Should Bombesin imaging be integrated into prostate cancer imaging?

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Dr Stuart More
Division of Nuclear Medicine
Department Of Radiation Medicine
University of Cape Town and Groote Schuur Hospital

Outline

- Review bombesin and GRPR imaging
- Outline current indications and applications
- Highlight potential future trends related to prostate cancer imaging

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Bombina bombina

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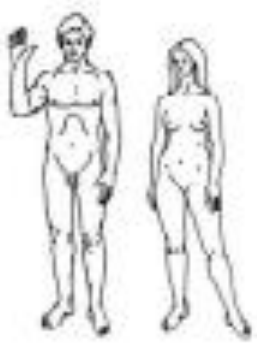
European fire-bellied toad

BBN  pGlu-Gln-Arg-Leu-**Gly-Asn**-Gln-**Trp-Ala-Val-Gly-His-Leu-Met**-NH_2

GRP Val-Pro-Leu-Pro-Ala-Gly-Gly-Gly-Thr-Val-Leu-Thr-Lys-Met-
Tyr-Pro-Arg-**Gly-Asn**-His-**Trp-Ala-Val-Gly-His-Leu-Met**-NH_2



NMB **Gly-Asn**-Leu-**Trp-Ala**-Thr-**Gly-His**-Phe-**Met**-NH_2

NMC **Gly-Asn**-His-**Trp-Ala-Val-Gly-His-Leu-Met**-NH_2

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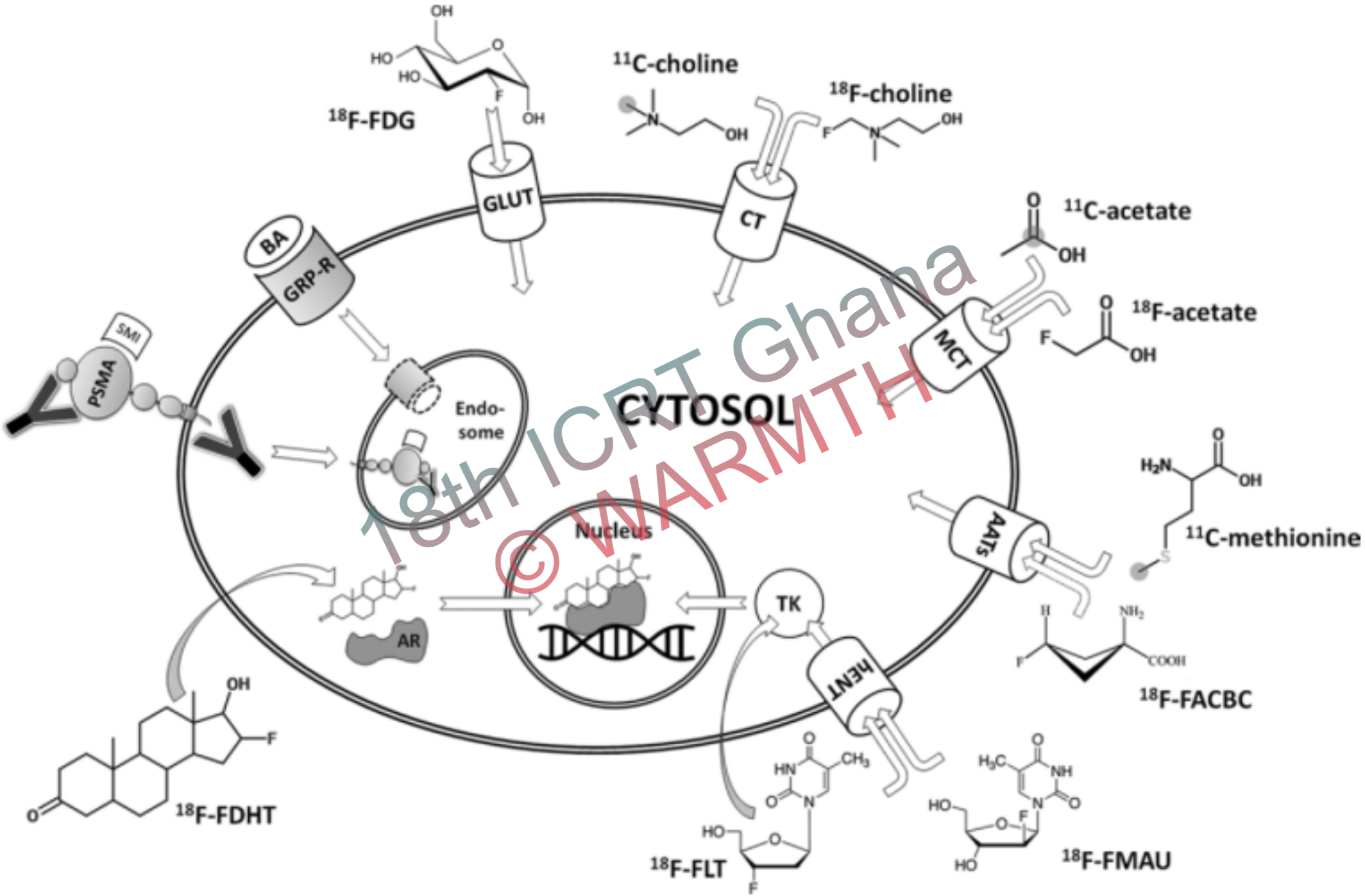
^{18}F-FDG
^{11}C-choline
^{18}F-choline
GLUT
CT
BA
GRP-R
SMI
PSMA
Endo-
some
CYTOSOL
MCT
^{11}C-acetate
^{18}F-acetate
Nucleus
AR
AATs
^{11}C-methionine
TK
hENT
^{18}F-FACBC
^{18}F-FDHT
^{18}F-FLT
^{18}F-FMAU
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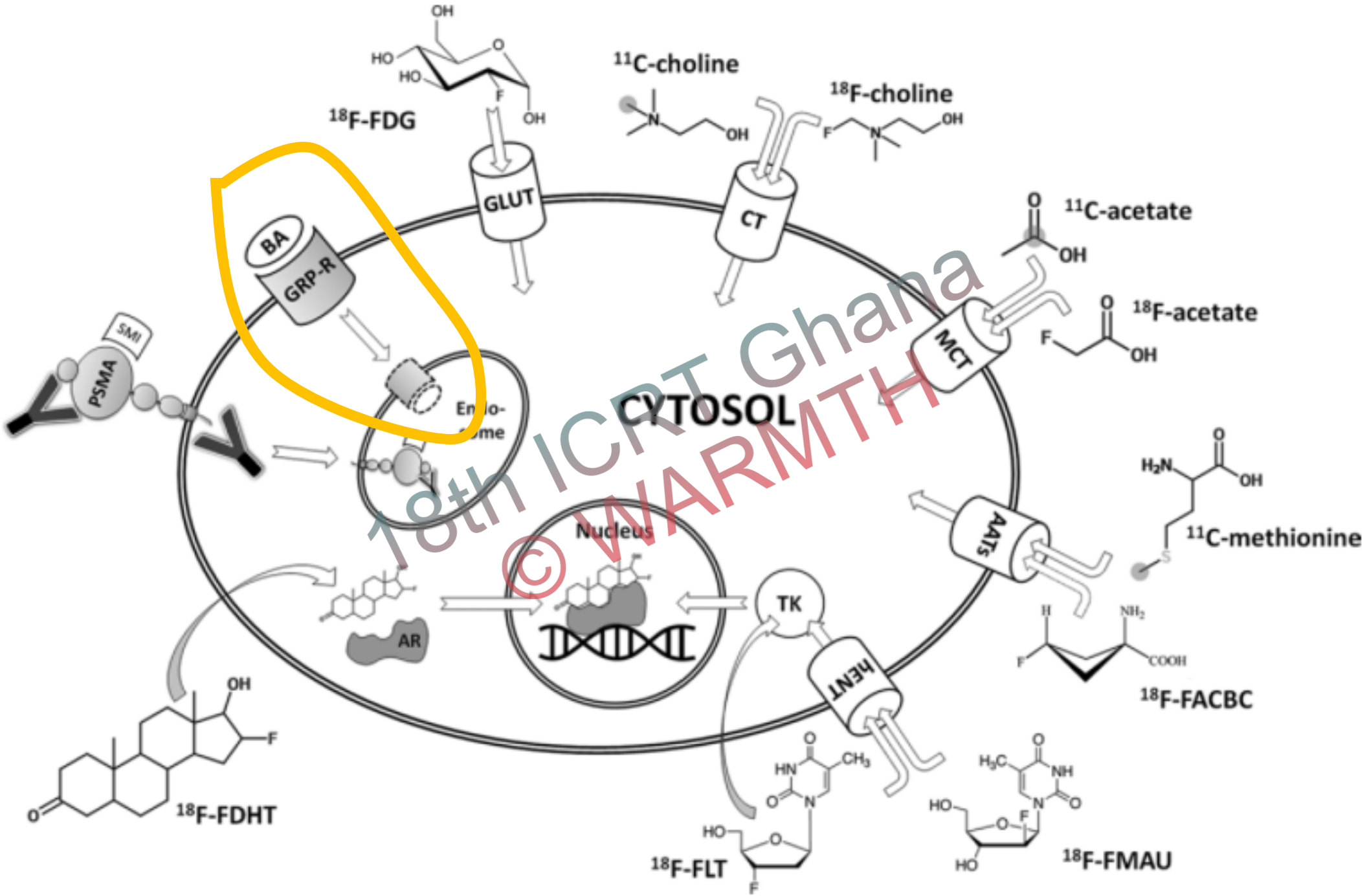
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^{11}C-acetate
^{18}F-acetate
AATs
^{11}C-methionine
Nucleus
AR
TK
hENT
^{18}F-FACBC
^{18}F-FDHT
^{18}F-FLT
^{18}F-FMAU
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Utility of Gastrin Releasing Peptide in Prostate Cancer

- Overexpressed in 63–100% of primary prostate cancers
- Heterogenous expression of GRPR in prostate cancer and dependent on disease stage
- Overexpression of GRPR and GPRR-mediated signaling
  - stimulate the growth of both androgen-dependent and androgen-independent prostate cancer cells
  - indirectly promote angiogenesis
  - and increase the invasive potential of prostate cancer

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Radiolabeled somatostatin receptor antagonists are preferable to agonists for *in vivo* peptide receptor targeting of tumors

Mihaela Ginj*, Hanwen Zhang*, Beatrice Waser†, Renzo Cescato†, Damian Wild*, Xuejuan Wang*, Judit Erchegyi‡, Jean Rivier‡, Helmut R. Mäcke*, and Jean Claude Reubi†§

*Division of Radiological Chemistry, Institute of Nuclear Medicine, Department of Radiology, University Hospital Basel, Petersgraben 4, CH-4031 Basel, Switzerland; †Division of Cell Biology and Experimental Cancer Research, Institute of Pathology, University of Berne, Murtenstrasse 31, CH-3010 Berne, Switzerland; and ‡Clayton Foundation Laboratories for Peptide Biology, The Salk Institute, 10010 North Torrey Pines Road, La Jolla, CA 92037

Communicated by Roger Guillemin, The Salk Institute for Biological Studies, La Jolla, CA, September 5, 2006 (received for review May 6, 2006)

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Peptide	Isotope	Target	Usage	Dosage	Object	References
BN (agonist)	^{99m}Tc	GRPR	SPECT imaging and staging	185 MBq	10 patients with PCa and invasion of pelvic lymph nodes	Scopinaro et al., 2003
BN (agonist)	^{99m}Tc	GRPR	SPECT imaging and staging	185 MBq	14 patients with primary PCa and loco-regional node involvement	De Vincentis et al., 2004
AMBA (agonist)	^{68}Ga	GRPR	PET imaging and staging	160 MBq	1 patient with metastatic PCa	Baum et al., 2007
RP527 (agonist)	^{99m}Tc	GRPR	SPECT imaging and staging	555 MBq	4 patients with metastatic PCa	Van de Wiele et al., 2000
RM26 (antagonist)	^{68}Ga	GRPR	PET imaging and staging	51.85 MBq/kg	28 patients with primary PCa and metastasis	Zhang et al., 2018
CB-TE2A-AR06 (antagonist)	^{64}Cu	GRPR	PET imaging	130–233 MBq	4 patients with newly diagnosed PCa	Wieser et al., 2014
RM2 (antagonist)	^{68}Ga	GRPR	PET imaging and staging PET imaging and staging	167.9–294.5 MBq 133.2–151.7 MBq	16 patients with metastatic PCa 32 patients with BCR of PCa	Wieser et al., 2017 Minamimoto et al., 2018
SB3 (antagonist)	^{68}Ga	GRPR	PET imaging and staging	283 ± 91 MBq	9 patients with advanced PCa	Maina et al., 2016
NeoBOMB1 (antagonist)	^{68}Ga	GRPR	PET imaging	/	A 69-year-old patient with primary bilateral prostate adenocarcinoma	Nock et al., 2017
BAY 86-4367 (antagonist)	^{18}F	GRPR	PET imaging and staging	302 ± 11 MBq	5 patients with primary PCa and 5 patients with PSA recurrence after radical prostatectomy	Sah et al., 2015
BBN-RGD	^{68}Ga	GRPR	PET imaging and staging	130 MBq	5 healthy volunteers and 13 patients with PCa	Zhang et al., 2017

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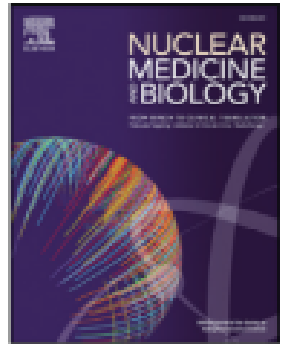

A comparative study of peptide-based imaging agents [^{68}Ga]Ga-PSMA-11, [^{68}Ga]Ga-AMBA, [^{68}Ga]Ga-NODAGA-RGD and [^{68}Ga]Ga-DOTA-NT-20.3 in preclinical prostate tumour models

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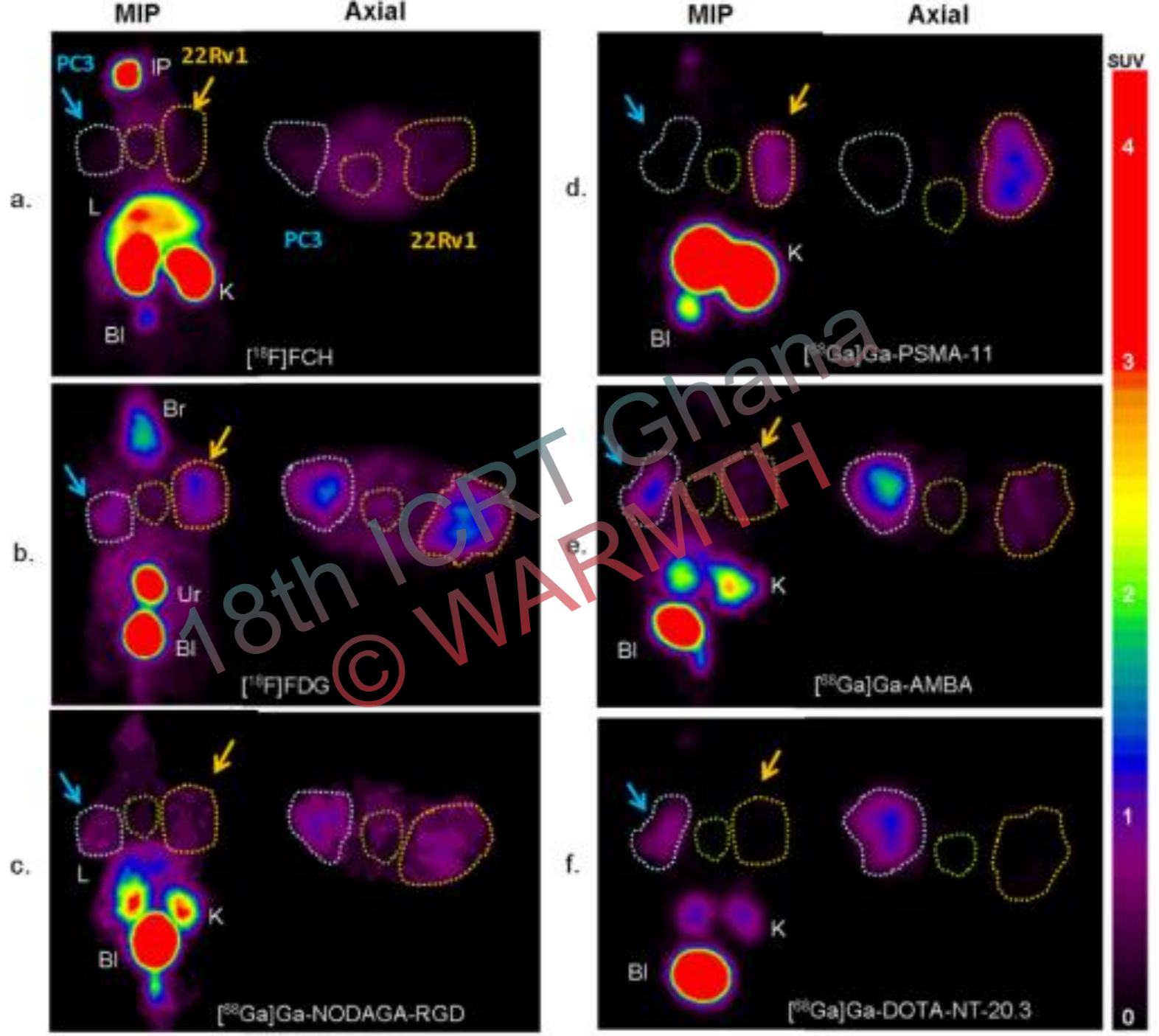
Zhang-Yin et al. Nuclear Medicine and Biology (2020)



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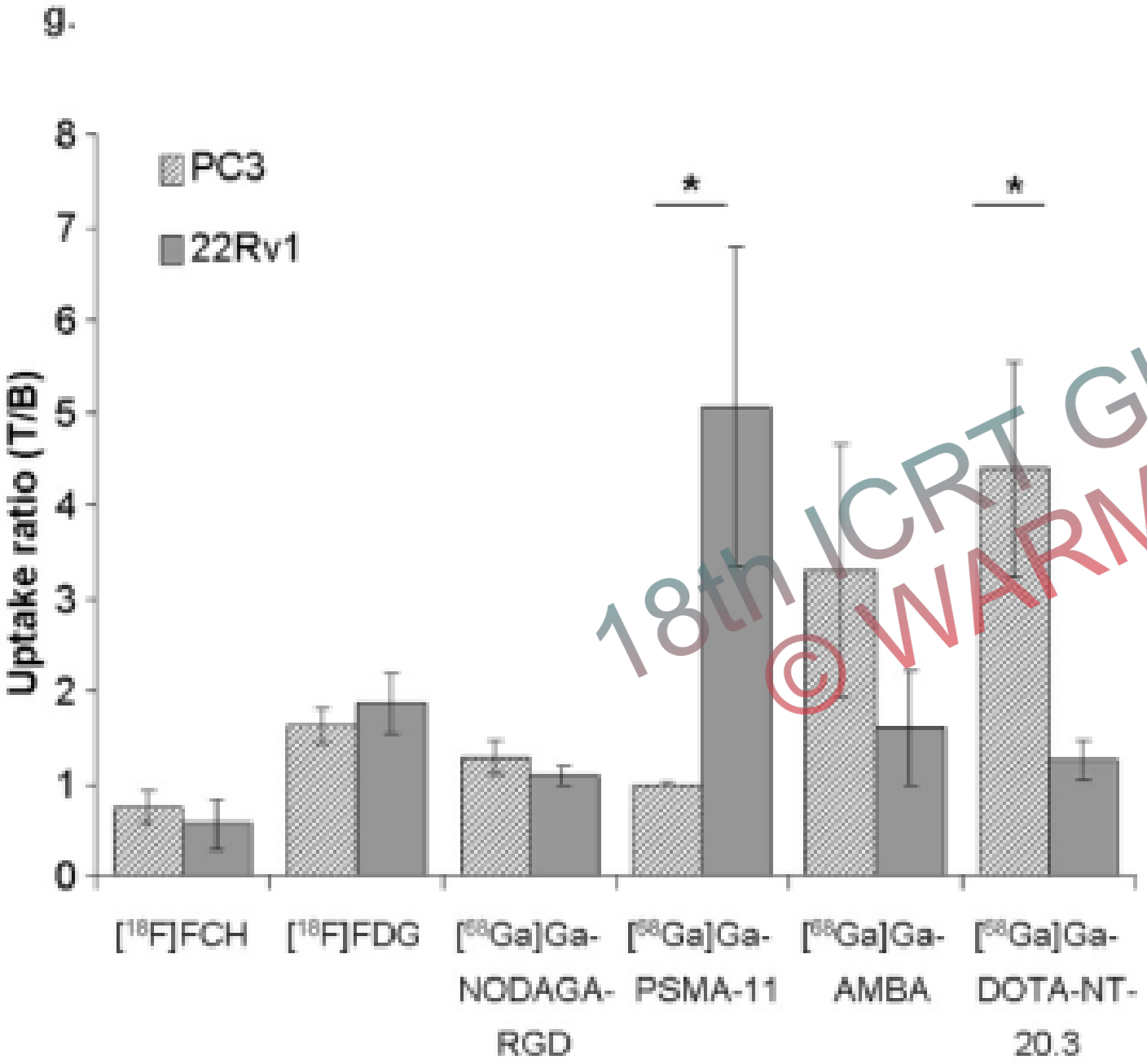

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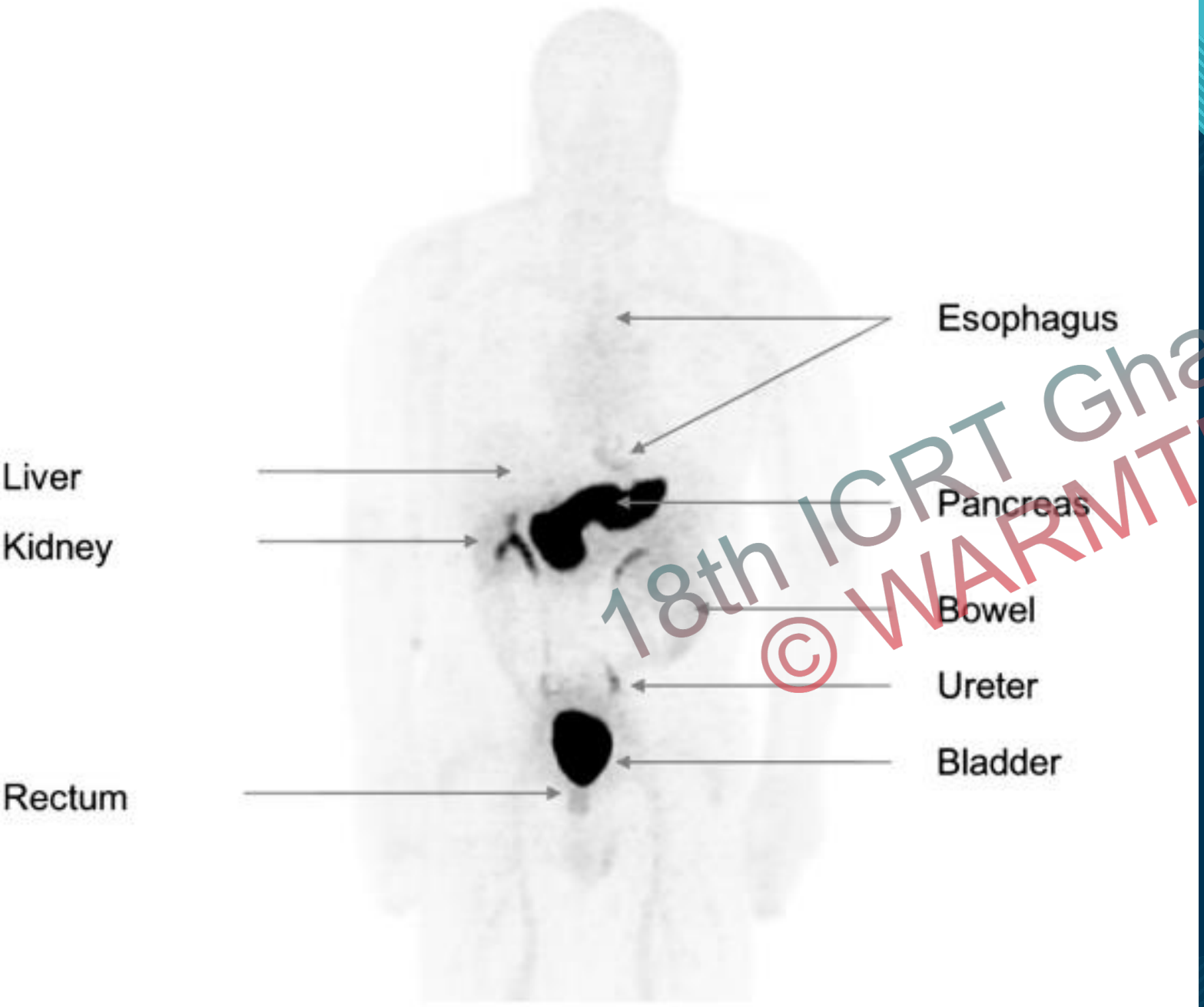
- Ga68-AMBA demonstrates GRPR a viable option for diagnostic or therapeutic applications in prostate cancer with limited PSMA expression



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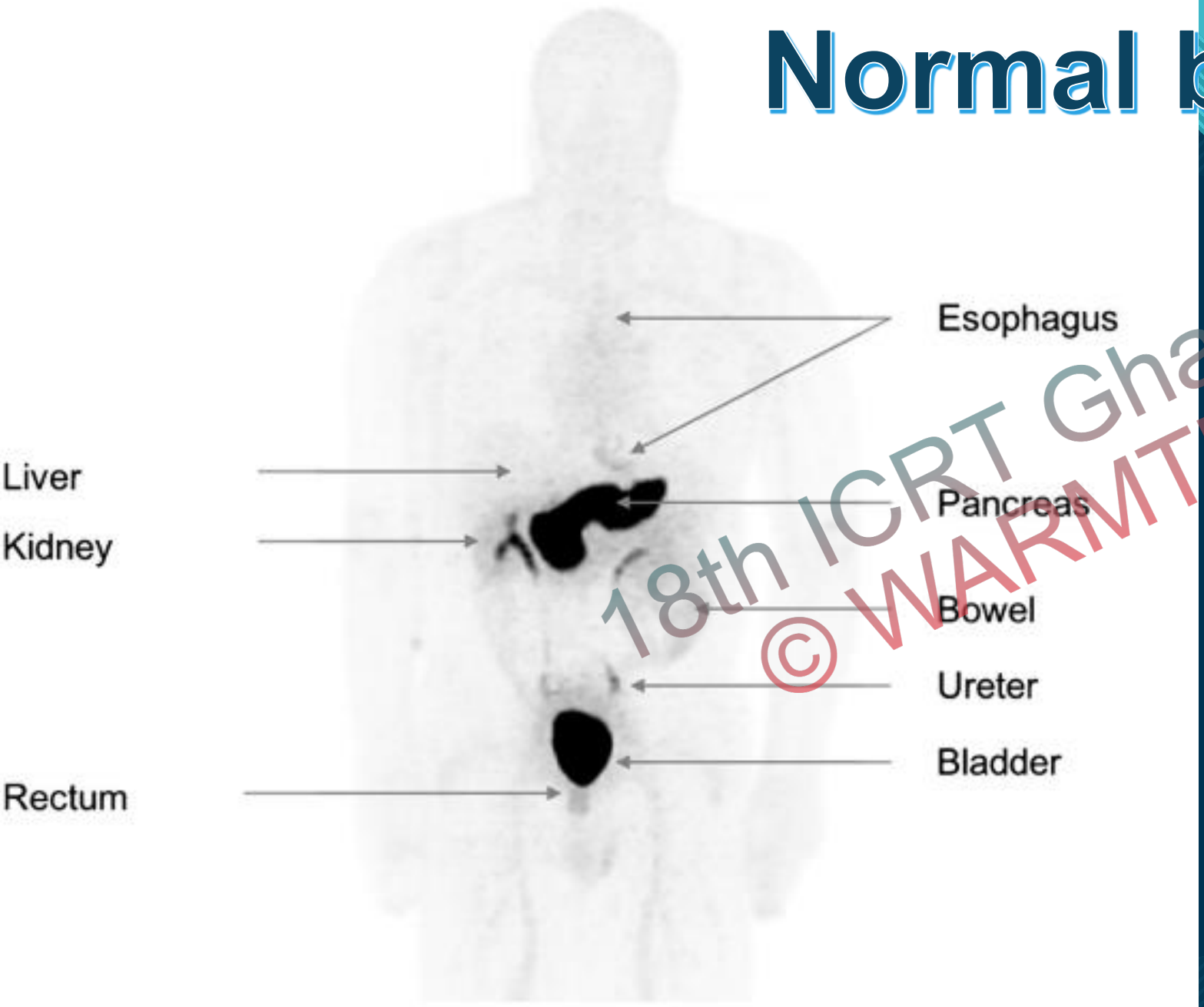
Normal biodistribution



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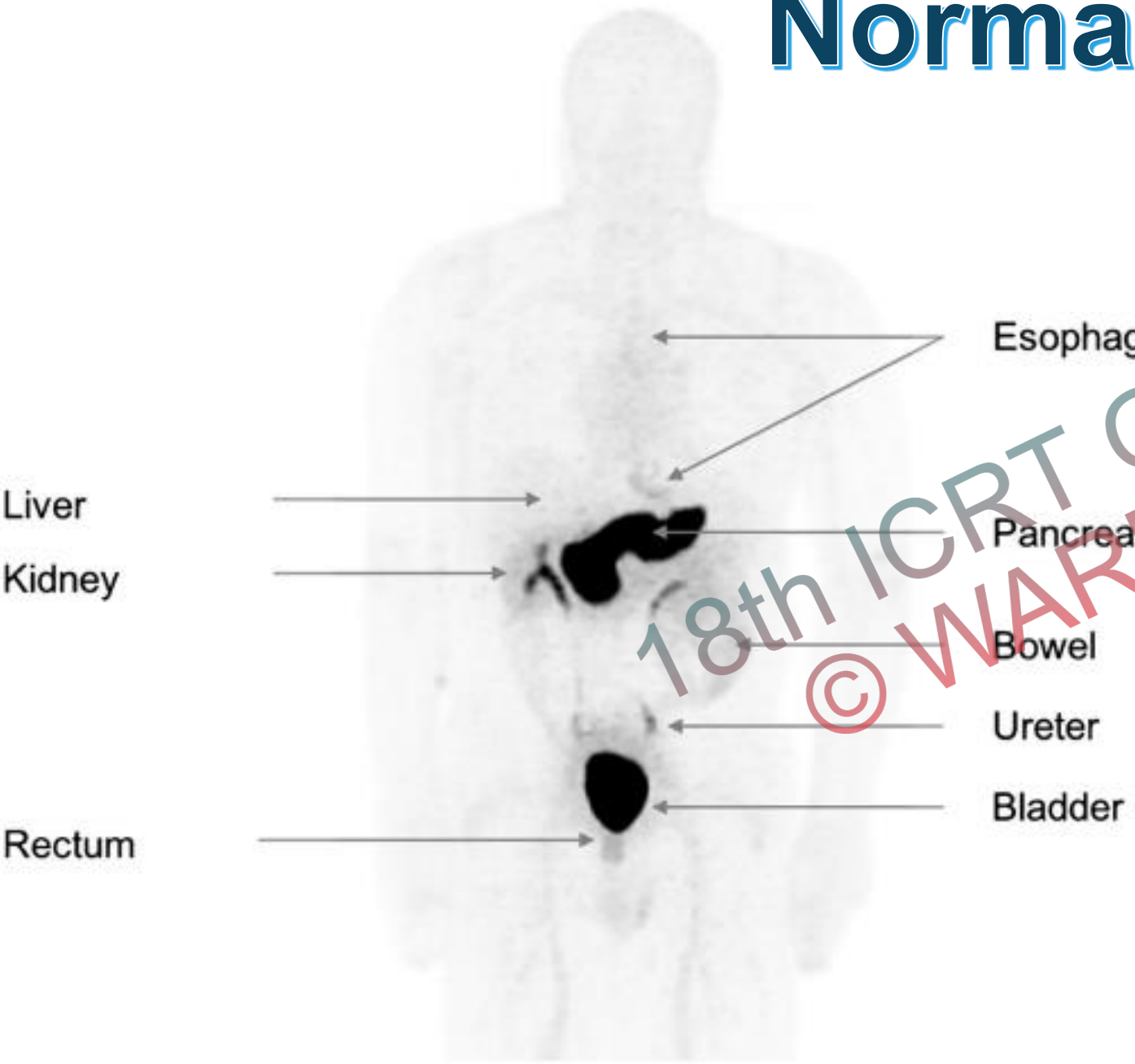
Normal biodistribution



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Grading	SUVmean
Not significant	<aortic arch
Mild	≤2.5 but >AA
Moderate	2.5≤x≤5
intense	≥5

Current norms and standards for PrCa Care NCCN and EAU

"The NCCN panel has recognized the increased sensitivity and specificity of PSMA-PET tracers, compared to conventional imaging (CT, MRI) for detecting micrometastatic disease, at both initial staging and biochemical recurrence. The updated guidelines state that the NCCN Panel does not feel that conventional imaging is a necessary prerequisite to PSMA-PET and that PSMA-PET/CT or PSMA-PET/MRI can serve as equally effective, if not more effective front-line imaging tools for these patients."

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1. NCCN Guidelines Updated to Include PSMA-PET Imaging. Posted online September 13, 2021. Accessed September 15, 2021. https://bit.ly/3kbCgJF.

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1. NCCN Guidelines Updated to Include PSMA-PET Imaging. Posted online September 13, 2021. Accessed September 15, 2021. https://bit.ly/3kbCgJF.

Recommendations	Strength rating
Any risk group staging	
Use pre-biopsy MRI for local staging information.	Weak
Low-risk localised disease	
Do not use additional imaging for staging purposes.	Strong
Intermediate-risk disease	
In ISUP grade 3, include at least cross-sectional abdominopelvic imaging and a bone-scan for metastatic screening.	Weak
High-risk localised disease/locally advanced disease	
Perform metastatic screening including at least cross-sectional abdominopelvic imaging and a bone-scan.	Strong
When using PSMA PET or whole body MRI to increase sensitivity, be aware of the lack of outcome data of subsequent treatment changes.	Strong

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From Bench to Bedside—The Bad Berka Experience With First-in-Human Studies

Jingjing Zhang, MD, PhD,* Aviral Singh, MD, MSc,* Harshad R. Kulkarni, MD,* Christiane Schuchardt, Dipl. -Ing,* Dirk Müller, PhD,* Hans-J. Wester, PhD,† Theodosia Maina, PhD,‡ Frank Rösch, PhD,§ Nicholas P. van der Meulen, PhD,||,¶ Cristina Müller, PhD,|| Helmut Mäcke, PhD,# and Richard P. Baum, MD, PhD*

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Radiopharmaceutica;	Year	Target	Indication
Ga-68 AMBA 08/2006	2006	Bombesin analogue—GRP and NMB receptor targeting	Carcinomas of breast, prostate, colon
Lu-177 AMBA Bombesin analogue—		GRP and NMB receptor targeting	Radionuclide therapy of metastatic carcinoma breast
Ga-68 demobesin	2009	GRP receptor antagonist	Carcinomas of breast, prostate, colon
Lu-177 demobesin	2009	GRP receptor antagonist	Radionuclide therapy in carcinoma breast
Tc-99m demobesin	2009	GRP receptor antagonist	Carcinomas of breast, prostate, colon
Ga-68 sarabesin-6	2011	GRP receptor antagonist	Carcinomas of breast, prostate, colon
Lu-177 sarabesin-6	2011	GRP receptor antagonist	Radionuclide therapy in carcinoma prostate

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Author Year	Peptide Radionuclide	*n*	Clinical Context	Positivity Rate	Se	Sp	Acc
Kähkonen et al. 2013 [15]	RM2 Gallium-68	14	Primary staging = 11 Recurrence = 3	48%	T = 89% N = 67%	T = 81%	T = 83%
Wieser et al. 2014 [16]	CB-TE2A-AR06 Copper-64	4	Primary staging = 4	75%	Ns	Ns	Ns
Sah et al. 2015 [17]	BAY 864367 Fluorine-18	10	Primary staging = 5 Recurrence = 5	50%	Ns	Ns	Ns
Maina et al. 2016 [18]	SB3 Gallium-68	9	Metastatic = 9	55%	Ns	Ns	Ns
Minamimoto et al. 2016 [19]	RM2 Gallium-68	7	Recurrence = 7	86%	Ns	Ns	Ns
Nock et al. 2017 [20]	NeoBOMB1 Gallium-68	4	Ns	Ns	Ns	Ns	Ns
Wieser et al. 2017 [21]	RM2 Gallium-68	16	Recurrence = 16	63%	Ns	Ns	Ns
Minamimoto et al. 2018 [22]	RM2 Gallium-68	32	Recurrence = 32	72%	Ns	Ns	Ns
Zhang et al. 2018 [23]	RM26 Gallium-68	28	Primary staging = 17 Recurrence = 11	82%	Ns	Ns	Ns
Gnesin et al. 2018 [24]	MJ9 Gallium-68	5	Recurrence = 5	Ns	Ns	Ns	Ns
Fassbender et al. 2019 [25]	RM2 Gallium-68	15	Primary staging = 15	93%	69%		63%
Touijer et al. 2019 [26]	RM2 Gallium-68	16	Primary staging = 16	100%	85%	67%	79%
Hoberück et al. 2019 [27]	RM2 Gallium-68	16	Primary staging = 2 Recurrence = 12 Other = 2	31%	Ns	Ns	Ns
Fassbender et al. 2020 [28]	RM2 Gallium-68	8	Primary staging = 8	Ns	Ns	Ns	Ns
Bakker et al. 2021 [29]	SB3 Gallium-68	10	Primary staging = 10	80%	88%	88%	Ns
Baratto et al. 2021 [30]	RM2 Gallium-68	50	Recurrence = 50	70%	Ns	Ns	Ns

Se: sensitivity; Sp: specificity; Acc: accuracy; Ns: not specified.

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Clinical Cancer Research

Imaging, Diagnosis, Prognosis

In Vivo Imaging of Prostate Cancer Using [^{68}Ga]-Labeled Bombesin Analog BAY86-7548

Esa Kähkönen[1], Ivan Jambor[5,6], Jukka Kemppainen[2,5], Kaisa Lehtiö[3], Tove J. Grönroos[5], Anna Kuisma[3], Pauliina Luoto[5], Henri J. Sipilä[5], Tuula Tolvanen[5], Kalle Alanen[4], Jonna Silén[5], Markku Kallajoki[4], Anne Roivainen[5], Niklaus Schäfer[7,8], Roger Schibli[9], Martina Dragic[9], Anass Johayem[8], Ray Valencia[10], Sandra Borkowski[10], and Heikki Minn[3,5]

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- Eleven patients (mean age, 63 years; range, 48–72 years)
- Histologically confirmed prostate adenocarcinoma

Key Results

Detection of Primary PCa

- Sensitivity 88%
- Specificity 81%
- Accuracy 83%

Detection metastatic Lymph Nodes – 70%

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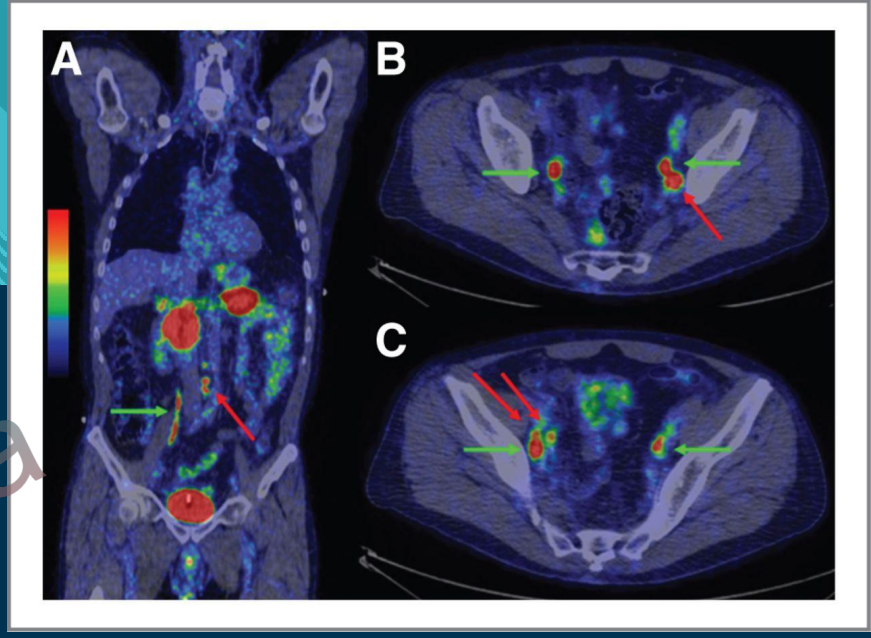
Key Results



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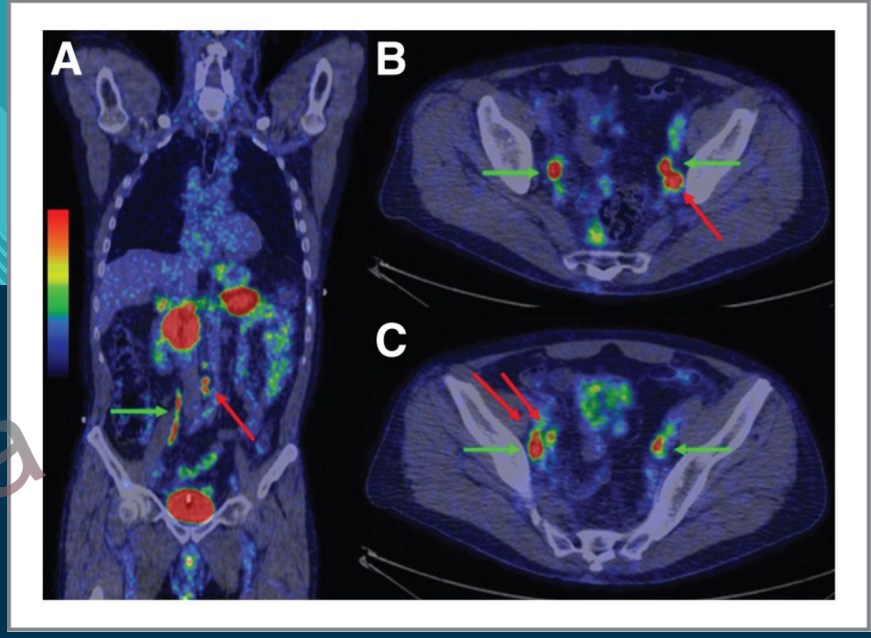

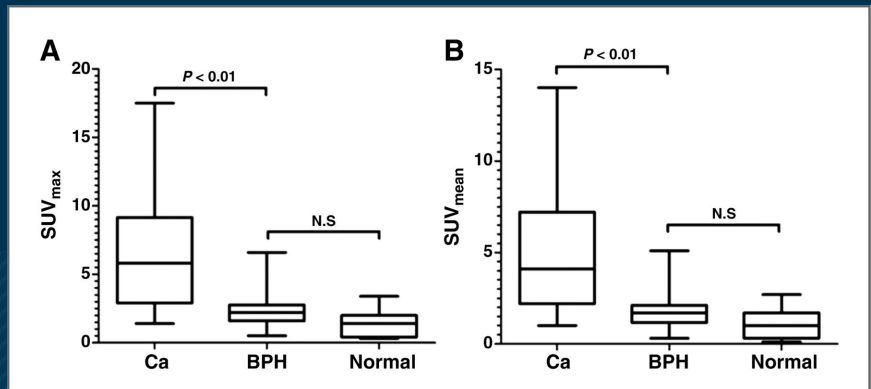

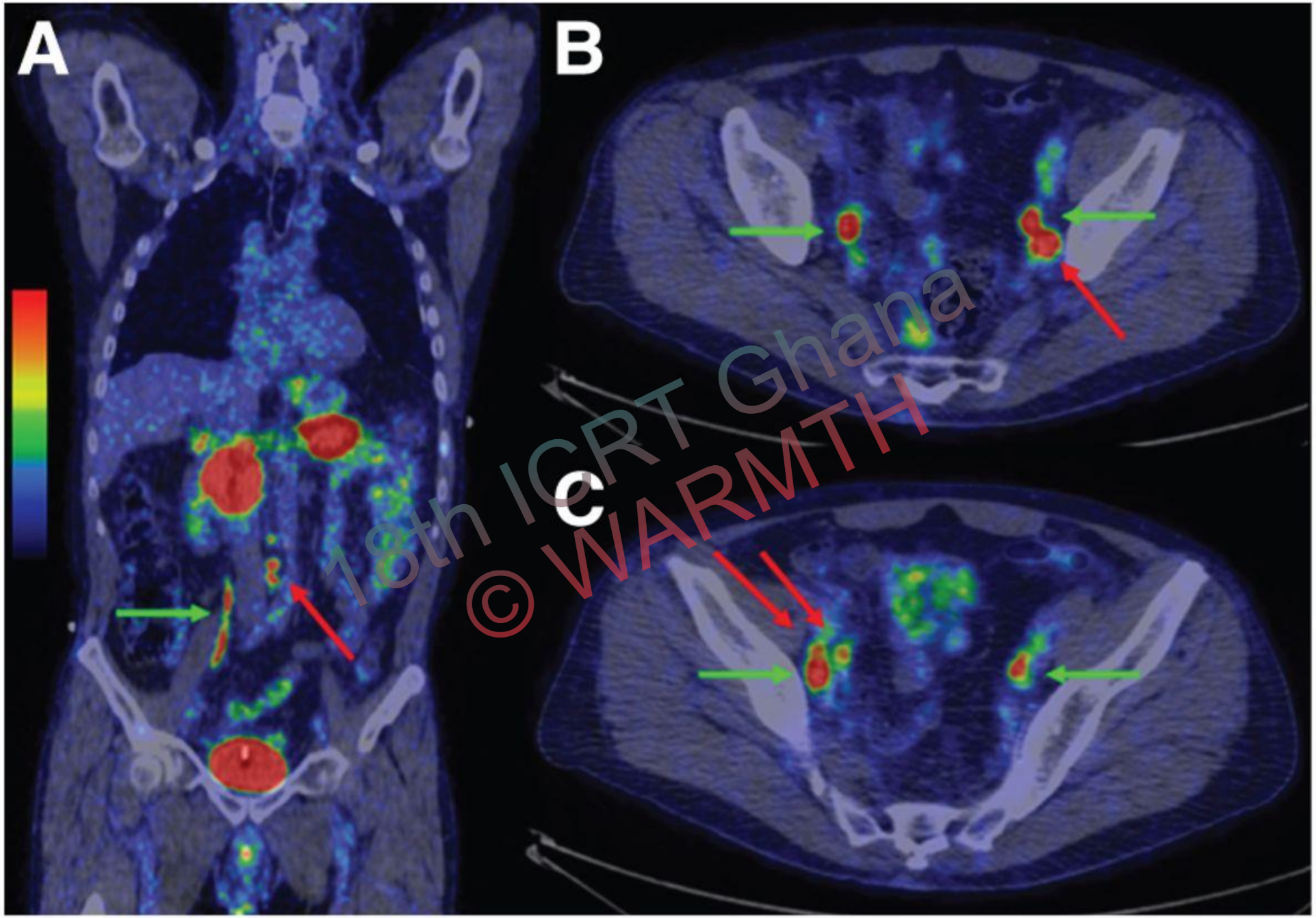

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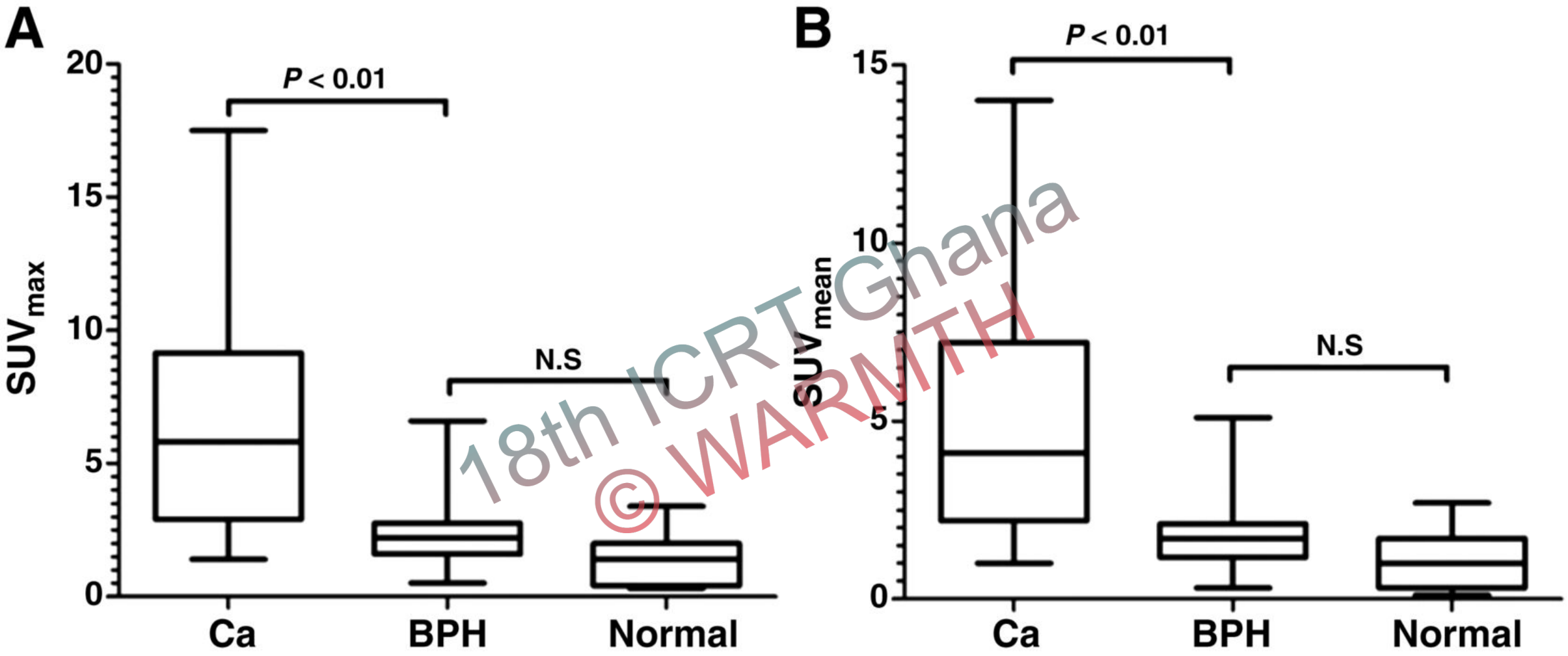

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Primary Staging

Comparison of ^{68}Ga-PSMA-617 PET/CT and ^{68}Ga-RM2 PET/CT in Patients with Localized Prostate Cancer Who Are Candidates for Radical Prostatectomy: A Prospective, Single-Arm, Single-Center, Phase II Study

J Nucl Med 2023; 64:379–385
DOI: 10.2967/jnumed.122.263889

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Romain Schollhammer[1,2], Grégoire Robert[3], Julien Asselineau[4], Mokrane Yacoub[5], Delphine Vimont[2], Nicolas Balamoutoff[1], Franck Bladou[3], Antoine Bénard[4], Elif Hindié[1,2,6], Henri de Clermont Gallerande[1,2], and Clément Morgat[1,2]

[1]Nuclear Medicine Department, Bordeaux University Hospital, Bordeaux, France; [2]INCIA, University of Bordeaux, CNRS, EPHE, UMR 5287, Bordeaux, France; [3]Department of Urology, Bordeaux University Hospital, Bordeaux, France; [4]CHU Bordeaux, Public Health Department, Clinical Epidemiology Unit, Bordeaux, France; [5]Department of Pathology, Bordeaux University Hospital, Bordeaux, France; and [6]Institut Universitaire de France, Paris, France

Hypothesis

Overexpression of GRPR in low grade PCa

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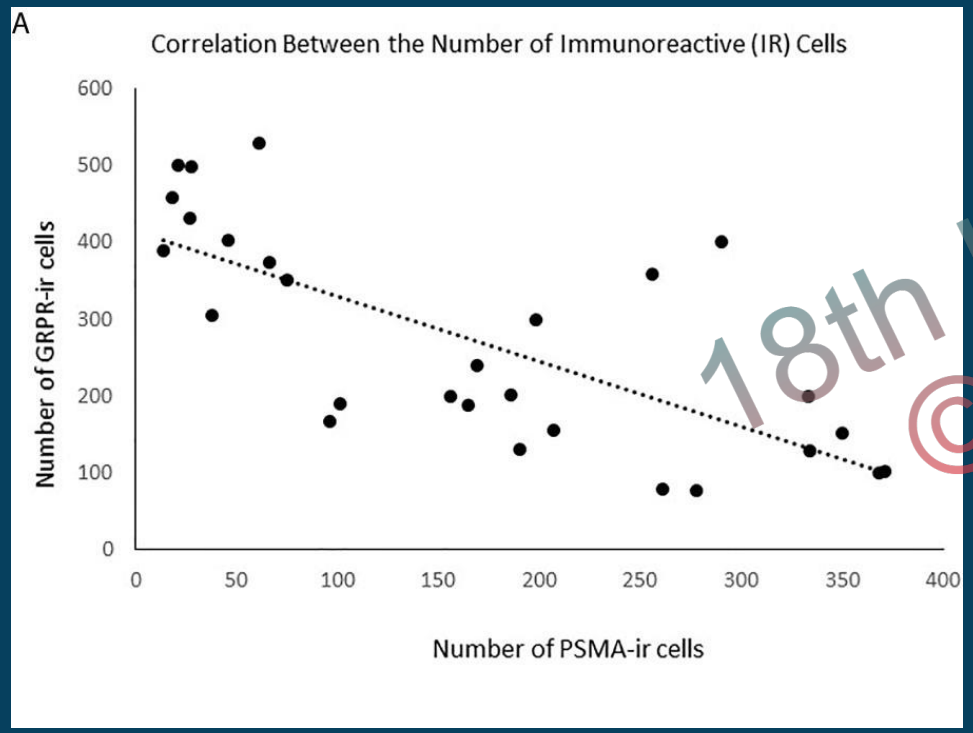
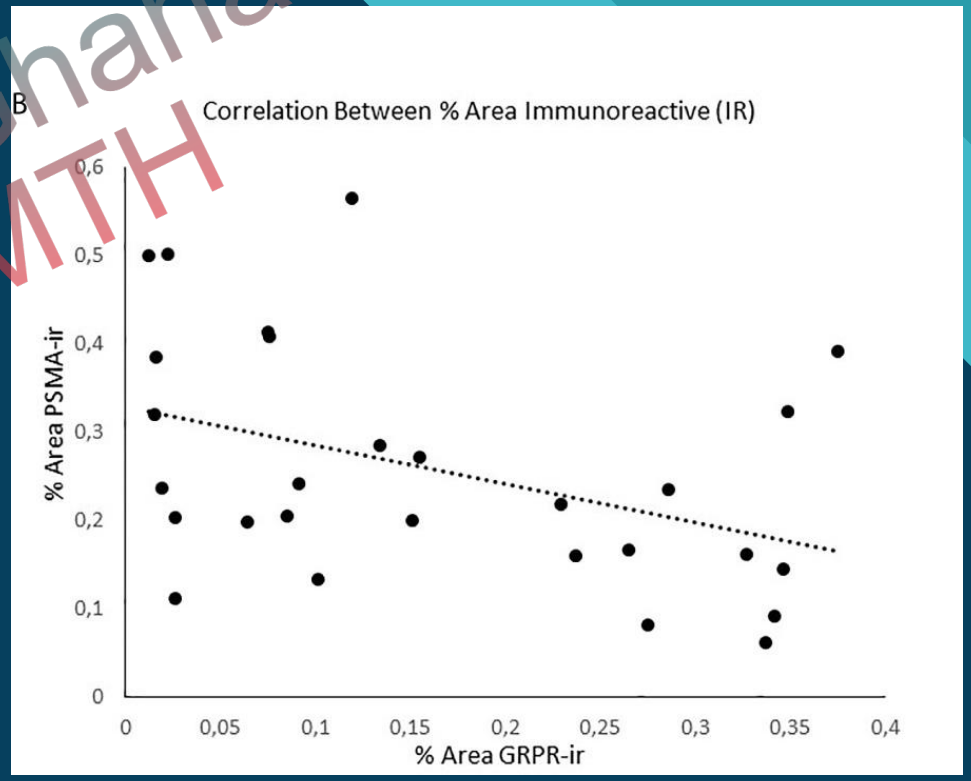
Faviana et al. Frontiers Oncol 2021

Hypothesis

Overexpression of GRPR in low grade PCa





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Key Findings

- Assess uptake intensity (SUVmax) with 68GaPSMA-617 and 68Ga-RM2 PET/CT at the level of prostatic lesions
- compare SUVmax between ISUP score categories

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TABLE 3
Comparison of ^{68}Ga-PSMA-617 and ^{68}Ga-RM2 Uptake with ISUP Score

ISUP score	Median SUV_{max}	
	^{68}Ga-RM2	^{68}Ga-PSMA-617
1	3.45 (2.50–4.70)	3.00 (2.60–3.50)
2	6.30 (5.30–7.50)	3.60 (3.40–4.50)
3	8.30 (3.80–9.80)	6.80 (5.10–7.10)
≥4	7.35 (3.25–9.05)	7.45 (5.90–12.50)

Key Findings

- Assess uptake intensity (SUVmax) with 68GaPSMA-617 and 68Ga-RM2 PET/CT at the level of prostatic lesions
- compare SUVmax between ISUP score categories

TABLE 3
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≥4	7.35 (3.25–9.05)	7.45 (5.90–12.50)

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Biochemical Recurrence

AUA criteria:

An increase in PSA to ≥ 0.2 ng/mL, measured at 6 to 13 weeks following prostatectomy, and confirmed by a second PSA level > 0.2 ng/mL.

ASTRO -Phoenix criteria:

A rise in PSA of ≥ 2 ng/mL above the nadir achieved after radiotherapy with or without androgen deprivation therapy

*** Biochemical persistence: persistently elevated PSA ≥ 0.1 ng/mL morethan 6 weeks after prostatectomy.**

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EAU-EANM-ESTRO-ESUR-SIOG-Guidelines-on-Prostate-Cancer-2022

Prostatectomy:rising PSA

PSA >0,4ng/ml best correlated to progression

Radiotherapy:EBRT:PSA nadir + 2ng/ml

Brachytherapy: PSA nadir + 2 ng/ml

Biochemical Recurrence

THE JOURNAL of UROLOGY®
www.auajournals.org/journal/juro

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Detection Rate of Prostate Specific Membrane Antigen Tracers for Positron Emission Tomography/Computerized Tomography in Prostate Cancer Biochemical Recurrence: A Systematic Review and Network Meta-Analysis

Biochemical Recurrence

- Overall detection rate 74.1% regardless of PSMA tracer utilized

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PSA (ng/ml)	Detection Rate (%)
<0,2	33,7
0,2 – 0,49	50,0
0,50 – 0,99	62,8
1,00 – 1,99	73,1
> 2.00	91,7

Potential Indication in BCR: PSMA PET negative studies

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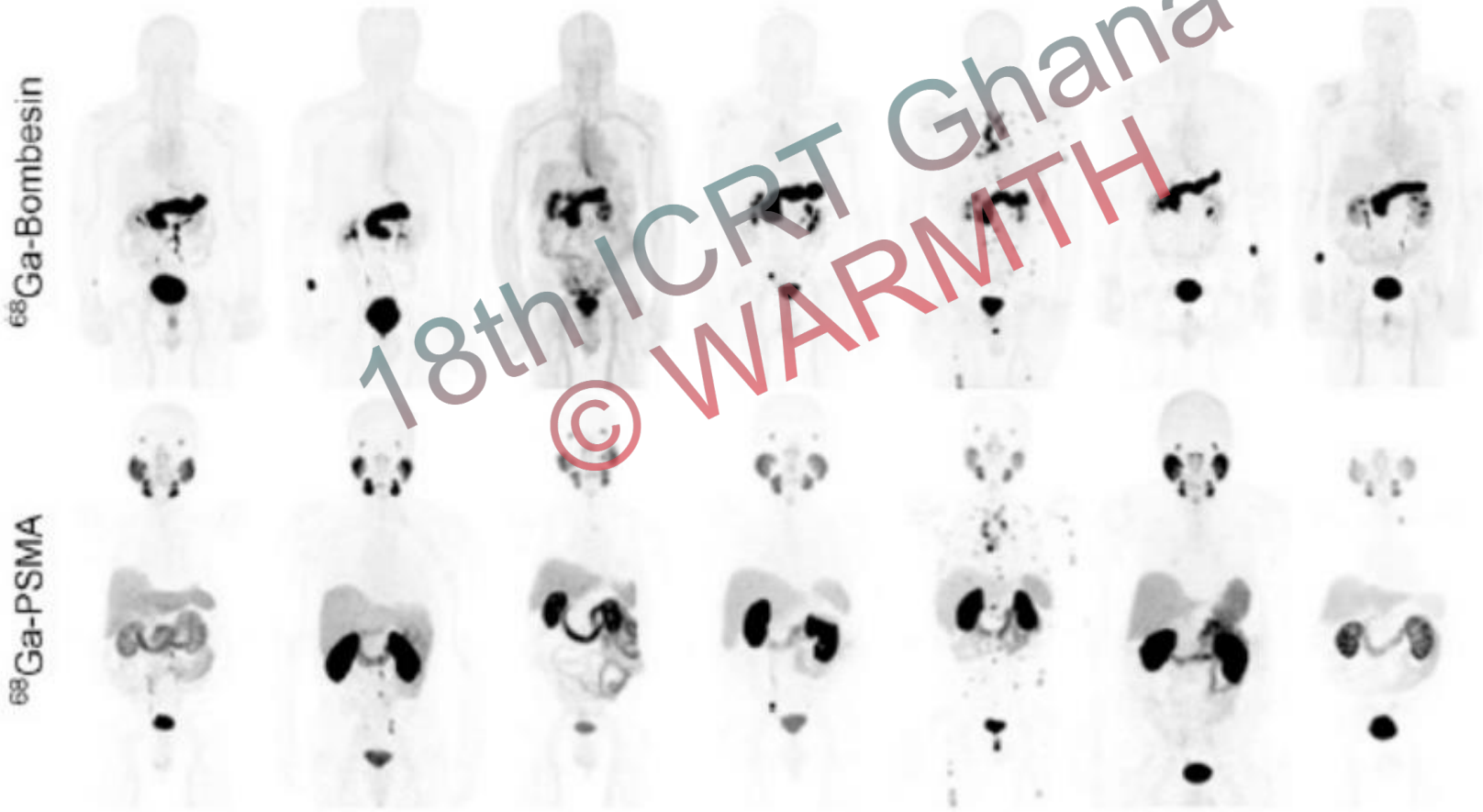
Pilot Comparison of ^{68}Ga-RM2 PET and ^{68}Ga-PSMA-11 PET in Patients with Biochemically Recurrent Prostate Cancer

Ryogo Minamimoto[1,2], Steven Hancock[3], Bernadette Schneider[2], Frederick T. Chin[2], Mehran Jamali[1,2], Andreas Loening[4], Shreyas Vasanawala[4], Sanjiv Sam Gambhir[2], and Andrei Iagaru[1]



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Positivity Rate 72%

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PSMA- and GRPR-Targeted PET: Results from 50 Patients with Biochemically Recurrent Prostate Cancer

Lucia Baratto[1], Hong Song[1], Heying Duan[1], Negin Hatami[1], Hilary P. Bagshaw[2], Mark Buyyounouski[2], Steven Hancock[2], Sumit Shah[3], Sandy Srinivas[3], Patrick Swift[2], Farshad Moradi[1], Guido Davidzon[1], and Andrei Iagaru[1]

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	Local recurrence		Lymph node metastases		Bone metastases	
Agent	*n*	Average SUV_{max}	*n*	Average SUV_{max}	*n*	Average SUV_{max}
^{68}Ga-RM2	13	13.3	46*	7.9	12*	6.1
PSMA	13	11.6	69†	17.7	17†	14.3

*3 lymph nodes were not detected by ^{68}Ga-PSMA11; 3 bone lesions were not detected by ^{8}F-DCFPyL.
†27 lymph nodes were not detected by ^{68}Ga-RM2; 8 bone lesions were not detected by ^{68}Ga-RM2.
PSMA also identified 1 lung nodule. ^{68}Ga-RM2 also identified 1 adrenal gland metastasis. Both PSMA and ^{68}Ga-RM2 also identified 6 hepatic lesions.

PSMA- and GRPR-Targeted PET: Results from 50 Patients with Biochemically Recurrent Prostate Cancer

Lucia Baratto[1], Hong Song[1], Heying Duan[1], Negin Hatami[1], Hilary P. Bagshaw[2], Mark Buyyounouski[2], Steven Hancock[2], Sumit Shah[3], Sandy Srinivas[3], Patrick Swift[2], Farshad Moradi[1], Guido Davidzon[1], and Andrei Iagaru[1]

Positivity Rate 70%

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Agent	Local recurrence		Lymph node metastases		Bone metastases	
	n	Average SUV_{max}	*n*	Average SUV_{max}	*n*	Average SUV_{max}
^{68}Ga-RM2	13	13.3	45*	7.9	12*	6.1
PSMA	13	11.6	69†	17.7	17†	14.3

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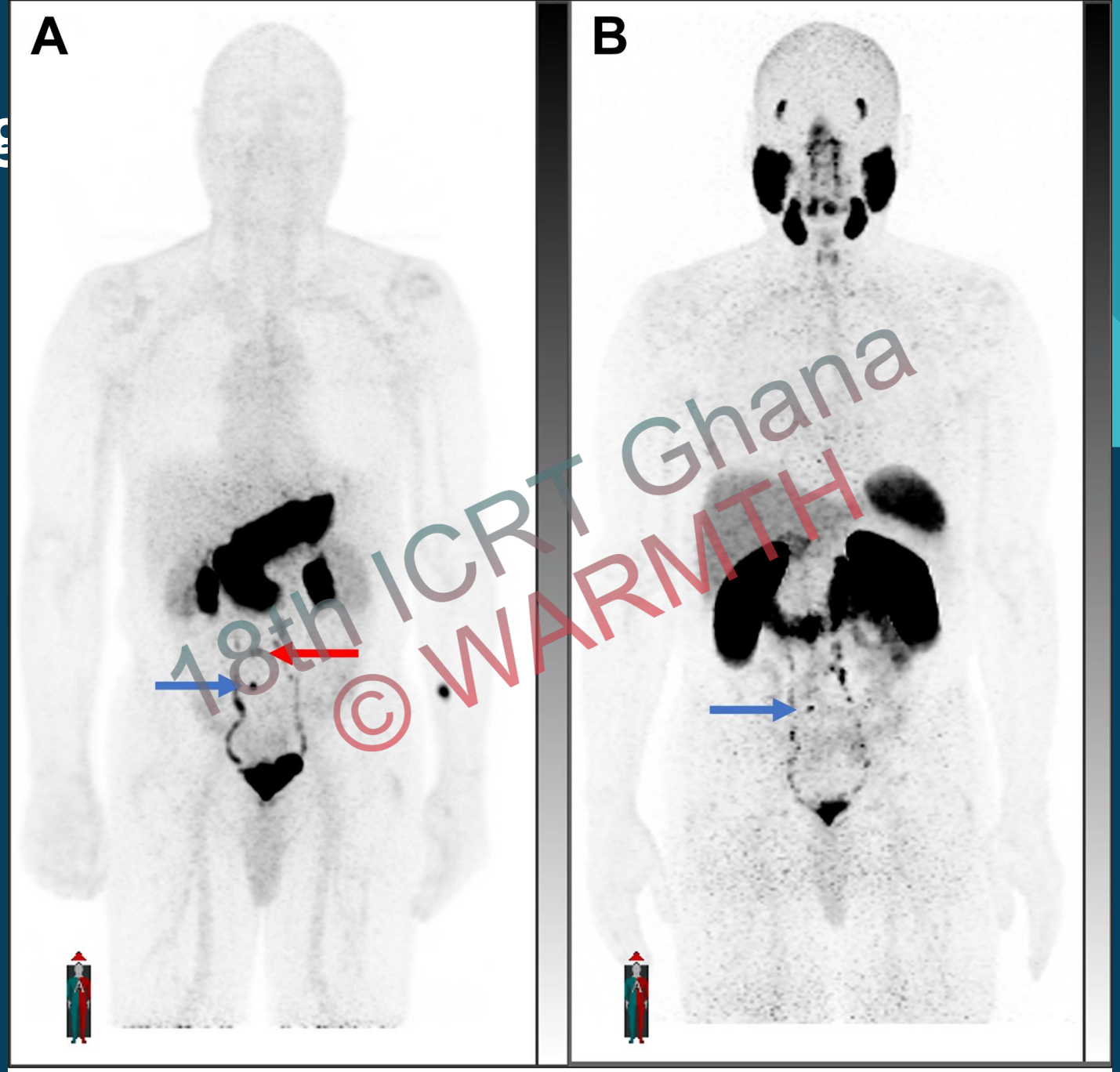
Primary Stag



Planning for PSMA Radioligand Therapy

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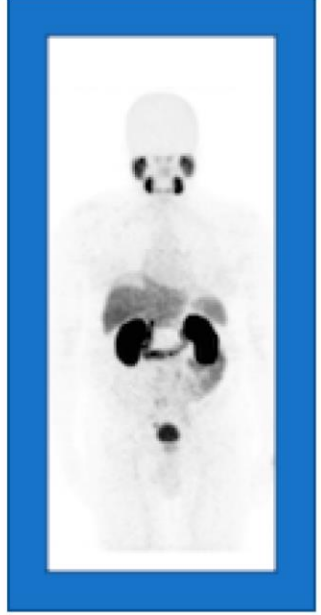


PSMA -ve

PSMA +ve (*)

Conventional therapies

- Hormonal therapy
- Chemotherapy

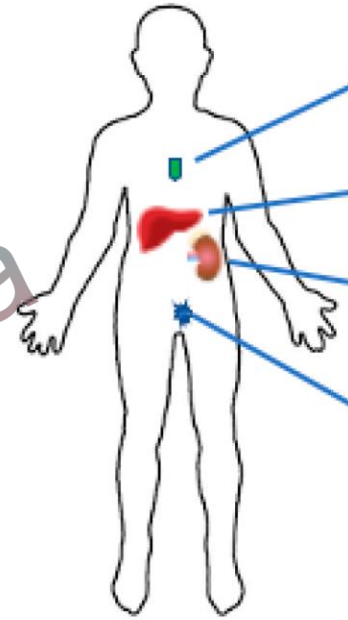
Heavily treated pt with – PSMA scan at follow-up and rising s-PSA consider:

- CT or MRI
- 18F-FDG PET/CT

* ^{18}F—FDG concordant

PRIOR TO PRLT

Life expectancy > 6months
ECOG > 2



Bone marrow function:
WCC > 2.5x10^9/L
Platelet count > 75x10^9/L

LFTs < 5-fold ULN

99mTc-MAG3 or 99mTc-DTPA
GFR > 30mL/min
Creatinine > 2-fold ULN

s-PSA and s-testosterone

6 – 8.5GBq ^{177}Lu-PSMA
2 – 6 cycles
Every 6 weeks
1 – 2l NaS } On the
Anti-emetic } day of Rx

Follow-up

BM function
eGFR and creatinine
LFTs
s-PSA and s-testosterone

Clinical evaluation

Repeat PSMA PET/CT

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Mokoala et al. *Cancers* **2021**, *13*(15), 3904

Potential Indications

Administrations in a group of mCRPC patients who had insufficient PSMA uptake or poor response to standard RLT with Lu177PSMA

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European Journal of Nuclear Medicine and Molecular Imaging (2020) 47:123–135
https://doi.org/10.1007/s00259-019-04504-3

ORIGINAL ARTICLE

Check for updates

First-in-human dosimetry of gastrin-releasing peptide receptor antagonist [^{177}Lu]Lu-RM2: a radiopharmaceutical for the treatment of metastatic castration-resistant prostate cancer

Jens Kurth[1] · Bernd Joachim Krause[1] · Sarah M. Schwarzenböck[1] · Carina Bergner[1] · Oliver W. Hakenberg[2] · Martin Heuschkel[1]

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Indications

- progressive metastatic castration-resistant prostate cancer,
- completed treatment options according to current clinical practice for castration resistant disease
- previous [68Ga]Ga-PSMA-11 and [68Ga]Ga-RM2 PET/CT imaging with a visually higher RM2 uptake in the tumor lesions,
- sufficient renal function
- no myelosuppression
- a normal liver function

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Table 1 Patient characteristics

Pat. no.	Cycle	Age [year]	Weight [kg]	Pretreatments	Metastases	PSA [ng/mL]	Gleason Score	KPS [%]	Administered activity [GBq]
1	1	60	88	DXL, CXL, abiraterone, enzalutamide, [^{177}Lu]Lu-PSMA-617	OSS, HEP, CER	752	9 (4 + 5)	60	3.74
2	1	63	57	DXL, CXL, abiraterone, mitoxantrone, enzalutamide, [^{177}Lu]Lu-PSMA-617	OSS, HEP, VIS, LN	4705	8 (4 + 4)	60	4.59
	2		60			5884		70	3.06
3	1	80	97	DXL, abiraterone, enzalutamide, [^{177}Lu]Lu-PSMA-617	OSS, LN	519	9 (4 + 5)	80	4.47
	2		98			349		80	4.98
4	1	62	95	DXL, CXL, [^{177}Lu]Lu-PSMA-617	OSS, LN	0.06	10 (5 + 5)	90	6.05

DXL, docetaxel; *CXL*, cabazitaxel; *PSA*, prostate-specific antigen measured prior to RM2 therapy; *KPS*, Karnofsky Performance Score; *OSS*, osseous; *HEP*, hepatic; *CER*, cerebral; *VIS*, visceral; *LN*, lymph nodes

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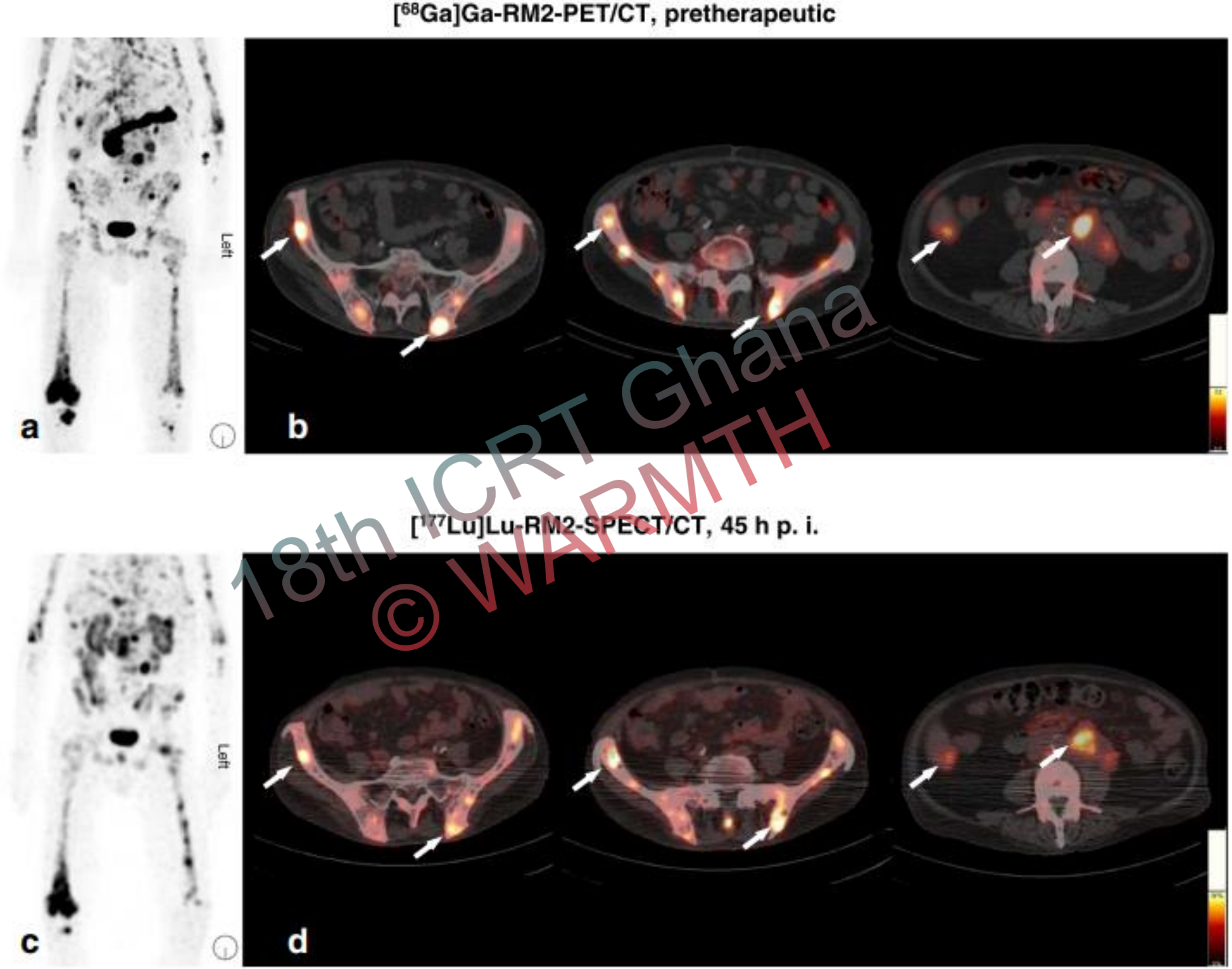

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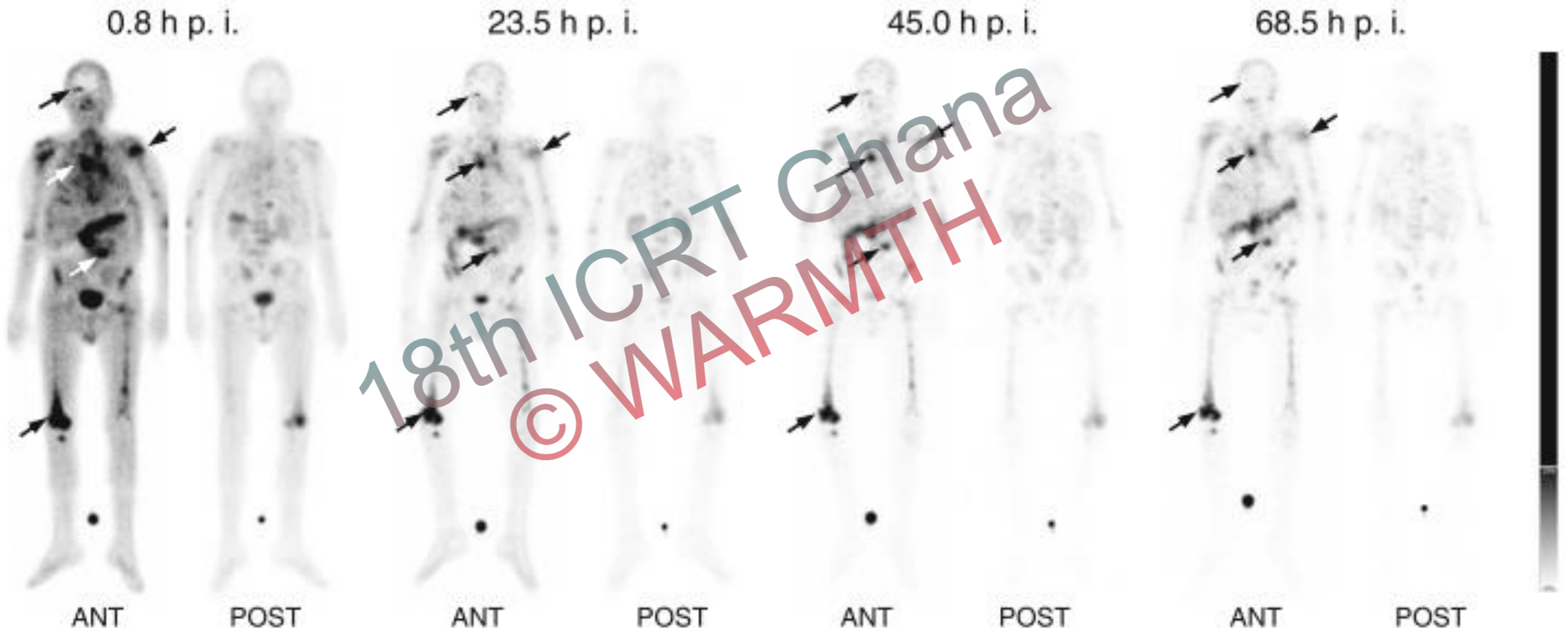

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NCT Number	Category Type	Peptide Radionuclide	Phase	Population Number of Planned Patients	Endpoints
NCT04264208	GRPR Imaging	RM2 Gallium-68	2	PCa patients scheduled for HDR Brachytherapy $n = 100$	Definition of [^{68}Ga]Ga-RM2 PET/MRI detection rate versus mpMRI Definition of [^{68}Ga]Ga-RM2 PET/MRI ability to assess changes response to treatment Determination of progression-free survival
NCT03949517	GRPR Imaging	RM2 Gallium-68	1/2	PCa patients scheduled for HDR or HIFU $n = 10$	Evaluation of PCa response to HIFU or HDR Therapy
NCT03809078	GRPR Imaging	RM2 Gallium-68	2	Suspected PCa $n = 20$	Evaluation of [^{68}Ga]Ga-RM2 PET/MRI for biopsy guidance in patients with suspected PCa
NCT03698370	GRPR Imaging	NeoBOMB1 Gallium-68	2	Recurrent PCa $n = 50$	To evaluate gallium [^{68}Ga]Ga-NeoBOMB1 PET/MRI for detection of recurrent PCa after initial definitive therapy
NCT03606837	GRPR Imaging	RM2 Gallium-68	2	PCa patients scheduled for prostatectomy $n = 15$	Determination of uptake intensity assessed with median SUV
NCT03113617	GRPR Imaging	RM2 Gallium-68	2	PCa patients scheduled for prostatectomy $n = 90$	Determination of [^{68}Ga]Ga-RM2 PET/CT detection rate in intermediate and high-risk PCa patients prior to prostatectomy.
NCT02624518	GRPR Imaging	RM2 Gallium-68	2/3	Recurrent PCa $n = 125$	Determination of [^{68}Ga]Ga-RM2 PET/MRI detection rate in recurrent PCa after initial definitive therapy
NCT00588185	Androgen receptor Imaging	FHDT Fluorine-18	Ns	Progressive PCa $n = 300$	Determination of the accumulation and biodistribution of FDHT in patients with progressive PCa
NCT04457232	FAP Imaging	FAPi-46 Gallium-68	1	Metastatic recurrent PCa $n = 30$	Definition of the biodistribution of [^{68}Ga]Ga-FAPi-46 in normal and cancer tissues of PCa patients
NCT04000776	SSTR Imaging	Octreotate Gallium-68	Ns	mCRPC patients $n = 100$	Determination of the prevalence of mCPRC intrapatient intermetastasis polyclonality and neuroendocrine using PET/CT triple tracer PSMA/FDG/OCTREOTATE imaging and their eligibility for radioligand therapy

GRPR: gastrin-releasing peptide receptor; FAP: fibroblast activation protein; SSTR: somatostatin receptor; PCa: prostate cancer; mCRPC: metastatic castration-resistant prostate cancer; HIFU: High intensity focused ultrasound; HDR: High dose-rate; Ns: not specified.

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Table 3. Currently recruiting clinical studies available on ClinicalTrial.gov concerning the use of radiolabeled ligands of potential targets other than PSMA for prostate cancer theranostics (accessed 20 August 2021).

NCT Number	Category Type	Peptide Radionuclide	Phase	Population Number of Planned Patients	Endpoints
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The future (or the present?)

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[^{68}Ga]Ga-iPSMA-Lys^{3}-Bombesin: Biokinetics, dosimetry and first patient PET/CT imaging

Belén Rivera-Bravo [a], Gerardo Ramírez-Nava [b,c], Mónica J. Mendoza-Figueroa [d], Blanca Ocampo-García [b], Guillermina Ferro-Flores [b,*], Miguel A. Ávila-Rodríguez [d,**], Clara Santos-Cuevas [b,**]

A Radiotracer for Molecular Imaging and Therapy of Gastrin-Releasing Peptide Receptor–Positive Prostate Cancer

Ivica J. Bratanovic[1], Chengcheng Zhang[1], Zhengxing Zhang[1], Hsiou-Ting Kuo[1], Nadine Colpo[1], Jutta Zeisler[1], Helen Merkens[1], Carlos Uribe[2,3], Kuo-Shyan Lin[1,2], and François Bénard[1,2]

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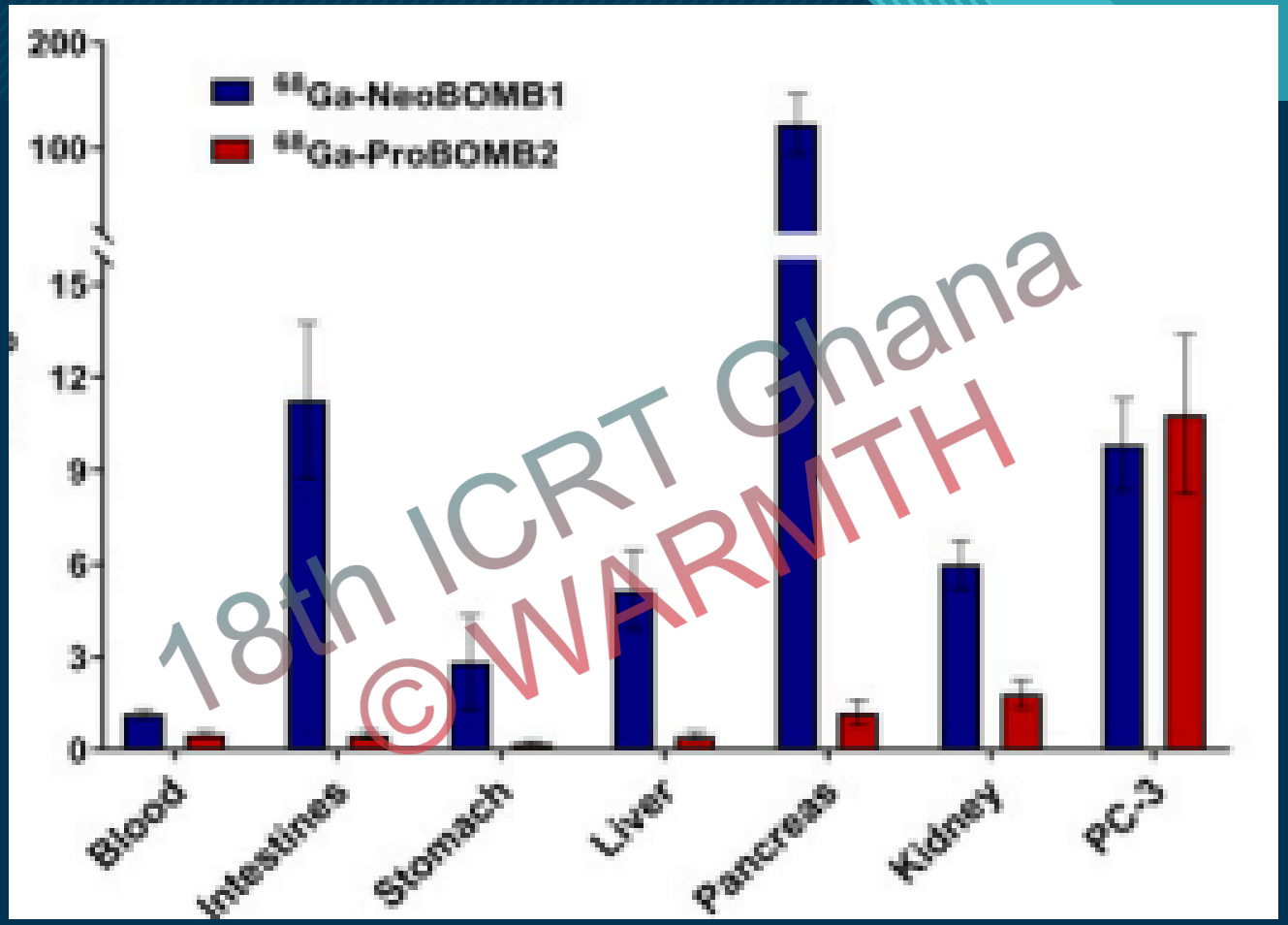

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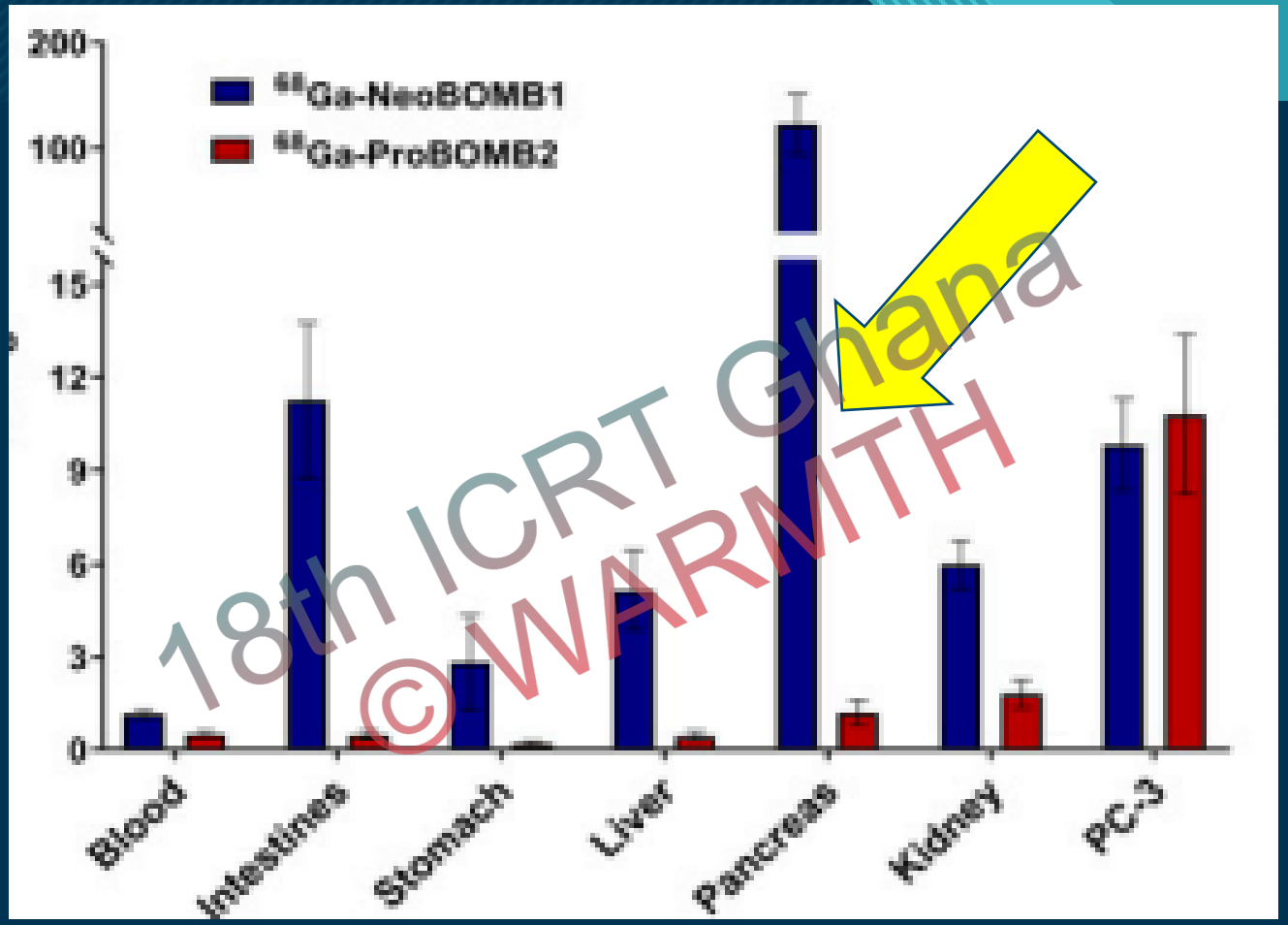

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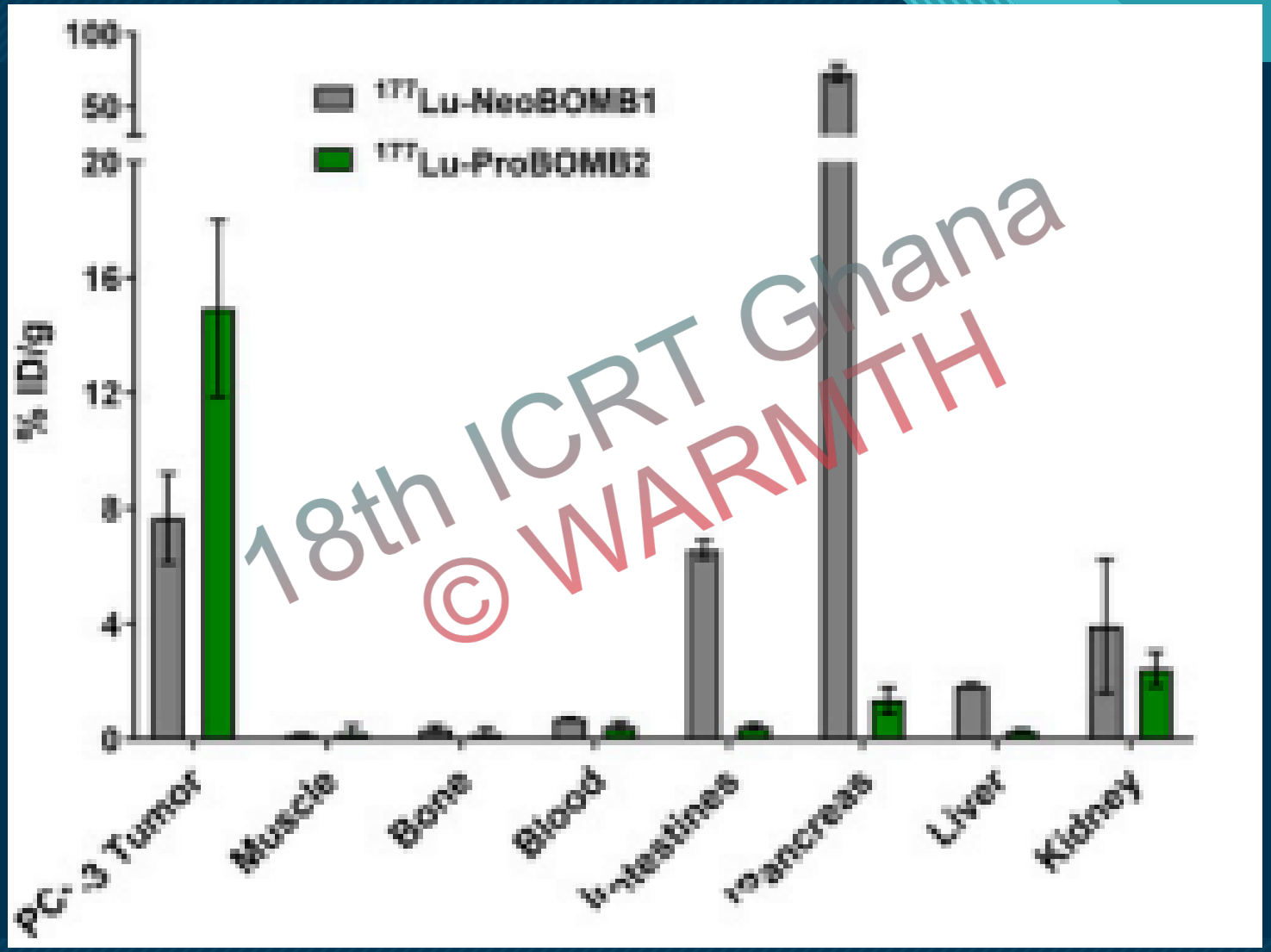

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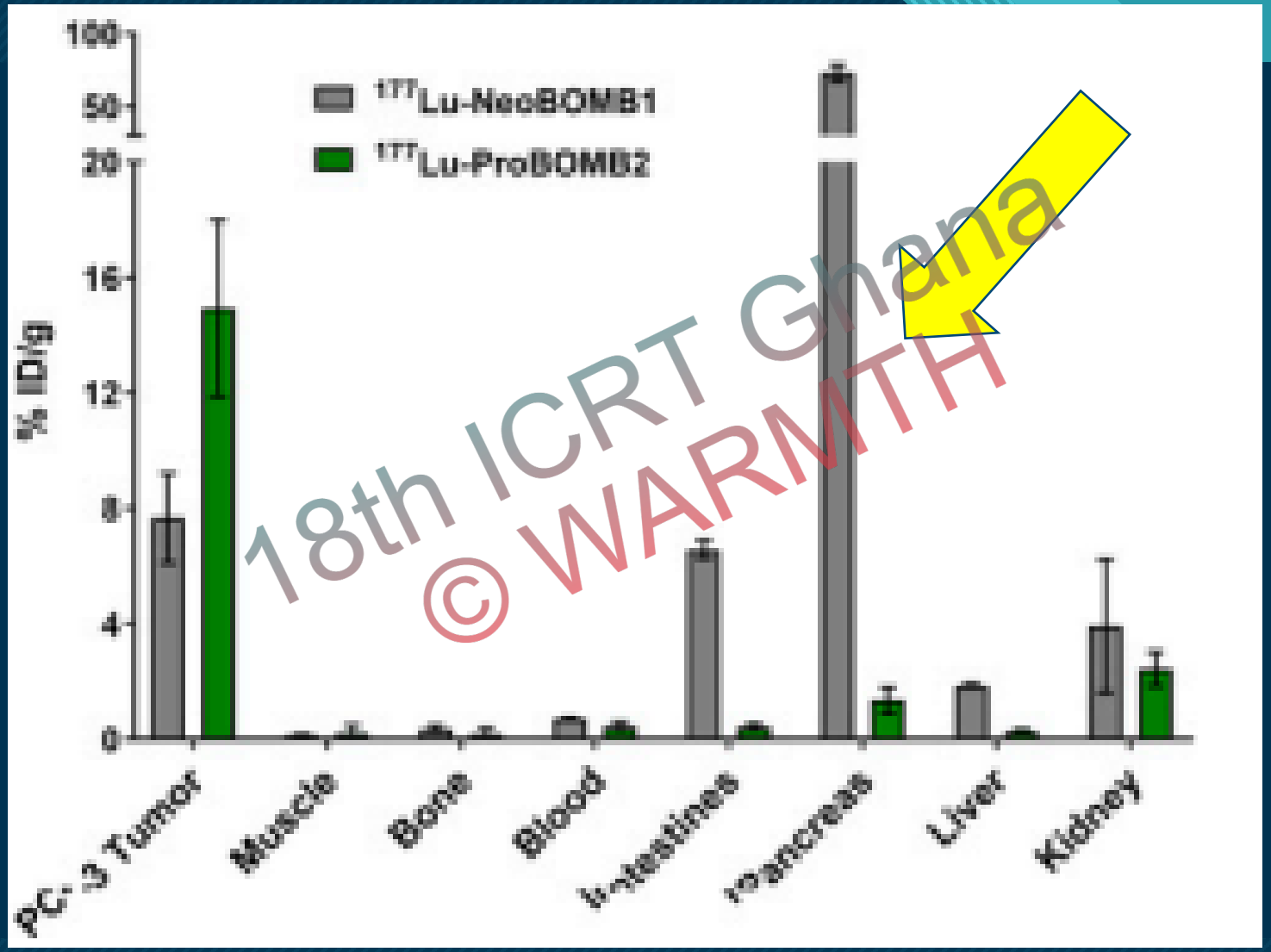

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pharmaceuticals

MDPI

Article

Copper-67-Labeled Bombesin Peptide for Targeted Radionuclide Therapy of Prostate Cancer

Truc T. Huynh [1,2], Ellen M. van Dam [3], Sreeja Sreekumar [1], Cedric Mpoy [1], Benjamin J. Blyth [4,5], Fenella Muntz [4], Matthew J. Harris [3] and Buck E. Rogers [1,*]

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Conclusions

- Primary Prostate Cancer
  - Consider in low prostate cancer taking into account Gleason Score, PSA and ISUP Grade(Ideally 2)
- Biochemical recurrence
  - PSA in undetectable range of PSMA targets
- Radioligand therapy
  - Consider in patients who have insufficient PSMA avidity post Lu177 PSMA therapy

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Important Dates

31 March 2023
Abstract submission deadline

26 April 2023
End of early-bird registration

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