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Letter from the Editors



Coronavirus disease 2019 (COVID-19) is the third coronavirus infection in two decades that was originally described in Asia, after severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS).¹ During 2020 to 2021, the pandemic with more than 200 million cases of the coronavirus disease 2019 (COVID-19) has caused nearly 4.6 million deaths since the first COVID-19 pneumonia was recorded in Wuhan, China, December 2019.² The very quick spread of COVID-19 tremendously strained health care systems to their limit including departments of nuclear medicine and radiology. The COVID-19 pandemic has presented an extraordinary global challenge for medical care for more than a year now. Even with an increasing number of vaccinated individuals, the challenges persist due to new virus mutations, unequal distribution of vaccinations and people who elect to remain unvaccinated. *Seminars in Nuclear Medicine* has in the beginning of the COVID-19 pandemic published few papers on imaging of COVID-19^{3,4} including pitfalls after COVID vaccination.⁵ However, during the COVID-19 pandemic an increasing number of papers with focus on COVID-19 are published. Therefore, we dedicated this issue of *Seminars in Nuclear Medicine* to the impact of COVID-19 on nuclear medicine in order to provide updated information to the readers of the Journal. The issue includes a collection of reviews that cover clinical management of COVID-19, the impact of COVID-19 on nuclear medicine worldwide (US, Europe, Asia, Africa, Latin America), update on COVID-19 guidelines for nuclear medicine, lung scintigraphy, cardiac SPECT and PET, remote reading and teaching of nuclear medicine, telemedicine in target delineation in radiotherapy, and finally what have we learned and what to expect in the future.

In order to give the clinicians, radiologists and specialists in nuclear medicine an update on the clinical management of COVID-19, Dr Weise and colleagues provide a good overview on the following topics: Receiving COVID-19 suspected or confirmed patients, diagnosis (test, biochemistry, imaging) treatment (oxygen and fluid therapy, antiviral treatment, immunosuppression), discharge, and patients with post infectious long-term COVID-sequelae including nervous system and cognitive complaints.⁶ The current treatment is based on symptom relief and rehabilitation as there is no

documented specific medical treatment yet, and a multidisciplinary approach is recommended for patients with multiple symptoms following COVID-19.

The pandemic of COVID-19 not only directly causes high morbidity and mortality of the disease, but also indirectly affects patients with pre-existing medical conditions, particularly cardiovascular diseases, with delayed or deferred outpatient care and procedure including nuclear medicine studies because of concerns about exposure to the virus. Dr. Dilsizian et al. describe the impact of COVID-19 on nuclear medicine operations including cardiovascular manifestations in the US.⁷ Furthermore, potential correlation between decreased volume of nuclear cardiac studies performed during the pandemic and corresponding increased deaths from ischemic and hypertensive cardiac disease is discussed. The authors conclude that to minimize disease spread during the pandemic of the COVID-19, nuclear medicine departments in the US strictly follow up the recommendations and guidance of the government, hospital administrative, and academic organizations such as the SNMMI and ASNC, to modify imaging protocols and to adjust daily volume loading, reflecting the best evidence of benefits and risks.

COVID-19 also has a profound effect on nuclear medicine in Europe. Dr Kirienko, et al. describe the impact of COVID-19 on nuclear medicine practice in Europe and critically discuss actions and strategies applied to face the pandemic.⁸ As described by the authors, the pandemic strongly challenged nuclear medicine departments: a reduction in the workforce has been experienced in almost every center in Europe due to personnel diagnosed with COVID-19 and other reasons related to the coronavirus. Human resources, diagnostic and therapeutic management of patients, radiopharmaceutical supplies, teaching, training and research, were affected in nuclear medicine departments across Europe, and as a consequence new operative models have been applied during the pandemic to prevent the spread of SARS-CoV-2.

COVID-19 was first detected in China in late 2019 and rapidly spread to nearby Asian countries in early 2020. Outbreaks occurred differently in each country and affected nuclear medicine practice significantly even before the COVID-19 pandemic. The review by Dr. Bom et al. describe

the effect of COVID-19 in Asia.⁹ The practice of nuclear medicine in Asia was significantly affected from the beginning of the COVID-19 pandemic involving both imaging studies and therapies with radionuclides. The authors reported the case-in-point operational histories of four representative institutions in the East, Southeast, South, and West Asia. As stated by the authors “Living in the COVID-19 pandemic has become the new normal”, and despite restrictions and difficulties, many nuclear medicine departments in Asia are returning to their pre-COVID-19 practices.

The next paper by Dr. Giammarile et al. describe the impact of COVID-19 on nuclear medicine departments in Africa (19 countries, 41 centers) and Latin America (15 countries, 83 centers) obtained from a survey conducted by IAEA.¹⁰ Overall in 2020, the pandemic-related challenges resulted in significant decrease in nuclear medicine diagnostic and therapeutic procedures in Africa and Latin America. The impact was more pronounced in Latin America than in Africa.

The contribution by Dr. Paez et al. presents a revision of recommendations given mid-pandemic to nuclear medicine centers, some of which may become a mainstay in nuclear medicine service delivery and implementation.¹¹ Discussed are (1) comparative worldwide survey results of the measurable impact of COVID-19 on the practice of nuclear medicine, (2) the definitions of a pandemic and its phases, (3) relevant, recently developed or updated guidelines specific to nuclear medicine, (4) incidental findings of COVID-19 on hybrid nuclear medicine studies performed primarily for oncologic indications, and (5) how pertinent pedagogical methods for medical education, research, and development have been re-invented in a suddenly more virtual world.

One of the major effects of the COVID-19 pandemic within nuclear medicine was on lung ventilation studies, due to concern regarding spread of contaminated secretions into the ambient air. Dr. Zuckier review the origin and implementation of several approaches to performance of lung scintigraphy during the COVID-19 pandemic, and consider their potential impact on the future practice of lung scintigraphy.¹² There are a range of approaches, and they should be carefully weighed against the prevalence of COVID-19, availability of protective measures, and immunity of staff, in order tailor and modify protocols as indicated in the paper. A compelling body of evidence points to pulmonary thrombosis and thromboembolism as a key feature of COVID-19.¹³ However, the component of post-thrombotic sequelae has been less widely considered and need to be evaluated further. Nuclear medicine departments may be involved in the evaluation of COVID-19 survivors with persistent pulmonary symptoms.

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, 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 2019.¹⁴ Drs Mills and Thompson 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 COVID-19 pandemic.¹⁵

While standard radiologic imaging techniques, mainly chest X ray and CT, are the primary imaging modalities to diagnose lung infection, FDG-PET/CT has proven to be effective in cases where conventional imaging falls short. FDG PET/CT can identify infection and inflammation both earlier and with higher sensitivity than anatomic imaging modalities. Dr. Gholamrezanezhad et al. summarize the actual and potential benefits of FDG-PET/CT in the imaging of COVID-19 and other lung infections like pulmonary fungal infections, aspergillosis, blastomycosis, candidiasis, Coccidioidomycosis, Cryptococcosis, Histoplasmosis Mucormycosis, tuberculosis and nontuberculous mycobacterial infections.¹⁶

The following review by Dr. Zuckier et al. focus on remote reading and teaching of nuclear medicine in the era of COVID-19.¹⁷ The authors share observations, best practices from the literature, as well as offer illustrations from their own experience at Montefiore Medical Center in the Bronx, NY, one of the early epicenters of the pandemic in the US. Usual interactive methods of in person image interpretation were no longer possible in the supervision of resident activities. Virtual communications software was used to maintain daily case review, reintroduce conferences and meetings, and disseminate lectures. Implementation of virtual communication platforms facilitated quick sharing and group access of online educational material for cohort learning sessions. The authors suggest that when returning to “normal”, it may be worthwhile to maintain some aspects of virtual communications in resident education.

Like all other medical specialties, radiotherapy has been deeply influenced by the COVID-19 pandemic. The pandemic has had severe influence on the entire patient trajectory in oncology, from diagnosis to treatment and follow-up. Dr. Jensen et al, shortly review the influence of COVID-19 on radiotherapy and describe some of the possible solutions for telehealth in target delineation a crucial part of high-quality radiotherapy, which often requires multidisciplinary effort, hands-on corporation, and high-quality multimodal imaging.¹⁸ Furthermore, the authors, as an example, describe their own technical telehealth solution used for multidisciplinary target delineation for radiotherapy during the COVID-19 pandemic.

The last paper in this COVID-19 issue is provided by Dr. Freudenberg et al.¹⁹ The authors reflect and elaborate on the COVID-19 pandemic what have we learned and what to expect in the future. The paper summarizes the major events imposed on nuclear medicine by COVID-19 from a global perspective, focuses on the major lessons learned regarding attitude, medical procedures, organizational implications and strategical considerations, and then discusses what to expect and important how to prepare for the future.

The COVID pandemic continues to evolve with the rollout of vaccines and the emergence of COVID variants. We hope that the reviews included in this important COVID-19 issue will help the specialists in nuclear medicine, radiologists and other health professionals to meet these challenges and adapt practices in order to provide vital services to patients while protecting patients and staff from transmission. We would

like to thank the highly esteemed experts and colleagues who contributed to this COVID-19 issue and for sharing their important knowledge and experience with the readers of *Seminars in Nuclear Medicine*.

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