Total-body PET/CT – first clinical experiences and future perspectives

[1]Quinn Kwan-Tai Ng, [1,3]Elizabeth Katherine Anna Triumbari, [2]Negar Omidvari, [1,2]Simon R. Cherry, [1,2]Ramsey D. Badawi, [1]Lorenzo Nardo

[1]Department of Radiology, UC Davis, [2]Department of Biomedical Engineering, UC Davis, [3]Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome, Italy

Total-body PET and long axial field of view (> 77 cm) scanners have been in development since the 90's and now available commercially world-wide. The first total-body PET/CT in the US, uEXPLORER, was installed at UC Davis in 2019 as part of the EXPLORER Consortium. We describe potentials of this scanner, impact on diagnosis and quantification, early clinical challenges, and future perspectives.

The uEXPLORER total-body PET/CT is composed of 8 PET units along the axial direction, forming a total axial length of 194.0 cm and provides signal collection efficiency gain (15–68-fold compared to conventional length PET) and high spatial resolution. This allows for higher sensitivity and improved lesion detection, enhancing clinical applications not readily available on current conventional scanners including: (a) reduction in acquisition times (as low as few minutes) with preservation of diagnostic quality images, beneficial for pediatric/anesthesia patients, motion mitigation, radiotracers with transient uptake; (b) reduction in administered activity with minimal impact on image noise, improving safety and logistical concerns; (c) delayed scanning, increasing detection of small and previously occult lesions by improved clearance of significant background activity and coexisting inflammatory processes; (d) improvement in image quality, allowing for better appreciation of small structures with downstream prognostic consequences; (e) simultaneous total-body dynamic imaging, allowing the measurement of full spatiotemporal distribution of radiotracers, kinetic modeling, and creation of multiparametric images, providing simultaneous whole body physiologic and biologically relevant data.

However, higher sensitivity of total-body scanners bring along new limitations and challenges as this potentially increases false positive findings and delayed scanning can cause logistical workflow issues. Data storage capacity, longer processing/reconstruction time issues are other limitations, but may be overcome by future advancements in reconstruction algorithms and computing hardware. With better understanding of the potential of total-body PET, smooth implementation and optimization of this technology can be achieved.

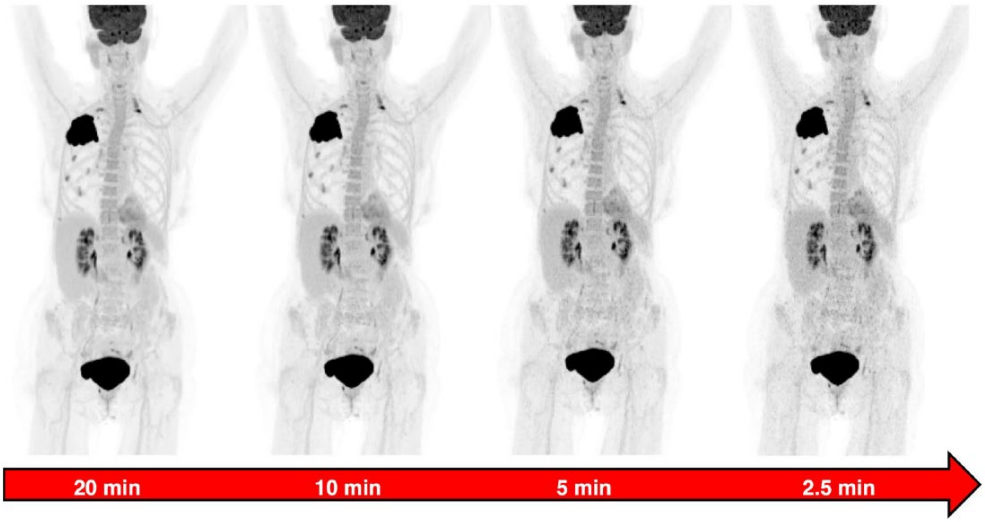

Figure 1: Example of enhanced total-body PET/CT applications. Diagnostic quality images at reduced acquisition times in a patient with right upper lobe lung cancer. Image noise increases at shorter acquisition time; however, the quality of this scan at 2.5 minutes is still within the diagnostic range.