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ST-Elevation Myocardial Infarction in Patients with COVID-19:

Clinical and Angiographic Outcomes

Running Title: *Stefanini et al.; STEMI in COVID-19*

Giulio G. Stefanini, et al.

The full author list is available on page 5.

Address for Correspondence:
Giulio G. Stefanini, MD, PhD, MSc
Cardio Center, Humanitas Clinical and Research Hospital IRCCS
Via Manzoni 56
20089 Rozzano-Milan, Italy
Email: giulio.stefanini@gmail.com

Data sharing: The data that support the findings of this study are available from the corresponding author upon reasonable request by email. .

Coronavirus disease 2019 (COVID-19) due to severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is causing a dramatic pandemic.[1] Lombardy, in northern Italy, is one of the regions most affected worldwide.[2] Cardiovascular complications occur frequently in COVID-19 patients,[3] with challenges in the acute management. We aimed to evaluate incidence, clinical presentation, angiographic findings, and clinical outcomes of ST-elevation myocardial infarction (STEMI) in COVID-19 patients.

All hospitals with catherization laboratories in Lombardy were contacted to collect cases of patients with confirmed COVID-19 whom underwent an urgent coronary angiogram due to STEMI between February 20 (date of first COVID-19 case in Lombardy) and March 30, 2020.[2] Data were collected retrospectively, in anonymized fashion without any sensitive data, therefore not requiring institutional review board approval. COVID-19 was confirmed a reverse transcription–polymerase chain reaction assays. STEMI was defined based on the presence of typical symptoms associated with ST-segment elevation or new left bundle branch block (LBBB).[4] A stenosis was considered as culprit lesion in case of angiographic evidence of thrombotic occlusion/subocclusion. Obstructive coronary artery disease was defined based on the angiographic evidence of a stenosis >50% on visual estimation.

A total of 28 COVID-19 patients with STEMI were included. All patients met guideline-definition of STEMI[4] with localized ST-elevation (25 patients, 89.3%) or new LBBB (3 patients, 10.7%), and were all treated in the setting of emergent activation.

The **Table** displays a detailed overview of each included patient. The mean age was 68±11 years, 8 patients (28.6%) were women, 20 (71.4%) had arterial hypertension, 9 (32.1%) had diabetes mellitus, 8 (28.6%) had chronic kidney disease, and 3 (10.7%) had a prior myocardial infarction.

For 24 patients (85.7%) the STEMI represented the first clinical manifestation of

COVID-19, and did not have a COVID-19 test result at the time of coronary angiography. The remaining 4 patients suffered from STEMI during hospitalization for COVID-19. Twenty-two patients (78.6%) presented with typical chest pain associated or not with dyspnea, 6 patients (21.4%) had dyspnea without chest pain.

On echocardiography, 23 patients (82.1%) had localized wall motion abnormalities, 3 (10.7%) had diffuse hypokinesia, and 2 (7.1%) did not have abnormalities. The left ventricular ejection fraction was <50% in 17 patients (60.7%).

All patients underwent urgent coronary angiography and none was treated with fibrinolysis. Out of 28 patients, 17 patients (60.7%) had evidence of a culprit lesion requiring revascularization and 11 patients (39.3%) did not have obstructive coronary artery disease.

As of March 31, 2020 (median follow-up 13 days, interquartile range 2-20 days), 11 patients (39.3%) died, 1 (3.6%) was still hospitalized in intensive care unit, and 16 (57.1%) had been discharged.

During the COVID-19 outbreak the regional STEMI-network was reorganized[2] and we have been observing a reduction in the number patients presenting with STEMI. Both factors might have contributed to the relative low number of cases observed during the study period. However, considering the cardiovascular risk profile of COVID-19 patients, many of these are expected to suffer from STEMI in the upcoming months. Evidence-based strategies are mandatory to guide their clinical management. Our findings provide relevant evidence showing that, while all patients had a typical STEMI presentation, angiography demonstrated the absence of a culprit lesion in 39.3% of cases, therefore excluding a type 1 myocardial infarction.

A recent document from the American College of Cardiology's Interventional Council and the Society of Cardiovascular Angiography and Intervention discusses how

to guarantee state-of-the-art treatment as well as safety of healthcare providers involved in management of STEMI in the context of a COVID-19 outbreak.[3] The document recommends to weight carefully the balance between healthcare providers exposure and patient benefit. Our findings underscore that all efforts should be made to differentiate between type 2 myocardial infarctions and myocarditis versus type 1 myocardial infarctions.

Our findings also show that a strategy relying on systematic fibrinolysis[5] is not justified, since reperfusion appears not to be required in a significant proportion of COVID-19 patients with STEMI.

We acknowledge that this is an early report on a relatively small number of patients. However, we wish to underscore to have systematically collected COVID-19 patients with STEMI in Lombardy during the first 6 weeks of outbreak.

In patients in whom a culprit lesion was excluded by coronary angiography we were unable to determine whether the clinical presentation was due to a type 2 myocardial infarction, to a myocarditis subsequent to SARS-CoV-2 infection, to SARS-CoV-2-related endothelial dysfunction, or to a cytokine storm. Further investigations are needed to fully elucidate the pathophysiology of myocardial injury in COVID-19 patients.

In conclusion, our findings show that STEMI may represent the first clinical manifestation of COVID-19. In approximately 40% of COVID-19 patients with STEMI, a culprit lesion is not identifiable by coronary angiography. A dedicated diagnostic pathway should be delineated for COVID-19 patients with STEMI, aimed at minimizing patients procedural risks and healthcare providers risk of infection.

Disclosures

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Authors

Giulio G. Stefanini, MD, PhD[1]; Matteo Montorfano, MD[2]; Daniela Trabattoni, MD[3]; Daniele Andreini, MD[3,4]; Giuseppe Ferrante, MD, PhD[1]; Marco Ancona, MD[2]; Marco Metra, MD[5]; Salvatore Curello, MD[5]; Diego Maffeo, MD[6]; Gaetano Pero, MD[6]; Michele Cacucci, MD[7]; Emilio Assanelli, MD[3]; Barbara Bellini, MD[2]; Filippo Russo, MD[2]; Alfonso Ielasi, MD[8]; Maurizio Tespili, MD[8]; Gian Battista Danzi, MD[9]; Pietro Vandoni, MD[10]; Mario Bollati, MD[11]; Lucia Barbieri, MD[12]; Jacopo Oreglia, MD[13]; Corrado Lettieri, MD[14]; Alberto Cremonesi, MD[15]; Stefano Carugo, MD[12]; Bernhard Reimers, MD[1]; Gianluigi Condorelli, MD, PhD[1]; Alaide Chieffo, MD[2]

[1]Cardio Center, Humanitas Clinical and Research Hospital IRCCS, Rozzano – Milan, Italy; [2]IRCCS San Raffaele Hospital, Milan, Italy; [3]Centro Cardiologico Monzino IRCCS, Milan, Italy; [4]Department of Clinical Sciences and Community Health, University of Milan, Milan, Italy; [5]Cardiology Unit, ASST Spedali Civili, Brescia, Italy; [6]Fondazione Poliambulanza, Brescia, Italy; [7]Ospedale Maggiore di Crema, Crema, Italy; [8]Istituto Clinico Sant'Ambrogio, Milan, Italy; [9]Ospedale di Cremona, Cremona, Italy; [10]Ospedale San Gerardo, Monza, Italy; [11]Ospedale Maggiore di Lodi, Lodi, Italy; [12]Ospedale San Paolo, Milan, Italy; [13]Grande Ospedale Metropolitano Niguarda, Milan, Italy; [14]Ospedale di Mantova, Mantova, Italy; [15]Humanitas Gavazzeni, Bergamo, Italy

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Table. Overview of included patients.

N	Age, y	Sex	BMI, Kg/m^2	Cardiovascular risk factors					Medical history			Clinical presentation						EKG changes	LVE F, %	WMA	Culprit vessel	Stenosis	Clinical status*
				HTN	Dyslip	DM	CKD	Active smoke	Prior PCI	Prior CABG	Prior MI	Symptoms			Hemodynamic parameters								
												Chest pain	Dyspnea	NYHA	SBP, mmHg	HR,bpm	O2sat,%						
Patients without a culprit lesion																							
1	79	F	30.2	Y	N	N	N	N	Y	N	N	N	Y	II	145	90	95	ST-elevation, inferior	58	13,14,15,16, 17	-	-	Discharged
2	66	F	22.7	Y	N	N	N	N	N	N	N	Y	Y	III	165	90	97	ST-elevation, inferior	39	4,9,10,14,15,17	-	-	Discharged
3	64	F	24.4	Y	N	N	N	N	N	N	N	Y	N	I	160	114	92	ST-elevation, anterolateral	35	13,14,15,16, 17	-	-	Discharged
4	77	M	24.6	Y	N	Y	Y	N	N	N	N	Y	Y	III	145	66	96	ST-elevation, lateral	60	None	-	-	Death
5	89	M	27.4	Y	N	N	Y	N	N	N	N	Y	N	II	140	92	89	ST-elevation, anterolateral	35	7,13,17	-	-	Death
6	53	F	19.9	N	N	N	Y	N	N	N	N	N	Y	III	110	98	92	ST-elevation, inferolateral	26	Diffuse	-	-	Discharged
7	69	M	24.5	Y	Y	N	Y	N	N	N	N	N	Y	IV	70	110	90	new LBBB	30	1,7,13	-	-	Death
8	54	F	23.4	N	N	N	N	N	N	N	N	Y	Y	IV	110	60	96	new LBBB	60	None	-	-	Discharged
9	71	M	22.2	Y	Y	N	N	N	N	N	N	Y	Y	II	130	80	96	ST-elevation, inferior	35	3,4,5,10,11	-	-	Discharged
10	65	M	27.6	Y	N	N	N	Y	N	N	Y	N	Y	IV	70	118	88	ST-elevation, inferior	55	4,10	-	-	Death
11	75	M	23.7	Y	Y	N	Y	N	N	N	N	Y	Y	II	140	90	90	ST-elevation, inferolateral	40	Diffuse	-	-	Death
Patients with a culprit lesion																							
12	79	M	24.2	N	N	N	Y	N	N	N	N	Y	Y	IV	80	95	96	ST-elevation, anterolateral	10	6,12,16,17	LM	100%, thrombotic	Death
13	74	M	24.8	Y	Y	Y	N	N	Y	N	Y	Y	Y	III	150	115	90	ST-elevation, anterior	25	1,7,13	ostial LAD	100%, thrombotic	Death
14	66	M	22.9	N	N	Y	N	N	N	N	N	Y	Y	IV	90	99	91	ST-elevation, anterolateral	26	7,8	prox LAD	100%, thrombotic	Discharged
15	59	M	27.7	Y	Y	Y	Y	N	N	N	N	Y	Y	IV	120	105	88	ST-elevation, anterior	35	8,12	prox LAD	90%, thrombotic	Death
16	45	F	27.5	N	N	N	N	N	N	N	N	Y	Y	II	120	115	98	ST-elevation, anterior	50	7,8,13,14	mid LAD	100%, thrombotic	Discharged
17	83	M	30.0	Y	Y	N	N	N	N	N	N	N	Y	III	160	65	95	new LBBB	48	2,8,14,17	mid LAD	90%, thrombotic	Discharged
18	63	M	22.6	Y	N	Y	N	N	N	N	N	Y	N	I	150	82	98	ST-elevation, anterior	51	13,14,17	mid LAD	99%, thrombotic	Discharged
19	49	M	23.5	N	N	N	N	Y	N	N	N	Y	N	II	113	66	98	ST-elevation, inferior	55	3,4,5,10,11	prox LCX	99%, thrombotic	Discharged
20	70	F	26.6	Y	Y	N	N	N	N	N	N	Y	N	I	150	85	92	ST-elevation, inferolateral	55	4,5,10,11,15	prox LCX	100%, thrombotic	Discharged
21	57	M	26.4	Y	Y	N	N	Y	N	N	N	Y	N	I	110	62	98	ST-elevation, inferior	57	4,10,15	prox LCX	100%, thrombotic	Discharged
22	67	M	24.2	N	N	N	N	N	N	N	N	Y	N	I	140	80	98	ST-elevation, inferior	55	4,10,15	prox RCA	100%, thrombotic	Discharged
23	58	M	34.5	Y	Y	Y	N	N	N	N	N	Y	Y	IV	140	95	97	ST-elevation, inferior	45	4,10,15	prox RCA	100%, thrombotic	ICU
24	74	M	27.3	Y	Y	Y	-	N	Y	N	N	Y	N	IV	80	98	86	ST-elevation, inferolateral	30	4,10,15	mid RCA	99%, thrombotic	Death
25	83	M	25.4	Y	Y	Y	Y	N	Y	N	Y	Y	Y	I	130	75	99	ST-elevation, inferolateral	38	4,10,15	mid RCA	100%, thrombotic	Discharged
26	61	M	21.7	Y	Y	Y	N	Y	N	Y	N	Y	N	I	160	68	97	ST-elevation, inferior	54	4,5	mid RCA	100%, thrombotic	Discharged
27	72	M	21.6	N	N	N	N	N	N	N	N	Y	Y	IV	60	42	90	ST-elevation, inferior	20	Diffuse	mid RCA	100%, thrombotic	Death
28	74	F	22.5	Y	N	N	N	N	N	N	N	N	Y	IV	100	66	98	ST-elevation, inferior	35	3,4,5,9,10,11	PDA	100%, thrombotic	Death

BMI=body mass index, bpm=beats per minute, CKD=chronic kidney disease, Dyslip=dyslipidemia, DM=diabetes mellitus, EKG=electrocardiographic, F=female, HTN= arterial hypertension, HR=heart rate, ICU=intensive care unit, LAD=left anterior descending, LBBB=left bundle branch block, LCX=left circumflex artery, LM=left main, LVEF=left ventricular ejection fraction, M=male, MI=myocardial infarction, PCI=percutaneous coronary interventions, PDA=posterior descending artery, N=no, O2 sat=oxygen saturation, RCA=right coronary artery, SBP=systolic blood pressure, WMA=Wall motion abnormalities assessed by echocardiography, segments based on the cardiac segmentation model of the American Heart Association (AHA). Y=yes. *As of March 31, 2020 (median follow-up 13 days, interquartile range 2-20 days).BMI=body mass index, bpm=beats per minute, CKD=chronic kidney disease, Dyslip=dyslipidemia, DM=diabetes mellitus, EKG=electrocardiographic, F=female, HTN= arterial hypertension, HR=heart rate, ICU=intensive care unit, LAD=left anterior descending, LBBB=left bundle branch block, LCX=left circumflex artery, LM=left main, LVEF=left ventricular ejection fraction, M=male, MI=myocardial infarction, PCI=percutaneous coronary interventions, PDA=posterior descending artery, N=no, O2 sat=oxygen saturation, RCA=right coronary artery, SBP=systolic blood pressure, WMA=Wall motion abnormalities assessed by echocardiography, segments based on the cardiac segmentation model of the American Heart Association (AHA). Y=yes. *As of March 31, 2020 (median follow-up 13 days, interquartile range 2-20 days).