



Clinical Practice of ^{177}Lu – PSMA therapy, imaging and dosimetry

Kuopio University Hospital
Diagnostic Imaging Centre
Department of Clinical Physiology and Nuclear Medicine



SPECTRUM
DYNAMICS MEDICAL

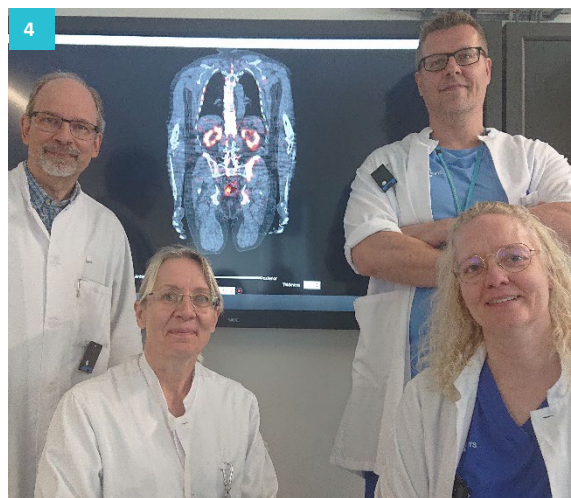
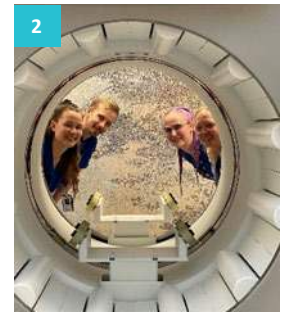
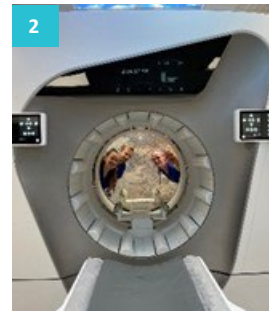
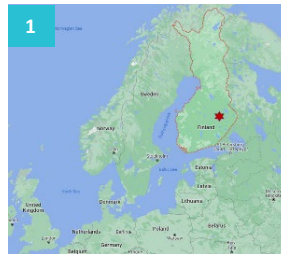


Kuopio University Hospital:

Kuopio University Hospital (KUH) is one of five university hospitals in Finland, and part of the Wellbeing Services County of North Savo. KUH is responsible for the specialized medical care of approximately one million Finns in Eastern and Central Finland. Internationally respected research is carried out at KUH, and it is one of the largest teaching hospitals in Finland.

The Nuclear Medicine (NM) Department is part of the Diagnostic Imaging Center of KUH and moved into new premises at the beginning of 2023. Currently the NM Department has two state of the art PET/CTs and SPECT/CTs, one of them being VERITON-CT, and has a radiopharmacy unit with a cyclotron. The Nuclear Medicine Department performs around 3,700 studies and treatments per year, including applications for cardiology, oncology, and neurology. ¹⁷⁷Lu-PSMA treatments are carried out in close collaboration with KUH Cancer Center. KUH was the second university hospital in Finland to start these treatments.

Kuopio is located in the east of Finland, about 500 km south from the Arctic Circle. More than half of Kuopio's area is forest and lakes, and with a population of around 123,000, Kuopio is the eighth largest city in Finland.

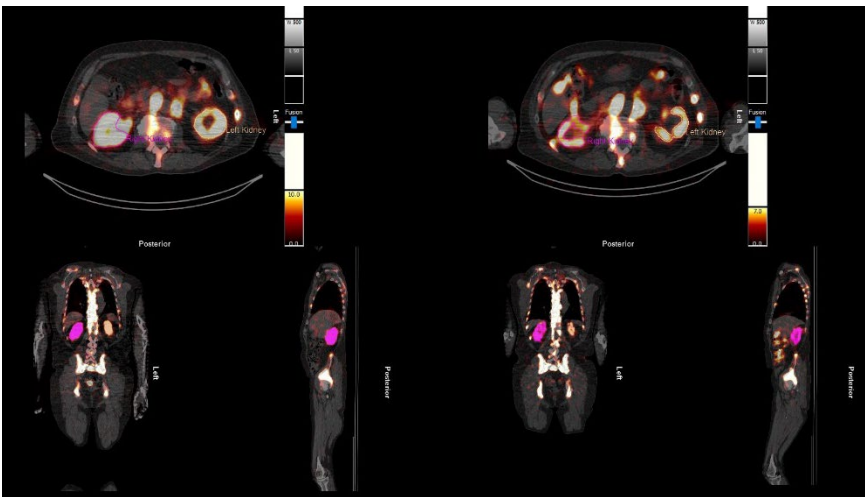


We started ¹⁷⁷Lu-PSMA treatments at Kuopio University Hospital in March 2020. From the very beginning we have used in-house labeled ¹⁷⁷Lu-PSMA I&T and a treatment dose of 7.4GBq. Recently the number of treatments has been markedly increasing, with over 280 treatment cycles given. In addition to patients from our own area, we also treat patients from Northern Finland and from Norway.

1. Kuopio, Finland location
2. VERITON-CT and KUH "VERITON team": technologist Anniina Keinänen, MD Svante Halttunen, technologist Johanna Kaunisto, Medical Physicist Heidi Gröhn
3. Kuopio University Hospital
4. People involved in ¹⁷⁷Lu-PSMA dosimetry project: Professor Chief Physician Tomi Laitinen, Chief Physicist Tiina Laitinen, Deputy Chief Physicist Mikko Hakulinen and Medical Physicist Heidi Gröhn.

At Kuopio University Hospital dosimetry is performed for all ¹⁷⁷Lu-PSMA treatments to monitor dose to critical organs such as salivary glands and kidneys. The dosimetry imaging protocol consists of imaging sessions at 4hrs and 24hrs post treatment, with the 24hr scan range matched to the patient's ¹⁸F PSMA PET scan range, as it is used for treatment evaluation. The long scan times of up to 75 minutes, as previously required when using our analog camera, had negative effects on ¹⁷⁷Lu-PSMA therapies;

- Reduced scan range performed on the 4hr imaging session to minimize patient discomfort
- Mismatch of scan ranges negatively affected dosimetry calculations
- Limited the number of possible treatments that could be provided to patients
- Limited the flexibility in patient scheduling

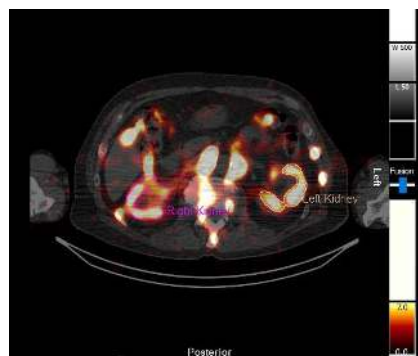


Dosimetry dose contours from ¹⁷⁷Lu-PSMA VERITON-CT SPECT scans

Patient name: [REDACTED]
ID: [REDACTED]

Treatment cycle	Absorbed doses (Gy)	
	Kidneys	Salivary glands
2023 1	2,1	1,0
2023 2	2,3	0,7
2023 3	2,6	0,6
4		
5		
6		
Accumulated dose	7,0 Gy	2,3 Gy
- % of the dose limit	18 %	7 %
Estimated dose for 6 cycles	14,1 Gy	4,6 Gy
- % of the dose limit	35 %	13 %
Dose limits	28 - 40 Gy ¹	35 Gy ¹

¹procedure guidelines for radionuclide therapy with ¹⁷⁷Lu-labelled PSMA ligands (¹⁷⁷Lu-PSMA-RLT), Kuroki et al., 2019
size of normal tissue to therapeutic irradiation, Evans et al., 1991



¹⁷⁷Lu-PSMA Customized Dosimetry Report

The installation of our new 3D digital VERITON-CT scanner at the beginning of 2023 gave us an opportunity to tackle these challenges. However, as the VERITON-CT 3D SPECT/CT 216 system utilizes the 113 keV energy peak instead of the 208 keV peak for Lu-177 imaging, we needed to compare the dosimetry on VERITON-CT to our established clinical protocol to be confident that we could get comparable results and image quality from the lower energy peak.

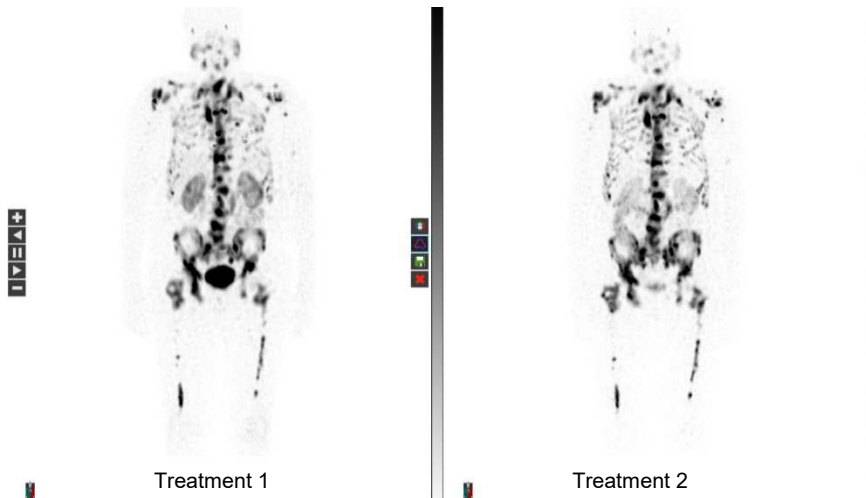
To validate the new approach, we scanned ten patients using both analog SPECT/CT utilizing the 208 keV energy peak and VERITON 3D digital SPECT/CT utilizing the 113keV peak, 4hrs and 24hrs after ¹⁷⁷Lu-PSMA treatment. On analog SPECT/CT we used our validated clinical protocol and reconstruction parameters. On VERITON-CT the scan range was matched to the ¹⁸F PSMA PET FOV for both time point scans and imaging time was 4 min per bed position, approximately 20 minutes for the complete scan. Suitable reconstruction parameters for VERITON-CT data were tested in collaboration with the manufacturer, Spectrum Dynamics Medical.

Absorbed doses for kidneys and salivary glands were calculated using MIRD based Organ Dosimetry from Hermes Medical Solutions. Four physicists drew VOIs for both data sets, and the difference between means was evaluated using a paired t-test.

There was no significant difference between absorbed doses calculated from different peaks, nor any trend towards consistently higher values with either of the approaches. This was a very promising and exciting result and gave us confidence to transfer ¹⁷⁷Lu-PSMA dosimetry studies to the VERITON-CT scanner.

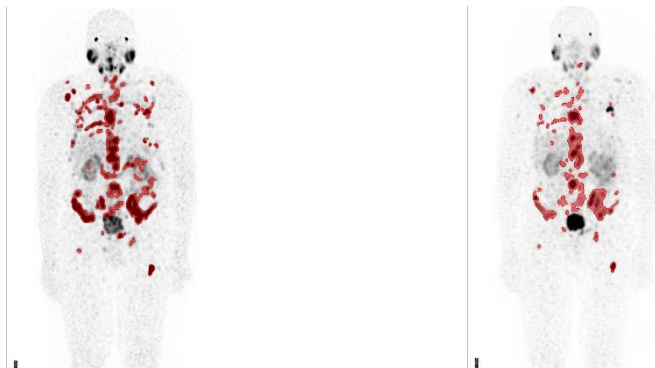
Technologist's comments:

We like VERITON-CT because the workflow is fluid and positioning the patient and determining the imaging range is easy. In the new ¹⁷⁷Lu-PSMA protocol it is nice that the scan range is the same for both timepoints, so there is no need to choose different protocols. It is also much more convenient for patients, since the scan only takes about 20 min. Previously, scanning four ¹⁷⁷Lu-PSMA patients would have meant a long day and no other studies on the scanner that day, but now there is still time to also do other studies.



Quote from ¹⁷⁷Lu-PSMA therapy patient:

"It's such a relief that scan time is nowadays only about 20 min, so I don't have to lie down motionless on a hard narrow bed for as long as before."



Tumor Burden Summary	2023-03-28
	SUVbw
Uptake Time (hr)	5.2
Volume (ml)	718.7
Max	135
Mean	13.4
TLA (mean*ml)	9646.3

Tumor Burden Summary	2023-05-24
	SUVbw
Uptake Time (hr)	4.4
Volume (ml)	485.6
Max	139.1
Mean	14.3
TLA (mean*ml)	6951.8

¹⁷⁷Lu-PSMA Treatment 1 and 2 showing reduced Tumor Burden (under evaluation, not currently clinical routine)

VERITON-CT®



Spectrum Dynamics Medical's VERITON-CT combines the best-in-class CZT detectors, novel system design, high resolution CT, and advanced image reconstruction algorithms that support high energy imaging up to 400 keV.

With fast 3D Total Body scanning you have quantification-ready SPECT/CT images in under 30 minutes.



About Spectrum Dynamics

Spectrum Dynamics is spearheading the transformation of Nuclear Medicine from analog to digital technology, enabling clinicians to provide superior healthcare services with improved image quality and efficiency at lower doses.

D-SPECT®: the world's first digital cardiac SPECT system based on Broadview Technology: swiveling CZT digital detectors. It is the platform for advanced applications such as TruCorr Attenuation Correction, TruFlow 3D dynamic SPECT imaging for Myocardial Flow Reserve (MFR) analysis and Simultaneous Dual Isotope Imaging (SDI).

TruCorr: a deep learning application to generate attenuation corrected myocardial perfusion images. There is no need for an additional CT transmission scan, as TruCorr utilizes the SPECT scan emission data.

VERITON-CT®: the world's first digital 360°CZT-based, ring-shaped gantry design SPECT/CT, with high-resolution 16 or 64 slice CT. Its 80cm wide bore accommodates patients of all sizes. VERITON features TruFlow 3D dynamic SPECT/CT imaging for SPECT MFR, bone, renal, and general studies. VERITON-CT continues to evolve with an energy range up to 400 keV and multiple peak imaging, providing highest quality and quantitation-ready images.

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