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# Cardiac PET and SPECT During the COVID-19 Pandemic

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The severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) spread rapidly around the world in the early months of 2020 before the COVID-19 outbreak was officially declared a pandemic in March 2020. Worldwide volumes of non-emergent testing, such as cardiac PET and SPECT, decreased dramatically at the beginning of the lockdown as health systems attempted to limit the spread of the COVID-19 virus. Published reports of increasing cardiovascular mortality compared to months prior to the pandemic raised concerns that lack of access to appropriate cardiovascular testing was adversely affecting patient outcomes. Medical societies published guidance for the best practices of cardiovascular nuclear medicine laboratories to address this emerging cardiovascular epidemic. These nuclear cardiology expert consensus recommendations were remarkably consistent with those from other health organizations and heavily emphasized patient triage, screening of symptoms, strict PPE usage, and limiting patient dwell time in the nuclear medicine lab by favoring shorter testing protocols. Survey responses indicated that nuclear medicine labs took heed of these recommendations and adjusted practices to meet the cardiovascular needs of their population while minimizing transmission risk.

Semin Nucl Med 52:56-60 © 2021 Elsevier Inc. All rights reserved.

## Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) was first identified in the Chinese province of Wuhan in December 2019.<sup>1</sup> The highly transmissible virus spread globally over the ensuing months and the World Health Organization declared the outbreak as a pandemic on March 11, 2020.<sup>2</sup> The coronavirus-2019 (COVID-19) pandemic has had a profound impact on society as governments and institutions raced to limit the spread of the deadly virus, although local response to the pandemic varied widely across the globe.<sup>3</sup> At the forefront of the fight to contain the virus, the medical field experienced dramatic changes in patient volumes and practices across nearly every specialty. The purpose of this review is to summarize the effect of COVID-19 on cardiac PET and SPECT, including recommendations from professional societies and practice trends of cardiac nuclear medicine laboratories over the course of the pandemic.

## Trends in Cardiac PET and SPECT During the Early Pandemic

As countries went into lockdown in March of 2020, there was an abrupt decrease in cardiovascular testing and procedures as non-urgent cases were deferred to reduce risk of transmission to patients and staff. In a worldwide survey performed by the International Atomic Energy Agency (INCAPS COVID), survey participants reported a 64% decrease in overall cardiovascular testing and a 73% decrease in nuclear stress test volume in April 2020 compared to April 2019.<sup>4</sup> Lower income countries experienced an even greater decline in cardiovascular testing which was thought due to decreased access to personal protective equipment.<sup>4</sup> Utilization rates of cardiac SPECT fell further than cardiac PET (74 vs 51%) during the initial phases of the pandemic.<sup>5</sup>

## Trends in Cardiovascular Outcomes During the Pandemic

Although a decline in diagnostic testing was anticipated as health systems grappled with the pandemic, hospitals also noticed a worrisome decline in non-respiratory presentations. The Centers for Disease Control reported a 42% decrease in emergency

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department visits in March/April 2020 compared to the year prior.<sup>6</sup> Across nine hospital systems in the United States, there was a 38% decrease in STEMI activations in the early COVID-19 era.<sup>7</sup> Similar decreases in acute coronary syndrome presentations were described in England, France, and Italy.<sup>8-10</sup> As these trends became increasingly defined, concern grew that the cardiovascular needs of the global population were not being met. One meta-analysis reported that out of hospital cardiac arrests had increased by 120% in five countries (Australia, Italy, Spain, United States, and France) compared to before the pandemic.<sup>11</sup> In-hospital mortality rates for patients presenting with acute coronary syndrome were found to be significantly higher in patients who had COVID-19 (27.9%) compared to those who did not carry the virus (3.7%) as reported by Case et al.<sup>12</sup> Only 20% of patients with acute myocardial infarction and COVID-19 infection underwent coronary angiography in that study.<sup>12</sup> One observational cohort study discovered that during the initial months of the pandemic, deaths from ischemic heart disease and hypertensive disorders significantly increased compared to the months leading up to the pandemic, confirming fears that withholding indicated cardiovascular testing was impacting patient morbidity and mortality.<sup>13</sup>

### Expert Consensus Recommendations

As the pandemic wore on, professional societies across the world released guidance for the safe introduction of cardiovascular testing. The goal of these position statements was to balance the risk of transmission with the cardiovascular needs of individual patients. Uniformly, societies heavily emphasized prioritization of urgent tests, pretest screening of symptoms, judicious use of COVID testing, enhanced cleaning and other hygiene measures, use of personal protective equipment, and physical distancing.<sup>14-23</sup> Other common recommendations were to substitute pharmacologic vasodilator stress for exercise stress when possible because of evidence that exercise is an aerosolizing procedure and, when feasible, to favor shorter testing protocols.<sup>14,16,17,20,22,23</sup> As an example, a joint statement by the American Society of Nuclear Cardiology and the Society of Nuclear Medicine and Molecular Imaging recommended consideration of 1-day studies, stress-first protocols, and favoring PET over SPECT in order to shorten testing and minimize patient dwell time in the nuclear laboratory.<sup>22,23</sup> The operational changes that were recommended are still in effect are summarized in Table 1.<sup>22,23</sup> After completion of the test, use of telemedicine and physical distancing during image interpretation was encouraged.<sup>16, 20-23</sup> Wallis et al provided technical recommendations for the establishment of remote viewing stations for the interpretation of nuclear medicine images.<sup>24</sup> Several societies recommended that the CT attenuation scans be reviewed prior to patient leaving the laboratory to ensure there were no incidental findings of COVID-19 pneumonitis.<sup>16,17,21,22,23</sup> Incidental CT findings of COVID-19 include ground-glass opacities, air-bronchograms, consolidations, and septal lobular thickening.<sup>25</sup> Figure 1 shows ground glass opacities noted incidentally on a CT attenuation scan at our facility.

**Table 1 Partial List of Key Operational Changes Recommended in Order to Safely and Efficiently Perform Myocardial Imaging Studies During the Covid-19 Pandemic**

#### Optimizing Myocardial Perfusion Imaging in the COVID Era

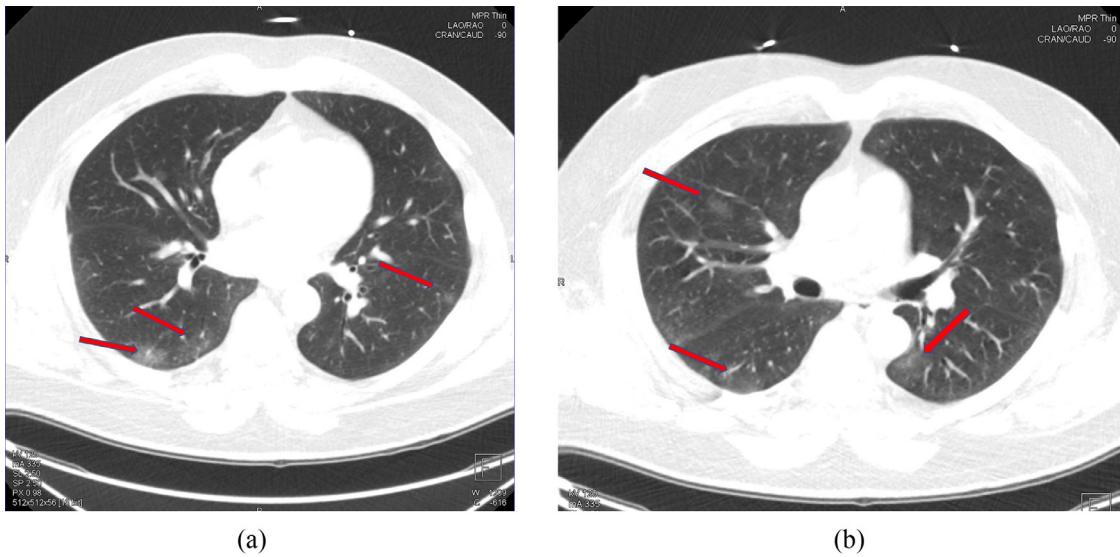
- Utilize pharmacologic stress over exercise
- When feasible, perform stress first/stress only protocols
- Favor rapid acquisition protocols over radiation sparing protocols
- PET is preferable to SPECT, if available, due to shorter study duration
- Review CT attenuation scan prior to patient departure

Guidelines also emphasize appropriate hygiene and other measures to maintain social distancing in concert with other departments.<sup>22,23</sup>

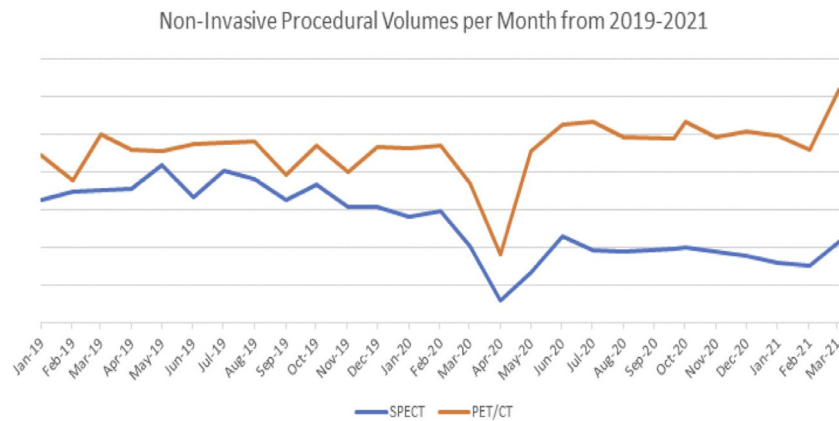
### Response of the Global Nuclear Cardiology Community to the Pandemic

Overwhelmingly, the global nuclear cardiology community embraced the expert consensus recommendations.<sup>26</sup> For example, the INCAPS COVID survey participants reported the greatest reductions in aerosolizing stress protocols (exercise ECG and stress echocardiograms) and cardiac PET volumes were not impacted as much as cardiac SPECT, in line with published guidance.<sup>4-5</sup> Although the political climate surrounding the COVID pandemic was divisive in the United States and some other countries, regional variation in procedure volume reduction was not associated with the political affiliation of state leadership.<sup>5</sup> Instead, these variations in testing restriction appeared to be associated with other factors such as severity in local outbreaks at the time of the survey.<sup>5</sup> These encouraging findings demonstrated that the nuclear cardiology community decision makers assumed a leadership role, followed guidelines, and exercised common sense in a confusing and contentious period in medical history.<sup>26</sup>

In our center's experience, payors have generally been accommodating of society recommendations by allowing pharmacologic stress MPI over exercise ECG and by allowing substitution of PET for SPECT. This has helped our laboratory resume cardiovascular testing in a safe manner. Evidence from our center shows recovery of MPI volumes compared to pre-pandemic levels. Following published recommendations, our PET volumes have increased while our SPECT volumes have decreased (Fig. 2) as some patients who would have undergone exercise or pharmacologic SPECT studies were converted to rest-stress Rb82 MPI PET tests, a protocol that takes less than half an hour. The expeditious nature of this protocol is even more of an advantage in the patient who is Covid positive yet needs urgent cardiac evaluation (Fig. 3). Our center has also embraced other guideline recommendations by increasing stress-only SPECT imaging, prioritizing rapid acquisition SPECT protocols rather than radiation sparing ones in selective cases, and using 2-day protocols more liberally than in the past. The 2-day approach in the past was generally reserved for obese patients or for selected circumstances for optimizing



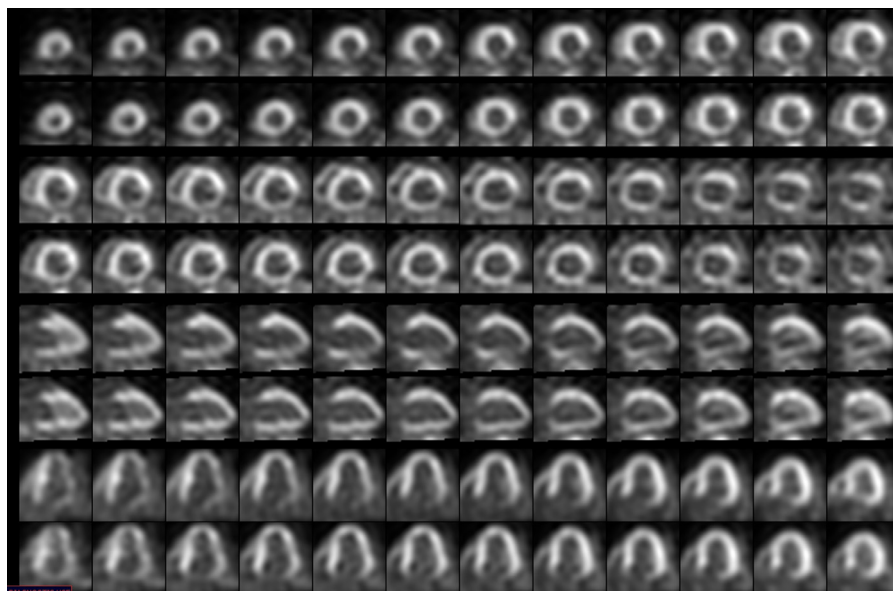
**Figure 1** Panels A and B show CT scan performed as part of a PET – CT MPI study with infiltrates typical of Covid-19 pneumonitis in a patient not previously known to be infected. Arrows demonstrate mostly peripheral ground glass opacities.



**Figure 2** SPECT and PET volumes per month at St. Luke’s Mid America Heart Institute. The number of myocardial perfusion imaging (MPI) studies per month were sharply reduced in March and April of 2020, but with adoption of recommended protocols, procedure volumes recovered fairly quickly and there has been a shift from SPECT MPI to PET MPI.

workflow (for example at small town outreach sites where a supervising cardiologist was only available 1 day each week, but resting scans could be obtained other days). Instead of most patients remaining in the laboratory waiting area for 3-4 hours between the two portions of a 1-day rest-stress or stress-rest SPECT MPI study, they leave the facility after the stress scan, only to return the following day for the rest scan if necessary. Patients have not only accepted the 2-day approach despite some added inconvenience, they have generally appreciated the extra social distancing it allows. By following these key guidelines, our center has not only been able to perform as many MPI tests as before the pandemic, the average number of patients in the facility including waiting areas is much less than in the past and the time

of contact with staff has been shortened substantially. It should be noted, however, that our center’s experience with recovery of patient testing volume likely represents a best-case scenario with relatively abundant PPE and ready availability of pharmacologic PET. There is almost certainly high variability in volume recovery trends across the world, depending on PPE availability and local pandemic conditions. It remains unclear at this time how many patients whose cardiovascular testing was deferred were eventually accommodated. Will centers be able to ‘catch-up’ on those lost months of testing or will the initial bump in cardiovascular mortality evolve into a mini-epidemic of cardiovascular disease? This is a major concern facing health care systems around the world.



**Figure 3** Rest-stress rubidium-82 PET MPI study in an inpatient who presented with cough and chest pain and tested positive for Covid-19. Stress images on top, rest images below. The study was performed at the end of the workday to allow more time for cleaning of the imaging area. MPI showed a large partially reversible defect in the inferior, inferolateral, and inferoseptal LV segments consistent with scar and ischemia. Computer quantitation estimated that 10% of the LV mass is scar with 12% ischemic. The left ventricular ejection fraction measured 24% at rest and 32% with stress. The patient ultimately underwent coronary angiography and complex coronary intervention to stenoses in the right and circumflex coronary arteries.

## Conclusion

The initial phase of the COVID-19 pandemic was met with drastic reductions in cardiac PET and SPECT volumes as non-emergent testing was limited. Professional societies across the world offered consistent guidance for the safe reintroduction of cardiovascular testing after it became evident that cardiovascular mortality was increasing. The nuclear cardiology community utilized this guidance and was able to safely resume operations. Despite often conflicting rhetoric from politicians, survey responses indicate that nuclear practices were driven by medical evidence and not by politics. The COVID pandemic continues to evolve with the rollout of vaccines and the emergence of COVID variants. However, we are confident that the physicians and allied health professionals of the nuclear cardiology community will rise to meet these challenges and adapt practices in order to provide vital services to patients while protecting patients and staff from transmission.

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