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# The Clinical Utility of Molecular Imaging in COVID-19: An Update

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**The novel pathogen severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first discovered in Wuhan, China in late 2019 with Coronavirus disease 2019 (COVID-19) declared a global pandemic in March 2020. Primarily involving the lungs, conventional imaging with chest radiography and CT can play a complementary role to RT-PCR in the initial diagnosis, and also in follow up of select patients. As a broader understanding of the multi-systemic nature of COVID-19 has evolved, a potential role for molecular imaging has developed, that may detect functional changes in advance of standard cross-sectional imaging. In this review, we highlight the evolving role of molecular imaging such as fluorine-18 ($^{18}$F) fluorodeoxyglucose (FDG) with PET/CT and PET/MRI in the evaluation of both pulmonary and extra-pulmonary COVID-19, ventilation and perfusion scan with SPECT/CT for thromboembolic disease, long term follow-up of COVID-19 infection, and COVID-19 vaccine-related complications.**

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## Introduction

Coronavirus disease 2019 (COVID-19), a disease caused by the novel virus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was declared a global pandemic in March 2020, with patients presenting most commonly with pneumonia. Imaging has an essential role in the evaluation and workup of patients with suspected or confirmed COVID-19, including in initial diagnosis, evaluating progression of disease, monitoring response to treatment, and assessing for the presence of complications related to COVID-19.

Although considered a disease primarily affecting the lungs, COVID-19 has emerged as a multisystem inflammatory condition that can involve myriad of organs.[1] Chest radiography and CT of the chest are the most common imaging modalities used to diagnose COVID-19 pneumonia,[2,3] however, molecular imaging techniques, in particular $^{18}$F-fluorodeoxyglucose (FDG) PET/CT have become potential diagnostic tools to assess the diverse inflammatory processes caused by COVID-19, in part due to their superiority over conventional imaging in determination of disease severity, therapy monitoring and even as a prognostic too in select patients.[4,5]

Post-acute COVID-19 syndrome describes several heterogenous symptoms due to the impact of the viral infection on multiple organ systems that may persist for ≥28 days after initial onset of SARS-CoV-2 symptoms. The cause of post-acute COVID-19 remains unclear; however, 'hyperinflammation' caused by antibodies to persistent SARS-CoV-2 virus has been hypothesized, resulting in an increase in inflammatory cytokines increasing the expression of glucose co-transporter on inflammatory cells resulting in an increase in glucose and therefore FDG uptake, facilitating imaging of the body with FDG PET/CT.[6]

In addition to evaluation the thoracic and multisystem imaging features of COVID-19, molecular imaging may also demonstrate both the potential short- and long-term complications associated with COVID-19 vaccination, including COVID-19 vaccination associated lymphadenopathy, which has been described in several studies.[7-9]

The purpose of this review is to demonstrate the role of molecular imaging techniques in evaluating both thoracic and extra-thoracic manifestations of COVID-19 and assessment of post-acute COVID-19 syndrome. In addition, we will describe

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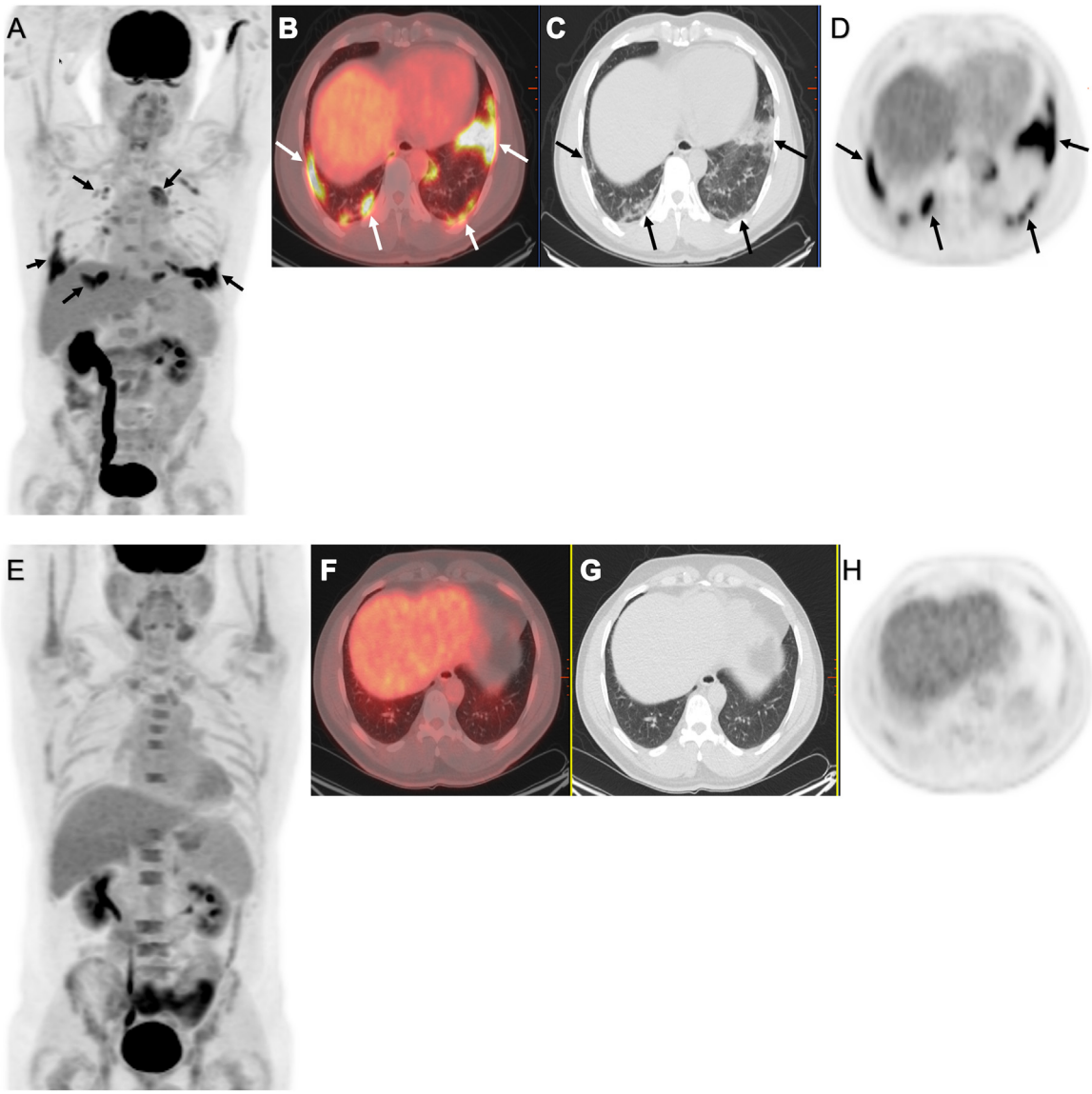


**Figure 1** 62-year-old male patient with history of lymphoma underwent PET/CT scan for restaging. PET maximum intensity projection (MIP) images (A,D) and axial PET/CT fusion images (B) shows hypermetabolic bilateral predominantly subpleural areas (arrows) with the highest SUV max of 8.7, corresponding to ground glass opacities and solid consolidations on the axial low dose CT scan. PET maximum intensity projection (MIP) images (E,H) and axial PET/CT fusion images (F) on 3 month follow-up PET/CT showed complete resolution of bilateral hypermetabolic ground glass opacities and solid consolidations.

the imaging features of COVID-19 vaccination associated complications on molecular imaging. Finally, we will consider the potential role that molecular imaging may play in understanding the COVID-19 disease process, the development of targeted therapies against COVID-19, and highlight the impact of the pandemic on nuclear medicine practice globally.

## Molecular Imaging in COVID-19 Detection and Complications

### $^{18}$F-FDG PET/CT for COVID-19 Detection

Initial reports of COVID-19 discovered on FDG PET/CT primarily described the incidental findings of SARS-CoV-2 pneumonia detected incidentally in asymptomatic patients, in small retrospective series and case reports. Findings on PET/CT in these early reports described heterogeneous or diffuse FDG uptake in ground glass opacities and consolidation, predominantly with a subpleural distribution (Fig. 1).[10,11]

Subsequent studies attempted to describe a potential role for FDG PET/CT in predicting COVID-19 disease severity. Yeh et al. reported that positive findings with FDG-avid pulmonary disease on PET/CT found in 13/31 patients (42%) was associated with higher risks of symptomatic infection and hospitalization, compared to patients with negative FDG PET/CT imaging.[12] Yet, the degree of FDG uptake and maximum standardized uptake value (SUVmax) of pulmonary COVID-19 disease vary widely, with no established

association between FDG uptake and presence or absence of symptoms, severity of disease, or disease duration. Wakfie-Corieh et al. evaluated whether the SUVmax of pulmonary findings in a cohort of 23 patients with COVID-19 pneumonia differed from that in a non-COVID-19 control group, finding no difference between the two groups.[13] A subsequent prospective study sought to establish a SUVmax threshold to establish disease severity to assess "high inflammatory" vs "low inflammatory" disease using an SUVmax cut-off of 7, and found no significant correlation between SUV max and the inflammatory status, evolution of pulmonary findings on chest CT, or clinical outcome.[14]

Few studies have investigated both the quantification of FDG uptake and the evolution and distribution of FDG uptake longitudinally in patients with COVID-19. In most cases, FDG uptake increase in later stage disease compared to the 'early' and 'very early' stages of acute disease, with disease progressing from low-level FDG uptake in ground-glass pulmonary opacities to more FDG-avid pulmonary consolidation in the later stages of disease, with subsequent decrease in extent and avidity of pulmonary disease with viral clearance and the establishment of immunity. Of note, persistantly high FDG uptake has been reported in a subset of COVID-19 patients with delayed recovery.[15] Thornton et al. demonstrated persistent increased pulmonary FDG uptake in patients with post-COVID-19 lung disease (PCLD), and higher in untreated patients compared to those who received high-dose steroids and those who were asymptomatic. The authors concluded that FDG PET/CT may play a role in understanding COVID-19 disease trajectory and guide management for those patients with persistent respiratory symptoms.[15]

While FDG PET/CT has poor specificity for diagnosing COVID-19 pneumonia, it is important for nuclear medicine physicians and PET readers to be aware of suspicious findings on PET/CT that may represent the thoracic manifestations of COVID-19, facilitating early detection and management, especially in vulnerable populations such as oncology patients, who may deteriorate more rapidly without prompt diagnosis and treatment.[16]

Although primarily used in the assessment of pulmonary parenchymal disease, FDG PET/CT may also be used for the evaluation of thoracic extrapulmonary disease. The most commonly reported extra-pulmonary involvement is increased FDG uptake in thoracic nodes.[10,13] Prior studies have reported FDG uptake in non-enlarged mediastinal and hilar nodes in almost 50% of the patients with COVID-19.[12,13] Interestingly, a recent meta-analysis of the CT findings of COVID-19 by Bao et al. reported lymphadenopathy in just over 3% of patients,[17] highlighting the potential added value of FDG PET/CT in identifying very early stages of COVID-19 disease in patients without or prior to the development of conspicuous pulmonary findings on CT imaging.

## Cardiac Imaging

COVID-19 infection may also affect the heart resulting in acute myocarditis, however the exact mechanism is poorly understood. Although, endomyocardial biopsy (EMB) is considered the gold standard for diagnosing acute myocarditis, there is no specific histopathologic features of COVID-19-related myocarditis, and at present, the European Society of Cardiology (ESC) guidelines do not recommend myocardial biopsy for diagnosing myocarditis in COVID-19 patients.[18] Therefore, noninvasive cardiac imaging such as cardiac MRI and nuclear cardiology exams play a role in diagnosis.[10] Few reports on FDG PET/CT have described increased focal or diffuse uptake as a possible signs of myocardial involvement in COVID-19 patients.[10] Hanneman et al evaluated the role of FDG PET/MRI in a prospective study of 47 patients with COVID-19 who underwent imaging within 3 months of diagnosis. The authors found that 17% of patients had focal FDG myocardial uptake with corresponding signal abnormalities on the MRI, was consistent with myocardial inflammation especially in the context of elevated serum inflammatory markers such as C-reactive protein and erythrocyte sedimentation rate (ESR) that were elevated at baseline, and that resolved or improved on follow-up.[19] The authors concluded that these results demonstrated the possible utility of FDG PET/MRI as a quantitative imaging biomarker in the evaluation and follow-up of COVID-19 patients with persistent cardiac symptoms.

## Neuroimaging

COVID-19 infection may result in neurological signs and symptoms with or without corresponding findings on CT and MRI. However, molecular imaging may provide value in diagnosing neurologic manifestations of COVID-19 even in the absence of abnormalities on conventional cross-sectional imaging, with a few case reports describing imaging features on FDG PET/CT.[10] For example, COVID-19 infection may result in focal FDG uptake in the putamen, in addition to diffuse hypermetabolism of the cerebellum and in the cerebral cortex on $^{18}$F-FDG PET/CT, as was described previously in a COVID-19 patient presenting with subacute cerebellar syndrome and myoclonus, despite negative brain MRI and CSF testing.[20] Another case series of four COVID-19 positive patients with COVID-19-related-encephalopathy showed common pattern of FDG hypometabolism in the prefrontal or orbito-frontal cortices and FDG hypermetabolism in the cerebellar vermis, again in the absence of abnormality on MRI and CSF analysis, including RT-PCR for SARS-CoV-2.[21] The authors of prior studies have suggested a possible relationship between SARS-CoV-2 infection and autoimmune encephalitis, rather than due to direct viral neuroinvasion. These findings suggest a possible indication for FDG PET/CT as a problem solving tool in COVID-19 patients with unexplained neurological symptoms.[10,19,20]

## Multisystemic Imaging

Post-acute COVID-19 syndrome, characterized as persistent symptoms and/or delayed or long-term complications beyond four weeks from the first onset of COVID-19 symptoms[22] may result in abnormal multifocal brain FDG

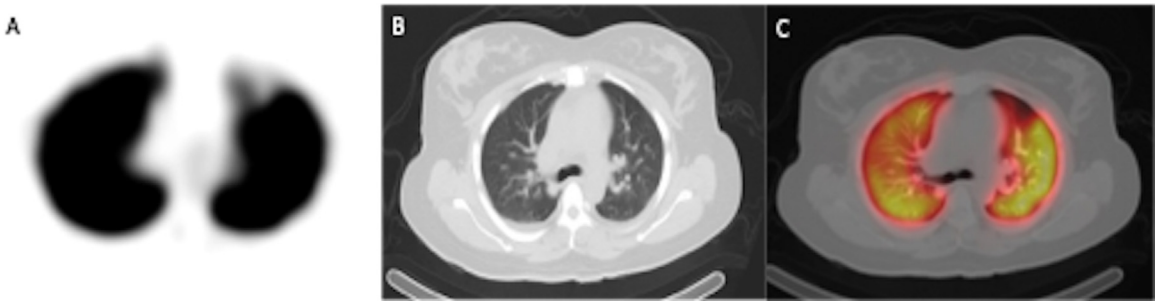


**Figure 2** 64-year-old woman with laboratory diagnosis of COVID-19 presenting with pleuritic left-sided chest pain. Axial perfusion (Q)-only SPECT image (A) demonstrating wedge-shaped defects in the left upper lobe without corresponding parenchymal abnormalities on axial CT chest (B). Fused axial Q-SPECT/CT showing wedge-shaped perfusion defect in the left upper lobe, suspicious for pulmonary embolus.

uptake.[6] A recent retrospective study investigating the imaging abnormalities in 13 patients with post-acute COVID-19 syndrome using whole body FDG PET and PET/resting state functional (rsf) MRI brain[6] and found that 8/13 (61%) had myositis and vasculitis (mainly involving the thoracic aorta), with lung involvement seen in 7/13 (54%). One patient who had markedly elevated serum anti-receptor binding domain (RBD) IgG antibody demonstrated diffusely increased FDG uptake in skeletal muscle throughout the body suspected as an immune-mediated myositis. Another patient experienced autoimmune-mediated psoriasis exacerbation following COVID-19 and had multiple areas of cutaneous FDG uptake consistent with worsening skin lesions. On FDG PET/rsfMRI brain, most patients had multiple areas of abnormal brain connectivity involving the thalamus and frontal and parieto-temporo-occipital lobes, with concordant hypometabolism on PET.[6] Whole body FDG PET may be a useful tool in the assessment of the 'long COVID' post-inflammatory processes involving multiple organs, including the brain, lung, skeletal muscle and vessel walls, especially as the natural history and long-term sequalae of COVID-19 are currently being investigated.

# SPECT/CT for Pulmonary Embolism and Cardiac Imaging in COVID-19

## Pulmonary Embolism

SPECT using radiolabelled technetium 99m (Tc99m) plays an important role in molecular imaging, including for pulmonary embolism (PE) evaluation and assessing cardiac abnormalities in certain patients.[23-25] During the global SARS-CoV-2 pandemic, emergent changes to workflow impacted how SPECT was utilized in nuclear medicine departments worldwide. For example, several proposals to modify established guidelines during the pandemic were considered by the Society of Nuclear Medicine and Molecular Imaging (SNMMI) and by the European Association of Nuclear Medicine (EANM) including the routine use of ventilation (V) scanning for the evaluation of PE.[26-28] Because lung scintigraphy often induces coughing and can contaminate air with minute amounts of radioactivity and aerosolized COVID-19, the 'V' component of V/Q SPECT raised concern as a source of potential spread of viral contagion.[29] As a result, the nuclear medicine community implemented and evaluated novel approaches to lung scintigraphy to adapt to the COVID-19 pandemic in an attempt to mitigate contagion risk to both patients and staff.[29-34]

One such attempt to improve the specificity of Q-only scintigraphy is to utilize chest CT as described by Lu et al. to identify and rule out etiologies of regional pulmonary hypoventilation such as emphysematous disease, bulla, and pulmonary infiltrates at the time of SPECT acquisition.[35] Das et al. adopted this approach following the declaration of the global pandemic and demonstrated the clinical utility of Q-SPECT/CT for diagnosing PE in hospitalized COVID-19 patients with a moderate to high pre-test probability of PE based on Wells Score at time of admission during the first 3 months following declaration of the global pandemic (Figs. 2 and 3). Of 33 patients who had a contraindication to iodinated CT contrast and who were subsequently imaged with Q-SPECT/CT, 18% had a confirmed diagnosis of COVID-19 with a positivity rate of 67% with additional acute ancillary thoracic findings seen in 75% of patients (Fig. 4).[29]

Le Roux et al. described a multicenter retrospective review of 145 V/Q SPECT/CT scans by two nuclear medicine physicians blinded to each individual patients clinical information who assessed each case by sequentially using Q SPECT, Q SPECT/CT and V/Q SPECT/CT images. The authors found that PE could be confidently excluded without ventilation in only 57% of patients, however the overall prevalence of PE was low in this patient population (12%).[30] Zuckier et al. implemented a similar protocol during the pandemic for the study of patients with COVID-19 with an initial negative chest radiograph. The authors found that ~80% of these patients demonstrated less than one segmental perfusional defects and were cleared of PE without the need for further imaging whereas patients with >1 perfusion defects were subsequently referred for additional testing such as pulmonary CTA where appropriate.[26]

In a retrospective study by Sajal et al., 54 patients with early post-COVID-19 and hypoxia were evaluated with lung perfusion, with the goal to identify the risk factors associated with mismatched perfusion defects. Lung perfusion defects

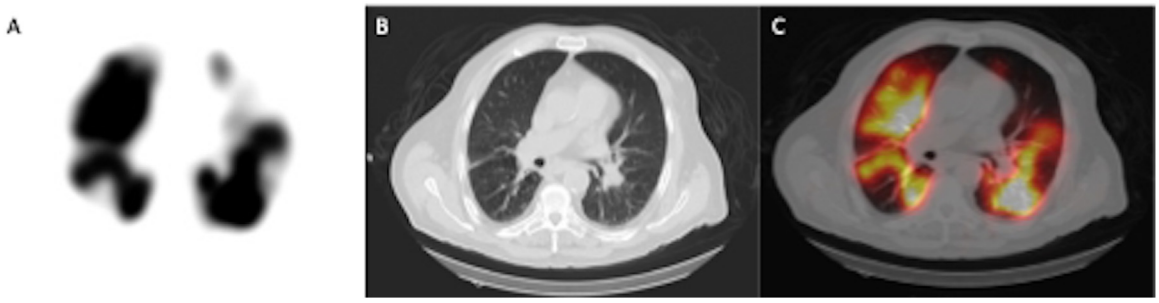


**Figure 3** 49-year-old man with laboratory diagnosis of COVID-19 with chest pain and dyspnea. Axial perfusion (Q)-only SPECT image (A) demonstrating bilateral wedge-shaped defects, without corresponding parenchymal abnormalities on axial CT chest (B). Fused axial Q-SPECT/CT demonstrating bilateral upper and lower lobe perfusion defects suspicious for pulmonary emboli.

of any type were seen in almost 90% of patients with 43% having mismatched perfusion defects. Older age was a risk factor for mismatched perfusion defects, however subjects with a serum D-dimer level of at least 2,500 ng/mL on the day prior to the scan were found to not be at higher risk for having mismatched perfusion defects. The author concluded that the decision to extend anticoagulant prophylaxis in post-COVID-19 patients should be support by evidence of pulmonary embolism on imaging studies.[31]

Kumar et al. described their experience following the introduction of a PE 'Q'-only screening protocol performed in 53 patients during the pandemic surge, which included 17 patients with a laboratory confirmed diagnosis of COVID-19. The authors found that this protocol excluded PE in almost 80% of patients with the remaining patients considered indeterminate for PE. Of the 42 patients with negative 'Q'-only studies, there was mortality rate of 2.4% prior to hospital discharge with normal follow up studies performed in 14% of which all were negative.[32]

Ozturk et. al aimed to show the potential benefit of Q-SPECT/CT in evaluating for the presence of perfusion defects in a low-risk outpatient cohort with mild-to-moderate COVID-19. Perfusion defects on Q-SPECT without a corresponding CT abnormality were present in 37% who presented with high D-dimer and/or dyspnea. 57% of patients had a positive Q-SPECT scan without a corresponding CT abnormality with all positive studies demonstrating segmental perfusion defects only. For D-dimer = 0.5 mg/dL, cut-off sensitivity is 85%, whereas for for D-dimer = 1.5 mg/dL, the cut-off specificity is 81%. The authors concluded that there was a tendency for thrombosis in outpatients with mild and moderate severity COVID-19 and suggested that based on these results for select patients, anticoagulant prophylaxis could be considered during the COVID-19 period.[33]

Tan et al. evaluated the clinical outcomes in 30 patients including those imaged during the early period of the COVID-19 pandemic who were suspected to have PE or chronic thromboembolic pulmonary hypertension. All patients were negative for COVID-19 infection. Q-SPECT/CT was positive in 63%, negative in 33% and indeterminate in 3%. False positive cases were seen in 3 patients during follow-up. Overall, sensitivity was 100%, specificity 79% with an overall diagnostic accuracy of 90 %. The authors concluded that Q-SPECT/CT was a useful tool to detect pulmonary thromboembolic disease during the COVID-19

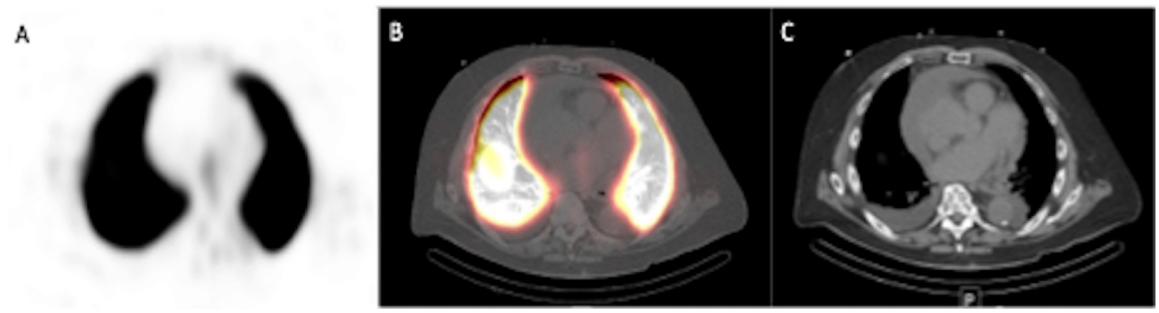


**Figure 4** 77-year-old man with laboratory diagnosis of COVID-19 with progressive dyspnea on evertion. Axial perfusion (Q)-only SPECT image (A) and fused Q-SPECT/CT (B) showing bilateral homogenous radiotracer uptake, without focal perfusion pulmonary defect. Axial low dose CT shows moderate sized pericardial effusion and small bilateral pleural effusions, suspicious for decompensated cardiac failure.

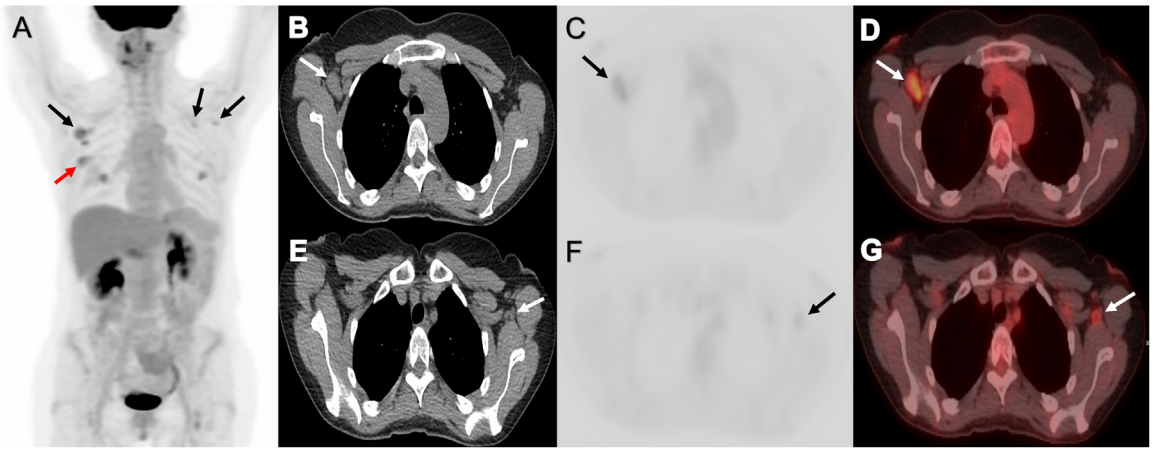


**Figure 5** 49-year-old female patient with right breast cancer underwent baseline PET/CT scan for staging. PET maximum intensity projection (MIP) images (A,C,F) and axial PET/CT fusion images (D,G) shows hypermetabolic right breast malignant mass (red arrow), enlarged hypermetabolic biopsy-proven metastatic right axillary adenopathy (SUV max of 3.3) and faint FDG uptake in COVID-19 vaccine-related reactive sub-centimeter left axillary and sub-pectoral lymph nodes (SUV max of 1.8) 3 months after left arm vaccine injection (black and white arrows). (Color version of figure is available online.)

pandemic, in addition to excluding the presence of VTE with high degree of certainty, however noting that false positives were observed in some patients.[34]

### Cardiac Imaging

In addition to the impact of COVID-19 on SPECT in terms of its use for the evaluation of PE, nuclear cardiology also experienced a significant impact on their practice regarding their use of SPECT. For example, the utilization of cardiac SPECT fell considerably in the US during the initial phases of the pandemic as elective procedures were significantly reduced.[36-38]

Hasnie et al evaluated the rate of abnormal myocardial perfusion imaging (MPI) studies at a single medical center during the COVID-19 pandemic compared to prior to the pandemic. The authors retrospectively analysed all SPECT-MPI studies between April 1-May 31, 2020 and compared this with studies from a corresponding cohort during the same time period in 2019. They found a reduction in volume of over 80% between 2020 and 2019, however the proportion of abnormal SPECT-MPI studies did not differ (31% vs 27%) with the authors suggesting that this suggested that this revealed the challenge faced by nuclear cardiology departments in predicting which patients will have abnormal SPECT-MPI even when forced to prioritize the performance of studies to high-yield patients.[39]

## Molecular Imaging of COVID-19 Vaccine-associated Complications

### Vaccine-associated Adenopathy

Adenopathy is a frequent imaging finding following COVID-19 vaccination. COVID-19 vaccine-associated hypermetabolic nodes on PET/CT have been reported more frequently with the novel class of mRNA vaccines compared to other conventional vaccines using attenuated viral vectors.[7,40] COVID-19 vaccine-related FDG uptake is most commonly seen in ipsilateral axillary nodes, and to a lesser extent, supraclavicular nodes (Fig. 5).[7,41] Focal or diffuse FDG-uptake may also be seen in the deltoid muscle at the site of administration of the COVID-19 vaccine.

A variable incidence of vaccine-related nodal and muscular FDG uptake has been reported in prior studies. Kubota et al. reported COVID-19 vaccination induced FDG uptake in the axillary lymph nodes (ALN) and deltoid muscle (DM) ipsilateral to injection site was present in approximately 60% of subjects within four says of initial vaccination, with rates increasing after the second vaccination (to 87.5% and 75.0%, respectively). The SUVmax of FDG-avid ALN and DM after the second vaccination was 4.79 $\pm$ 4.91 and 2.17 $\pm$ 1.02, respectively.[42] Cohen et al. reported an incidence of hypermetabolic nodes in 36 % of patients following their first vaccine dose versus 54 % of patients following their second booster dose of an mRNA vaccine. Median SUVmax was 2.63, with high grade vaccine-associated FDG uptake (SUV max $\geq$ 4 in enlarged nodes) reported in 10 % of patients.[43]

Differentiating between expected COVID-19 vaccine-associated hypermetabolic nodes and an axillary or supraclavicular nodal metastasis can be challenging and is of the utmost importance in terms of follow -up and clinical management of oncology patients, especially in those with breast cancer, head and neck cancers, lymphoma and cutaneous melanoma of the back or upper extremities, which have a propensity to metastatize to nodal basins in the axilla or neck.

The clinical and radiological evolution of COVID-19 vaccine-associated hypermetabolic lymphadenopathy and recommendations for imaging follow-up have been described in prior reports. For example, Kubota et al. reported that shorter duration since vaccination, younger age and female

sex, were associated with a higher incidence of FDG uptake in vaccine-associated nodes.[42] Guidelines and recommendations for follow up of oncology patients post-COVID-19 vaccination have been suggested by several authors. Becker et al. addressed this potential diagnostic conundrum based on input from a multidisciplinary panel of experts across three leading US tertiary cancer centers. According to these recommendations, some routine imaging examinations including FDG PET/CT for the purpose of screening, should be scheduled before or at least 6 weeks post final vaccination dose to allow for any reactive nodal uptake to resolve. In addition, the authors suggested that where possible, the vaccine should be administered on the side contralateral to the primary or suspected cancer, with both doses administered in the same arm, to assist in discriminating whether FDG-avid nodes represent metastatic or vaccine associated nodes.

Cohen et al. reported that vaccine associated FDG uptake following the third COVID-19 vaccine dose was short in duration (lasting 5 days or less) and uncommonly interfered with the interpretation of PET-CT studies performed in oncologic patients. In addition, vaccine associated FDG avid nodes were less likely in patients with older age and obesity.[44] For this reason, the authors concluded that PET/CT imaging should not be postponed for urgent indications or follow-up in oncology patients, but that due consideration should be given to the short-term imaging sequelae of the COVID booster vaccine on PET/CT, as well as other predictors of positive axillary nodal uptake after vaccination.

### Other Vaccine-associated Complications

Longterm data from follow-up of post-vaccine-associated unwanted effects has yet to be fully evaluated, with some authors reporting potential cardiac and neurologic adverse reactions following COVID-19 vaccination.[9,45,46] To date, $^{18}$F-FDG PET/CT and $^{18}$F-FDG PET/MRI have both demonstrated a potential role in the initial evaluation and follow-up of COVID-19 vaccine-related myocarditis in terms of offering quantitative analysis, with imaging features similar to the previously described pattern of COVID-19-infection related myocarditis.

Siripongsatian et al. recently investigated functional abnormalities in the brain of patients with neurological adverse effects following COVID-19 vaccination using $^{18}$F-FDG PET/MRI and $^{15}$O-water PET. The authors demonstrated both semiquantitative and visual analyses of $^{18}$F-FDG PET/MRI showing significant metabolic changes in the bilateral parietal and occipital lobes, as well as perfusion abnormalities on $^{15}$O-water PET, despite negative conventional imaging on CT and/or MRI. All regions of FDG PET abnormalities were part of the so-called 'fear network model', which has been implicated in patients experiencing anxiety.[9]

## Future directions

Molecular imaging can play an important role in the work up of patients with suspected COVID-19 or confirmed laboratory diagnosis of COVID-19, both at initial presentation, and during follow up to detect complications. Although most studies to date have focused on PET/CT with FDG and SPECT/CT using Technetium 99m, there is potential for more novel molecular imaging methods including imaging of activated macrophages with folic acid-based radiotracers or fibrobast activation protein inhibitor (FAPI) to provide better clinical care and prognostication of adverse clinical outcomes.[47,48] In addition, using quantitative CT and PET/CT data analysis to derive radiomic features based on the extraction and analysis of shape and texture characteristics from medical images combined with deep learning may offer additional diagnostic and predictive value for COVID-19 disease management including kinetic analysis for FDG.[49,50]

## Conclusion

Following the initial diagnosis of infection with SARS-CoV-2, molecular imaging can play a key role in assessing both pulmonary and extra-pulmonary manifestations of COVID-19. FDG PET/CT may be a sensitive tool to detect COVID pneumonia, vaccine associated lymphadenopathy and to detect multi-systemic inflammation. In addition, PET may be combined with MRI to detect and characterize cardiac and neurologic inflammation post-COVID-19 infection. Q-SPECT/CT can also be utilized as a first-line imaging modality in patients with laboratory confirmed or suspected COVID-19 to evaluate for pulmonary embolism, however only in select patients, as specificity may be limited. Post-pandemic, there likely remains many clinical applications where molecular imaging may add value. At present, it remains underutilized, both in diagnosis and follow up of COVID-19 patients. Further studies are required to elucidate future postential uses, as the impact of the pandemic abates but continues to influence global healthcare policies and procedure.

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