

The Cardiology Cath Lab in the COVID-19 Era

Evaluating the steps from pre- to postprocedure to ensure patient and staff safety.

BY SARA C. MARTINEZ, MD, PhD, FACC

In less than 6 months, the novel coronavirus 2019 (COVID-19) caused by a severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) spread to a pandemic.¹⁻⁴ SARS-CoV-2 is the third and most widespread coronavirus within the last 20 years to cause acute respiratory distress syndrome (ARDS), with infectivity and mortality rates surpassing influenza.^{2,5} Patients and their families, health care workers (HCWs), and administrators all share a common goal of reducing infectivity, morbidity, and mortality. Hospital procedures, particularly elective procedures, were suspended this spring throughout the country to absorb a surge of sick COVID-19 patients and reduce patient exposure. However, heart disease remains the leading cause of death in the United States, and as we learn more about COVID-19, catheterization labs are implementing strategies for providing diagnosis and treatment while protecting staff and patients.^{6,7} Unfortunately, risk factors for worse outcomes from COVID-19 comprise most patients who present to the cath lab, including patients aged ≥ 60 years, or with hypertension, diabetes, or coronary artery disease.^{8,9}

The COVID-19 pandemic is not the first instance of rising anxiety for medical staff in contracting an infectious agent from a patient. Universal Precautions were adopted in 1992 to assure no differential treatment in patients with or without blood-borne pathogens, such as human immunodeficiency virus or hepatitis viruses, who were undergoing invasive procedures and to protect staff from acquiring these infections.¹⁰ However, not all blood-borne pathogens are screened for every patient. Guidelines state, "It should be assumed that every patient has the potential to transmit an infectious agent."¹¹ Currently, many hospitals are initiating protocols for molecular SARS-CoV-2 screening of all inpatients and for outpatient procedures as an attempt at infection control and understanding prevalence. However, the performance and sensitivity of COVID-19 screening remain

questionable in providing definitive answers to prevalence. Early comparative studies of SARS-CoV-2 detection in samples revealed that the positivity of nasal swab sample collection (63%) was inferior to bronchoalveolar lavage (93%) in COVID-19 patients.¹² Many questions remain regarding an individual's exposure and protection from COVID-19 disease, as well as the fidelity of antibody-detection assays. With a lack of universal testing mandates and relatively low sensitivity levels of testing assays, it is difficult to know an individual's day-to-day status of infectivity and susceptibility. With nearly 130,000 deaths in the United States and an average of $> 30,000$ new cases diagnosed daily, it is a fair assumption that COVID-19 will remain for the foreseeable future.¹³ Priorities within the cath lab should be to first protect the team from COVID-19 and then to protect patients from staff and each other.

PREPROCEDURE

Outpatient/Scheduled Procedures

During either virtual or face-to-face cardiology consultation, meticulous documentation of cardiac symptoms and efforts at guideline-directed medical therapy are imperative for truly assessing the need for angiography and possible intervention in stable patients. Public health measures to remind patients to seek immediate attention for heart attack or stroke symptoms are needed. Patients with unstable symptoms must be triaged promptly for urgent angiography because the 30-day risk of death or conversion to ST-segment elevation myocardial infarction (STEMI) is up to 10% in patients who initially present with unstable angina (non-ST-segment elevation acute coronary syndrome [NSTEMI]).^{14,15} Even with treatment, the 30-day mortality rate of patients who present to the hospital with a STEMI is between 5% to 10%, with delay to presentation significantly associated with increased death.¹⁶ We do not yet know the mortality rate of COVID-19 because the number of deaths attributed to

COVID-19 divided by confirmed cases worldwide (14%) and within the United States (19%) is not representative of the actual death rate, considering the unknown number of asymptomatic or minimally symptomatic individuals who never present for medical attention.¹³ Best estimates with the World Health Organization (WHO) data place the mortality rate at approximately 5.7% for infected and symptomatic patients who present for medical attention.¹⁷

Once the decision is made for outpatient angiography and possible intervention, patients should have COVID-19 test results within 48 hours of the procedure, if feasible. Per routine, patients' temperatures are taken, and screening questions are asked at the hospital entrance regarding symptoms and known exposures. In many hospitals, those patients without masks are provided surgical masks to minimize droplet dissemination of the virus. Many health care settings are restricting access of nonpatient visitors and family members and promoting that staff manage the transportation of patients to cars after procedures. Also, restricting exposure to hospitals and social distancing measures favors increasing same-day discharge practices in clinically appropriate patients.

Inpatient and Emergency Procedures

The SARS-CoV-2 virus is not limited to manifest solely in the respiratory system. Fulminant myocarditis with cardiogenic shock, heart block, cardiomyocyte injury with elevated troponin, coronary artery vasospasm, and STEMI are associated with COVID-19, often with increased mortality.¹⁸ With or without an available portable C-arm fluoroscopy, physicians may consider bedside placement of intra-aortic balloon pumps, temporary pacemakers, pulmonary artery catheters, and pericardiocentesis to minimize cath lab team exposure. Point-of-care ultrasound has surged in utility to aid in the differential of questionable STEMI electrocardiography with a quick evaluation of wall motion. A recent consensus statement from the Society for Cardiovascular Angiography and Interventions, American College of Cardiology, and American College of Emergency Physicians recommends primary percutaneous coronary intervention (PCI) as standard of care for STEMI patients at PCI-capable hospitals with appropriate personal protective equipment (PPE) during the COVID-19 pandemic.¹⁹ There has been a decline of about 38% in STEMI activations, likely due to a combination of factors including public apprehension of presenting to the hospital and, perhaps, increased use of fibrinolytic therapy or deferral to medical management.²⁰ Unfortunately, the collateral damage of increased morbidity and mortality on delayed presentation of STEMI has yet to be fully

understood. Regarding hemodynamically stable patients presenting with NSTEMI-ACS, it is prudent to test for COVID-19 before formulating a decision for an invasive or conservative strategy. All patients entering the cath lab, even with negative screening results, should wear surgical masks. During the pandemic, rapid dissemination of COVID-19 testing results and communication about strong suspicions from CT scans, indeterminate testing results, or history/physical exam need to be at the forefront of staff-to-staff communication and in the preprocedural pause.

There is no time for COVID-19 screening results in patients with cardiac arrest, severe respiratory compromise, or shock who are presenting to the cath lab for angiography/PCI/mechanical circulatory support (MCS) stabilization. Therefore, full PPE and the presumption of COVID-19–positive status for the dedicated team managing the patient should be standard, with other team members maintaining distance. For tenuous respiratory status, intubation of the patient must be strongly considered before entering the cath lab by anesthesia or emergency physicians with appropriate PPE.

Patients with the need for MCS for PCI or in extremis for cardiogenic shock and suspicions for COVID-19 present a unique challenge. Unfortunately, COVID-19 is highly variable in an individual's physiologic impact, clinical course, and recovery, with evolving data regarding when MCS would be beneficial or futile for the gravely ill. In patients with severe comorbidities and an extremely high expected mortality with multiorgan compromise or failure, discussion with the primary team and family for comfort measures and withholding advanced MCS may be appropriate instead of adding risks of vascular compromise and further staff exposure. At the discretion of a multidisciplinary team, interim WHO guidelines recommend extra-corporeal membrane oxygenation (ECMO) to patients with ARDS and/or severe cardiovascular compromise.²⁰ Various configurations of ECMO cannulation exist, and implantation and management are best in specialized and experienced centers.²¹

Hospital administrators and cath lab directors from communities with a high density of cath labs may consider transport and consolidation of emergent and high-presumptive positive (family members of known COVID-19–positive patients) or known COVID-19–positive patients to one tertiary center as resources allow and the pandemic dictates.

CATH LAB OPERATION

The most valuable resources in a cardiac cath lab are the staff and physicians. Availability and preservation of PPE are the most critical aspects of infection

control. In Italy, up to 20% of HCWs were infected with COVID-19; worldwide, > 1,000 nurses, physicians, technicians, and first-line responders have died.²²⁻²⁴ Each cath lab must consider the regional epidemiology and prevalence of COVID-19 and the availability of PPE with the development of protocols. The greatest luxury in PPE is routine use of fresh N95 respirators or personally dedicated powered air-purifying respirators (PAPRs) to adopt “universal precautions” for COVID-19 and treat all patients as potentially positive, but this may not be practical. When the surge and crisis of COVID-19 decrease, all cath labs, hospitals, and health care systems need to strategize on long-term provisions for consumable PPE, as well as durable PAPRs, logistics of airborne-pathogen management, and terminal disinfection protocols.

TEAM AND ROOM ORGANIZATION

Personnel

Regarding personnel management, reasonable efforts to protect high-risk staff with advanced age and/or comorbidities may be considered. One example would be to allow a 63-year-old cath lab technician to fulfill more roles with ordering, quality control, and monitoring within the control room, or not be scrub assist for known COVID-19–positive patients in prolonged cases. Depending on the acuity of cases and availability of PPE, cath lab directors and individual interventional cardiologists need to make judgments on the balance of patient/personnel safety versus training for residents, fellows, or visiting students from other institutions. It would be prudent to limit involvement in known or strongly suspected COVID-19–positive cases to essential staff for efficiency and safety. In high COVID-19–pandemic areas, several cardiology practices are dividing and rotating the exposure potential between two or more teams of interventional cardiologists so that not all interventionalists are in the hospital at the same time. For example, two to four interventional cardiologists could share call burden for 1 to 2 weeks, while the remainder of the interventional cardiology physicians remain “on the bench” to see virtual patients, recover from their stint on call, or rest. When not at the hospital, a common behavior among colleagues is to remain “risk averse” and have a self-imposed “stay home” mentality to preserve themselves as a resource for the community.

Procedural and Postprocedural Operation

Consider dedicating one cath lab operatory as the “COVID-19 room.” It should be self-sufficient, with readily accessible standard equipment for radial or femoral angiography and PCI, including an ultrasound machine, to minimize room entry and exit. Dedicate and assure

PPE for the “COVID team” every day, including provisions for call/emergent cases. Each cath lab staff member should be comfortable with their fit test for an N95 respirator or PAPR and wear appropriate eyewear, face shields, and gowns. Consider the addition of another individual for the call team as a “clean” member who is physically distanced from the patient and can circulate for materials outside of the room or provide urgent communication to other services.

If a patient is likely to require MCS, have the appropriate materials near the COVID room ready for complex vascular access and complication management before the patient’s arrival, including stiff guidewires, sheaths, peripheral balloons, and stents, if possible. Each cath lab member should have dedicated lead vests/aprons, which should be disinfected frequently with viricidal wipes. After a positive or presumptive COVID-19 case, all surfaces should be wiped with viricidal wipes; if available, consider terminal disinfection of the room with a UV-C device.^{25,26} Cath labs should implement and periodically rehearse donning and doffing of PPE.²⁷

Postprocedure and at the end of the workday, staff should have the opportunity for self-care, including well-maintained, safe, and clean shower facilities and scrub exchange. Until a SARS-CoV-2 vaccine is available, employee health facilities and programs may wish to instill a routine surveillance and screening protocol of asymptomatic staff members. In practice, many institutions ask or record daily temperatures from staff in addition to yes/no answers on potential COVID-19 symptoms. As rapid nasal swab and antibody tests become more prevalent with, hopefully, increased sensitivities, health care settings may choose to implement biweekly or monthly diagnostic testing of staff and physicians.

CONCLUSION

The COVID-19 pandemic is confronting all medical disciplines, with more attributable deaths by the middle of 2020 than the average yearly tally from influenza.²⁸ The uncertainty of disease course, transmission to loved ones, recovery, prospects of cure, vaccination, and immunity are daunting and at the forefront of HCWs’ minds throughout the world. Infection control with protocol development and PPE provisions is a continuously iterative process dependent on active listening and open-mindedness to the concerns and constructive ideas of patients, staff, and administration. Open communication and listening with a “roundtable” mentality is a unifying force, and I would encourage administration and cath lab directors to hold regular dialogues with colleagues, staff, and trainees on information dissemination, with as much assurance as possible for staff protection and

expression of humility toward the unprecedented. More than ever, the time is now to unite and value all staff members as one team with the shared goal of maintaining health and vigilance. ■

1. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet*. 2020;395:507-513. doi: 10.1016/S0140-6736(20)30211-7
2. Lu R, Zhao X, Li J, et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. *Lancet*. 2020;395:565-574. doi: 10.1016/S0140-6736(20)30251-8
3. Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. *Acta Biomed*. 2020;91:157-160. doi: 10.23750/ABM.V91I1.9397
4. Paules CI, Marston HD, Fauci AS. Coronavirus infections—more than just the common cold. *JAMA*. 2020;323:707-708. doi: 10.1001/jama.2020.0757
5. Faust JS, Del Rio C. Assessment of deaths from COVID-19 and from seasonal influenza. *JAMA Intern Med*. Published online May 14, 2020. doi: 10.1001/jamainternmed.2020.2306
6. Benjamin EJ, Muntner P, Alonso A, et al. Heart disease and stroke statistics—2019 update: a report from the American Heart Association. *Circulation*. 2019;139:e56-e58. doi: 10.1161/CIR.0000000000000659
7. Welt FGP, Shah PB, Aronow HD, et al. Catheterization laboratory considerations during the coronavirus (COVID-19) pandemic: from the ACC's interventional council and SCAL. *J Am Coll Cardiol*. 2020;75:2372-2375. doi: 10.1016/j.jacc.2020.03.021
8. Lagi F, Piccica M, Graziani L, et al. Early experience of an infectious and tropical diseases unit during the coronavirus disease (COVID-19) pandemic, Florence, Italy, February to March 2020. *Euro Surveill*. 2020;25:2000556. doi: 10.2807/1560-7917.ES.2020.25.17.2000556
9. Du RH, Liang LR, Yang CQ, et al. Predictors of mortality for patients with COVID-19 pneumonia caused by SARS-CoV-2: a prospective cohort study. *Eur Respir J*. 2020;55:2000524. doi: 10.1183/13993003.00524-2020
10. Heupler Jr FA, Heisler M, Keys TF, Serkey J. Infection prevention guidelines for cardiac catheterization laboratories. Society for Cardiac Angiography and Interventions laboratory performance standards committee. *Cathet Cardiovasc Diagn*. 1992;25:260-263. doi: 10.1002/CCD.1810250317
11. Chambers CE, Eisenhauer MD, McNicol LB, et al. Infection control guidelines for the cardiac catheterization laboratory: society guidelines revisited. *Catheter Cardiovasc Interv*. 2006;67:78-86. doi: 10.1002/ccd.20589
12. Wang W, Xu Y, Gao R, et al. Detection of SARS-CoV-2 in different types of clinical specimens. *JAMA*. 2020;323:1843-1844. doi: 10.1001/jama.2020.3786
13. Worldometer. United States coronavirus cases. Accessed May 22, 2020. <https://www.worldometers.info/coronavirus/country/us/>
14. Global Use of Strategies to Open Occluded Coronary Arteries (GUSTO) IIb investigators. A comparison of recombinant hirudin with heparin for the treatment of acute coronary syndromes. *N Engl J Med*. 1996;335:775-782. doi: 10.1056/NEJM199609123351103
15. Kotecha T, Rakhit RD. Acute coronary syndromes. *Clin Med (Lond)*. 2016;16(suppl 6):s43-s48. doi: 10.7861/CLINMEDICINE.16-6S-S43
16. Bugiardini R, Ricci B, Cenko E, et al. Delayed care and mortality among women and men with myocardial infarction. *J Am Heart Assoc*. 2017;6:e005968. doi: 10.1161/JAHA.117.005968
17. Baud D, Qi X, Nielsen-Saines K, et al. Real estimates of mortality following COVID-19 infection. *Lancet Infect Dis*. 2020;S1473-3099(20)30195-X. doi: 10.1016/S1473-3099(20)30195-X
18. Stefanini GG, Montorfano M, Trabattani D, et al. ST-elevation myocardial infarction in patients with COVID-19: clinical and angiographic outcomes. *Circulation*. Published online April 30, 2020. doi: 10.1161/CIRCULATIONAHA.120.047525
19. Mahmud E, Dauerman HL, Welt FG, et al. Management of acute myocardial infarction during the COVID-19 pandemic. *J Am Coll Cardiol*. Published online April 21, 2020. doi: 10.1016/j.jacc.2020.04.039
20. 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;75:2871-2872. doi: 10.1016/J.JACC.2020.04.011
21. Ramanathan K, Antognini D, Combes A, et al. Planning and provision of ECMO services for severe ARDS during the COVID-19 pandemic and other outbreaks of emerging infectious diseases. *Lancet Respir Med*. 2020;8:518-526. doi: 10.1016/S2213-2600(20)30121-1
22. Zhan M, Qin Y, Xue X, Zhu S. Death from Covid-19 of 23 health care workers in China. *N Engl J Med*. 2020;382:2267-2268. doi: 10.1056/NEJMc2005696
23. Remuzzi A, Remuzzi G. COVID-19 and Italy: what next? *Lancet*. 2020;395:1225-1228. doi: 10.1016/S0140-6736(20)30627-9
24. The Lancet. COVID-19: Protecting health-care workers. *Lancet*. 2020;395:922. doi: 10.1016/S0140-6736(20)30644-9
25. Dexter F, Elhakim M, Loftus RW, et al. Strategies for daily operating room management of ambulatory surgery centers following resolution of the acute phase of the COVID-19 pandemic. *J Clin Anesth*. 2020;64:109854. doi: 10.1016/j.jclinane.2020.109854
26. Dexter F, Parra MC, Brown JR, Loftus RW. Perioperative COVID-19 defense: an evidence-based approach for optimization of infection control and operating room management. *Anesth Analg*. 2020;131:37-42. doi: 10.1213/ANE.0000000000004829
27. John TJ, Hassan K, Weich H. Donning and doffing of personal protective equipment (PPE) for angiography during the COVID-19 crisis. *Eur Heart J*. 2020;41:1786-1787. doi: 10.1093/eurheartj/ehaa283
28. Centers for Disease Control and Prevention. Deaths and Mortality. Accessed May 23, 2020. <https://www.cdc.gov/nchs/fastats/deaths.htm>

Sara C. Martinez, MD, PhD, FACC
 Interventional Cardiologist
 Providence St. Peter Hospital
 Olympia, Washington
sara.martinez@providence.org
 Disclosures: None.