Total body PET: leveraging new technology and UK infrastructure to help improve patient outcomes

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PET is a compelling technology in the fight against some of the most common causes of death. PET scanners sensitively measure biological and biochemical processes in the body by measuring the location of radioactive molecules (radiotracers) following their injection into patients. However, traditional PET technologies can only image part of the body, meaning that multiple scans must be performed as the bed is moved to take a number of images and acquire a full body view. Total body PET covers the whole body with increased sensitivity and spatial resolution while using a single bed position and a reduced number of scans.

The advantages of total body PET

The result of total body PET is a rapid yet holistic view of the entire body. This increased sensitivity means that patients receive a low dose of radiation, enabling previously vulnerable populations to benefit from PETCT technology. Adults requiring longitudinal studies may also undergo repeated scans. The approach offers various opportunities to address currently unsolved clinical issues, opening the door to new perspectives and vast information about disease processes. This is particularly true for complex diseases that impact multiple organs, facilitating early diagnoses and supercharging drug discovery efforts. This ultimately leads to an enhanced capacity for research breakthroughs – and improved outcomes for patients.

The creation of a national total body PET platform accessible to all was established in 2022, with the goal to accelerate key areas of research and strengthen the UK's leadership in the international PET research landscape.

Introducing NPIP

The National PET Imaging Platform (NPIP) is a partnership between Medicines Discovery Catapult, the Medical Research Council (MRC) and Innovate UK that was formed to provide UK researchers with access to total body PET infrastructure. The infrastructure includes the installation of two total body scanners (located in Scotland and London) and access to PET research from various programmes and trials. As total body PET gathers pace in the UK, it is hoped that these will be the first of many scanners made available to researchers. The platform aims to connect research projects and create a community that can deliver progress across key areas of research, driving progress and improving outcomes for patients.

The Royal Free Hospital, London, currently hosts a total body scanner and is also a collaborative partner of the platform. Additional benefits of the platform include the capacity to build on the range of PET training programmes available in the UK, addressing the lack of access to trained PET professionals, which has been a historic barrier to use. The platform also increases the possibility of attracting international research projects of global importance to UK shores. Total body PET capabilities in the UK will also improve the clinical translation of associated technologies and novel radiotracers, further increasing the potential of future PET research.

What are the key clinical applications for NPIP?

Improving diagnoses

The total body PET infrastructure is of great value to the UK Government, NHS, MRC, UK Trade and Investment and patients while also assisting clinical research interests and investment by supporting commercial studies.

Access to total body PET could afford untold opportunities for UK researchers and patients. The most immediate outcome would be the increased diagnostic throughput of cancer patients. The total body approach shows promise for patients with cancer due to its capacity to image distant metastases in a single scan; this is particularly important for staging cancer patients to ensure they receive the right treatment.[1]

The increased sensitivity of total body PET can translate into clinical advantages such as the receipt of lower radiation doses by patients and reduced scan times. The lower radiation dose associated with total body PET will enable the delivery of PET imaging to a wider set of patients and allow multiple scans to be given.[2] Given production issues inherent with some radiotracers such as ^{68}Ga-DOTATATE, imaging with less injected activity may enable more patient access, the ability to scan more quickly and use less radioactivity, which will lead to the provision of diagnostic PET scans to a greater number of patients.

Advances in clinical research

Beyond direct clinical applications, the increased sensitivity of total body PET scanners and the ability to image all major organs simultaneously has profound research implications. Potential applications span a wide range of complexity, from static imaging with known radiotracers to whole body dynamic studies of novel agents. Moreover, imaging the entire body will not limit an investigator to select an anatomic area for dynamic coverage. A total body PET scanner will capture all lesions and, combined with kinetic analysis, would mainstream whole body parametric imaging, which in turn will enable a more complete classification of disease burden across an entire patient.

For example, given known associations of tumoural heterogeneity and resistance to targeted therapy, such information could inform treatment. However, what is unique about a total body PET scanner is the inclusion of all organs in a single field of view that enables novel approaches to study the physiologic or pathophysiological interactions between organs, including brain-body interactions.

The superior sensitivity of the total body PET scanner can be applied to image radioisotopes with a low detectable radiation signal. For example, imaging the emission of the Yttrium 90n (90Y) isotope with PET would allow dosimetry estimates after radioembolisation of hepatic tumours with a goal of predicting outcome. Imaging with long-lived isotopes such as Zirconium 89 (89Zr) with a 3.27-day half-life could enable extended cell-tracking studies.

Opportunities in drug development

A total body PET infrastructure in the UK will also support

drug discovery by providing an understanding of how an agent can concentrate in tissues across the entire body over time. Thus, clinicians can assess the interactions and distribution of novel therapeutic agents in all body organs, yielding vital information before launching expensive clinical trials. This ultra-sensitive technology can also stimulate the development of novel imaging radiotracers, with only a low dose of agent necessary to establish the distribution and total radiation exposure in patients.

In addition, total body PET will provide complementary and additional information to the imaging methods currently used to measure drug activity during clinical development. In oncology, the current gold standard is CT. CT is useful for measuring parameters like tumour shrinkage, which tends to happen over many months or years. PET can provide information about whether a drug is working before these physical changes occur. For multi-organ diseases that impact the whole body – such as cancers and neurological, cardiovascular, and inflammatory disorders – total body PET can also be applied to study important facets of the molecular mechanisms of disease, which supports the design of future drugs targeting key pathological processes. The total body approach is also useful for selecting suitable patients to enter clinical trials based on the presence of molecular markers.

Realising our potential

Total body PET represents a huge opportunity for UK research that cannot be underestimated. The national total body PET infrastructure will facilitate previously unseen collaboration, including the democratisation of PET research and an increase in the volumes of data available to researchers. Such advances will drive an integrated understanding of human disease and the development of effective drugs and diagnostics that can reach the market – and patients – more quickly. These changes could also stimulate foreign investment into UK research and facilitate industrial expansion through increased investment in small and medium-sized enterprises. The long-term goal is to establish the UK as a major component of the international PET infrastructure with associated world-leading expertise.

References

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