# The Whole Picture:
## *Total-Body PET and the Future of Biopharma*

**What if a clinical scan could transform biopharmaceutical innovation and patient care, streamlining drug development, clinical trials, and complex disease diagnosis? Total-body Positron Emission Tomography (PET) imaging is turning that vision into reality, offering a full-body, real-time view of human physiology.**

Total-body PET is redefining what is possible in molecular imaging and biopharmaceutical development. This advanced PET technology can deliver full-body scans in minutes, with a sensitivity of up to 40x greater than conventional standard field PET scanners[1] and potential for significantly lower radiation exposure. This opens exciting new avenues for research and discovery. It enables clinicians to study disease in real time across the whole body, revolutionising how we diagnose, stage and treat complex conditions like cancer, cardiovascular disease and neurodegenerative disorders. For patients, this means faster scans and earlier interventions, with the opportunity for more personalised treatments. For research and industry, it unlocks a powerful new platform for evaluating novel therapies, tracking their behaviour and accelerating their path to market.

But realising the full potential of total-body PET requires more than cutting-edge scanners. It demands a robust infrastructure, one that includes a reliable supply of radiotracers and an integrated framework for data sharing and collaboration. In the UK, the National PET Imaging Platform (NPIP) is building exactly that. What it reveals is not just a clearer image of the body, but a blueprint for the future of biopharmaceutical development.

### FROM CONCEPT TO CLINIC – THE EVOLUTION OF TOTAL-BODY PET

PET is a type of imaging technology that helps clinicians and researchers visualise cellular and molecular processes inside the body. Prototype PET scanners emerged in the 1950s, gained traction in nuclear medicine during the 1970s and were later adopted clinically for disease diagnosis, staging and monitoring.

PET scanning involves the injection of radiotracers into the body. Radiotracers are made up of two parts: a radionuclide (a compound or molecule that emits radiation), combined with a molecule or drug that guides the radionuclide to a specific area of the body to be studied or targeted for treatment. As the radionuclide decays, it will emit gamma rays inside the body, which are detected by the PET scanner. Through image processing, the detected gamma rays are used to build a detailed picture of where the radiotracer has accumulated. This picture helps clinicians and researchers to diagnose diseases and make decisions about treatments.

Continued technological advances in hardware and software have led to a new generation of PET scanners with far greater sensitivity and resolution. While conventional PET relies on multiple bed positions and generating multiple images to acquire a whole picture of the body, total-body PET has a field of view wide enough to take an image from head to toe in a single scan, and a detector capable of 40x higher sensitivity.[1] This means the whole body can be imaged faster, at higher resolution and in real-time. It also means lower doses of radiotracer are required to generate the same amount of detail (Table 1).[1,3]

| Feature | Conventional PET | Total-Body PET |
|---|---|---|
| **Large Axial Field of View (LAFOV)** | 15–20cm | >100cm* |
| **Sensitivity** | Moderate | Ultra-high (up to 40x higher for whole-body images) |
| **Average Total-Body scan time**** | 10–30 min | 30 seconds–3 minutes |
| **Average radiation dose for a full-body scan**** | ~370 MBq | ~9.25 MBq |
| **Dynamic imaging potential (continuous capture of data over time)** | Tracers can be followed for ~3 half-lives, limiting dynamic imaging | Tracers can be followed for 5–6 additional half-lives, enabling whole-body, real-time imaging |
| **Patient throughput** | Lower | Potential for twice as many clinical scans per day |

*Scanners in the NPIP network have a LAFOV of between 106–194cm.
**Based on (18F)-FDG scan procedures.

*Table 1. Differences between conventional PET scanners and total-body PET scanners.*[1,4,5,6]

Importantly, total-body PET does not replace conventional PET imaging. Conventional PET remains indispensable in clinical practice, especially when imaging needs are localised to a specific area of the body. But for complex diseases that span multiple organ systems or in cases where lower doses of radiation are required, total-body PET offers a transformative new lens:

- In oncology, total-body PET enables earlier detection of metastases and monitoring of tumours throughout the body, as well as increasing the potential for radiotheranostics (radiopharmaceuticals that can both detect and treat disease).[7,8]
- In cardiology, it helps us to understand how heart disease affects, or is affected by, other organ systems, supporting approaches to systems-based or preventative cardiovascular medicines.[9]
- In neurology, it allows the brain to be imaged at the same time as the rest of the body, which is critical for our understanding of complex neurodegenerative diseases.[10]
- In infectious disease and immunology, it offers a powerful tool for visualising infection and immune responses throughout the body, opening new avenues for treatment.[11]
- Finally, the higher sensitivity of total-body PET reduces the amount of radiotracer required for a high-resolution image, enabling paediatric studies in children and other patient populations where higher levels could be unsafe.[12]

In short, total-body PET is paving the way for a future where a systems-level understanding of human physiology may be possible. This will enable new insights into complex disease mechanisms and therapeutic targets where whole-body context is essential, or where study was previously difficult.

## TRANSFORMING DRUG DISCOVERY

In addition to enabling more comprehensive study of complex disease mechanisms and therapeutic targets, total-body PET imaging is also set to change the way we assess and validate those targets and progress novel therapeutics through clinical trials. It does this by offering a more complete, accurate and efficient way to study their behaviour and role in the human body.

### Total-body PET Provides Whole-body Systems Insight

One of the most powerful capabilities of total-body PET is the potential for whole-body pharmacokinetics (PK) and pharmacodynamics (PD) analysis. Through capturing real-time data on how a radionuclide-tagged drug accumulates and clears across the entire body or by using another radiotracer to measure its effect, researchers can gain a better understanding of its behaviour far earlier and with more confidence than with traditional imaging or blood sampling. This is especially valuable for drugs with systemic effects on the body, like cell therapies, RNA therapies and biologics.

### Total-body PET Delivers Longitudinal Safety Data

The heightened sensitivity of total-body PET also opens the door to the use of a wider range of imaging agents or radionuclides and, therefore, longer-term studies in the human body. Conventional PET typically relies on short-lived radionuclides such as Fluorine-18 ($^{18}F$) and Carbon-11 ($^{11}C$), which have half-lives of approximately 109 minutes and 20 minutes, respectively. These radionuclides decay quickly in the body, which is important for limiting the radiation dose to the patient, but limits their utility for imaging over longer time scales. In contrast, the ultra-high sensitivity of total-body PET allows for the use of longer-lived radionuclides like Zirconium-89 ($^{89}Zr$). $^{89}Zr$ has a half-life of approximately 3.3 days,[13] so when linked to an active molecule, total-body PET can measure its distribution and behaviour across the whole body up to 30 days post-injection.[14]

This is particularly useful for studying therapies like biologics. Biologics are slow circulating, so data captured over days or even weeks in the body can provide critical safety and efficacy insights to support their progression through clinical trials.[14]

### Total-body PET Empowers Translational Medicine Earlier

When it comes to the study of complex biological therapies in early trials, total-body PET is strategically placed. Its ultra-high sensitivity offers a powerful alternative to tissue models and provides the basis for earlier first-in-human studies.[15] Due to the lower dose of radiotracer required for visualisation, researchers can conduct microdosing studies in humans using concentrations small enough to minimise the risk of adverse events. It also enables the study of much earlier-stage drug effects or low-dose responses that conventional methods are not sensitive enough to detect. This offers a transformative new pathway for the study of novel biopharmaceuticals, helping us to identify promising candidates sooner and rule out those that are ineffective earlier in clinical trials with greater precision, using real human data.

### Total-body PET Improves the Efficiency of Clinical Trial Recruitment

Further down the drug development pipeline, total-body PET may also enable more targeted clinical trial recruitment. Increasingly, biomarkers (biological markers of disease) are used during clinical trial recruitment to stratify subjects, i.e. divide patients into groups based on their biological profile, and therefore their predicted response to the treatment is being studied. Total-body PET allows even more precise biomarker screening during patient recruitment, meaning that patients who are likely to demonstrate therapeutic efficacy can be selected more efficiently, increasing the likelihood of regulatory success.

### Total-body PET Enables Better Trial Design

Total-body PET imaging supports more effective and adaptive clinical trial design by enabling real-time, whole-body assessment of drug distribution and response. This allows researchers to make more informed adjustments to factors like dosing during the trial, potentially improving outcomes and reducing adverse effects.

Moreover, the data provided by total-body PET has the potential to enhance the development of healthcare 'digital twins'. Digital twins are 'virtual patients' resembling actual patients, created by combining available genetic and clinical data. This new concept in healthcare allows clinicians and researchers to simulate disease progression and predict treatment outcomes based on mathematical models of patients with the same phenotype.[16]

While still an emerging concept, digital twins represent a dramatic leap forward in biopharmaceutical development. Digital twins could offer predictive modelling capabilities that would enable researchers to optimise the design of clinical trials. They would allow for the simulation of a wide range of patient scenarios, dosing strategies and treatment schedules, far beyond what would be feasible to study in human participants. Ultimately, the result is more precise dosing and scheduling data, improving the clinical benefit of the drug when it reaches the market.

By combining total-body PET data with multi-omics and other clinical datasets, researchers will be able to build more robust and reliable digital twin models that will strengthen the foundations of the concept and support its transition from experimental research to mainstream practice.

## BARRIERS TO ADOPTION

However, as with many technologies, the widespread integration of total-body PET into today's drug development pipelines will face several hurdles. It requires investment in infrastructure, both in the systems and facilities where they will be installed.[6] Central to this is the need for an infrastructure capable of managing the huge data volumes generated by whole-body dynamic imaging, spanning storage, processing and analysis.[17] Integration into existing clinical workflows presents additional challenges, as protocols must be adapted and staff trained, not only in operating the new systems, but also in interpreting complex multi-organ data and conducting new studies using emerging radionuclides.

Radionuclide supply presents another critical barrier in some countries. At present, in the UK, the production of many of the radionuclides that are valuable for total-body PET, such as Zirconium-89 and Copper-64, is limited. This challenge is compounded by a lack of sovereign manufacturing capacity, leading to overreliance on unreliable production and importation of radionuclides made outside the UK in ageing nuclear reactors. To combat this, there is an ongoing need and support research and innovation funding, policy change and new routes to production.

Even with the technology integrated, unlocking its full potential will require transforming how we use and share its data.

## NPIP: A NATIONAL PLATFORM FOR COLLABORATION AND DISCOVERY

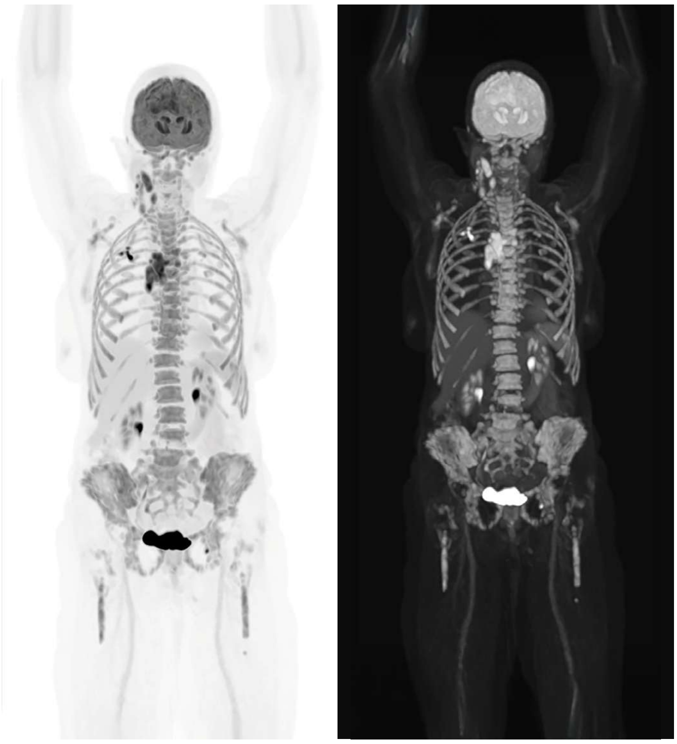
At the heart of this transformation in the UK is the National PET Imaging Platform (NPIP), a £32 million government-funded initiative delivered by Medicines Discovery Catapult, the Medical Research Council and Innovate UK, that is deploying advanced total-body PET scanners across the country.[18] Launched in 2023 through investment from the UK Research and Innovation's Infrastructure Fund,[19] NPIP is delivering more than just a technological upgrade. Crucially, the platform is providing standardised protocols and a national infrastructure for collaboration and data sharing that aims to foster innovation across trials and institutions. The platform is designed to accelerate drug discovery and redefine the future of what is possible in healthcare, providing unprecedented access to high-resolution, whole-body molecular imaging data.

**Total-body PET in Crohn's disease**
A new research project is utilising the UK's NPIP total-body scanner network to study intestinal fibrosis in Crohn's disease for the first time, one of its most debilitating complications. The study aims to explore whole-body disease dynamics in Crohn's and advance therapeutic development.[20]

All total-body PET systems in NPIP's network have been harmonised with respect to camera functionality and adhere to protocols that guide best practice in image capture and data interpretation. This standardisation helps to ensure consistency in imaging data, supporting and building regulatory confidence in clinical trials, especially those that span multiple centres.

NPIP also aims to ensure that, where possible, clinical data is centralised and harmonised, empowering researchers to tackle complex biomedical challenges together. The NPIP network is developing a fully functional and accessible database, led by the UK's Medical Research Council, for the scientific community to leverage.

The availability of large imaging datasets like this is critical to driving forward innovation in systems biology, biopharmaceutical development and patient care using total-body PET scanners. Through machine learning and artificial intelligence, we will be able to use stored data to develop novel algorithms that will be able to predict and diagnose disease earlier, as well as optimise clinical trials and suggest personalised treatment plans.[21] This could lead to a world where



*Clinical images provided by Siemens Healthineers AG ©2025*

clinicians will be able to 'see and treat' patients for increasingly complex diseases in the same visit.

However, arguably the most critical factor in scaling the impact of total-body PET will be the continued collaboration across platforms like NPIP and the accessibility of imaging data from research and clinical sites around the world. Diverse datasets are essential for training artificial intelligence models to provide unbiased outputs in healthcare, which in turn enables more accurate diagnostics and personalised treatments across populations.[22] With broader reach, more inclusive data and continued access to that data, the outputs of this technology will only become more precise and equitable.

## CONCLUSION

Total-body PET is more than a sensitive imaging tool; it is a strategic asset with the potential to reshape the future of biopharmaceutical development. Enabling earlier, safer and more precise evaluation of therapies, it sets the stage for a future where drug discovery is more efficient, more inclusive and deeply data-driven. This means more confidence in emerging therapeutics from regulatory bodies and more effective therapies for patients reaching the market faster.

But the true transformation lies in how we deploy this technology, not in isolation but as part of a connected and collaborative ecosystem. The UK's National PET Imaging Platform offers a blueprint, providing a benchmark for the integration of total-body PET technology into existing healthcare systems and opportunities to expand its potential impact through global data sharing and continued innovation.

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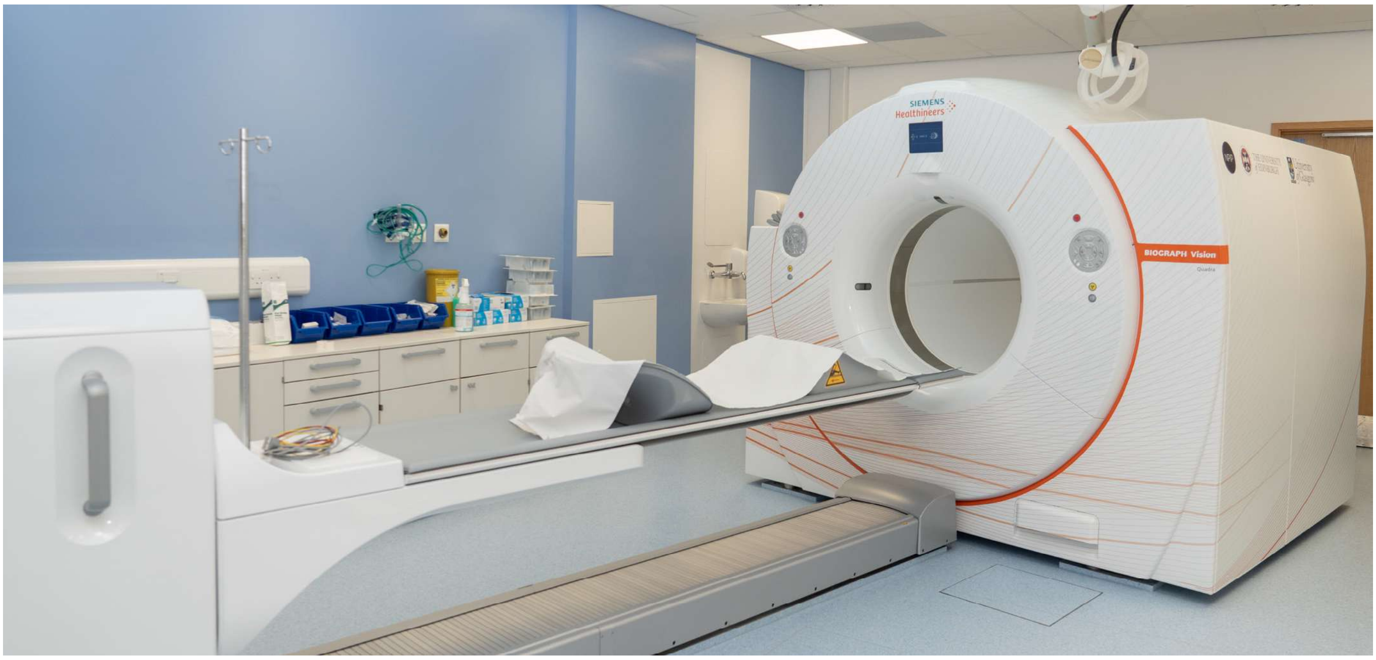


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