

Guiding Principles for Cardiology Care in Times of the COVID-19 Pandemic: Gazing through the Crystal Ball

Abstract

In the current scenario of COVID-19 pandemic, it has become imperative to recognize and acknowledge the scope of coexistence with the contagion. The management of serious non-COVID conditions such as cardiovascular illness has taken a step back in these times which may affect the overall population wellbeing in the long-term. It is, therefore, essential to adapt certain modified mechanisms which help to subvert the transmission risk despite maintaining reasonable standards in cardiac patient care. Underlying proposition remains to avoid unnecessary elective invasive procedures, reduce patient-healthcare provider contact time, minimize hospitalization duration, frequent application of personal and health-facility sanitization methods, and conform strictly to universal precautions including usage of protective equipment, face barriers, respirators, etc. Various national and international cardiological agencies have steered the formulation of advisories regulating different aspects of cardiology encompassing coronary interventions, structural heart disease, arrhythmia and pacing, heart failure management, cardioactive drugs, and pediatric cardiac issues. Apart from the treatment aspect, alterations have been suggested in the diagnostic cardiological arena as well that incorporates cardiac biomarker estimation, echocardiographic evaluation, and cardiac computed tomography. We through this document attempt to present a holistic and comprehensive overview of the recommendations to be considered while dealing a cardiac patient in clinical practice in contemporary times.

It is important to rapidly identify and triage patients with suspected COVID-19 infection and underlying cardiovascular disease, since this subset is at high risk of adverse outcomes. Telephonic or telehealth care should be extended for all stable cardiac patients to minimize and if possible, avoid hospital visits. As per new Indian guidelines,^[1] medical practitioners are entitled to provide telemedicine consultation to patients while upholding the same professional and ethical norms and standards as applicable to traditional in-person care. All practitioners are also encouraged to get familiar with these guidelines by online programs developed and made available by the Board of Governors.

Patients with heart failure, those with implantable rhythm devices and stable coronary artery disease deserve special attention for tele-follow up and all efforts should be made to manage them with medication or device parameter adjustment via the telehealth conduit and virtual care. Reducing and deferring elective visits by delivering virtual

follow-up care will enable patient triage at home and ensure that they visit the hospitals, only if specifically indicated, to avoid the risk of unnecessary exposure.

Patients Posted for Elective Cardiac Catheterization Laboratory Procedures

Although the exact definition of an elective case is a matter of clinical judgment, individualized decision making should be done, balancing the risk of COVID-19 exposure (once in hospital) vs. the risk of delay in diagnosis or treatment. As a general rule, it is preferable to stop elective cath lab procedures to preserve resources and avoid exposing patients to suspect hospital environments. This is especially true for patients with existent comorbidities in whom longer hospital stay and therefore increased exposure risk is anticipated. According to a joint statement by American College of Cardiology (ACC) and Society of Cardiac Angiography and Interventions (SCAI),^[2] procedures that can be deferred include:

- Percutaneous coronary interventions (PCI) for stable ischemic heart disease
- Endovascular interventions for iliofemoral disease
- Patent foramen ovale (PFO) closure
- Atrial septal defect closure
- Left atrial appendage occlusion
- Alcohol septal ablation.

Early discharge of all patients is important to avoid continued patient exposure within the hospital. Subsequent follow-up through telehealth services should be encouraged.

Patients with ST Elevation MI

Fibrinolysis can be considered a reasonable option for the stable STEMI patient with suspected COVID-19 infection, after performing the rapid nucleic acid testing to confirm infection.^[3] Fibrinolysis should be performed in the isolation ward, taking all requisite precautions to avoid exposure. Ideally, all efforts should be made to perform diagnostic testing for COVID-19, prior to considering for PCI. If primary PCI is being considered for confirmed COVID-19 cases, or if preprocedure COVID-19 test has not been performed due to time constraints, appropriate use of personal protective equipment (PPE) including gown, gloves, goggles (or shields), and an N95/FFP2/FFP3 respirator for all cath lab personnel is mandatory. It is further advisable that a minimum number of operators/assistants be scrubbed in the case. All cardiology team members should be familiarized with correct protocols of donning of PPE. One dedicated cath lab for interventions in COVID-19 patients should be earmarked with a

separate entry and exit passage at all PCI enabled centers. Flowchart for the purported management of STEMI patients endorsed by SCAI/ACC/American College of Emergency Physicians (ACEP)^[4] has been shown.

- As underlying mechanisms for troponin elevation in COVID-19 patients include direct viral infection of myocytes, inflammatory cytokine signaling in myocytes, hypotension, besides ischemia, clinicians are advised to only measure troponin if the diagnosis of acute MI is being considered on clinical grounds and an abnormal troponin should not be considered evidence for an acute MI without corroborating evidence
- Coronary CT angiography may be considered in cases where the findings of ST elevation and transthoracic echocardiography (TTE) are divergent
- In Acute myocardial infarction (AMI) patients with severe pulmonary involvement (ARDS or pneumonia) who are intubated in the ICU and felt to have excessively high mortality, consideration for compassionate medical care may be appropriate in place of invasive procedure
- Due to the safety concerns, logistical issues, and time delays secondary to diagnostic uncertainty of STEMI with COVID-19, direct transport of the patient from ambulance/triage area to cath lab should be avoided
- Out-of-hospital cardiac arrest (OHCA) patients without ST-elevation should not receive a routine early invasive approach unless hemodynamic instability ensues and the possibility of an acute coronary occlusion remains high
- If required, consideration of revascularization and potential mechanical circulatory support (MCS) for patients in cardiogenic shock should proceed with PPE and special precautions for high droplet components of the procedure (i.e., intubation and extubation in negative pressure room under anesthesia if possible, with intubation prior to arrival in the lab)
- For known COVID-19 positive or probable patient, while MCS might be considered for a cardiomyopathy and cardiogenic shock, bedside placement of venous-venous (V-V) extracorporeal membrane oxygenation (ECMO) should be considered for severe pulmonary decompensation and failure to oxygenate to reduce the risk of exposure to the cath lab or cardiothoracic surgical team
- For aerosol-generating high-risk procedures such as bi-level or continuous positive pressure ventilation, those requiring intubation/extubation, defibrillation with need for Cardio-pulmonary resuscitation (CPR) and airway suctioning, a powered air-purifying respirator (PAPR) should be used.^[5,6]

Patients with Non-ST Elevation MI (NSTEMI)

For most patients with NSTEMI and suspected COVID-19, diagnostic testing for COVID-19 should be performed prior to shifting into a cardiac catheterization lab. It is relevant to

remember that troponin leak and associated ST-T changes may be present in 5%–7% of patients with COVID-19, representing type 2 MI or myocarditis.^[7] Based on the patient's underlying risk profile, many stable patients can be managed by medical therapy alone. Hemodynamically unstable NSTEMI patients whose instability is perceived to be due to the acute coronary syndrome can be managed similarly to patients with STEMI.

It is recommended that sick patients with definite or suspected COVID-19 be intubated prior to arrival to the catheterization laboratory to reduce aerosol exposure in lab. Efforts should be made to avoid emergent intubation in the catheterization laboratory as this can result in aerosolization of respiratory secretions with increased exposure risk to the cath lab personnel. Specific institutional protocols need to be developed for vigorous terminal clean following the procedure. Since most cath labs are not designed for such robust infection isolation, as is needed for COVID-19 cases, if possible, restriction of cases to a dedicated laboratory may be considered.

Patients with Heart Failure/Acute Cardiomyopathy

New onset cardiomyopathy has been ascribed to COVID-19 and increasing evidence suggests that the viral illness elicits a profound systemic inflammatory response. Cytokines like TNF- α and IL-1 β released during this phase can trigger cardiomyocyte dysfunction.^[8] ACE-2 receptor can be used by virus for direct cell entry leading to immune cell recruitment and myocarditis, demonstrated by the presence of SARS-CoV-2 viral RNA in 35% of hearts at autopsy.^[9,10] Interestingly, cardiac tissue from patients with positive viral RNA has been reported to have an increase in macrophage infiltration, but not a substantial T-cell response.^[9] Microvasculature is also affected triggering microvascular dysfunction and tissue ischemia precipitating ventricular dysfunction and/or arrhythmias. Diagnostic and management tools remain the same as in non-COVID times, albeit with a few modifications.

- NT-pro Brain natriuretic peptide (BNP) elevation should be scrutinized in the light of clinical presentation as COVID-19 patients often demonstrate a significant rise in NT-pro BNP levels despite no cardiac affliction. However, NT-pro BNP levels also have a prognostic role in predicting mortality and morbidity, especially in COVID-related ARDS. In addition, other biomarkers like C-reactive protein (CRP), ferritin, D-dimer, IL-6, and Lactate dehydrogenase (LDH) have also been found to be elevated in patients with profound systemic inflammation in response to SARS-CoV-2
- Point-of-care ultrasound (POCUS) must be employed to examine selected views for TTE to define left or right ventricular (LV/RV) size and function, wall motion abnormalities, and/or pericardial effusion
- Endomyocardial biopsy should be considered only in selective cases of myocarditis (such as patients

with echo findings of normal LV size, increased wall thickness, and depressed LV ejection fraction or cardiac MRI suggestive of myocarditis) in whom the decision to employ aggressive antiinflammatory or other investigational therapies (HCQ, azithromycin, intravenous immune globulin (IVIG), tocilizumab, anakinra, IV steroids, remdesivir, lopinavir, and ritonavir) requires a biopsy evidence of myocarditis.

Patients Requiring Echocardiography

All efforts must be made to determine and reschedule “elective” echocardiographic examinations while identifying “nonelective” (urgent/emergent) indications. American society of echocardiography (ASE)^[11] mandates that in cases considered for deferral, there should be no significant risk to patients in terms of morbidity or mortality and no expected clinical benefit of echocardiography (ECHO) in terms of avoiding the use of medical resources for symptomatic patients whose SARS-CoV-2 status is unknown.

- TTE should be performed by an experienced sonographer/practitioner, in order to minimize scanning time and to avoid reexaminations or reviews while obtaining images of the highest possible quality
- Echocardiogram machines including probes, keyboards, monitors, mouse, chairs, phones, desktops, and doorknobs should be frequently and thoroughly cleaned
- Number of personnel involved in scanning/reporting should be kept to a bare minimum. Also, avoid the exposure of staff who are >60 years old, having chronic conditions, pregnancy or immunocompromised states, or are pregnant with patients suspected or confirmed to have COVID-19
- As transesophageal echocardiography (TEE) carries a heightened risk of spread of the SARS-CoV-2 by provoking aerosolization due to coughing or gagging that may occur during the examination, TEE should be postponed or cancelled if an alternative imaging modality (e.g., off axis TTE views, ultrasound enhancing agent with TTE) can provide the necessary information
- Treadmill or bicycle stress echo tests on patients with COVID-19 may lead to exposure due to deep breathing and/or coughing during exercise and therefore should generally be replaced with a pharmacological stress echo
- Ultrasound enhancing agent (UEA) should be employed in patients with poor echocardiographic image to optimize and improve screen figure in order to limit the exposure time with suspected/confirmed COVID-19 patient
- Ultrasound-assisted physical examination (UAPE), point of care cardiac ultrasound (POCUS), and critical care echocardiography (CCE) performance should be maximized wherever possible, to allow

remote interpretive assistance from more experienced echocardiographers

- In patients planned for cardioversion, cardiac CT/MRI examinations may be preferred to TEE to evaluate structural abnormalities and rule out intracardiac thrombus prior to cardioversion in order to reduce the risk of aerosolization.^[12]

Patients with Structural Heart Disease

Since these procedures are resource intensive, they should be deferred until after the COVID-19 pandemic has adequately resolved provided such patients can be adequately managed on medical therapy in the interim period.^[13] For any high-risk procedure requiring TEE support, emphasis must be placed on availability of full PPE for the interventional team. Conversely, alternative imaging modalities like intracardiac echo (ICE) should be considered, if available.

- In a ventilated patient, care should be made that a HEPA filter is placed with the ET tube to maximize safety
- It is reasonable to schedule Transcatheter aortic valve replacement (TAVR) for outpatients with severe to critical aortic stenosis and class III-IV Congestive heart failure (CHF) symptoms. However, for NYHA I-II or asymptomatic patients, it is advisable to postpone consideration of TAVR for at least 3 months or so till the hospitals resume elective cath lab procedures. Meanwhile, TAVR teams can convene virtually on at least a weekly basis to review the status of patients on the “waiting” list
- Majority of percutaneous mitral valve repair (edge-to-edge repair) can be safely deferred
- ViV TMVR (Valve-in-valve) during the COVID-19 pandemic can be considered for hospitalized patients with severe bioprosthetic mitral stenosis/regurgitation and CHF or outpatients who have had a hospitalization for CHF within 30 days despite optimized guideline-directed medical therapy
- Patients with prosthetic valves and para-prosthetic leak with ongoing CHF and/or hemolysis can be considered for Paravalvular leak (PVL) closure during the COVID-19 pandemic.

Patients with Brady or Tachyarrhythmia

The current Heart Rhythm Society (HRS)^[14] guidelines recommend that procedures considered urgent or emergent which decrease the risk of clinical decompensation, hospitalization, or death should be performed with full precautions as follows:

- Ventricular tachycardia (VT) ablation for medically uncontrolled electrical storm in a hemodynamically compromised patient
- Catheter ablation of incessant, hemodynamically significant, severely symptomatic tachycardia (SVT/AF/atrial flutter) not responding to antiarrhythmic drugs, rate control, and/or cardioversion

- Catheter ablation for Wolff-Parkinson-White syndrome or preexcited AF with syncope or history of cardiac arrest
- Pacemaker implant for symptomatic complete heart block, Mobitz II AV block, or high-grade AVB
- Severe symptomatic sinus node dysfunction with long pauses
- Cardiac resynchronization therapy in the setting of severe refractory heart failure in guideline indicated patients
- Requirement of Implantable cardioverter defibrillator (ICD) as secondary prevention therapy
- Lead/device extraction for infection, including patients not responding to antibiotics or for endocarditis, bacteremia, or pocket infection
- Lead revision for malfunction in a pacemaker-dependent patient or ICD patient receiving inappropriate therapy/shocks
- Generator change in pacemaker-dependent patients who are at elective replacement indicator (ERI) or at device end of life (EOL)
- Pacemaker or ICD generator change with minimal battery remaining, depending on specific clinical situations
- Cardioversion for highly symptomatic atrial arrhythmias or rapid ventricular rates not controlled with medications
- To minimize transport of COVID-19 infected patients, direct-current or chemical cardioversions can be performed at the bedside in the ICU with suitable anesthesia support.

Preferably, patients with confirmed or suspected COVID-19 infection should be scheduled as the last case of the day, given the extensive cleaning required after the procedure. Device interrogation programmers, cables, and wands should be disinfected before and after examining a patient. Same day discharges after device implant should be considered to minimize the patient's risk of nosocomial COVID-19 infection.

- Remote CIED interrogation facility should be frequently employed in these situations to minimize patient contact risk:
 - Clinically actionable abnormality of CIED noted on routine ECG, telemetry, or ambulatory monitoring
 - ICD shocks, presyncope or syncope concerning for an arrhythmic event, to perform programming changes
 - Identified need for reprogramming of the implanted device (pacemaker, ICD, cardiac resynchronization device)
 - For CIED patients needing urgent or emergent MRI scanning.

Patients Taking ACEI/ARB for Cardiac Indications

Angiotensin-converting enzyme 2 (ACE2) receptors have

been shown to be the entry point into human cells for SARS-CoV-2. ACE inhibitors and angiotensin receptor blockers (ARBs) have been shown to upregulate ACE2 expression in the heart.^[9] This potential upregulation of ACE2 by ACE inhibitors or ARBs has resulted in a speculation of potential increased risk for COVID-19 infection in patients with background treatment of these medications. However, no experimental or clinical data demonstrate benefit or harm among COVID-19 patients using ACE-I or ARB medications. Therefore, HFSA/ACC/AHA^[15] and ESC^[16] recommend continuation of Renin angiotensin aldosterone system (RAAS) antagonists for the patients who are currently prescribed these drugs for indications for which these agents are known to be beneficial, such as heart failure, hypertension, or ischemic heart disease tailored according to individual patient's hemodynamic status and clinical presentation.

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