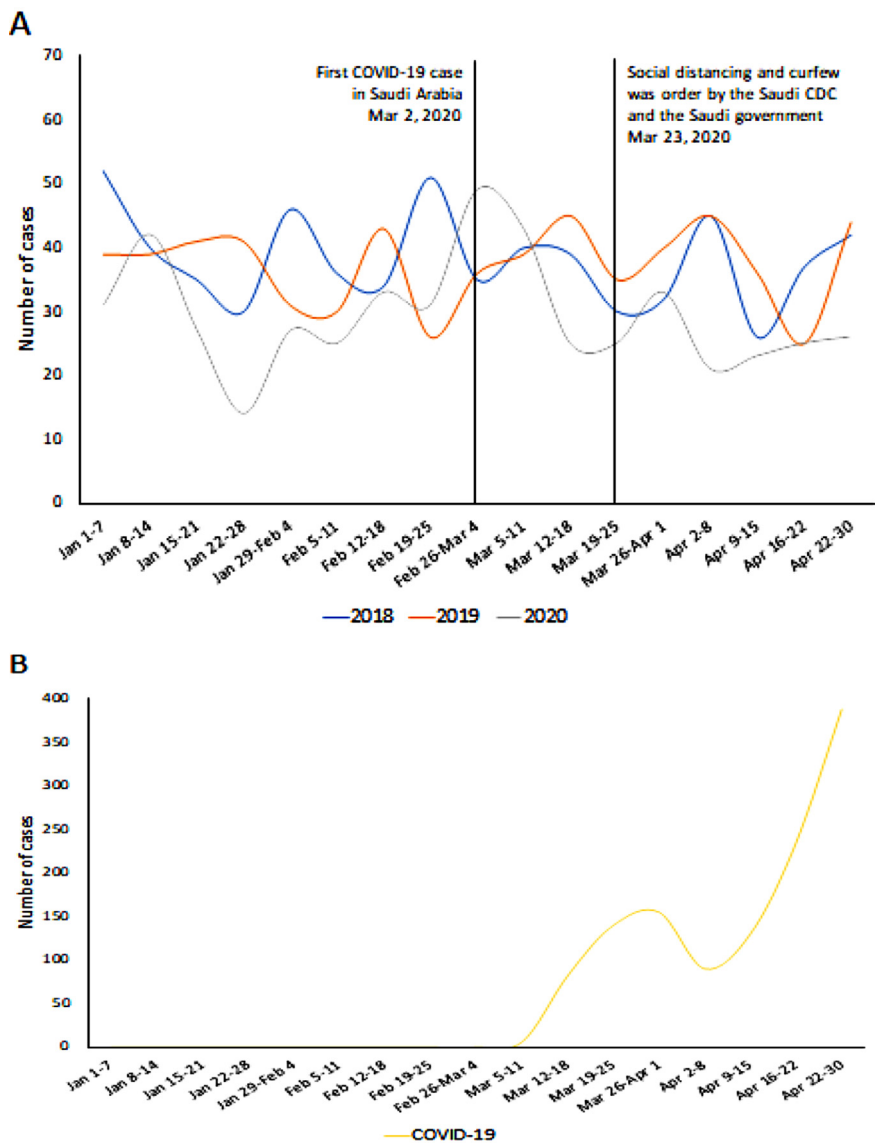
A

B

FIG 1. (A) Weekly rates of hospitalization for acute ST-segment elevation myocardial infarction among 1785 patients enrolled in the study between the pre COVID 19 (January 01 to April 30, 2018 and 2019) and after COVID 19 period (January 01 to April 30, 2020). (B) Weekly rates of hospitalization for positive COVID 19 cases (January 01 to April 30, 2020).

the pre-COVID 19 (January 01 to April 30, 2018 and 2019) and after COVID 19 period (January 01 to April 30, 2020). Figure 1B Weekly rates of hospitalization for positive COVID 19 cases (January 01 to April 30, 2020).

Baseline characteristics and comorbidities of patients during COVID 19 Pandemic (2020) and Pre-COVID 19 (2018 & 2019)

As outlined in Table 1, more than half of the study participants were Saudis 58.9%. The mean age was 56.3 [standard deviation = 12.4] years, 88.3% were male. An increased percentage of males was seen during the pandemic in 2020 relative to 2018 and 2019 ($P = 0.003$). Smoking was

Table 1. Baseline characteristics of patients during Covid-19 (2020) and pre-Covid-19 period (2018-2019)

	Total (n = 1785)	2018 (n = 650)	2019 (n = 635)	2020 (n = 500)	P value
Age (years), mean ± SD	56.3 ± 12.4	56.7 ± 12.3	56.5 ± 12.8	55.4 ± 11.8	0.174
Males, n (%)	1577 (88.3%)	584 (89.8%)	539 (84.9%)	454 (90.8%)	0.003
Saudis, n (%)	1023 (58.9%)	372 (58.9%)	374 (61.7%)	277 (55.5%)	0.113
Body mass index, mean ± SD	28.2 ± 5.0	28.2 ± 5.3	28.6 ± 5.3	27.8 ± 4.3	0.038
Smoking, n (%)	739 (42.5%)	278 (43.8%)	248 (40.2%)	213 (43.8%)	0.339
Diabetes mellitus, n (%)	889 (50.9%)	320 (50.3%)	312 (50.6%)	257 (52.1%)	0.819
IDDM	237 (26.7%)	77 (24.1%)	91 (29.2%)	69 (26.8%)	0.348
NIDDM	652 (73.3%)	243 (75.9%)	221 (70.8%)	188 (73.2%)	
Dyslipidemia, n (%)	640 (36.7%)	234 (36.7%)	216 (35.0%)	190 (38.9%)	0.394
Hypertension, n (%)	828 (47.4%)	303 (47.7%)	296 (47.5%)	229 (46.7%)	0.944
Family history of CAD, n (%)	138 (8.1%)	47 (7.4%)	53 (8.8%)	38 (8.0%)	0.696
Coronary artery disease, n (%)	208 (12.1%)	76 (12.0%)	68 (11.2%)	64 (13.4%)	0.532
Chronic kidney disease, n (%)	93 (5.4%)	31 (4.9%)	34 (5.6%)	28 (5.9%)	0.767
Peripheral vascular disease, n (%)	22 (1.3%)	10 (1.6%)	7 (1.2%)	5 (1.0%)	0.690
Cerebrovascular accident, n (%)	60 (3.5%)	16 (2.5%)	30 (5.0%)	14 (2.9%)	0.051
Percutaneous coronary intervention, n (%)	188 (10.9%)	79 (12.5%)	58 (9.5%)	51 (10.7%)	0.243
Coronary artery bypass grafting, n (%)	24 (1.4%)	9 (1.4%)	9 (1.5%)	6 (1.3%)	0.948
Atrial fibrillation, n (%)	30 (1.8%)	15 (2.4%)	6 (1.0%)	9 (1.9%)	0.171
Heart failure, n (%)	30 (1.8%)	12 (1.9%)	13 (2.1%)	5 (1.0%)	0.366

reported in 42.5% of the cohort, similar to previous years. Traditional cardiovascular risk factors and comorbidities, including; diabetes mellitus (50.9%), dyslipidemia (36.7%), hypertension (47.4%), past medical history of CAD (12.1%), PCI (10.9%), CABG (1.4%), PVD (1.3%), CVA (3.5%), CKD (5.4%), AFib (1.8%), all of which were not statistically different across the study period.

Clinical presentation, laboratory, and echocardiographic findings, and angiographic distribution

As shown in Table 2, at hospital presentation 81 patients (58.3%) had ventricular arrhythmia of which 65 (46.7%) had VF arrest requiring DC shock and 16 (11.5%) had sustained VT either converting spontaneously or treated with IV amiodarone (8 patients). 5 (3.59%) patients had cardiac arrest due to asystole and 8 (5.75%) due to pulseless electrical activity. Bradyarrhythmias were reported in 34 patients (24.5%); 28 (20.14%) had CHB, 22 were treated with temporary pacemaker wire and 6 resolved spontaneously. The remaining 6 patients (4.31%) had second degree AV block; 2 were treated with Atropine and the remaining 3 requiring no treatment. Atrial fibrillation was reported in 11 patients (7.9%), all of which were not statistically different across the study period. Cardiogenic shock which was reported in 8 patients (0.44%) were also not statistically different across the study period. Regarding the location of myocardial infarction, most occurred anteriorly (54.9%) followed by inferiorly (39.8%), Other locations were reported in 94 patients (5.3%) (lateral 67, posterior 17, posterolateral 10). Laboratory findings on admission include elevated WBCC [median (IQR), 11.2 (9-14)], Troponin [30 (12-50)], CK [1475 (600-2933]. Troponin were significantly more elevated in the 2018 and 2019 years compared to 2020 year. The COVID 19 PCR were negative in 57 patients (11.4%) and positive in 1 (0.2%) in 2020. The LV ejection fraction $\leq$ 30% were reported in (19.6%), 31%-40% (34.7%), 41%-50% (32.3%), and more than 50% (13.5%), were not statistically different across the study period. In terms of culprit vessel involvement, 0.9% had left main, 53.4% left anterior descending artery, 30.2% right coronary artery, 10.6% left circumflex artery, 0.3% multivessel, and 72 (4.1%) had either branch vessel (31 diagonal, 26 obtuse marginal, 6 ramus intermedius artery, 3 posterior descending artery, 3 posterior left ventricular artery) or SVG involvement (3 patients), all of which were not statistically different across the study period. Segment involvement within each culprit vessel, proximal 59.7%, mid 29.1%, and distal 9.7%. Branch involvement within the culprit vessel, diagonal 67.6%, obtuse marginal

Table 2. Clinical presentation, laboratory, echocardiography, and angiographic findings

	Total (n = 1785)	2018 (n = 650)	2019 (n = 635)	2020 (n = 500)	P value
Arrhythmias at presentation, n (%)	139 (7.8%)	50 (7.7%)	39 (6.1%)	50 (10.0%)	0.055
Asystole/PEA	13 (9.4%)	4 (8.0%)	5 (12.8%)	4 (8.0%)	0.415
Atrial Fibrillation	11 (7.9%)	7 (14.0%)	1 (2.6%)	3 (6.0%)	
Bradyarrhythmias	34 (24.5%)	12 (24.0%)	12 (30.8%)	10 (20.0%)	
Ventricular Arrhythmias	81 (58.3%)	27 (54.0%)	21 (538%)	33 (66.0%)	
Laboratory investigations, median (interquartile range)					
White blood cell count (g/L)	11.2 (9.0, 14.0)	11.4 (9.0, 14.1)	11.0 (8.6, 14.0)	11.0 (8.6, 14.0)	0.295
Troponin (ng/L)	30 (12, 50)	33 (13, 75)	30 (13, 50)	25 (12, 50)	0.002
Creatinine kinase (U/L)	1475 (600, 2933)	1467 (656, 2812)	1495 (602, 3190)	1452 (576, 2807)	0.554
COVID-19 PCR					
Not done	-	-	-	452 (90.4%)	
Negative	-	-	-	57 (11.4%)	
Positive	-	-	-	1 (0.2%)	
Location of infarction, n (%)					
Anterior wall	980 (54.9%)	358 (55.2%)	338 (53.2%)	284 (56.8%)	0.421
Inferior wall	710 (39.8%)	255 (39.3%)	258 (40.6%)	197 (39.4%)	
Other	94 (5.3%)	36 (5.5%)	39 (6.1%)	19 (3.8%)	
Ejection fraction, n (%)					
≤ 30%	349 (19.6%)	127 (19.6%)	133 (21.0%)	89 (17.8%)	0.319
31-40%	618 (34.7%)	242 (37.3%)	212 (33.4%)	164 (32.8%)	
41-50%	575 (32.3%)	193 (29.8%)	210 (33.1%)	172 (34.4%)	
> 50%	240 (13.5%)	86 (13.3%)	79 (12.5%)	75 (15.0%)	
Culprit vessel, n (%)					
Left anterior descending	947 (53.4%)	352 (54.3%)	321 (51.0%)	274 (55.1%)	0.327
Right coronary artery	535 (30.2%)	202 (31.2%)	191 (30.4%)	142 (28.6%)	
Left circumflex artery	188 (10.6%)	55 (8.5%)	74 (11.8%)	59 (11.9%)	
Left main artery	16 (0.9%)	3 (0.5%)	7 (1.1%)	6 (1.2%)	
Multi-vessel	5 (0.3%)	1 (0.2%)	2 (0.3%)	2 (0.4%)	
Others (branch vessel and SVG)	72 (4.1%)	29 (4.5%)	29 (4.6%)	14 (2.8%)	
Segment involved, n (%)					
Proximal	976 (59.7%)	345 (59.3%)	347 (59.3%)	284 (60.8%)	0.605
Mid	476 (29.1%)	176 (30.2%)	167 (28.5%)	133 (28.5%)	
Distal	159 (9.7%)	54 (9.3%)	62 (10.6%)	43 (9.2%)	
Branch involved, n (%)					
Diagonal	163 (67.6%)	74 (64.3%)	48 (71.6%)	41 (69.5%)	0.466
Obtuse marginal	37 (15.4%)	22 (19.1%)	6 (9.0%)	9 (15.3%)	
Posterior	41 (17.0%)	19 (16.5%)	13 (19.4%)	9 (15.3%)	
TIMI flow, n (%)					
TIMI 0		357 (55.9%)	396 (63.3%)	304 (61.7%)	0.031

Table 2. (*continued*)

	Total (n = 1785)	2018 (n = 650)	2019 (n = 635)	2020 (n = 500)	*P* value
	1057 (60.1%)				
TIMI 1	249 (14.2%)	103 (16.1%)	91 (14.5%)	55 (11.2%)	
TIMI 2	289 (16.4%)	117 (18.3%)	91 (14.5%)	81 (16.4%)	
TIMI 3	163 (9.3%)	62 (9.7%)	48 (7.7%)	53 (10.8%)	
Stenosis severity, n (%)					
100%	1069 (64.2%)	364 (61.5%)	400 (66.9%)	305 (64.3%)	0.113
90 to 99%	460 (27.6%)	168 (28.4%)	154 (25.8%)	138 (29.1%)	
< 90%	135 (8.1%)	60 (10.1%)	44 (7.4%)	31 (6.5%)	

15.4%, and posterior (17%). TIMI coronary flow were distributed as follow (TIMI-0 (60.1%), TIMI-1(14.2%), TIMI 2 (16.4%), TIMI-3 (9.3%). Stenosis severity within the culprit lesion were reported as follow 100% (64.2%), 90%-99% (27.6%), <90% (8.1%). The number of stent utilized within the culprit vessel per patient is reported in Table 2.

Strategy and patient management

As shown in Table 3, Medical management in all acute STEMI included primarily dual antiplatelet therapy, with 99.5% of patients on aspirin and 97.9% on P2Y12 inhibitor (53.3% had Ticagrelor, and the remaining 46.7% were placed on Clopidogrel). Heparin were used in 95.6% of cases. B-Blockers and statins were used in 91.4% and 98.3% of the patients respectively. Glycoprotein IIb/IIIa inhibitors used in 601 patients (35.2%) (Tirofiban 85.6%, Abciximab 10.9%, Eptifibatide 3.5%). Nitroglycerin were used in 39.7%. Revascularization therapy were reported as follow, 84% had PPCI, 7.5% thrombolytic therapy, 5.3% rescue PCI, and 3.2% had other causes of ST segment elevation MI or had coronary anatomy that was unfavorable or not feasible with percutaneous coronary intervention and undergo CABG 18 patients (1%).

Findings of the current study, as shown in Figures 2-6.

In Hospital events

As shown in Table 4, overall mortality rate was 4.2%. This was not significantly different between the 3 years. In-stent thrombosis were reported in 1.2% of the cohort. 1.9% of patients had redo PCI, and 3.2% undergo CABG. Bleeding rate both major and minor were reported in

Table 3. Strategy and patient management

	Total (n = 1785)	2018 (n = 650)	2019 (n = 635)	2020 (n = 500)	P value
Intervention, n (%)					
Primary PCI	1499 (84.0%)	526 (80.9%)	553 (87.1%)	420 (84.0%)	<0.001
Thrombolytic therapy	134 (7.5%)	76 (11.7%)	28 (4.4%)	30 (6.0%)	
Rescue PCI	94 (5.3%)	30 (4.6%)	28 (4.4%)	36 (7.2%)	
Others	58 (3.2%)	18 (2.8%)	26 (4.1%)	14 (2.8%)	
Door to balloon < 90 minutes, n (%)	1049 (70.4%)	370 (70.9%)	372 (67.8%)	307 (73.1%)	0.187
Door to needle < 30 minutes, n (%)	67 (54.5%)	34 (48.6%)	18 (66.7)	15 (57.7%)	0.258
Stents used, n (%)					
Zero stents	281 (15.8%)	134 (20.9%)	89 (14.1%)	58 (11.6%)	<0.001
1 stent	1049 (59.1%)	344 (53.6%)	385 (60.8%)	320 (64.0%)	
2 or more	445 (25.1%)	164 (25.5%)	159 (25.1%)	122 (24.4%)	
Medications					
Aspirin, n (%)	1774 (99.5%)	645 (99.5%)	632 (99.5%)	497 (99.4%)	0.999
Statins, n (%)	1745 (98.3%)	627 (97.4%)	627 (98.9%)	491 (98.6%)	0.088
Beta blockers, n (%)	1607 (91.4%)	569 (89.6%)	574 (91.0%)	464 (94.1%)	0.025
P2Y12 inhibitors, n (%)	1743 (97.9%)	635 (98.3%)	620 (97.6%)	488 (97.8%)	0.691
Clopidogrel, n (%)	802 (46.7%)	339 (54.6%)	296 (48.3%)	167 (34.6%)	<0.001
Ticagrelor, n (%)	914 (53.3%)	282 (45.4%)	317 (51.7%)	315 (65.4%)	
ACEis or ARBs, n (%)	1428 (82.9%)	513 (82.1%)	512 (83.0%)	403 (84.0%)	0.712
GIIbIIIa inhibitors, n (%)	601 (35.2%)	211 (33.7%)	238 (39.6%)	152 (31.8%)	0.017
Tirofiban, n (%)	511 (85.6%)	182 (86.7%)	205 (87.2%)	124 (81.6%)	0.575
Abciximab, n (%)	65 (10.9%)	22 (10.5%)	22 (9.4%)	21 (13.8%)	
Eptifibatide, n (%)	21 (3.5%)	6 (2.9%)	8 (3.4%)	7 (4.6%)	
Nitroglycerin, n (%)	504 (39.7%)	190 (36.6%)	184 (44.2%)	130 (38.7%)	0.055
Heparin, n (%)	1701 (95.6%)	603 (92.8%)	614 (97.2%)	484 (97.2%)	<0.001

1.2% and 1.6% respectively. 8.1% had cardiogenic shock. In-hospital arrhythmias both ventricular and bradyarrhythmias were reported in 4.7% and 3.9% respectively. Stroke was reported in 0.4%. Length of in-hospital stay, with a median time of 4 days (interquartile range: 3-5 days). Both in-hospital events and median length of hospital stay were not statistically different between the 3 years.

Discussion

We demonstrated a significant decrease in STEMI volume from 16 hospitals in 5 provinces in KSA during the COVID-19 pandemic era as compared to pre-COVID-19 era. While there was no significant difference in door to reperfusion time either through PPCI or thrombolytic therapy there was a significant increase in symptom to reperfusion time.
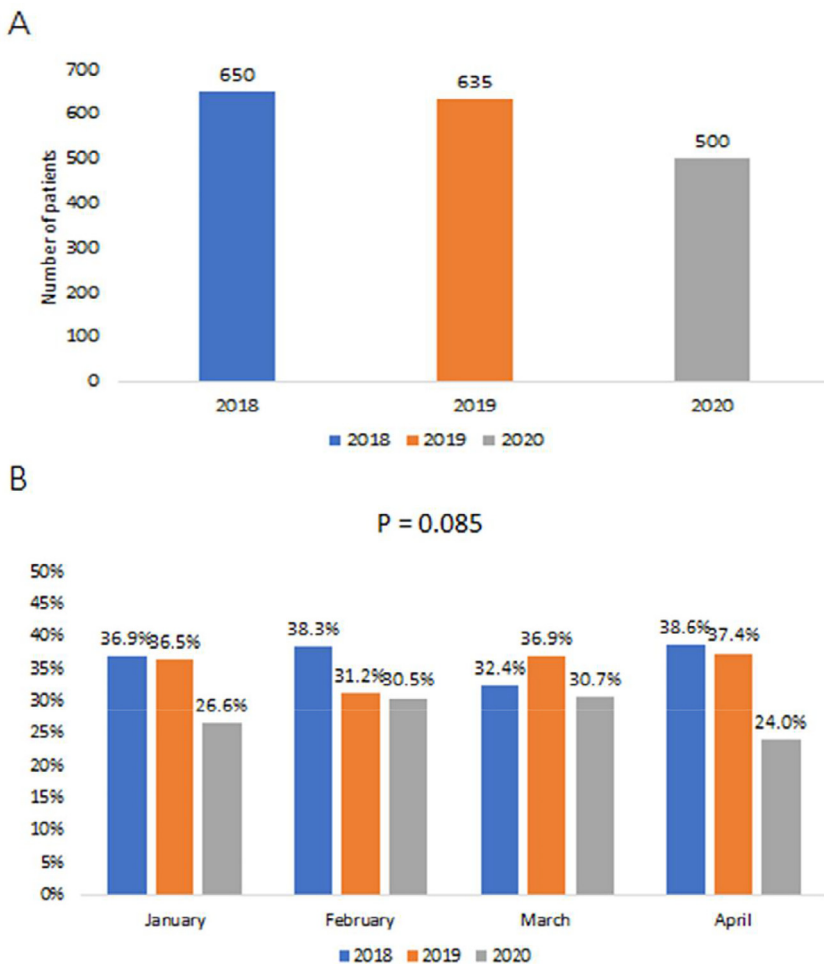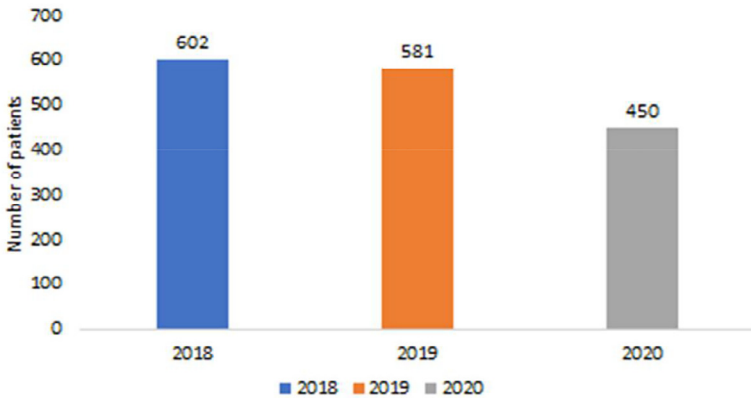
A

B

P = 0.085

FIG 2. Total STEMI volumes before and during COVID-19 Pandemic. (A) This graph compares the total STEMI volumes (n = 1785) by year (blue: 2018 brown: 2019 gray: 2020). (B) This graph compares similar month across the years, where the year 2020 was the lowest especially the month of April.

There was no difference between baseline characteristics and inpatient adverse event in STEMI patients treated during the COVID-19 pandemic timeframe versus pre-COVID-19 timeframe.

During the COVID-19 pandemic there have been significant concerns regarding appropriate personal protection equipment for protection of healthcare workers and concerns for patients staying away from health-care institution for the fear of being infected with the coronavirus.[13,14]
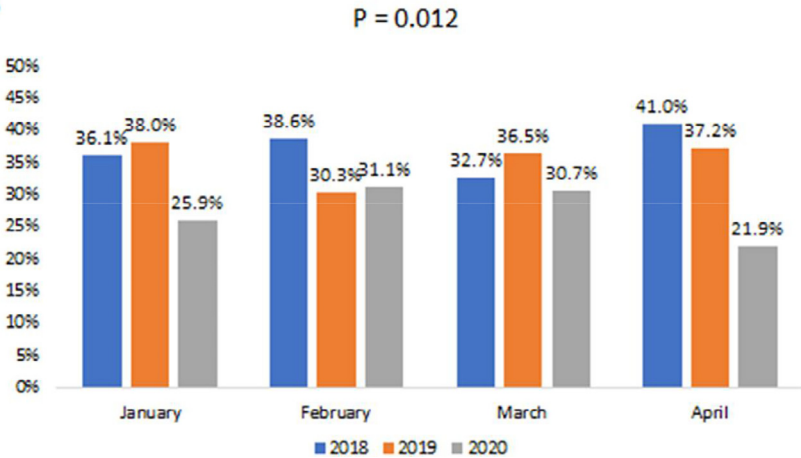
FIG 3. Total STEMI volumes for reperfusion therapy during COVID-19 Pandemic. (A) This graph compares the STEMI volumes for primary PCI and thrombolytic therapy (n = 1633) by year (blue: 2018 brown: 2019 gray: 2020). (B) This graph compares similar month across the years, where the year 2020 was the lowest especially the month of January and April.

In this retrospective analysis, as in previous studies, we demonstrated a statistically significance decrease in STEMI volume during COVID-19 era however there was no statistically significance difference in door to reperfusion indicating that hospital systems of care continued to operate efficiently. However, there symptoms to reperfusion were markedly increased during this timeframe indicating patient's hesitancy to present to the emergency department. In that context, we did not appreciate an increase in major adverse cardiovascular events, increasing biomarkers, cardiogenic shock, length of stay, and decreased ejection fraction during
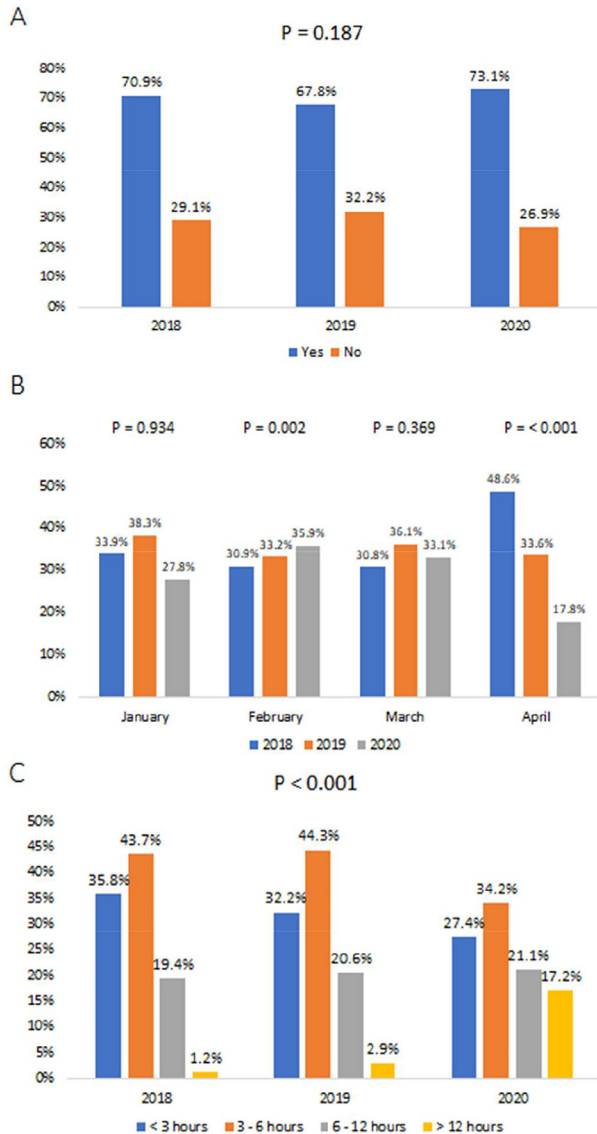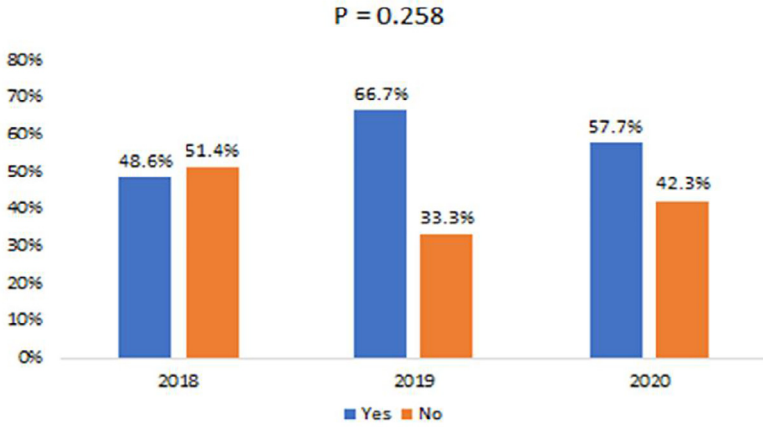
FIG 4. Distribution of door to balloon time during COVID-19 Pandemic. (A) This graph compares the door to balloon time of < 90 minutes for primary PCI patients (n = 1499) by year (blue: yes, brown: no). (B) This graph compares similar month across the years of primary PCI patients who achieved door to balloon time of < 90 minutes. where the month of April, 2020 was the lowest in achieving door to balloon time of < 90 minutes (blue: 2018 brown: 2019 gray: 2020). (C) This graph compares the different timing from the onset of symptoms to the balloon for primary PCI patients by year (blue: < 3 hours, brown: 3-6 hours, gray: 6-12 hours, yellow: > 12 hours).
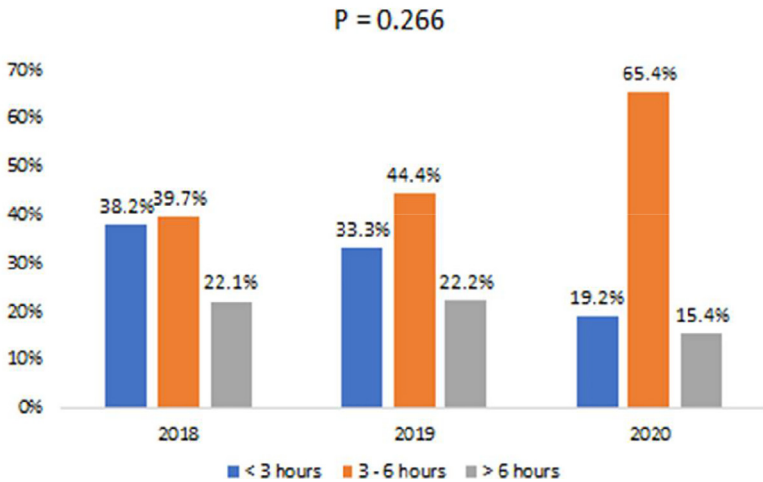
A

P = 0.258

B

P = 0.266

FIG 5. Distribution of door to needle time during COVID-19 Pandemic. (A) This graph compares the door to needle time of <30 minutes for patients treated with thrombolytic therapy (n = 134) by year (blue: yes, brown: no). (B) This graph compares the different timing from the onset of symptoms to the needle for patients treated with thrombolytic therapy by year (blue: < 3 hours, brown: 3-6 hours, gray: > 6 hours).

the inpatient stay. We cannot exclude the fact that some patients may have died from the acute cardiovascular event without seeking medical attention.

The patients in our cohort as compared to the Lombardy and Kaiser Permanente (KP) cohort have significant differences (1,3). Our cohort
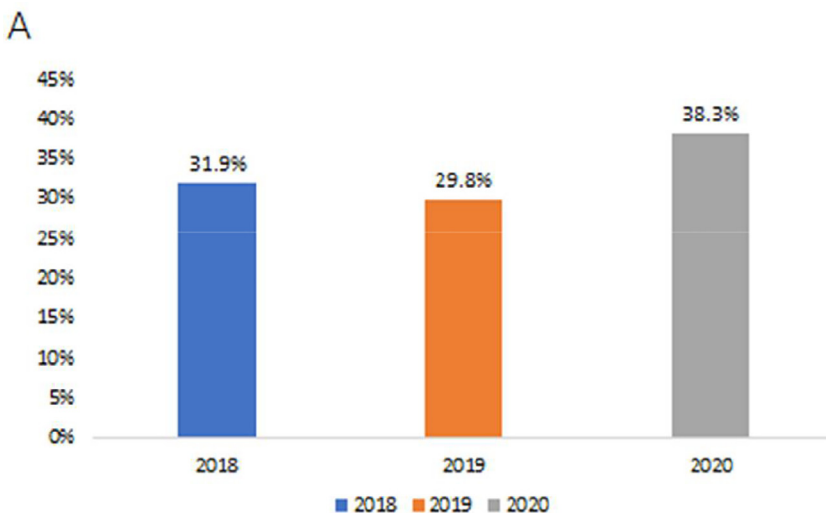
FIG 6. Percentage of rescue PCI during COVID-19 Pandemic. (A) This graph compares the percentage of rescue PCI (n = 94) by year (blue: 2018 brown: 2019 gray: 2020).

only assessed patients with STEMI as compared to acute coronary syndrome in both studies and our cohort was younger with an average age of 55.4 ± 11.8 years versus Lombardy being 68 ± 12 years and KP being 71 ± 13.3. However, 52.1% of our cohort had diabetes mellitus with 26.8% requiring insulin, 43.8% were active smokers, and 46% had hypertension versus the KP cohort with 7.7% who were active smokers and 78% of the patient with hypertension. Even though our cohort had multiple co morbidities and increase from symptom to reperfusion time there was no significant difference in major cardiovascular inpatient outcomes

Study limitations

A potential limitation is only 16 hospitals in 5 provinces were included in our study out of 35 hospitals in 13 provinces. This may have led to an overall small sample size. Nonetheless, all the Cath Lab hospitals enrolled in our registry were major tertiary centers that perform primary PCI 24 hours a day and received referrals from surrounding hospitals in their respective regions. However, this limitation was mitigated by the enrollment of the eligible hospitals in the five major provinces from all the 13 provinces of the country. Relatedly, the included hospitals were chosen using a convenience sample, and therefore a selection bias could

Table 4. In-hospital events

	Total (n = 1785)	2018 (n = 650)	2019 (n = 635)	2020 (n = 500)	P value
Death, n (%)	72 (4.2%)	24 (3.8%)	31 (5.1%)	17 (3.6%)	0.377
Reinfarction, n (%)	21 (1.2%)	8 (1.3%)	4 (0.7%)	9 (1.9%)	0.191
In-stent thrombosis, n (%)	21 (1.2%)	8 (1.3%)	4 (0.7%)	9 (1.9%)	0.191
Redo PCI, n (%)	33 (1.9%)	8 (1.3%)	15 (2.5%)	10 (2.1%)	0.288
CABG, n (%)	54 (3.2%)	19 (3.0%)	23 (3.8%)	12 (2.5%)	0.471
Renal Failure, n (%)	77 (4.5%)	31 (4.9%)	24 (4.0%)	22 (4.6%)	0.711
Minor Bleeding, n (%)	28 (1.6%)	9 (1.4%)	11 (1.8%)	8 (1.7%)	0.863
Major Bleeding, n (%)	21 (1.2%)	8 (1.3%)	8 (1.3%)	5 (1.0%)	0.912
Blood Transfusion, n (%)	36 (2.1%)	12 (1.9%)	16 (2.6%)	8 (1.7%)	0.496
Stroke, n (%)	7 (0.4%)	2 (0.3%)	3 (0.5%)	2 (0.4%)	0.898
Shock, n (%)	139 (8.1%)	50 (7.9%)	49 (8.1%)	40 (8.4%)	0.967
Heart Failure, n (%)	231 (13.5%)	92 (14.6%)	86 (14.2%)	53 (11.1%)	0.188
Ventricular arrhythmias, n (%)	80 (4.7%)	26 (4.1%)	28 (4.6%)	26 (5.5%)	0.585
Bradyarrhythmias, n (%)	66 (3.9%)	21 (3.3%)	23 (3.8%)	22 (4.6%)	0.547
Length of stay, median (interquartile range)	4 (3, 5)	4 (3, 5)	4 (3, 5)	3 (2, 5)	0.114

be present. Also the possibility of missing important unmeasured variables could have been introduced, due to the observational nature of registry studies.

Conclusions

In our study we demonstrated a significant decrease in STEMI volume during that COVID-19 era as compared to the pre-COVID 19 era with evidence of delayed presentation from time of symptom to reperfusion.

Kingdom of Saudi Arabia;

3-Rasmieh Ayed Alzeidan, department of Cardiac Sciences College of Medicine, King Saud University, Riyadh, Kingdom of Saudi Arabia;

Appendix 1. Total number of patients per hospital

Hospital (n=16)	Primary PCI (n = 1499)	Thrombolytic therapy (n = 134)	Rescue PCI (n = 94)	Others (n = 58)	Total (n = 1785)
King Faisal Specialist Hospital & Research Center - Riyadh "KFSH&RC"	45	0	6	2	53
King Khalid University Hospital - Riyadh "KKUH"	69	11	0	11	91
Saud Babtain Cardiac Center - AlKhobar "SBCC"	345	18	1	26	390
King Abdulaziz University Hospital - Jeddah "KAUH"	39	99	12	0	150
King Fahad Medical City - Riyadh "KFMC"	80	1	4	0	85
King Saud Bin Abdulaziz University for Health Sciences - Riyadh "KSAU-HS"	128	0	0	0	128
Prince Sultan Cardiac Center - AlHassa "PSCC-AlHassa"	163	0	1	1	165
Bugshan Hospital - Jeddah	43	1	30	0	74
King Fahad Armed Forces Hospital -Jeddah "KFAFH"	73	0	0	0	73
Prince Sultan Cardiac Center — Riyadh "PSCC-Riyadh"	63	1	0	2	66
Armed Forces Hospital for Southern Region "AFHSR"	70	0	1	4	75
Madinah Cardiac Center "MCC"	129	0	6	6	141
Saudi German Hospital - Jeddah "SGH-Jeddah"	59	0	2	0	61
Alhada Armed Forces - Taif	75	1	17	4	97
Prince Mohammed Bin Abdulaziz -Riyadh "PMBAH"	70	2	14	2	88
Dr. Erfan and Bagedo General Hospital - Jeddah	48	0	0	0	48

REFERENCES

1. De Filippo O, D'Ascenzo F, Angelini F, et al. Reduced rate of hospital admissions for ACS during Covid-19 Outbreak in Northern Italy [published online ahead of print, 2020 Apr 28]. *N Engl J Med* 2020. https://doi.org/10.1056/NEJMc2009166.

2. Garcia S, Albaghdadi MS, Meraj PM, et al. Reduction in ST-segment elevation cardiac catheterization laboratory activations in the United States during COVID-19 Pandemic. *J Am Coll Cardiol* 2020;75(22):2871−2872. https://doi.org/10.1016/j.jacc.2020.04.011.

3. Solomon MD, McNulty EJ, Rana JS, et al. The Covid-19 Pandemic and the incidence of acute myocardial infarction [published online ahead of print, 2020 May 19]. *N Engl J Med* 2020. https://doi.org/10.1056/NEJMc2015630.

4. Welt FGP, Shah PB, Aronow HD, et al. Catheterization laboratory considerations during the Coronavirus (COVID-19) Pandemic: from the ACC's Interventional Council and SCAI. *J Am Coll Cardiol* 2020;75(18):2372−2375. https://doi.org/10.1016/j.jacc.2020.03.021.

5. SACIS Guidance for ACS Management for the COVID-19 Pandemic Issued 22nd March 2020. www.sha.org.sa. Retrieved June 05, 2020.

6. MOH reports first case of Coronavirus Infection (March 02, 2020). www.moh.gov.sa/en/Ministry/MediaCenter/News/Pages/News-2020-03-02-002.aspx. Retrieved June 05, 2020.

7. Cucinotta D, Vanelli M. WHO declares COVID-19 a Pandemic. *Acta Biomed* 2020;91:157−160. https://doi.org/10.23750/abm.v91i1.9397. Published 2020 Mar 19.

8. COVID-19 in the Arab region. https://www.arabstates.undp.org/content/rbas/en/home/coronavirus.html. Retrieved June 05, 2020.

9. Custodian of the two holy mosques issues curfew order to limit spread of novel Coronavirus. www.spa.gov.sa/viewfullstory.php?lang=en&newsid=2050402. Retrieved June 05, 2020.

10. World Health organization (WHO)Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCOV) [30 January 2020] Available at: https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-noval-coronavirus-(2019-ncov). Retrieved June 05 2020.

11. RECOMMENDED GUIDANCE FOR THE MANAGEMENT OF ACUTE MYOCARDIAL INFARCTION (AMI) PATIENTS DURING THE COVID19 PANDEMIC. A consensus statement from the Cardiac Services Development team at the Ministry of Health of Saudi Arabia. https://covid19.cdc.gov.sa. Retrieved June 052020.

12. Respiratory triage checklist for suspected COVID 19. https://www.moh.gov.sa/CCC/healthp/regulations/Documents/SuspectedCOVID19Supplement.pdf. Retrieved March 23 2020.

13. Ranney ML, Griffeth V, Jha AK. Critical supply shortages - the need for ventilators and personal protective equipment during the Covid-19 Pandemic. *N Engl J Med* 2020;382:e41. https://doi.org/10.1056/NEJMp2006141.

14. Fear of Covid-19 leads other patients to decline critical treatment. https://www.nytimes.com/2020/05/25/health/coronavirus-cancer-heart-treatment.html. Retrieved June 05, 2020.