UNITED IMAGING

RSNA 2022 Edition

Issue Highlights

Disclaimer

The articles contained in this magazine are provided solely by the authors, and the author(s) of each article appearing in this magazine is/are solely responsible for the content thereof as well as personal data, which is used anonymously or complied with applicable data privacy laws or regulations. United Imaging Healthcare makes no representation or warranties, expressly or impliedly, with respect to the accuracy, timeliness, reliability, legitimacy, applicability, fitness, originality, or completeness of the contents of this magazine. United Imaging Healthcare assumes no legal responsibility or liability for any error, omission, or illegality with respect to the material contained within.

All articles contained in this magazine only represent the opinions and views of the authors and do not implicitly or explicitly represent any official positions or policies, or medical opinions of United Imaging Healthcare or the institutions with which the authors are affiliated unless this is clearly specified. Discussions of any brand, services, or products in the magazine should not be construed as promotion or endorsement thereof.

Articles published in this magazine are intended to inspire further general scientific research, investigation, understanding, and discussion only and are NOT intended to and should not be relied upon as recommending or promoting a specific medical advice, method, diagnosis, or treatment by physicians for any particular individual, nor to replace the advice of a medical doctor or other healthcare professional. Any individual wishing to apply the information in this magazine for the purposes of improving their own health should not do so without consulting with a qualified medical practitioner. All patients need to be treated in an individual manner by their personal medical advisors. The decision to utilize any information in this magazine is ultimately at the sole discretion of the reader, who assumes full responsibility for any and all consequences arising from such a decision. United Imaging Healthcare makes no representations or warranties with respect to any treatment, action, or application of medication or preparation by any person following the information offered or provided within or through the magazine. United Imaging Healthcare shall remain free of any fault, liability, or responsibility for any loss or harm, whether real or perceived, resulting from the use of information in this magazine.

The articles included in this magazine may contain work in progress, which represents ongoing research and development. Such technologies are not available for sale in China or the United States for clinical use and also may not available for such sales in other countries around the world.

Please note that the magazine is intended to be distributed only within a limited scope instead of publication.

If you have any questions about the magazine, or simply wish to reach out to us for any other reasons, you are welcomed to contact us at the following email address: compliance@united-imaging.com

Mercy Radiology: our molecular imaging goals and journey

Remy Lim[a,*], BHB, MBChB
[a]Department of Radiology, Mercy Radiology, New Zealand

1. Background

Aotearoa New Zealand, an island nation in the middle of the Pacific Ocean, is split into two main land masses, with a collective land area equivalent to that of the state of Colorado. New Zealand's land mass, however, stretches in a north-south orientation, equivalent to the distance from Pennsylvania to Florida. The country is also sparsely populated relative to its land area, with a population of only 5 million and only 50% of the population residing in one of six major urban centres[1,2].

In total, there are only six PET/CT scanners in New Zealand, of which five are located in three major urban centres on the North Island, and one is a solitary PET/CT scanner on the South Island. The largest city in New Zealand, Auckland, in the upper North Island (population of 1.5 million), has three of the six PET/CT scanners[3].

At Mercy Radiology, a private radiology group with a long history of excellence in molecular imaging, we operate two of the three PET/CT scanners in Auckland. We are also proud to have the only New Zealand's PET/CT facilities with digital PET scanners: United Imaging's uMI® 550 and uMI® 780.

To understand our molecular imaging journey, it is useful to start with the New Zealand health landscape. Healthcare is delivered to New Zealanders in a two-tier system: the public health sector, which is funded by taxpayers providing universal health coverage, and the private sector.

Public health sector services include acute and elective inpatient care, outpatient, mental health and long-term care. Imaging needs are provided by in-hospital radiology departments and outpatient centres.

Total New Zealand government health spending as percentage of GDP is just under 10% in 2019 and is expected to have been increased in the last 2 years[4].

The private sector on the other hand, is made up of smaller outpatient specialists' offices, smaller private hospitals and private radiology providers. Private sector work is funded by private insurance companies, self-funding patients or the New Zealand government by way of outsourced public hospital work. Treatments and associated imaging related to accidents, usually conducted in the private sector, are covered by a no-fault Accident Compensation Scheme (ACC).

All six PET/CT scanners in Aotearoa New Zealand are currently operated by private radiology groups. The New Zealand Ministry of Health determined several years ago that rather than providing for a PET/CT facility in one of the many public hospitals in the country, patients treated in the public sector would be outsourced to private PET providers for their PET/CT scans. Currently, provided that patient's disease status meets one of the numerous approved national criteria for a funded PET/CT scan, patients would be able to access a fully funded PET/CT scanner.

Despite a clear pathway allowing patients to access a PET/CT scan, with 760 scans per million of population, OECD Health Statistics (2) suggests an overall underutilisation of PET/CT scanners in Aotearoa New Zealand. Although the numbers are likely to be at least twice that once privately funded patients are taken into account, it remains much lower than Aotearoa New Zealand's neighbour, Australia, which performs 4,500 scans annually per million of population.

*Mercy Radiology New Zealand has a research agreement with United Imaging Healthcare. Dr. Remy Lim is a principal investigator on a research grant funded by United Imaging Healthcare.
[1]https://en.wikipedia.org/wiki/List_of_New_Zealand_urban_areas_by_population
[2]https://en.wikipedia.org/wiki/New_Zealand
[3]https://www.stuff.co.nz/national/health/300667942/new-mobile-cancer-scan-unit-hitting-the-road-to-help-ease-barriers-waittimes
[4]https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS?locations=NZ
[5]https://humanhealth.iaea.org/HHW/DBStatistics/IMAGINE.html

Based on the IMAGINE database developed by the International Atomic Energy Agency (IAEA), the number of PET scanners in a high-income country such as New Zealand is expected to be 3.6 per million of population[5]. Based on this, New Zealand would be expected to have around 14 PET/CT scanners.

At Mercy Radiology we recognised that this underutilisation of PET/CT scanners is driven by two major constraints. First, being a sparsely populated country, there are geographical barriers to accessing a PET/CT facility. Rural New Zealanders are often expected to travel significant distances between their homes and the closest PET/CT facility. For instance, a patient who lives in the town of Gisborne, on the east coast of North Island will need travel 380km to access a PET/CT facility in Hamilton, a five-hour journey on the road. As a result of this geographical barrier, New Zealanders who live in the regions or remote areas are more likely to encounter obstacles to early detection of and treatment for their cancer.

Secondly, the collective capacity of the current fleet of PET/CT scanners scattered throughout the country is woefully inadequate to service the demand for PET/CT scans. An appointment for a PET/CT scan can be up to 10 to 15 business days wait time.

2. Mercy Radiology goals and journey

In 2019, Mercy Radiology set two goals to address the chronic underutilisation and inequality in access to PET/CT scans in New Zealand.

Our first goal is capacity expansion. Having operated a solitary PET/CT scanner for the last 12 years, it was apparent that we had reached the limit of what we were able to achieve with our preexisting centre.

Our second goal is to improve accessibility. This applies for not only our patients who live in the greater Auckland region but also patients who live in the rural areas of New Zealand.

So why have we set these lofty goals for ourselves?

Simply put, we believe New Zealanders deserve the best oncological imaging available when they are diagnosed with cancer so that they can be optimally managed to achieve the best possible health outcomes.

An additional PET/CT scanner at a sister site remote to our preexisting facility is a logical solution to expand our capacity and to derisk our reliance on a solitary PET/CT scanner. A pre-requisite for the additional PET/CT scanner is that it must deliver improved image quality in less time than our current 10-year-old scanner.

From the outset, our evaluation team was convinced that a digital PET camera with increased sensitivity and superior signal-to-noise ratio compared to an analog scanner would be capable of fulfilling these criteria and future proof the installed base.

A second facility would shorten the period patients would have to wait for their examination from 10 working days to three to five days. A digital PET camera coupled with a longer axial field of view would translate to fewer bed positions and therefore a shortened PET acquisition time. This would improve patient comfort and experience and increase overall patient throughput.

A potential turnaround time of less than 24 hours would be facilitated by Mercy Radiology's team of trained PET/CT readers. Ultimately, this would allow our clinicians and oncologists to have a complete picture of patients' disease status and manage accordingly.

Just as importantly, we wanted to work with a vendor who would be receptive to our specific needs. Local engineering support and excellent applications support fulfilled all the critical elements needed to achieve our objectives.

There are many vendors with digital PET/CT offerings and excellent service. How did we end up with two of United Imaging's uMI PET/CT scanners?

First, there was good alignment of our objectives with United Imaging's mission of providing greater access to PET/CT. United Imaging's digital PET solution included other positive physical attributes, such as superior axial field of view and air-cooled systems.

Secondly, United Imaging's unique Software Upgrades for Life™ program speaks to their desire to ensure new innovations are available to all of their installed base. The program ensures all new systems have the same software and core technology. New upgrades are cascaded to their existing installed base.

Third, United Imaging's All In Configurations™ program means transparent costing without the need to navigate

[5]https://humanhealth.iaea.org/HHW/DBStatistics/IMAGINE.html

through multiple options which would typically increase the price of the scanner substantially beyond the starting base price.

Ultimately, it was the digital PET camera's superior image quality, further enhanced and optimised by United Imaging's advanced PET AI algorithm in the form of uAI HYPER DLR and uAI HYPER DPR, which cemented our decision to proceed with United Imaging's digital PET/CT scanners.

In the midst of the pandemic in 2020, we commissioned our sister PET/CT site 25 minutes north of our current facility. This new PET/CT site caters to the 600,000 Aucklanders who reside north of the Auckland Harbour Bridge and over 200,000 other patients in the northern province of Northland.

Converting a preexisting building which previously housed medical consultation rooms and an operating theatre into a PET/CT facility with multiple uptake rooms and a hot lab with New Zealand's strict quarantine rules in 2020 was no easy feat. Coupled with all the logistical difficulties of COVID restrictions and border closure in NZ, this was a project destined to be hampered by delays and logistical challenges.

United Imaging demonstrated their commitment to the project by ensuring the PET/CT system arrived into the country on schedule. Overseas-based installation engineers and applications support personnel underwent mandatory 2-week quarantine to be available at critical times during the commissioning phase. Happily, the facility was successfully delivered on time and on budget, with the first patient scanned in the latter half of 2020.

In 2021, we turned our attention to our flagship site, where we had been operating an analog PET/CT scanner for the last 12 years. We had outgrown the facility due to increased patient numbers and the introduction of a theranostics service line in 2018. We took the opportunity to create a dedicated therapy suite that doubles as an additional uptake room, having anticipated a decreased scan time necessitating more uptake rooms.

As our flagship site, it was critical for us to have a high performing, reliable system to cater for greater patient throughput. Our evaluation team, which included our lead technologist, undertook due diligence and applied rigour in an open tender process before eventually settling on the uMI 780.

In the next 12 months, Mercy Radiology will work to further increase patient accessibility to PET/CT scans for our regional patients, by embarking on a project to deliver Australasia's first mobile PET/CT.

The custom designed trailer, incorporating a mobile uMI 550 unit on board once commissioned, will travel every day to service the regions in the North Island of New Zealand, obviating the need for regional patients to travel for up to six hours simply to have a PET/CT scan.

3. Mercy Radiology's experience with United Imaging

What has been our experience operating the uMI 550 and the uMI 780 so far?

First, we can attest to the field reliability of the scanners. Outside of scheduled down time for preventative maintenance, we have had a 100% uptime thus far with both scanners.

The United Imaging development team has been receptive to suggestions for workflow improvement. Our fruitful relationship with them has now evolved into a collaboration to develop advanced AI algorithm to enhance and optimise Prostate Specific Membrane Antigen (PSMA) PET images.

Secondly, in terms of image quality, our team has seen first-hand the major step up from analog to digital cameras and the progressive image improvement with successive iteration of United Imaging's AI algorithm. This is particularly striking when the same patient returns for their follow-up studies (see Figure 1-3) on the different platforms.

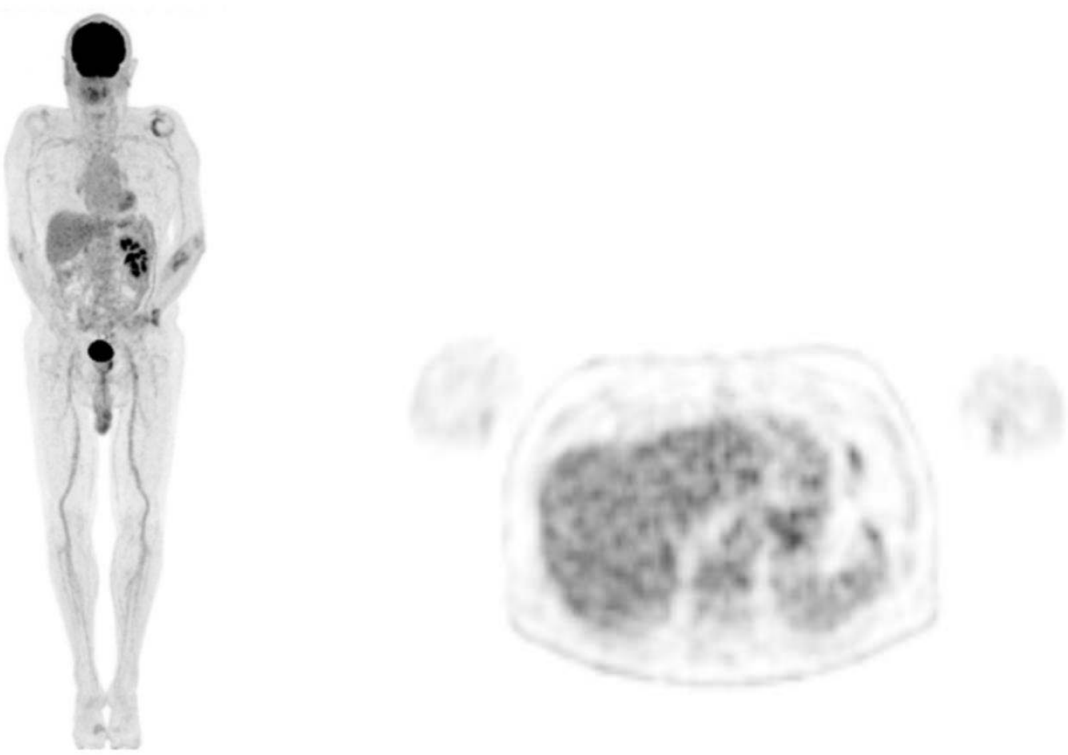


Figure 1. Whole body maximum intensity projection and axial image of a patient with metastatic renal cell carcinoma scanned on the now decommissioned analog PET/CT (injection dose: 242 MBq of ^{18}F-FDG, 60 min uptake time, scan time: 2 min/bed position).

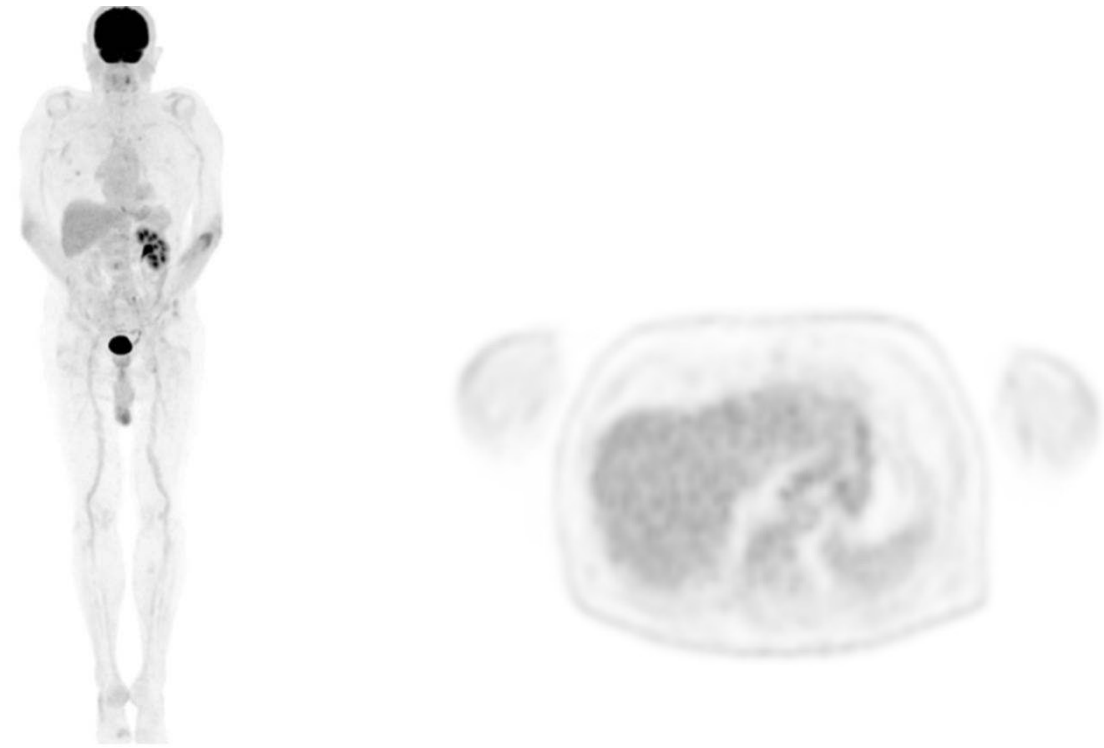


Figure 2. MIP and axial image of the same patient scanned on uMI 550 with HYPER DLR AI PET algorithm (injection dose: 239 MBq of ^{18}F-FDG, 60 min uptake time, scan time: 2 min/bed position).

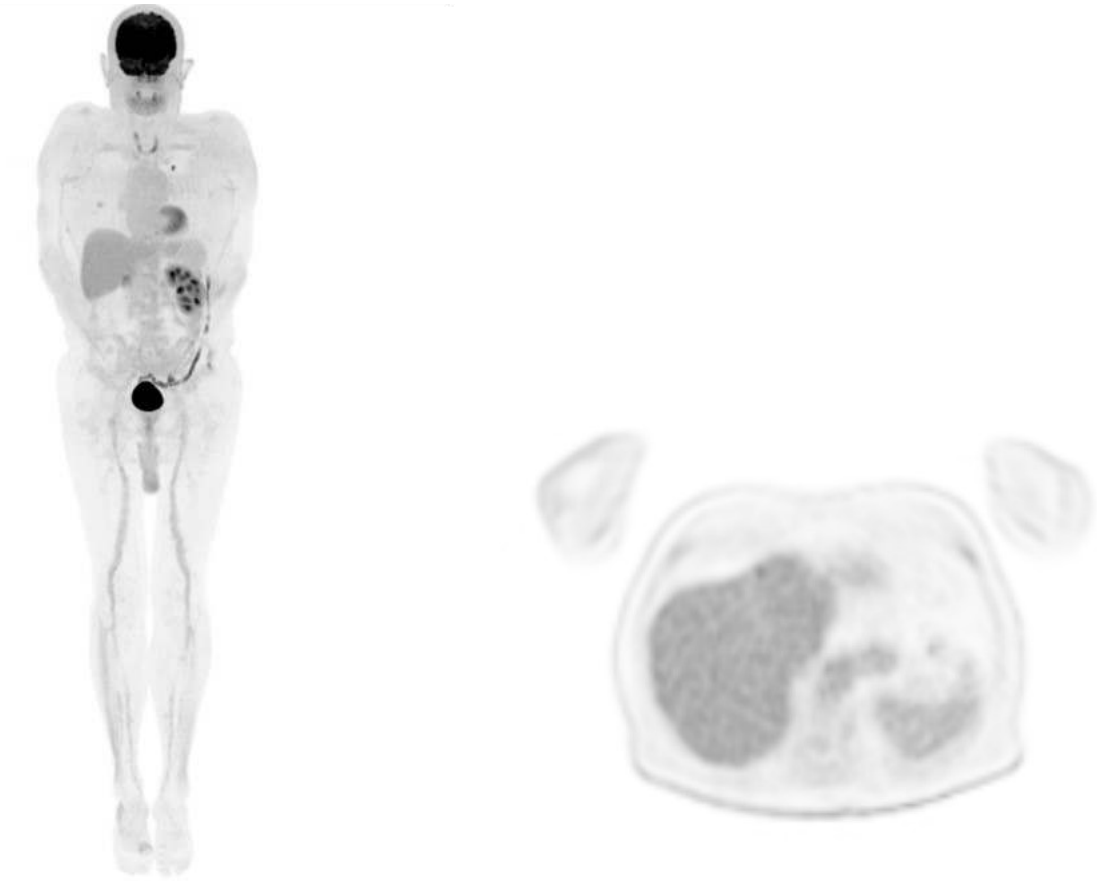


Figure 3. MIP and axial image of patient with metastatic renal cell carcinoma scanned on uMI 780 with latest generation HYPER DPR, AI PET algorithm (injection dose: 244 MBq of ^{18}F-FDG, 60 min uptake time, scan time: 2 min/bed position).

uAI HYPER DLR's algorithm is based on deep learning through artificial neural networks. The algorithm improves signal to noise ratio by up to 50%, allowing shorter acquisition time if required. It is also effective in reducing image noise in patients with high BMI.

uAI HYPER DPR builds on this, further enhancing the signal to noise ratio, accentuating lesion contrast and thus improving small lesion detectability. Compared with other possible AI algorithms, its unique advantage is that its networks were created using United Imaging's uEXPLORER® data. HYPER DPR claims a 32% improvement on noise reduction, 66% improvement on image contrast and overall 2.5 times improvement on SNR.

As a result, HYPER DLR and HYPER DPR have delivered images of consistently high signal-to-noise ratio. PET images with low levels of background noise and improved lesion conspicuity are now the expectation, even in patients with high BMI. In line with United Imaging's Software Upgrades for Life program, the uAI HYPER DPR algorithm has been cascaded into our two-year-old uMI 550.

Third, Mercy Radiology's in-house applications "superuser", trained in United Imaging's USA headquarters in Houston, Texas, now also serves as our applications support and provides support to other Australasian users. Our technologists have found United Imaging's platform to be user friendly and intuitive to operate. Combined with 30 cm axial field of view, the uMI 780 provides for an efficient workflow and has significantly increased our overall patient throughput.

Finally, we have expanded our capacity! PET acquisitions that previously required 25 minutes are now completed in 15 minutes or less on the new uMI 780, freeing up more appointment times and facilitating greater patient throughput.

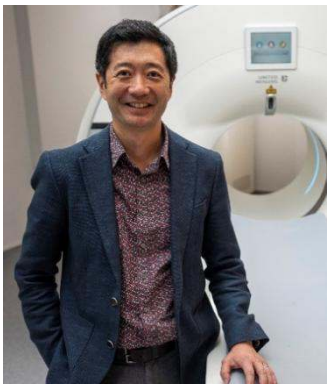
With the uMI 550 and uMI 780, and a mobile uMI 550 in the pipeline, Mercy Radiology, in partnership with United

Imaging, is well on the way to achieving our twin goals of increasing capacity and improving PET/CT accessibility to the people of Aotearoa New Zealand.

4. Image/Figure Courtesy

All images are the courtesy of Mercy Radiology, Auckland, New Zealand.

Author Biography



Dr. Remy Lim, BHB, MBChB (Auckland), FRANZCR, CMInstD
Medical Director, Mercy Radiology
Newmarket, Auckland, New Zealand

Remy Lim is a graduate of Auckland University School of Medicine and completed his Radiology training in Auckland and Hamilton. Following a two-year fellowship at Memorial Sloan Kettering Cancer Center in New York, Remy returned to NZ in 2011 to join Mercy Radiology and the public hospital. His subspecialty interest is in Oncology scans and Genitourinary scans, including the reporting of prostate MRI and PET/CT scans.

Remy introduced PSMA PET/CT scan to New Zealand in 2015, which fundamentally changed the way prostate cancer was imaged and treated in the country. In 2018, Remy administered the first dose of Lutetium PSMA in New Zealand in a pilot study. He has since treated over 200 men with advanced prostate cancer. Remy has been the Medical Director at Mercy Radiology for the last six years and is currently working on a couple of exciting projects that will hopefully change the way PET/CT imaging is delivered to the regional centres in North Island. He also has a part- time appointment at Auckland City Hospital where he is part of the Auckland region genitourinary multi-disciplinary team.

PASSION for CHANGE

If you have any questions about the magazine, or simply wish to reach out to us for any other reasons, you are welcomed to contact us at the following email address: uinnovation-global@united-imaging.com