UNIVERSITY OF GOTHENBURG

DOSIMETRIC COMPARISION OF THE RADIOLANTHANIDES LU-177 AND TB-161 FOR CANCER THERPIES WITH RADIOPHARMACEUTICALS

PETER BERNHARDT, DEPARTMENT OF MEDICAL RADIATION SCIENCES, INSTITUTE OF CLINICAL SCIENCE

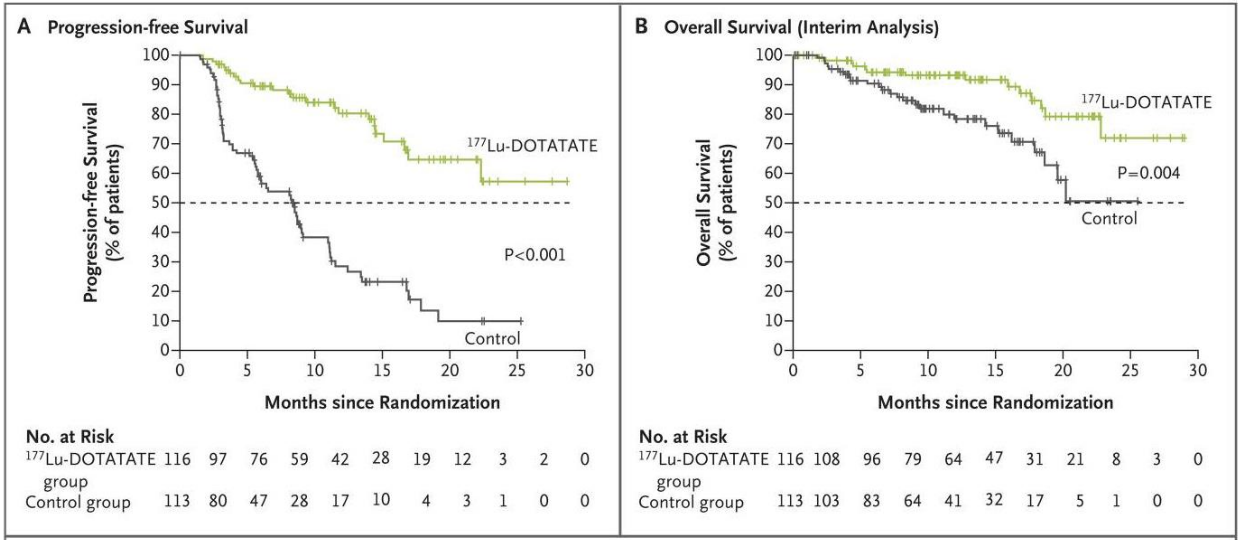
Is Peptide Receptor Radionuclide Therapy Really Happening?

- **1987** — Identification of sstr in neuroendocrine tumours
- **1989** — ^{123}I-tyr-3-octreotide
- **1992** — ^{111}In-Pentetteotide (Octreoscan)
- **1994/1996** — Treatment with ^{111}In-Pentetreotide (PRRT)
- **1999** — Phase I trial with ^{111}In-Pentetreotide
- **2001** — Phase I trial with ^{90}Y-DOTATOC
- **2001** — ^{68}Ga-PET imaging
- **2003** — First treatments with ^{177}Lu-DOTATATE
- **2003-2017** — ”In-house” production and PPRT treatments

N Engl J Med. 2017 January 12; 376(2): 125–135. doi:10.1056/NEJMoa1607427.

Phase 3 Trial of ^{177}Lu-Dotatate for Midgut Neuroendocrine Tumors

J. Strosberg, **G. El-Haddad**, **E. Wolin**, **A. Hendifar**, **J. Yao**, **B. Chasen**, **E. Mittra**, **P.L. Kunz**, **M.H. Kulke**, **H. Jacene**, **D. Bushnell**, **T.M. O'Dorisio**, **R.P. Baum**, **H.R. Kulkarni**, **M. Caplin**, **R. Lebtahi**, **T. Hobday**, **E. Delpassand**, **E. Van Cutsem**, **A. Benson**, **R. Srirajaskanthan**, **M. Pavel**, **J. Mora**, **J. Berlin**, **E. Grande**, **N. Reed**, **E. Seregni**, **K. Öberg**, **M. Lopera Sierra**, **P. Santoro**, **T. Thevenet**, **J.L. Erion**, **P. Ruszniewski**, **D. Kwekkeboom**, **E. Krenning**, and **for the NETTER-1 Trial Investigators***



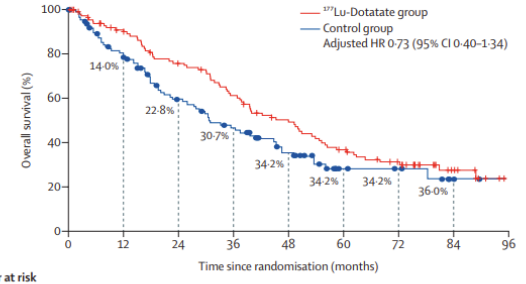
LUTATHERA®
(lutetium Lu 177 dotatate)
injection, for intravenous use

Is Peptide Receptor Radionuclide Therapy Really Happening?

1987	1989	1992	1994/1996	1999	2001	2001	2003	2003-2017
Identification of sstr in neuroendocrine tumours	^{123}I-tyr-3-octreotide	^{111}In-Pentetteotide (Octreoscan)	Treatment with ^{111}In-Pentetreotide (PRRT)	Phase I trial with ^{111}In-Pentetreotide	Phase I trial with ^{90}Y-DOTATOC	^{68}Ga-PET imaging	First treatments with ^{177}Lu-DOTATATE	"In-house" production and PPRT treatments

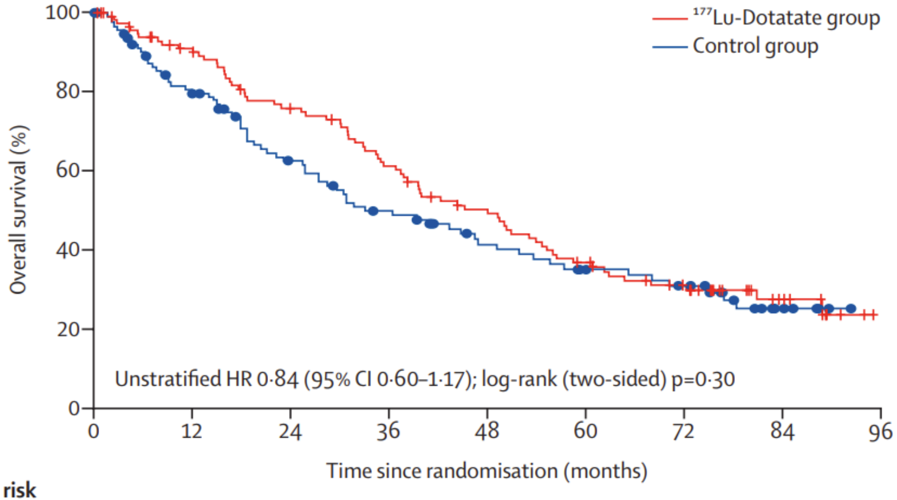
^{177}Lu-Dotatate plus long-acting octreotide versus high-dose long-acting octreotide in patients with midgut neuroendocrine tumours (NETTER-1): final overall survival and long-term safety results from an open-label, randomised, controlled, phase 3 trial

*Jonathan R Strosberg, Martyn E Caplin, Pamela L Kunz, Philippe B Ruszniewski, Lisa Bodei, Andrew Hendifar, Erik Mittra, Edward M Wolin, James C Yao, Marianne E Pavel, Enrique Grande, Eric Van Cutsem, Ettore Seregni, Hugo Duarte, Germo Gericke, Amy Bartalotta, Maurizio F Mariani, Arnaud Demange, Sakir Mutevelic, Eric P Krenning, on behalf of the NETTER-1 investigators**



Number at risk (number censored)									
^{177}Lu-Dotatate group	117 (0)	98 (9)	79 (12)	63 (13)	48 (16)	35 (17)	25 (22)	10 (35)	0 (44)
Control group	114 (0)	84 (8)	57 (15)	42 (18)	26 (25)	9 (38)	7 (40)	2 (44)	0 (46)

Figure 4: **Rank-preserving structured failure time analysis of overall survival accounting for crossover to any PRRT in the control group during long-term follow-up**
Percentages at each timepoint are cumulative proportions of patients crossing over from the control group to PRRT. HR=hazard ratio. PRRT=peptide receptor radionuclide therapy.



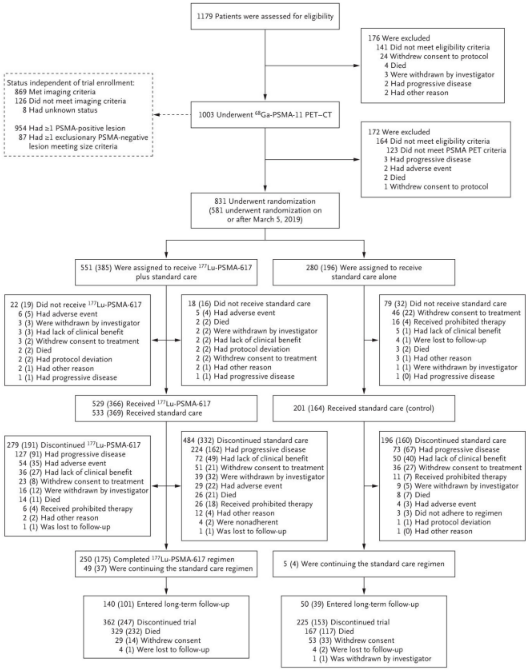
Number at risk (number censored)									
^{177}Lu-Dotatate group	117 (0)	98 (9)	79 (12)	63 (13)	48 (16)	35 (17)	25 (22)	10 (35)	0 (44)
Control group	114 (0)	84 (8)	61 (14)	45 (18)	33 (23)	25 (26)	21 (27)	6 (39)	0 (45)

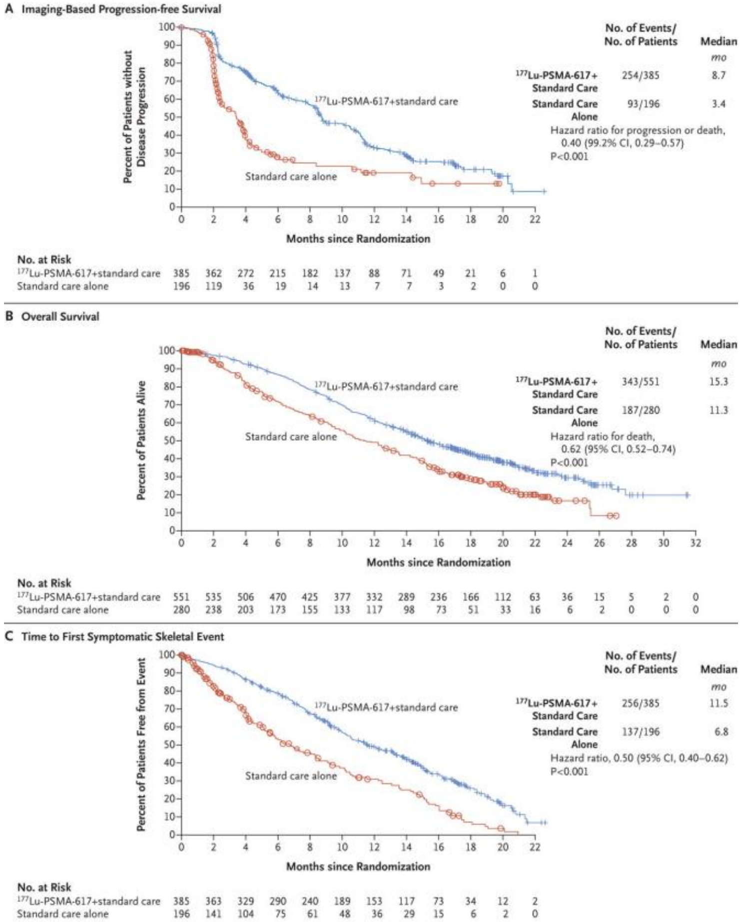
Is Radioligand Therapy of mCRPC Really Happening?

Clinical Trial > N Engl J Med. 2021 Sep 16;385(12):1091-1103. doi: 10.1056/NEJMoa2107322.
Epub 2021 Jun 23.

Lutetium-177-PSMA-617 for Metastatic Castration-Resistant Prostate Cancer

Oliver Sartor [1], Johann de Bono [1], Kim N Chi [1], Karim Fizazi [1], Ken Herrmann [1], Kambiz Rahbar [1], Scott T Tagawa [1], Luke T Nordquist [1], Nitin Vaishampayan [1], Ghassan El-Haddad [1], Chandler H Park [1], Tomasz M Beer [1], Alison Armour [1], Wendy J Pérez-Contreras [1], Michelle DeSilvio [1], Euloge Kpamegan [1], Germo Gericke [1], Richard A Messmann [1], Michael J Morris [1], Bernd J Krause [1]; VISION Investigators





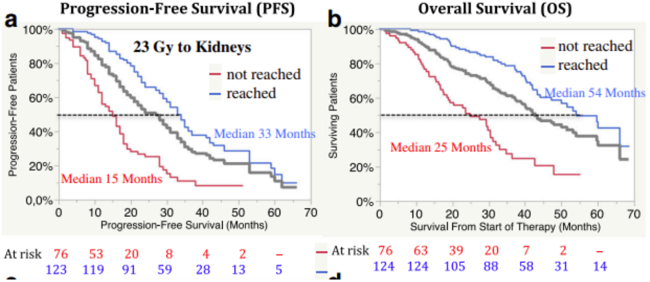
Peptide receptor radionuclide therapy (PRRT)

Is Dosimetry Really Happening?

1987	1989	1992	1994/1996	1999	2001	2001	2003	2003-2017
Identification of sstr in neuroendocrine tumours	^{123}I-tyr-3-octreotide	^{111}In-Pentetteotide (Octreoscan)	Treatment with ^{111}In-Pentetreotide (PRRT)	Phase I trial with ^{111}In-Pentetreotide	Phase I trial with ^{90}Y-DOTATOC	^{68}Ga-PET imaging	First treatments with ^{177}Lu-DOTATATE	"In-house" production and PPRT treatments

Prospective observational study of ^{177}Lu-DOTA-octreotate therapy in 200 patients with advanced metastasized neuroendocrine tumours (NETs): feasibility and impact of a dosimetry-guided study protocol on outcome and toxicity

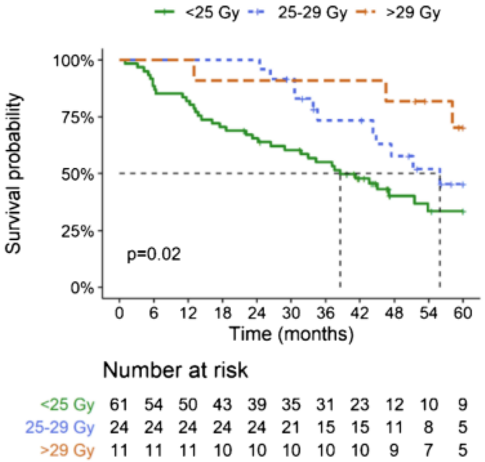
Ulrike Garske-Román[1,2] · Mattias Sandström[3] · Katarzyna Fröss Baron[4] · Lars Lundin[2] · Per Hellman[2] · Staffan Welin[4]
Silvia Johansson[4] · Tanweera Khan[4] · Hans Lundqvist[3] · Barbro Eriksson[4] · Anders Sundin[2] · Dan Granberg[4]



European Journal of Nuclear Medicine and Molecular Imaging (2018) 45:970–988

Phase II trial demonstrates the efficacy and safety of individualized, dosimetry-based ^{177}Lu-DOTATATE treatment of NET patients

Anna Sundlöv[1] · Katarina Sjögreen Gleisner[2] · Jan Tennvall[1] · Michael Ljungberg[2] · Carl Fredrik Warfvinge[1]
Kajsa Holgersson[3] · Andreas Hallqvist[3,4] · Peter Bernhardt[5,6] · Johanna Svensson[3,4]



European Journal of Nuclear Medicine and Molecular Imaging (2022) 49:3830–3840

Ongoing Clinical trial

Systemic Targeted Adaptive RadioTherapy of NeuroEndocrine Tumors (START-NET)

Is Radionuclide Therapy with ^{161}Tb Really Happening?

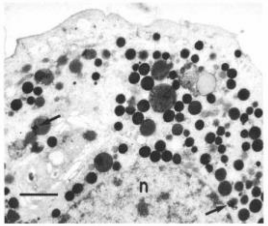
1987	1989	1992	1994/1996	1999	2001	2001	2003	2003-2017
Identification of sstr in neuroendocrine tumours	^{123}I-tyr-3-octreotide	^{111}In-Pentetteotide (Octreoscan)	Treatment with ^{111}In-Pentetreotide (PRRT)	Phase I trial with ^{111}In-Pentetreotide	Phase I trial with ^{90}Y-DOTATOC	^{68}Ga-PET imaging	First treatments with ^{177}Lu-DOTATATE	"In-house" production and PPRT treatments

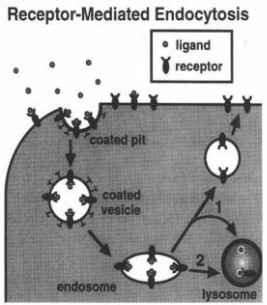
LABORATORY STUDIES

Internalization of Indium-111 into Human Neuroendocrine Tumor Cells after Incubation with Indium-111-DTPA-D-Phe[1]-Octreotide

TABLE 1
Tumor-to-Blood Ratios (T/B) and Indium-111 Activity Concentration (C) Postintravenous Injection of Indium-111-DTPA-D-Phe[1]-Octreotide

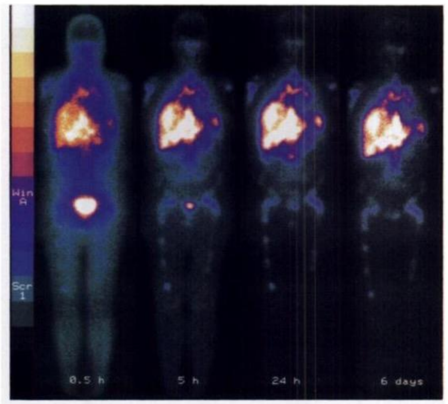
Tumor biopsy	T/B	C (%IA/g)	Time after injection (d)
Glucagonoma			
Primary tumor	910	0.059	3
Liver metastasis	650	0.042	3
Midgut carcinoid			
Primary tumor	150	0.008	7
Liver metastasis	400	0.020	7
Liver metastasis	470	0.024	7
Liver metastasis	650	0.033	7
Gastric carcinoid			
Primary tumor	71	0.017	1
Lymph node metastasis	190	0.047	1
Liver metastasis	150	0.035	1
Liver metastasis	180	0.044	1
Liver metastasis	210	0.051	1





Systemic Radionuclide Therapy Using Indium-111-DTPA-D-Phe[1]-Octreotide in Midgut Carcinoid Syndrome

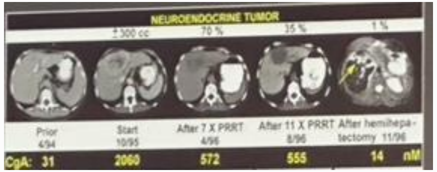
Fjälling et al. JNM 1996



Radiotherapy with a Radiolabeled Somatostatin Analogue, [^{111}In-DTPA-D-Phe^{1}]-Octreotide

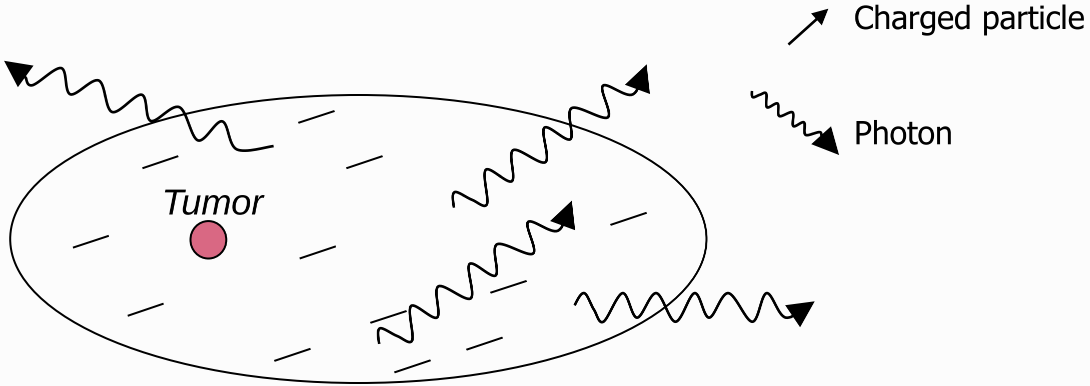
A Case History

E. P. KRENNING,[a,b,c] P. P. M. KOOIJ,[a] W. H. BAKKER,[a] W. A. P. BREEMAN,[a] P. T. E. POSTEMA,[b] D. J. KWEKKEBOOM,[a] H. Y. OEI,[a], M. DE JONG,[a] T. J. VISSER,[b] A. E. M. REIJS,[a] AND S. W. J. LAMBERTS[b]



Dosimetric characterization of radionuclides

TND - the tumour-to-normal- tissue mean absorbed dose rate ratio

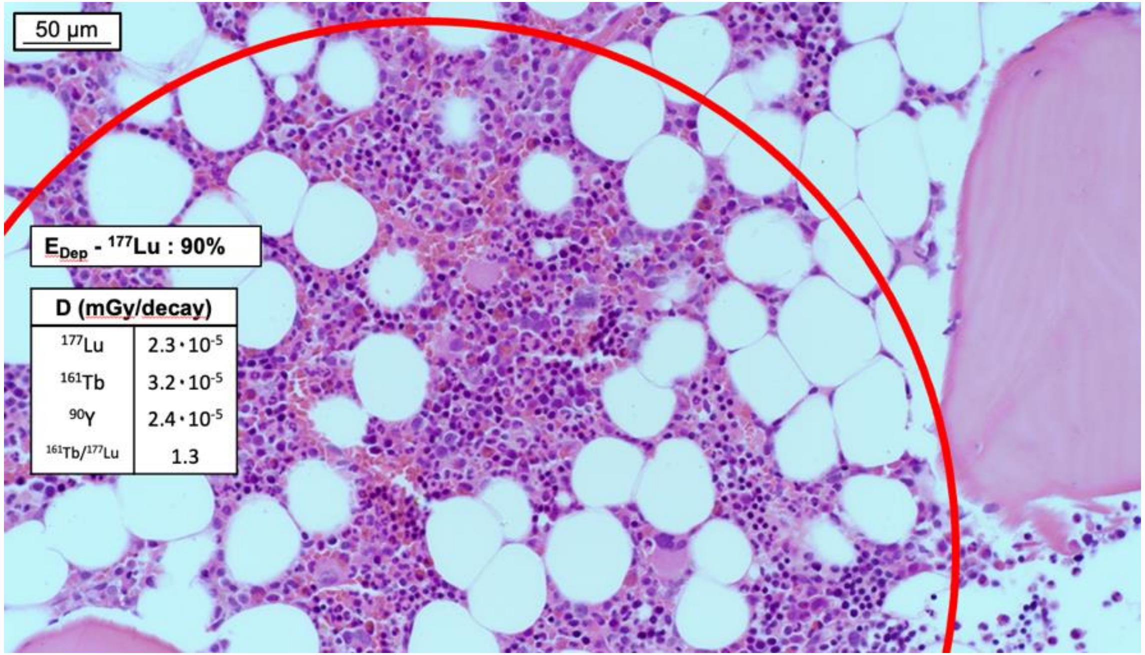


$$TND = \frac{D_T}{D_N}$$

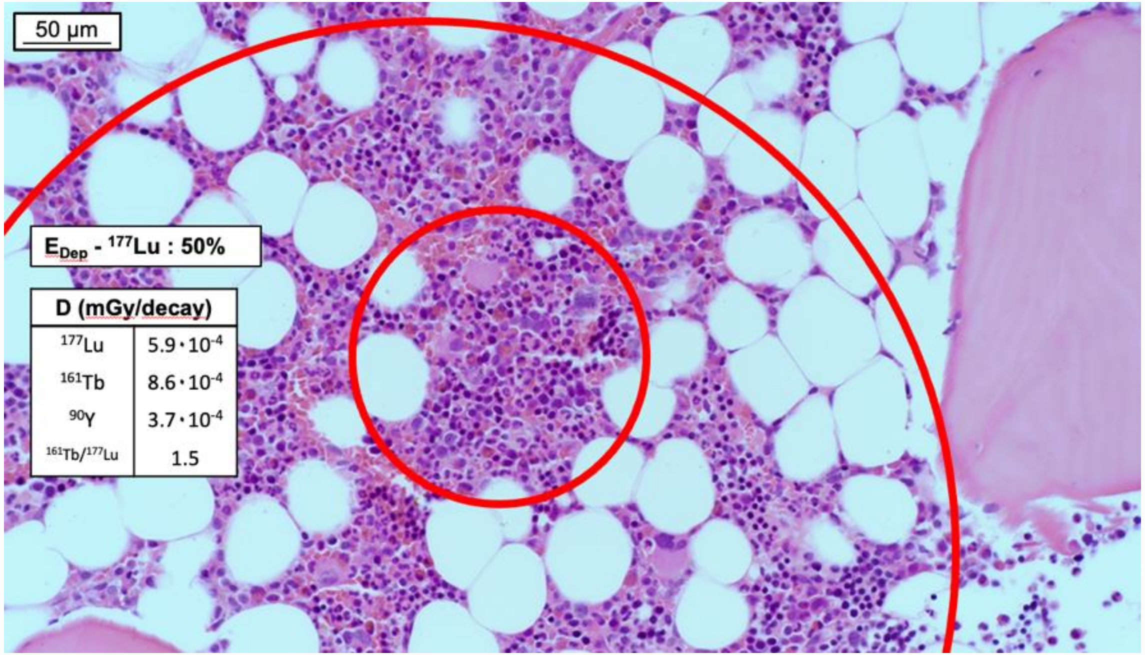
30-40 % of all emitted photons will be absorbed in adults, less than a few percent in mice and rats

Bernhardt et al, Int J Rad Oncol Biol Phys, 2001

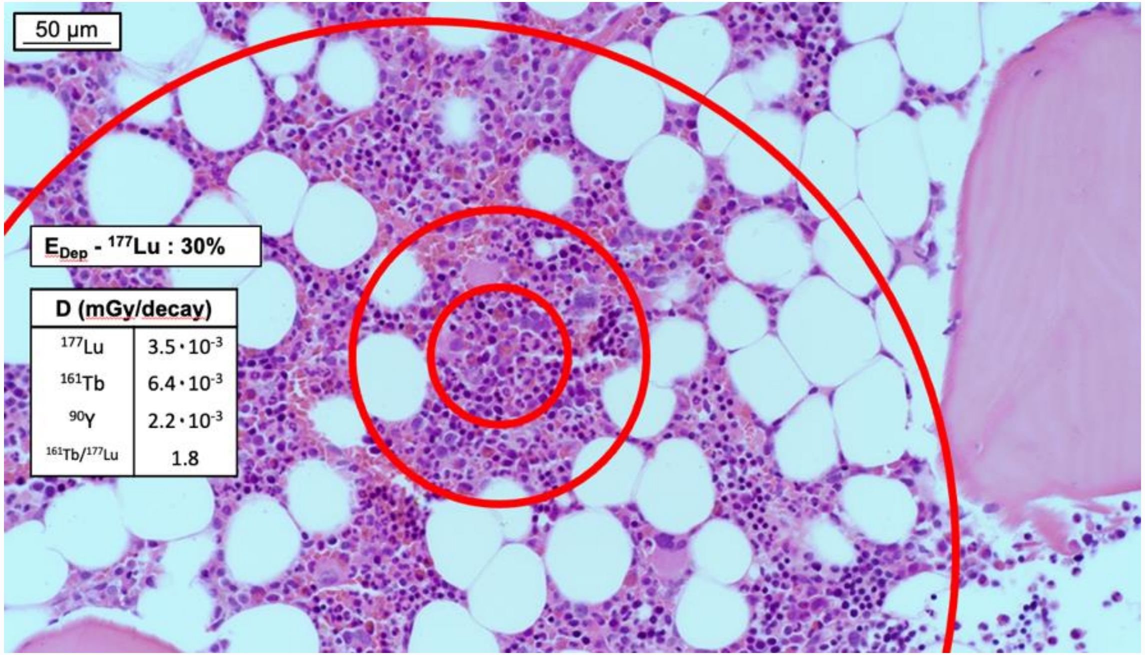
Small-scale dosimetry



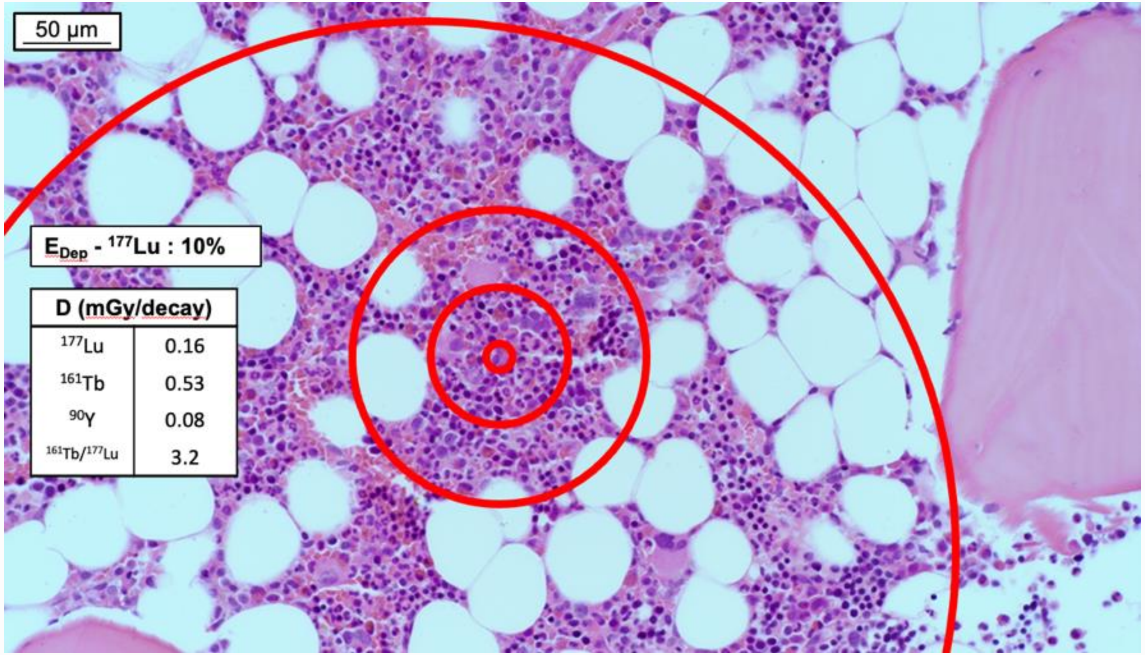
Small-scale dosimetry



Small-scale dosimetry



Small-scale dosimetry



Is Radionuclide Therapy with ^{161}Tb Really Happening?

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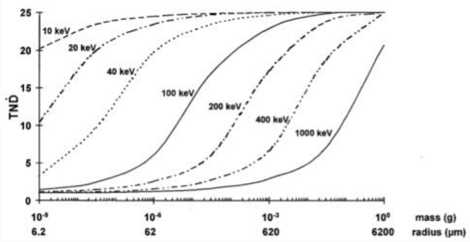
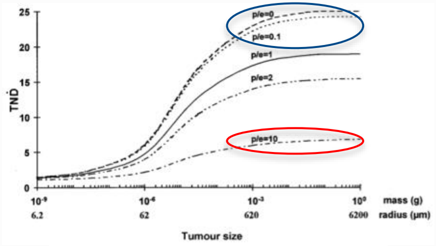
- **2003-2017** — ”In-house” production and PPRT treatments

Low-energy Electron Emitters for Targeted Radiotherapy of Small Tumours

Peter Bernhardt, Eva Forssell-Aronsson, Lars Jacobsson and Gunnar Skarnemark

From the Department of Radiation Physics, Göteborg University, Sahlgrenska University Hospital (P. Bernhardt, E. Forssell-Aronsson, L. Jacobsson), and the Department of Nuclear Chemistry, Chalmers University of Technology (G. Skarnemark), Göteborg, Sweden



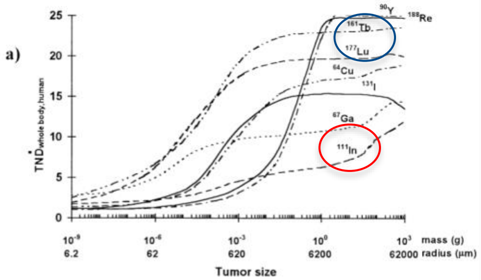


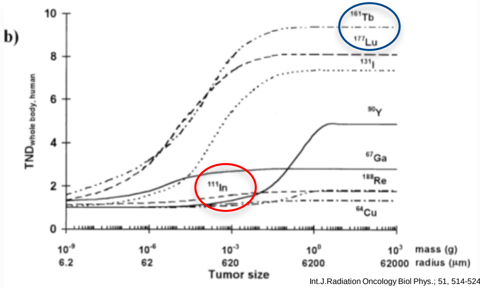
Acta Oncologica Vol. 40, No. 5, pp. 602–608, 2001

BIOLOGY CONTRIBUTION

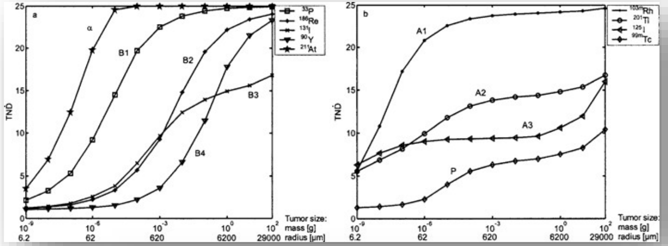
DOSIMETRIC COMPARISON OF RADIONUCLIDES FOR THERAPY OF SOMATOSTATIN RECEPTOR–EXPRESSING TUMORS

Peter Bernhardt, Ph.D.,* Sven Anders Benjegård, M.Sc.,* Lars Kölby, M.D., Ph.D.,† Viktor Johanson, M.D., Ph.D.,‡ Ola Nilsson, M.D., Ph.D.,† Håkan Ahlman, M.D., Ph.D.,‡ and Eva Forssell-Aronsson, Ph.D.*





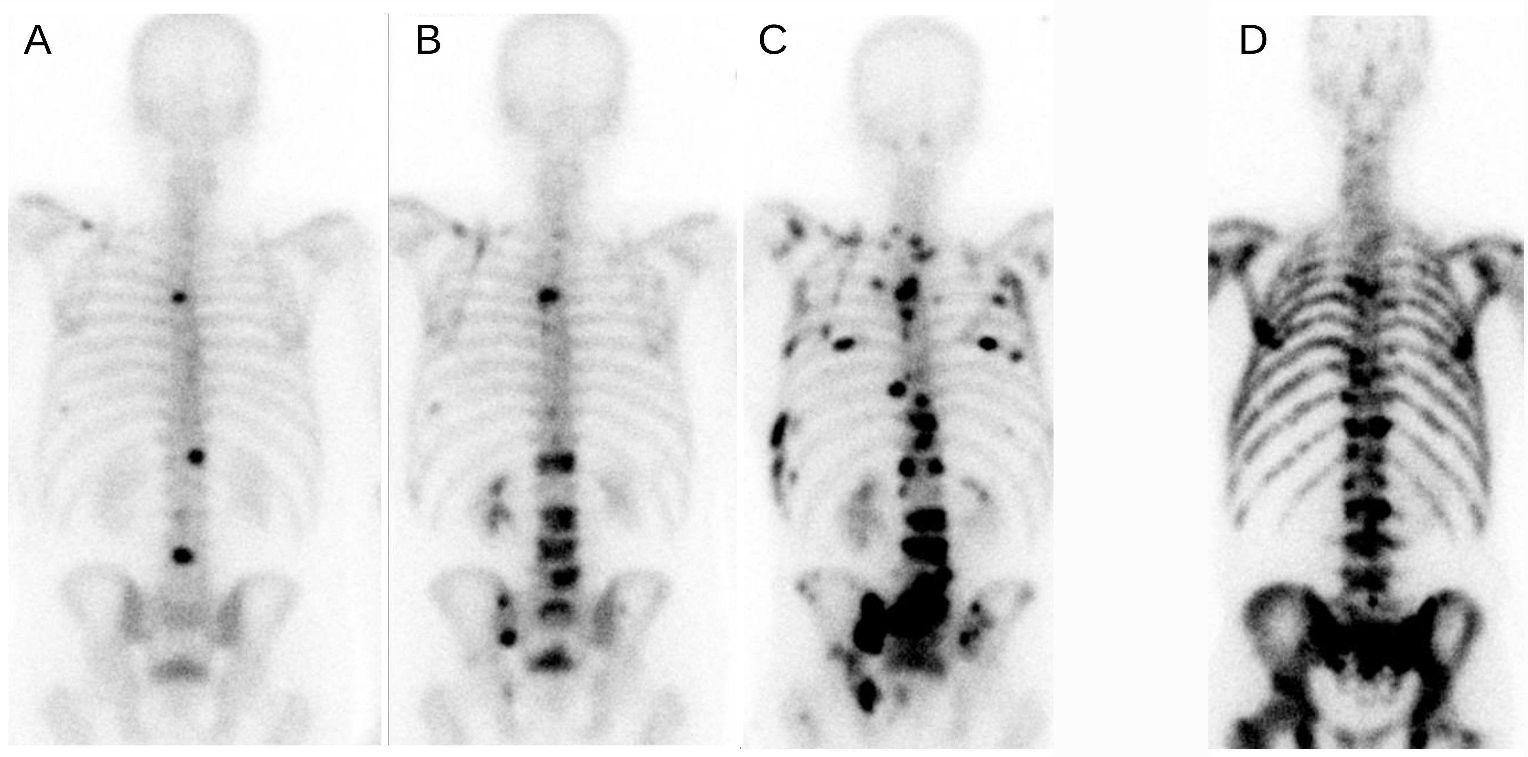
Int.J.Radiation Oncology Biol Phys.; 51, 514-524, 2001



Group	Radio-nuclide	Decay mode	Half-life	p/e	Mean energy (keV)	$TN\dot{D}$ value, mean/max		
						Uniform	Nucleus	Cytoplasm
B1	^{33}P	β^-	25 d	0	76	17/25	19/28	19/28
	^{121}Sn	β^-	1.1 d	4.1×10^{-4}	115	15/25	16/26	16/26
B2	^{161}Tb	β^-	6.9 d	0.16	154	14/23	19/29	16/26
	^{177}Lu	β^-	6.7 d	0.24	145	13/23	15/25	14/25
	^{199}Au	β^-	3.1 d	0.62	82	13/21	15/23	15/23
	^{153}Sm	β^-	1.9 d	0.23	229	12/23	14/25	13/24
	^{77}As	β^-	1.6 d	0.04	231	12/24	13/25	13/25
	^{105}Rh	β^-	1.5 d	0.50	133	12/22	13/23	12/23
	^{109}Pd	β^-	14 h	0.03	361	12/24	13/26	12/25
	^{114m}In	IT, EC	50 d	0.66	162	12/21	13/23	12/22
	^{67}Cu	β^-	2.6 d	0.74	121	12/21	13/22	12/22
	^{47}Sc	β^-	3.3 d	0.66	143	11/21	12/22	12/22
	^{186}Re	β^-, EC	3.7 d	0.06	362	11/24	11/25	11/24
	^{111}Ag	β^-	7.5 d	0.08	263	10/24	11/24	11/24
	^{149}Pm	β^-	2.2 d	0.03	370	10/24	11/24	11/24
B3	^{167}Tm	EC	9.2 d	1.16	16	11/19	14/22	13/21
	^{115m}In	IT, β^-	4.5 h	0.94	308	9/20	10/21	9/20
	^{64}Cu	β^-, EC, β^+	13 h	1.54	190	9/18	10/19	9/18
	^{131}I	β^-	8.0 d	2	192	8/17	9/17	9/17
B4	^{80m}Br/^{80}Br	IT/β^-, EC, β^+	4.4 h/17 min	0.13	801	9/23	10/24	10/24
	^{32}P	β^-	14 d	0	695	9/24	9/24	9/24
	^{89}Sr	β^-	51 d	0.002	583	9/24	9/24	9/24
	^{166}Ho	β^-	1.1 d	0.04	695	9/23	9/24	9/24
	^{188}Re	β^-	17 h	0.07	795	8/23	8/23	8/23
	^{194}Ir	β^-	19 h	0.11	847	8/23	8/23	8/23
	^{90}Y	β^-	2.7 d	1.2×10^{-5}	934	8/23	8/23	8/23
	^{134}Ce/^{134}La	EC/EC, β^+	3.2 d/6.7 min	0.96	1206	6/18	6/19	6/19

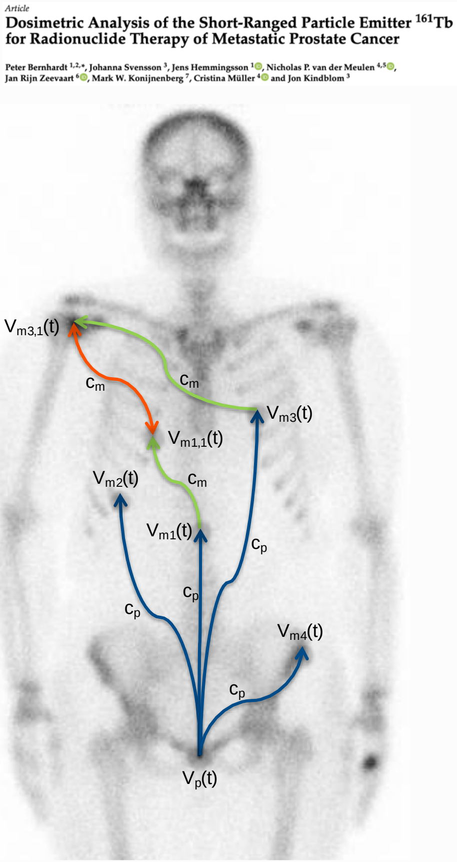
Response characterization of radionuclides

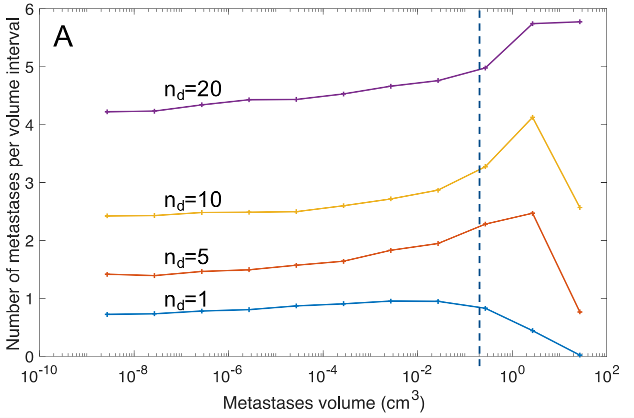
The metastatic control probability model

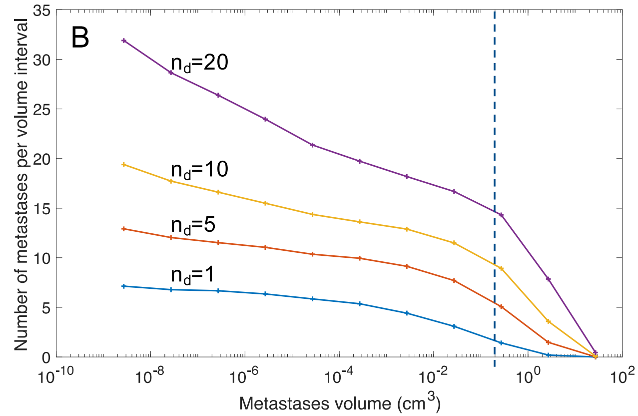


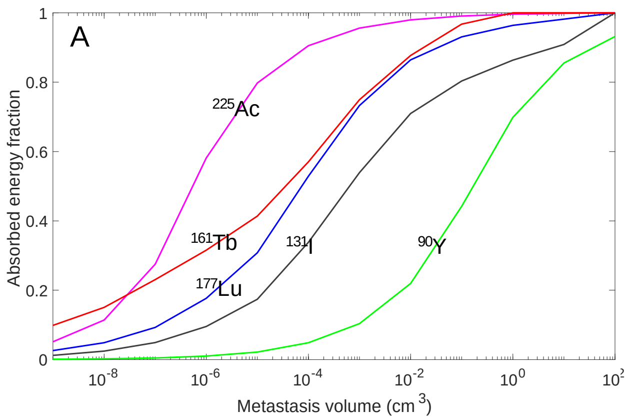
Bernhardt P, Ahlman H, Forssell-Aronsson E. Model of metastatic growth valuable for radionuclide therapy. Med Phys. 2003 Dec;30(12):3227-32.

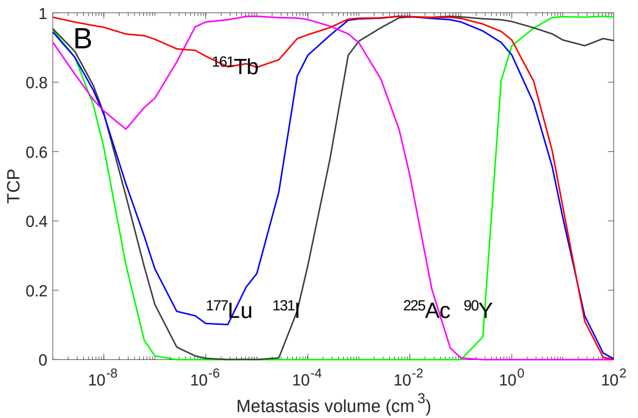
Response characterization of radionuclides











Response characterization of radionuclides

Radionuclide		Required absorbed dose			
		Number of detectable metastases			
	0	1	5	10	20
^{90}Y	80	2630-3010 Gy	2740-3130 Gy	2860-3220 Gy	3000-3330 Gy
^{131}I	80	920-1120 Gy	985-1170 Gy	1040-1220 Gy	1100-1270 Gy
^{177}Lu	80	558-682 Gy	598-715 Gy	630-742 Gy	672-777 Gy
^{225}Ac	80	243-292 Gy_5	252-307 Gy_5	269-320 Gy_5	288-335 Gy_5
^{161}Tb	80	207-247 Gy	220-260 Gy	230-270 Gy	245-281 Gy

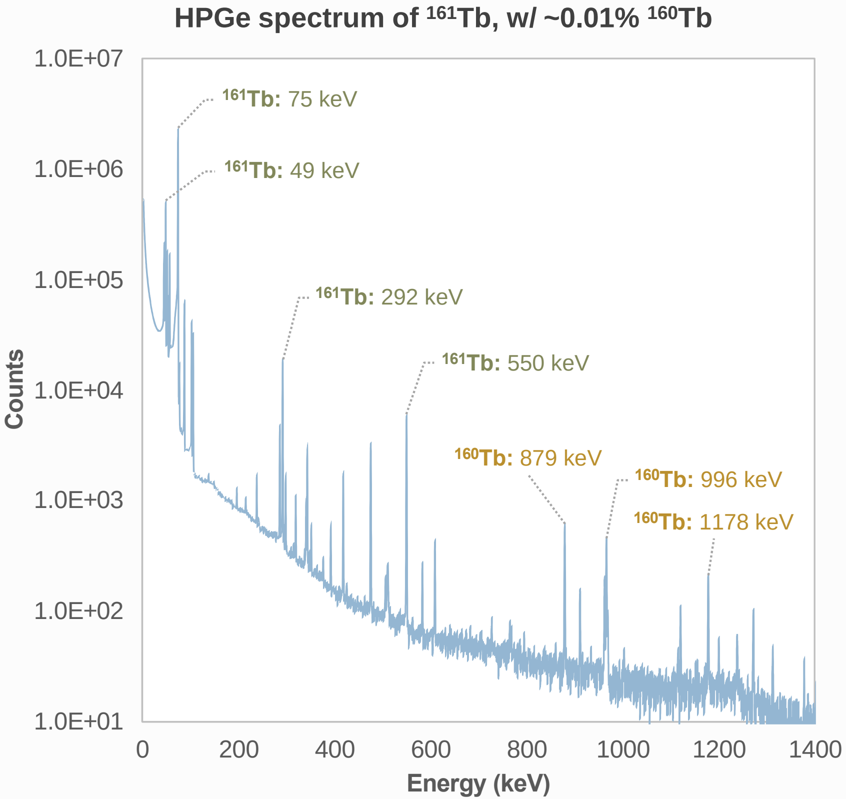
Clinical dosimetry & SPECT imaging with ^{161}Tb

Isotope	^{177}Lu	^{161}Tb
Decay mode	β^- (100%)	β^- (100%)
$T_{1/2}$ (d)	6.64	6.89
Daughter	^{177}Hf (Stable)	^{161}Dy (Stable)
$\Delta_{\beta-}$ (keV)	133	156
$\Delta_{CE\&Auger}$ (keV)	13.8	46.3
Notable X/γ-emissions (Yield >1%)	8.9 (3.2%, X) 54.6 (1.6%, X) 55.8 (2.8%, X) 112.9 (6.2%, γ) 208.4 (10.4%, γ)	7.2 (22.1%, X) 25.7 (23.1%, γ) 45.2 (6.3%, X) 46.0 (11.3%, X) 48.9 (17.1%, γ) 52.2 (3.6%, X) 57.2 (1.8%, γ) 74.6 (10.3%, γ)

Westerbergh, F., Rydén, T., van Essen, M., van der Meulen, N. P., Müller, C., & Bernhardt, P. (2022). Exploring the quantitative impact of non-uniformities in SPECT-imaging with ^(161)Tb [Conference abstract]. Eur J Nucl Med Mol Imaging, Vol 49, Suppl 1 (p. 256). Available from: https://doi.org/10.1007/s00259-022-05924-4

Westerbergh, F., van der Meulen, N. P., Müller, C., Grings, A., Ritt, P., & Bernhardt, P. (2023). Demonstrating the quantitative potential of terbium-161 SPECT/CT imaging: An anthropomorphic phantom study [Conference abstract]. Eur J Nucl Med Mol Imaging, Vol 50, Suppl 1 (p. 38). Available from: https://doi.org/10.1007/s00259-023-06333-x

Clinical dosimetry & SPECT imaging with ^{161}Tb



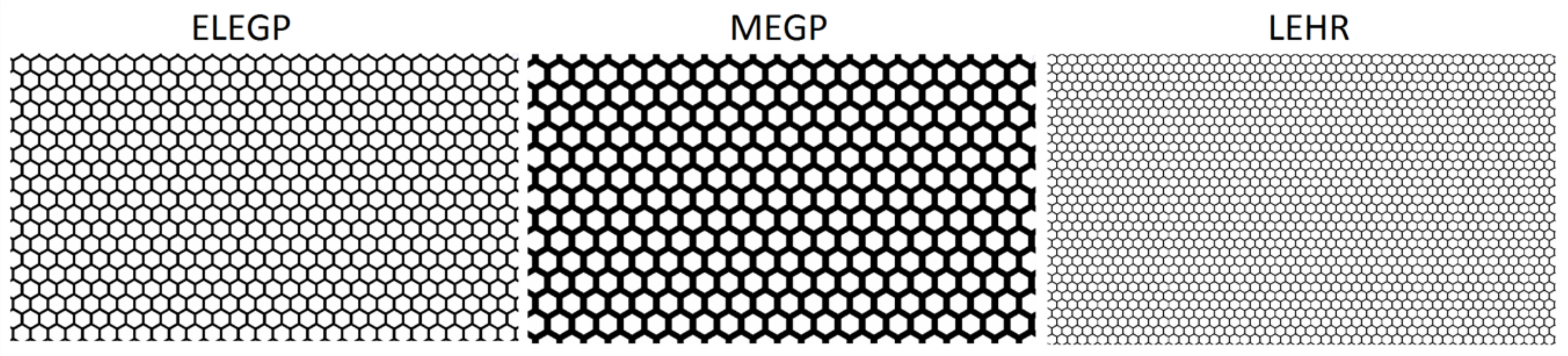
Challenges in ^{161}Tb-imaging

- Imageable emissions are low in energy (49 & 75 keV)
  - Outside the usual γ-camera operating range
- Some higher-energy, low-yield ^{161}Tb γ
  - E.g. 103 keV (0.1%), 292 keV (0.06%), 550 keV (0.04%)
- Some very high-energy ^{160}Tb γ
  - E.g. 879 keV (30%), 966 keV (25%), 1178 keV (15%)
  - High yield, but low abundance [1]

[1] Gracheva N, Müller C, Talip Z, Heinitz S, Köster U, Zeevaart JR, et al. Production and characterization of no-carrier-added 161Tb as an alternative to the clinically-applied 177Lu for radionuclide therapy. EJNMMI Radiopharmacy and Chemistry. 2019;4(1).

Choice of collimator

- Extended low energy general purpose (ELEGP)
- Medium energy general purpose (MEGP)
- Low energy high resolution (LEHR)



Choice of collimator

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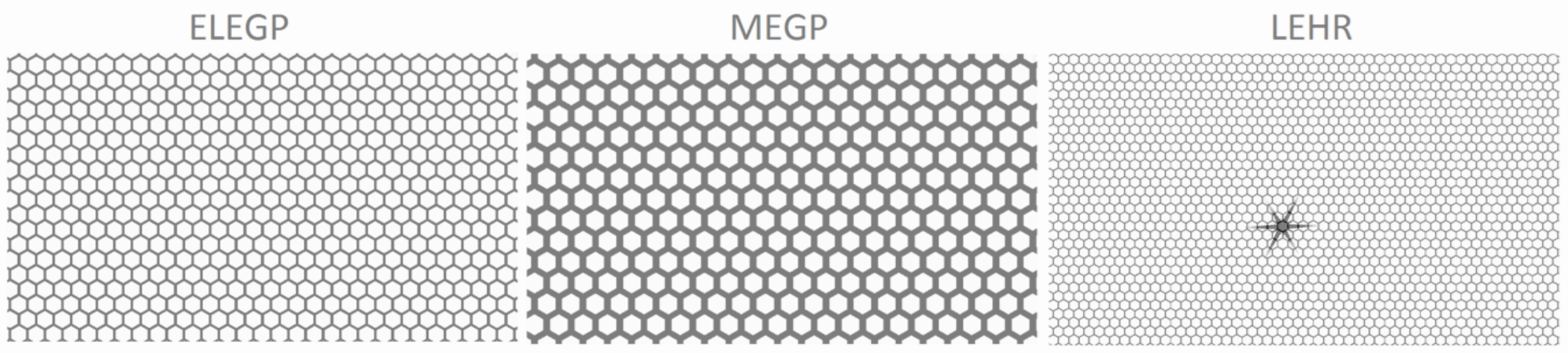
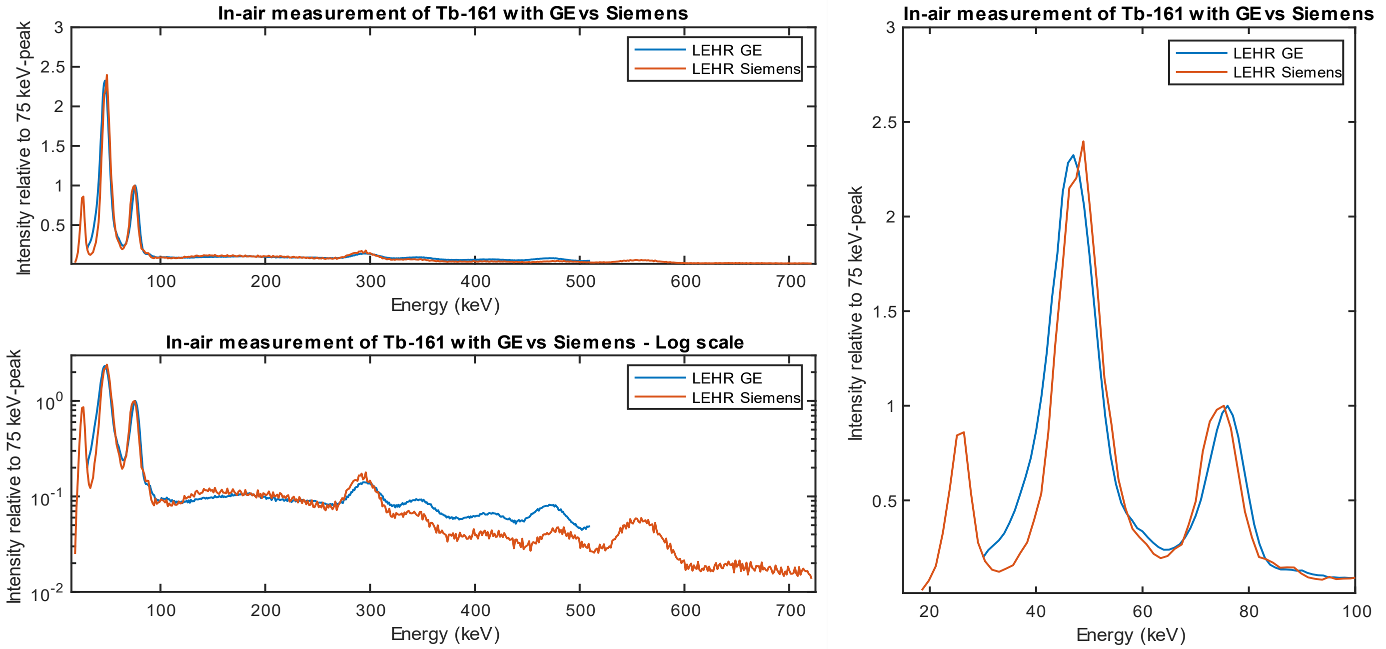
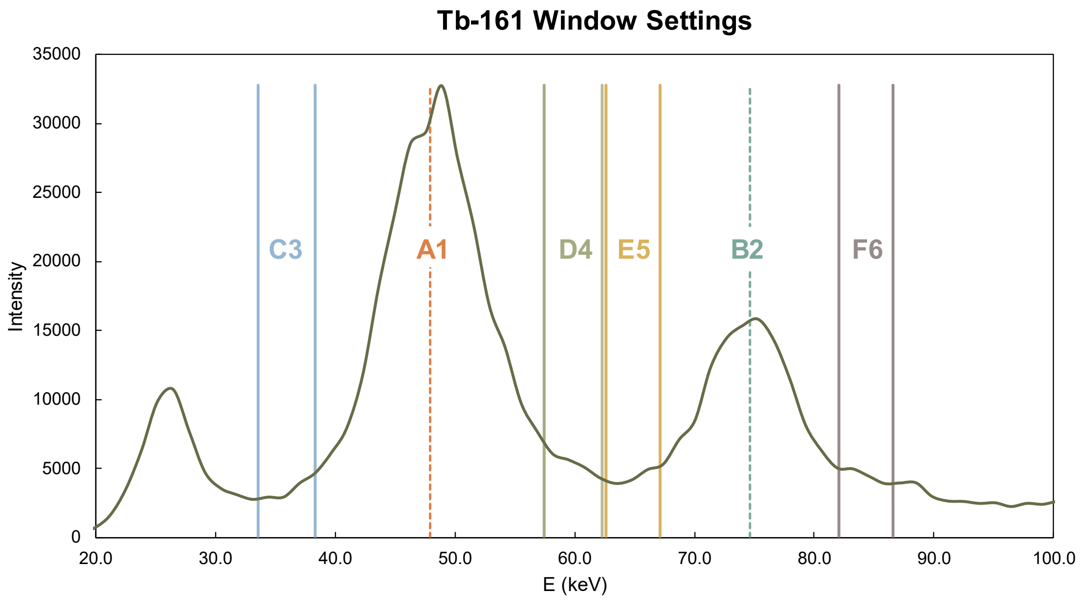


Clinical dosimetry & SPECT imaging with ^{161}Tb

Energy window settings



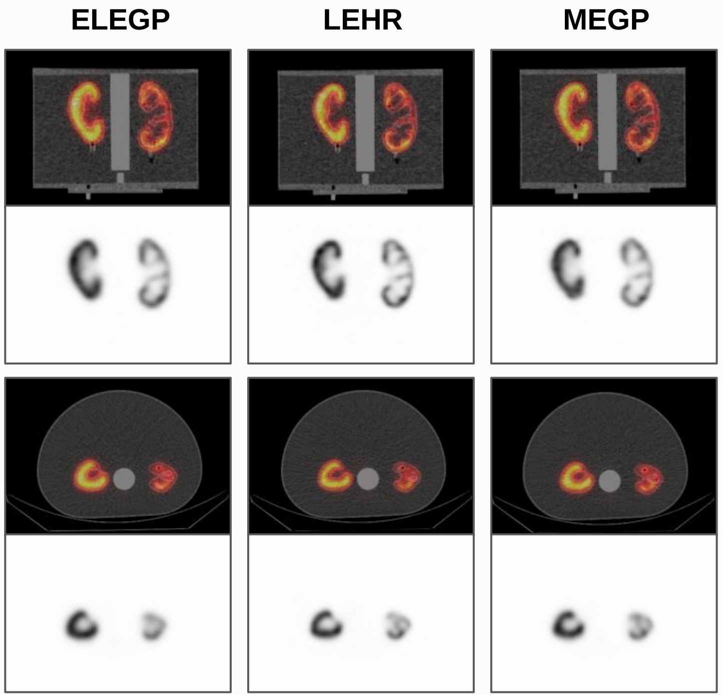
Clinical dosimetry & SPECT imaging with ^{161}Tb

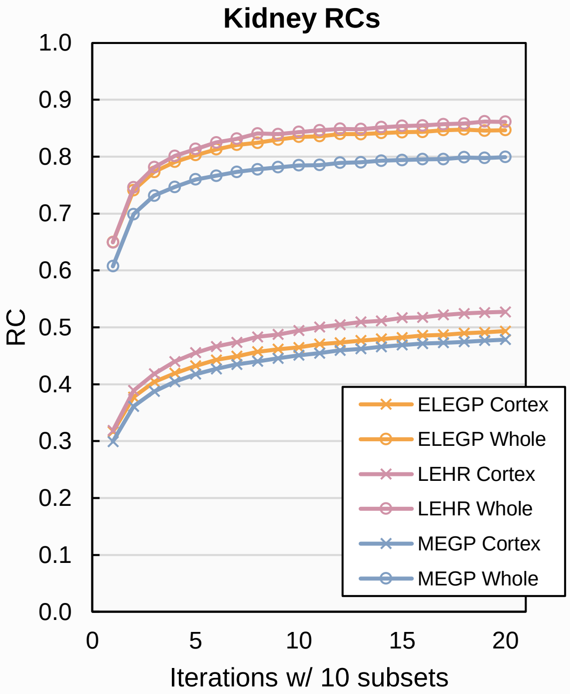


Number	Center (keV)	Width (%)	Shift (%)	Type	Parent
A1	48	40	0	Photopeak	
B2	75	20	0	Photopeak	
C3		10		Lower Scatter	A1
D4		10		Upper Scatter	A1
E5		6		Lower Scatter	B2
F6		6		Upper Scatter	B2

Clinical dosimetry & SPECT imaging with ^{161}Tb

Kidney RCs





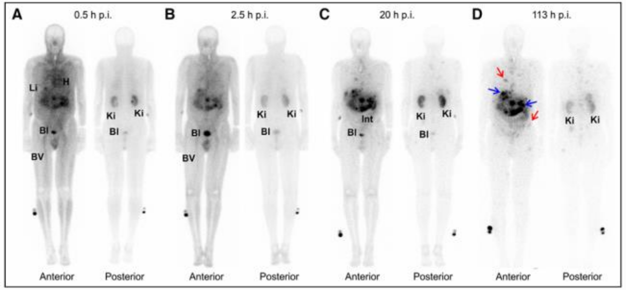
- RC highest for LEHR, followed by ELEGP and MEGP

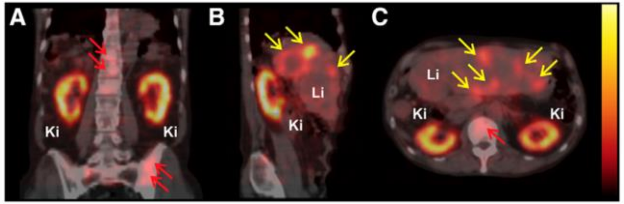
Is Radionuclide Therapy with ^{161}Tb Really Happening?

First-in-Humans Application of ^{161}Tb: A Feasibility Study Using ^{161}Tb-DOTATOC

Richard P. Baum*[1], Aviral Singh*[1,2], Harshad R. Kulkarni[1], Peter Bernhardt[3,4], Tobias Rydén[3,4], Christiane Schuchardt[1], Nadezda Gracheva[5], Pascal V. Grundler[5], Ulli Köster[6], Dirk Müller[7], Michael Pröhl[7], Jan Rijn Zeevaart[8], Roger Schibli[5,9], Nicholas P. van der Meulen[5,10], and Cristina Müller[5]

J Nucl Med 2021; 62:1391–1397



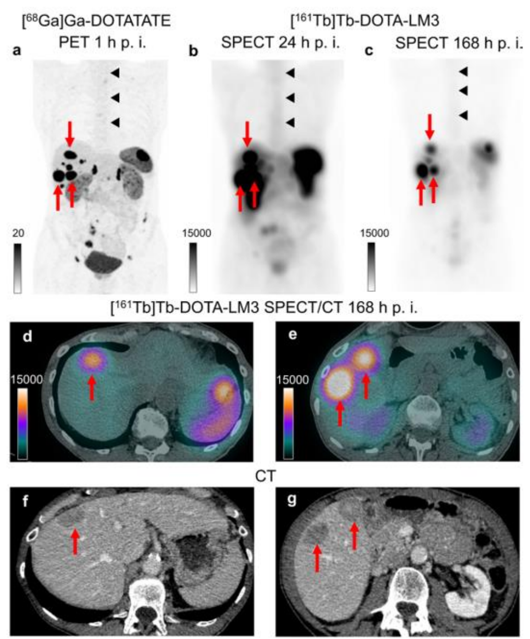


European Journal of Nuclear Medicine and Molecular Imaging
https://doi.org/10.1007/s00259-024-06641-w

IMAGE OF THE MONTH

First-in-human administration of terbium-161-labelled somatostatin receptor subtype 2 antagonist ([^{161}Tb]Tb-DOTA-LM3) in a patient with a metastatic neuroendocrine tumour of the ileum

Julia Fricke[1] · Frida Westerbergh[2] · Lisa McDougall[1] · Chiara Favaretto[1,3] · Emanuel Christ[4,5] · Guillaume P. Nicolas[1,4] · Susanne Geistlich[3] · Francesca Borgna[3] · Melpomeni Fani[6] · Peter Bernhardt[2,7] · Nicholas P. van der Meulen[3,8] · Cristina Müller[3,9] · Roger Schibli[3,9] · Damian Wild[1,4]



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Theranostics
2024; 14(5): 1829-1840. doi: 10.7150/thno.92273

Research Paper

[^{161}Tb]Tb-PSMA-617 radioligand therapy in patients with mCRPC: preliminary dosimetry results and intra-individual head-to-head comparison to [^{177}Lu]Lu-PSMA-617

Andrea Schaefer-Schuler, Caroline Burgard, Arne Blickle, Stephan Maus, Christine Petrescu, Sven Petto, Mark Bartholomä, Tobias Stemler, Samer Ezziddin and Florian Rosar

From Despair to Hope: First Arabic Experience of ^{177}Lu-PSMA and ^{161}Tb-PSMA Therapy for Metastatic Castration-Resistant Prostate Cancer

by Akram Al-Ibraheem [1,2,*], Ahmed Saad Abdlkadir [1], Deya' Aldeen Sweedat [1], Stephan Maus [3], Ula Al-Rasheed [1], Samer Salah [4], Fadi Khriesh [5], Diyaa Juaidi [1], Dina Abu Dayek [1], Feras Istatieh [1], Farah Anwar [6], Aisha Asrawi [7], Alaa Abufara [4], Mohammad Al-Rwashdeh [4], Ramiz Abu-Hijlih [8], Baha' Sharaf [4], Rami Ghanem [9], Hikmat Abdel-Razeq [4] and Asem Mansour [10]

McIntosh et al. EJNMMI Physics (2024) 11:18
https://doi.org/10.1186/s40658-024-00611-9
EJNMMI Physics

ORIGINAL RESEARCH Open Access

Quantitative calibration of Tb-161 SPECT/CT in view of personalised dosimetry assessment studies

Lachlan McIntosh[1,2*†], Price Jackson[1,3†], Brittany Emmerson[1], James P. Buteau[1,3], Ramin Alipour[1,3], Grace Kong[1,3] and Michael S. Hofman[1,3]

Is Radionuclide Therapy with ^{161}Tb Really Happening?

Clinical trials

Beta plus

Combined Beta- Plus Auger Electron Therapy Using a Novel Somatostatin Receptor Subtype 2 Antagonist Labelled With Terbium-161 (161Tb-DOTA-LM3) (Beta plus)

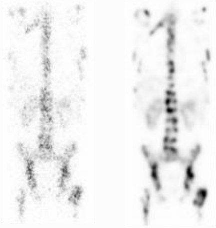
PROGNOSTICS

Targeted Radionuclide Therapy in Metastatic Prostate Cancer Using a New PSMA Ligand Radiolabelled With Terbium-161 (161Tb-SibuDAB) - Dose Identification/Escalation Phase Ia/b Study

VIOLET

EValuation of radIOLigand Treatment in mEn With Metastatic Castration-resistant Prostate Cancer With [161Tb]Tb-PSMA-I&T

Image reconstruction



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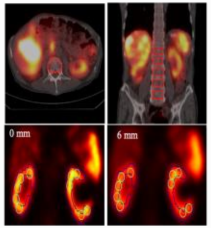
Tobias Rydén, PhD
Martijn Van Essen, PhD, MD
Emma Wikberg, PhD student
Frida Westerbergh, PhD student
Katja Smits, PhD student
Jakob Himelmann PhD student

Dosimetry



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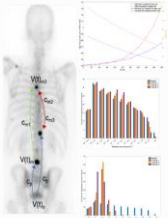
Jens Hemmingsson, Postdoc
Johanna Svensson, PhD, MD
Andreas Hallqvist, PhD, MD
Linn Hagmarker, PhD student
Jehangir Khan, PhD student

Response modelling & Clinical studies



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International Collaborators

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Radiochemistry

Nick Van der Meulen , PhD
Paul Scherrer institute, Schweiz

Clinical studies

Daiman Wild, Professor
Basel University Hospital, Schweiz

Clinical studies:

ILUMINET; ^{177}Lu-DOTATATE, academic driven phase II study, PI: Johanna Svensson, Gothenburg University; PI: Anna Sundlöv, Lund University

STARTNET; ^{177}Lu-DOTATOC, academic driven phase II study, PI: Andreas Hallqvist, Gothenburg University; PI: Pernilla Asp, Lund University

LuPARP; ^{177}Lu-DOTATATE+olaparib, academic driven phase I study, PI: Andreas Hallqvist, Gothenburg University

Betaplus; ^{161}Tb-ML3, academic driven phase 0/1 study, PI: Daiman Wild, Basel University Hospital

PROGNOSTICS; ^{161}Tb-PSMA, academic driven phase 0/1 study, PI: Daiman Wild, Basel University Hospital

VISION, PSMAaddition, PSMAfore, multicenter phase III studies, PI: Jon Kindblom, Gothenburg University

Cancerfonden
Swedish Research Council
Strål säkerhets myndigheten
JUBILEUMSKLINIKENS CANCERFOND
VÄSTRA GÖTALANDSREGIONEN SAHLGRENSKA UNIVERSITETSSJUKHUSET

DOSIMETRIC COMPARISION OF THE RADIOLANTHANIDES LU-177 AND TB-161 FOR CANCER THERPIES WITH RADIOPHARMACEUTICALS

PETER BERNHARDT, DEPARTMENT OF MEDICAL RADIATION SCIENCES, INSTITUTE OF CLINICAL SCIENCE