



## Perfusion SPECT/CT to diagnose pulmonary embolism during COVID-19 pandemic

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The global pandemic of novel coronavirus disease 2019 (COVID-19) has affected the way we practice nuclear medicine [1]. The virus can spread from person to person very quickly through respiratory droplets, which is the major reason causing the global pandemic. Thus, it is very important for nuclear medicine service to take prudent measures when dealing with aerosol-generating procedures, such as request for ventilation/perfusion (V/Q) scan to diagnose pulmonary embolism (PE). The patients referred to nuclear medicine service for PE diagnosis usually had symptoms of dyspnea on exertion and elevated D-dimer levels, which were commonly seen in both PE and COVID-19 infection [2]. Meanwhile, there are increased evidence of association of PE in patients with COVID-19 infection, and failure to diagnose PE will worsen the prognosis [3, 4].

In routine V/Q procedures, ventilation studies may be accompanied by airborne radioaerosol contamination, with subsequent small degree of contamination to both the nuclear medicine personnel and imaging room surface [5–7]. In addition, the patients' symptom of cough and shortness of breath frequently get temporarily worse after radioaerosol inhalation, which increased the potential risk of COVID-19 infection. To protect nuclear medicine personnel from potential respiratory viral infection, and provide the most clinical meaningful results for better patient care, we decide to abolish ventilation and adopt perfusion single photon emission computed tomography/computed tomography (Q-SPECT/CT) technique for PE diagnosis

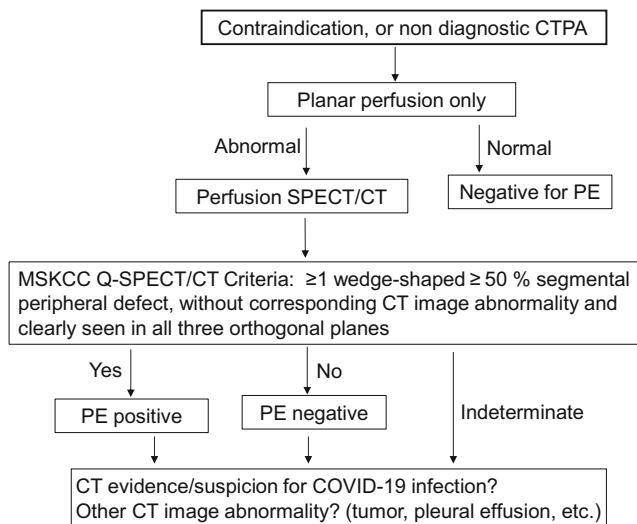
during the COVID-19 pandemic [1]. The practice algorithm is illustrated in Fig. 1.

For better patient care, it is important for nuclear medicine physician to understand referring physician's concern and assess the patient's pretest probability for COVID-19 and PE. Usually, the patients are symptomatic, with contraindications for CT pulmonary angiography (CTPA) or nondiagnostic on CTPA. It is a good practice to obtain planar perfusion images first due to the wide acceptance among technologists and physicians. In some cases, due to patient's clinical status, only portable, bedside planar perfusion images can be obtained. However, normal planar perfusion images can safely rule out PE. When planar perfusion images showed abnormality, further Q-SPECT/CT should be obtained. The PE diagnosis on Q-SPECT/CT images can be made using the previously published "MSKCC Q-SPECT/CT criteria" [8, 9], whereas PE is indicated by at least one wedge-shaped peripheral defect estimated as  $\geq 50\%$  of a pulmonary segment without corresponding CT image abnormality and clearly seen in all three orthogonal planes. Based on the available CT lung images, additional interpretation should be made on the probability/suspicion for COVID-19 pneumonia [10] and other CT image abnormalities such as presence of lung tumor and pleural effusions. This practice can make most of Q SPECT/CT test, hit two birds with one stone: to diagnose PE and identify if there are suspicious CT findings of COVID-19 pneumonia. We think this is a safe and effective approach that will benefit nuclear medicine practice and patient management during the COVID-19 pandemic. To be cautious, even though we did not perform the ventilation study, given the high pretest probability of COVID-19 infection in patients referred for PE diagnosis, we still recommend that health care personnel in the room should wear an N95 mask, eye protection, gloves, and a gown based on the guidance from the US Centers for Disease Control and Prevention [11].

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**Fig. 1** Diagnostic algorithm for nuclear medicine evaluation of PE during COVID-19 pandemic

## Compliance with ethical standards

**Conflicts of interest** The authors declare that they have no conflict of interest.

**Ethical approval** This article does not contain any studies with human participants or animals performed by any of the authors.

**Consent for publication** All the authors consent for publication if accepted.

## References

- Lu Y, Yan SX, Lan X, Zhu X, Macapinlac HA. Nuclear medicine in responding to global pandemic COVID-19-American College of Nuclear Medicine member experience. *Eur J Nucl Med Mol Imaging*. 2020. <https://doi.org/10.1007/s00259-020-04799-7>.
- Leonard-Lorant I, Delabranche X, Severac F, Helms J, Pauzet C, Collange O, et al. Acute pulmonary embolism in COVID-19 patients on CT angiography and relationship to D-dimer levels. *Radiology*. 2020;201561. <https://doi.org/10.1148/radiol.2020201561>.
- Kollias A, Kyriakoulis KG, Dimakakos E, Poulakou G, Stergiou GS, Syrigos K. Thromboembolic risk and anticoagulant therapy in COVID-19 patients: emerging evidence and call for action. *Br J Haematol*. 2020. <https://doi.org/10.1111/bjh.16727>.
- Poissy J, Goutay J, Caplan M, Parmentier E, Duburcq T, Lassalle F, et al. Pulmonary embolism in COVID-19 patients: awareness of an increased prevalence. *Circulation*. 2020. <https://doi.org/10.1161/CIRCULATIONAHA.120.047430>.
- Greaves CD, Sanderson R, Tindale WB. Air contamination following aerosol ventilation in the gamma camera room. *Nucl Med Commun*. 1995;16:901–4. <https://doi.org/10.1097/00006231-199511000-00004>.
- Mackie A, Hart GC, Ibbett DA, Whitehead RJ. Airborne radioactive contamination following aerosol ventilation studies. *Nucl Med Commun*. 1994;15:161–7. <https://doi.org/10.1097/00006231-199403000-00008>.
- Williams DA, Carlson C, McEnerney K, Hope E, Hoh CK. Technetium-99m DTPA aerosol contamination in lung ventilation studies. *J Nucl Med Technol*. 1998;26:43–4.
- Kumar N, Xie K, Mar W, Anderson TM, Carney B, Mehta N, et al. Software-based hybrid perfusion SPECT/CT provides diagnostic accuracy when other pulmonary embolism imaging is indeterminate. *Nucl Med Mol Imaging*. 2015;49:303–11. <https://doi.org/10.1007/s13139-015-0359-8>.
- Lu Y, Lorenzoni A, Fox JJ, Rademaker J, Vander Els N, Grewal RK, et al. Noncontrast perfusion single-photon emission CT/CT scanning: a new test for the expedited, high-accuracy diagnosis of acute pulmonary embolism. *Chest*. 2014;145:1079–88. <https://doi.org/10.1378/chest.13-2090>.
- Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, et al. Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases. *Radiology*. 2020;200642. <https://doi.org/10.1148/radiol.2020200642>.
- Prevention CfDca. Interim infection prevention and control recommendations for patients with suspected or confirmed coronavirus disease 2019 (COVID-19) in healthcare settings. 2020.

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