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Letter from the Editors

Solid organ transplantation (SOT) has changed the survival and quality of life of patients with end-organ dysfunction. SOT offers life-saving treatment for diseases considered terminal or those associated with a significant impairment in a patients' quality of life. New advancements in surgical technique have allowed for more efficient and refined multiorgan treatments with minimal complications and decreased ischemic injury events. Additionally, immunosuppression therapy has improved and is used to dampen the host immune response and improve short and long-term graft survival. For many years' nuclear medicine techniques have played an important role for evaluation both before and after SOT. In the recent year's developments and advancement have been seen in nuclear medicine, therefore this issue of *Seminars in Nuclear Medicine* is dedicated nuclear medicine for evaluations of transplants.

The SOT recipients represent an extremely vulnerable patient cohort: in frequent contact with healthcare personnel, chronically immunosuppressed, and having other concomitant medical conditions. It is well known that SOT recipients have an increased risk of developing infections. COVID-19 pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) exploded onto the world stage in early 2020, and the impact on SOT has affected potential donors, candidates, and recipients.[1,2] Clinical manifestations of COVID-19 have typically been associated with respiratory complaints, though gastrointestinal, neurologic, cardiac, and hematologic presentations have also been observed. Significant overlap in presentation with other respiratory tract infections, such as the influenza virus, makes diagnosis on the basis of clinical grounds challenging. It is important for radiologists, specialists in nuclear medicine and other health care professionals to know the clinical manifestations of COVID-19 on imaging modalities. In the first review Drs. Fields, Gholamrezanezhad and colleagues summarize the characteristic imaging findings associated with COVID-19 pneumonia, with special focus on chest CT, MRI, and FDG PET/CT.[3] These manifestations may also be seen in patients after SOT since this group of patients have an increased risk of severe infections. Infectious complications after SOT are often more severe and remain a diagnostic challenge due to vague and atypical clinical presentations due to long-term immunosuppression. The relative absence of symptoms and signs of inflammation caused by the ongoing immunosuppression together with underlying chronic illnesses such as diabetes or cardiovascular diseases all add to the complexity. Furthermore, noninfectious conditions may cause fever or resemble infection, including cancer, graft rejection, or drug interactions. Diagnostic performance of conventional diagnostic modalities is frequently inadequate which may lead to delayed diagnosis with the risk of poorer outcomes. FDG PET/CT is often used for detection of infectious diseases.[4-7] Drs. Wareham and colleagues excellent review the literature for current evidence on the use of FDG PET/CT in infectious complications after SOT.[8] The authors conclude that overall, in the absence of initial diagnostic clues, FDG PET/CT should be considered as the imaging technique of choice as it may guide further investigations and eventually reveal the diagnosis in most of the patients.

Heart transplantation (HTx) remains the optimal treatment for selected patients with endstage advanced heart failure. However, survival is limited early by acute rejection and long term by cardiac allograft vasculopathy (CAV). Despite improvement of the immunosuppressive therapy, acute rejection is still a significant problem causing early mortality after HTx. Some patients with CAV present with diffuse epicardial lesions, other with microvascular dysfunction and other with both micro and macrovascular dysfunction. During the early period after HTx, routine endomyocardial biopsies are used as surveillance for rejection. It is an invasive and costly procedure with potential risk of complications. For decades' nuclear medicine techniques like SPECT and PET have played an important role for imaging of myocardial perfusion.[9-12] In HTx patients' standard follow up of CAV development includes coronary angiograms and noninvasive imaging modalities including PET. Drs. Clemmesen, Jensen and Eiskjær provide a very good review on the different invasive and noninvasive imaging modalities to detect and monitor CAV and rejection after HTx.[13]

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The next review focuses more detailed on PET for evaluation of CAV. Recent imaging and transplantation guidelines recommend cardiac PET for CAV evaluation. Current evidence demonstrates high diagnostic HTx accuracy of PET myocardial blood flow and myocardial flow reserve quantification for CAV as well as utility for post-transplant patient risk stratification. Drs. Chih, Beanlands and colleagues review contemporary studies examining the use of PET for diagnostic assessment of CAV and prognostication after HTx.[14] Current evidence demonstrates high diagnostic accuracy of PET myocardial blood flow and myocardial flow reserve quantification for CAV as well as utility for post-transplant patient risk stratification. However, further prospective studies are important to establish universal parameters for PET to enable successful clinical application, wide implementation, and the adoption of PET as standard of care for noninvasive assessment in HT patients.

Because of the constant shortage of donor hearts, mechanical circulatory support, mainly left ventricular assist device (LVAD) is increasingly being used in advanced heart failure patients. Unfortunately, the incidence of LVAD-related infections increases with time, and LVAD infection is associated with high rate of hospitalization, and significantly increases all-cause mortality, especially when complicated by blood infection. Therefore, early and accurate diagnosis of LVAD infection is important for the management of the patients, and for survival. Drs. Chen and Dilsizian provide a good overview of the current role of FDG PET/CT for the diagnosis and image guided therapy of LVAD.[15] FDG PET/CT has been demonstrated to have high sensitivity and specificity for LVAD infection and can predict clinical outcome based on the location of LVAD infection. FDG PET/CT provides information on the extent and severity of LVAD infection, as well as infectious embolism and potential extra cardiac source of infection.

Renal transplantation has been widely used for several decades as a treatment for the patients with chronic renal insufficiency. After successful kidney transplantation, the transplant patients are followed closely in order to diagnose allograft dysfunction. The estimated glomerular filtration rate may decrease, and serum creatinine levels may increase. Change in urine output may be a possible presentation in these patients. Both acute, subacute and chronic rejections can be seen, and several renal and extra renal causes may be identified. Pelvic ultrasonography and color Doppler ultrasonography are used as a first-line imaging method. Assessment of allograft functions both qualitatively and quantitatively are possible using nuclear medicine methods. Renal scintigraphy is widely used for evaluation of native kidney function and renal transplant function.[16-18] Drs. Volkan-Salanci and Erbas give an excellent update on imaging of renal transplants, including several illustrative cases.[19]

Hematopoietic stem cell transplantation (HSCT) has been used for decades and consists of two major types: autologous and allogeneic HSCT. The underlying principles of both are myeloablation of the patient's own bone marrow cells followed by reinfusion of stem cells to repopulate the bone marrow. In autologous HSCT, the patient is reinfused with his/her own previously collected stem cells, while in allogenic HSCT, the reinfused stem cells are collected from a healthy donor. The appropriate selection of patients to undergo HSCT is critical due to the risk of treatment-related morbidity and mortality. In the next paper Dr Jacene discusses the most common indications for autologous stem cell transplant in which FDG-PET/CT has been evaluated, including for lymphoma and multiple myeloma.[20]

Post-transplant lymphoproliferative disorders (PTLD) are a spectrum of heterogeneous lymphoproliferative conditions that are serious and possible fatal complications after solid organ or allogenic hematopoietic stem cell transplantation. The incidence of PTLD in transplant recipients is ranging from 1% to 20% in SOT. PTLD are related to immunosuppression and Epstein-Barr virus and can lead to significant morbidity and mortality following transplantation. FDG PET/CT has played an increasingly important role in hematologic diseases and have shown high sensitivity and specificity in detection, staging, and assessing treatment response over the last decades.[21-23] In the last paper by Drs Song, Guja and Iaguru, the current role of FDG PET/CT in PTLD is reviewed.[24]

This issue of *Seminars in Nuclear Medicine* contains a selection of papers with focus on nuclear medicine techniques for evaluation of SOT recipients. We find it important for specialists in nuclear medicine, radiologists, clinicians and researchers to be updated on evaluation of SOT recipients, since SOT is increasingly performed worldwide in patients with end-organ dysfunction. The reviews are provided by colleagues and esteemed experts in the field, and we would like to thank all the contributors of this issue for sharing their important knowledge with the readers of *Seminars in Nuclear Medicine*.

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