

# Letter to the Editor

Nuclear Medicine Communications 2020, XXX:000–000

## Single photon emission computed tomography-computed tomography lung perfusion imaging during the COVID-19 pandemic: does nuclear medicine need to reconsider its guidelines?

Stefan Vöö<sup>a</sup> and Sabina Dizdarevic<sup>b</sup>, <sup>a</sup>Institute of Nuclear Medicine, University College London Hospital, University College Hospital NHS Trust and <sup>b</sup>Brighton

and Sussex University Hospital NHS Trust and Brighton and Sussex Medical School, London, UK

Correspondence to Sabina Dizdarevic, MD, PhD, Brighton and Sussex University Hospital NHS Trust and Brighton and Sussex Medical School, London, UK  
Tel: +44 1273 696955; x64512; e-mail: sabina.dizdarevic@nhs.net

Received 18 May 2020 Accepted 7 June 2020

We read with a great interest the British Society of Nuclear Medicine (BNMS) consensus document by Buscombe *et al.* [1] on behalf of the BNMS Council covering the comprehensive range of nuclear medicine practice, elaborated as coronavirus disease 2019 (COVID-19): guidance for infection prevention and control in nuclear medicine. We fully support the need to address the importance of adapting nuclear medicine and radiology practice in light of the COVID-19 pandemic [2] as we aim to move forward to find efficient diagnostic approaches in the near post first peak COVID-19 era.

An area of interest and controversy in clinical practice remains that of ventilation-perfusion scans in patients with respiratory symptoms who are referred for nuclear medicine imaging to exclude pulmonary embolism as a differential diagnosis to other respiratory conditions. This includes infective viral pneumonia. The population of patients presenting with shortness of breath as a result of pulmonary embolism symptomatically overlaps with symptoms related to COVID-19 infection [3,4].

Studies have shown that many of COVID-19 patients have preserved lung compliance, suggesting that processes other than alveolar damage might be involved in hypoxaemia related to COVID-19 pneumonia [5]. Indeed, COVID-19 virus infects the host using the angiotensin-converting enzyme 2 receptor, which is ubiquitously expressed in several organs. Consequently, viral inclusions have been found by electron microscopy in endothelial cells and microvasculature of different organs, including the lungs [6]. The direct viral infection of the endothelial cells and/or subsequent antiviral immune-response results in diffuse endothelial inflammation which leads to microvascular dysfunction and subsequent organ ischaemia, inflammation and a procoagulant state with an increased risk of major thromboembolic events [6,7]. Thus, pulmonary embolisms may be a common finding in patients during or after COVID-19 disease.

The performance of a ventilation-perfusion scan involves intravenous administration of a tracer (perfusion) in

addition to ventilation which is based on the administration of tracer via aerosols and inhalation by the patient [8].

In total agreement with the authors, the potential effects of the COVID-19 disease pandemic on Nuclear Medicine departments needs to be addressed, as nuclear medicine staff may be at a high risk of exposure or spreading the COVID-19. We, as diagnostic clinicians, remain fully responsible for the best diagnostic procedures for our patients. But, to note, the virus is highly contagious, and the main route of transmission is via respiratory droplets and aerosols.

In contrast to the suggested procedure for the ventilation-perfusion scans during the early post-COVID-19 pandemic, we remain concerned about the performance and early reintroduction of the ventilation component. There is a continuous concern that performing aerosol-generating procedures poses a high risk of infection to healthcare workers [9–13]. Recent guidelines indicate that stringent infection control measures are needed in all patients, not only in confirmed or highly suspicious COVID-19 cases [14,15]. Moreover, viral filters inserted between the face mask and ventilation devices and the requirement of negative pressure rooms to perform the ventilation scans are not immediately available in all Nuclear Medicine departments. Furthermore, the proximity of healthcare workers to the patient during ventilation, the use of nebulizers with high gas flows, the high likelihood of aerosol leakage from the closed delivery system, the difficulty to thoroughly disinfect the ventilation systems and performing ventilation studies in patients who are already having respiratory difficulties (coughing, agitated, combative due to hypoxia) are all of high risk for contamination in nuclear medicine staff members [9–13].

We think that a perfusion-only scintigraphy with single photon emission computed tomography (SPECT) low-dose computed tomography (CT) of the chest while excluding the ventilation scan, as a first line investigation, could be still a well tolerated option while preserving the

diagnostic quality of the scan and avoiding unnecessary risk related to aerosolization and possible viral spread. Although disputable, according to a recent statement by the Society of Nuclear Medicine and Molecular Imaging [12], the ventilation aspect of the scan may be well skipped. This is because: (1) the ventilation systems are difficult to thoroughly disinfect; (2) suspicious patients should not be encouraged waiting longtime in the waiting area even if adhering to social distancing; and (3) the exposure of personnel to infectious risk during less-controlled ventilation scan should be minimized.

However, if ventilation scan is deemed absolutely indicated, it should only be performed if CT pulmonary angiogram (CTPA) is contraindicated and in exceptional circumstances in COVID-19 confirmed or suspected cases. The number of the personnel in the unit should be minimized when dealing with an individual suspected to have COVID-19 pneumonia [12,16], the personnel must follow the recommended protective personal protective equipment (PPE) for COVID-19, which includes masks (such as, FFP3 or N95), apron, gown, gloves and eye protection [14,15] and ventilation should preferably be performed in negative pressure rooms [2,17,18], which are unfortunately not readily available. Some centres opted to request COVID-19 PCR swab testing prior to ventilation scan if perfusion scan is abnormal [17]. However, regardless on PCR status in the current COVID-19 situation, the staff should wear the full PPE for aerosols procedures, if performing ventilation scan.

According to the European Association of Nuclear Medicine (EANM) guidelines, perfusion-only scintigraphy is currently recommended during pregnancy and in patients with suspected massive PE [8,19]. Perfusion defects are caused by a variety of lung conditions and are considered nonspecific if additional information on their localization (e.g., perifissural) and/or lung parenchymal substrate is not available. But the addition of low-dose CT to the SPECT images and corroborated reporting of the scintigraphic and structural information leads to an increase in sensitivity to ~97%, comparable to that of CTPA, and a significant increase in specificity to 97.2–100% [20,21]. When the perfusion scan is normal, pulmonary thromboembolism is ruled out. On this basis, recent evidence demonstrates that perfusion-only SPECT-CT scintigraphy is diagnostically accurate in the majority of patients with suspicion of acute PE yielding a sensitivity of ~86% and a specificity of 88–96% [21–24].

On this basis, we consider that perfusion-only SPECT low-dose CT is appropriate, if CTPA is contraindicated, in patients with suspicion of acute PE, including also patients with dyspnoea of equivocal nature, PE- and/or COVID-19 pneumonia-related. The low-dose CT component increases the diagnostic accuracy of the test as perfusion defects can be correlated with parenchymal abnormalities on the CT, including those related to viral

pneumonia as in COVID-19 infection. Of course, pulmonary embolism cannot be ruled out within the pulmonary infiltrates and it can lead to pulmonary abnormalities. In patients with multiple repeated embolisms, wedge-shaped subpleural opacities without air bronchograms (Hampton hump) are indeed a key finding for pulmonary haemorrhage or infarction. But usually, haemorrhage and infarction are found only in few affected areas, while areas with fresh pulmonary embolism did not have the time to develop changes due to the reduced perfusion. In fact, patients with pulmonary infiltrates show stronger perfusion in the nonaffected lung areas. As a result, clots should be expected in vessels of nonaffected pulmonary segments. This can be observed in recently published cases of pulmonary emboli on contrast-enhanced CT in patients with COVID-19 illness [25].

For dose reduction, in pregnant women, a perfusion-only SPECT without CT remains the diagnostic option. However, in certain cases, if the pregnant woman has associated risk factors (such as cardiovascular disease, asthma, etc.) and falls in the clinical 'vulnerable group' for COVID-19 infection [26], a perfusion-only SPECT with low-dose CT may be still considered.

We, therefore, propose that lung perfusion-only SPECT-CT should be considered in patients with contraindications for CTPA and suspected acute PE during the COVID-19 pandemic as a first line of investigation. SPECT perfusion only remains a preferable imaging choice in pregnant women. However, ventilation SPECT scan, although debatable, may still be performed, if lung perfusion scan is abnormal, after PCR swab testing preferably in PCR Covid-19 negative patients and with use of full PPE for aerosol generating procedures.

## Acknowledgements

### Conflicts of interest

There are no conflicts of interest.

## References

- 1 Buscombe JR, Notghi A, Croasdale J, Pandit M, O'Brien J, Graham R, et al.; Council and Officers of British Nuclear Medicine Society. COVID-19: guidance for infection prevention and control in nuclear medicine. *Nucl Med Commun* 2020; **41**:499–504.
- 2 Kooraki S, Hosseiny M, Myers L, Gholamrezaezhad A. Coronavirus (COVID-19) outbreak: what the Department of Radiology should know. *J Am Coll Radiol* 2020; **17**:447–451.
- 3 Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020; **395**:497–506.
- 4 Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, 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.
- 5 Gattinoni L, Coppola S, Cressoni M, Busana M, Rossi S, Chiumello D. COVID-19 does not lead to a 'Typical' acute respiratory distress syndrome. *Am J Respir Crit Care Med* 2020; **201**:1299–1300.
- 6 Varga Z, Flammer AJ, Steiger P, Haberecker M, Andermatt R, Zinkernagel AS, et al. Endothelial cell infection and endotheliitis in COVID-19. *Lancet* 2020; **395**:1417–1418.
- 7 Bonetti PO, Lerman LO, Lerman A. Endothelial dysfunction: a marker of atherosclerotic risk. *Arterioscler Thromb Vasc Biol* 2003; **23**:168–175.

- 8 Bajc M, Schümichen C, Grüning T, Lindqvist A, Le Roux PY, Alatri A, *et al.* EANM guideline for ventilation/perfusion single-photon emission computed tomography (SPECT) for diagnosis of pulmonary embolism and beyond. *Eur J Nucl Med Mol Imaging* 2019; **46**:2429–2451.
- 9 Brewster DJ, Chrimes NC, Do TAT, Fraser K, Groombridge CJ, Higgs A, *et al.* Consensus statement: safe airway society principles of airway management and tracheal intubation specific to the covid-19 adult patient group. 2020. <https://www.mja.com.au/journal/2020/consensus-statement-safe-airway-society-principles-airway-management-and-tracheal>. [Accessed 16 May 2020].
- 10 European centre for disease prevention and control: COVID-19 situation for the EU/EEA and the UK, as of 15 May 2020. 2020. <https://www.ecdc.europa.eu/en/cases-2019-ncov-eueea>.
- 11 Environmental cleaning and disinfection recommendations: interim recommendations for us households with suspected/confirmed coronavirus disease 2019. 2020. <https://www.Cdc.Gov/coronavirus/2019-ncov/community/home/cleaning-disinfection.Html>. [Accessed 16 May 2020].
- 12 Society of Nuclear Medicine & Molecular Imaging. COVID-19 and ventilation/perfusion (v/q) lung studies. 2020. <https://www.Snmml.Org/newspublications/newsdetail.aspx?Itemnumber=33543>. [Accessed 16 May 2020].
- 13 High consequence infectious diseases (HCID). 2020. <https://www.Gov.Uk/guidance/high-consequence-infectious-diseases-hcid>. [Accessed 16 May 2020].
- 14 Paez D, Gnanasegaran G, Fanti S, Bomanji J, Hacker M, Satheke M, *et al.* COVID-19 pandemic: guidance for nuclear medicine departments. *Eur J Nucl Med Mol Imaging* 2020; **47**:1615–1619.
- 15 Huang HL, Allie R, Gnanasegaran G, Bomanji J. COVID19 -Nuclear Medicine Departments, be prepared! *Nucl Med Commun* 2020; **41**:297–299.
- 16 Kooraki S, Hosseiny M, Myers L, Gholamrezanezhad A. Re: Ventilation-perfusion scans during the coronavirus disease 2019 (covid-19) outbreak. *J Am Coll Radiol* 2020; **17**:698–699.
- 17 Zuckier LS, Gordon SR. COVID-19 in the Nuclear Medicine Department, be prepared for ventilation scans as well! *Nucl Med Commun* 2020; **41**:494–495.
- 18 Zuckier LS, Moadel RM, Haramati LB, Freeman LM. Diagnostic evaluation of pulmonary embolism during the COVID-19 pandemic. *J Nucl Med* 2020; **61**:630–631.
- 19 Bajc M, Lindqvist A. Ventilation/perfusion SPECT imaging-diagnosing other cardiopulmonary diseases beyond pulmonary embolism. *Semin Nucl Med* 2019; **49**:4–10.
- 20 Gutte H, Mortensen J, Jensen CV, Johnbeck CB, von der Recke P, Petersen CL, *et al.* Detection of pulmonary embolism with combined ventilation-perfusion SPECT and low-dose CT: head-to-head comparison with multidetector CT angiography. *J Nucl Med* 2009; **50**:1987–1992.
- 21 Bhatia KD, Ambati C, Dhaliwal R, Paschkewitz R, Hsu E, Ho B, *et al.* SPECT-CT/VQ versus CTPA for diagnosing pulmonary embolus and other lung pathology: Pre-existing lung disease should not be a contraindication. *J Med Imaging Radiat Oncol* 2016; **60**:492–497.
- 22 Miniati M, Pistolesi M, Marini C, Di Ricco G, Formichi B, Prediletto R, *et al.* Value of perfusion lung scan in the diagnosis of pulmonary embolism: results of the Prospective Investigative Study of Acute Pulmonary Embolism Diagnosis (PISA-PED). *Am J Respir Crit Care Med* 1996; **154**:1387–1393.
- 23 Miniati M, Sostman HD, Gottschalk A, Monti S, Pistolesi M. Perfusion lung scintigraphy for the diagnosis of pulmonary embolism: a reappraisal and review of the Prospective Investigative Study of Acute Pulmonary Embolism Diagnosis methods. *Semin Nucl Med* 2008; **38**:450–461.
- 24 Sostman HD, Miniati M, Gottschalk A, Matta F, Stein PD, Pistolesi M. Sensitivity and specificity of perfusion scintigraphy combined with chest radiography for acute pulmonary embolism in PIOPED II. *J Nucl Med* 2008; **49**:1741–1748.
- 25 Burger IA, Niemann T, Patriki D, Fontana F, Beer J-H. Is there a role for lung perfusion [(99m)tc]-maa spect/ct to rule out pulmonary embolism in covid-19 patients with contraindications for iodine contrast? *Eur J Nucl Med Mol Imaging* 2020.
- 26 Coronavirus (covid-19) infection in pregnancy. Information for healthcare professionals. 2020. <https://www.rcog.org.uk/globalassets/documents/guidelines/2020-05-13-coronavirus-covid-19-infection-in-pregnancy.pdf>. [Accessed 16 May 2020].

DOI: 10.1097/MNM.0000000000001246