Update on guidance and best practices for nuclear cardiology laboratories during the coronavirus disease 2019 (COVID-19) pandemic: Emphasis on transition to chronic endemic state. An information statement from ASNC, IAEA, and SNMMI

Randall C. Thompson, MD, MASNC (chair),[a,n] Lawrence M. Phillips, MD, FASNC,[b,n] Vasken Dilsizian, MD, MASNC,[c,p] Diana Paez Gutierrez, MD,[d,o] Andrew J. Einstein, MD, PhD, MASNC,[e,n] Suzanne F. Crews, MPA, RT, NMTCB,[f,n] Hicham Skali, MD, MSc, FASNC,[g,h,n] Felix Keng Yung Jih, MBBS, MASNC,[i,n] Maurizio Dondi, MD,[d,o] Alessia Gimelli, MD,[j,n] Timothy M. Bateman, MD, MASNC,[a,p] Mouaz H. Al-Mallah, MD, FASNC,[k,n] Munir Ghesani, MD,[l,p] Sharmila Dorbala, MD, MPH, MASNC,[g,h,n] and Dennis A. Calnon, MD, MASNC[m,n]

[a] Department of Cardiology, Saint Luke's Mid America Heart Institute, University of Missouri-Kansas City, Kansas City, MO
[b] Division of Cardiology, NYU Langone Medical Center, New York, NY
[c] Department of Diagnostic Radiology and Nuclear Medicine, University of Maryland School of Medicine, Baltimore, MD
[d] Nuclear Medicine and Diagnostic Imaging Section, Division of Human Health, Department of Nuclear Sciences and Applications, International Atomic Energy Agency, Vienna, Austria
[e] Seymour, Paul, and Gloria Milstein Division of Cardiology, Department of Medicine, and Department of Radiology, Columbia University Irving Medical Center and NewYork-Presbyterian Hospital, New York, NY
[f] Nuclear Cardiology, Northeast Georgia Health System, Gainesville, GA
[g] Division of Nuclear Medicine and Molecular Imaging, Department of Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA
[h] Cardiovascular Division, Department of Medicine. Brigham and Women's Hospital, Harvard Medical School, Boston, MA
[i] National Heart Centre, Singapore, Singapore
[j] Fondazione Toscana Gabriele Monasterio, Pisa, Italy
[k] Department of Cardiology, Houston Methodist DeBakey Heart and Vascular Center, Houston, TX
[l] Icahn School of Medicine, Mount Sinai Hospital, New York, NY

Reprint requests: Randall C. Thompson, MD, MASNC (chair), Department of Cardiology, Saint Luke's Mid America Heart Institute, University of Missouri-Kansas City, Kansas City, MO; *rthompson@saint-lukes.org*

J Nucl Cardiol 2022;29:2013–8.
1071-3581/$34.00

[m] OhioHealth Heart and Vascular Physicians, Columbus, OH
[n] American Society of Nuclear Cardiology (ASNC), Fairfax, VA
[o] International Atomic Energy Agency (IAEA), Vienna, Austria
[p] Society of Nuclear Medicine and Molecular Imaging (SNMMI), Reston, VA

Received Apr 18, 2022; accepted Apr 18, 2022
doi:10.1007/s12350-022-02984-9

Pandemics have different phases and transition scenarios. Regardless of the phase, health service providers must be prepared, have strategic response plans, and implement specific measures with the ultimate goal of continuing to provide essential services while protecting patients, staff, and the public to prevent the spread of disease.[1]

The American Society of Nuclear Cardiology (ASNC) along with the Society of Nuclear Medicine and Molecular Imaging (SNMMI) have previously published two documents on guidance and best practices for nuclear cardiology laboratories during the COVID-19 pandemic.[2,3] The first document provided recommendations when early containment measures, such as lockdowns, quarantines, and curfews were adopted. The second document (which was also authored by The International Atomic Energy Agency [IAEA] and endorsed by the Infectious Diseases Society of America) primarily dealt with reopening laboratories following the lockdown period and issues such as the prioritization of cases. Other medical societies have published similar advice documents.[4–6] As the COVID-19 pandemic evolves, we have seen the emergence of several variants with changes in disease severity and transmissibility. Vaccination rates have increased, as have rates of post-infection immunity. However, scientists are in a race to identify how virus mutations could affect our immunity and the effectiveness of vaccines available. Cases of people experiencing break-through infections and re-infections are on the rise. On the positive side, newer oral and intravenous therapeutics have shown promise in treating patients with mild to moderate disease who are at high risk, as well as for certain high-risk patients pre-exposure.[7–9]

Around the world, there remains a disparity in availability of resources. Particularly during times of increasing infection rates, the availability of personal protective equipment (PPE), mechanical ventilation systems, testing equipment, medical staff, and hospital beds—especially ICU beds—becomes more tenuous. Given these factors, we present updated guidance for best practices in nuclear cardiology as we move from a pandemic to a chronic endemic state.

THE APPROACH TO NUCLEAR STRESS TESTING SHOULD BE FLEXIBLE

A major takeaway from this guidance is that there is no *status quo* during this pandemic. Local case rates will be variable and may change rapidly. The decision to proceed with nuclear testing, as well as with any other cardiac imaging test, and the approach should include risk/benefit assessments for both the patient as well as analysis of the impact on the local healthcare system, including risk to the medical staff. Laboratories should also continue to vary their approach based on levels of infection in the community as well as local institutional and governmental policies.[4] Please see Figure 1. Table 1 lists practice recommendations that should be employed when case rates of COVID-19 are high or rising, and Table 2 lists the U.S. Centers for Disease Control definitions of levels of rates of transmission.[10]

HEALTHCARE TEAM WELLBEING

Nuclear cardiology laboratories continue to be impacted by major staffing issues. In prior guidance statements, COVID-19 best practices focused on methods to operate safely and efficiently.[2,3] During this stage of the pandemic, even greater attrition of healthcare personnel has been seen secondary to both the physical and mental stress of working during the pandemic.[11,12] In addition, more recent variants, such as Omicron, are highly infectious and have the capability to incapacitate large numbers of healthcare workers resulting in acute staffing shortages and test cancellations. Not only do laboratories need to optimize safety practices to prevent transmission to and from patients and try to mitigate service disruption to allow access for needed diagnostic tests, but they also need to manage the demands upon the general working environment for the healthcare providers. Thus, some practices to enhance access and social distancing, such as extending hours of operation, may not be advisable if it will tax the already stressed or short-handed workforce. Also, even if the level of COVID-19 infections in a community is low, services may nonetheless need to be restricted if the nuclear cardiology staff is inadequate. It is imperative that healthcare workers have proper supplies of PPE and have priority for vaccinations (and comply with

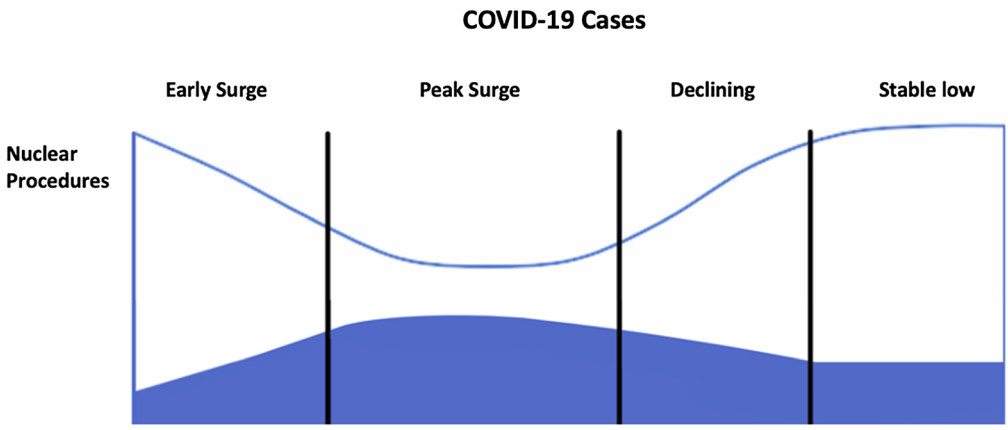

Figure 1. Recommendations: as the level of COVID-19 transmission severity increases in a community, laboratories should enhance levels of screening, PPE, social distancing practices, and hygienic measures, and perform stress testing predominantly with vasodilator pharmacologic agents rather than exercise. However, as levels of transmission are low and stable, these measures can and should be relaxed. See Table 2 for the U.S. Centers for Disease Control and Prevention definitions for the 4 levels of severity of transmission.[9]

Table 1. Recommended nuclear cardiology practices when COVID-19 cases are high or rapidly rising in a community

Restrict visitors in the nuclear cardiology laboratory
Provide screening questionnaires, temperature screening, and frequent COVID-19 testing for all patients, and PPE for all patients and staff
Vasodilator stress rather than exercise for the majority of patients with the understanding that exercise testing, when needed, can be performed safely
For patients who benefit from testing with exercise, routine use of rapid COVID-19 testing and enhanced PPE should be available
Strong preference for PET MPI over SPECT MPI when pharmacologic stress is planned, and PET is available
Restriction of testing to the highest priority patients when the case rates are extremely high, hospital resources are overwhelmed, or staffing shortages are extreme

Table 2. CDC Definitions of County Transmission Severity[10]

"Low" transmission $\leq$10 cases per 100,000 people, or a test positivity rate <5%
"Moderate" transmission = 10 to 50 cases per 100,000 people, or positivity rate 5% to 8%
"Substantial" transmission = 50 to 100 cases per 100,000, or a positivity rate 8% to 10%
"High" transmission $\geq$100 cases per 100,000 people or a positivity rate >10%

If a county has values in two different transmission levels, use the metric that is higher.

appropriate local COVID-19 vaccine mandates). A workflow should be established at all testing locations for enforcing masking requirements, so the primary burden does not fall on the nuclear cardiology staff. In the long run, medical facilities will likely need to be designed and built to better accommodate features of sanitation and social distancing that have been developed during this pandemic.

GUIDANCE ON EXERCISE TESTING

In the pre-COVID era, the guidance generally had been to utilize exercise as the preferred stress modality for SPECT imaging when (a) the patient was able to exercise adequately, and (b) there were no electrocardiographic or medical contraindications. During the COVID-19 pandemic, this approach has often been modified to limit exercise stress in favor of pharmacological testing,[2,3] reasoning that pharmacologic stress myocardial perfusion imaging (MPI) risk stratifies as well as exercise stress,[13] and it likely leads to less aerosolization. To date, there has been no evidence to support an increased risk of COVID transmission to patients who underwent exercise testing. Rather, the concern has been the potential increased risk to the healthcare team. Respiratory patterns change when patients undergo treadmill or bicycle exercise testing, and data support an increased risk of droplet spread, with a potential increase in the associated risk of infection to the healthcare team in the exercise/nuclear laboratory.[14–16] The functional assessment, hemodynamic, and electrocardiographic data obtained from exercise testing has value, and the benefit of this approach must be weighed against the potential risk to the healthcare team. In selecting a stress method, and in particular whether or not to perform exercise, we recommend consideration of several factors, including (a) availability of PPE; (b) room ventilation systems—laminar flow ventilation and appropriate air filters;[17–19] (c) availability of pre-test COVID-19 screening; (d) current local COVID-19 infection rates; (e) current local vaccination rates and individual vaccination status (patient and staff) to help balance the localized lab approach to utilization of exercise testing.

There are clinical scenarios where exercise stress is indeed needed. For example, the utility of exercise testing is widely accepted in the management of patients with asymptomatic aortic valve stenosis, anomalous coronary arteries, myocardial bridging, and some patients with cardiac arrhythmias. In these cases, pharmacologic stress testing may not be an appropriate substitute. Moreover, vasodilator pharmaceutical stress agents are not available in some countries and add to the cost structure of the test. Where COVID-19 testing is available, appropriate PPE is worn, and other infection prevention and control policies apply, exercise testing can be performed with reasonable safety, in particular when rates of COVID-19 infections in a community are low. Patient screening can be done in several ways: questionnaires, temperature checks, and rapid antigen testing. Conditions in a community can change very quickly, and health insurance companies should give medical decision makers latitude in choosing the best testing strategy and should not mandate exercise stress.

NUCLEAR CARDIOLOGY TESTING IN COVID-POSITIVE PATIENTS

Myocardial perfusion imaging is generally an elective test, and for most patients who are ill with an acute COVID-19 respiratory infection, the test can be postponed until their quarantine period has ended, at the discretion of the testing physician. Those who test positive for COVID-19 and have non-urgent cardiovascular symptoms usually should have their stress test postponed until their quarantine period has ended. Emergency room and hospital-based patients should be assessed on a case-by-case basis to balance the risk of the procedure to the patient and staff versus the benefit of the information obtained. There are also patients who are COVID-19-positive (including virus asymptomatic patients), who urgently need MPI (e.g., preoperative testing prior to urgent vascular surgery), or those who need other types of nuclear cardiology tests, such as ^{18}F-FDG metabolic imaging to evaluate possible endocarditis, device infections, myocardial viability, or cardiac sarcoidosis. In cases when a patient who has an active case of COVID-19 needs a nuclear cardiology test, laboratory-based protocols must be established, including the timing of the test (i.e., last test of the day to minimize exposure to other staff/patients), thorough cleaning and ventilation protocols, limiting the number of staff involved in the test, and use of appropriate PPE, which should include high-filtration masks (N95, FFP2, KN95, or KF94, as locally available), gloves, surgical gowns, and eye protection.[20]

AFFIRMATION OF PREVIOUSLY RECOMMENDED BEST PRACTICES FOR NUCLEAR CARDIOLOGY

It seems clear that some of the modifications laboratories have made to their standard operating procedures over the past two years will continue to be necessary. For example, COVID-19 screening, efforts at social distancing (including extra waiting room space), and increased use of PPE will remain very important. Also, the use of rapid and reliable COVID-19 testing, especially when prevalence rates are high, should be assessed locally on a case-by-case basis. Likewise, laboratory schedules must include time and resources for enhanced cleaning. The safety of healthcare workers and maintenance of high-quality imaging is critical. To emphasize, specific protocols that enhance social distancing and limit the exposure of patients and staff will remain important.

Table 3. Recommended nuclear cardiology practices regardless of whether COVID-19 cases are low, intermediate, or high in a community

Maintain extra distancing in waiting areas and corridors in the laboratory
Enhanced cleaning of imaging spaces and preparation areas between patients.
Allow extra time between cases for enhanced cleaning and maintenance of social distancing
Lengthen work hours as needed to allow extra time and physical distance between cases and to maintain access to testing if staffing is available
Dedicated room for exercise testing, ideally with laminar flow ventilation and appropriate air filters
Stress-first/stress-only SPECT MPI protocols when possible
Encourage two-day SPECT MPI protocols (with weight-based radiotracer dosing) to enhance social distancing and improve laboratory efficiency when feasible
PET MPI in preference to SPECT MPI when pharmacologic stress is planned, and PET is available
For PET-CT and SPECT-CT cases, routine review of the CT images as soon as possible
Staff, patients, and visitors should be encouraged to be fully vaccinated, practice frequent hand washing, and avoid large gatherings

Certain specific testing protocols (in addition to other benefits) can result in shorter test time and, therefore, limit COVID-19 related risk. For example, stress-first/stress-only SPECT imaging can shorten the test duration in some patients by more than 50%, and two-day SPECT MPI protocols can enhance social distancing. Also, PET MPI can be performed more quickly than SPECT and is routinely performed in one location rather than having the patient move between several rooms.

Finally, in the case of SPECT-CT and PET-CT, it remains good practice to examine the CT images prior to the patient leaving the medical facility to detect possible occult COVID pneumonia as soon as possible to limit further transmission from the infected patient.

Table 3 lists best practices that should endure even in times of relatively low levels of COVID activity in a community or if COVID-19 becomes an endemic disease.

CONCLUSION

Much has changed since the COVID-19 pandemic was declared in March 2020. Emphasis has been placed on protecting the lives and livelihoods of people around the world. Global efforts were made to have vaccines, specific treatments, and improved access to PPE. The global pandemic is not yet over; there is considerable uncertainty about the path the pandemic will take. Scientists predict that over time COVID-19 will become endemic, and there will continue to be sporadic outbreaks in which it spirals out of control. The transition from pandemic to endemic is likely to play out differently in different parts of the world.

Nuclear cardiology laboratories have adapted in many ways and will continue to provide high-quality, patient-centered, and optimized care. This can be accomplished with a continued focus on efficient screening, implementation of infection prevention and control measures, such as physical social distancing and sharing best practices. Proper care of the healthcare workforce and dealing with staffing shortages has risen as a key focus. As we move forward, it will be important to continue to have a flexible approach, adjusting levels of caution based on local health and regulatory conditions. Many of the lessons learned during the first two years of the pandemic will continue to be valuable going forward.[21]

DISCLOSURES

Dr. Al-Mallah has served as a consultant to Pfizer, Philips, and Jubilant; he has received grant support from Siemens. Dr. Bateman holds intellectual property rights in and receives royalties from Cardiovascular Imaging Technologies; he has served as a consultant to AIM, AstraZeneca, Curium, and GE Healthcare; and he has received grant support from Bracco, JDI Solutions, and GE Healthcare. Dr. Dilsizian has received grant support from GE Healthcare. Dr. Dorbala has received grant support from Pfizer, GE Healthcare, and Attalus; she serves on the advisory board for Pfizer, GE healthcare, Janssen, and Eidos; she serves on the speakers' bureau for Ionetix. Dr. Einstein has received speaker fees from Ionetix; has received consulting fees from W. L. Gore & Associates; has received authorship fees from Wolters Kluwer Healthcare – UpToDate; and has received grants or grants pending to his institution from Attralus, Canon

Medical Systems, Eidos Therapeutics, GE Healthcare, Pfizer, Roche Medical Systems, and W. L. Gore & Associates, and XyloCor Therapeutics. Dr. Ghesani serves on the advisory board for GE Healthcare; he serves on the speakers' bureau for Blue Earth and Novartis. Dr. Gimelli serves on the advisory board for Pfizer and GE Healthcare. Dr. Phillips serves as a consultant to NovoNordisk. Dr. Skali serves as a consultant to Astellas and has received research support form ABT Associates. The following contributors have nothing relevant to disclose: Dennis A. Calnon, MD, MASNC; Suzanne F. Crews, MPA, RT, NMTCB; Maurizio Dondi, MD; Felix Keng Yung Jih, MBBS, MASNC; Diana Paez Gutierrez, MD; Randall C. Thompson, MD, MASNC.

References

1. WHO Europe. Strengthening and Adjusting Public Health Measures Throughout the COVID-19 Transition Phases. Available at WHO-EURO-2020-690-40425-54211-eng.pdf. Accessed March 14, 2022.
2. Skali H, Murthy VL, Al-Mallah MH, Bateman TM, Beanlands R, Better N. Guidance and best practices for nuclear cardiology laboratories during the coronavirus disease 2019 (COVID-19) pandemic: An Information Statement from ASNC and SNMMI. J Nucl Cardiol 2020;27:1022-9. https://doi.org/10.1007/s12350-020-02123-2.
3. Skali H, Murthy VL, Paez D, Choi EM, Keng FYJ, Iain MA, et al. Guidance and best practices for reestablishment of non-emergent care in nuclear cardiology laboratories during the coronavirus disease 2019 (COVID-19) pandemic: An information statement from ASNC, IAEA, and SNMMI: Endorsed by the Infectious Diseases Society of America. J Nucl Cardiol 2020;27:1855-62. https://doi.org/10.1007/s12350-020-02203-3.
4. Zoghbi WA, DiCarli MF, Blankstein R, Choi AD, Dilsizian V, Geske JB, et al. Multimodality cardiovascular imaging in the midst of the covid-19 pandemic: Ramping up safely to a new normal. JACC Cardiovasc Imaging 2020;13:1615-26. https://doi.org/10.1016/j.jcmg.2020.06.001.
5. Wallis JW, Klein R, Bradshaw TJ, Catana C, Hatt M, Laforest R, et al. Guidelines on setting up stations for remote viewing of nuclear medicine and molecular imaging studies during COVID-19. J Nucl Med Technol 2021;49:2-6. https://doi.org/10.2967/jnmt.120.261890.
6. Paez D, Gnanasegaran G, Fanti S, Bomanji J, Sathekge M, Bom HS, et al. COVID-19 pandemic: guidance for nuclear medicine departments. Eur J Nucl Med Mol Imaging 2020;47:1615-9. https://doi.org/10.1007/s00259-020-04825-8.
7. National Institutes of Health. 2022. Anti-SARS-CoV-2 Monoclonal Antibodies. In: COVID-19 Treatment Guidelines. https://www.covid19treatmentguidelines.nih.gov/therapies/anti-sars-cov-2-antibody-products/anti-sars-cov-2-monoclonal-antibodies/. Accessed 4 Mar 2022.
8. U.S. Food and Drug Administration. 2022. FDA authorizes revisions to Evusheld dosing. Drug Safety and Availability.
9. U.S. Food and Drug Administration. 2021. Coronavirus (COVID-19) Update: FDA Authorizes First Oral Antiviral for Treatment of COVID-19. In: FDA News Release. https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-first-oral-antiviral-treatment-covid-19. Accessed 4 Mar 2022.
10. Centers for Disease Control and Prevention. 2022. COVID-19 Community Levels: A measure of the impact of COVID-19 illness on health and healthcare systems. In: Centers for Disease Control and Prevention. https://www.cdc.gov/coronavirus/2019-ncov/science/community-levels.html. Accessed 4 Mar 2022.
11. Smallwood N, Harrex W, Rees M, Willis K, Bennett CM. COVID-19 infection and the broader impacts of the pandemic on healthcare workers. Respirology 2022. https://doi.org/10.1111/resp.14208.
12. Centers for Disease Control and Prevention. 2022. Strategies to Mitigate Healthcare Personnel Staffing Shortages. In: Centers for Disease Control and Prevention. https://www.cdc.gov/coronavirus/2019-ncov/hcp/mitigating-staff-shortages.html. Accessed 4 Mar 2022.
13. Navare SM, Mather JF, Shaw LJ, Fowler MS, Heller GV. Comparison of risk stratification with pharmacologic and exercise stress myocardial perfusion imaging: A meta-analysis. J Nucl Cardiol 2004;11:551-61. https://doi.org/10.1016/j.nuclcard.2004.06.128.
14. Blocken B, Malizia F, van Druenen T, Marchal T. Towards aerodynamically equivalent COVID19 1.5 m social distancing for walking and running. 2020. [Preprint]
15. Sajgalik P, Garzona-Navas A, Csécs I, Askew JW, Lopez-Jimenez F, Niven AS, et al. Characterization of aerosol generation during various intensities of exercise. Chest 2021;160:1377-87. https://doi.org/10.1016/j.chest.2021.04.041.
16. Klompas M, Rhee C. Aerosol generation during exercise: implications for preventing viral transmission in and out of the exercise laboratory. Chest 2021;160:1174-6. https://doi.org/10.1016/j.chest.2021.05.065.
17. Katsumata Y, Sano M, Okawara H, Sawada T, Nakashima D, Ichihara G, et al. Laminar flow ventilation system to prevent airborne infection during exercise in the COVID-19 crisis: A single-center observational study. PLoS ONE 2021;16:e0257549. https://doi.org/10.1371/journal.pone.0257549.
18. Blocken B, van Druenen T, Ricci A, Kang L, van Hooff T, Qin P, et al. Ventilation and air cleaning to limit aerosol particle concentrations in a gym during the COVID-19 pandemic. Build Environ 2021. https://doi.org/10.1016/j.buildenv.2021.107659.
19. Klompas M, Baker MA, Rhee C. Airborne transmission of SARS-CoV-2: Theoretical considerations and available evidence. JAMA 2020;324:441-2. https://doi.org/10.1001/jama.2020.12458.
20. Interim Infection Prevention and Control Recommendations for Healthcare Personnel During the Coronavirus Disease 2019 (COVID-19) Pandemic. NCIRD, Division of Viral Diseases. Updated February 2, 2022. Available at https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html#anchor_1604360721943. Accessed March 14, 2022.
21. Skali H. The COVID-19 pandemic and nuclear cardiology: An opportunity to grow stronger? J Nucl Cardiol 2021;28:336-7. https://doi.org/10.1007/s12350-020-02383-y.