

## FLUCICLOVINE:

1<sup>ST</sup> FDA APPROVED F-18 PET IMAGING  
AGENT FOR RECURRENT PROSTATE CANCER

KEVIN P BANKS, MD

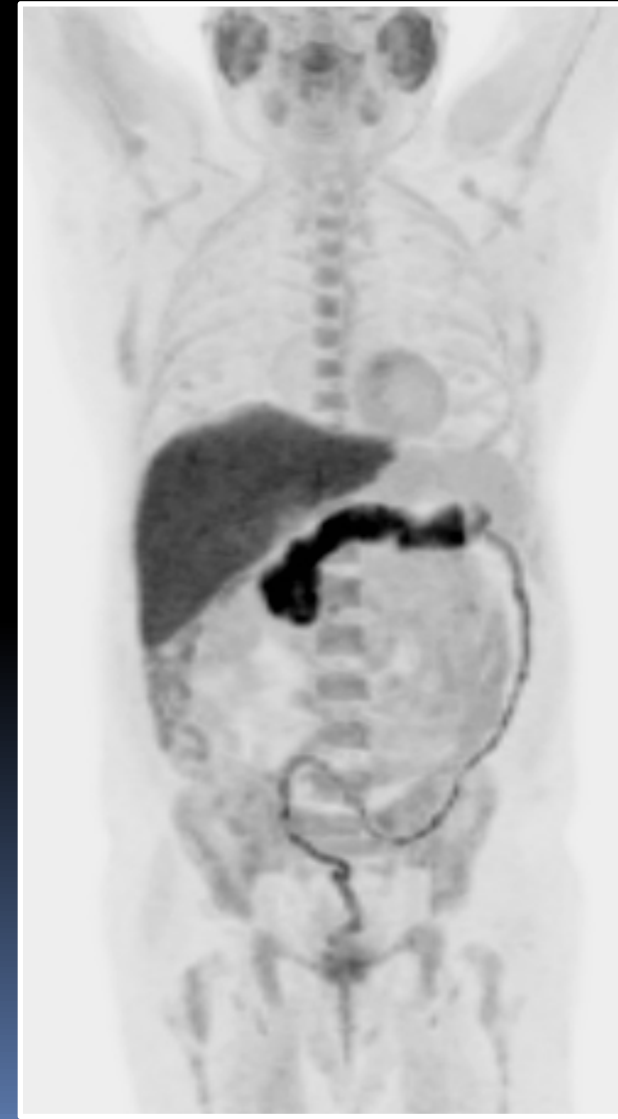
SAN ANTONIO MILITARY MEDICAL CENTER

ASSISTANT PROFESSOR OF RADIOLOGY, USU

**I HAVE NO FINANCIAL DISCLOSURES.**

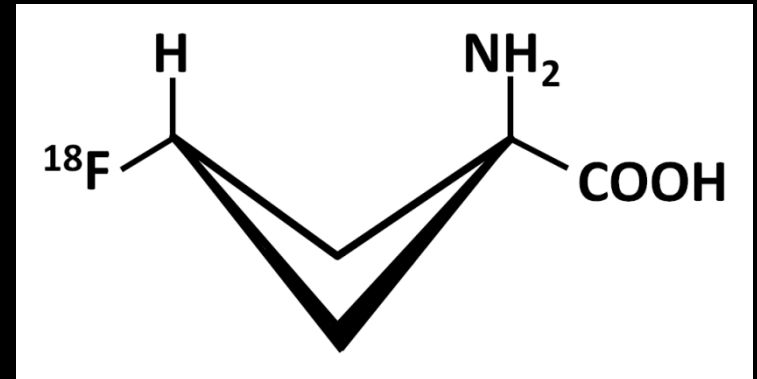
# GOALS AND OBJECTIVES

1. Review characteristics and clinical pharmacology of Fluciclovine F-18.
2. Discuss role of Fluciclovine F-18 in management of prostate cancer and research supporting its efficacy.
3. Contrast administration & image acquisition of Fluciclovine F-18 to commonly utilized FDG.
4. Review interpretation criteria for Fluciclovine F-18 images in setting of suspected recurrent prostate cancer.



# Anti-1-Amino-3-<sup>18</sup>F-Fluorocyclobutane-1-Carboxylic Acid (FACBC)

## ❖ L-Leucine Amino Acid Analogue



- LEUCINE: essential amino acid for protein synthesis and cell growth
- Taken up via LAT & ASCT systems
- LAT & ASCT systems up regulated in many carcinomas
  - LAT1 and ASCT2 associated with more aggressive disease
- FACBC does not undergo metabolism
- Uptake in prostate-specific membrane antigen (PSMA) expressing and non-expressing tumor cells

# PERFORMANCE OF F-18 FACBC

- Efficacy initially evaluated by Emory University
- 105 F18-FACBC PET/CT scans compared to histopathology
- Interpreted by 3 blinded independent readers
- Detection rate 60% PSA <1.78
- Detection rate 80% PSA >1.78
- <10% extra-prostatic FP rate

	READER 1	READER 2	READER 3
<b>PATIENT</b>	<b>N=104</b>	<b>N=105</b>	<b>N=99</b>
TP	75	72	63
FP	24	23	13
TN	5	7	15
FN	0	3	8
<b>PROSTATE BED</b>			
TP	58	56	47
FP	29	26	15
TN	10	12	24
FN	1	3	10
<b>EXTRAPROSTATIC</b>			
TP	25	26	22
FP	2	2	2
TN	0	0	0
FN	1	0	1

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- Detection rate 60% PSA <1.78
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## PATIENT


Sensitivity	95%
Specificity	31%
PPV	78%
NPV	71%

## PROSTATE/BED

Sensitivity	92%
Specificity	40%
PPV	70%
NPV	77%

## EXRAPROSTATIC

Sensitivity	97%
Specificity	0%
PPV	92%
NPV	0%



# 18F-FLUCICLOVINE PET-CT VS IN-111 CAPROMAB PENDETIDE SPECT-CT

## Patients and methods:

- 93 patients with suspected recurrent prostate carcinoma
- Underwent 18F-Fluciclovine PET-CT & 111In-capromab pendetide (Prostascint) SPECT-CT
- Both exams completed in 90 days
- Reference standards applied by multidisciplinary board

## Results:

<u>PROSTATE/BED</u>	<u>TP</u>	<u>TN</u>	<u>FP</u>	<u>FN</u>	
• FACBC	55	12	18	6	
• Capromab pendetide	41	17	13	20	
<u>PROSTATE/BED</u>	<u>SENS</u>	<u>SPEC</u>	<u>ACC</u>	<u>PPV</u>	<u>NPV</u>
• FACBC	90%	40%	74%	75%	67%
• Capromab pendetide	67%	57%	64%	76%	46%

- ✓ FACBC identified 14 more positive prostate bed recurrences (55 vs 41)

# 18F-FLUCICLOVINE PET-CT VS IN-111 CAPROMAB PENDETIDE SPECT-CT

## Patients and methods:

- 93 patients with suspected recurrent prostate carcinoma
- Underwent 18F-Fluciclovine PET-CT & 111In-capromab pendetide (Prostascint) SPECT-CT
- Both exams completed in 90 days
- Reference standards applied by multidisciplinary board

## Results:

	<u>EXTRAPROSTATIC</u>	<u>TP</u>	<u>TN</u>	<u>FP</u>	<u>FN</u>
• FACBC	22	29	1	18	
• Capromab pendetide	4	26	4	36	

	<u>EXTRAPROSTATIC</u>	<u>SENS</u>	<u>SPEC</u>	<u>ACC</u>	<u>PPV</u>	<u>NPV</u>
• FACBC	55%	97%	73%	96%	62%	
• Capromab pendetide	10%	87%	43%	50%	42%	

- ✓ FACBC identified 18 more patients with extraprostatic involvement (22 vs 4)
- ✓ Correctly up-staged 18 of 70 cases (26%)
- ✓ Radiation exposure of FACBC was ~1/3 of Prostascint



# 18F-FLUCICLOVINE VS 11C-CHOLINE PET/CT

**Choline:** Marker of lipogenesis; enters cell and catalyzed by choline kinase (up-regulated in PCa) to phosphorylcholine then phosphatidylcholine in cell membrane.

## Patients and methods:

- Fifteen patients radically treated for prostate cancer
- Presented with rising PSA levels, median PSA 1.44 ng/mL
- Underwent (11)C-choline PET/CT & (18)F-fluciclovine PET/CT within 1 week

## Results:

- (18)F-fluciclovine significantly superior to (11)C-choline
  - Patient-based analysis AND
  - Lesion-based analysis; lymph nodes, bone, & local relapse
- ✓ Superior performance of FACBC at low, intermediate, and high PSA levels

C11-CHOLINE  
POS 3/15 PTs → 20%

F18-FACBC  
POS 6/14 PTs → 40%

C11-CHOLINE  
DETECTED 6 LESIONS  
4 BONE, 1 LN, 1 LOCAL

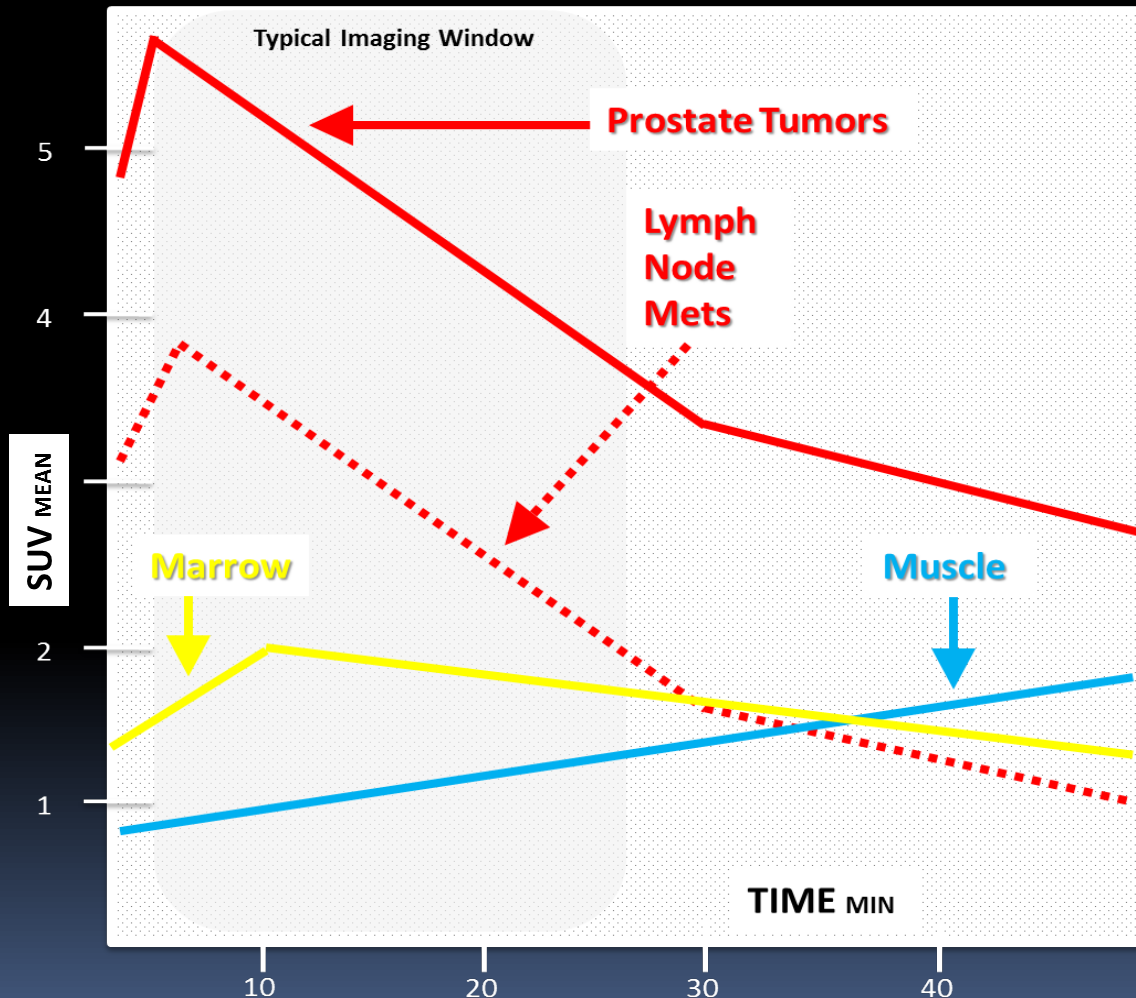
F18-FACBC  
DETECTED 11 LESIONS  
5 BONE, 5 LN, 1 LOCAL  
TO INCLUDE ALL 6  
SEEN ON C11

# BIODISTRIBUTION



- **PANCREAS** > **LIVER** most intense uptake
- Moderate salivary & pituitary uptake
- Variable mild to moderate bowel activity
- Moderate red marrow & mild **MUSCLE** activity present early (<15 min)
  - Marrow activity ↓ while **MUSCLE** activity ↑ with time
- Lungs have little to no uptake
- In contrast to FDG:
  - Minimal to no brain uptake
  - Little **RENAL** excretion
  - Mild activity may accumulate in **BLADDER**, but not to degree that interferes with interpretation

# PHARMACOKINETICS



→ In contrast to FDG:

FACBC uptake in prostate cancer & lymph node mets peaks early @ 4-10 min

*VERSUS*

FDG peaks @ 90+ min most tumors

❖ 61% ↓ uptake of FACBC by prostate cancer lesions @ 90 min

GIVEN THIS, imaging begins

3-5 min post injection FACBC

*VERSUS*

45-90 min for FDG

# PROTOCOL

## FACBC (Fluciclovine)

- Withhold voiding x30 min prior
- Perform injection with patient on PET-CT scanner bed in supine position
- Immediately reposition arms above head
- 1-2 min after injection, initiate CT
- Begin PET scan 3-5 min after injection
  - ▶ Tumor-to-normal tissue contrast is highest 4-10 min after injection
  - ▶ 61% ↻ tumor uptake by 90 min

*If acquisition started too early, increased blood pool may be encountered*

*If acquisition started too late, increased muscle uptake typically present*

# INTERPRETATION CRITERIA

## PROSTATE BED AND PROSTATE GLAND

Avidity of pathologic FACBC uptake assessed visually

### Prior Prostatectomy

- Focal avidity  $\geq$  bone marrow is suspicious for cancer.
  - *BUT* if focus of avidity small (<1cm), suspicious if  $\gg$  blood pool.

### Non-Prostatectomy

- Focal asymmetric  $\geq$  bone marrow is suspicious for recurrence.
  - *BUT* if focus of uptake small (<1cm), suspicious if  $\gg$  blood pool.
    - Focal median lobe uptake has high likelihood of FP.
- Diffuse uptake  $\gg$  bone marrow is moderately suspicious for recurrence

*Manufacturer recommends review of PET only coronal images to aid interpretation.*

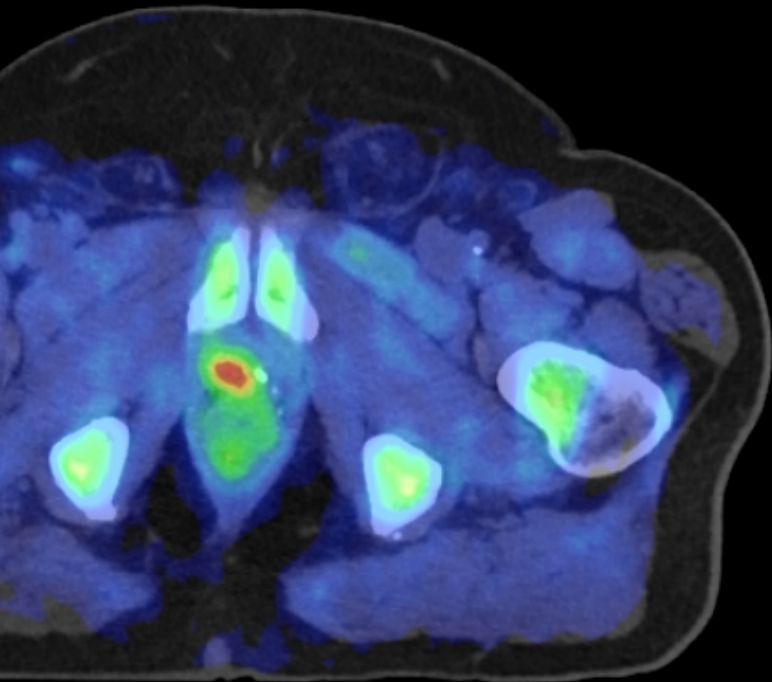


## PATHOLOGIC UPTAKE

PROSTATE BED, PROSTATECTOMY

66 YO S/P PROSTATECTOMY WITH BCR

- ▶ FOCAL UPTAKE
- ▶  $\geq 1$  CM IN SIZE
- ▶ VISUALLY  $\geq$  BONE MARROW
- ✓ SUSPICIOUS FOR CANCER RECURRENCE



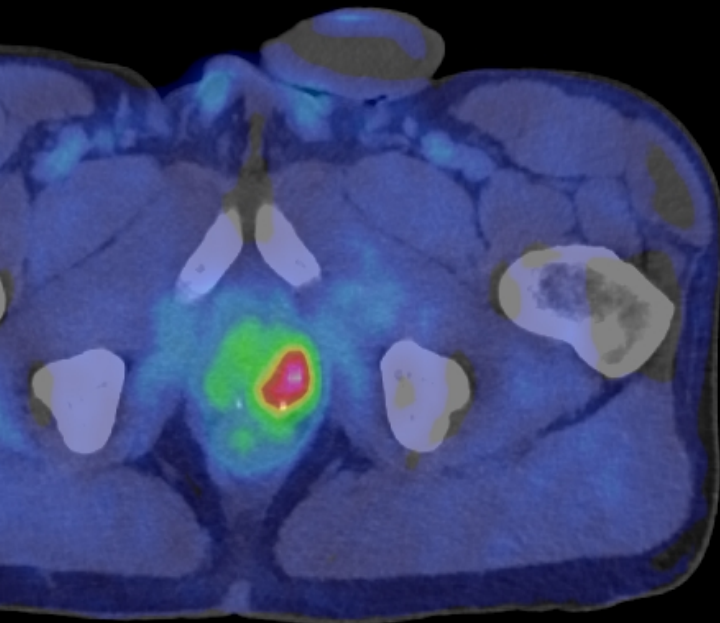


## PATHOLOGIC UPTAKE

### NON-PROSTATECTOMY

62 YO S/P XRT WITH BIOCHEMICAL RECURRENCE (BCR)

- ▶ FOCAL ASYMMETRIC UPTAKE
- ▶  $\geq 1$  CM IN SIZE
- ▶ VISUALLY  $\geq$  BONE MARROW
- ✓ SUSPICIOUS FOR CANCER RECURRENCE

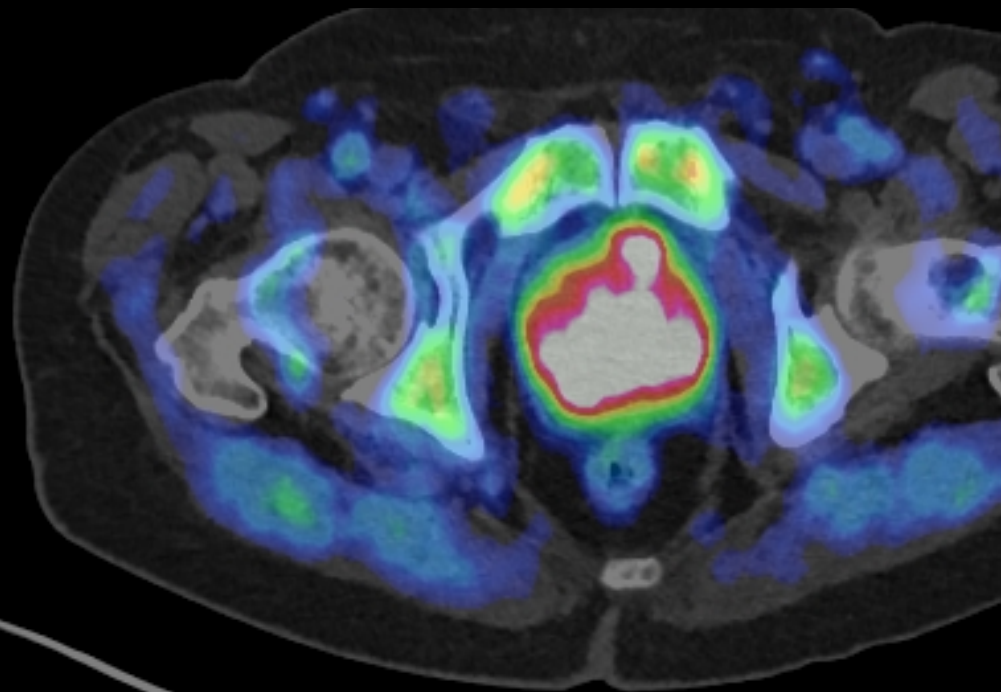


# DIFFUSE UPTAKE

## NON-PROSTATECTOMY

66 YO S/P XRT WITH BCR

- ▶ *DIFFUSE UPTAKE*
- ▶ *VISUALLY >> BONE MARROW*
- ✓ *SUSPICIOUS FOR CANCER RECURRENCE*



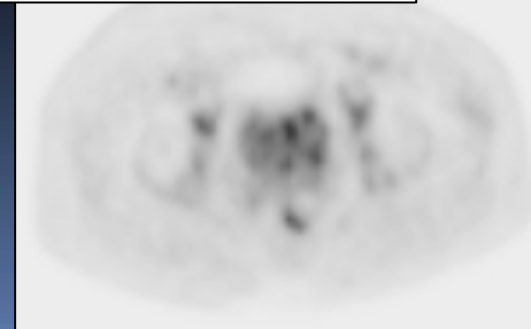
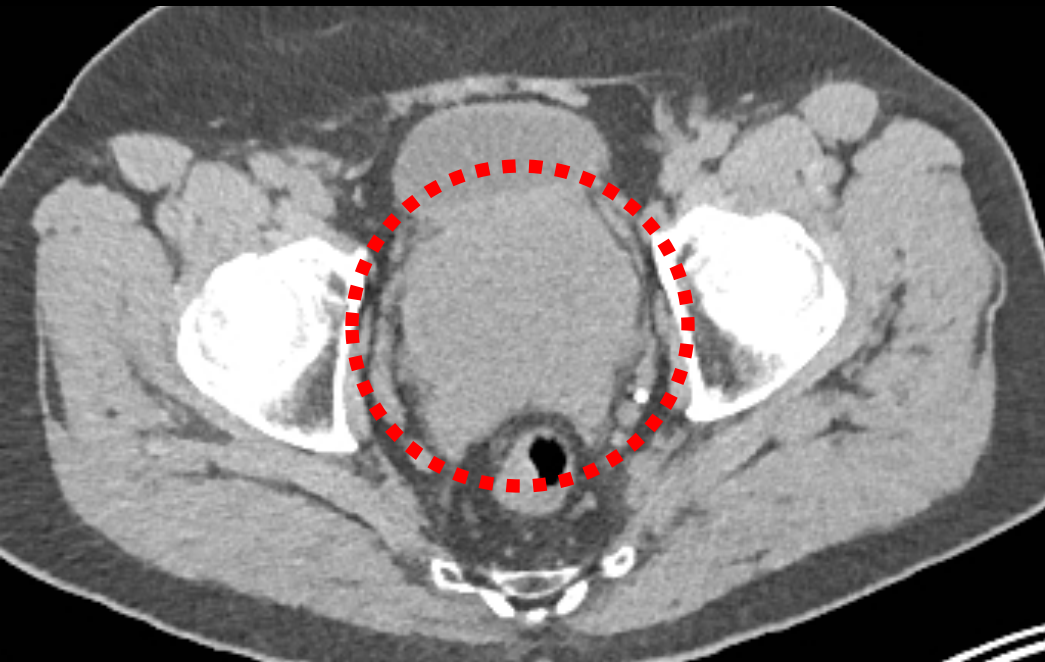


# HETEROGENOUS OR MULTIFOCAL UPTAKE

## NON-PROSTATECTOMY

58 YO S/P XRT WITH BCR

- ▶ *HETEROGENOUS UPTAKE*
- ▶ *VISUALLY  $\geq$  BONE MARROW*
- ✓ *SUSPICIOUS FOR CANCER RECURRENCE*



# 18F-FLUCICLOVINE PET-CT FOR PRIMARY PROSTATE CANCER?

Schuster, *AJNMMI* 2013

- Correlated uptake of anti-3-[18F] FACBC with histology of prostatectomy specimens
- 10 patients
- Average SUVmax tumor 4.0 +/- 1.3
  - BUT nonmalignant 3.4 +/- 0.9

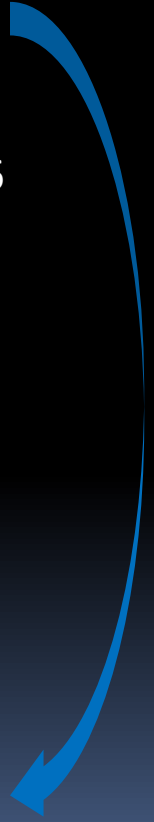
**→ SIGNIFICANT OVERLAP OF AVIDITY FOR PCa VS NONMALIGNANT TISSUE**

Turkbey, *Radiology* 2014

- Compared FACBC PET to MRI and Histology
- 21 patients with tumors > 0.5 cm
- Average SUVmax tumor 4.5 +/- 0.6
  - 2.8 +/- 0.5 normal prostate
  - BUT 4.3 +/- 0.7 BPH

**→ NO DIFFERENCE PCa VS BPH**

T2-weighted MR	ADC maps of DW MR	18F FACBC PET/CT
Sensitivity 73%	Sensitivity 73%	Sensitivity 67%
Specificity 79%	Specificity 80%	Specificity 66%
PPV 66%	PPV 68%	PPV 50%
NPV 87%	NPV 87%	NPV 78%



# INTERPRETATION CRITERIA

## LYMPH NODES

Avidity of pathologic FACBC uptake assessed visually

### Sites Typical for Prostate Cancer Recurrence

- Avidity  $\geq$  bone marrow considered suspicious.
  - *BUT* if node is small (<1cm) and in site typical for recurrence, may still consider suspicious if  $\gg$  than blood pool

### Atypical Sites (inguinal, distal external iliac, hilar, and axillary nodes)

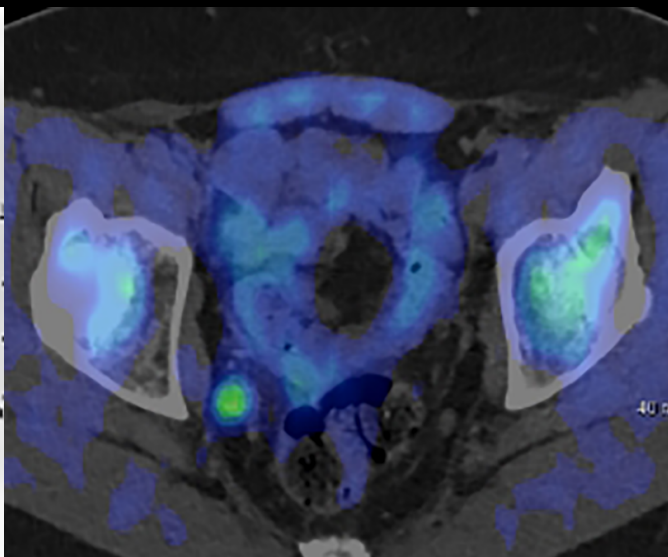
- Mild, symmetric uptake is typically physiologic
  - *BUT* if uptake present in context of other clear malignant disease, it may be considered suspicious for cancer recurrence.

# SUSPICIOUS NODAL UPTAKE

## ASYMMETRIC LYMPH NODE AVIDITY

69 YO WITH HISTORY OF PROSTATE CANCER

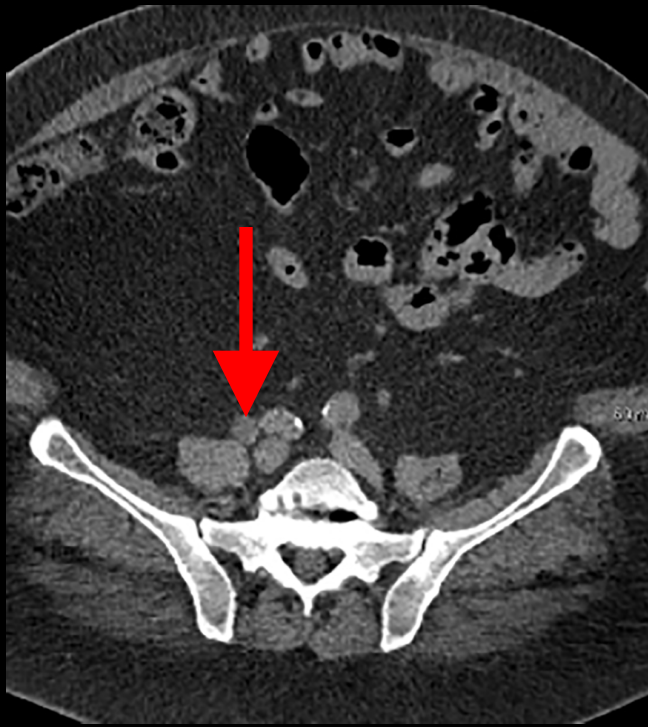
- ▶ *NODES TYPICAL FOR PROSTATE CANCER SPREAD*
- ▶ *≥ 1 CM IN SIZE*
- ▶ *VISUALLY ≥ BONE MARROW*
- ✓ *SUSPICIOUS FOR CANCER RECURRENCE*



# BENIGN NODAL UPTAKE

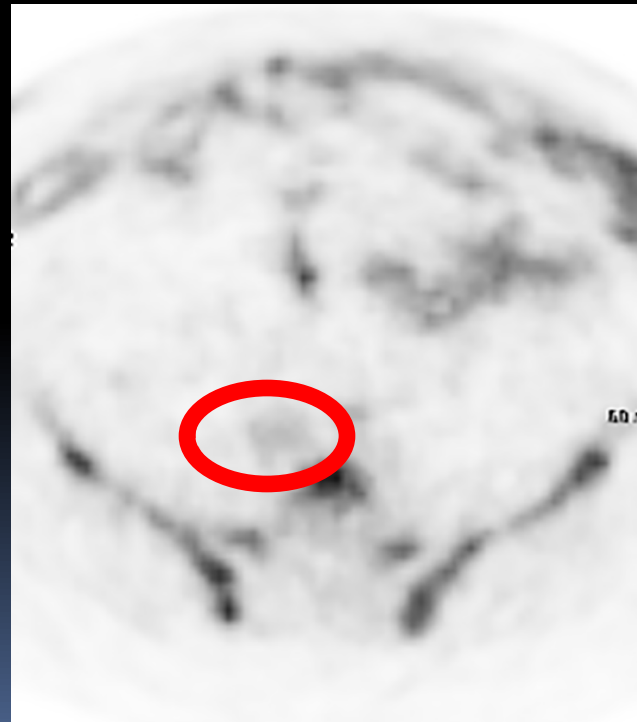
## MILD LYMPH NODE AVIDITY

- ▶ *NODES TYPICAL FOR PROSTATE CANCER SPREAD*
- ▶ *>= 1 CM IN SIZE*
- ▶ *VISUALLY < BONE MARROW*
- ✗ *NOT SUSPICIOUS FOR CANCER RECURRENCE*



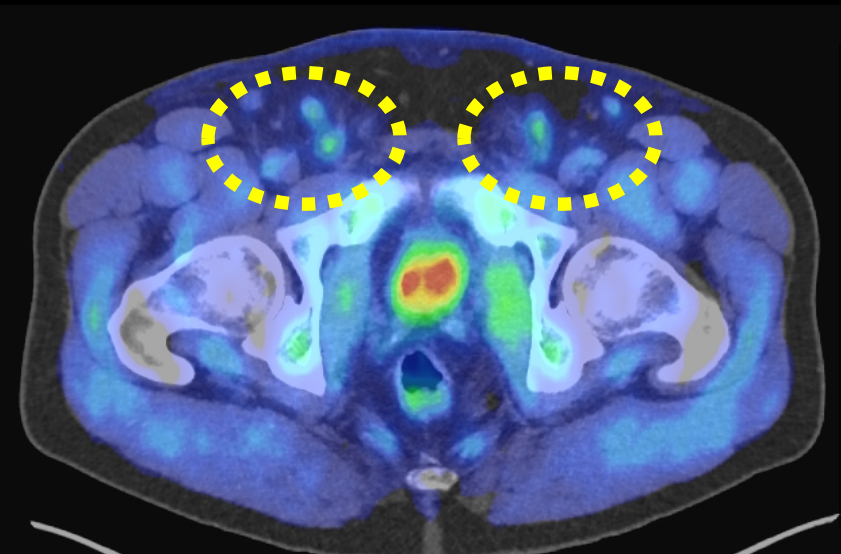
### IF < 1 CM IN SIZE

- ▶ *NODES TYPICAL FOR PROSTATE CANCER SPREAD*
- ▶ *VISUALLY NOT >> BLOOD POOL & NOT APPROACHING BONE MARROW*
- ✗ *SUSPICIOUS FOR CANCER RECURRENCE*

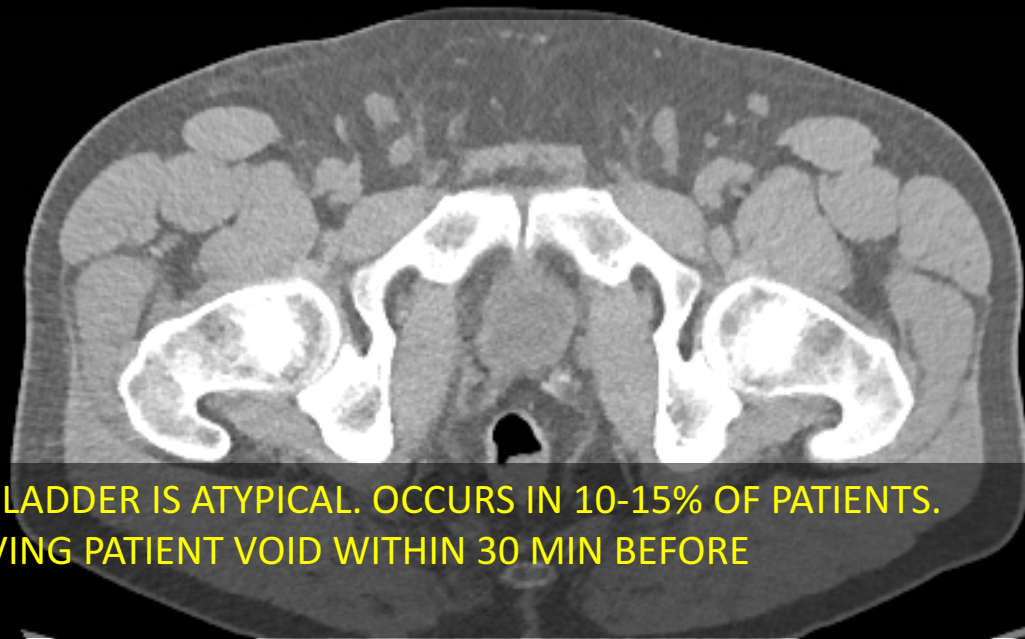


# BENIGN NODAL UPTAKE

## ATYPICAL SYMMETRIC LYMPH NODE AVIDITY



- ▶ *ATYPICAL LN SITES FOR RECURRENCE*
  - INGUINAL*
  - DISTAL EXTERNAL ILIAC*
  - HILAR*
  - AXILLARY*
- ▶ *MILD TO MODERATE SYMMETRIC UPTAKE*
- ✗ *NOT SUSPICIOUS FOR CANCER RECURRENCE*



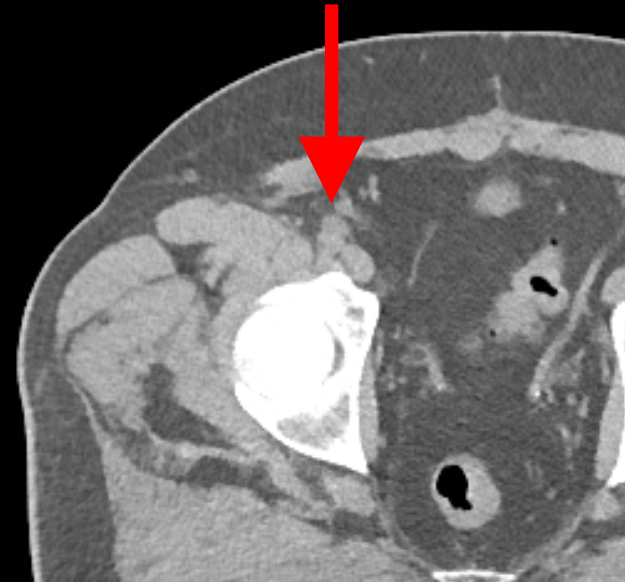
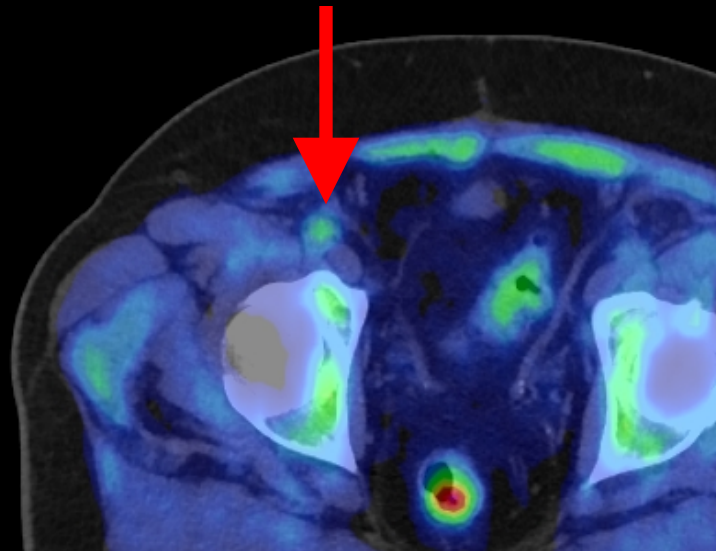
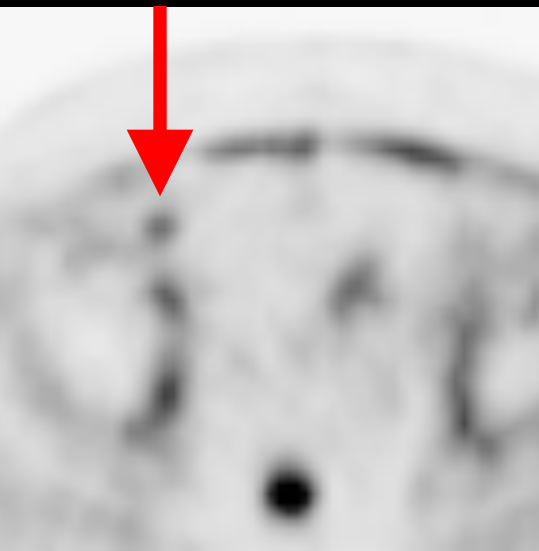
MODERATE PHYSIOLOGIC FACBC ACTIVITY IN BLADDER IS ATYPICAL. OCCURS IN 10-15% OF PATIENTS. MAY THEORETICALLY BE REDUCED BY NOT HAVING PATIENT VOID WITHIN 30 MIN BEFORE ADMINISTERING RADIOTRACER.

# SUSPICIOUS NODAL UPTAKE

## ISOLATED ASYMMETRIC LYMPH NODE AVIDITY

65 YO WITH PRIOR PROSTATECTOMY AND BCR

- ▶ *ATYPICAL NODAL SITE FOR RECURRENCE: DISTAL EXTERNAL ILIAC*
- ▶ *ASYMMETRIC UPTAKE (INTENSITY DEPENDENT UPON SIZE)*
- ▶ *CAUSES OF FALSE POSITIVITY EXCLUDED: RECENT PROCEDURE OR IPSILATERAL HARDWARE/GRAFTS*
- ✓ *MODERATELY SUSPICIOUS FOR CANCER RECURRENCE*



# INTERPRETATION CRITERIA

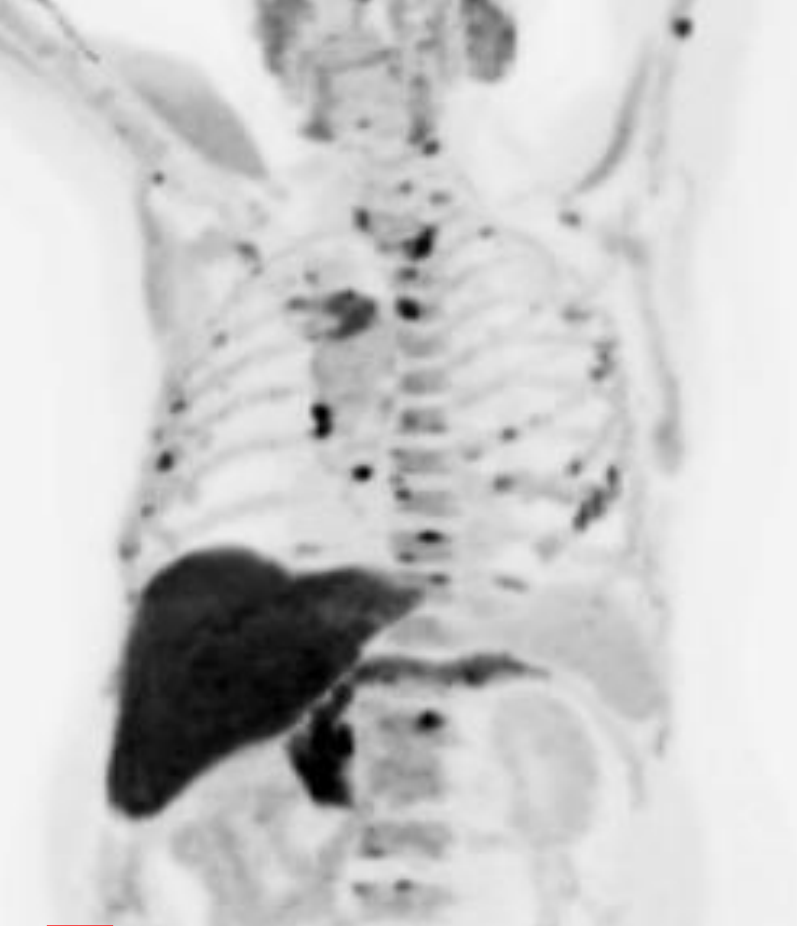
## BONE

Focal uptake CLEARLY visualized on Maximum Intensity Projection (MIP) or PET-only images, can be considered suspicious for cancer.

- o Lytic metastases typically show intense FACBC avidity
- o Mixed bony lesions most commonly show moderate uptake
- o Dense sclerotic abnormality on CT without uptake does not exclude metastasis

☞ Alternative imaging should be considered



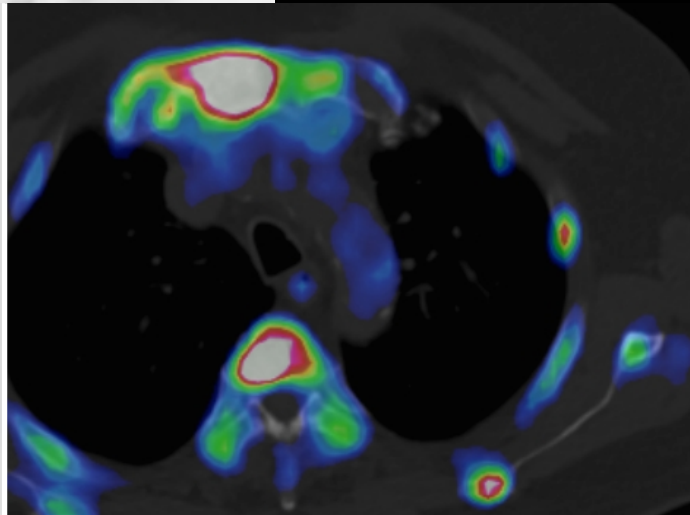
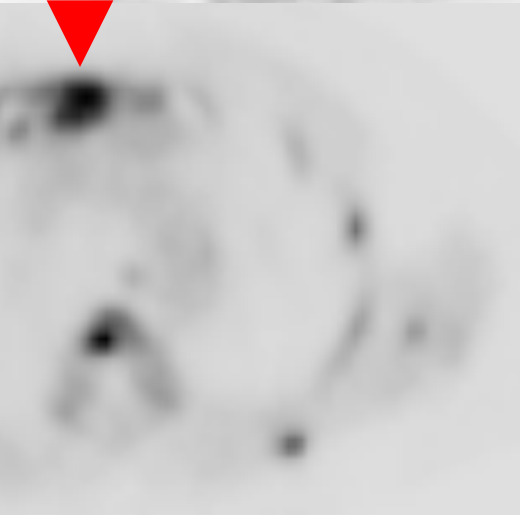


## BONE UPTAKE

### SUSPICIOUS LESIONS

#### 73 YO S/P PROSTATECTOMY WITH BCR

- ▶ FOCAL UPTAKE CLEARLY VISUALIZED ON MIP OR PET-ONLY IMAGES SUSPICIOUS
- ▶ LYTIC LESIONS MOST INTENSE
- ▶ MIXED LESIONS MODERATELY INTENSE
- ▶ DENSE SCLEROTIC METS MAY BE FALSELY NEGATIVE



# INDETERMINATE SCLEROTIC BONE LESION

58 YO S/P PROSTATECTOMY WITH BCR

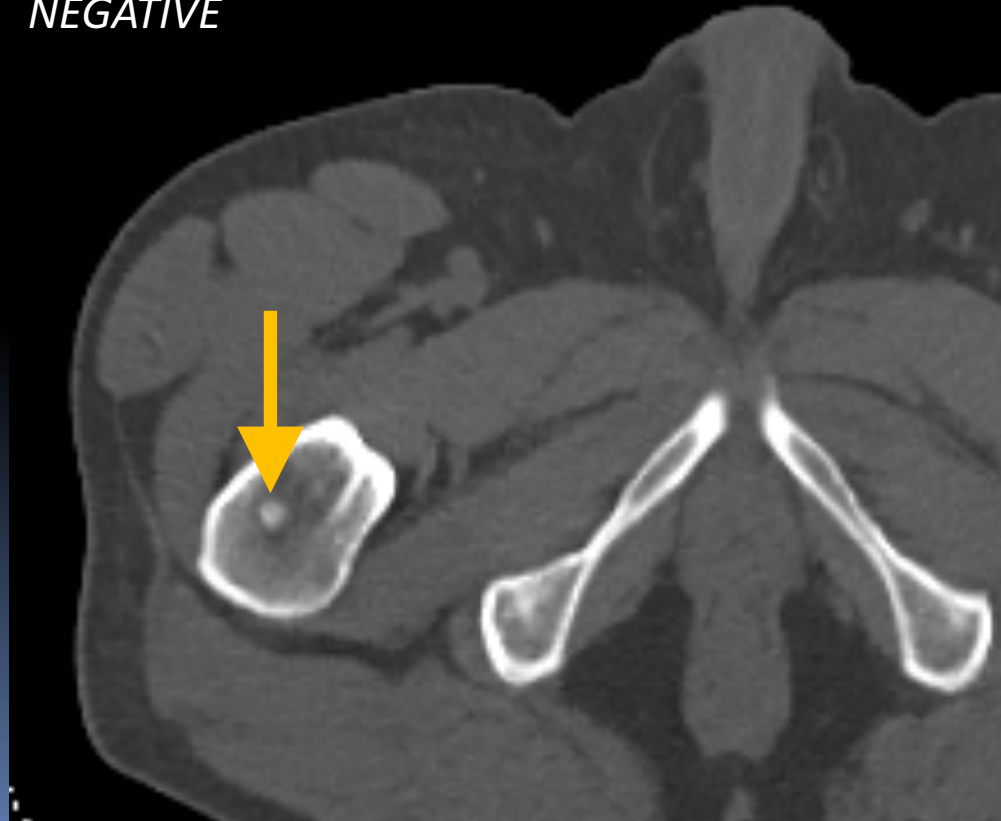
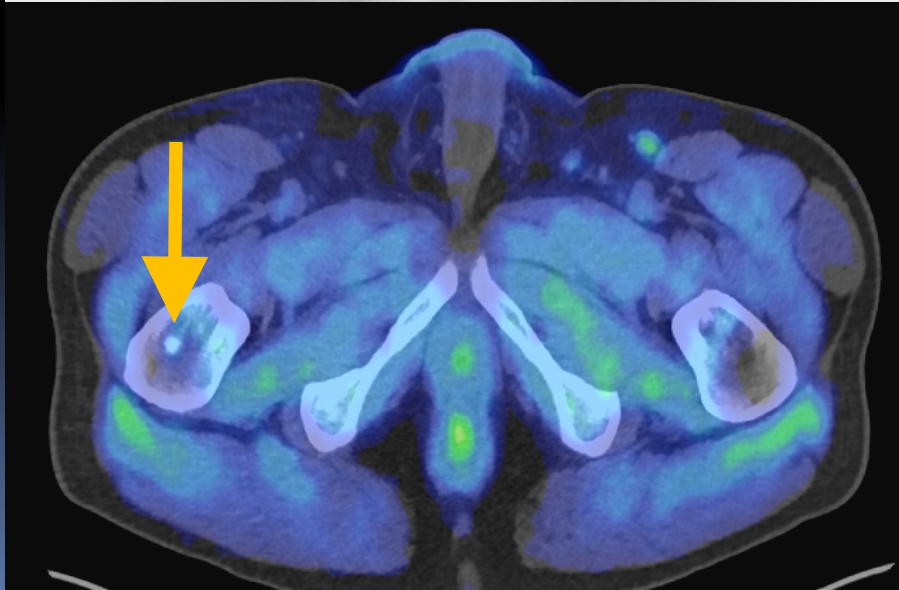
- 9 MM SCLEROTIC LESION IN RIGHT FEMUR
- REMAINDER OF EXAM NEGATIVE



# INDETERMINATE SCLEROTIC BONE LESION

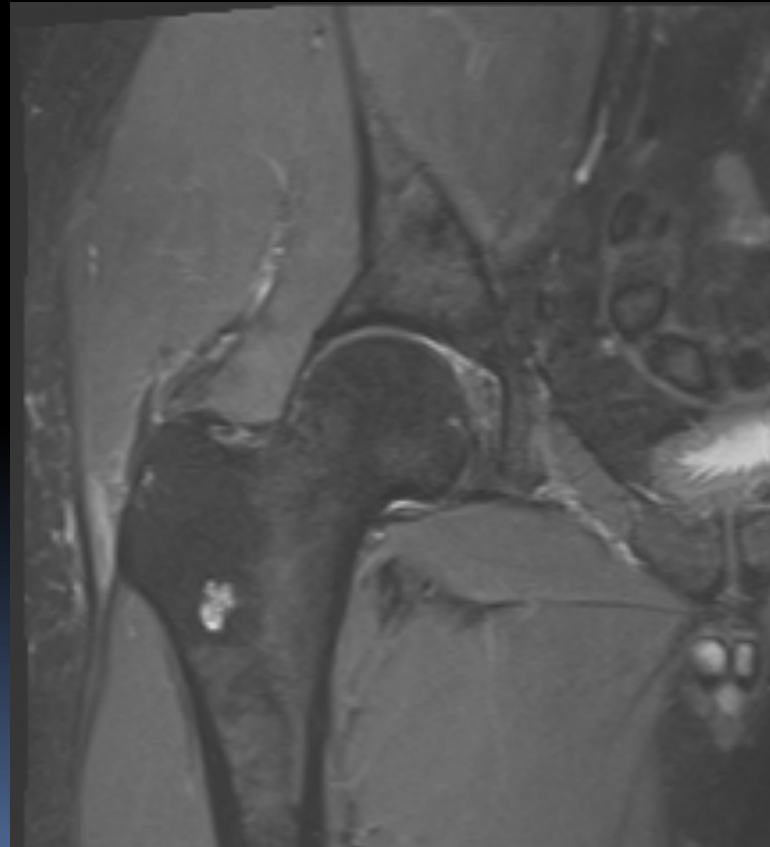
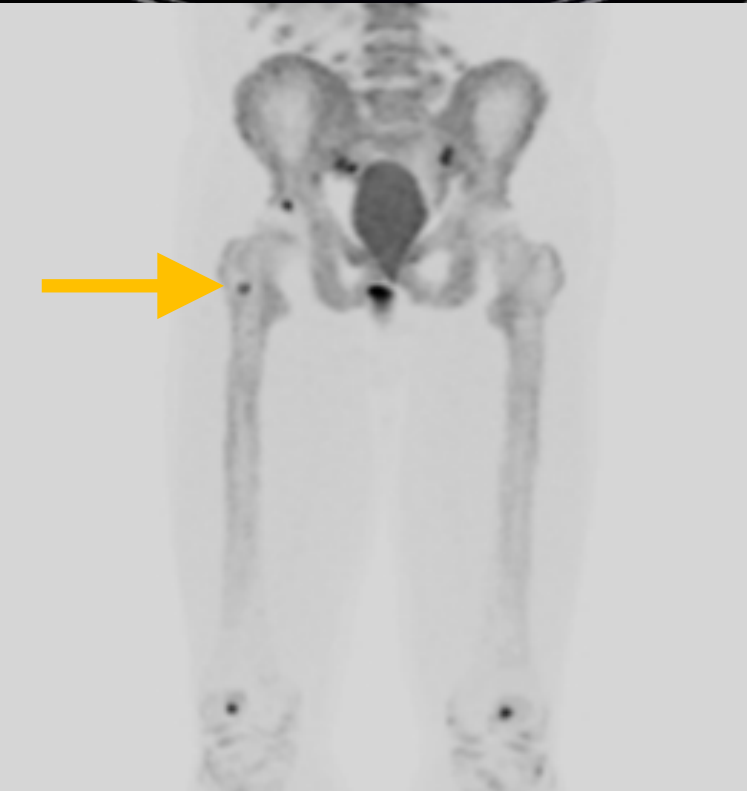
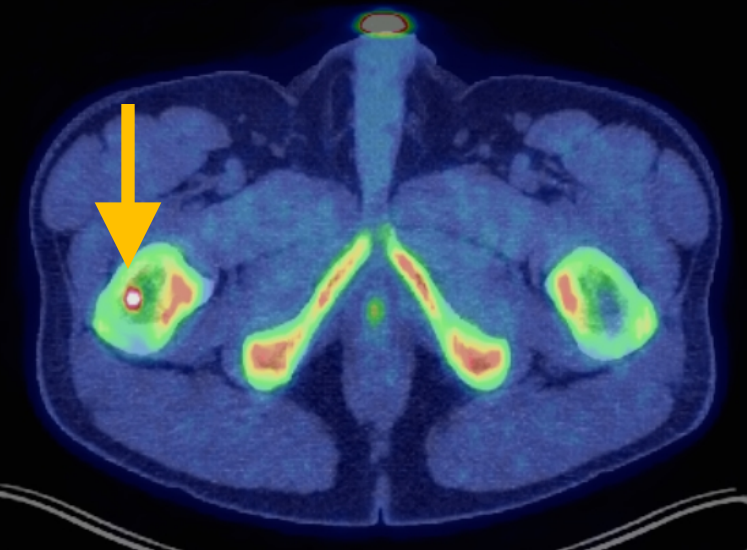


- ▶ FOCAL UPTAKE CLEARLY VISUALIZED ON MIP OR PET-ONLY IMAGES SUSPICIOUS
- ▶ LYTIC LESIONS MOST INTENSE
- ▶ MIXED LESIONS MODERATELY INTENSE
- ▶ DENSE SCLEROTIC METS MAY BE FALSELY NEGATIVE



# INDETERMINATE SCLEROTIC BONE LESION

- ▶ DENSE SCLEROTIC ABNORMALITY ON CT WITHOUT UPTAKE DOES NOT EXCLUDE METASTASIS
- ☞ ALTERNATIVE IMAGING SHOULD BE CONSIDERED



ADDITIONAL FOCI OF NAF AVIDITY SEEN ON MIP CORRESPONDED TO BENIGN DEGENERATIVE ACTIVITY.

# NORMAL VARIANTS, ARTIFACTS, AND NONMALIGNANT PROCESSES

## POTENTIAL SOURCES OF FALSE POSITIVES

$^{18}\text{F}$ -FACBC has elevated uptake in numerous malignancies:

- Breast cancer
- Lung carcinoma
- Malignant and premalignant colonic neoplasia
- Squamous cell carcinoma of scalp
- Follicular lymphoma
- Multiple myeloma
- Primary and metastatic brain tumors

$^{18}\text{F}$ -FACBC also shows elevated uptake in benign tumors:

- Pituitary adenoma, meningioma, osteoid osteoma, and adrenal adenoma have been described.

# NORMAL VARIANTS, ARTIFACTS, AND NONMALIGNANT PROCESSES

## POTENTIAL SOURCES OF FALSE POSITIVES

$^{18}\text{F}$ -FACBC also shows elevated uptake in inflammation:

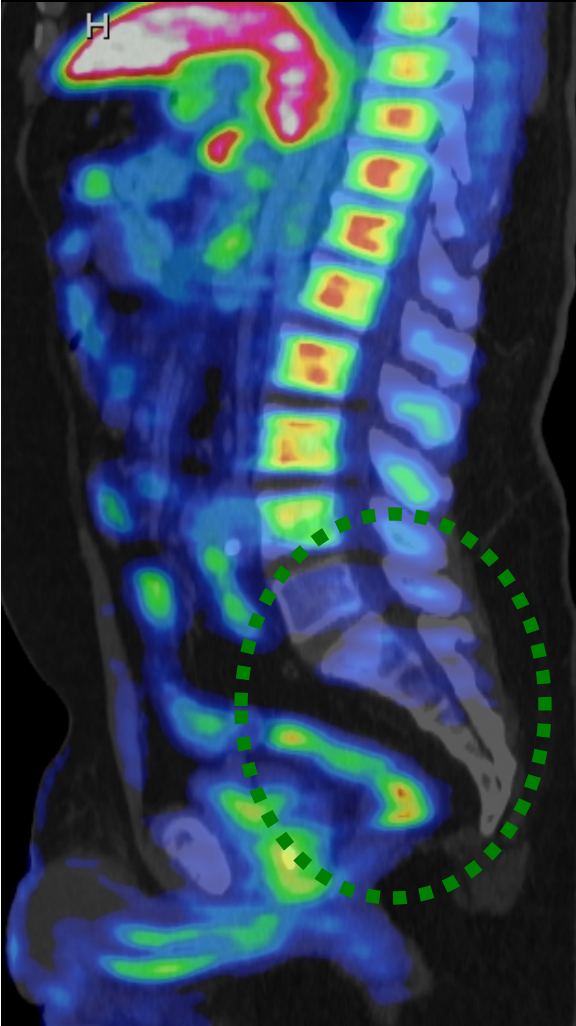
- Mild to moderate linear esophageal uptake in >50% of patients
- Other acute and chronic inflammation and infection:
  - Hilar, axillary, and inguinal lymph nodes
  - Inflammatory skin lesions, ringworm infection, and muscle inflammation
  - Mild uptake in degenerative facet disease  
→ intensity generally < than  $^{18}\text{F}$ -FDG.



# NORMAL VARIANTS, ARTIFACTS, AND NONMALIGNANT PROCESSES

XRT CHANGES TO MARROW UPTAKE OF FACBC

59 YO S/P XRT FOR CAP WITH BCR



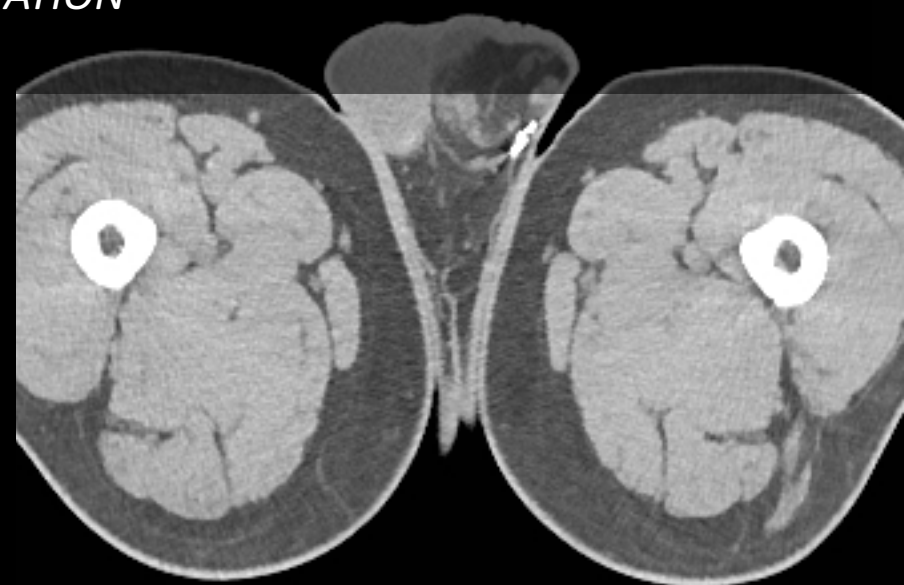
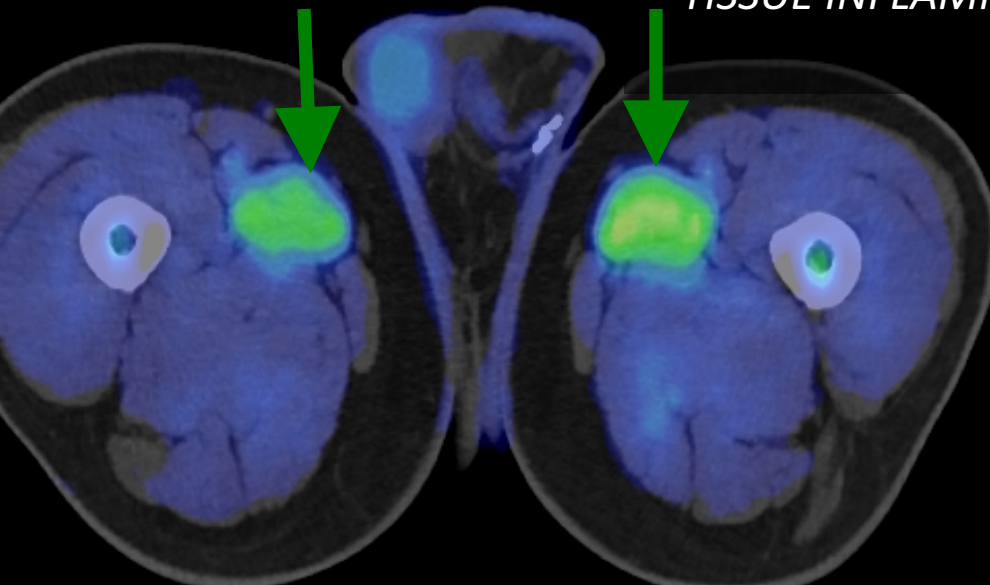
# NORMAL VARIANTS, ARTIFACTS, AND NONMALIGNANT PROCESSES

BENIGN INCREASED MUSCLE UPTAKE OF FACBC SECONDARY TO EXERCISE

59 YO S/P PROSTATECTOMY FOR CAP WITH BCR

▶ MILD DIFFUSE HOMOGENEOUS MUSCLE UPTAKE IS NORMAL & INCREASES WITH TIME AFTER INJECTION

▶ MODERATE TO INTENSE UPTAKE IS OFTEN SEEN IN SOFT TISSUE INFLAMMATION



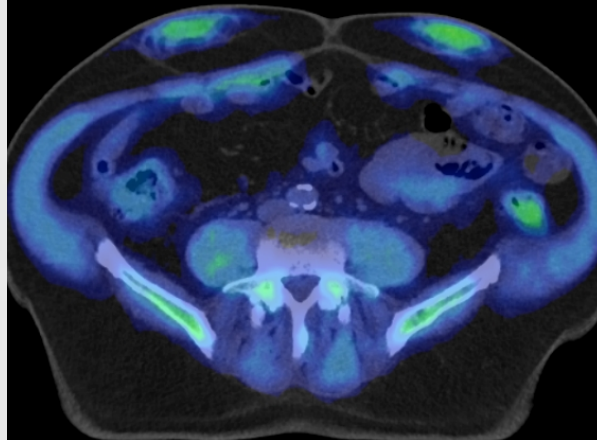


# NORMAL VARIANTS, ARTIFACTS, AND NONMALIGNANT PROCESSES

FACBC UPTAKE SECONDARY TO SOFT TISSUE INFLAMMATION RELATED TO INSULIN INJECTIONS

55 YO S/P PROSTATECTOMY FOR CAP WITH BCR

► MODERATE TO INTENSE UPTAKE IS OFTEN SEEN IN SOFT TISSUE INFLAMMATION

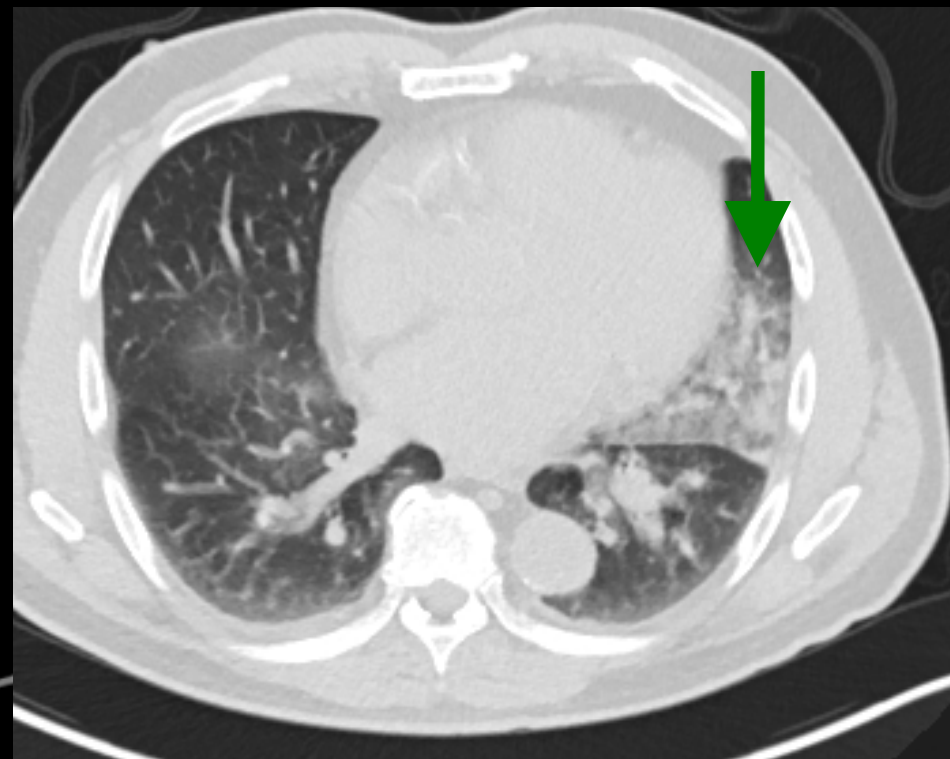
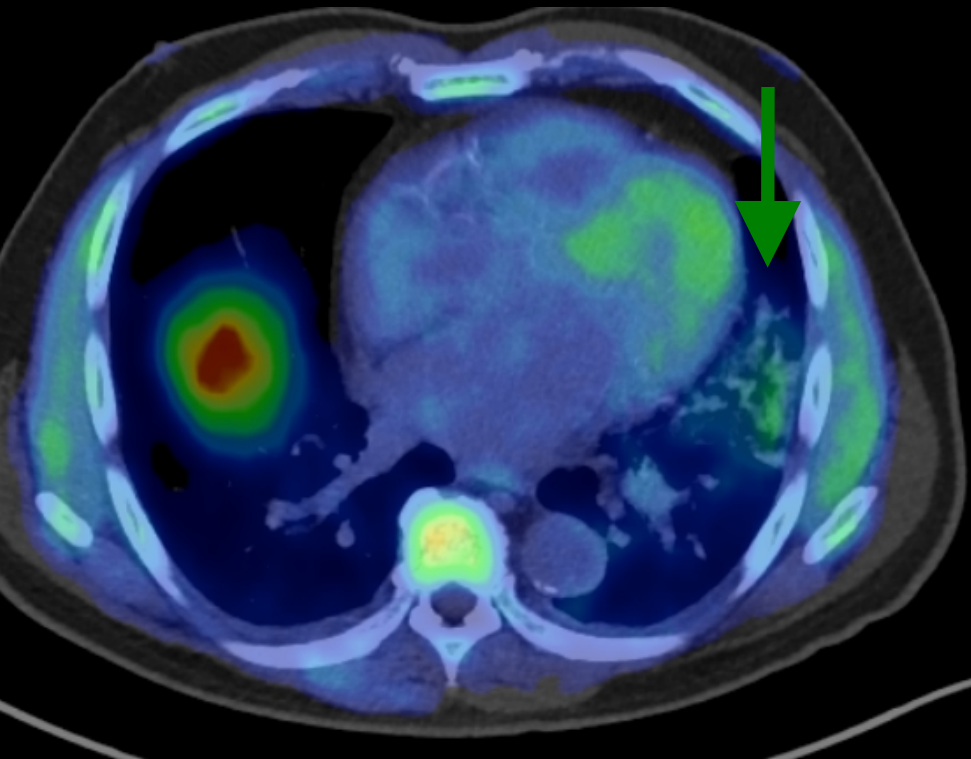


# NORMAL VARIANTS, ARTIFACTS, AND NONMALIGNANT PROCESSES

FACBC UPTAKE SECONDARY TO PNEUMONIA

62 YO S/P PROSTATECTOMY FOR CAP WITH BCR

*MODERATE TO INTENSE UPTAKE IS OFTEN SEEN IN INFLAMMATION*

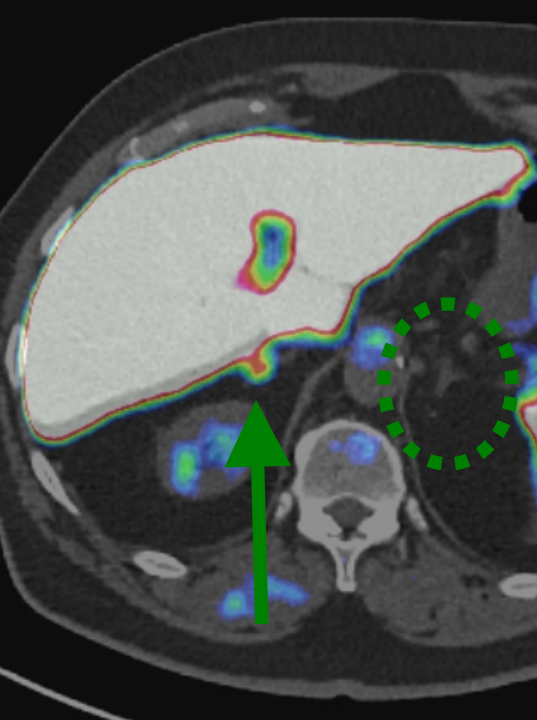
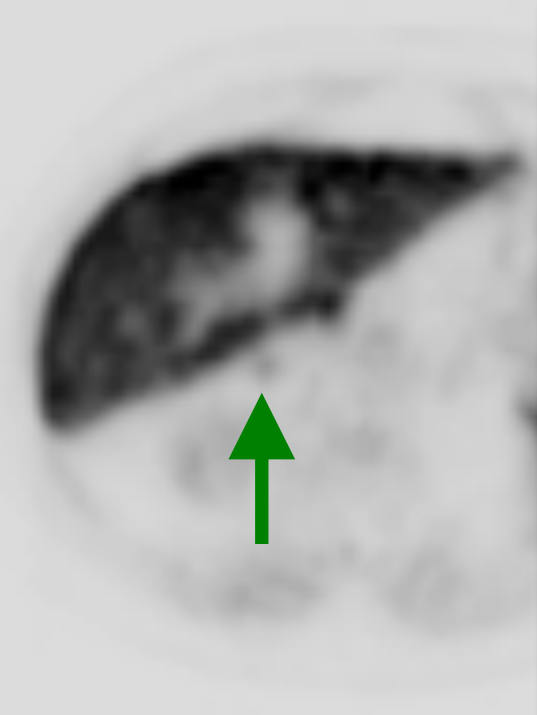


## NORMAL VARIANTS, ARTIFACTS, AND NONMALIGNANT PROCESSES

BENIGN INCREASED UPTAKE OF FACBC RELATED TO ADRENAL ADENOMA

**62 YO S/P PROSTATECTOMY FOR CAP WITH BCR**

- 18F-FACBC PET SHOWS SMALL FOCUS OF MILD INCREASED RADIOTRACER JUST POSTERIOR TO LIVER (ARROWHEAD).
- AXIAL CT IMAGE SHOWS AVIDITY LOCALIZES TO ADRENAL NODULE WITH ATTENUATION AND LONG TERM STABILITY CONSISTENT WITH BENIGN ADENOMA
- CONTRALATERAL NORMAL ADRENAL WITHOUT UPTAKE

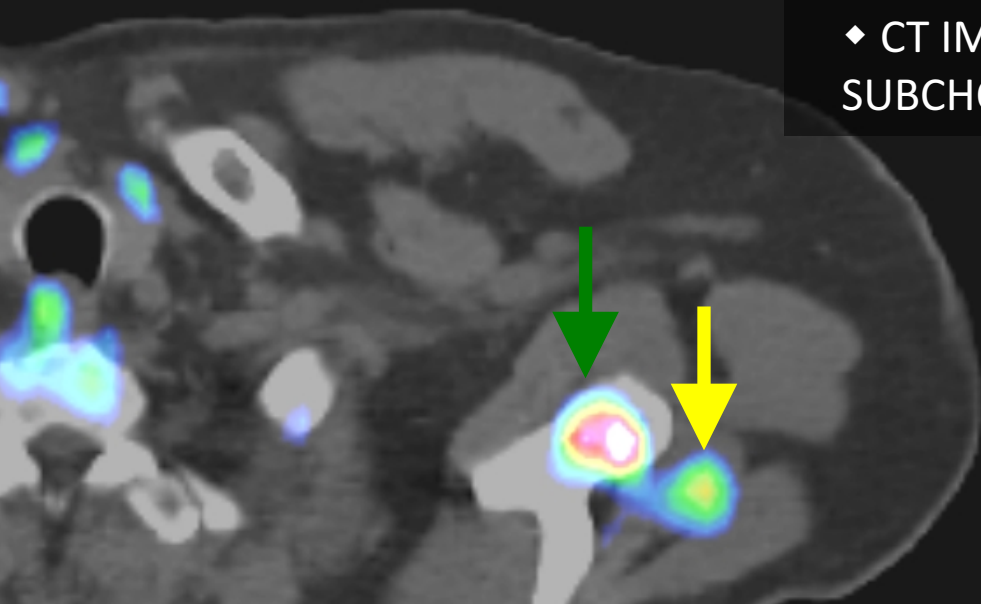
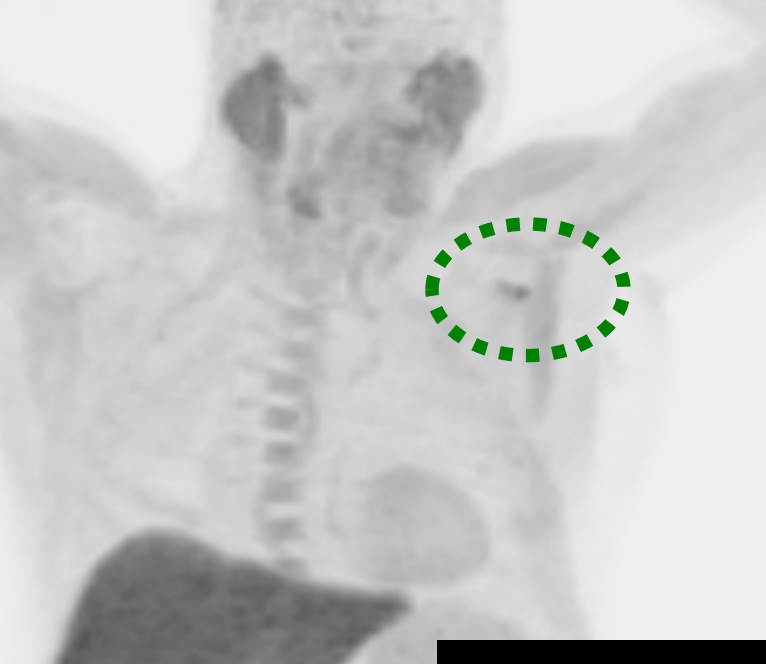


## NORMAL VARIANTS, ARTIFACTS, AND NONMALIGNANT PROCESSES

INTENSE FACBC UPTAKE SECONDARY TO BENIGN BONE LESION

69 YO WITH PRIMARY CAP

- ▶ FOCAL UPTAKE CLEARLY VISUALIZED ON MIP OR PET-ONLY IMAGES SUSPICIOUS
- ◆ CT IMAGE SHOWS AVIDITY LOCALIZES TO SUBCHONDRAL GLENOID LESION

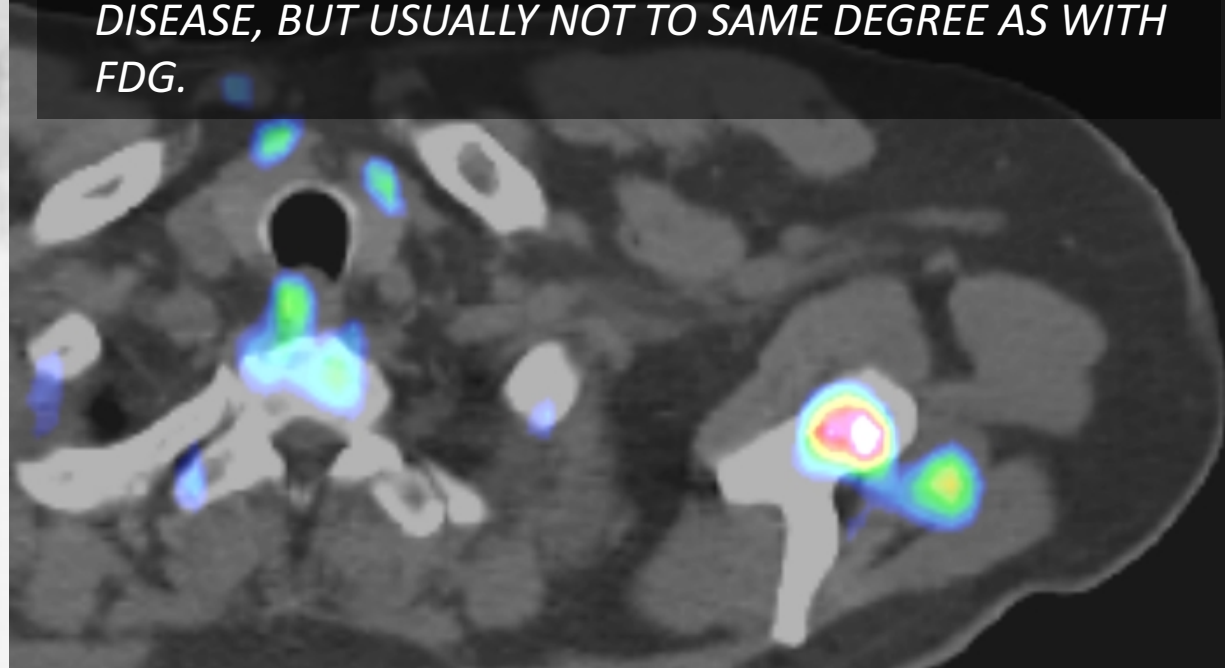


INCIDENTAL FOCUS OF UPTAKE ON AXIAL FUSED IMAGE (ARROWHEAD) RELATED TO ROTATOR CUFF INJURY RELATED INFLAMMATORY FACBC AVIDITY.

## NORMAL VARIANTS, ARTIFACTS, AND NONMALIGNANT PROCESSES

INTENSE FACBC UPTAKE SECONDARY TO BENIGN BONE LESION

- ◆ MDP BONE SCAN SHOWS OSTEOBLASTIC ACTIVITY AT SITE OF LESION IN ADDITION TO OTHER AREAS OF DEGENERATIVE UPTAKE
- ◆ NO FEATURES OF BONY METASTASES
- ▶ *MILD FOCAL UPTAKE MAY BE SEEN IN DEGENERATIVE DISEASE, BUT USUALLY NOT TO SAME DEGREE AS WITH FDG.*

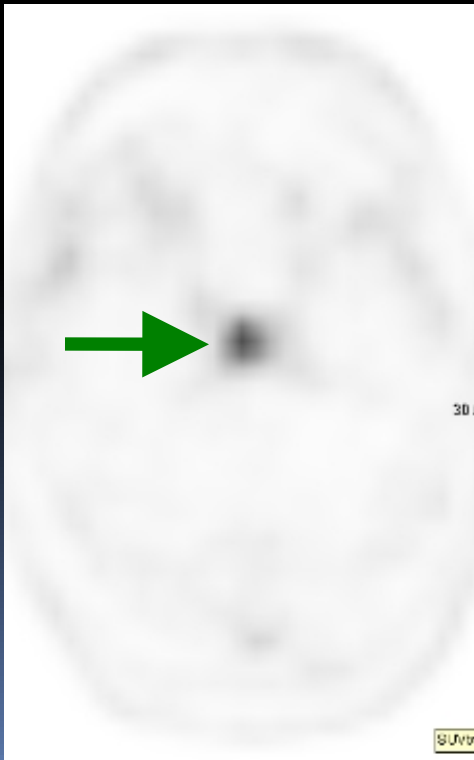
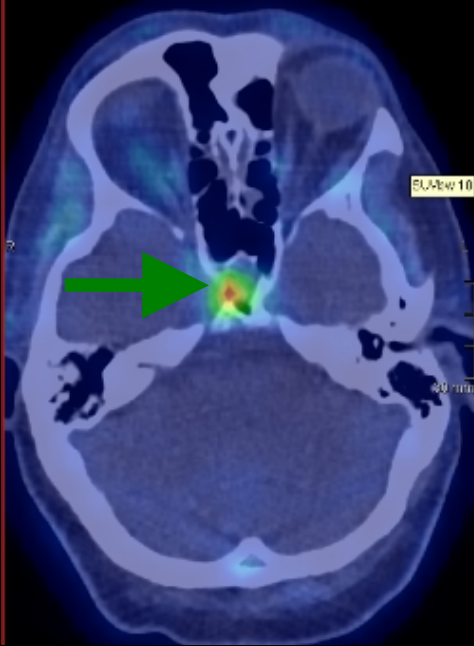


# NORMAL VARIANTS, ARTIFACTS, AND NONMALIGNANT PROCESSES

BENIGN FOCAL AVIDITY FROM NORMAL PITUITARY GLAND UPTAKE

59 YO S/P XRT FOR CAP WITH BCR

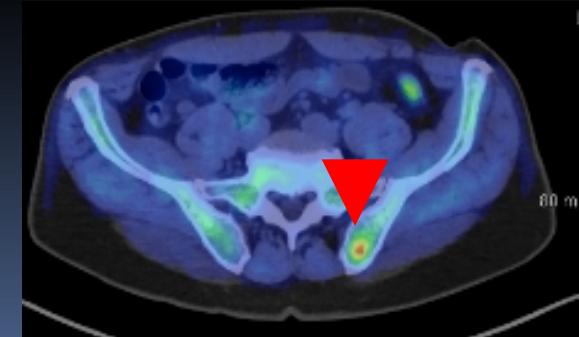
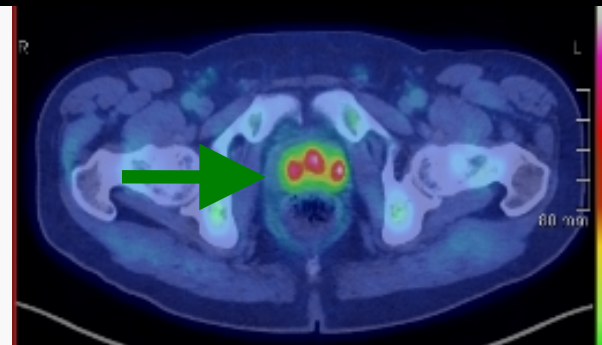
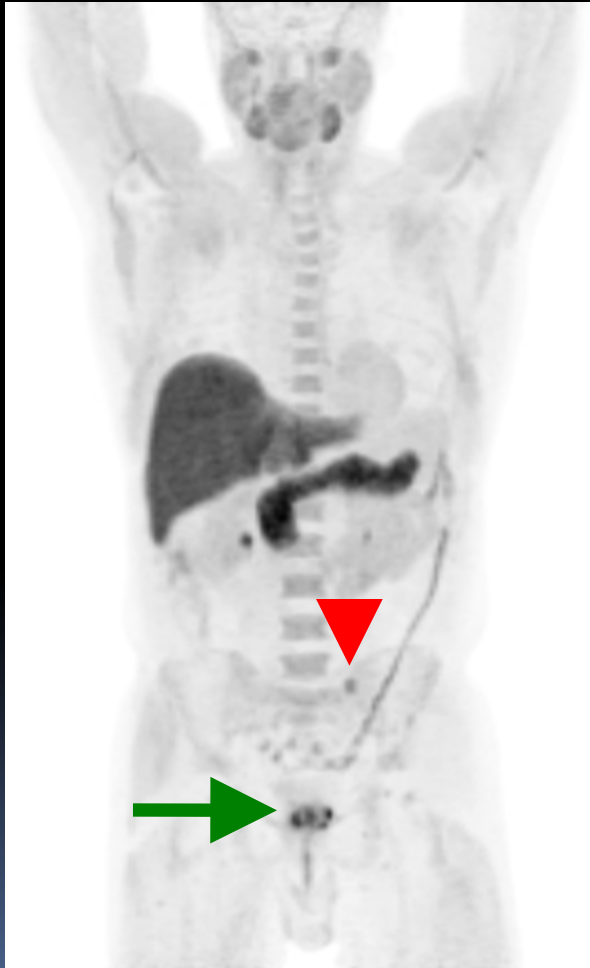
▶ MODERATE PITUITARY GLAND UPTAKE IS PART OF THE NORMAL FACBC BIODISTRIBUTION



# FUTURE DIRECTIONS

## STAGING PRIMARY DZ

59 YO S/P WITH HIGH GRADE PROSTATE CANCER ON MULTIPLE BIOPSY SPECIMENS



# CONCLUSION

- ❖ In May of 2016, Fluciclovine F-18 was first FDA approved F-18 PET imaging agent for use in patients with suspected recurrent prostate cancer.
- ❖ Shows better accuracy than C-11 choline and In-111 Prostascint, only other radiotracers currently FDA approved for imaging recurrent prostate cancer
- ❖ Detection rate increases with increasing PSA
- ❖ Familiarization with novel imaging protocol and proper interpretation criteria key to success



# REFERENCES

- Miller M. Axumin Fluciclovine F18 Injection Image Acquisition Training. Blue Earth Diagnostics Inc. July 2016.
- Axumin (fluciclovine F18) Imaging & Interpretation Manual. Blue Earth Diagnostics Inc. Version 1.0; July 2016.
- Furlong L. NDA 208054 Axumin/fluciclovine F18. Application Number: 208054Orig1s000. Center for Drug Evaluation and Research. May 25, 2016.
- Schuster DM, Nanni C, Fanti S, et al. Anti-1-amino-3-18F-fluorocyclobutane-1-carboxylic acid: Physiologic uptake patterns, incidental findings, and variants that may simulate disease. *JNM* 2014;55:1986-92.
- Schuster DM, Nieh PT, Jani AB, et al. Anti-3-[(18)F]FACBC positron emission tomography-computerized tomography and (111)In-capromab pendetide single photon emission computerized tomography-computerized tomography for recurrent prostate carcinoma: results of a prospective clinical trial. *J Urol*. 2014 May;191(5):1446-53
- Nanni C, Schiavina R, Boschi S, et al. Comparison of 18F-FACBC and 11C-choline PET/CT in patients with radically treated prostate cancer and biochemical relapse: preliminary results. *Eur J Nucl Med Mol Imaging* 2013;40:S11-7.
- Turkbey B, Mena E, Shih J, et al. Localized prostate cancer detection with 18F FACBC PET/CT: Comparison with MR imaging and histopathologic analysis. *Radiology* 2013;270(3):849-856.
- Schuster DM, Taleghani PA, Nieh PT, et al. Characterization of primary prostate carcinoma by anti-1-amino-2-[(18)f]-fluorocyclobutane-1-carboxylic acid (anti-3-[(18)F] FACBC) uptake. *Am J Nucl Med Mol Imaging* 2013;3(1):85-96.
- Akin-Akintayo OO, Jani AB, Odewole O, et al. Change in salvage radiotherapy management based on guidance with FACBC (Fluciclovine) PET/CT in postprostatectomy recurrent prostate cancer. *Clin Nucl Med* 2016;00(00):1-7.
- Schreibmann E, Schuster DM, Rossi PJ, et al. Image guided planning for prostate carcinomas with incorporation of anti-3-[18F]FACBC (Fluciclovine) positron emission tomography: Workflow and initial findings from a randomized trial. *Int J Radiation Oncol Biol Phys* 2016;96(1):206-13.
- Jadvar H. Positron emission tomography in imaging evaluation of staging, restaging, treatment response, and prognosis in prostate cancer. *Abdom Radiol* 2016;41:889-898.
- Vargas HA, Wassberg C, Fox JJ, et al. Bone metastases in castration-resistant prostate cancer: associations between morphologic CT patterns, glycolytic activity, and androgen receptor expression on PET and overall survival. *Radiology*. 2014 Apr;271(1):220-9
- Sah B-R, Burger IA, Schibli R, et al. Dosimetry and first clinical evaluation of the new 18F-radiolabeled bombesin analogue BAY 864367 in patients with prostate cancer. *J Nucl Med*. 2015;56:372–378

# CONTACT

Dr. Kevin P Banks

Department of Radiology and Nuclear Medicine

San Antonio Military Medical Center

Assistant Professor, Uniformed Services University

[kevin.p.banks.civ@mail.mil](mailto:kevin.p.banks.civ@mail.mil)