C. Bailly

The theranostic approach « à la Nantaise »

CHU NANTES
AUX NOUVELLES FRONTIÈRES DE LA SANTÉ

Inserm
Institut national de la santé et de la recherche médica

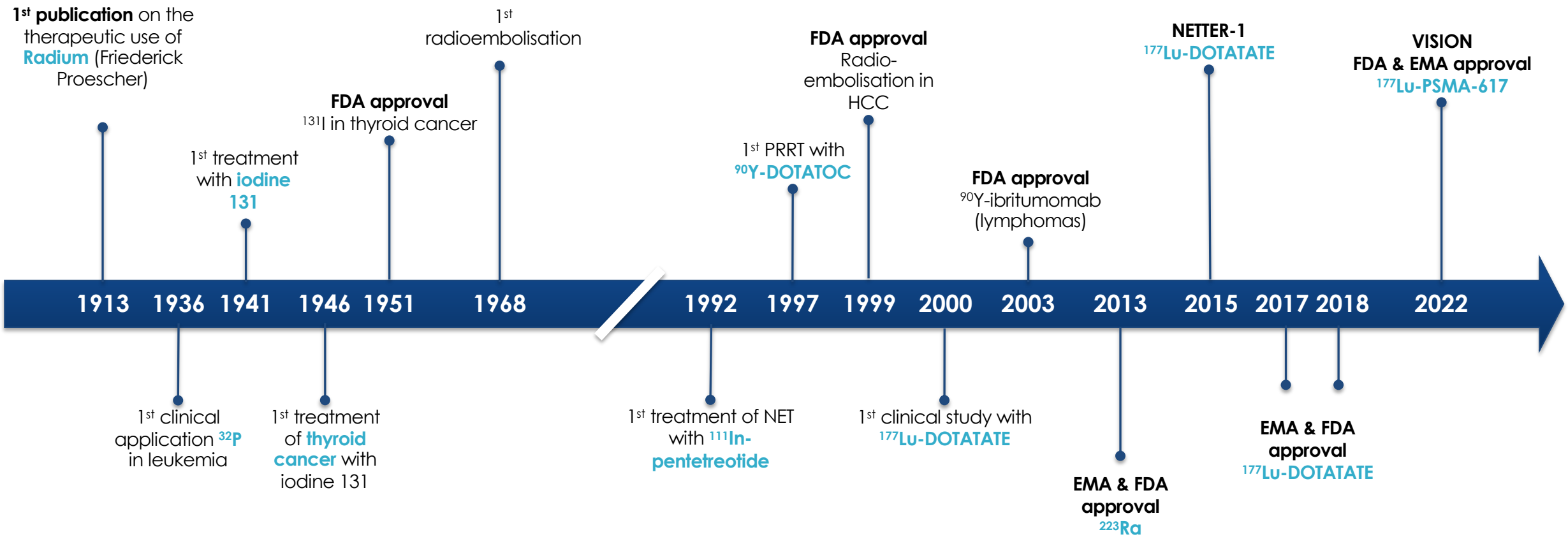
CRCI²NA
CANCER & IMMUNOLOGY

iron labex

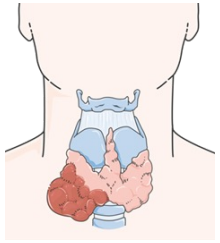
ILIAD

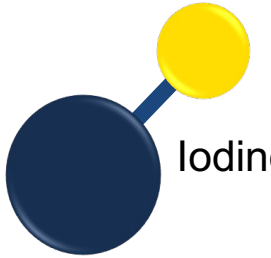
Nantes Université

Targeted radionuclide therapy

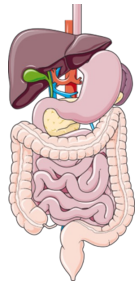


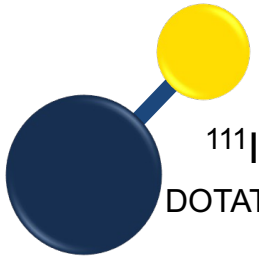
TRT in daily practice





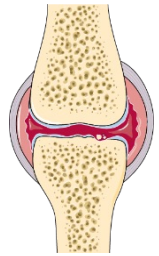
Iodine^{131}

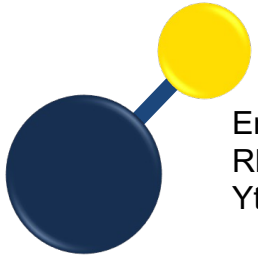




^{111}In/^{90}Y/^{177}Lu

DOTATATE

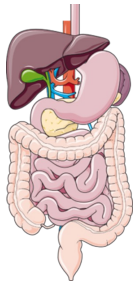


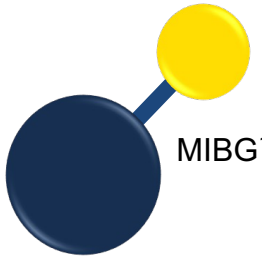


Erbium^{169}

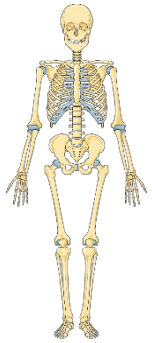
Rhenium ^{186}

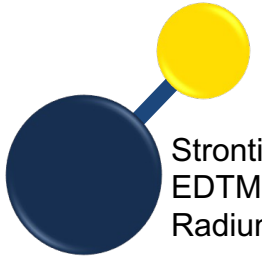
Yttrium^{90}





MIBG^{131}

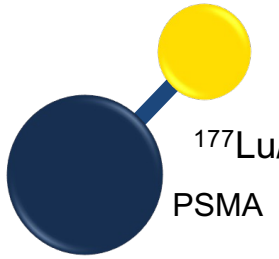




Strontium^{89} /

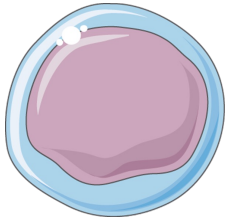
EDTMP-Samarium^{153}/

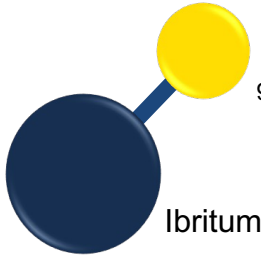
Radium^{223}



^{177}Lu/^{213}Bl/^{225}Ac

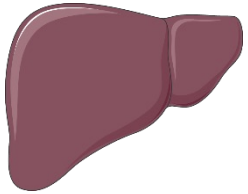
PSMA

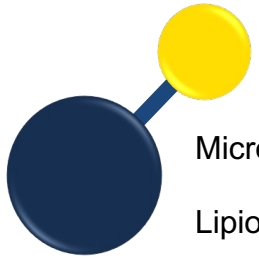




^{90}Y

Ibritumomab





Microspheres Y^{90}

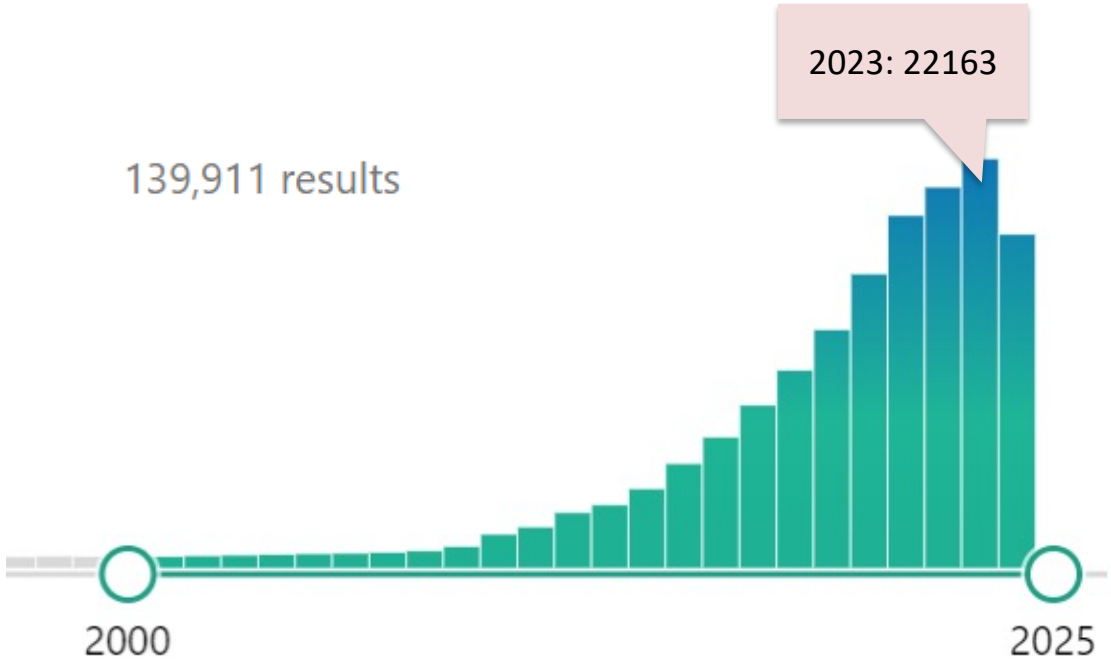
Lipiodol I^{131}

Theranostics ?

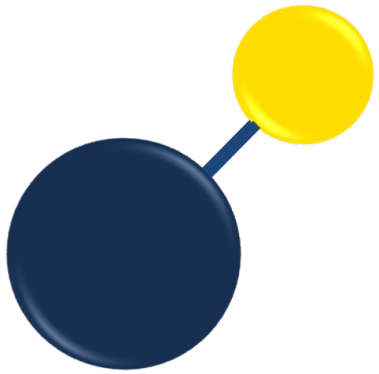
- Combination of 2 words:

Diagnostics Therapeutics

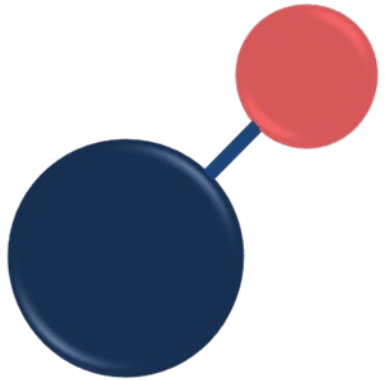
- First used by John Funkhouser (Chief Executive Officer of PharmaNetics) in 2002 to describe one of his company's objectives: to develop **diagnostic tests** directly linked to **specific therapies**.



Radiotheranostics



γ or β+ : Imaging

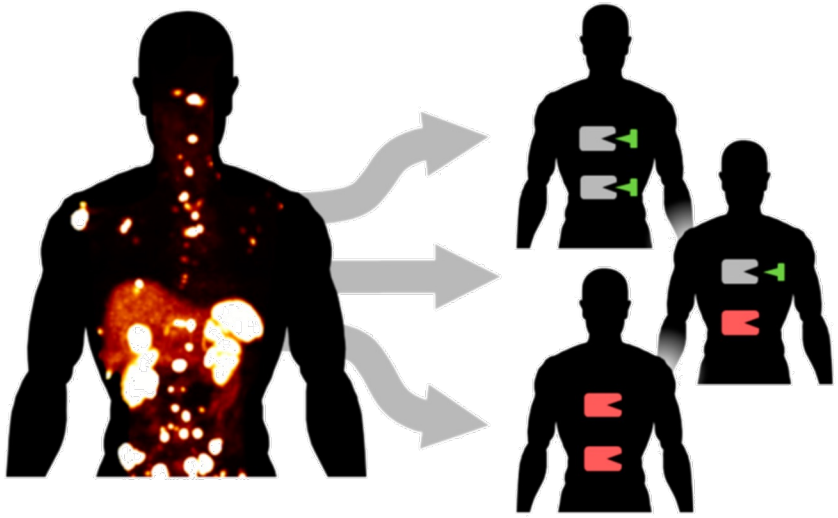


β- or α : Therapy

Molecular Imaging
i.e. PET imaging

Cancer Stratification
Target expression?

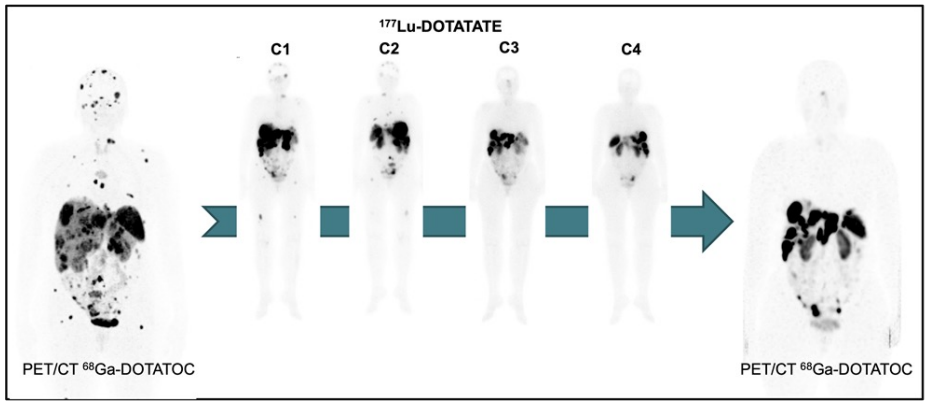
Treatment Decision
Individualized therapy



Positive outcome to be expected

Outcome is unknown

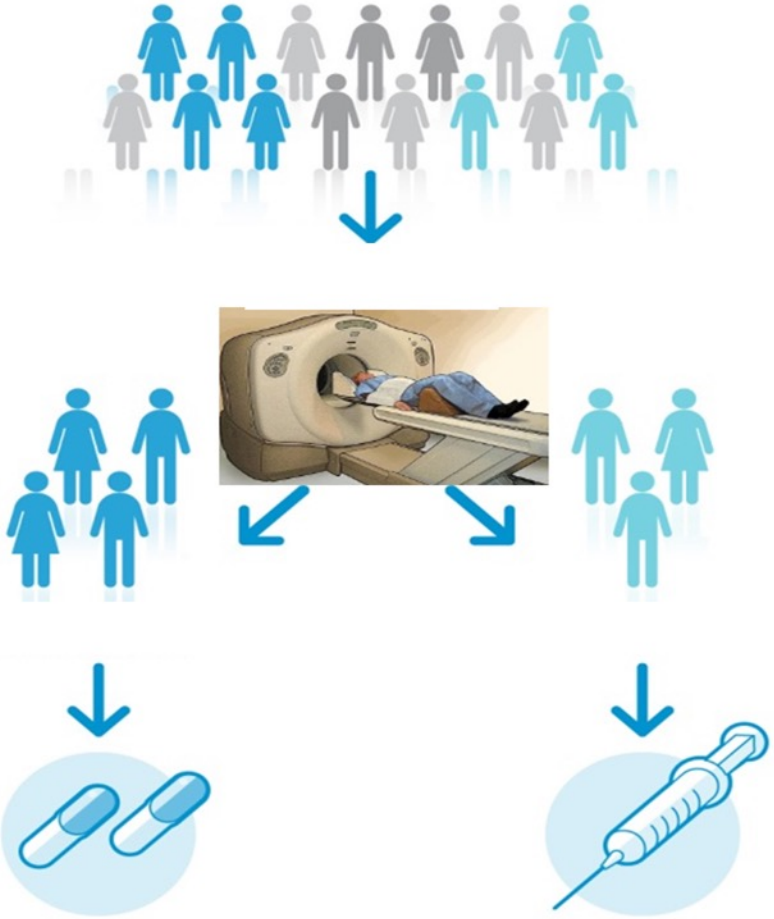
Negative outcome to be expected



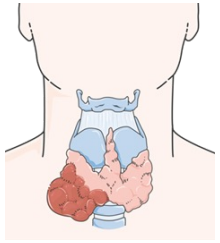
Aims of Radiotheranostics?

- To determine **localization/accessibility** in the site or disease state under study as a **surrogate for a potential therapeutic** agent with similar chemical properties
- To examine its **biodistribution** as predictive of **off target (adverse)** effects of the potential therapeutic agent
- To **monitor the response** to this treatment
- As an aid in determining the **optimal therapeutic dose** or **activity** to be administered, based on the anticipated tumoricidal doses measured in the tumor site

SELECTION of the patient

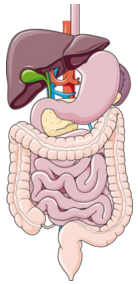


TRT in daily practice



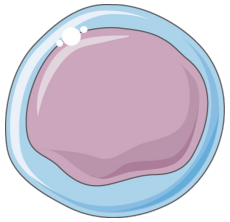
Iode^{131}

Iode^{131}



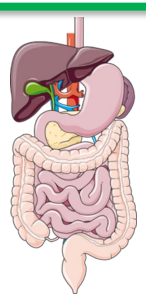
MIBG^{123}

MIBG^{131}



^{111}In Ibritumomab

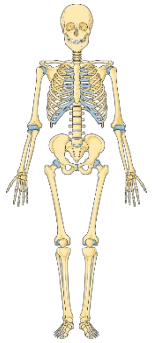
^{90}Y Ibritumomab



DOTANOC
DOTATOC
DOTATATE

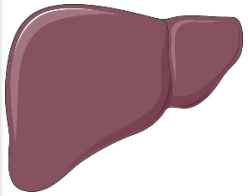
^{68}Ga

^{177}Lu DOTATATE



HDP Tc^{99m}

Strontium^{89} / EDTMP-Samarium^{153}/ Radium^{223}



MAA Tc^{99m}

Microspheres Y^{90}

SPECT/CT

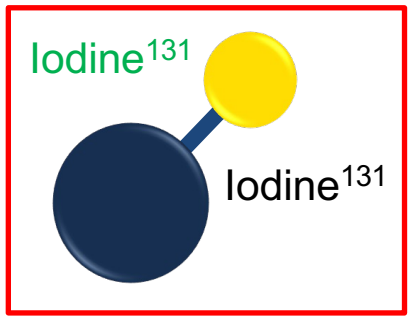
PET/CT

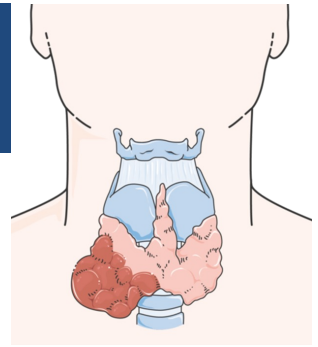
PSMA

^{68}Ga/^{18}F

^{177}Lu/^{213}Bl/^{225}Ac PSMA

Thyroid cancer: a historical application





838 RADIOACTIVE IODINE—SEIDLIN ET AL. J. A. M. A. Dec. 7, 1946

autumn, a single month providing 5 per cent of the infections. Grassing, paving roads and runways and ultimately the use of highly refined oil on athletic areas were important dust control measures. This control reduced infection rates from one half to two thirds.

2330 Clay Street, San Francisco 15.
2330 Clay Street, San Francisco 15.
636 South Painter Street, Whittier, Calif.
2298 Durant Avenue, Berkeley 4, Calif.

ABSTRACT OF DISCUSSION

Dr. Russell V. Lee, San Francisco: Dr. Smith and his associates know more about coccidioidomycosis than any one else, and this work with the Army Air Forces and Ground Forces was a most remarkable piece of combined epidemiology and curative medicine. They surveyed every man in that

a lot of dust; soldiers around camps and marching in physical training kick up a lot of dust, and they have become infected at a terrific rate. There was a hospital at San Benito where

RADIOACTIVE IODINE THERAPY

Effect on Functioning Metastases of Adenocarcinoma of the Thyroid

S. M. SEIDLIN, M.D.
L. D. MARINELLI, M.A.
and
ELEANOR OSHRY, B.S.
New York

Therapy of neoplastic disease usually consists of two phases: first, the treatment of the primary focus and, second, that of metastases. Specifically, in adenocarcinoma of the thyroid, the primary site together with its immediate extensions is conventionally treated by surgery, radiation or both. Distant metastases, if treated, are usually subjected to palliative external

of the thyroid. In a patient with multiple lesions, Geiger counter measurements showed appreciable uptake of radioactive iodine in only one of the metas-

RADIOACTIVE IODINE THERAPY

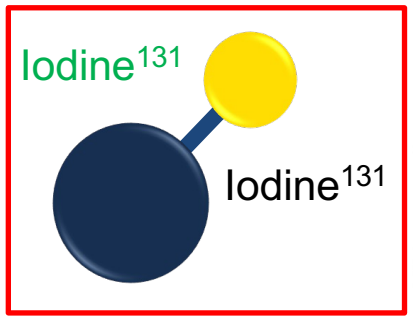
Effect on Functioning Metastases of Adenocarcinoma of the Thyroid

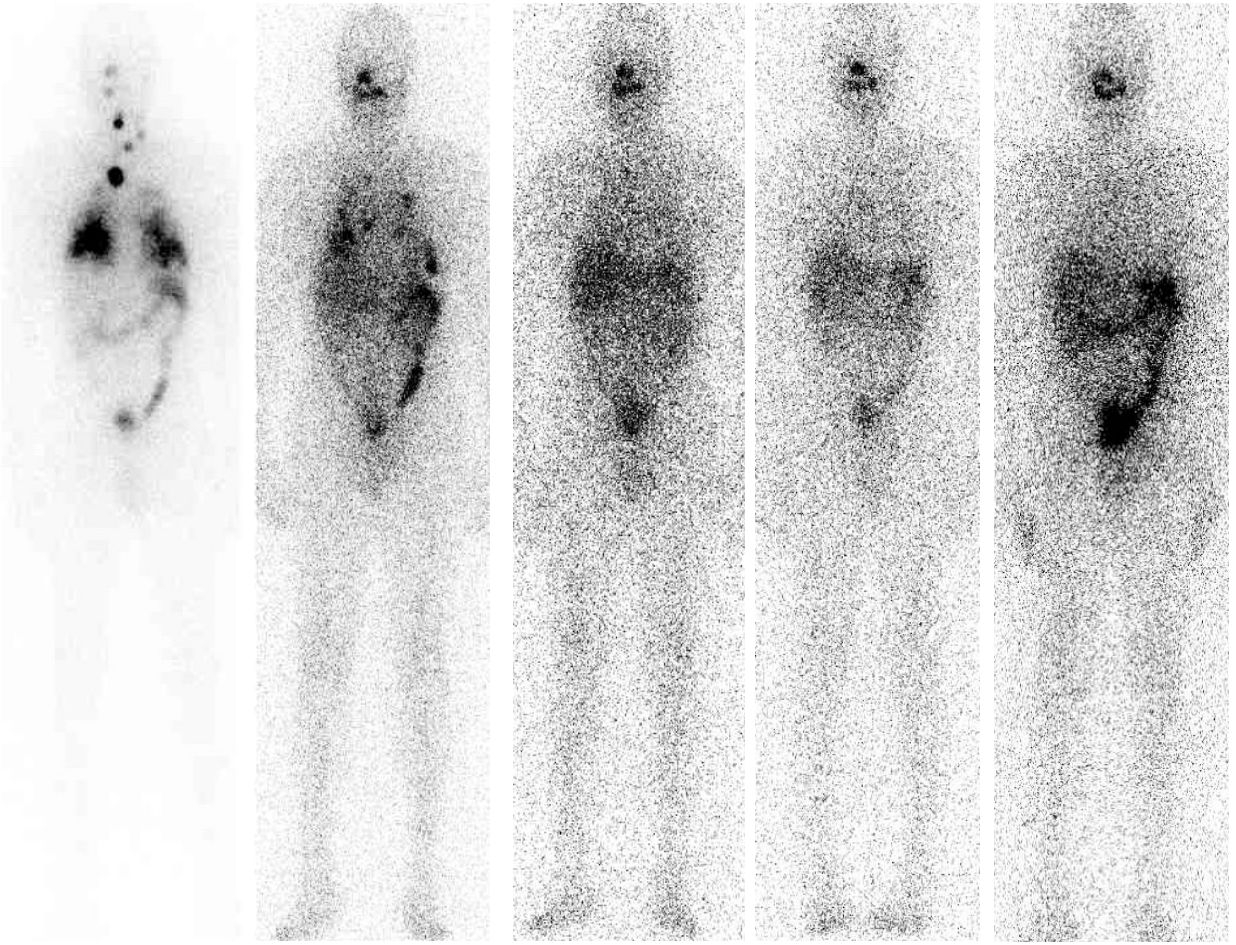
S. M. SEIDLIN, M.D.; L. D. MARINELLI, M.A.; ELEANOR OSHRY, B.S.

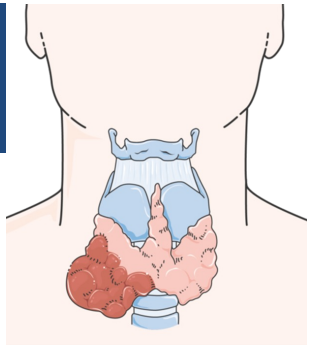
JAMA. 1946;132(14):838-847.

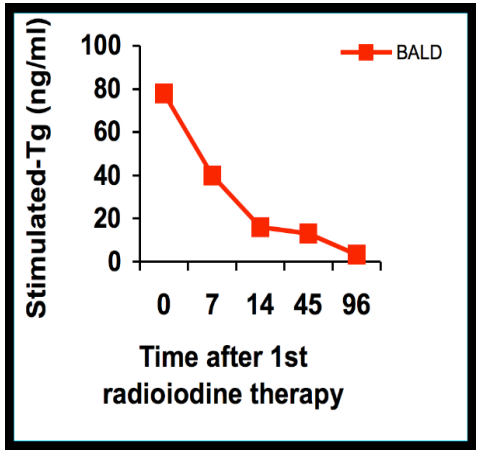
- Diagnostic whole body scan with ^{131}I : first example of theranostics

Thyroid cancer: a historical application





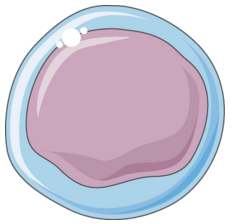




D.Taïeb 2007

- Ability to **detect iodine uptake** in metastases of differentiated thyroid carcinoma and to **identify patients** who would benefit from therapeutic doses of ^{131}I.

Haematological diseases: whistles in the wind



- **Rituximab** (Rituxan) is a chimeric (murine and human) monoclonal antibody **targeting CD-20+** antigen

YET…. a commercial failure.

VOLUME 28 · NUMBER 18 · JUNE 20 2010

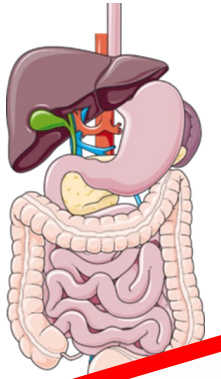
JOURNAL OF CLINICAL ONCOLOGY

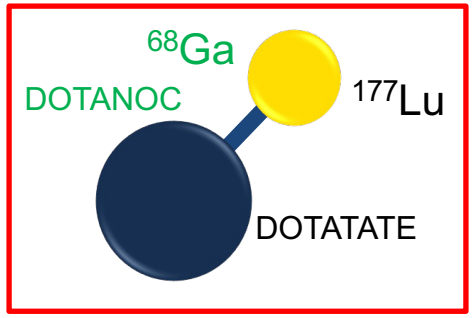
COMMENTS AND CONTROVERSIES

Radioimmunotherapy of Lymphoma: A Treatment Approach Ahead of Its Time or Past Its Sell-By Date?

Tim Martin Illidge, *School of Cancer and Imaging Sciences, Manchester Academic Health Sciences, University of Manchester, Manchester, United Kingdom*

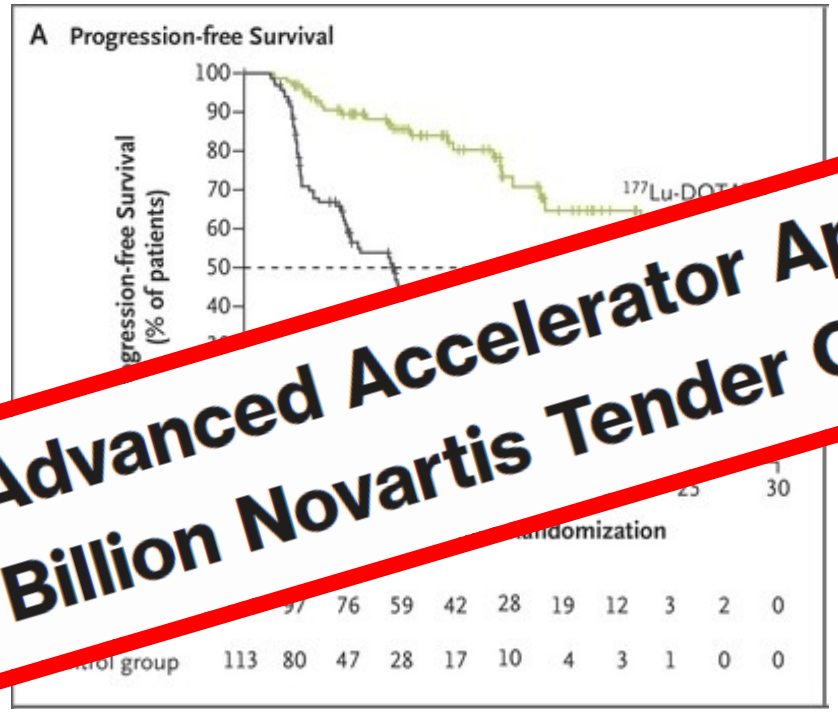
Neuroendocrine tumors: the new "flagship"





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, and E. Krenning, for the NETTER-1 Trial Investigators*

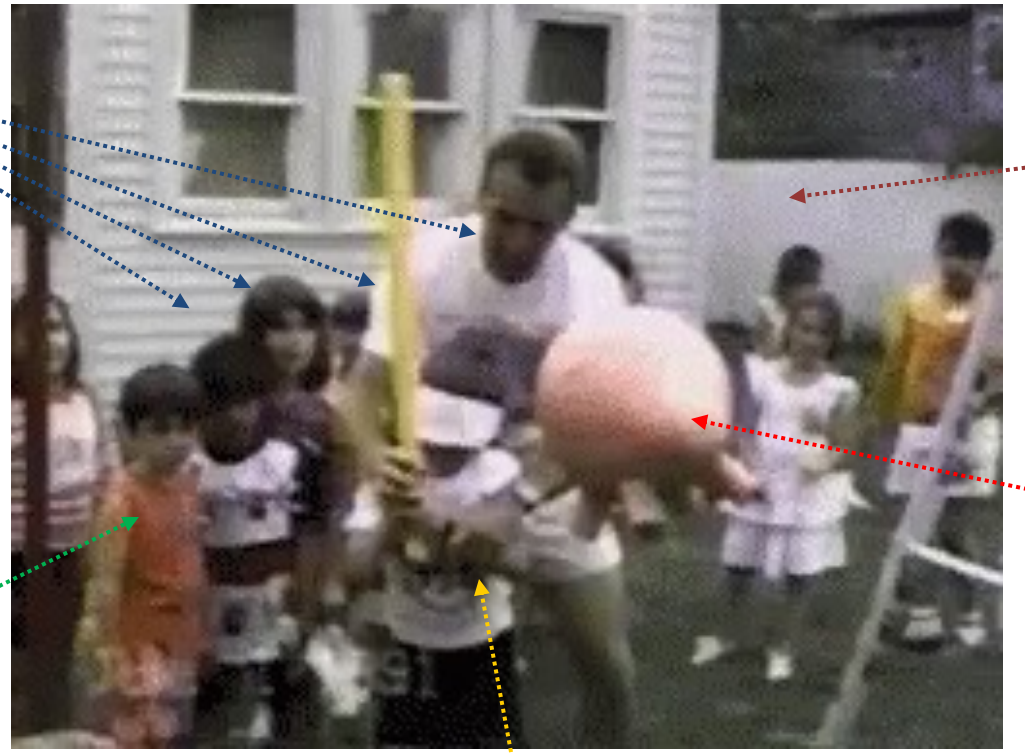


Advanced Accelerator Applications Announces Completion of $3.9 Billion Novartis Tender Offer

Radiotheranostics

« We treat what we see, we see what we treat »

Multidisciplinary board



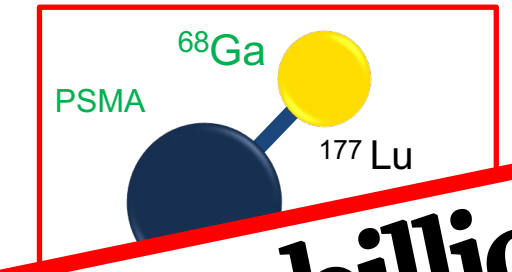
Oncologist

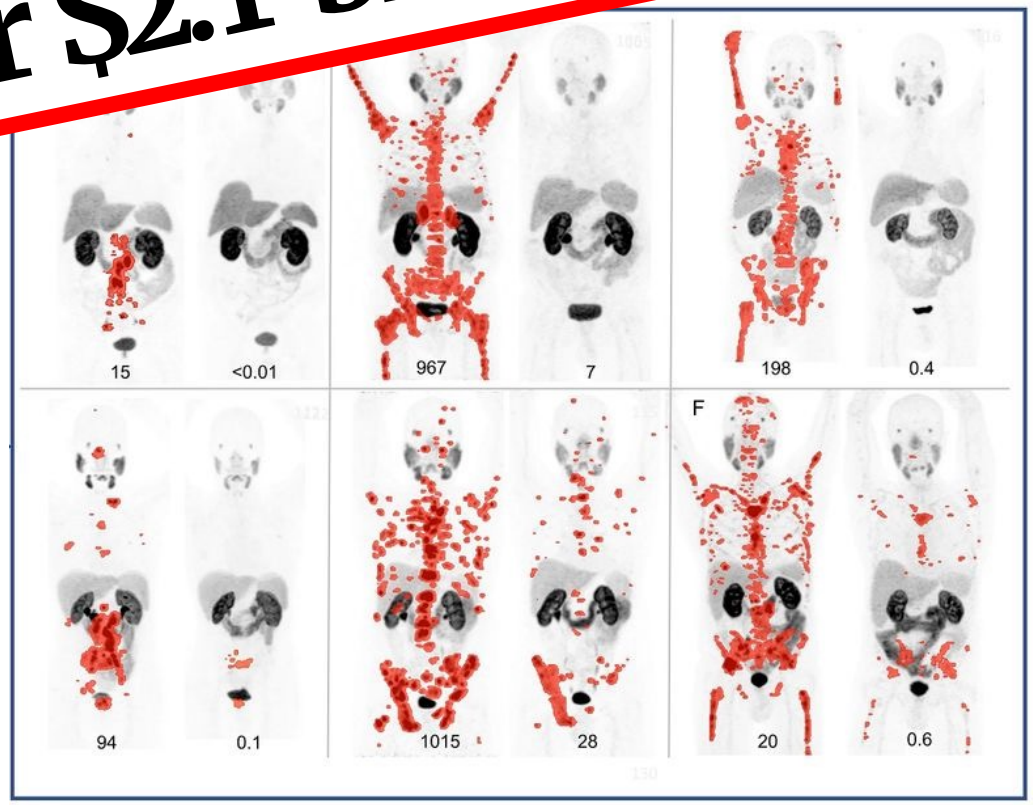
Tumor

Patient

Treatment

177Lu-PSMA: future "success story"?

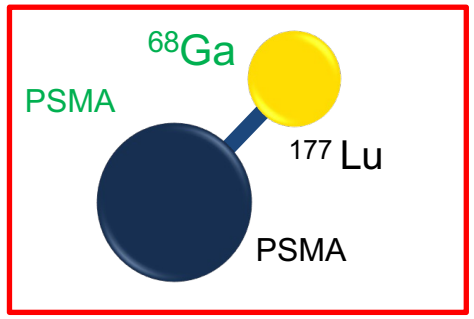




68Ga-PSMA11 PET maximum intensity projection (MIP) images at baseline and 3 months after 177Lu-PSMA617 in 6 patients with PSA decline >98%. Any disease with SUVmax over 3 in red.

Novartis buys Endocyte for $2.1 billion

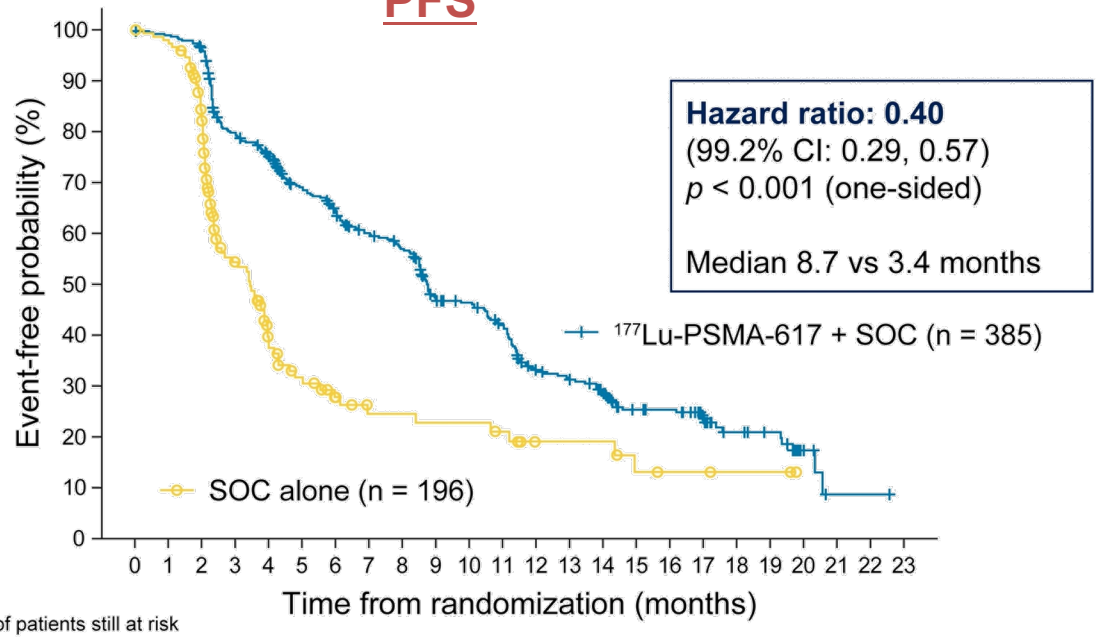
177Lu-PSMA: future "success story"?



Hofman et al 2018

ASCO 2021: Phase III Study of Lutetium-177-PSMA-617 in Patients with Metastatic Castration-Resistant Prostate Cancer (VISION)

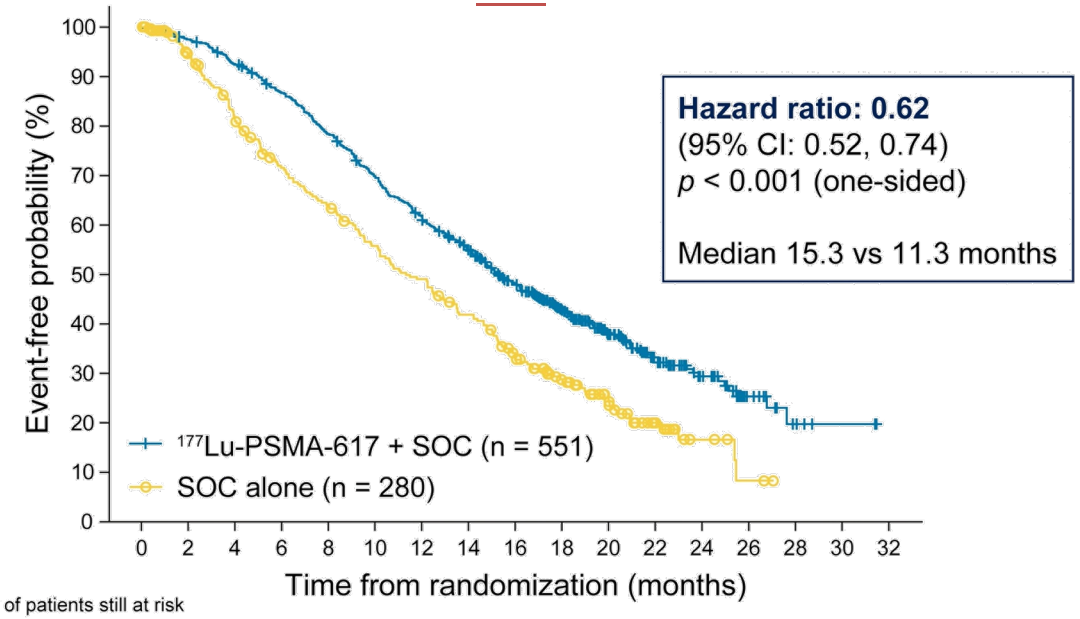
PFS



Number of patients still at risk

177Lu-PSMA-617 + SOC	385	373	362	292	272	235	215	194	182	146	137	121	88	83	71	51	49	37	21	18	6	1	1	0
SOC alone	196	146	119	58	36	26	19	14	14	13	13	11	7	7	7	4	3	3	2	2	0	0	0	0

OS



Number of patients still at risk

177Lu-PSMA-617 + SOC	551	535	506	470	425	377	332	289	236	166	112	63	36	15	5	2	0						
SOC alone	280	238	203	173	155	133	117	98	73	51	33	16	6	2	0	0	0						

ansm
Agence nationale de sécurité du médicament et des produits de santé

Temporary autorisation since december 2021

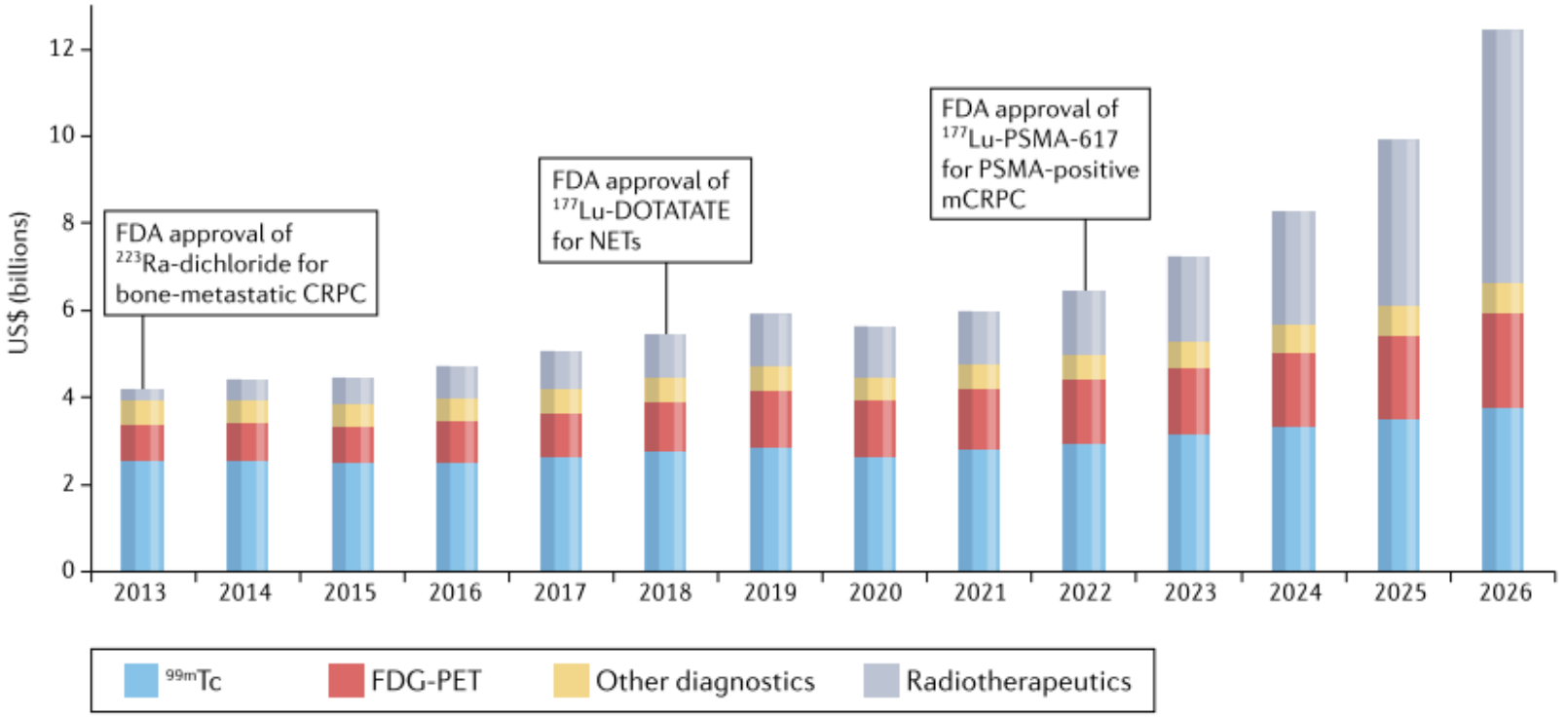
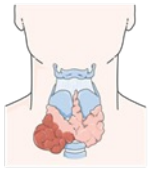


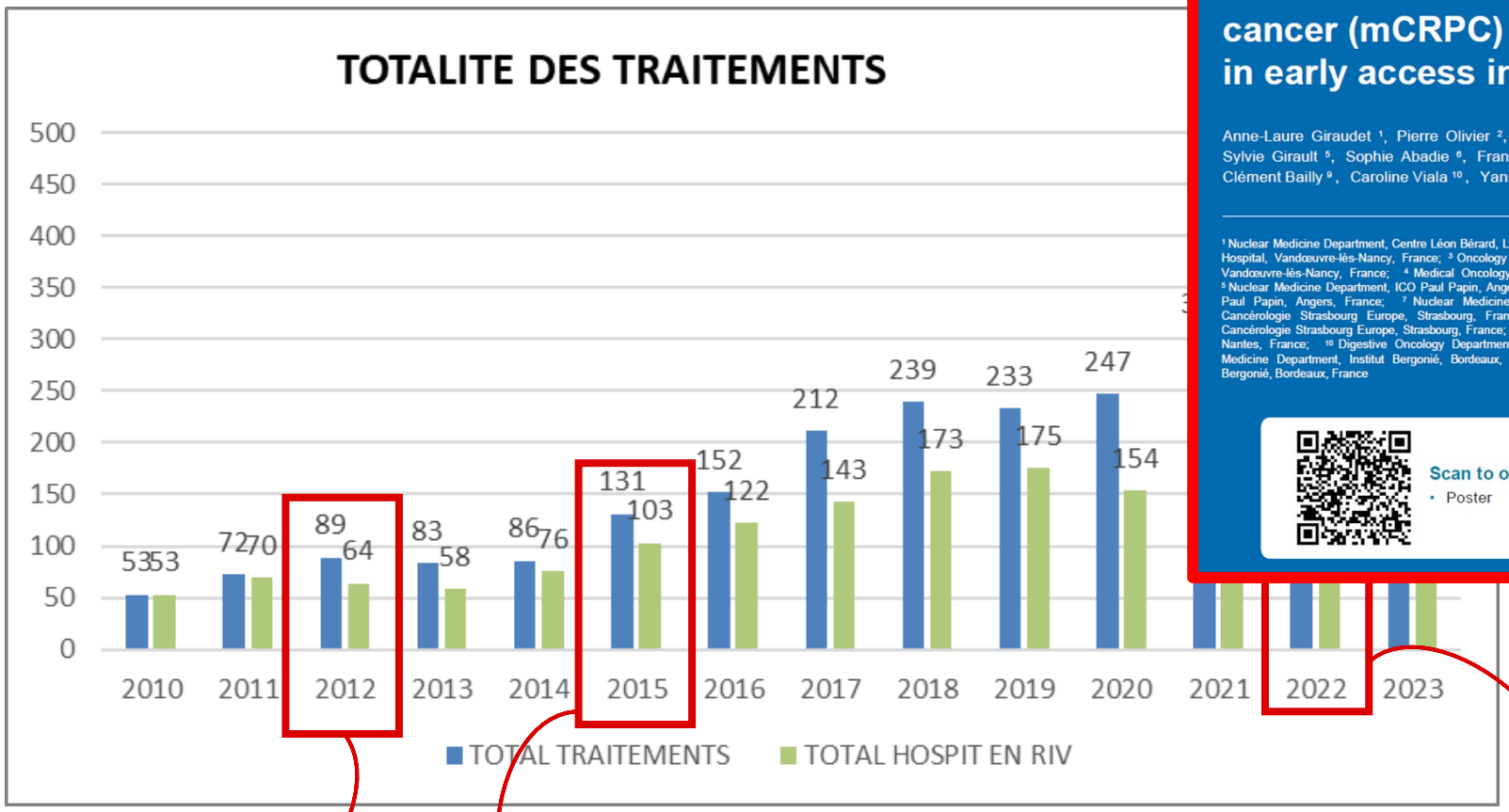
Fig. 3 | **The predicted global nuclear medicine market 2013–2026.** This projected market growth likely reflects the availability of a greater number of agents, implementation at an increasing number of centres and projected increases in the numbers of patients with cancer globally. ©MEDraysintell Nuclear Medicine Report & Directory, Edition 2021. CRPC, castration-resistant prostate cancer; mCRPC, metastatic CRPC; NET, neuroendocrine tumour; PSMA, prostate-specific membrane antigen.

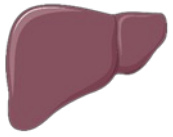
Bodei L,. Radiotheranostics in oncology: current challenges and emerging opportunities. Nat Rev Clin Oncol. (2022)

Nuclear Medicine Department
CHU de Nantes

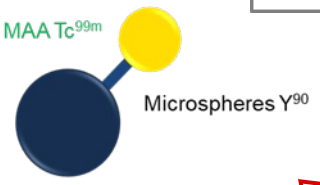


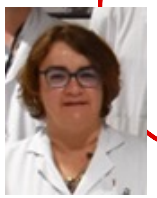
Iode^{131}





MAA Tc^{99m}





^{68}Ga
DOTANOC
^{177}Lu
DOTATATE

^{68}Ga
PSMA
^{177}Lu
PSMA

First real-life data on [^{177}Lu]Lu-PSMA-617 : Descriptive analysis on the largest metastatic castration-resistant prostate cancer (mCRPC) cohort treated in early access in France

Anne-Laure Giraudet [1], Pierre Olivier [2], Vincent Massard [3], Aude Fléchon [4], Sylvie Girault [5], Sophie Abadie [6], François Somme [7], Philippe Barthélémy [8], Clément Bailly [9], Caroline Viala [10], Yann Godbert [11] and Guilhem Roubaud [12]

[1] Nuclear Medicine Department, Centre Léon Bérard, Lyon, France; [2] Nuclear Medicine Department, Brabois Hospital, Vandœuvre-lès-Nancy, France; [3] Oncology Department, Institut de Cancérologie de Lorraine, Vandœuvre-lès-Nancy, France; [4] Medical Oncology Department, Centre Léon Bérard, Lyon, France; [5] Nuclear Medicine Department, ICO Paul Papin, Angers, France; [6] Department of Medical Oncology, ICO Paul Papin, Angers, France; [7] Nuclear Medicine and Molecular Imaging Department, Institut de Cancérologie Strasbourg Europe, Strasbourg, France; [8] Medical Oncology Department, Institut de Cancérologie Strasbourg Europe, Strasbourg, France; [9] Nuclear Medicine Department, University Hospital, Nantes, France; [10] Digestive Oncology Department, University Hospital, Nantes, France; [11] Nuclear Medicine Department, Institut Bergonié, Bordeaux, France; [12] Medical Oncology Department, Institut Bergonié, Bordeaux, France

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http://novartis.medicalcongressposters.com/Default.aspx?doc=fe99a

Nuclear Medicine in Nantes

2008 2009 2012 2015 2017 2018 2019 2022 2023

Cancéropôle grand ouest

Axe Vectorisation & radiothérapies

Isotop4life

Arronax Plus

DHU ONCO-GREFFE

NeXT HEALTH AND ENGINEERING

SIRIC ILIAD Nantes - Angers

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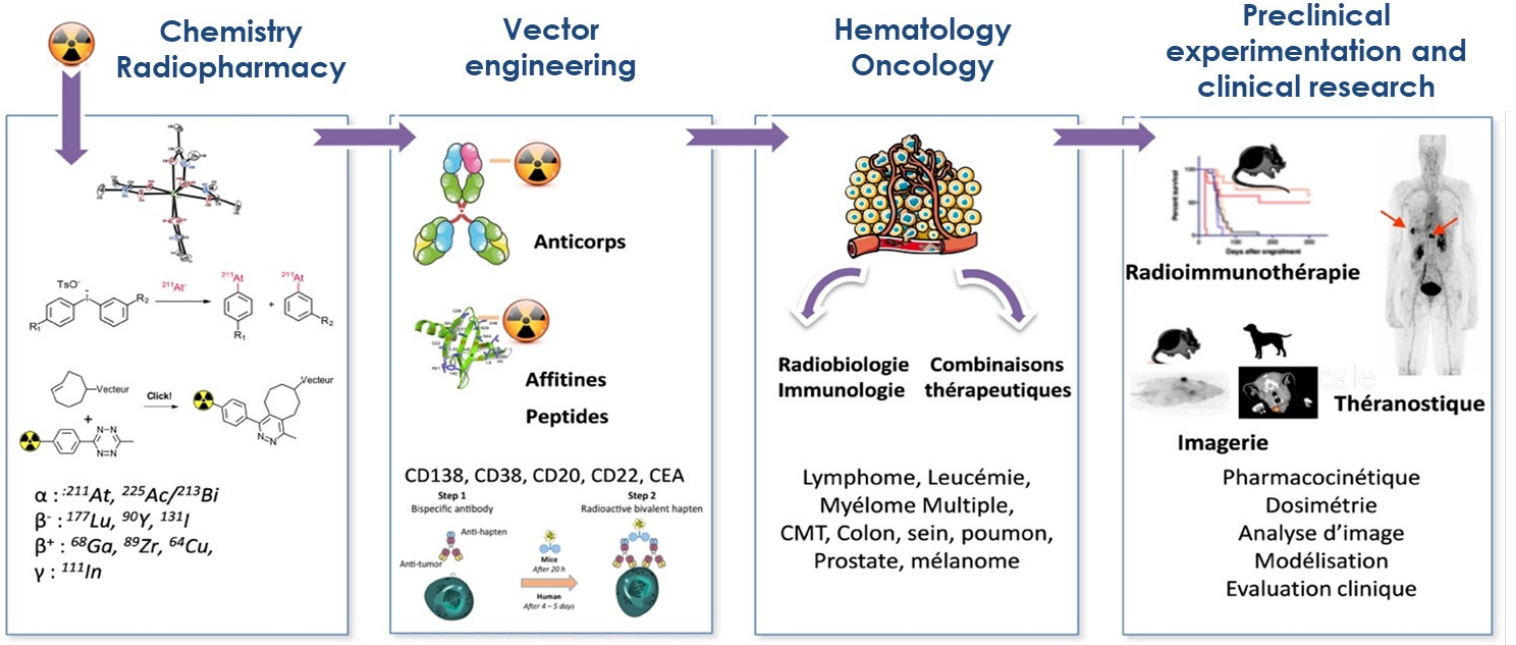
ARRONAX



CHU NANTES AUX NOUVELLES FRONTIÈRES DE LA SANTÉ

Institut de Cancérologie de l'Ouest UNICANCER PAYS DE LA LOIRE

Crip Centre de Recherche et d'Investigation Préclinique

CEISAM Chimie et Interdisciplinarité Synthèse, Analyse, Modélisation

CRCI²NA CANCER & IMMUNOLOGY

LS2N LABORATOIRE DES SCIENCES DU NUMÉRIQUE DE NANTES

What future for theranostics ?

- **Optimising/standardising/improving** current applications/therapies
- **Search** for new **targets**
- **Development** of new **molecules**
- **Technological inovations**
- **Alphatherapy**

What future for theranostics ?

Normalization ??

Annals of Nuclear Medicine (2018) 32:512–522
https://doi.org/10.1007/s12149-018-1291-7

REVIEW ARTICLE

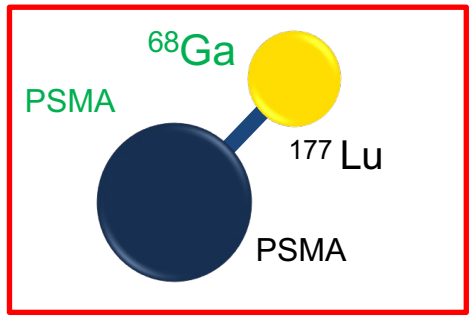
Molecular imaging reporting and data systems (MI-RADS): a generalizable framework for targeted radiotracers with theranostic implications

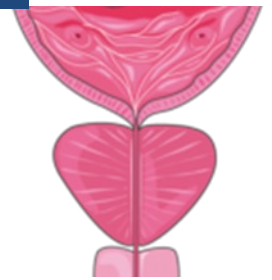
Rudolf A. Werner[1,2,3] · Ralph A. Bundschuh[4] · Lena Bundschuh[4] · Mehrbod S. Javadi[1] · Takahiro Higuchi[2,5] · Alexander Weich[3,6] · Sara Sheikhbahaei[1] · Kenneth J. Pienta[7] · Andreas K. Buck[2,3] · Martin G. Pomper[1] · Michael A. Gorin[1,7] · Constantin Lapa[2,3] · Steven P. Rowe[1,7]

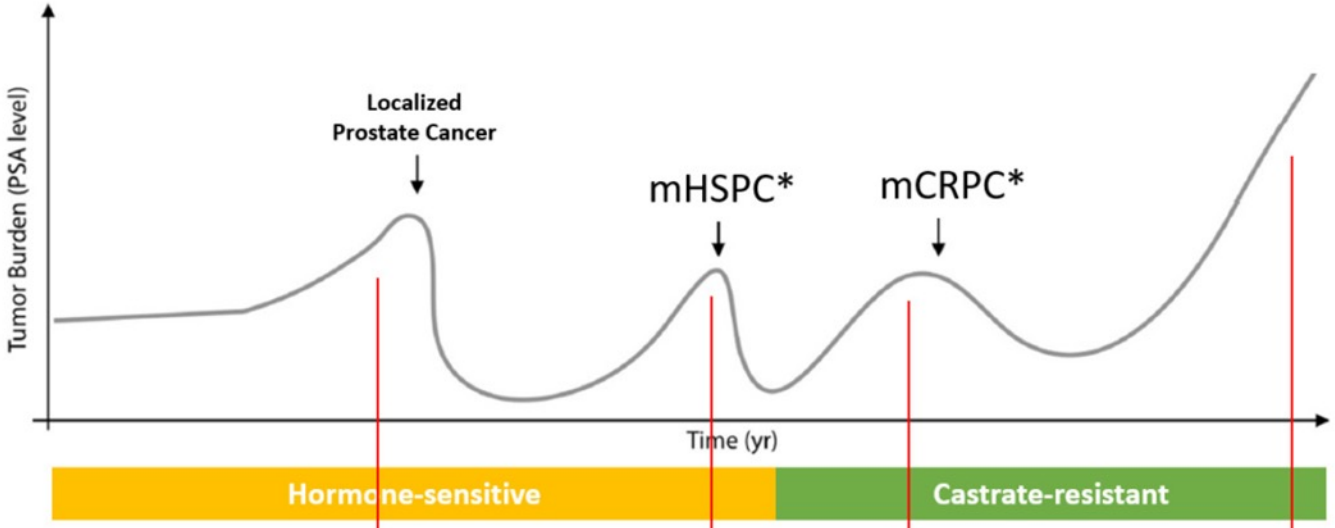
Molecular Imaging Reporting and Data System

1	1A	Benign lesion, characterized by biopsy or anatomic imaging without abnormal uptake	n/a	1	N
	1B	Benign lesion, characterized by biopsy or anatomic imaging with abnormal uptake	n/a	2–3	N
2		Soft-tissue site or bone lesion atypical for metastatic PCa or NET	n/a		N
3	3A	Equivocal uptake in soft-tissue lesion typical of PCa or NET	B, F/U	1–2	N
	3B	Equivocal uptake in bone lesion not atypical of PCa or NET	B, F/U	1–2	N[b]
	3C	Intense uptake in site highly atypical of all but advanced stages of PCa or NET (i.e., high likelihood of nonprostatic/non-NET malignancy or other benign tumor)	B	3	N
	3D	Lesion suggestive of malignancy on anatomic imaging but lacking uptake. For SSTR-RADS: 2-deoxy-2-[^{18}F]-fluoro-D-glucose [^{18}F]-FDG is recommended to rule out potential dedifferentiation of a single lesion	B, F/U	Not available	N[b]
4		Intense uptake in site typical of PCa or NET but lacking definitive findings on conventional imaging	n/a	3	Y
5		Intense uptake in site typical of PCa or NET but with definitive findings on conventional imaging	n/a	3	Y

What future for theranostics ?







Neoadjuvant therapy for localized disease

1. ^{177}Lu-PSMA-617 (LuTectomy)

First-line therapy for mCRPC

1. ^{177}Lu-PSMA-I&T (Bullseye)
2. ^{177}Lu-PSMA-617 + enzalutamide (ENZA-P)

First-line therapy for mHSPC

1. ^{177}Lu-PSMA-617 (UpFrontPSMA, PSMAddition)

Second-line or later therapy for mCRPC

1. ^{177}Lu-PSMA-617 (LuPSMA,TheraP, VISION)
2. ^{177}Lu-PSMA-617 + olaparib (LuPARP)
3. ^{177}Lu-PSMA-617 + pembrolizumab (PRINCE)
4. ^{177}Lu-PSMA-I&T (SPLASH)
5. ^{225}Ac-PSMA-617 (AcTION)
6. ^{177}Lu-J591 (NCT00538668)
7. ^{225}Ac-J591 (NCT04506567)
8. ^{227}Th-PSMA-TTC (NCT03724747)
10. ^{177}Lu-PSMA-R2 (NCT03490838)
11. ^{225}Ac-PSMA-R2 (SATISFAcTION)

*mHSPC (metastatic hormone-sensitive prostate cancer)
*mCRPC (metastatic castrate-resistant prostate cancer)
*Different colours represent various PSMA-targeted radiopharmaceuticals (^{177}Lu-PSMA-617, ^{177}Lu-PSMA-I&T, ^{177}Lu-J591, ^{225}Ac-J591, ^{227}Th-PSMA-TTC, ^{131}I-MIP-1095, ^{177}Lu-PSMA-R2)

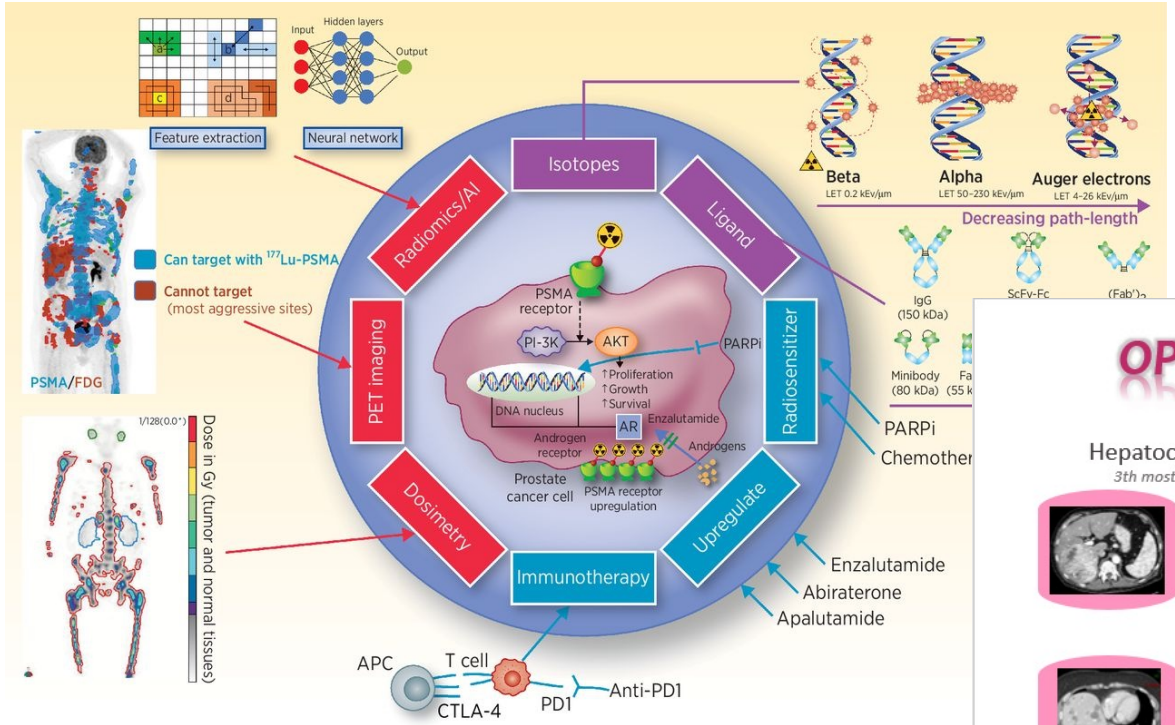
Figure 1. Schematic overview of selected PSMA theranostics clinical trials as of June 2021.

CHU NANTES
AUX NOUVELLES FRONTIÈRES DE LA SANTÉ

First patients World

Zhang et al. Cancer. 2021

What future for theranostics ?



Clin Cancer Res (2020) 26 (12): 2774–2776.

OPERANDI

Optimisation and im**P**roved **E**fficacy of targeted **RA**dio**N**uclide therapy in **D**igestive cancers by **I**magomics

Hepatocellular Carcinoma (HCC)

3th most cancer related death worldwide

Gastro-Entero-Pancreatic Neuro-Endocrine Tumor (GEP-NET)

low incidence - high prevalence

Targeted Radionuclide Therapy (TRT)

TARE*

^{90}Y

PRRT**

PRRT

19% tumor response (SARAH)

19% tumor response (NETTER-1)

Common features

- Morphological and clinical **similarities**
- Heterogenous tumors → Lack of **relevant** and **reproducible** imaging markers
- Major targets of TRT → Lack of **personalized** treatment strategy

PROPOSE : New diagnostic and follow up approaches

DEVELOP : New therapeutic concepts to treat more efficiently

RESULTING : Better outcome + Reduced healthcare costs

* Transarterial Radioembolisation

** Peptide Receptor Radionuclide Therapy

FRANCE 2030

CENTRE HOSPITALIER UNIVERSITAIRE DE NANTES

Inserm

Cima recherche

ARRONAX

ASSISTANCE PUBLIQUE HÔPITAUX DE PARIS

What future for theranostics ?

To do or not to do dosimetry….

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unicancer PAYS DE LA LOIRE

Radioactive chemotherapy.

- Administered like any other drug on a fixed or weight basis.
- Management of adverse events as they occur over the course of therapy.

MBq

Systemic radiotherapy.

- Dose-dependent delivery to a target tissue.
- Anticipating adverse effects.

Gy

What future for theranostics ?

To do or not to do dosimetry….

CHU NANTES
AUX NOUVELLES FRONTIÈRES DE LA SANTÉ

sfpm

Dosimetry for targeted radionuclide therapy in routine clinical practice: experts advice vs. clinical evidence

Arnaud Dieudonné[1,2] · Clément Bailly[3] · Florent Cachin[4] · Agathe Edet-Sanson[1] · Françoise Kraeber-Bodéré[3] · Sébastien Hapdey[1] · Charles Merlin[4] · Philippe Robin[5] · Pierre-Yves Salaun[5] · Paul Schwartz[6] · David Tonnelet[1] · Pierre Vera[1] · Frédéric Courbon[7] · Thomas Carlier[3]

European Journal of Nuclear Medicine and Molecular Imaging (2024) 51:947–950

CENTRE HOSPITALIER UNIVERSITAIRE DE NANTES

Calcul de durée de restriction des contacts après radiothérapie interne vectorisée RIV

établi le lundi 2 septembre 2024

SFMN

sfpm

Nom Prénom Né-e le	Date du traitement Opérateur ?

Eléments obligatoires à préciser (en jaune)	
Radiopharmaceutique (menu déroulant)	Iode-131-25%-fixation
Débit de dose à 1m (µSv/h) en sortie de chambre	
Taille du patient(e) (cm)	

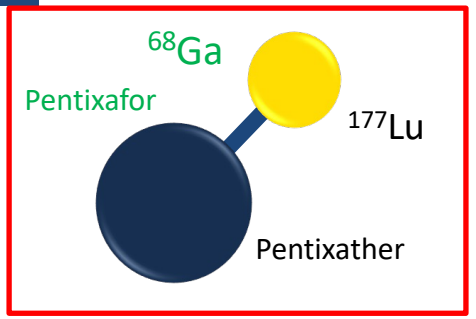
Eléments optionnels (en bleu)		
Période effective (j) imposée par l'utilisateur (laisser vide sinon)		
Scénario utilisateur (éventuel)	*Temps (h)*	*Distance (m)*
Durée à la distance X		

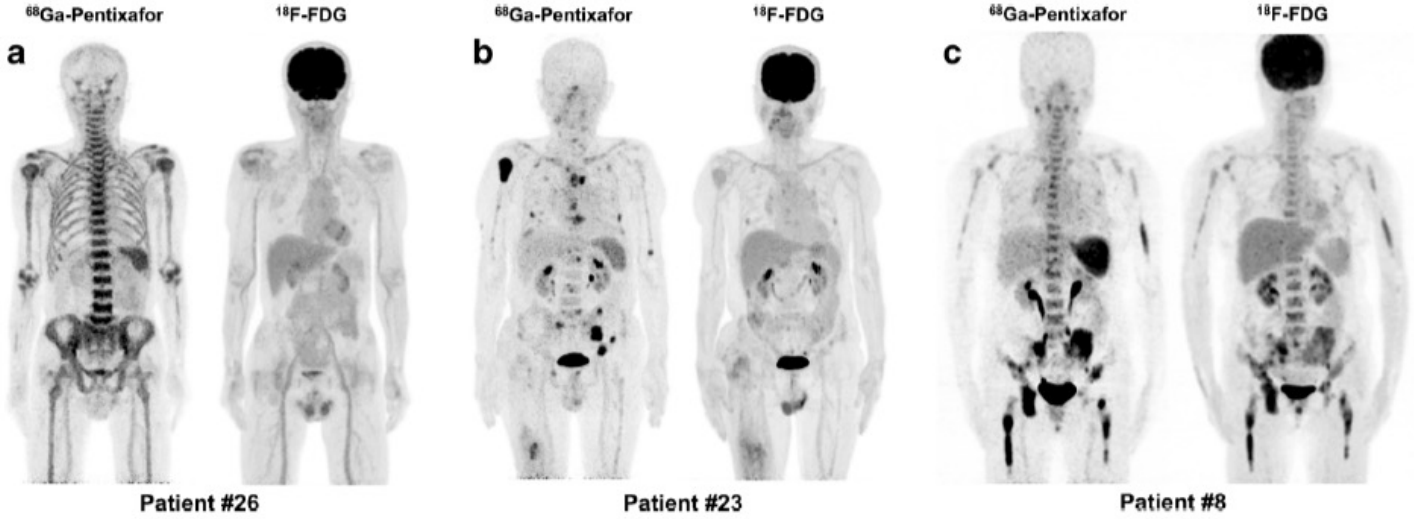
What future for theranostics ?

- **Optimising/standardising/improving** current applications/therapies
- **Search** for new **targets**
- **Development** of new **molecules**
- **Technological inovations**
- **Alphatherapy**

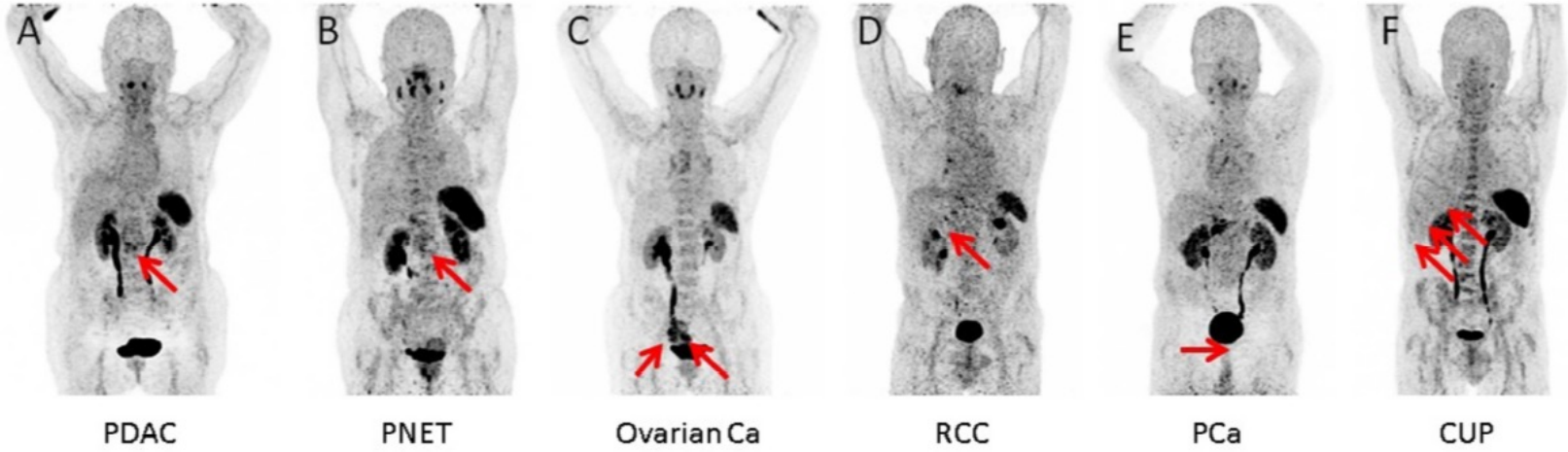
New targets ?

^{68}Ga-PENTIXAFOR (CXCR4)



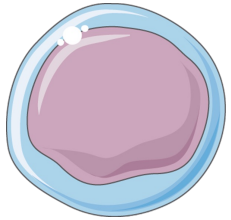


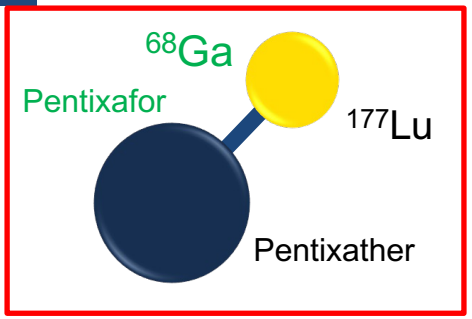
European Journal of Nuclear Medicine and Molecular Imaging
Doi : 10.1007/s00259-019-04605-z



Front. Oncol. 9:770.
doi: 10.3389/fonc.2019.00770

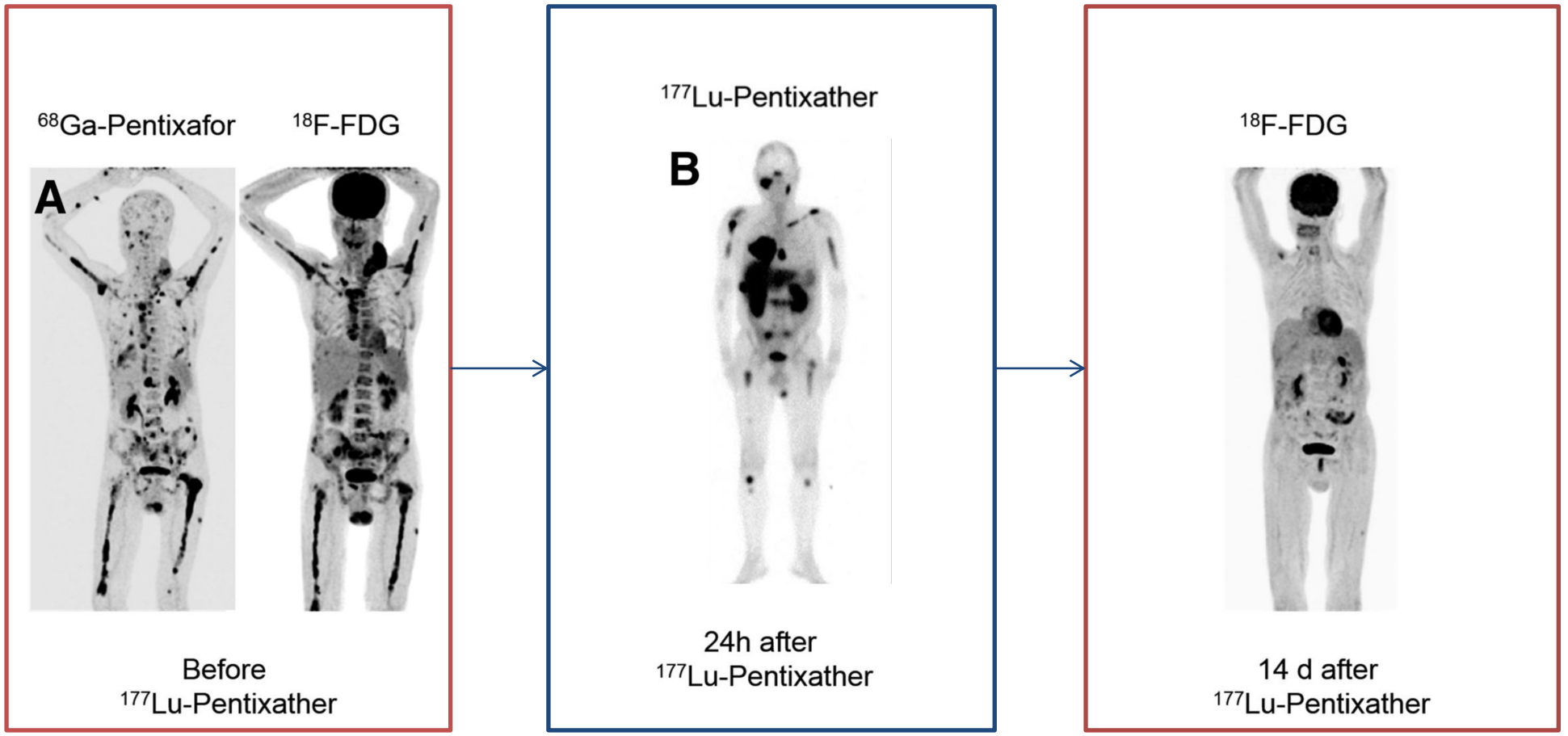
New targets ?



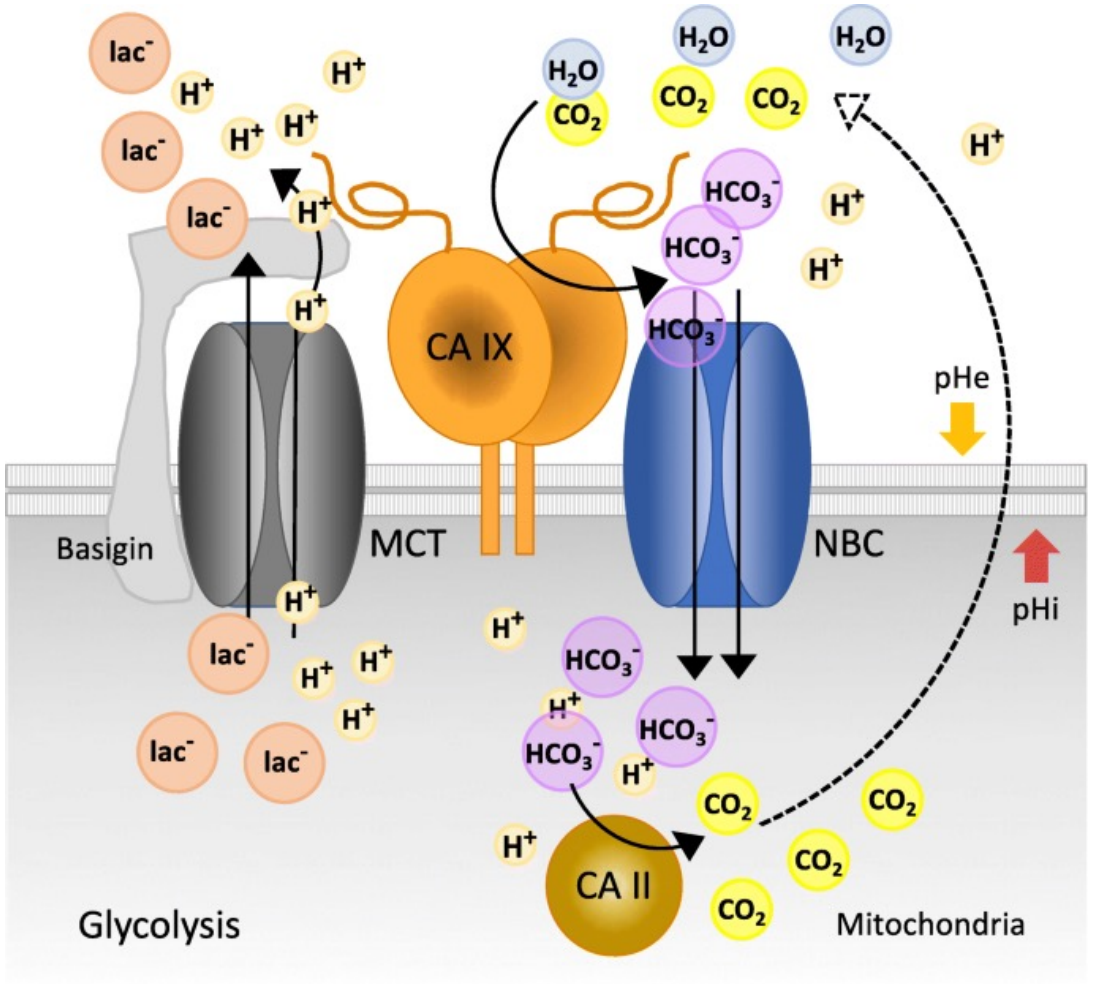


First-in-Human Experience of CXCR4-Directed Endoradiotherapy with ^{177}Lu- and ^{90}Y-Labeled Pentixather in Advanced-Stage Multiple Myeloma with Extensive Intra- and Extramedullary Disease

Ken Herrmann*[1–3], Margret Schottelius*[4], Constantin Lapa[1], Theresa Osl[4], Andreas Poschenrieder[4], Heribert Hänscheid[1], Katharina Lückerath[1], Martin Schreder[5], Christina Bluemel[1], Markus Knott[5], Ulrich Keller[6,7], Andreas Schirbel[1], Samuel Samnick[1], Michael Lassmann[1], Saskia Kropf[8], Andreas K. Buck[1], Hermann Einsele[5], Hans-Juergen Wester†[4], and Stefan Knop†[5]



New targets ?



- CA IX is a cell-surface **glycoprotein**
- Contributes to **pH regulation**
- Can also behave as an **adhesion molecule** through its proteoglycan-like domain

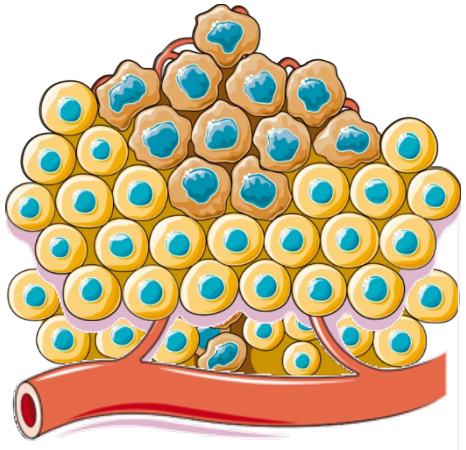
Pastorekova el al. Cancer Metastasis Rev. 2019 ; Pastorek et al. Semin Cancer Biol. 2015 ; Supuran. Metabolites. 2017.

New targets ?

Proliferation

Neoangiogenesis

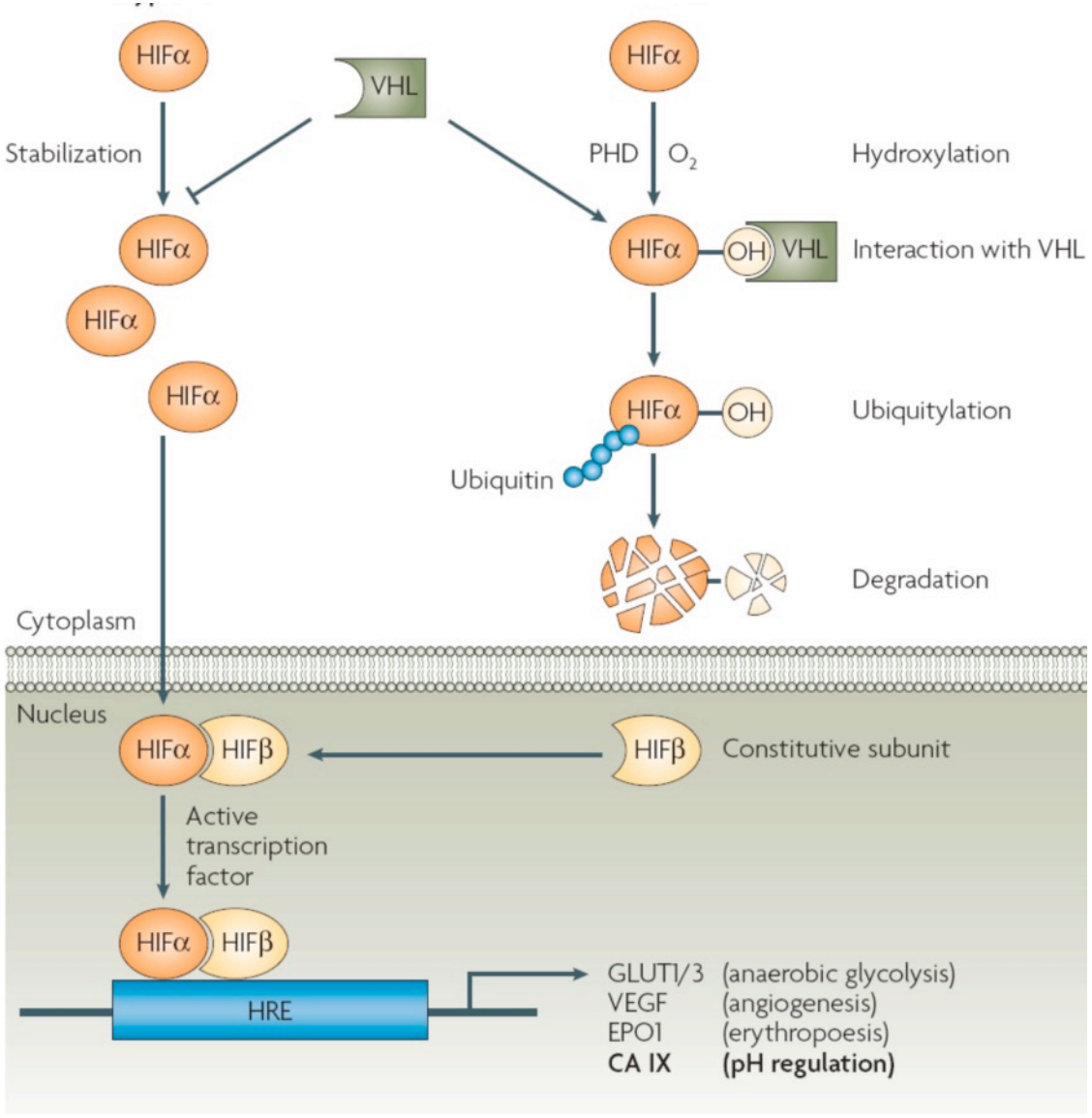
Dissemination



- CA IX is a cell-surface **glycoprotein**
- Contributes to **pH regulation**
- Can also behave as an **adhesion molecule** through its proteoglycan-like domain
- CA IX expression in **non-cancerous tissues** is **rare** and generally confined to epithelia of the stomach, gallbladder, pancreas, and intestine
- Involved in diverse aspects of **cancer development**

Pastorekova el al. Cancer Metastasis Rev. 2019 ; Pastorek et al. Semin Cancer Biol. 2015 ; Supuran. Metabolites. 2017.

New targets ?



- CA IX is a cell-surface **glycoprotein**
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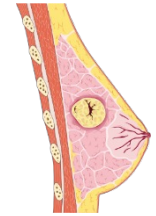
- Can also behave as an **adhesion molecule** through its proteoglycan-like domain
- CA IX expression in **non-cancerous tissues** is **rare** and generally confined to epithelia of the stomach, gallbladder, pancreas, and intestine
- Involved in diverse aspects of **cancer development**
- Expression **notably** induced by **hypoxia**

Pastorekova el al. Cancer Metastasis Rev. 2019 ; Pastorek et al. Semin Cancer Biol. 2015 ; Supuran. Metabolites. 2017.

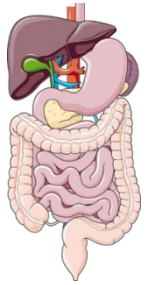
Targeting CA IX

- OPALESCENCE project (zircOn PET-CT imAging TLX mEtaStatiC triplE Negative CancEr)
  - Prospective feasibility pilot study, assessing imaging performance of 89Zr-labelled Girentuximab PET-CT in **metastatic triple negative breast cancer** patients
  - ClinicalTrials.gov Identifier: NCT04758780 Sponsor: ICO



- PERTINENCE project
  - A Pilot Open-label, Feasibility Study to Assess safEty, Tolerability, Radiation Dosimetry, and Imaging Properties of 89Zr-labeled giRenTuximab in patIents With **Non-muscIE-iNvasive Bladder CancEr**
  - ClinicalTrials.gov Identifier: NCT04897763 Sponsor: ICO

- OPERANDI RHU (Optimisation and imProved Efficacy of targeted RAdioNuclide therapy in Digestive cancers by Imagomics)
  - An Open-label, Pilot Study to Assess Safety, Tolerability, Radiation Dosimetry, and Imaging Properties of 89Zr-labelled Girentuximab for in Vivo Detection of **HCC** and aggressive or refractory **GEP-NENs** by PET

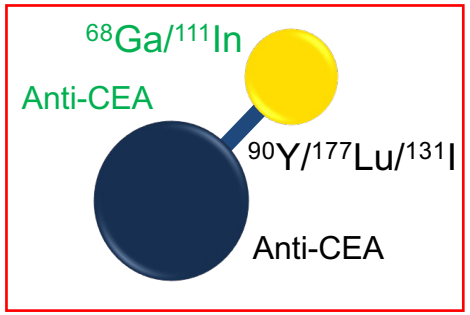


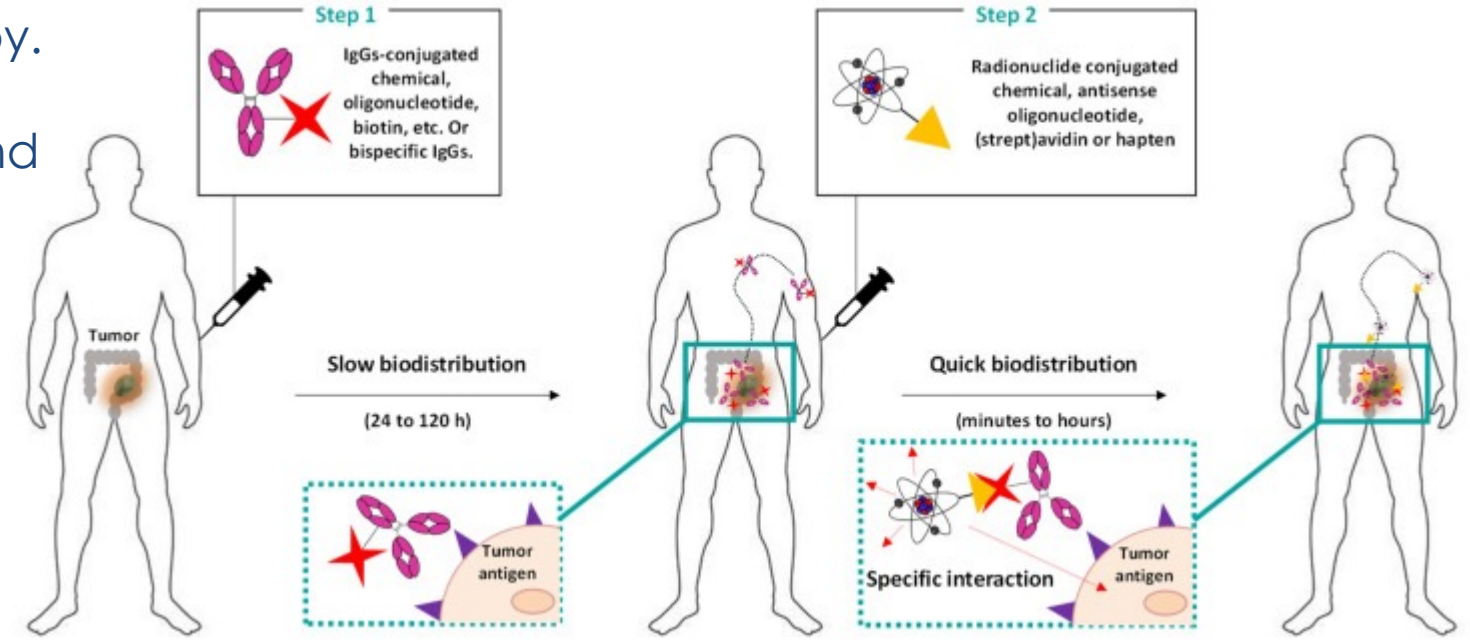
New targets ?

CEA expressed by numerous tumors: MCT (100%), colorectal cancer, lung cancer, breast cancer...

Direct targeting: Insufficient tumor contrast in imaging and too low tumor doses in therapy.

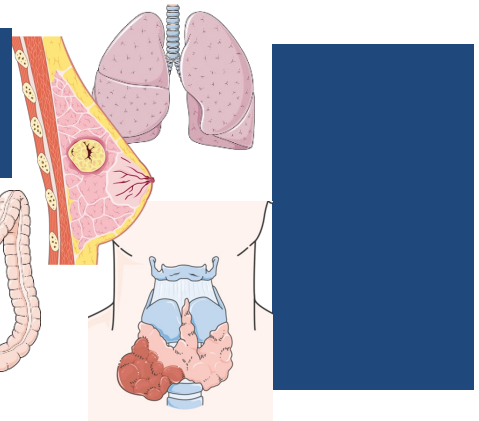
Solution: decouple injection of antibody and radionuclide to improve contrast.





Cancers (Basel). 2021 Nov; 13(21): 5570.

Pretargeting of CEA expressing tumors



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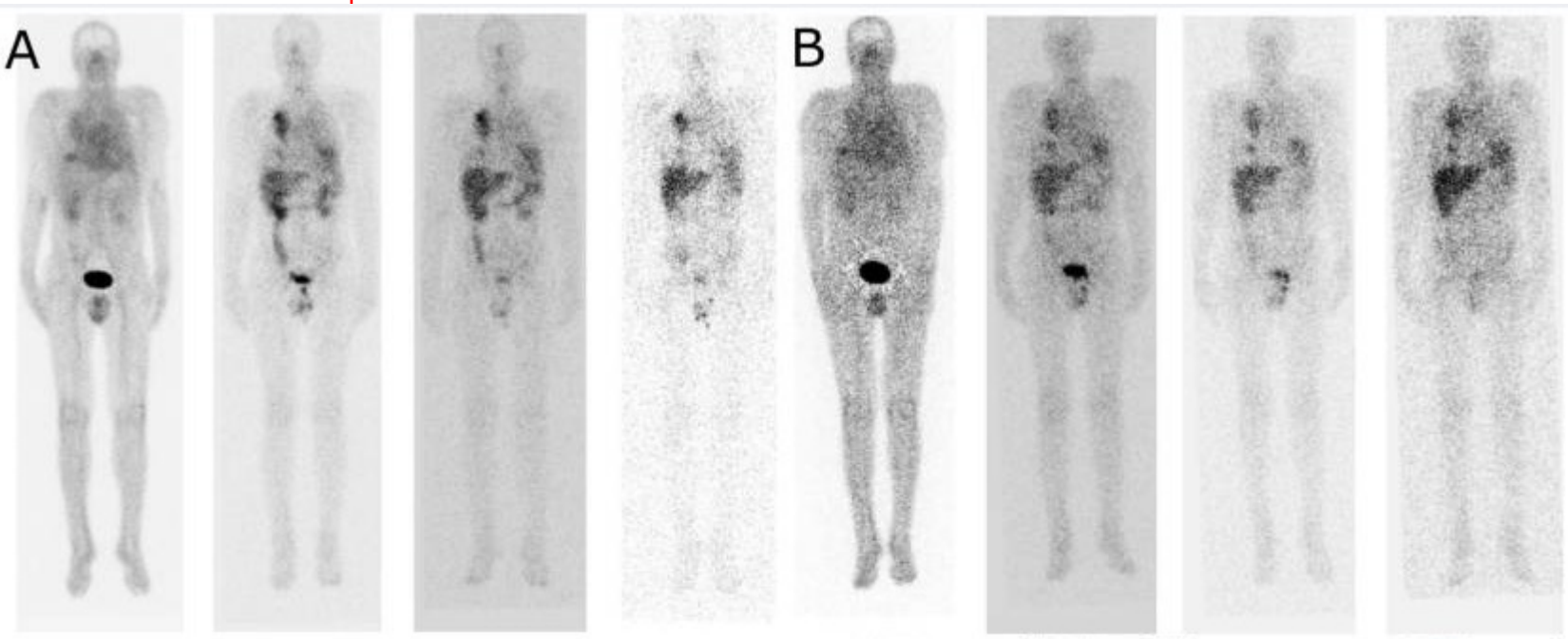

Clinic

Rafke Schoffelen · Wietske Woliner-van der Weg · Eric P. Visser · David M. Goldenberg · Robert M. Sharkey · William J. McBride · Chien-Hsing Chang · Edmund A. Rossi · Winette T. A. van der Graaf · Wim J. G. Oyen · Otto C. Boerman

Françoise Krae
Alain Faivre-Chauvet, PhD[1,2]; Loïc Campion, MD[3]; Jean-Philippe Vuillez, MD, PhD[4]; Anne Devillers, MD[5]; Chien-Hsing Chang, PhD[5]; David M. Goldenberg, ScD, MD[5,6]; Jean-François Chatal, MD, PhD[1,2]; and Jacques Barbet, PhD[2]

ınoscintigraphy for Non-Small-Cell
:aging Using a Bispecific
·Indium-DTPA Antibody and
Labeled DTPA Dimer

, E. Rouvier, E. Brambilla, J. Barbet, P. Peltier, P. Meyer, R. Sarrazin and Ch. Brambilla
ıeumology, Thoracic Surgery and Pathology, CHU de Grenoble, Centre Catherine de
ırseille, France

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frontiers in Medicine

Front Med (Lausanne). 2015; 2: 84.
Published online 2015 Nov 27. doi: 10.3389/fmed.2015.00084
PMCID: PMC4661432

Pharmacokinetics and Dosimetry Studies for Optimization of Pretargeted Radioimmunotherapy in CEA-Expressing Advanced Lung Cancer Patients

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Theranostic and technological inovations?

First Human Imaging Studies with the EXPLORER Total-Body PET Scanner*

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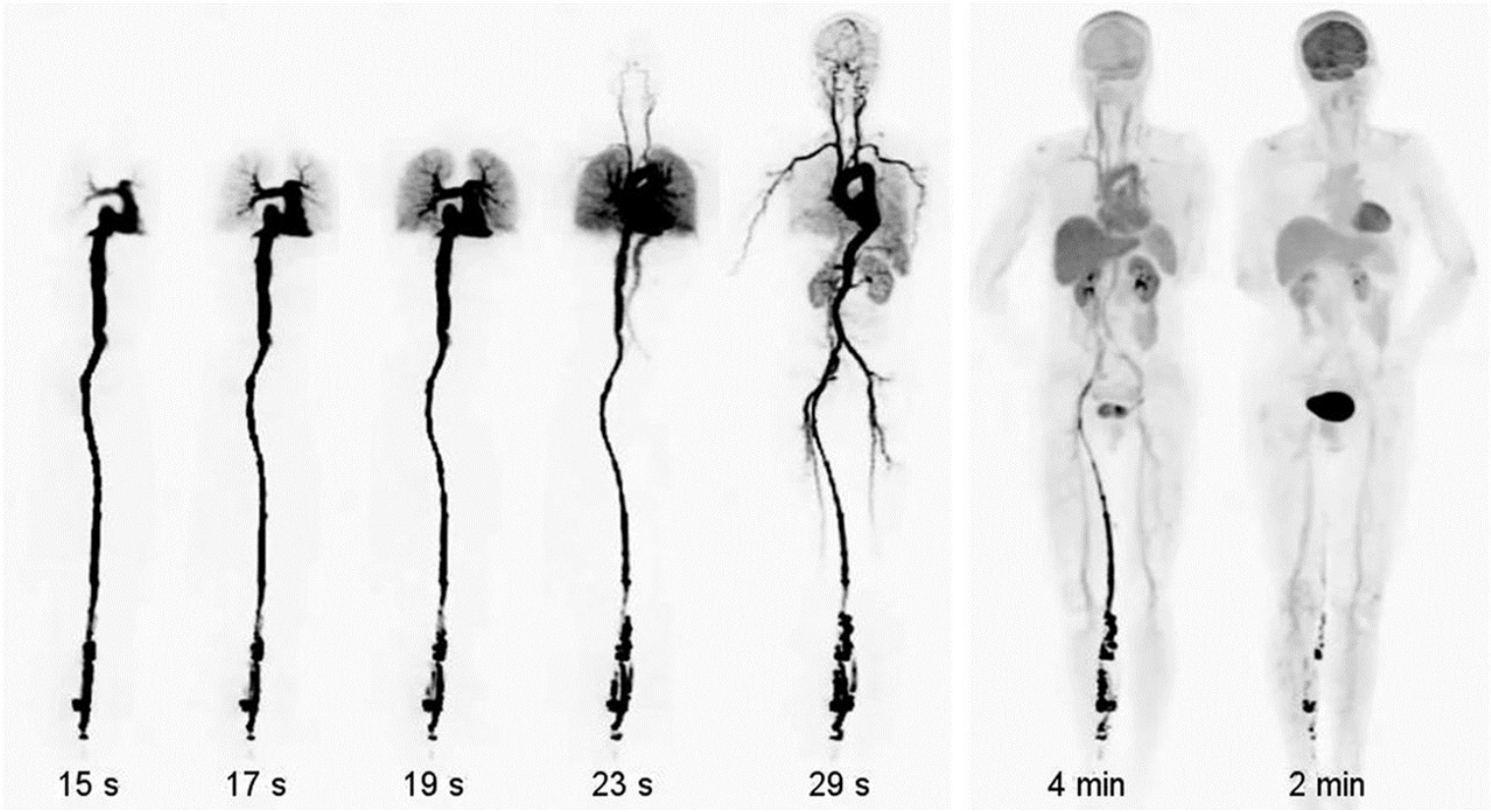

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Our Evolution, their Revolution !!

- Rapid growth of precision medicine

- Rapid growth in diagnostic, predictive and prognostic **molecular imaging**

- Image-guided targeted therapies
- Growth ++ of TRT via theranostic approaches

What's next ?

- **Optimisation** of actual applications
- **Development of new molecules**

Revolution or evolution ?

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CHU NANTES
AUX NOUVELLES FRONTIÈRES DE LA SANTÉ