



TLJCC • CLINICAL BRIEFING

Beyond the Scan

How Nuclear Medicine Changes Patient Management

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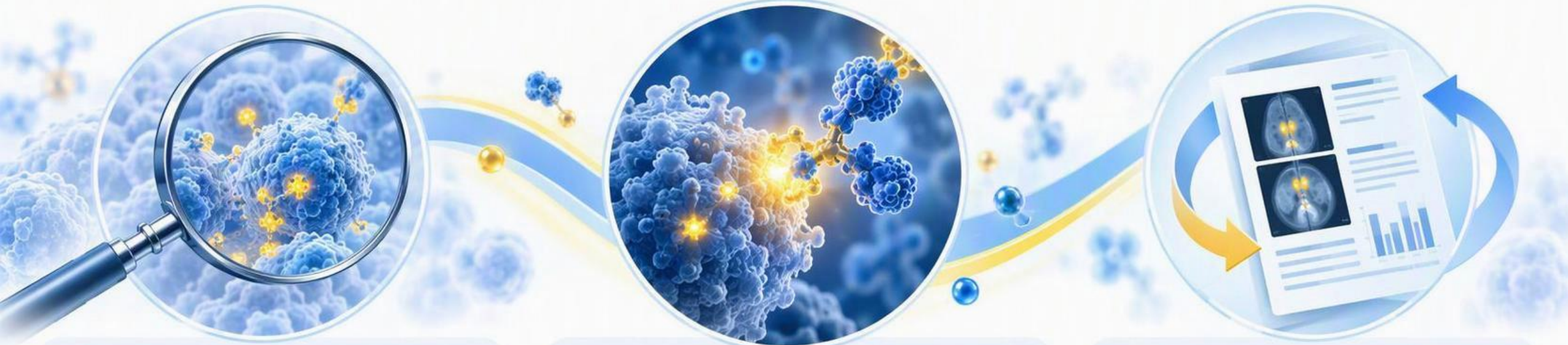
About the speaker



drzool.com

See → Decide → Treat → Reassess

Three questions for GPs and the referring team



See

Does molecular imaging add biology that anatomy alone cannot? Evidence: PET frequently changes intended management.

Decide & Treat

How do FDG (now), PSMA and SSTR imaging (planned) move stage, fields and therapy selection — including theranostics?

Reassess

After treatment starts, can imaging still change the plan — and how should the MDT use the report?

Where nuclear medicine sits

Sources of ionizing radiation and the speciality that uses each



Ionizing Radiation	Source	Types of ionizing radiation		Speciality
	Machine-generated X-rays 	Low photon-energy	e.g. conventional X-ray, CT scan	Conventional Radiology
		Teletherapy / Radiosurgery	High photon energy e.g. LINAC device for teletherapy and radiosurgery	
	Sealed or solid radioactive sources 	Teletherapy / Radiosurgery	Source head houses sealed radionuclides e.g. Co-60 in gamma-knife for stereotactic radiosurgery	Radiotherapy / Oncology
		Brachytherapy	Sealed radioactive source in instilled compounds, ceramics, metal foils or wires e.g. Cs-137 needles	
	Unsealed radioactive sources Radioactive medical products radiopharmaceutical 	For treatment	β -rays (particulate emissions) e.g. Sr-89, P-32	Nuclear Medicine
		For diagnosis & treatment	Both β and γ -rays e.g. I-131, Re-186	
		For diagnostics	γ -rays (non-particulate emissions) Imaging (e.g. Tc-99m, In-111 etc.) Non-imaging (e.g. Cr-51)	
	Three sources, three specialities			
	Machine X-rays: radiology and radiotherapy		Sealed sources: radiotherapy / oncology	Unsealed sources: nuclear medicine

Anatomy to molecular: what each scan shows

Ultrasound, CT, MRI and PET/SPECT/CT compared

	Anatomy	Physiology	Metabolism	Molecular
CT scan 				
Ultrasound 				
MRI 				
PET / SPECT / CT 				

Only PET / SPECT / CT runs from anatomy all the way to molecular.

A molecular decision tool

Biology that crosses a clinical decision threshold

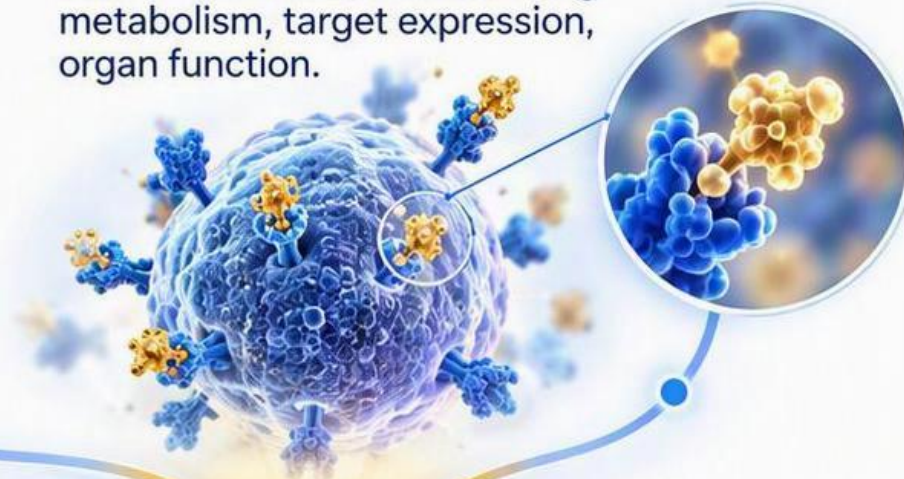
Anatomy

Tells us where a lesion is — size, shape, location.



Molecular imaging

Tells us what the lesion is doing — metabolism, target expression, organ function.



Referral filter

If the study will not change next week's plan, ask whether we needed it.

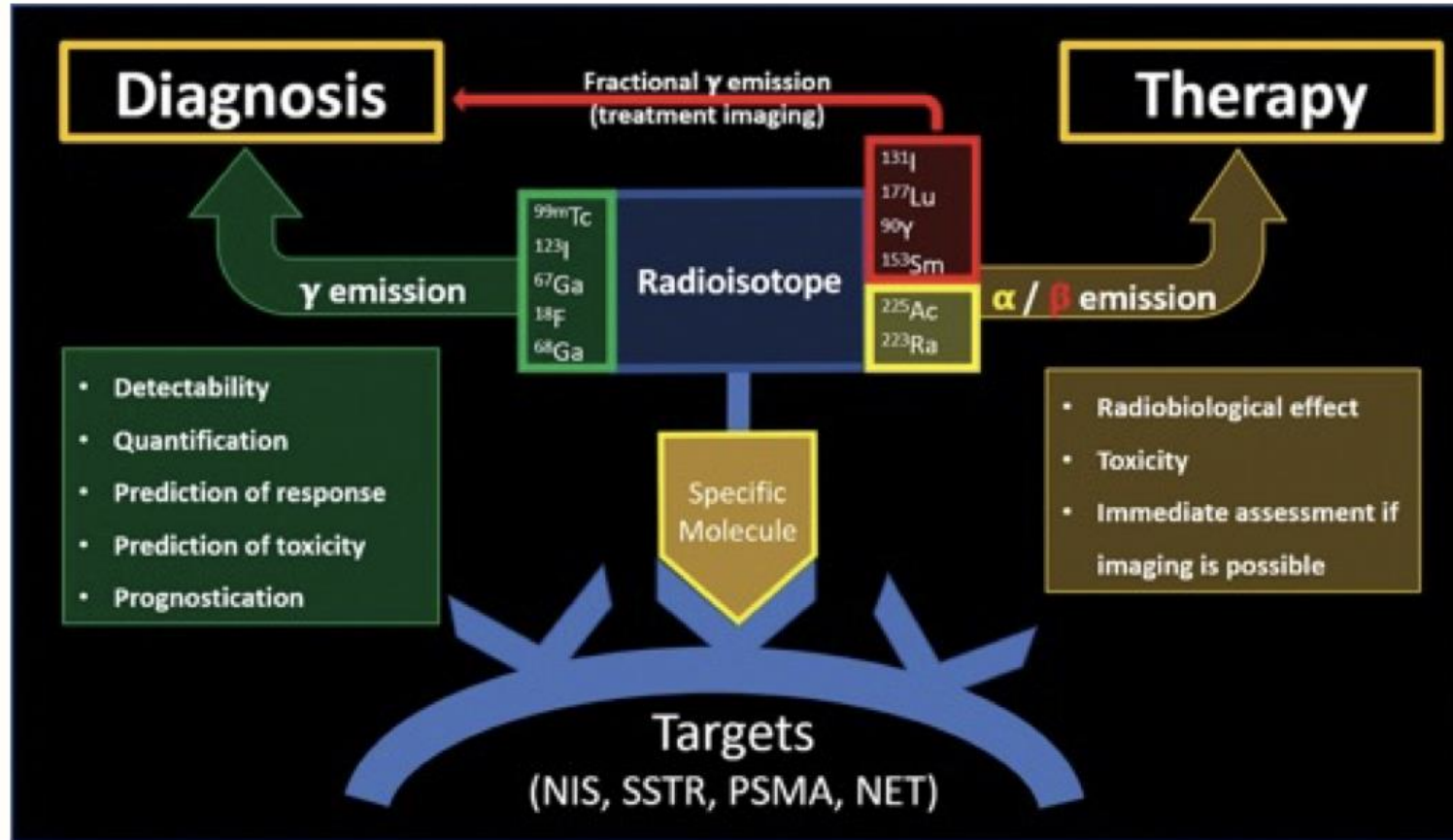


Decision threshold

Management value appears when biology crosses a clinical fork in the road.

Theranostics: one target, two jobs

Diagnosis and therapy with radioisotopes on the same specific molecule



Same molecule, different isotope

- γ emission: diagnosis
- α / β emission: therapy
- Targets: NIS, SSTR, PSMA, NET

Point to the diagram to explore. Click to keep a selection.

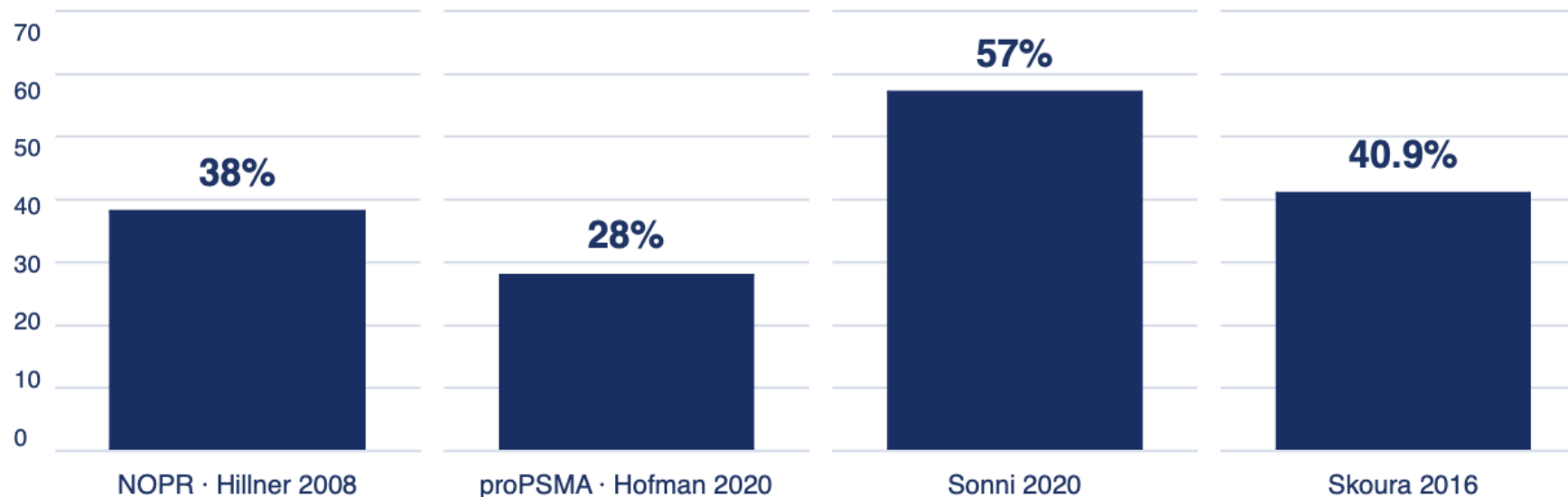
Point to explore · Click to pin

Show all results



The evidence in one slide

Management-change rates across four landmark studies — not a meta-analysis



Four landmark studies

28–57%

Management change

Different studies, not a meta-analysis

Point or focus to highlight. Click to keep a study selected.

Show all studies

CLINICAL IMPACT

Across major studies, PET frequently changes intended management.

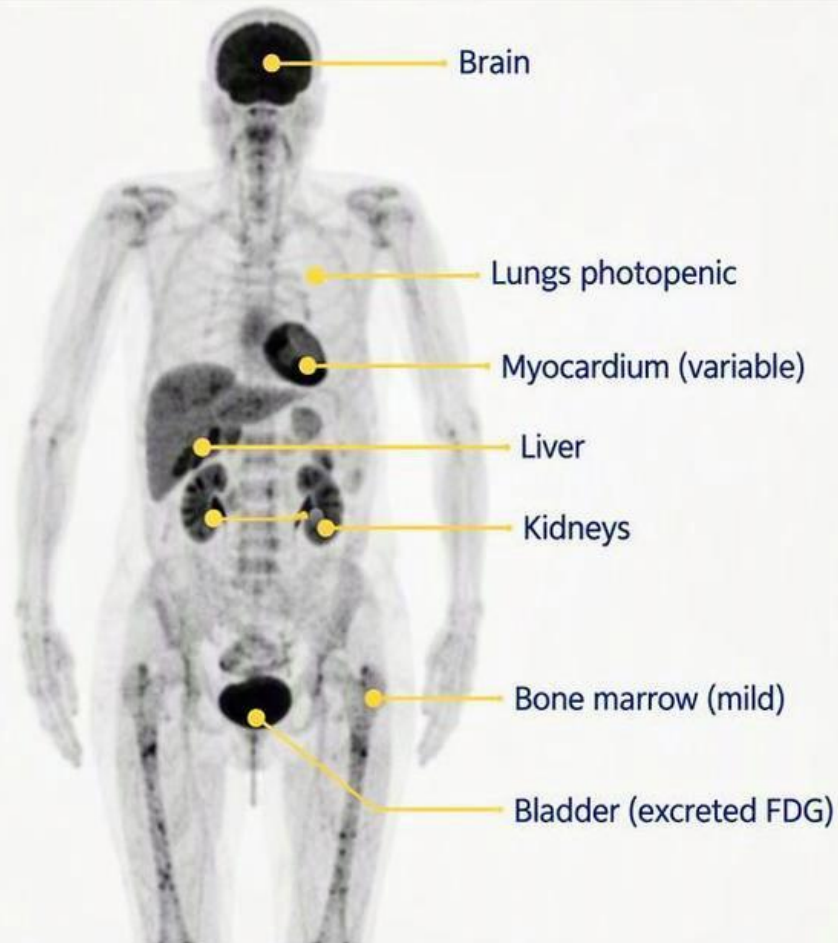


PART I • AVAILABLE NOW

FDG PET/CT — for GPs

How to read the pictures. When they change the plan. What is bookable today.
Available now at TLJCC (uMI Panvivo).

Why metabolism matters



Teaching MIP — physiologic FDG biodistribution (not a TLJCC patient)



Tumour glycolysis may declare itself before size changes.



Whole-body map can uncover unsuspected nodal or distant disease.



Result can change intent: curative ↔ palliative, local ↔ systemic.



Available today at TLJCC on the uMI Panvivo.

PART I • FDG HISTORY

Where it all began: FDG, 1976

FDG behaves like glucose, so PET can map metabolism

Pioneer — still active today



1975 • BROOKHAVEN, NEW YORK

^{18}F -FDG made by Al Wolf's team (Ido et al)



AUGUST 1976 • PENN, PHILADELPHIA

First human FDG scans: Alavi, Reivich and colleagues



1998–2001 • PET/CT

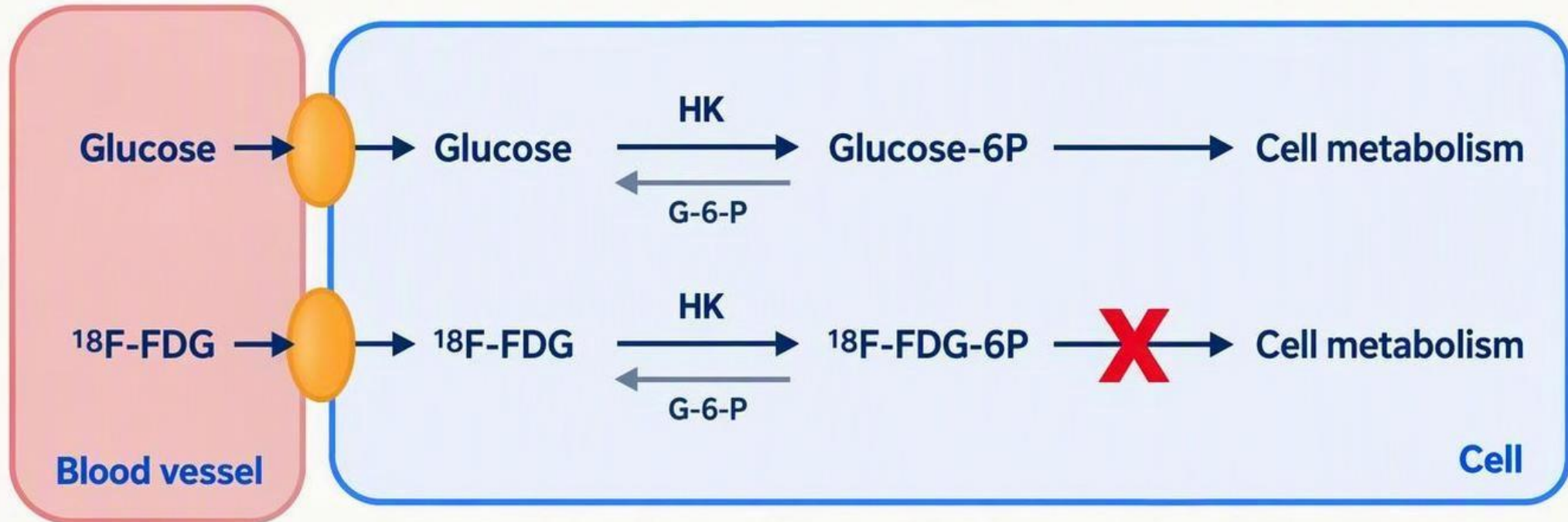
Metabolism and anatomy in one scan



TODAY • TLJCC

FDG PET/CT is available here now

How FDG is trapped — look at the red X



Peer-reviewed teaching schematic — mechanism, not a patient image

**GLUT → hexokinase →
FDG-6P trapped.**

**Micrograms of tracer;
whole-body map.**

**Not a cancer stain —
inflammation lights up too.**

Glucose vs FDG: one small change

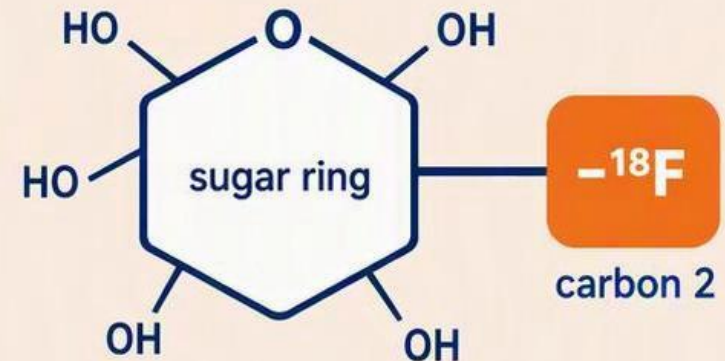
Glucose



- Enters the cell
- Phosphorylated by hexokinase
- Continues through glycolysis for energy

FDG

2-deoxy-2-[^{18}F]fluoro-D-glucose



- Same shape, but the -OH on carbon 2 is replaced by fluorine-18
- Enters through GLUT and is phosphorylated
- Cannot continue down glycolysis



What really happens inside the cell



Both are phosphorylated by hexokinase. Only glucose goes on.

Why FDG-6-P is trapped

- Not a substrate for phosphoglucose isomerase (needs the C2 -OH)
- Charged, so it cannot leave the cell
- Glucose-6-phosphatase is low in most tumours

Why cancer cells look brighter

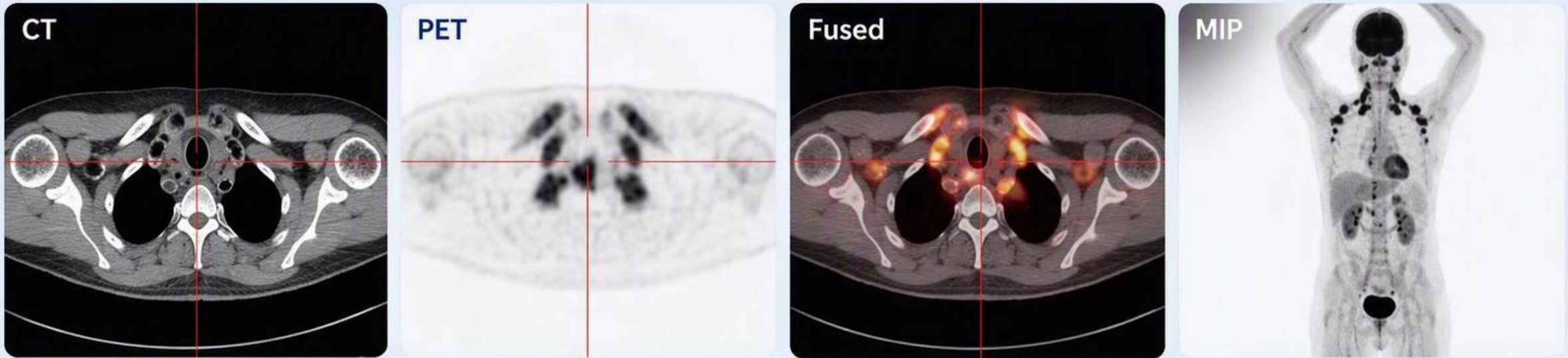
- Many cancers over-express GLUT, especially GLUT1: far more FDG gets in
- High hexokinase: more FDG-6-P
- Result: accumulation, so high uptake



Caveat: trapping also happens in normal cells (brain, heart, muscle, inflammation), and not every cancer is FDG-avid.

How to read PET/CT: CT • PET • fused

Four panels, one patient — teaching figure, not a TLJCC patient



IJNM brown-fat teaching panel — CT / PET / fused / MIP (not a TLJCC patient)

1



Look here first: MIP for the whole-body pattern.

2



Then the triad — CT anatomy, PET metabolism, fused location.

3



Same slice, same crosshair — that is how we decide what is hot.

All fluorine-18: FDG • PSMA-1007 • AIF-octreotide

Head→mid-torso • normal / volunteer OA MIPs (not disease cases)

[18F]FDG

Normal physiology • brain hot • variable myocardium



[18F]PSMA-1007

Healthy volunteer • salivary • liver/bowel



[18F]AIF-NOTA-octreotide

Healthy volunteer • spleen • pituitary • adrenals



FDG bookable at TLJCC

PSMA / DOTA PET planned — not bookable yet

FDG: TLJCC teaching MIP (classic physiology). [18F]PSMA-1007: Giesel et al, EJNMMI 2017 Fig 2a ~60–80 min healthy volunteer (CC BY 4.0; upscaled from OA strip). [18F]AIF-OC: Pauwels et al, EJNMMI 2020 Fig 1a ~57 min healthy volunteer (CC BY 4.0).

Mixed isotopes: FDG • Ga-PSMA-11 • Ga-DOTATATE

Head → mid-torso • normal biodistribution OA MIPs



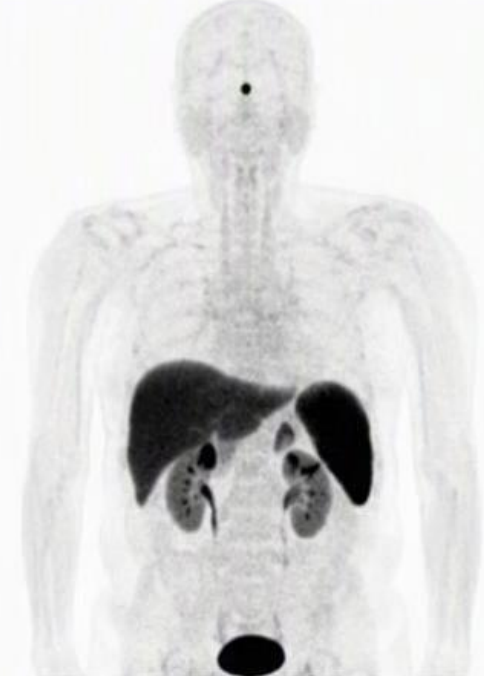
[18F]FDG

Normal physiology • brain hot • variable myocardium



[68Ga]Ga-PSMA-11

Normal • salivary + lacrimal • kidneys/bladder



[68Ga]Ga-DOTATATE

Normal • pituitary • intense spleen • adrenals

FDG bookable at TLJCC

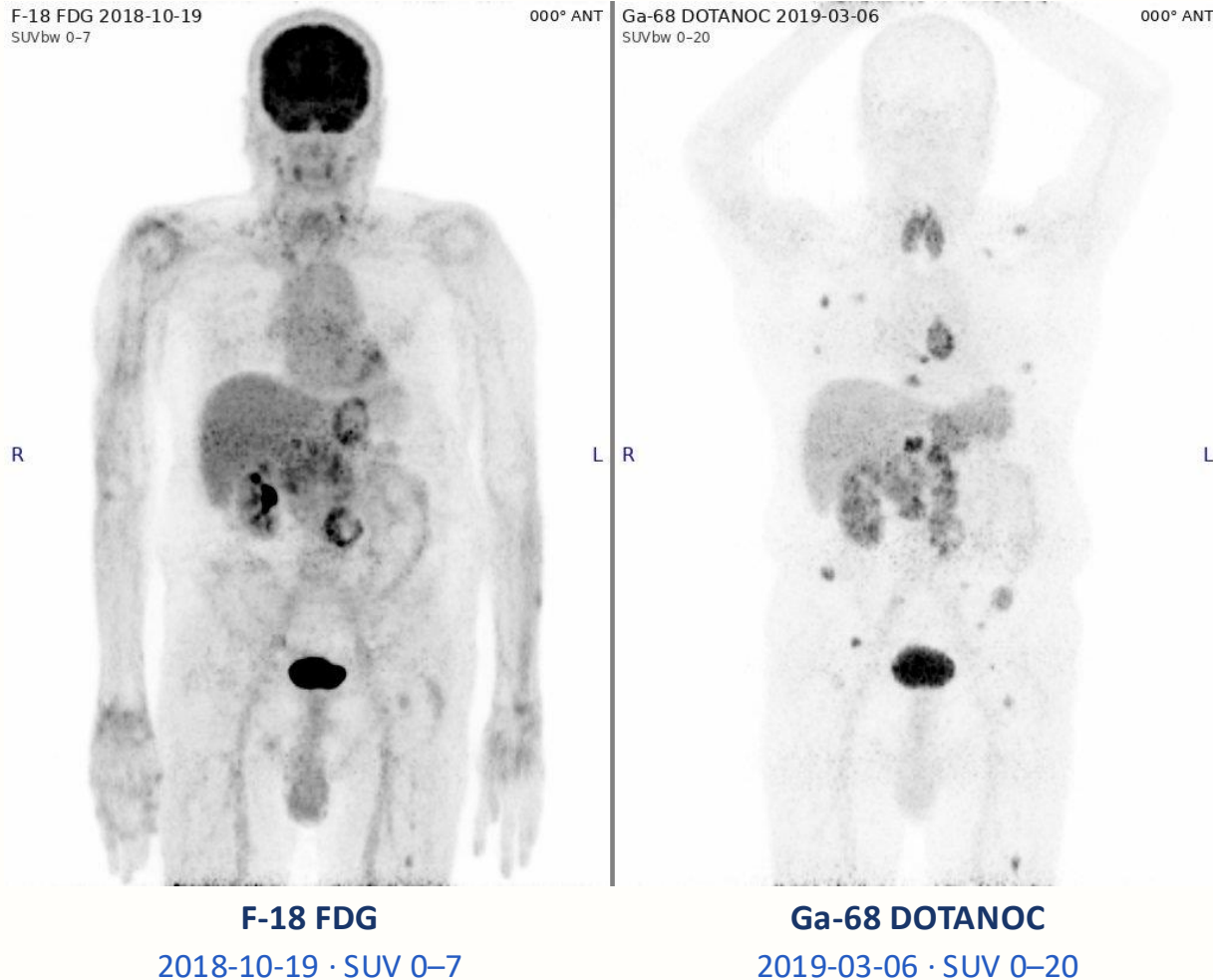
PSMA / DOTA PET planned — not bookable yet

FDG: TLJCC teaching MIP (classic physiology). [68Ga]Ga-PSMA-11 + [68Ga]Ga-DOTATATE: Werner et al, J Clin Med 2019 Fig 3A–B (CC BY 4.0 MDPI) • doi:10.3390/jcm8071060.



One patient, two tracers: FDG vs Ga-68 DOTANOC

De-identified teaching case · one patient, serial scans · rotating 360° MIPs, synced angle



FDG

Glucose use: brain bright, bladder collects tracer.

Ga-68 DOTANOC

SSTR map (not PSMA): brain cold; liver, spleen, kidneys.

Same patient

Two dates, synced rotation: compare where the uptake sits.

SUV windows differ — compare distribution, not intensity.

▶ Rotating 360° video

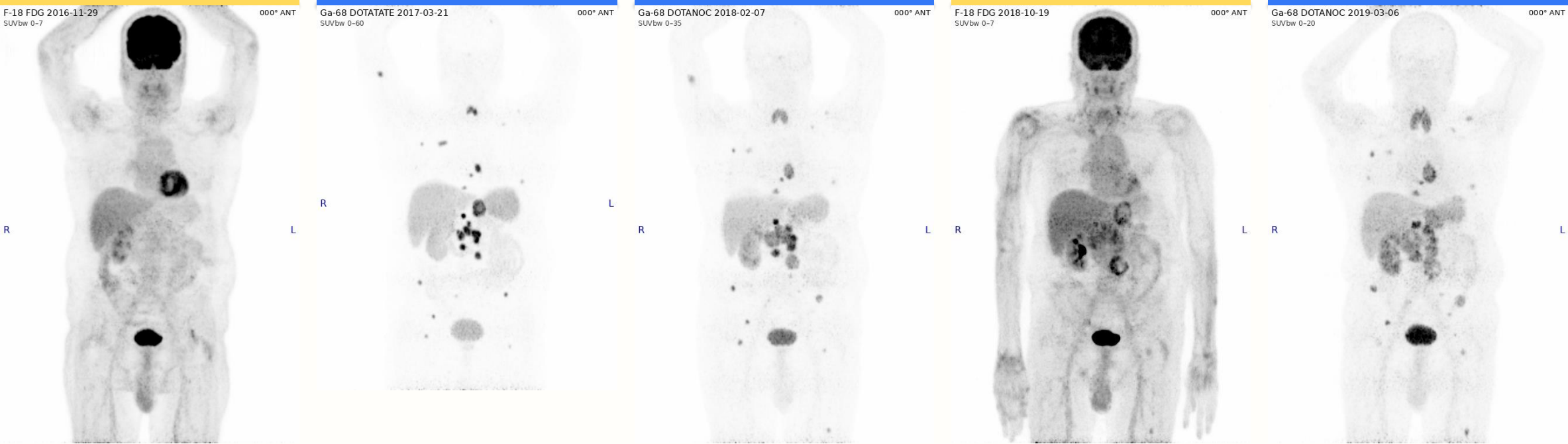
FDG bookable at TLJCC

DOTA PET planned at TLJCC — not bookable yet



Serial scans over time: one patient, 2016–2019

De-identified teaching case · one patient, serial scans · FDG and SSTR (Ga-68 DOTATATE / DOTANOC)



F-18 FDG
2016-11-29 · SUV 0–7

Ga-68 DOTATATE
2017-03-21 · SUV 0–60

Ga-68 DOTANOC
2018-02-07 · SUV 0–35

F-18 FDG
2018-10-19 · SUV 0–7

Ga-68 DOTANOC
2019-03-06 · SUV 0–20

SUV windows differ — compare distribution, not intensity.

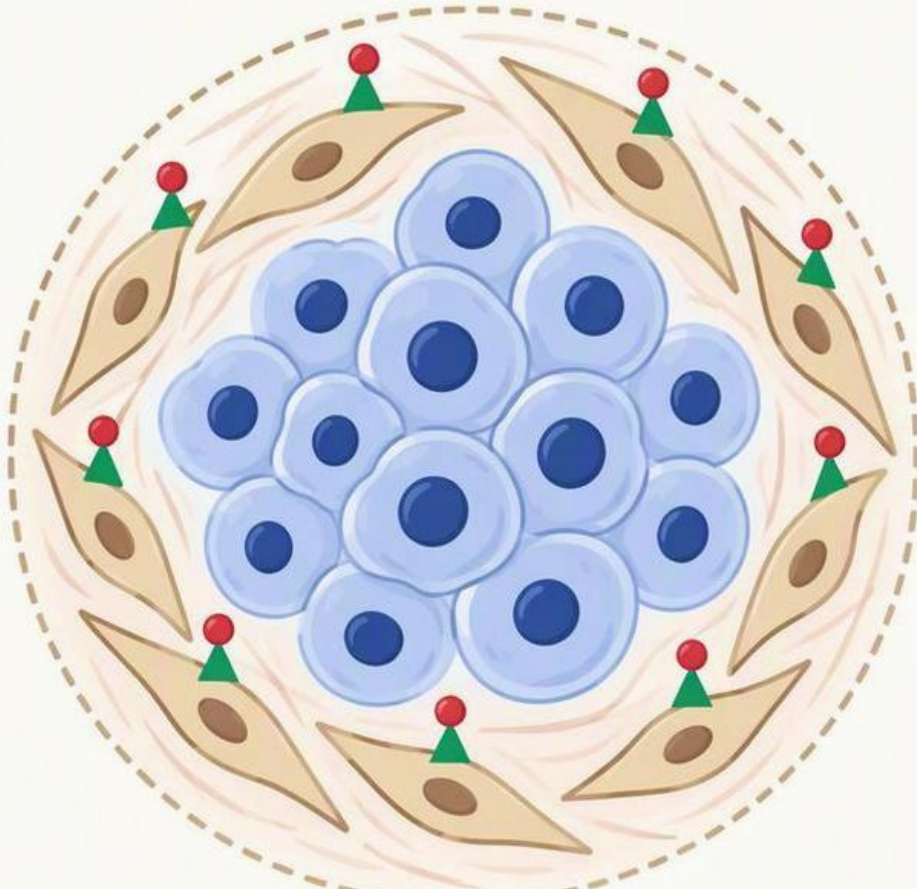
▶ Rotating 360° video

FDG bookable at TLJCC

DOTA PET planned at TLJCC — not bookable yet

What is a FAPI scan?

A tracer that sticks to the tumour's supporting cells, not the cancer cells



Tumour = cancer cells + supporting stroma

- 1**  Fibroblasts build and repair tissue.
- 2**  →  Cancer switches them on → CAFs (cancer-associated fibroblasts).
- 3**  CAFs carry an enzyme on their surface: FAP.
- 4**  FAPI sticks tightly to FAP.
- 5**  Labelled with Ga-68 → PET shows where FAP is high.



Schematic for teaching • Kalluri R. *Nat Rev Cancer* 2016;16:582–598 • Loktev A et al. *J Nucl Med* 2018;59:1423–1429

How do we scan with FAPI?

Simple for the patient — but read it with care



Inject

Ga-68 FAPI into a vein.



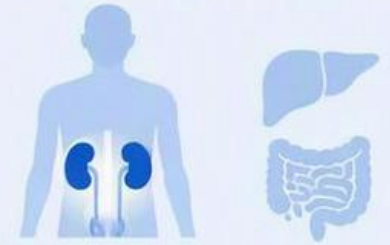
No fasting

Eat as normal.



Scan

10–60 min after injection.



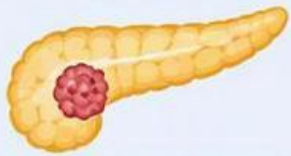
Clean picture

Kidneys clear it; quiet liver and bowel.



Shows well

Stroma-rich tumours: pancreatic cancer (strong desmoplastic stroma), cholangiocarcinoma, sarcoma — where FDG can be weak.



FAPI-positive ≠ cancer

Scars, wound healing, arthritis or degenerative joints, fibrosis and inflammation can also light up.



Loktev A et al. *J Nucl Med* 2018;59:1423–1429 · Kratochwil C et al. *J Nucl Med* 2019;60:801–805 · Kessler L et al. *J Nucl Med* 2022;63:890–896 · Bentestuen M et al. *Semin Nucl Med* 2023;53:694–705

FAPI PET: one tracer, many cancers

^{68}Ga -FAPI-04 MIPs, 12 tumour types — research tracer, not TLJCC patients

FAPI-PET in different kinds of cancer

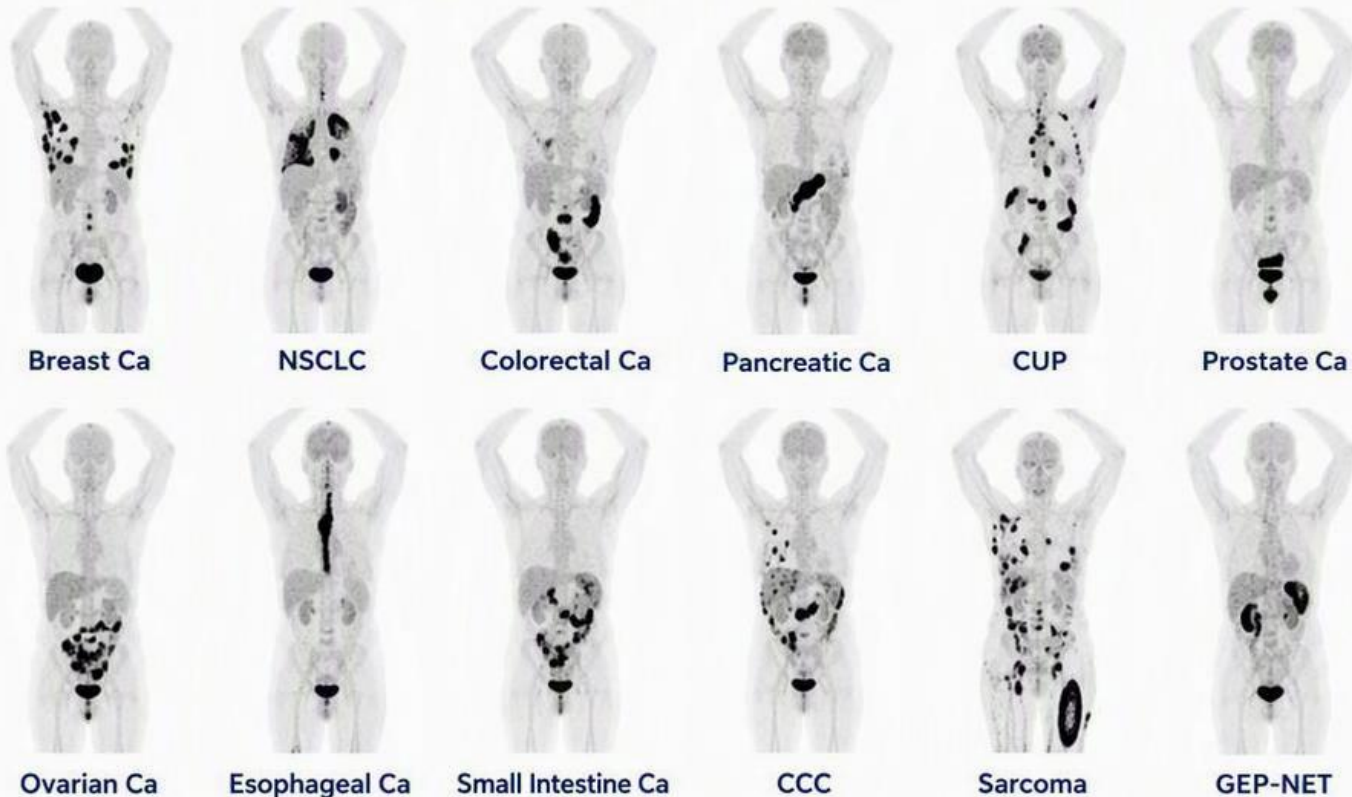


Image supplied · data: Kratochwil C et al. J Nucl Med 2019;60:801-805 (open access)

Average SUVmax by tumour

High (>12):

sarcoma, oesophageal, breast, CCC, lung

Intermediate (6–12):

HCC, colorectal, head-neck, ovarian, pancreatic, prostate

Low (<6):

renal, thyroid, gastric, phaeo

80 patients · 28 tumour types

FAPI: imaging the tumour's scaffolding

What it is, why it helps, where to be careful



What it is

^{68}Ga -FAPI binds fibroblast activation protein on cancer-associated fibroblasts.



Why stroma lights up

Fibroblasts and fibrosis can make up to 90% of tumour mass.



Advantages vs FDG

No fasting. Low liver (SUV 1.7 vs 2.8) and bowel background; no brain uptake seen in early patients.



Be careful

Benign fibrosis may also take up FAPI. Renal, thyroid and gastric cancers stay low.



FAPI — Not available at TLJCC

Kratochwil C et al. J Nucl Med 2019;60:801–805 · Giesel F et al. J Nucl Med 2019;60:386–392 (liver SUV, cited therein)

PART I • BEYOND FDG

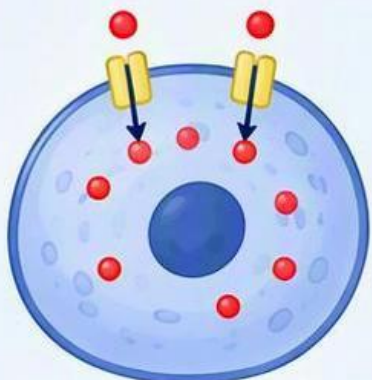
Five tracers, five targets

Each tracer sticks to a different target



F-18 FDG

trapped inside

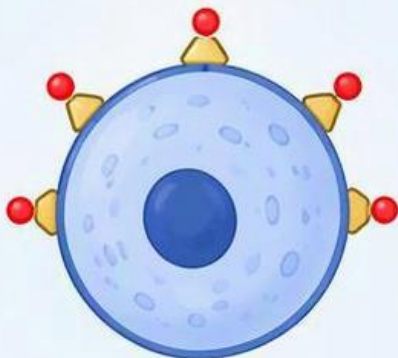


GLUT + hexokinase inside
sugar-hungry cells

Available at TLJCC

Ga-68 PSMA

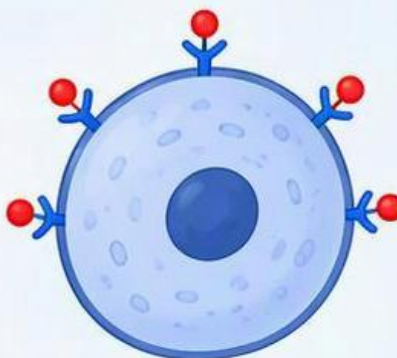
PSMA on prostate
cancer cell surface



Planned at TLJCC –
not bookable yet

Ga-68 DOTATATE

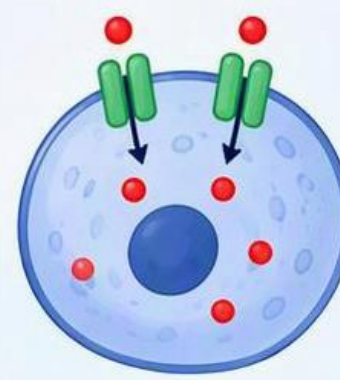
SSTR2 receptor on
NET cell surface



Planned at TLJCC –
not bookable yet

F-18 Fluciclovine

pulled inside

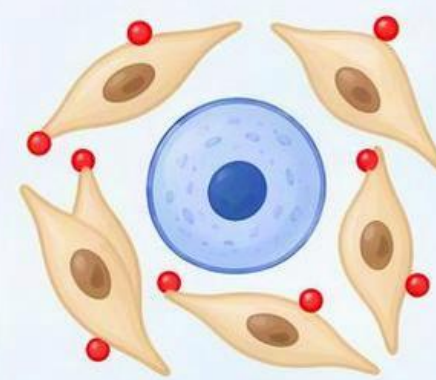


LAT1/ASCT2 amino-acid
transporters – no PSMA needed

Not available at TLJCC

Ga-68 FAPI

cancer cell



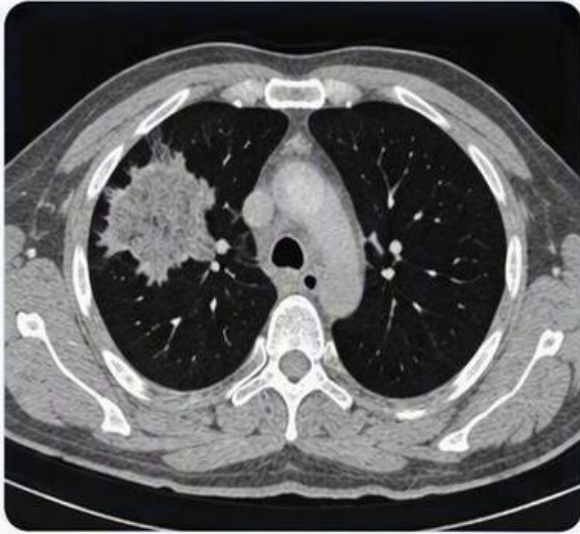
FAP enzyme on CAFs in stroma –
not the cancer cell

Not available at TLJCC

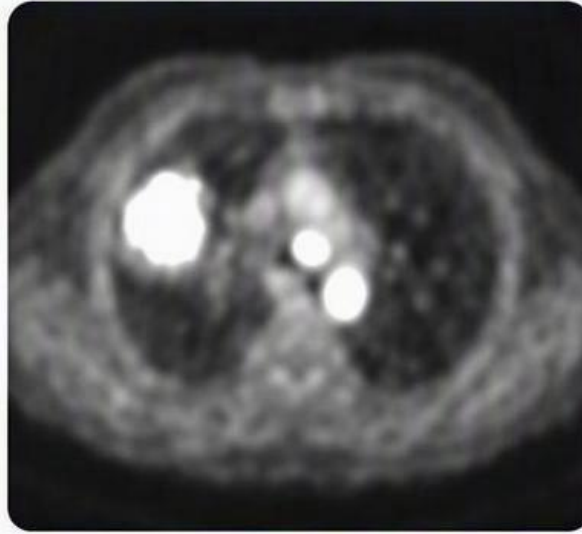
Red dot = tracer. FDG is trapped inside; fluciclovine is pulled in through amino-acid doors; PSMA and DOTATATE stick to the cancer cell; FAPI sticks to the fibroblasts around it.

What cancer looks like on FDG PET/CT

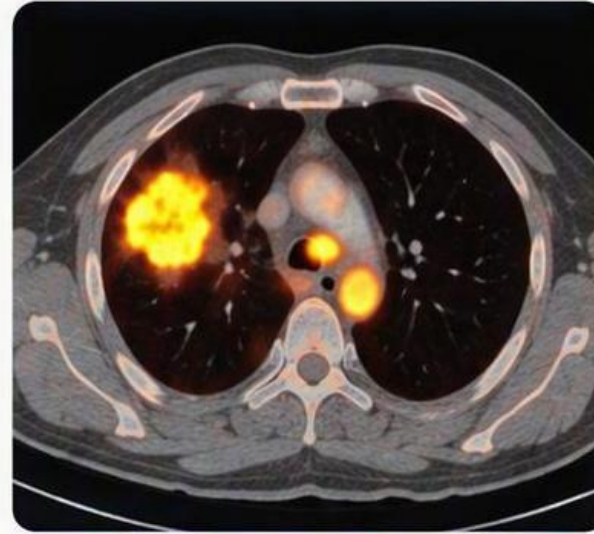
Open-access teaching figure — CT • PET • fused • MIP



CT



PET



Fused



MIP

NCBI Bookshelf CC BY-NC — NSCLC teaching case, not a TLJCC patient

CT: right upper lobe mass.

**PET: intensely avid (high SUV)
+ mediastinal nodes.**

**Stage can flip — or no distant
disease keeps curative intent.**



What would you do?

PAUSE & LOOK

Unexpected FDG-avid distant disease on staging PET/CT. Local treatment was planned. Next step?



- A. Proceed with radical local treatment as booked**
- B. Biopsy the hottest unexpected site, then MDT**
- C. Switch straight to systemic therapy without MDT**

WHAT THE GP SHOULD REMEMBER

When biology shows unexpected distant disease — pause, confirm, rethink the plan.

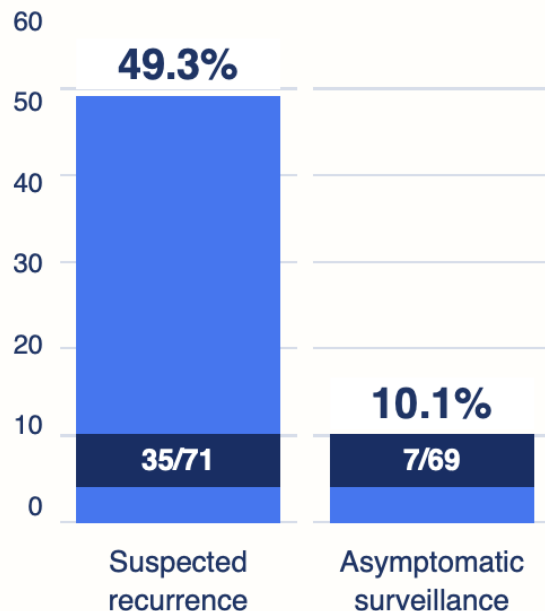


Breast: PET changes the plan when you suspect recurrence

Chang et al · suspected recurrence vs asymptomatic surveillance · $P < 0.001$

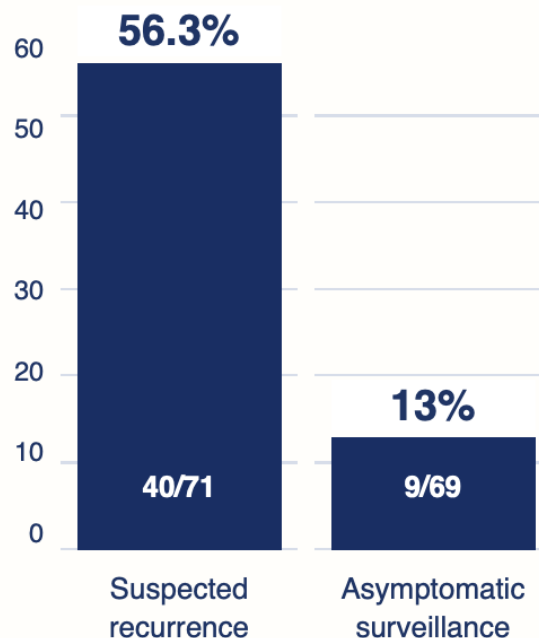
Plan changed after FDG PET/CT

Overall 30% (42/140)



Recurrence proven

$P < 0.001$ in both panels



Show all results

VERIFIED

- 140 post-therapy FDG PET/CT scans
- Plan changed: 49.3% vs 10.1%
- Recurrence proven: 56.3% vs 13%
- Overall change 30% (42/140)

Suspicion ≠ routine surveillance

FDG bookable at TLJCC

Point or focus to highlight.
Click to keep a result selected.

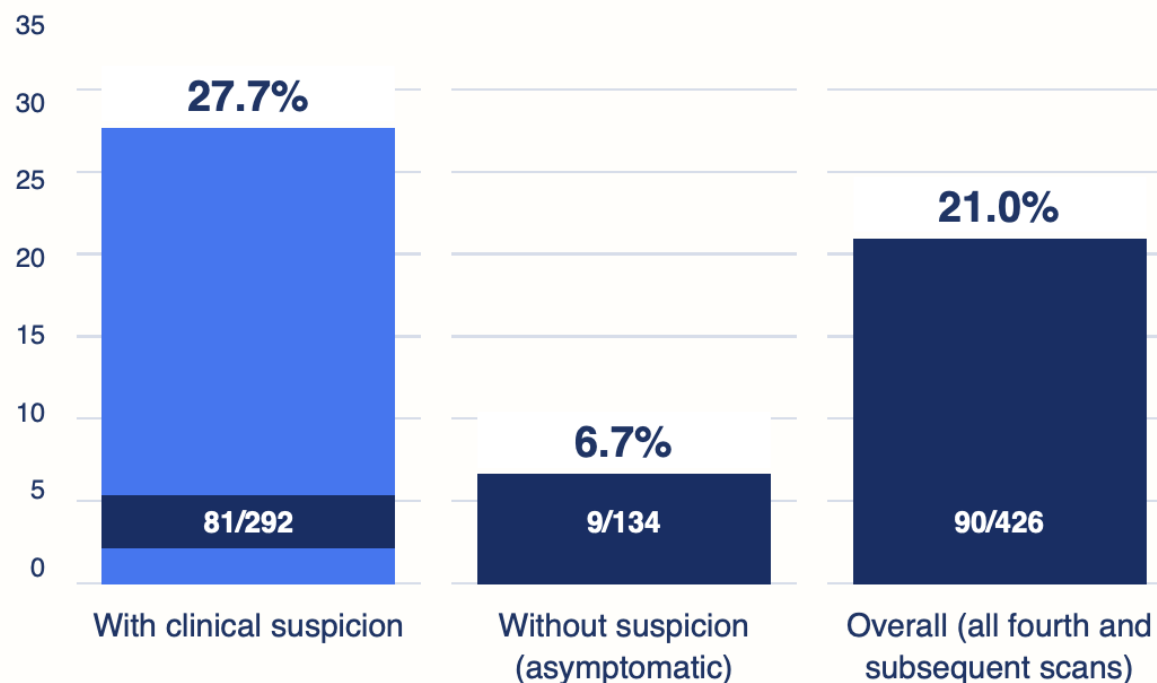


Fourth PET and beyond — only with a clinical question

Taghipour et al · fourth and subsequent post-therapy FDG PET/CT

Management change

Fourth and subsequent FDG PET/CT after primary treatment



Point or focus to highlight.
Click to keep a result selected.

Show all results

VERIFIED

- 92 women · 426 fourth+ PET/CT scans
- With suspicion: 27.7% plan change
- Without suspicion: 6.7% plan change
- Authors: avoid 4th+ without context

Guidelines: no routine asymptomatic PET

FDG bookable at TLJCC

PART I • MINI-SECTION

FDG-avid does not always mean cancer

Hot on PET = high glucose use. Cancer is one cause — not the only one.

COMING UP

Brown fat

Recent vaccine

Inflammation

Vasculitis

Granulomas

Rare histiocytosis

SHOW OF HANDS

Who has had a patient panic over a hot spot on a report?

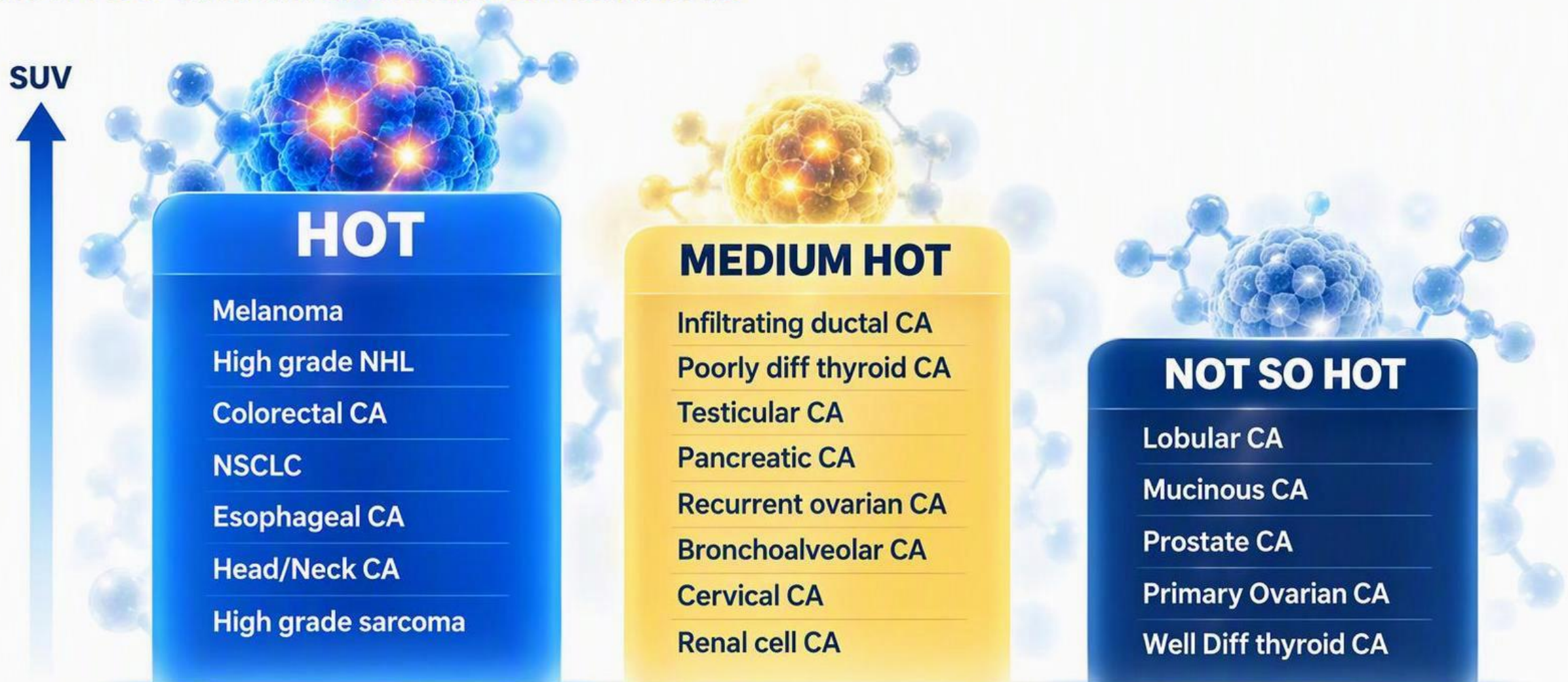


**A Positive PET Scan
Does NOT Always Mean Cancer.**

Illustration supplied by Dr Zool Hilmi — not a patient scan

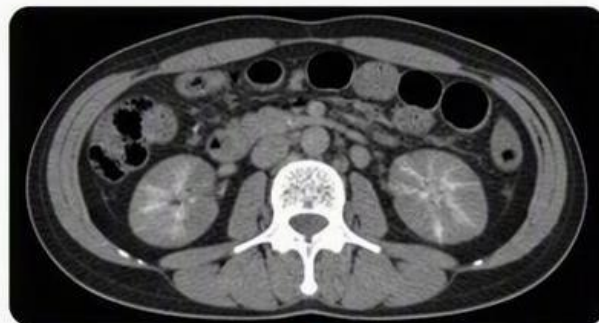
SUV: hot, medium hot, not so hot

How FDG-avid different cancers tend to be

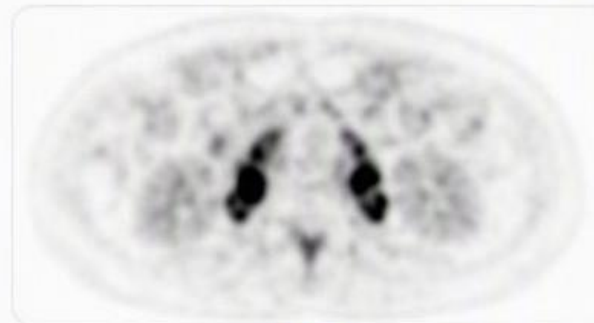


Tunku Laksamana Johor Cancer Centre

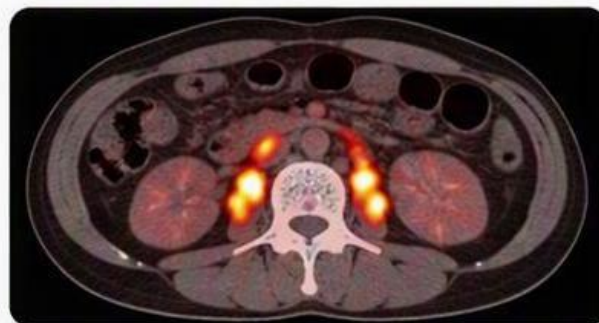
Not automatically cancer — brown fat



CT



PET



Fused



MIP

IJNM brown-fat teaching figure (Fig 2) — CT / PET / fused / MIP • not a TLJCC patient



Supraclavicular, paravertebral,
perirenal — all brown fat.

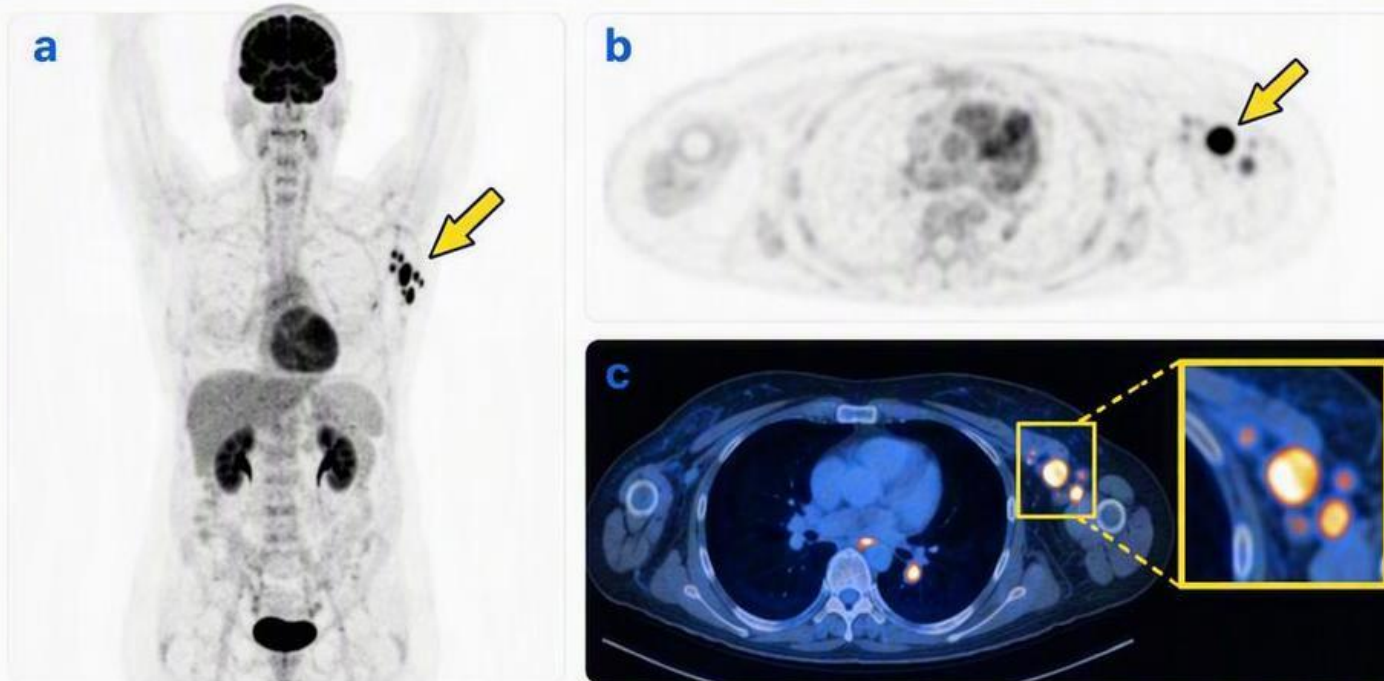


Crosshair: uptake sits in fat
density, not a node.



Keep patients warm —
don't stage lymphoma on it.

Hot axillary nodes — check the vaccine arm



Skawran et al, Eur Radiol 2022, Fig 2 (CC BY 4.0) • not a TLJCC patient



Left-arm Moderna 3 days before → hot left axillary nodes.

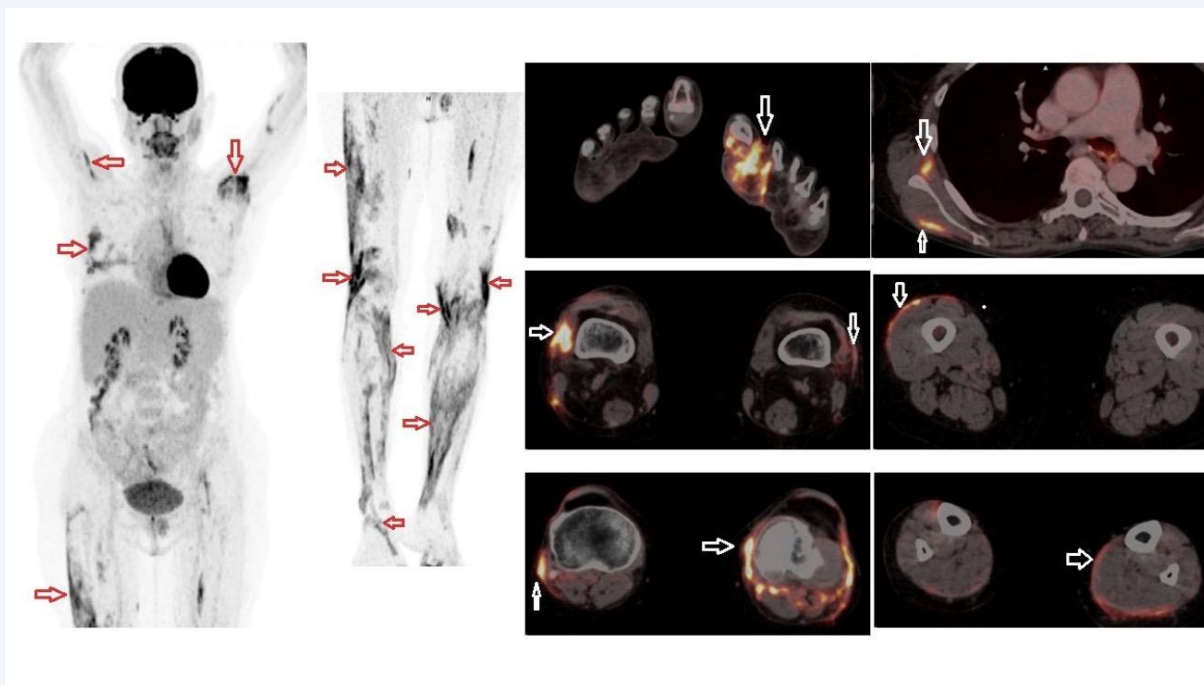


SUVmax 11.6 — intensity alone will not reassure.



Write vaccine date + arm on the request form.

Not lymphoma — autoimmune fasciitis



Shared teaching case — MIP + fused axials • not a TLJCC patient



**Fascia lights up;
muscle bellies spare.**



**Deauville 1 —
inflammation, not relapse.**



**Put autoimmunity
on the request form.**

Rings around the aorta — large-vessel vasculitis



Danial Azmy Habib & Gunawardena, Cureus 2024, Fig 2 (CC BY 4.0) • not a TLJCC patient



Ring-shaped uptake hugs the vessel wall.



Ascending + descending aorta, both axillary arteries.



Older patient, high ESR/CRP, no source → think vasculitis.

Small nodes, big stage change

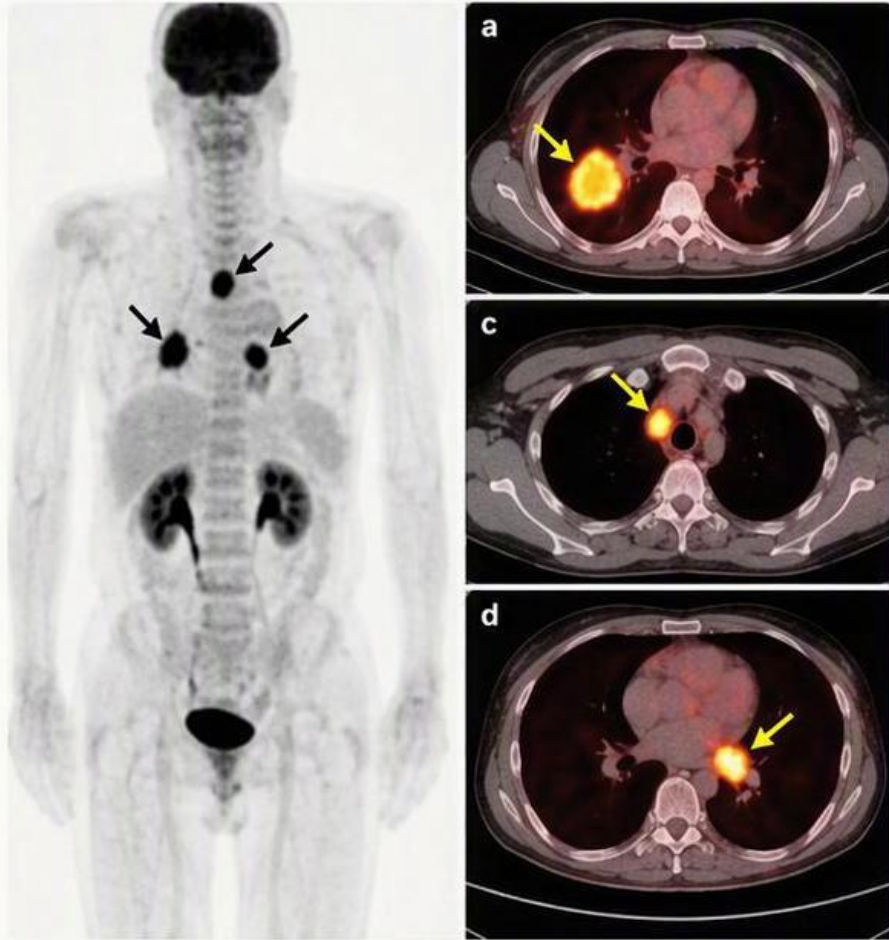
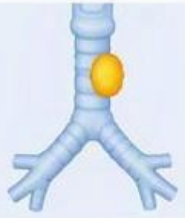


Fig 5.3, Agrawal A, Rangarajan V (eds). PET/CT in Lung Cancer. Springer 2018, p.51

1		Right middle lobe squamous carcinoma (block arrow)
2		Avid ipsilateral paratracheal node (a, c)
3		Avid contralateral hilar node (a, d): N3

9TH EDITION
Contralateral hilar node = N3, which overrides any N2a/N2b count. (IASLC 9th edition TNM (2024))

A tiny avid adrenal nodule was a metastasis

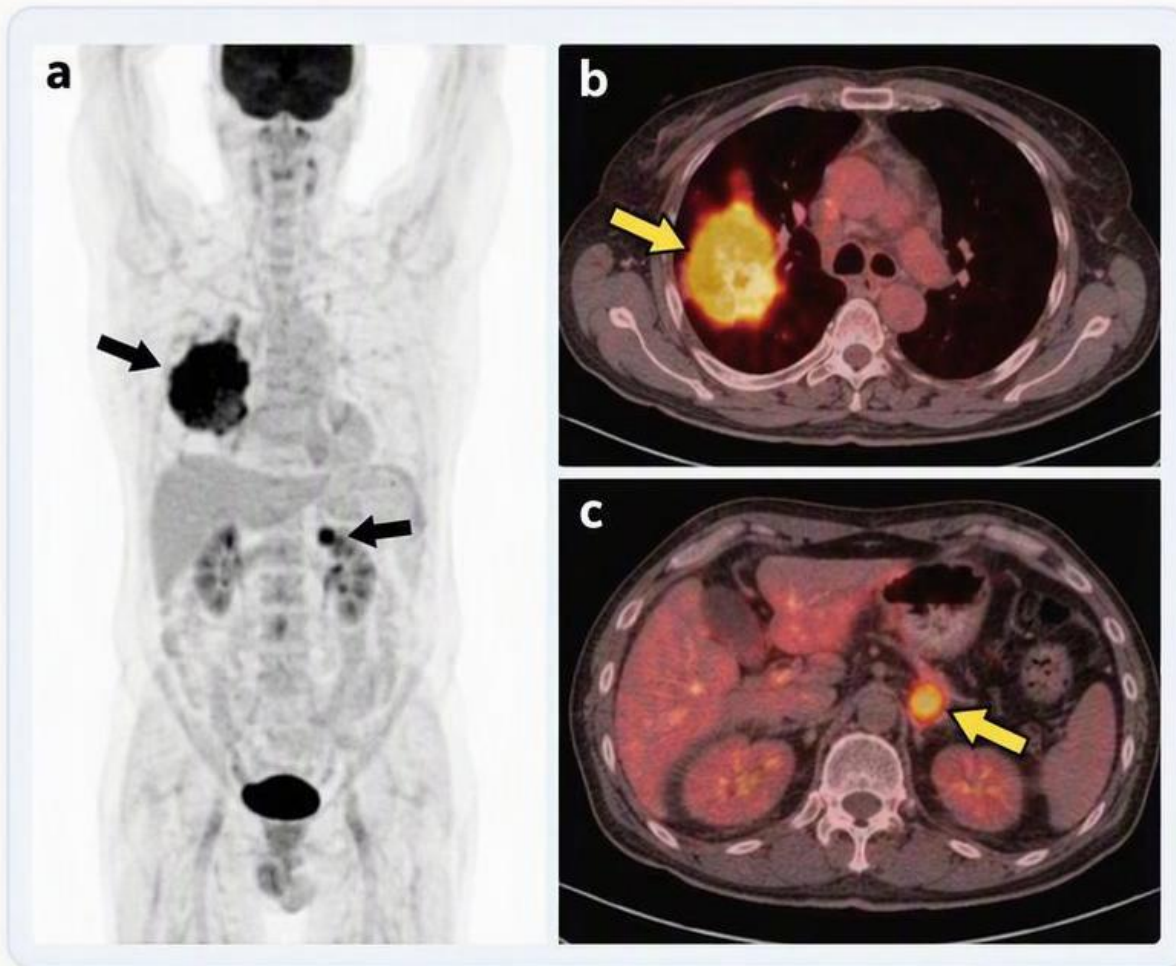


Fig 5.4, Agrawal A, Rangarajan V (eds). PET/CT in Lung Cancer. Springer 2018, p.52

1



Right lung mass
(block arrow)

2



Tiny avid left adrenal
nodule (a, c)

3



Adrenal: sens 93%, spec 90%,
accuracy 92% (p.50)

PRACTICE

Biopsy or adrenalectomy only for an isolated adrenal lesion with equivocal PET (p.50). Single adrenal = M1b; both adrenals = M1c1 (IASLC 9th edition TNM (2024)).

Tuberculosis mimicking stage IV cancer

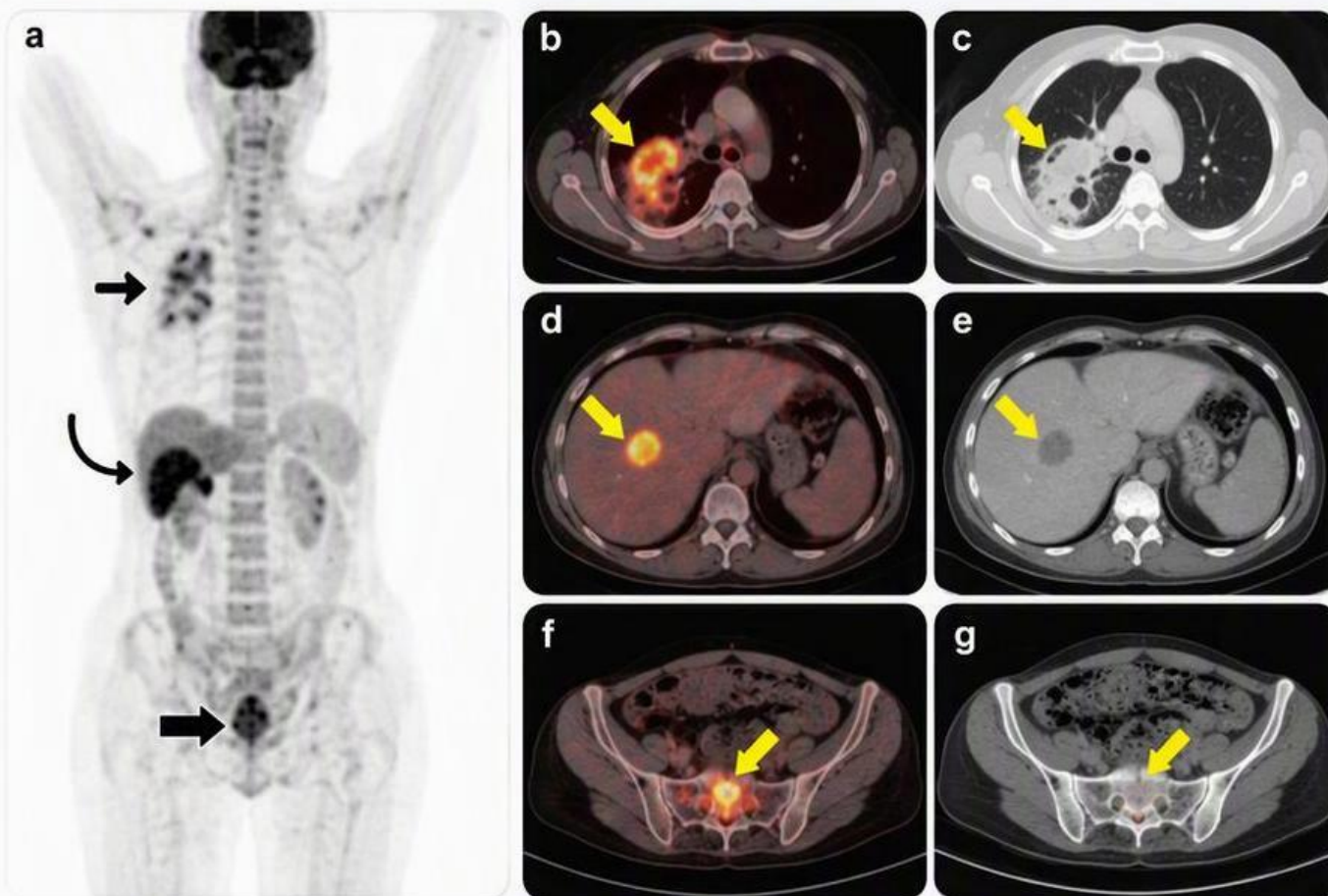


Fig 6.5, Agrawal A, Rangarajan V (eds). PET/CT in Lung Cancer. Springer 2018, p.65



- **Right upper lobe consolidation**, SUVmax 12.93 (b, c)



- Avid **liver lesion** (d, e) and **sacral marrow lesion** (f, g)



- All biopsies: **tuberculosis**

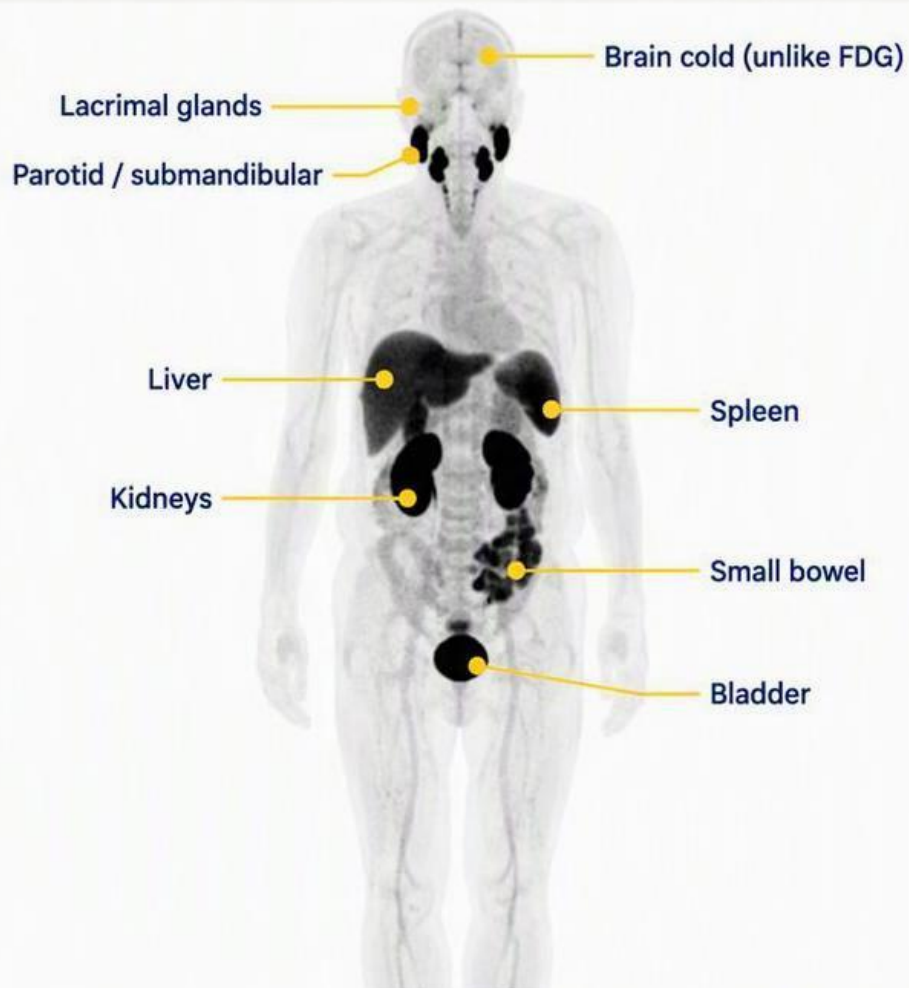


PART II • PLANNED AT TLJCC

PSMA PET/CT

What GPs need to know about molecular staging in prostate cancer.
Not yet bookable at TLJCC — we teach the evidence and help you refer.

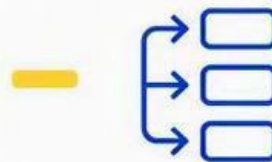
See disease at the molecular level



Teaching MIP — physiologic PSMA biodistribution (not a TLJCC patient)



High tumour-to-background contrast in many prostate cancers.



Roles: primary staging, biochemical recurrence, RLT selection.



Can identify small-volume nodal, bone and visceral disease.

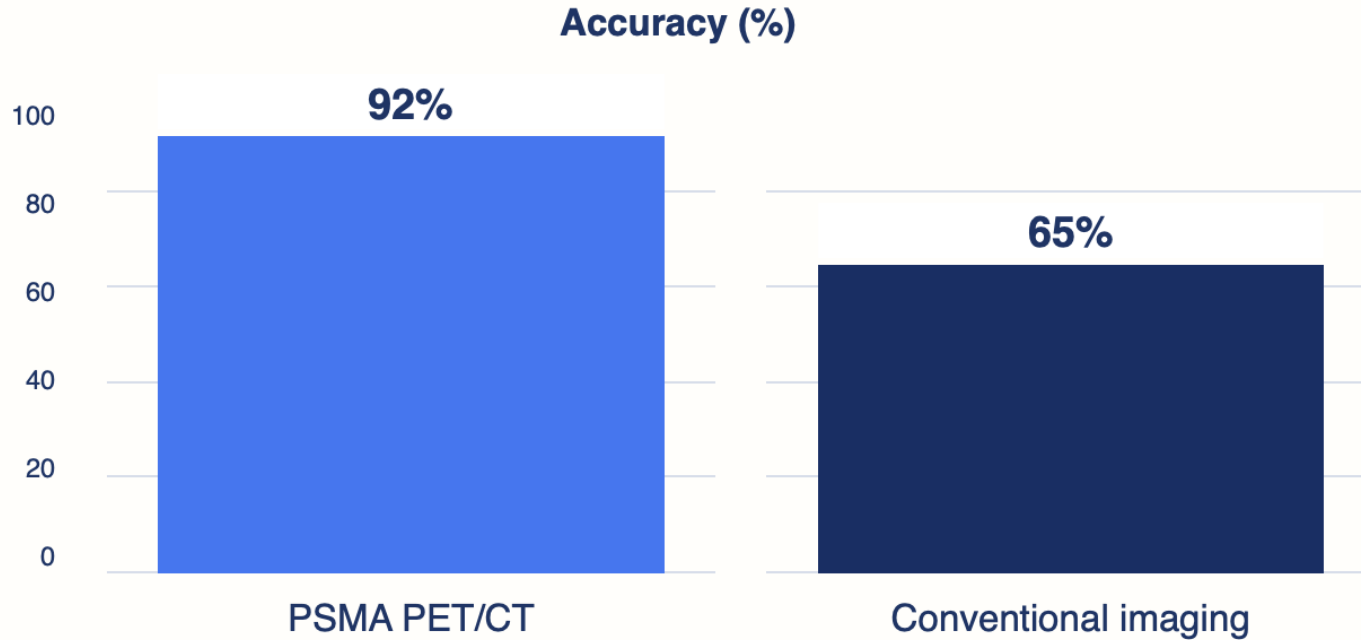


Planned at TLJCC – not bookable today.



Accuracy that sticks: 92% vs 65%

Hofman MS et al. Lancet 2020 — high-risk prostate cancer, Ga-68 PSMA-11



Point or focus to highlight.
Click to keep a result selected.

Show all results

proPSMA

High-risk prostate cancer

Before curative-intent treatment

Ga-68 PSMA-11 PET/CT compared with CT and bone scan

Hofman MS et al, Lancet 2020

Planned at TLJCC

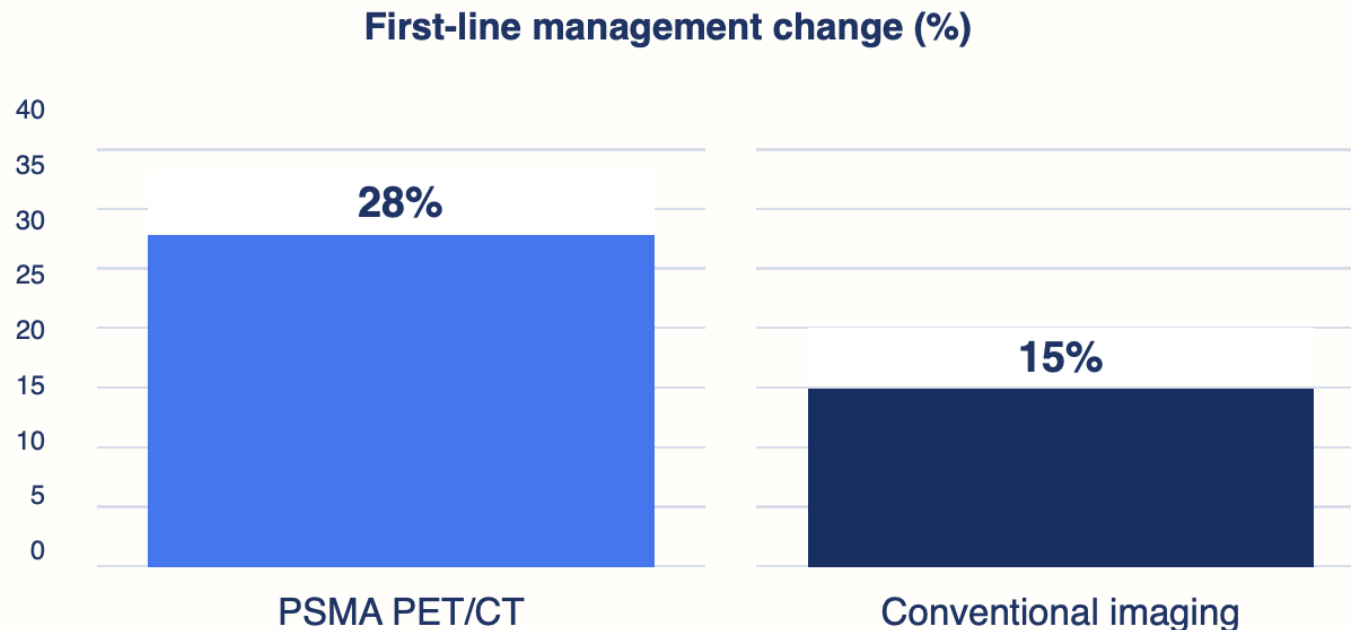
PRACTICE-CHANGING

PSMA PET/CT accuracy 92% versus 65% for conventional imaging.



Better imaging changed the plan (28% vs 15%)

First-line management change: 28% vs 15%



Point or focus to highlight.
Click to keep a result selected.

Show all results

proPSMA

First-line management

28% after PSMA PET/CT

15% after conventional imaging

Hofman MS et al, Lancet 2020

Planned tracer at TLJCC

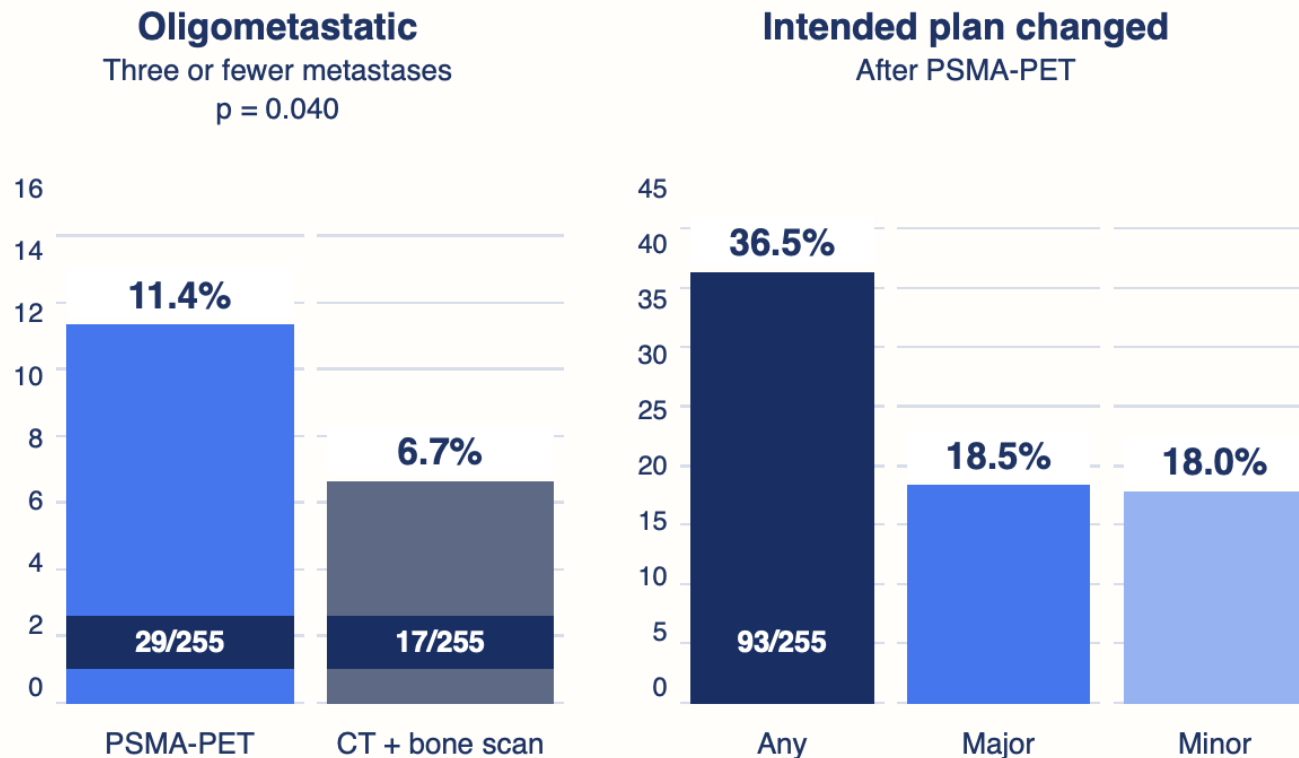
MANAGEMENT

28% management change after PSMA vs 15% after conventional imaging.



Stage migration: PSMA PET finds more oligometastases

Retrospective, multicentre · PSMA PET vs CT + bone scan within 4 months



Point or focus to highlight.
Click to keep a result selected.

Show all results

VERIFIED

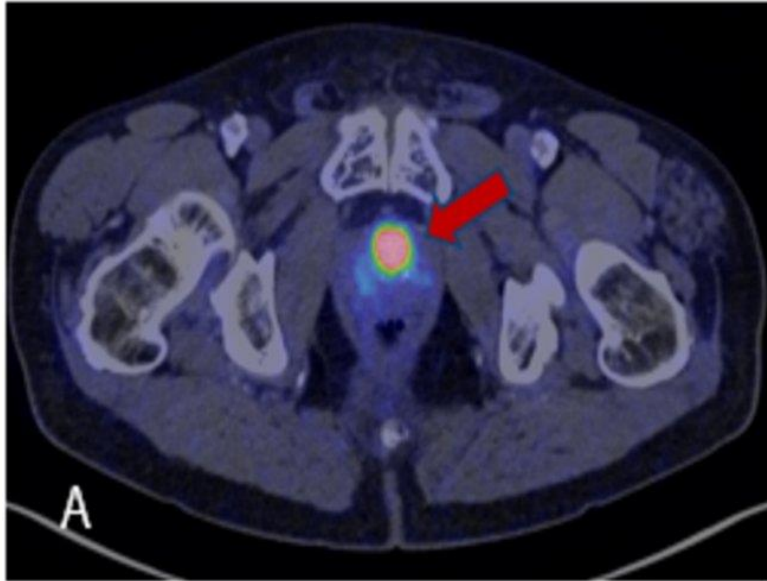
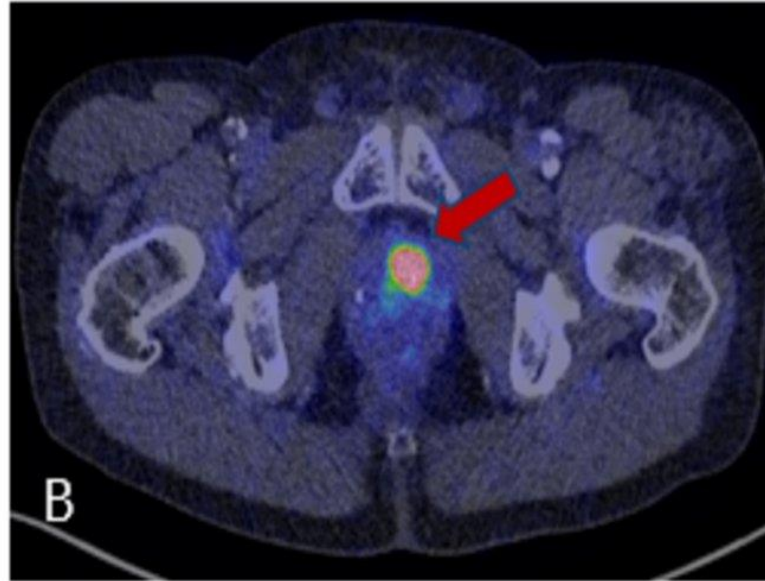
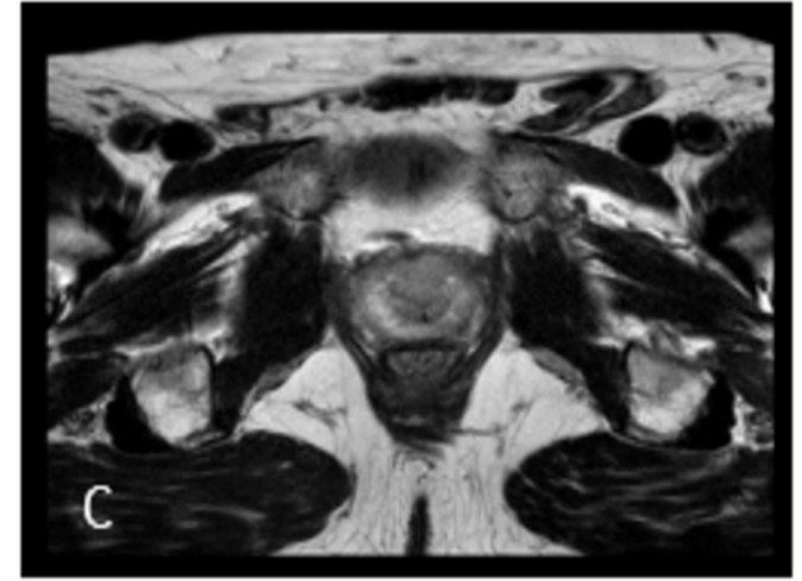
- 255 men, intermediate- to high-risk
- Oligometastatic: 11.4% vs 6.7%
- Plan changed: 36.5% (major 18.5%)
- Intended plans only; no follow-up

Stage migration ≠ survival benefit

PSMA PET planned at TLJCC

PSMA PET sees more — MRI confirms

50 men, high-risk; two PSMA tracers vs whole-mount pathology · PSMA PET planned at TLJCC



Gossili et al, Eur J Nucl Med Mol Imaging 2026, Fig 2 (CC BY 4.0) · published figure, not a TLJCC patient

PET: more sensitive

MRI: more specific

All three miss most extraprostatic extension

PLANNED AT TLJCC

PSMA PET is not yet bookable here. We help you read outside reports and refer when your patient needs it now.



When PET and MRI disagree, what changes your plan?

PAUSE & LOOK

PSMA PET: hot left apex lesion. MRI: clean in that region. Surgery is planned.

A. Go with the MRI — it is more specific, ignore the PET-only spot

B. Go with the PET — it is more sensitive, ignore the MRI

C. MDT: weigh both — nerve-sparing, RT boost, targeted biopsy?

WHAT THE GP SHOULD REMEMBER

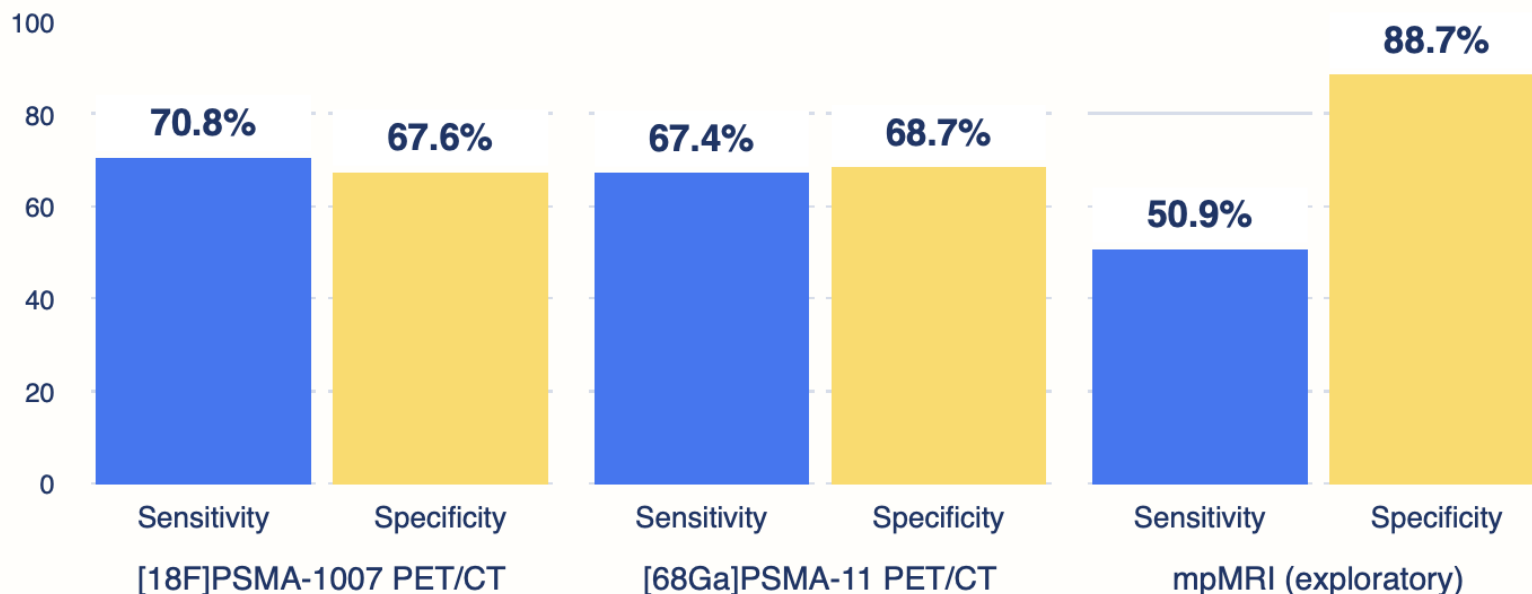
PET finds more, MRI confirms — neither sees capsule breach well. Discordance = MDT.



PET vs MRI inside the prostate — the numbers

Per-sextant detection of clinically significant cancer · mixed-model estimates

Per-sextant (%)



Point or focus to highlight.
Click to keep a result selected.

Show all results

MIXED-MODEL ESTIMATES

Clinically significant cancer

Each prostate split into six sextants.

MRI arm exploratory.

The study was not designed to prove the two PET tracers equivalent.

Point to any bar for its exact result.

OUTSIDE THE CAPSULE

Extraprostatic extension sensitivity: 12% (PSMA-1007) · 23% (PSMA-11) · 9% (MRI). No significant difference between the two PET tracers.

Biochemical recurrence: finding the target



At low PSA, disease may be occult on conventional imaging.



PSMA PET can localise bed, nodes, bone or multiple compartments.



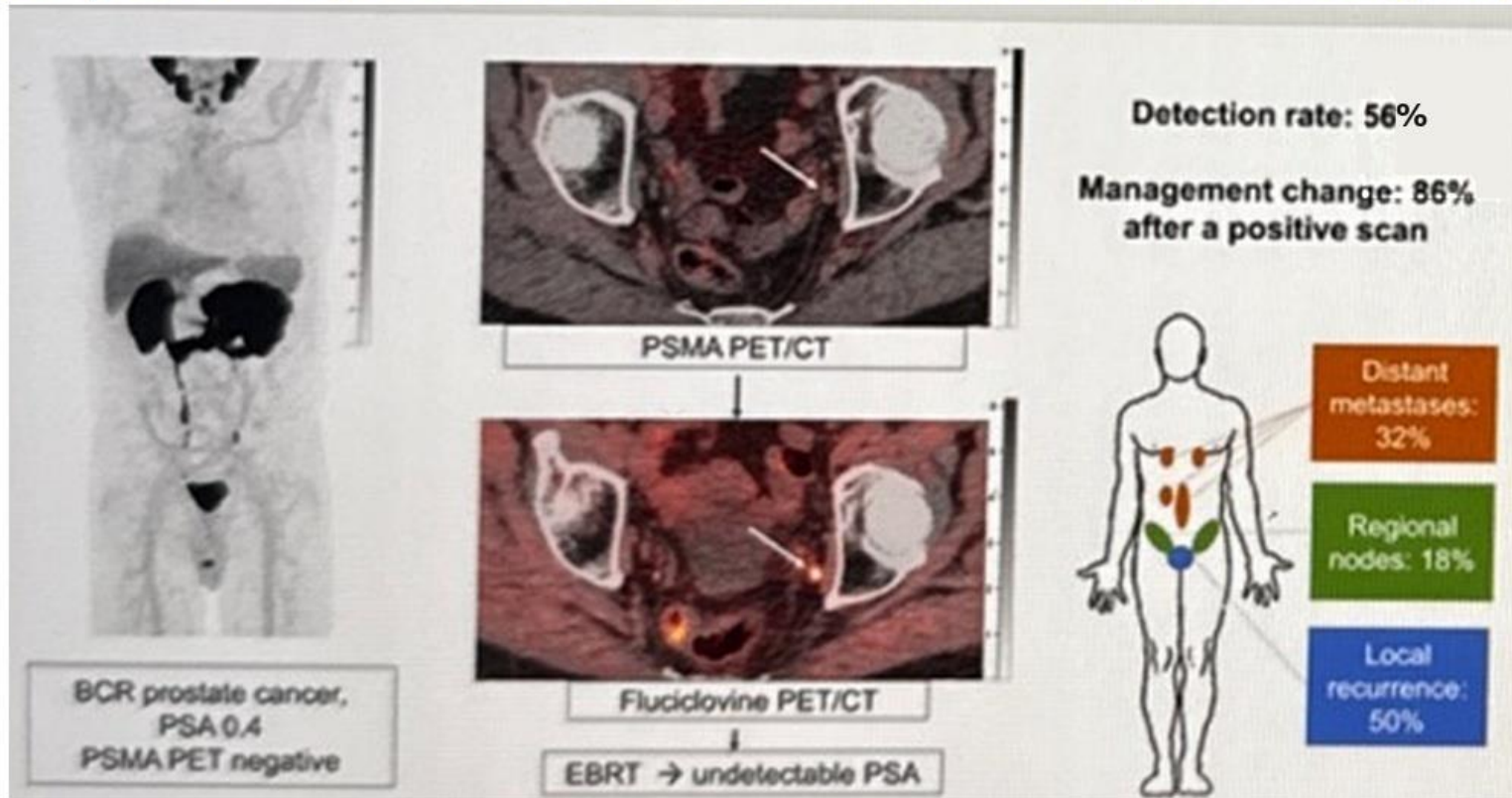
Location matters: salvage RT fields, metastasis-directed therapy, systemic treatment.



Blind escalation without a map is guesswork.

PSMA negative? Fluciclovine can still find recurrence

Prospective single-centre study • 50 men with BCR (PSA ≥ 0.2 ng/mL) and a negative PSMA PET



87%

management changed after a positive scan

56% scans positive (28/50)

50% of positives: prostate bed only

44% → **100%** detection as PSA rises

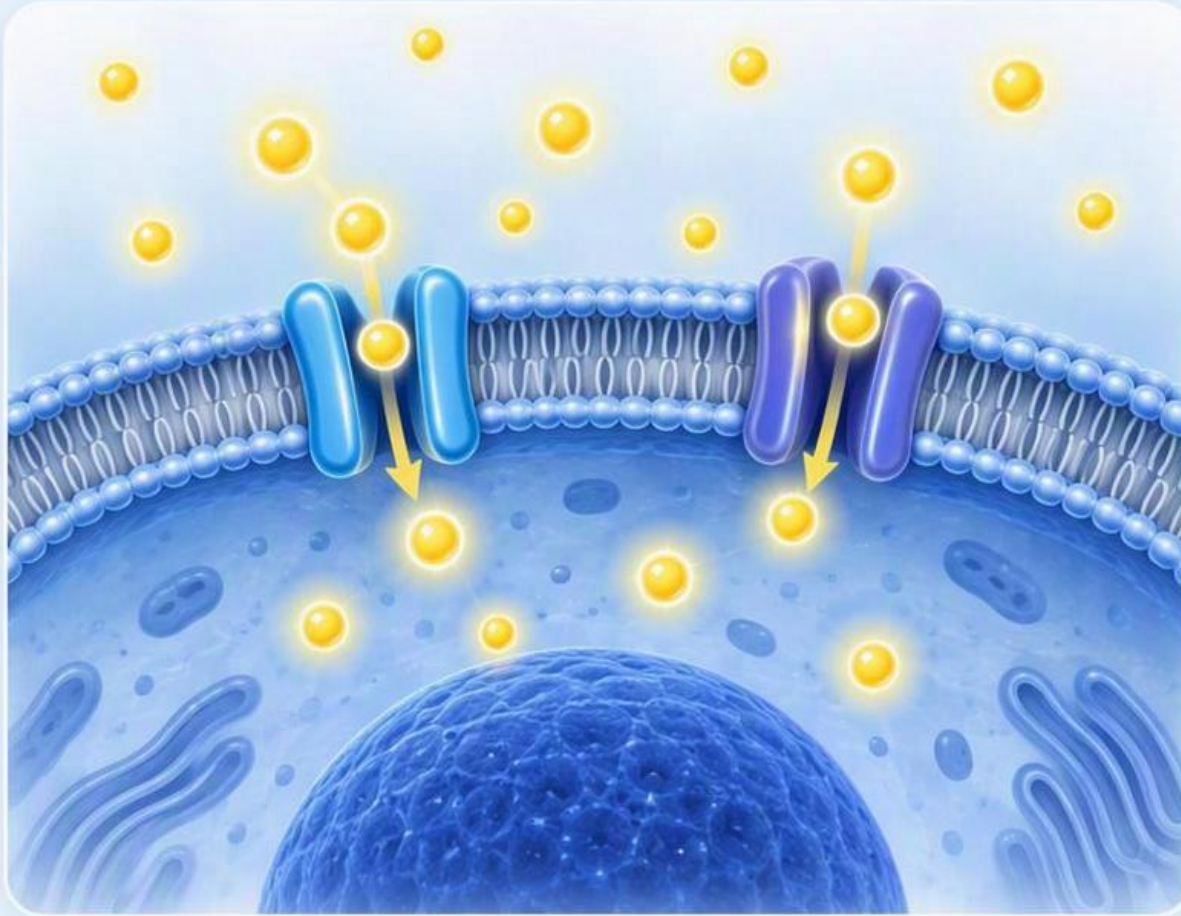
71% changed overall (54% if negative)

Visual abstract, Szidonya et al. JNM 2026

Szidonya L et al. J Nucl Med 2026 (Oct 29, online); doi:10.2967/jnumed.126.272834 • NCT05722925 • Not available at TLJCC

How does a fluciclovine scan work?

A man-made amino acid that hungry prostate cancer cells pull inside



- 1** Cells need amino acids to build proteins.
- 2** Fluciclovine is a man-made, leucine-like amino acid tagged with F-18.
- 3** Cancer cells pull more in through LAT1 and ASCT2 “doors”.
- 4** It does not need PSMA, so PSMA-negative disease can show.
- 5** Little reaches the bladder early, so we scan from 3–5 minutes.

Schematic for teaching · Axumin (fluciclovine F 18) US prescribing information, FDA 2016 · Not available at TLJCC



Fluciclovine: when to think of it, what can fool it

A second look after PSMA — not a replacement

When to think of it



Rising PSA after surgery or radiotherapy (BCR).



PSMA PET negative or unclear.



Suspected local recurrence near the bladder.



PSMA PET stays the first choice for BCR.

What can fool it



Not specific to prostate cancer.



Inflammation and benign prostate enlargement (BPH) can take it up.



Other cancers can light up too.



Read with PSA, history and CT/MRI.

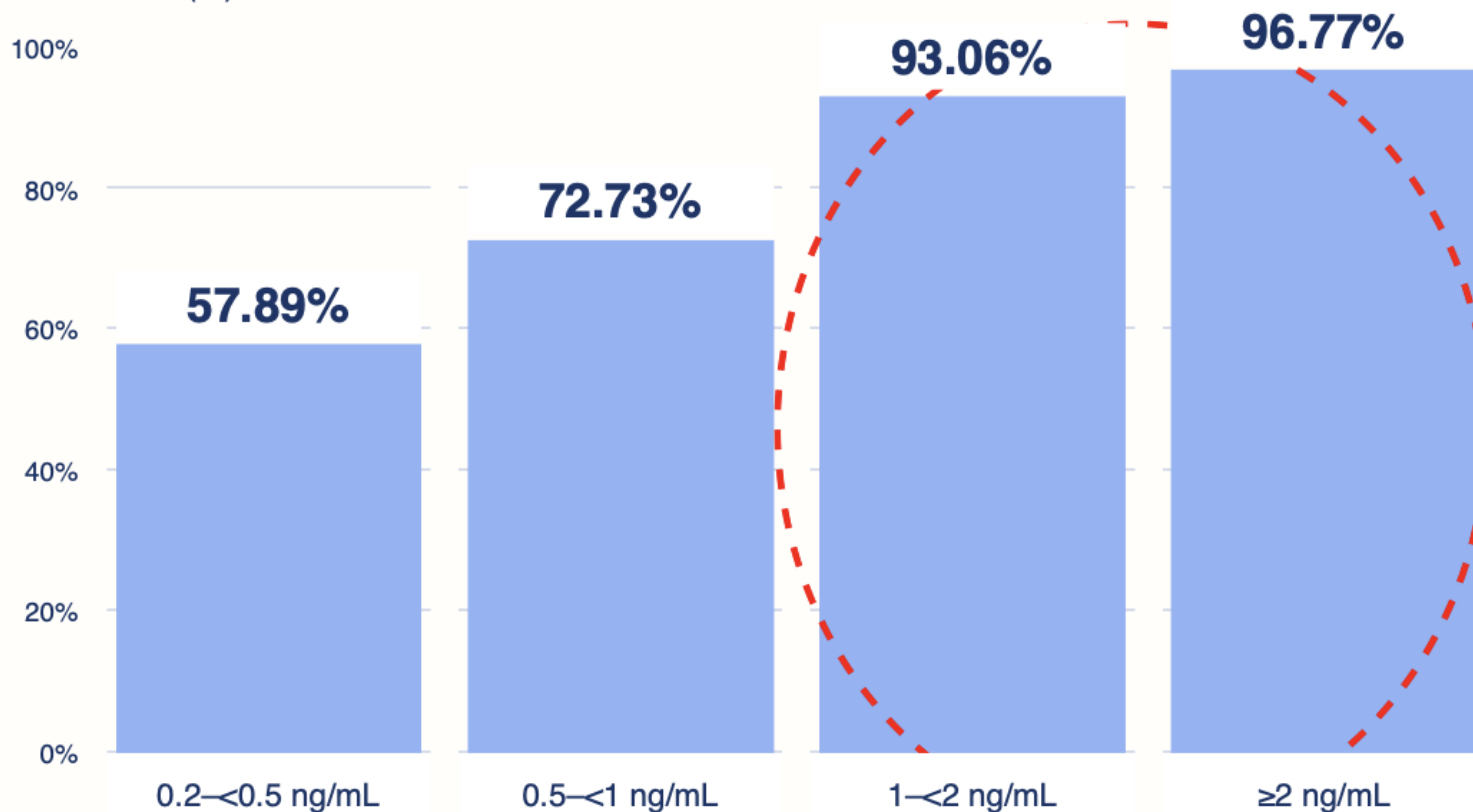
Fluciclovine: Not available at TLJCC

Axumin (fluciclovine F 18) US prescribing information, FDA 2016 • Szidonya L et al. J Nucl Med 2026 (Oct 29, online); doi:10.2967/jnumed.126.272834 • NCT05722925

PSMA PET/CT: diagnostic sensitivity

Eiber et al, JNM 2015 · 248 patients

Detection rate (%)



Point or focus to highlight.
Click to keep a result selected.

Show all results

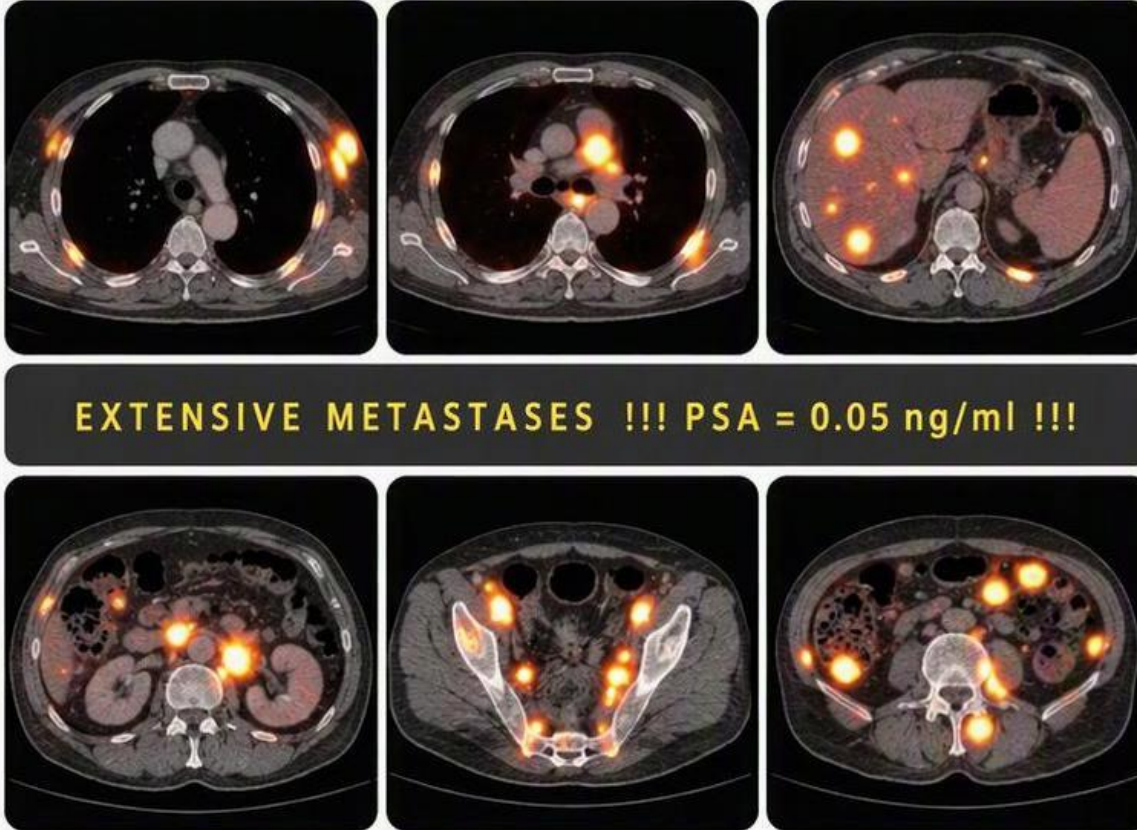
Detection rises with PSA

- ≥ 2 ng/mL: 96.77%
- $1 < 2$ ng/mL: 93.06%
- $0.2 < 0.5$ ng/mL: 57.89%

Red outline marks the two highest PSA groups.

Positive PSMA PET/CT at a very low PSA

Teaching example from Dr Zool Hilmi



MIP and fused axial PET/CT



Image label: extensive metastases at PSA 0.05 ng/mL



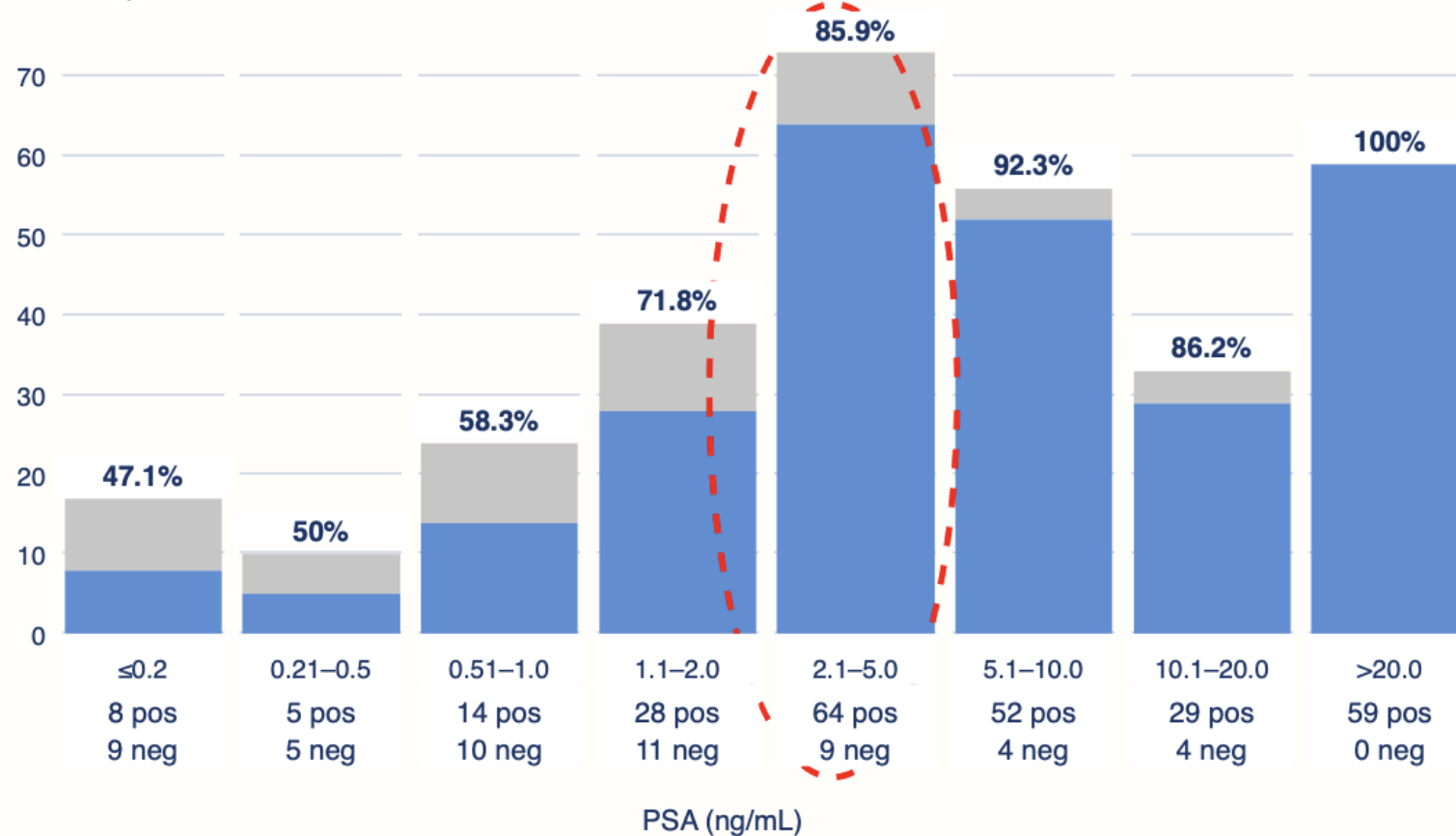
A low PSA does not rule out disease

Positive PSMA PET/CT: PSA cut-off value?

Afshar-Oromieh et al, EJNMMI 2015 · 319 patients

Number of patients

PET-positive PET-negative



Positive scans at every PSA level shown

- PSA ≤0.2: 8 of 17 positive (47.1%)
- PSA >20: 59 of 59 (100%)

Red outline highlights PSA 2.1–5.0 ng/mL.

Point or focus to highlight.
Click to keep a result selected.

Show all results

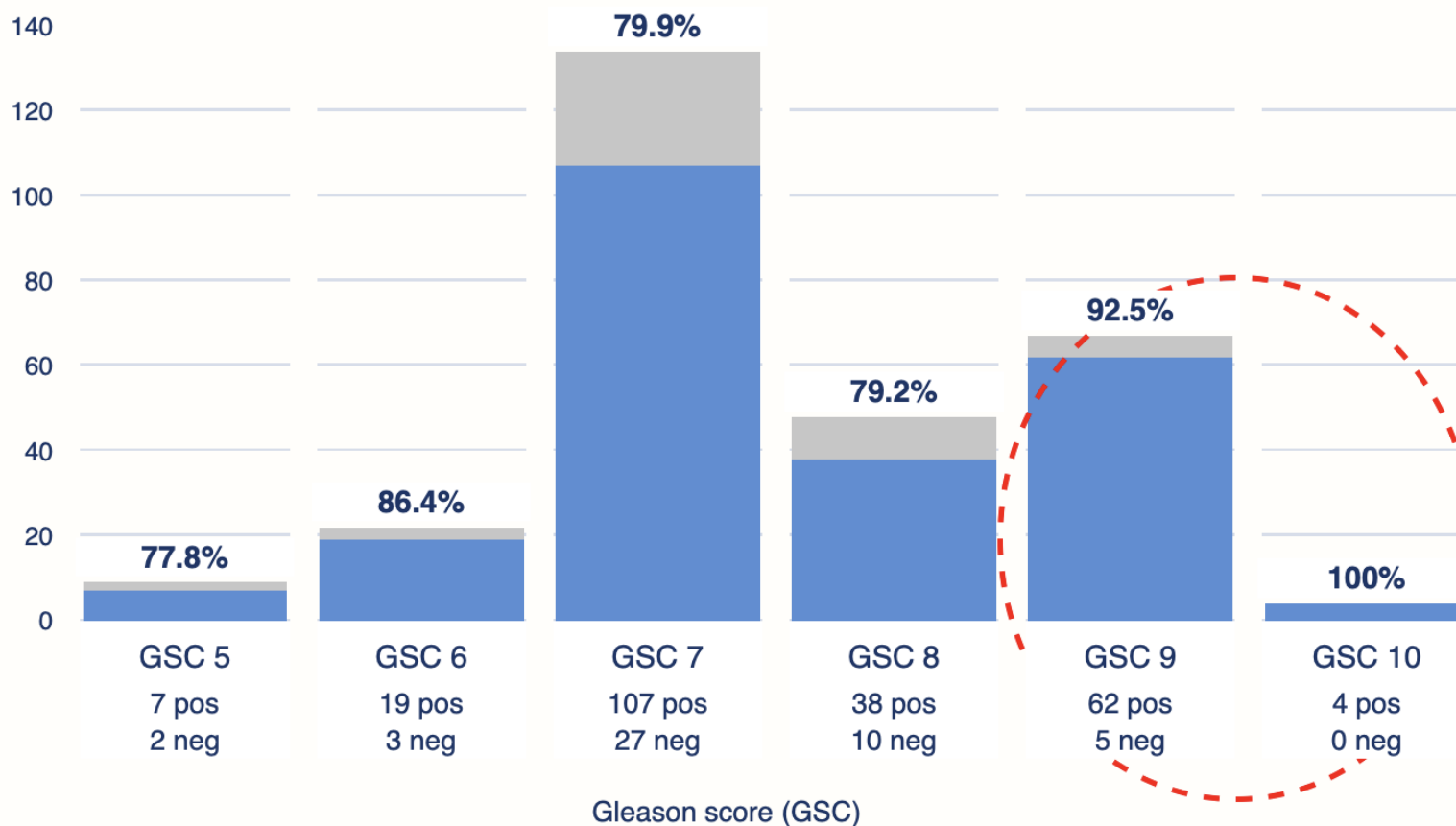


Positive PSMA PET/CT: correlation with Gleason score?

Afshar-Oromieh et al, EJNMMI 2015 · 319 patients

Number of patients

■ PET-positive ■ PET-negative



Point or focus to highlight.
Click to keep a result selected.

Show all results

Positivity by Gleason score

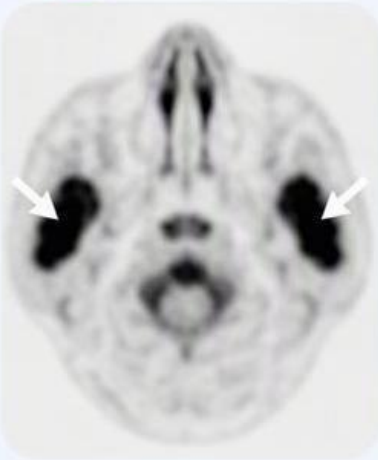
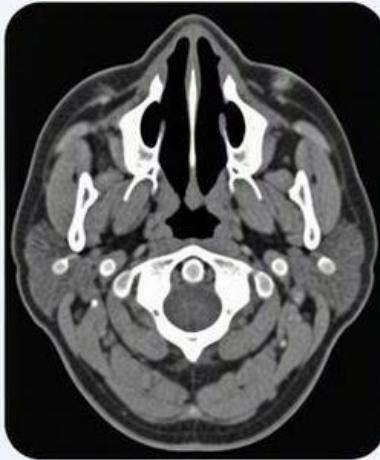
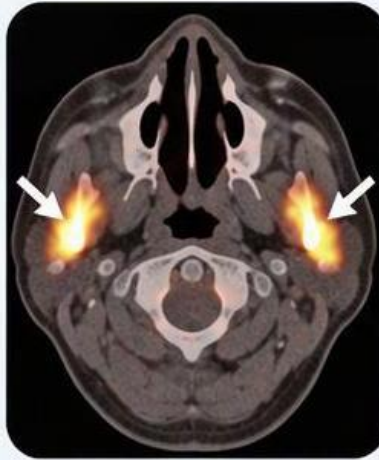
- GSC 9: 62 of 67 positive (92.5%)
- GSC 10: 4 of 4 (100%)
- GSC 7: 107 of 134 (79.9%)

Red outline highlights GSC 9 and 10.

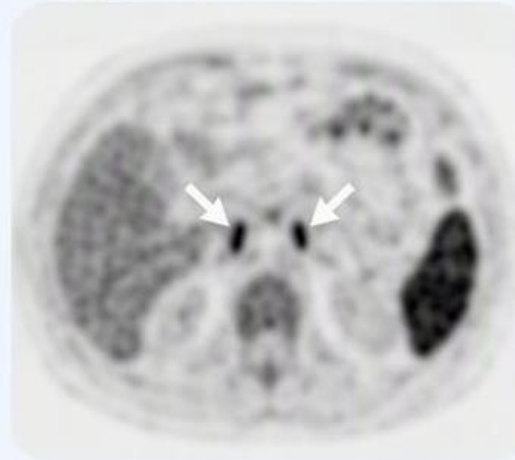
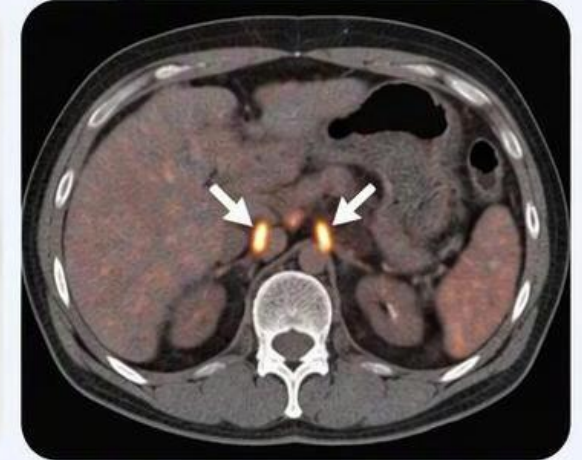
PSMA false friends



Salivary / accessory parotid



Celiac ganglion



Salivary glands —
intense physiology.



Celiac ganglia: linear/discoid,
not round mets.



Shetty review —
teach the shape.

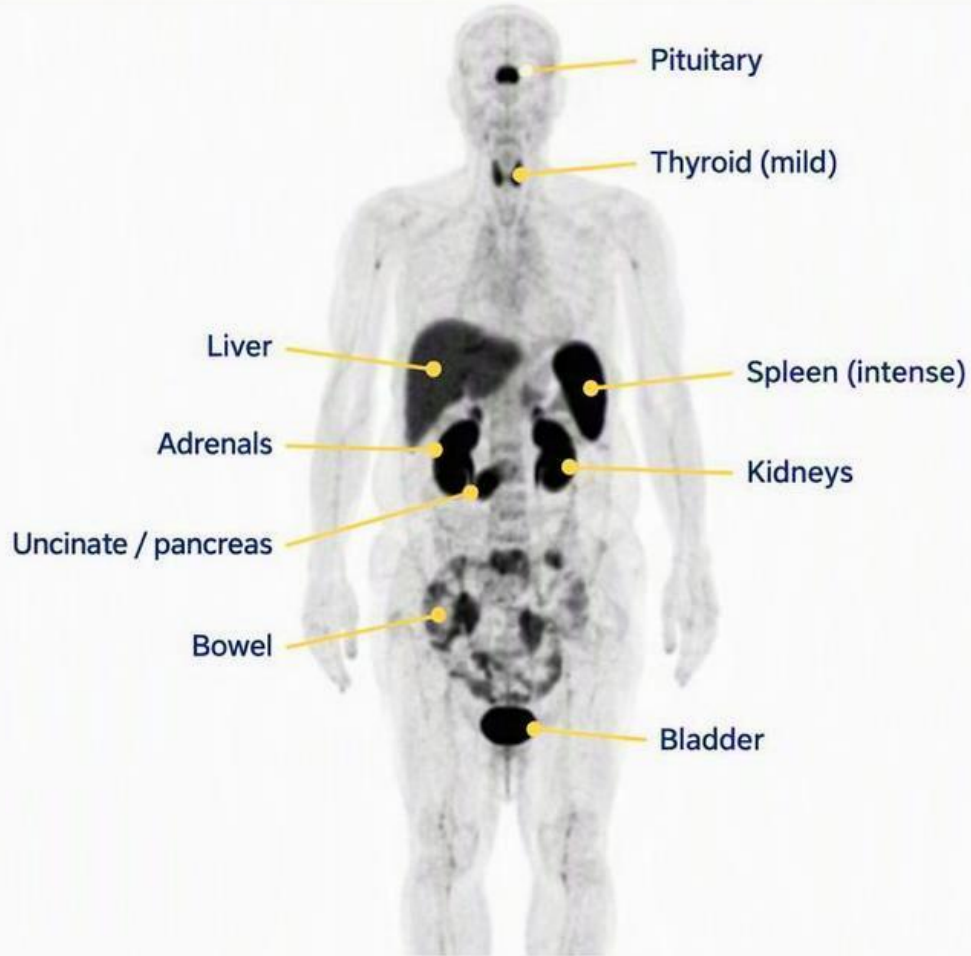


PART III · PLANNED AT TLJCC

SSTR imaging & NET

For GPs: the scan becomes a biomarker — and sometimes a gateway to treatment.
DOTA PET not yet bookable at TLJCC.

DOTATATE: more than localisation



Teaching MIP — physiologic DOTATATE biodistribution (not a TLJCC patient)



— **Maps somatostatin-receptor expression across tumour burden.**



— **Stages NET, searches for primary, assesses heterogeneity.**



— **Evaluates suitability for PRRT — same target links diagnosis and therapy.**



— **Planned at TLJCC — not bookable today.**

Large NET referral-centre experience

- 1,258 DOTATATE PET/CT scans in 728 patients.
- Treatment plan changed after 40.9% of scans — mainly unexpected findings.
- Changes included chemotherapy/PRRT, surgery and other pathway alterations.
- Skoura E et al. *J Nucl Med*. 2016;57:34–40.



1,258
scans · 728
patients

40.9%

Management change after DOTATATE PET/CT (Skoura 2016).

Biology can be heterogeneous

- DOTATATE + FDG changed the therapeutic plan in 80.8% in a 104-patient study.
- DOTA+ / FDG-low: differentiated — supports SSA, consider PRRT.
- FDG+ / SSTR-low: aggressive clones a 'good' SSTR scan can miss.
- Still integrate grade, burden, symptoms and organ function.

Panagiotidis E et al. J Nucl Med. 2017;58:91–96.

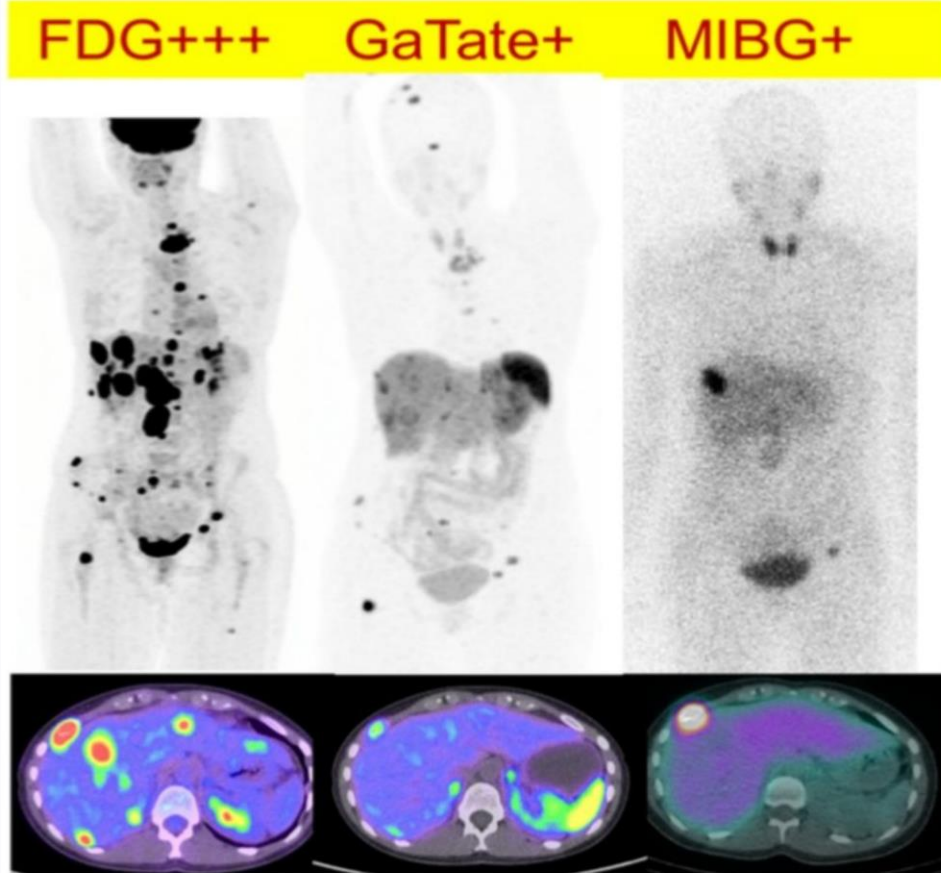


80.8%

Dual-tracer plan change (Panagiotidis JNM 2017). FDG available now • DOTA PET planned at TLJCC.

Paraganglioma: one disease, three tracers

FDG, Ga-68 DOTATATE and MIBG in the same patient



Chian et al. Cancer Imaging 2016

Figure: Chang et al, Cancer Imaging 2016 (labelled 'Chian' on the original image)

Uptake differs by tracer



● **FDG +++**



● **GaTate +**

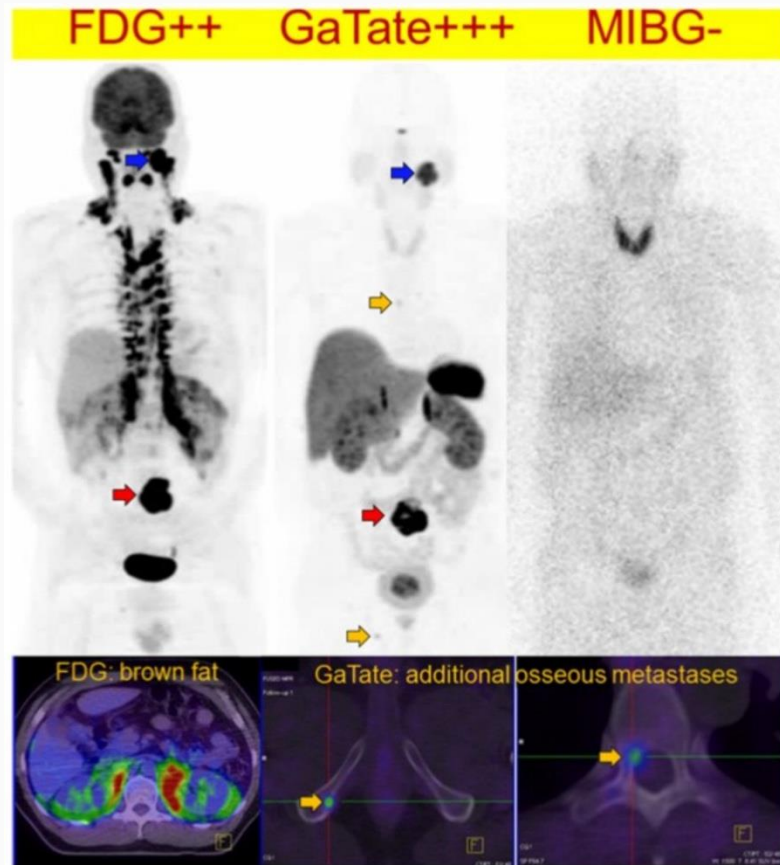


● **MIBG +**



Paraganglioma: FDG vs DOTATATE

FDG, Ga-68 DOTATATE and MIBG — a different pattern



Chian et al. Cancer Imaging 2016

Figure: Chang et al, Cancer Imaging 2016 (labelled 'Chian' on the original image)

The opposite pattern



FDG ++, GaTate +++, MIBG –



FDG: brown fat



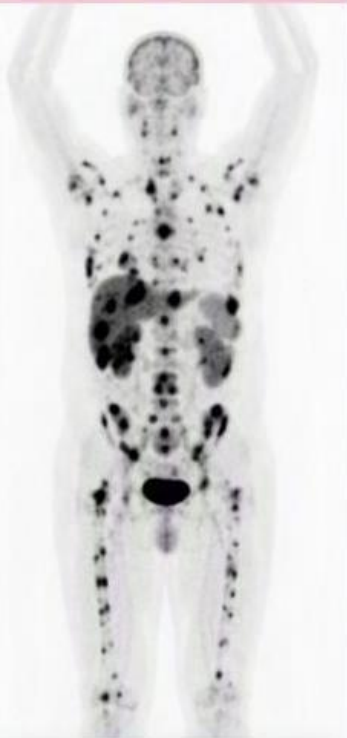
GaTate: extra bone metastases

Case: one patient, four scans

Teaching case — serial whole-body MIPs, April 2018 to March 2019

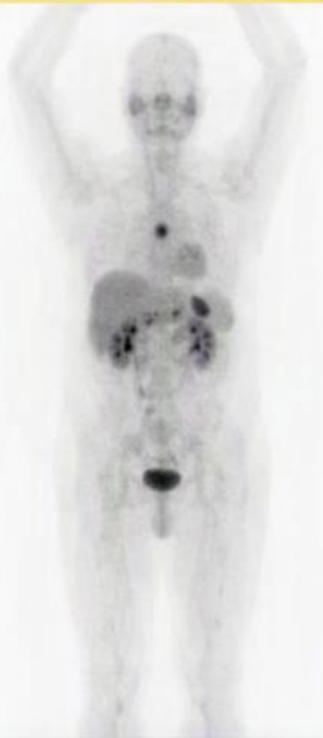


Ga-68 SSR +++



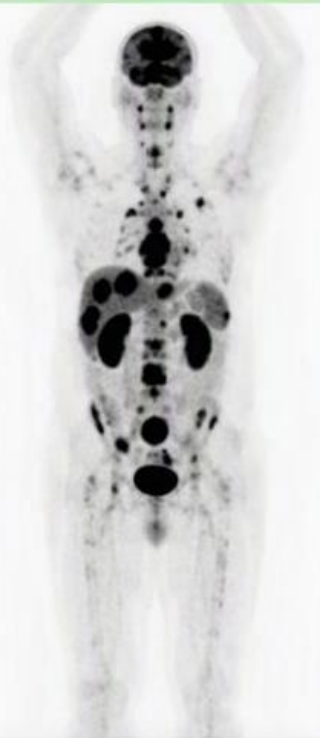
12.4.2018

MIBG +



25.4.2018

F-18 FDG +++



18.10.2018

Ga-68 SSR +++



11.3.2019

Serial scans

- 12.4.2018
Ga-68 SSR +++
- 25.4.2018
MIBG +
- 18.10.2018
F-18 FDG +++
- 11.3.2019
Ga-68 SSR +++

Case: SSR or FDG?

Teaching case — Ga-68 SSR PET/CT, then F-18 FDG PET/CT



Ga-68 SSR



Ga-68 SSR MIP

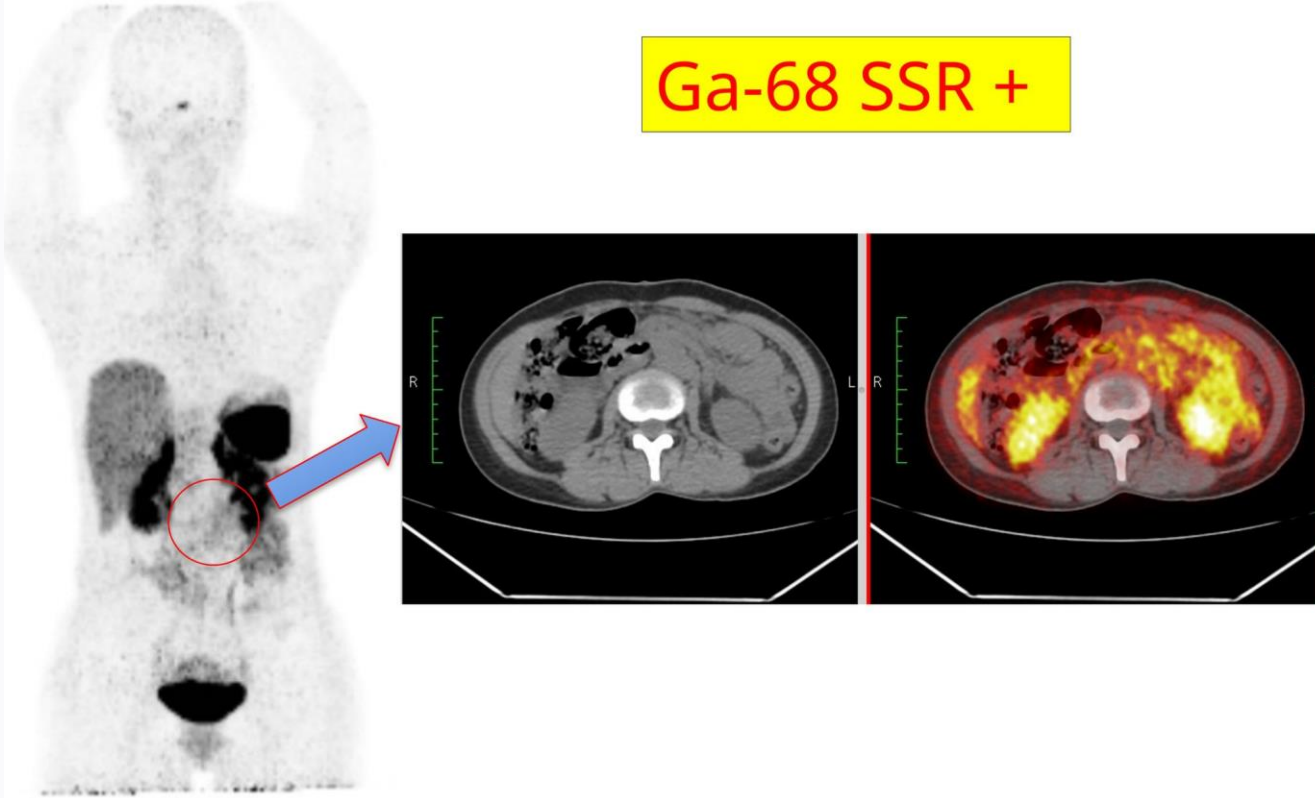
- Any SSR-avid disease?

Case: SSR or FDG?

Teaching case — Ga-68 SSR PET/CT. then F-18 FDG PET/CT



Ga-68 SSR +

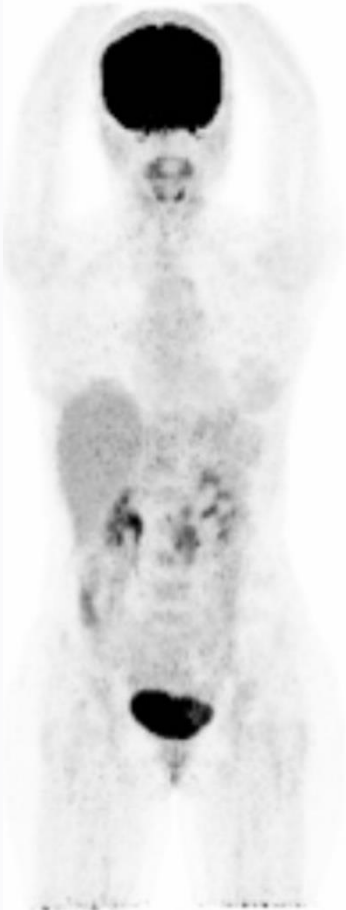


Ga-68 SSR +

- Circled para-aortic focus
- Axial CT and fused PET/CT

Case: SSR or FDG?

Teaching case — Ga-68 SSR PET/CT, then F-18 FDG PET/CT



F-18 FDG

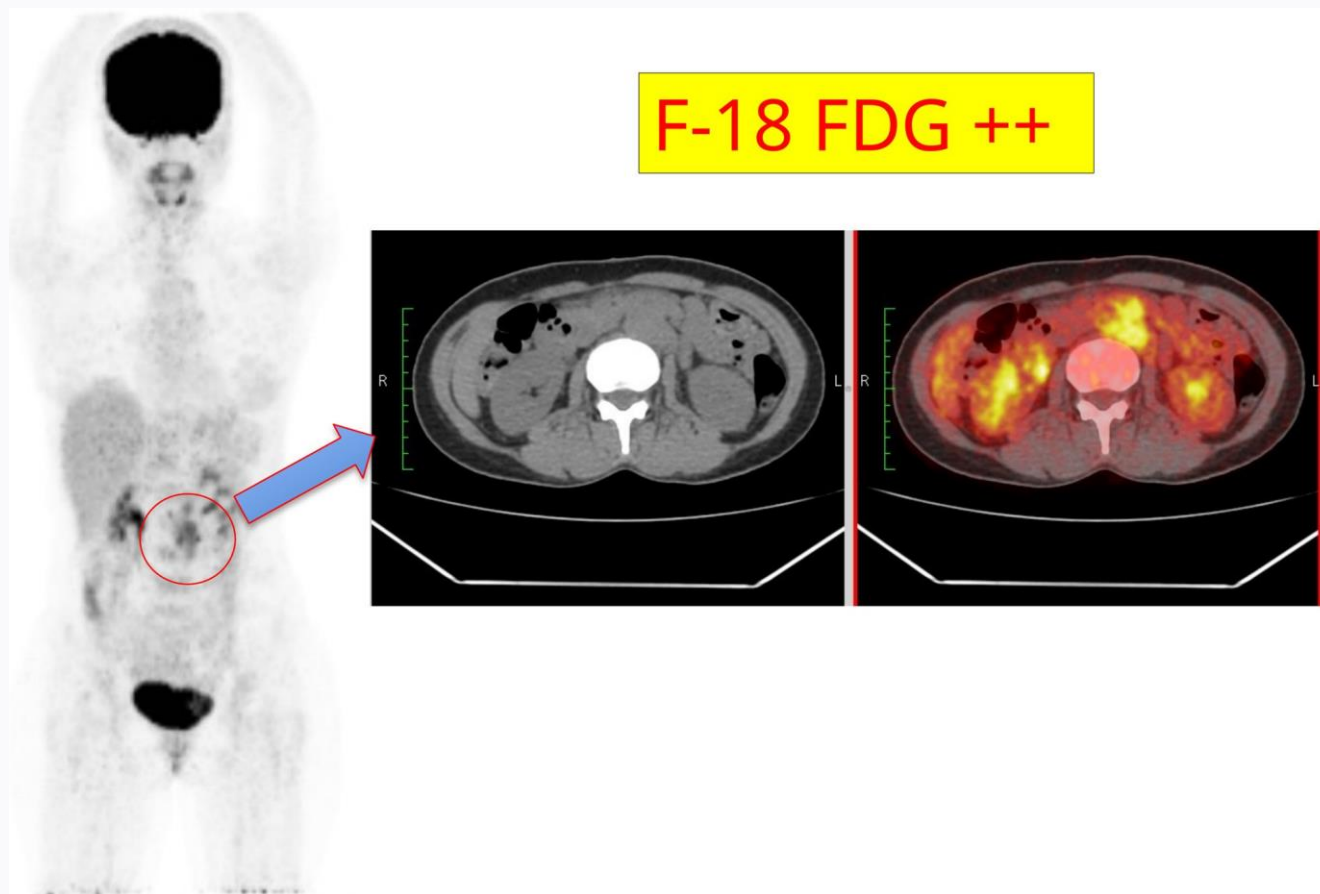


F-18 FDG MIP

- Any FDG finding?

Case: SSR or FDG?

Teaching case — Ga-68 SSR PET/CT, then F-18 FDG PET/CT



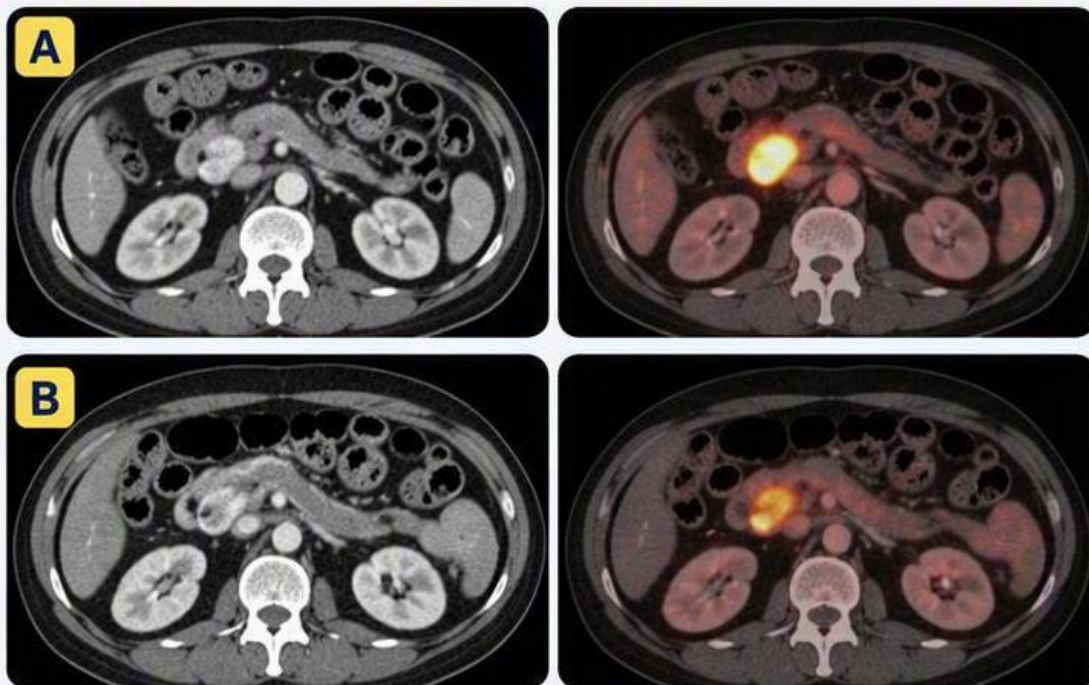
F-18 FDG ++

- Left para-aortic focus
- Axial CT and fused PET/CT
- Discussion: is PRRT an option?

DOTA false friends



Pancreatic uncinate

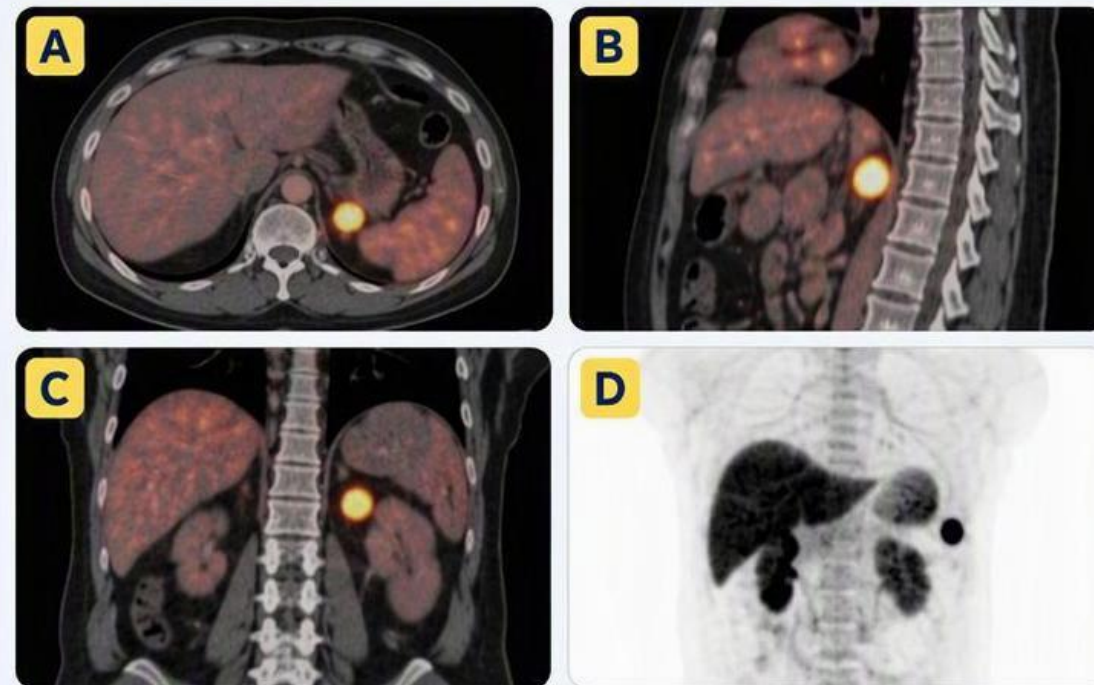


Hot uncinate can mimic a NET — check CT.



Accessory spleen after splenectomy.

Splenule / accessory spleen



Malan DOTATATE review — match morphology.



PART IV

Theranostics — see what we treat

Plain English: find the target on a scan, then deliver radiation to that target.
Lu-177 therapies planned at TLJCC — not current.



The theranostic principle

WE SEE WHAT WE TREAT · WE TREAT WHAT WE SEE

Diagnostic ligand identifies a molecular target.
A therapeutic radionuclide is paired with the same
or a closely related targeting molecule.

For GPs: the scan is how we choose who gets radioligand therapy — not a test done in another building and ignored.



How PSMA radioligand therapy works

Animation from the 2023 PSMA talk · click the video to play (has sound)



ON SCREEN

PSMA on the cancer-cell membrane

High-affinity ligand carries lutetium

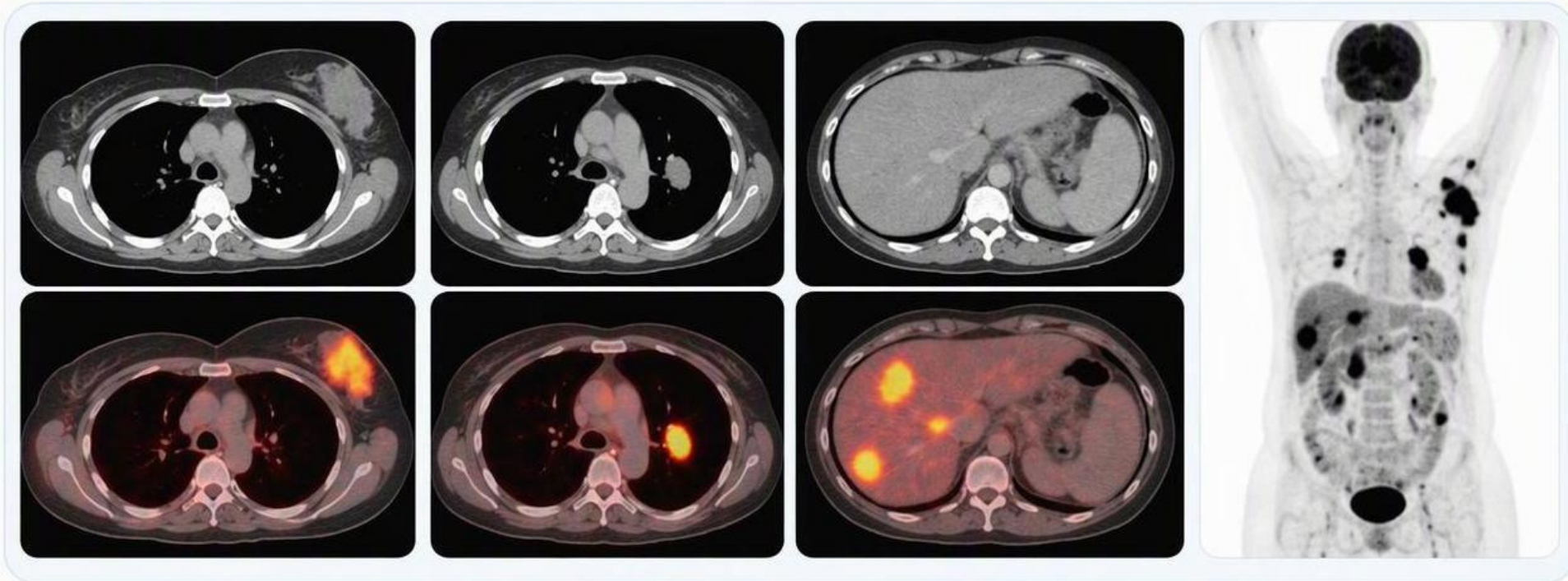
Cancer cells targeted; normal cells spared

PSMA PET & Lu-177 PSMA planned at TLJCC — not bookable yet

Mechanism animation re-used from Dr Zool Hilmi's PSMA 2023 deck — original source/credit to be confirmed

FDG PET changes intent — see the axials

Open-access staging panel — CT paired with fused PET/CT



NCBI Bookshelf CC BY-NC teaching figure — not a TLJCC patient



Before: seemingly operable breast cancer.

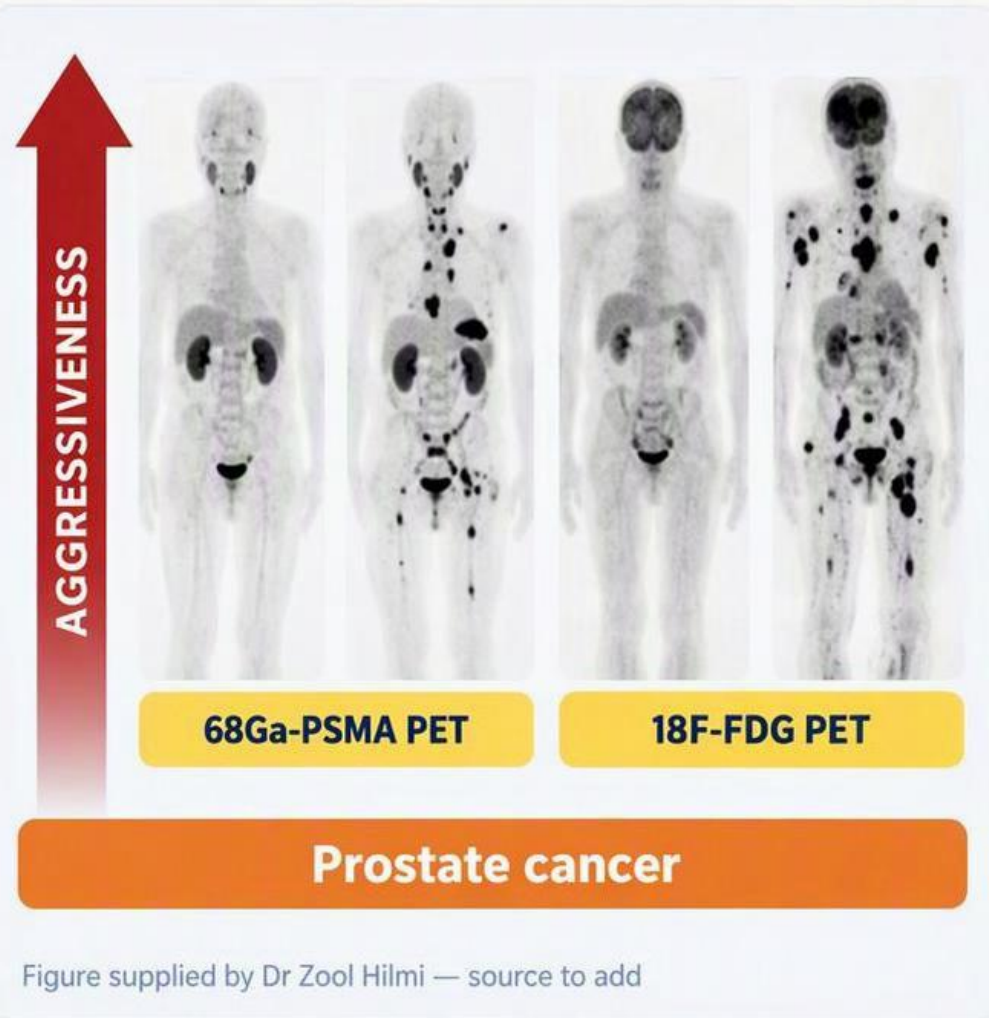


PET/CT: nodes, lung, liver — stage becomes M1.



After: systemic strategy, not futile local-only care.

Prostate cancer: more FDG, more aggressive disease



PSMA vs FDG

[68Ga]Ga-PSMA PET beside [18F]FDG PET in prostate cancer.



Higher FDG uptake

The more aggressive and less differentiated the tumour tends to be.



“Anti-theranostic”

FDG can act as an anti-theranostic marker in prostate cancer.

FDG bookable at TLJCC

PSMA PET planned at TLJCC — not bookable yet

Five messages for the GP clinic



1



Ask: will this scan change what we do next week?
If not, rethink the referral.

2



FDG can change stage, intent and response —
and it is bookable at TLJCC today.

3



Hot ≠ cancer until the fused axial says what tissue
is hot (brown fat, infection, fasciitis).

4

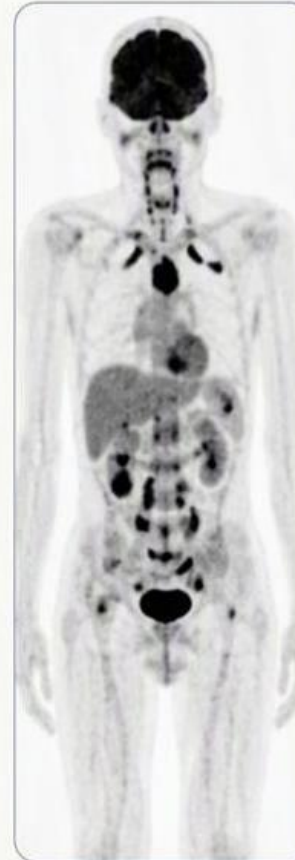
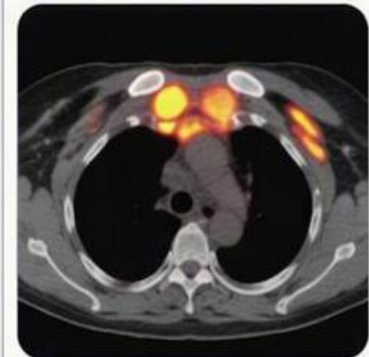
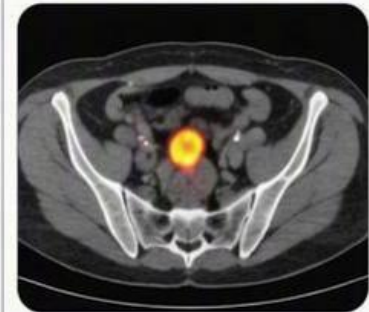


PSMA and DOTA are planned here — still teach the
evidence; help patients get the right centre.

5

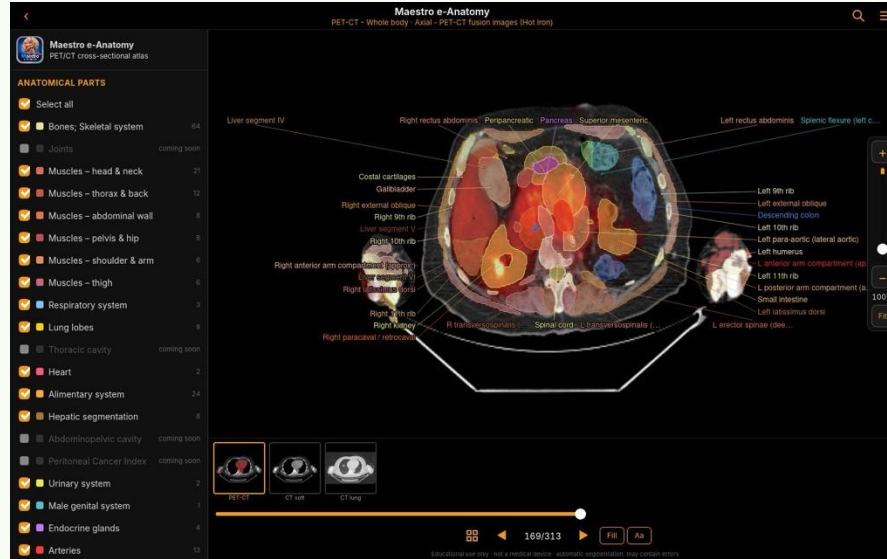


We see what we treat, and we treat what we see —
invite nuclear medicine into the MDT.



Maestro e-Anatomy: a PET/CT cross-sectional atlas

Developed by Dr Zool Hilmi



Accessible online



Scroll through axial PET-CT fusion, CT soft tissue and CT lung



Labelled anatomy by system: bones, muscles, organs, lung lobes, hepatic segments, arteries



For teaching only: not a medical device; automatic segmentation may contain errors



MY PROJECTS

Maestro DICOM Viewer: offline PET/CT reading & reporting

Developed in-house by Dr Zool Hilmi

MAESTRO DICOM Viewer

PET/CT - local - offline Quit server

DICOM folder
workspace/cases/case001/raw Scan

workspace/cases/case001/raw
home/box/PETViewer/library/20181019_F-18_FDG_a709153
home/box/PETViewer/library/20190306_Ga-68_DOTANOC...
home/box/PETViewer/library/20190306_Ga-68_DOTANOC...
home/box/PETViewer/anon_exports/20190306_Ga-68_DOT...

■ Anonymize view (hide identifiers on screen)

Import to library
Choose folder... Choose files / .zip...
...or drag & drop a folder, files or a .zip anywhere on this window. Files are copied to the local library (~\PETViewer\library), originals are never changed.

Series drag a tile onto a viewport

NEW 2019-03-06 Ga-68 DOTANOC WB
Fused AC PET 2019-03-06...
PET AC 2019-03-06...
PET NAC 2019-03-06...
CT 2019-03-06...
MIP 2019-03-06...

2019-03-06 Ga-68 DOTANOC LEGS
Fused AC PET 2019-03-06...
PET AC 2019-03-06...
PET NAC 2019-03-06...
CT 2019-03-06...

Library 2 studies - 497 MB
2018-10-19 F-18 FDG
2 CTAC (313)
3 PET_WB_3D_AC (313)
4 PET_WB_3D_NAC (313)
248.5 MB
Open Prior Anon copy Delete

2019-03-06 Ga-68 DOTANOC
2 CTAC (313)
3 PET_WB_3D_AC_GALLIUM (313)
4 PET_WB_3D_NAC_GALLIUM (313)
248.5 MB
Open Prior Anon copy Delete

Studies 7653 files, 10.8s
2016-11-29 F-18 FDG
PET SPOT VIEW 3D AC PET 85 - CT 85 (anonymized) ANON CASE001
Open Prior

2016-11-29 F-18 FDG
PET WB 3D AC PET 313 - CT 313 (anonymized) ANON CASE001
Open Prior

2016-11-29 F-18 FDG
NAC PET SPOT VIEW 3D NAC PET 85 - CT 85 (anonymized) ANON CASE001
Open Prior

Layout 3 - Single patient 6 - Comparison Custom Sync rows: ON

Sync Off Same study All studies zoom/pan plane SUV window (same tracer) Offset... Re-register 2018-02-07 Ga-68 DOTANOC WB: rigid CT-to-CT (SimpleITK Euler3D, Mattes MI)

Auto-compare Locked Reset offset offset 0.0, 0.0, 0.0 mm Report ? CT 1 Abdomen / soft tissue 400/40 W 400 L 40 Fusion 0.50

SUV 2019-03-06 Ga-68 DOTANOC WB 0 10 Auto Tool Navigate W/L drag adjusts PET SUV VOI Sphere 10 mm SUVpeak 1cc

Zoom 1.0x + Reset

Top-bottom sync ON: OLD row follows NEW (registration ✓)

NEW - Ga-68 DOTANOC - 06 Mar 2019 - PET WB 3D AC GALLIUM
NEW Fused AC PET - 2019-03-06 Ga-68 DOTANOC WB A C S Hot Iron Key
NEW - Ga-68 DOTANOC - 06 Mar 2019
R L 162/313
SUV 0-10 α 0.5
Axial z -497.4 mm - SUV 0-10 - CT W 400 L 40

NEW - Ga-68 DOTANOC - 06 Mar 2019 - PET WB 3D AC GALLIUM
NEW CT - 2019-03-06 Ga-68 DOTANOC A C S Abdomen Key
NEW - Ga-68 DOTANOC - 06 Mar 2019
R L 162/313
Axial z -497.4 mm - CT W 400 L 40

NEW - Ga-68 DOTANOC - 06 Mar 2019 - PET WB 3D AC GALLIUM
NEW Rotate Save .mov max 5 7 10 15 Label
MIP 0° - Inverted grey - SUV 0-10
R L 162/313
SUV 0-10
0° +15 fps 75°/s

OLD - Ga-68 DOTANOC - 07 Feb 2018 - PET WB 3D AC GALLIUM
OLD Fused AC PET - 2018-02-07 Ga-68 DOTANOC WB A C S Hot Iron Key
OLD - Ga-68 DOTANOC - 07 Feb 2018
R L 159/313
SUV 0-10 α 0.5
Axial z -522.3 mm - SUV 0-10 - CT W 400 L 40

OLD - Ga-68 DOTANOC - 07 Feb 2018 - PET WB 3D AC GALLIUM
OLD CT - 2018-02-07 Ga-68 DOTANOC A C S Abdomen Key
OLD - Ga-68 DOTANOC - 07 Feb 2018
R L 159/313
Axial z -522.3 mm - CT W 400 L 40

OLD - Ga-68 DOTANOC - 07 Feb 2018 - PET WB 3D AC GALLIUM
OLD Rotate Save .mov max 5 7 10 15 Label
MIP 0° - Inverted grey - SUV 0-10
R L 159/313
SUV 0-10
0° +15 fps 75°/s

SSTR - PERCIST liver threshold $1.5 \times 2.85 + 2 \times 0.96 = 6.21$ - 15 lesion(s), 21 physiological excluded - 47.4 s - All masks (TotalSegmentator fast) - liver pass (no Countraud - re-run AI)

Site SUVmax Size LxWxH CT Pri / %
L1 T12 vertebral body 19.38 2.2x1.9x2.0 cm No CT correlate (208 HU) 50.5 / -62%
L2 left hilar node (IASLC stat) 17.29 1.3x0.8x2.9 cm (SA 0.8) 17.7 / -39%
L3 peripancreatic - nodal / so 17.15 2.5x2.2x2.6 cm (SA 2.2) 28.5 / -42%
L4 L2 vertebral body 15.92 1.9x1.2x2.0 cm No CT correlate (193 HU) 33.0 / -52%
L5 superior mesenteric - nod 15.91 16.1x6.7x13.4 cm (SA 6.7) 34.3 / -54%
L6 C7 posterior elements ± pi 14.96 2.6x2.2x4.3 cm No CT correlate (138 HU) 15.1 / -14%
L7 L4 vertebral body 12.23 0.8x0.8x1.3 cm No CT correlate (103 HU) 9.86 / -22%

Study: SSTR PET/CT (Ga-68 DOTANOC), 2019-03-06, whole body.
Indication / clinical: Not provided
Technique: 160 MBq IV; uptake time 68 min; weight 66 kg; low-dose CT for attenuation correction and localisation. SUVbw.
Comparison: Ga-68 DOTANOC PET/CT 2018-02-07 (co-registered CT-to-CT; lesions matched automatically [physician to confirm]).
Findings:
Reference: liver SUVmean 2.85 (3 cm VOI); blood pool SUVmean 1.96 (approx.); spleen SUVmax 9.97.
Primary / surgical bed: no separate focus identified automatically [physician to confirm: primary site / surgical bed]
Nodes: L2 - left hilar node (IASLC station 10L), 1.3 x 0.8 x 2.9 cm, short axis 0.8 cm (measured on PET uptake, 50 % bg-corrected isocontour; no CT correlate): SUVmax 17.29 (lesion/liver 6.1) prior 17.75 - 2.0% L2 - peripancreatic - nodal Left lobe

Lesions Measurement - lesion size Re-measure prior
Export snapshots + CSV Download CSV
Measurements:
none - Tool = Measure (key m); drag a line on a fused or CT viewport; Shift-drag adds the short axis
ROIs / angles / text: none - Oval ROI (o), Angle (g), Text (x)
Arrows: none - Tool = Arrow (key i), click on a fused or CT viewport
Site SUVmax x,y,z (mm) VOI Size long x short Prior SUVmax % change
LPS

MAESTRO DICOM Viewer - personal tool - not a medical device; not for primary diagnosis. All processing runs locally on 127.0.0.1; no data leaves this computer. Hot Iron = DICOM PS3.6 standard palette; values SUVbw.



Runs locally



Fully offline: no data leaves the PC



Reads DICOM PET/CT



Fused, CT, rotating MIP



Current vs prior



SUV + lesion table



Auto draft report



Ongoing: still learning to report and link findings. Not a medical device: the physician reads.



THANK YOU

“The value of the scan
is the decision it changes.”

FDG PET/CT and low-dose I-131 are on today.
PSMA PET, DOTA PET and Lu-177 therapies are planned.

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