ABNM INFO & UPDATES

PET FOR MYELOMA

Twyla Bartel, DO, MBA, FACNM, FSNMMI

ABNM INFO & UPDATES

DISCLOSURES

ABNM Director

1st CODE: 2678

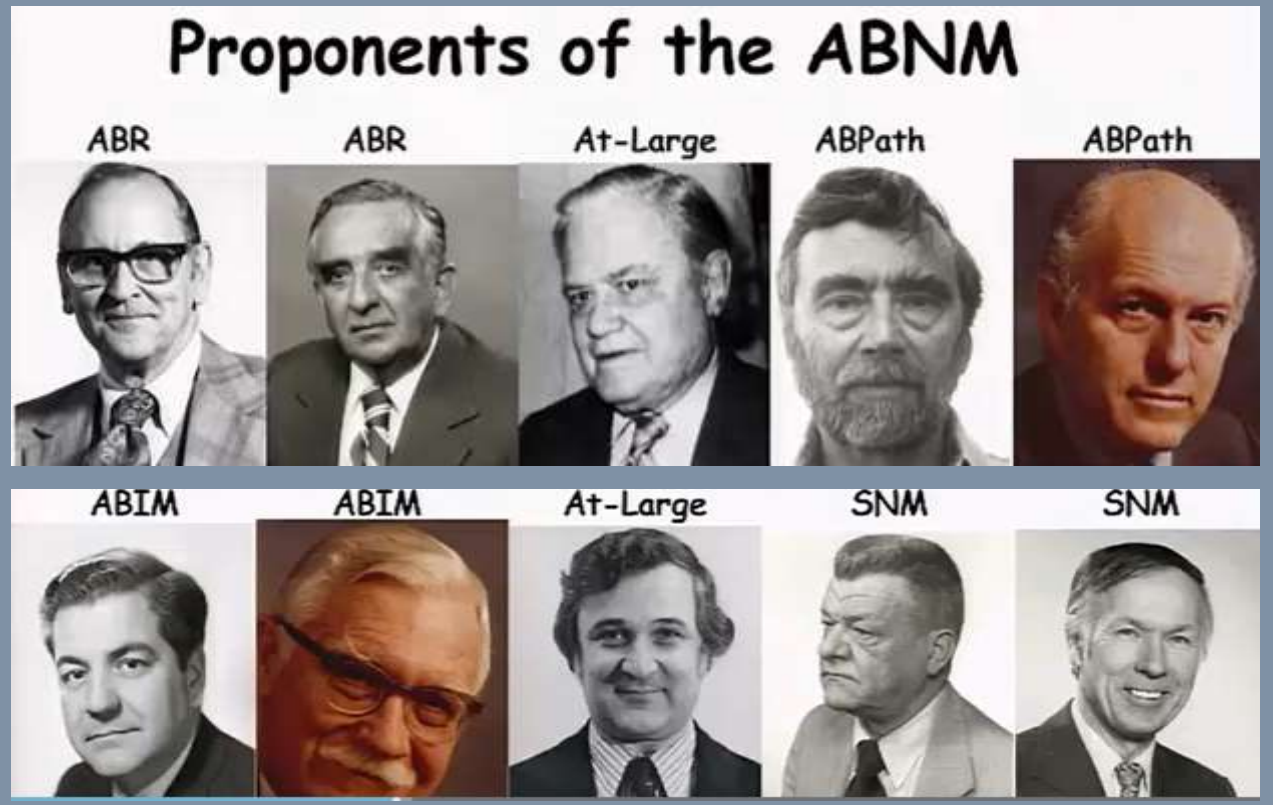
ABNM INFO - HISTORY

- ABMS criteria for new specialty at the time of initial NM board formation:
  - Based on major new concepts in medical science & represent a distinct & well-defined field of medical practice
  - A single standard for preparation for & evaluation of expertise in each specialty must be recognized by only one medical specialty board for each specialty
  - Training needed by applicant must be distinct from other ABMS member boards so that it is not included in established training programs leading to certification by these other boards
  - Evidence that new board will establish defined standards for training & a system for evaluation of educational program quality
  - Demonstrates support from the relevant field of medical practice & broad professional support

ABNM INFO - HISTORY

- June 6, 1967 – ABR suggested SNM undertake the establishment of a certifying board in NM
- First conjoint board established under provisions of “Essentials for Approval of Examining Boards in Medical Specialties” of the American Board of Medical Specialties (ABMS)
- Conjoint board sponsored by American Boards of Pathology (ABPath)/Internal Medicine (ABIM)/Radiology (ABR) & Society of Nuclear Medicine (SNM)

ABNM INFO - HISTORY



Top row (L to R): Frederick J Bonte, MD; E Richard King, MD; Paul Harper, MD; Ralph M Kniseley, MD, W Newlon Tauxe, MD

Bottom Row (L to R): Henry N Wagner Jr MD; Joseph S Ross MD; David Kuhl, MD; Merrill A Bender MD (CHAIR); Richard Peterson, MD

ABNM INFO - HISTORY

- By June 28, 1971, approved based on recommendation of Liaison Committee for Specialty Boards, ABMS, & Council on Medical Education of the American Medical Association (AMA)
- July 28, 1971 - formally incorporated in Delaware (quicker to incorporate here)
- October 23, 1971 - first organizational meeting
- First ABNM office in New York
- By 1985 - Primary certifying board

ABNM INFO - HISTORY

1st President

ABNM INFO - HISTORY

- The ABNM is an independent, non-profit organization, one of 24 medical specialty boards that make up the ABMS.
- Established to set educational standards & evaluate the competence of physicians in nuclear medicine.
- Sets the requirements for certification & maintenance of certification & for issuing certificates to those who fulfill its requirements

ABNM INFO - HISTORY

- 1972 - issued its first certificates
- 1992 - recertification every 10 yrs introduced
- 2007 - recertification replaced by ongoing process called maintenance of certification (MOC)
- 2017 - pilot of CertLink™ introduced as an alternate to the MOC exam

ABNM INFO - MOC

Between 1972 & 2023, the Board has certified 6082 individuals.

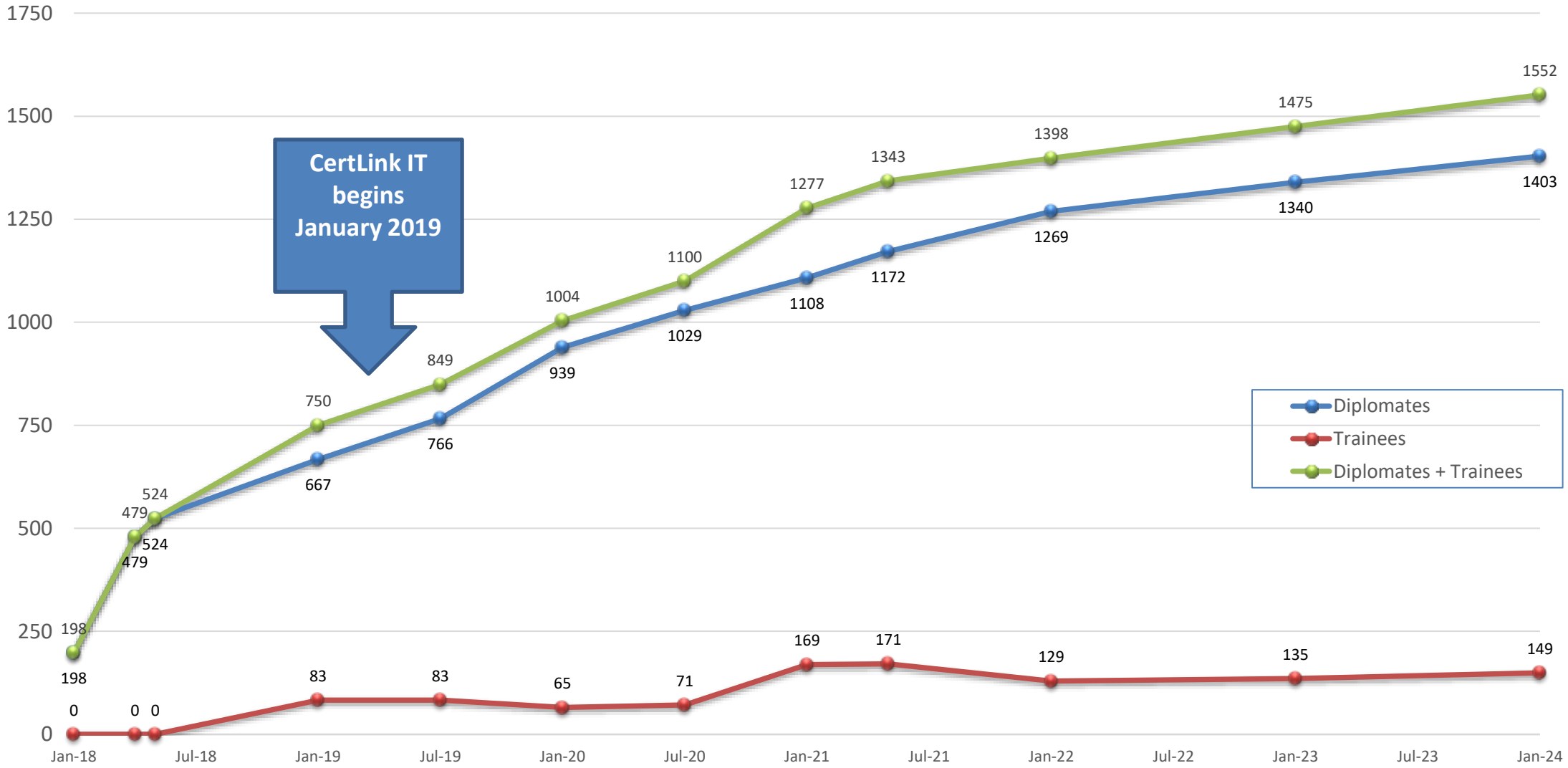
	Total Certificate Holders	Active Diplomates	Deceased	Retired	Percentage of Active Participation
Lifetime	3881	1646	1052	1183	2%
Time-Limited	2201	2138	19	42	64%
Total	6082	3784	1071	1225	37%

ABNM CertLink® Participation

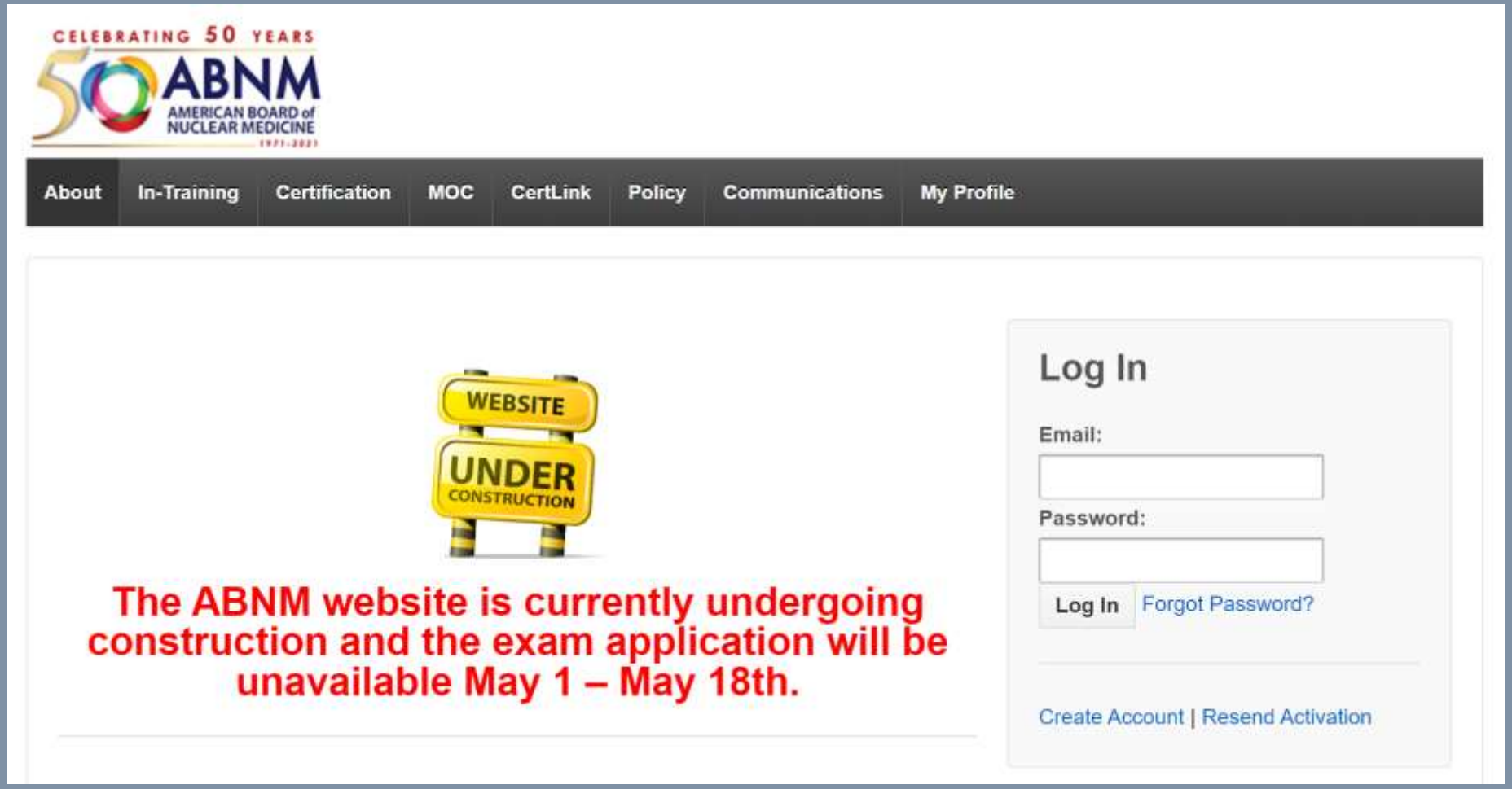
Certificate Expiration Year	CertLink Participants
Lifetime	53
2024	152
2025	137
2026	119
2027	89
2028	113
2029	120
2030	139
2031	132
2032	170
2033	174
2034	3
2035	2
Total CertLink Participants	**1403**

CertLink IT Enrollment Year	CertLink IT Participants
2022	13
2023	38
2024	98
Total CertLink IT Participants	**149**

CertLink and CertLink IT Participants



ABNM UPDATES - WEBSITE



ABNM UPDATES – TRAINEES

- Existing policy - Diagnostic Radiology residents who have completed a minimum of 16 mo of NM training in an institution with an ACGME-accredited NM or Nuclear Radiology program (either preceding or concurrent with their DR training) & who have fulfilled all ABNM training requirements, may take the ABNM certification exam in the final year of their ACGME-accredited DR training.
- New policy - DR in an institution with an ACGME-accredited NM or Nuclear Radiology program may take the ABNM certification exam in the final year of their pathway if: 1) they have completed 16 mo of NM training & have fulfilled all ABNM training requirements & 2) they have passed the ABR core exam.
- Trainees with prior foreign DR training participating in the DR alternate pathway in an institution with an ACGME-accredited NM or Nuclear Radiology program may take the ABNM certification exam in the final year of their pathway if: 1) they have completed 16 mo of NM training & have fulfilled all ABNM training requirements & 2) they have passed the ABR core exam.

ABNM UPDATES – RECERTIFICATION CYCLE

- For all ABNM diplomates, has been based on their initial certification year plus every 10 years.
- Beginning in 2025, the ABNM will be changing from a 10-year to a 5-year recertification cycle for all diplomates.
  - Demonstrate knowledge, judgment, and skills (Part 3) by taking an MOC exam every 5 yrs or by participating in a longitudinal assessment program (CertLink®).
  - New diplomates initially certified in 2025, will receive a certificate that expires on 12/31/2030.
  - Current diplomates with certificates that expire in 2025 will receive a new certificate that expires on 12/31/2030 if they meet the requirements for recertification.
- A diplomate whose certificate has expired can regain certification by passing the MOC exam within 5 years of the expiration date & being up to date with all MOC requirements.

ABNM UPDATES – MOC PART 2

As of January 2024:

Lifelong Learning and Self-Assessment:

The ABMS has replaced the 2015 Maintenance of Certification (MOC) with the 2024 Continuing Certification (CC) Standards

-Emphasizes Continuous Professional Development (CPD) & eliminates specific requirements for CME & SAM

-Emphasizes clinically-oriented, highly prevalent content

-CPD should increase a diplomates' knowledge, skills, & abilities that result in the provision of safe, high-quality care to patients

-Report completion with minimal administrative

ABNM UPDATES – MOC PART 2

- ~~A minimum 2-year average of 25 CME AMA category 1 credits per year which include a minimum average of 17.5 credits related to Nuclear Medicine, which in turn include a minimum average of 8 self-assessment credits (SAM) per year.~~
- A minimum 2-year average of 25 CME AMA category 1 credits per year of continuing professional development (CPD) activities that maintain, update, develop, & enhance knowledge, skills, & attitudes in response to the needs of patients
- Any combination of the below with a combined minimum 2-year average of 25 hrs
- Diplomates must maintain documentation of meeting the requirements which they may be required to submit prior to the start of a new recertification period.

Some examples of verifiable CPD include:
Courses, classes, seminars, and workshops
Distance or online learning
Attending conferences
Research
Writing articles or papers
Planning or running a course
Additional formal education

ABNM – MORE INFO

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Brief Review Multiple Myeloma Imaging From a Nuclear Medicine Perspective (Emphasis on FDG PET/CT)

Musculoskeletal Neoplasms

- Musculoskeletal neoplasms typically divided into bony/bone marrow (ex: multiple myeloma (MM)) & sarcomas (soft tissue versus bone sarcomas).
- This talk will focus on MM with FDG-PET/CT.
- FDG-PET/CT helps differentiate between malignant & benign musculoskeletal tumors & assists with staging, therapy planning, treatment response assessment, & monitoring for recurrence.

Multiple Myeloma (MM) Background

Lymphoma vs MM

- Both involve lymphocytes:
  - Lymphoma - B & T cells
  - MM - Plasma cells (terminally differentiated B lymphocytes); in the spectrum of plasma cell dyscrasias
- Lymphoma – usually begins in lymph node; “extranodal disease” as advanced disease
- MM – usually begins "extranodal" (bone marrow), then spread to bone as advanced disease

MM Background

- Increased production of one type of immunoglobulin (M-protein or paraprotein) by a single clone of cells ultimately displacing other hematopoietic cell lines and destructing the bone

- Occurs in myelomas/plasma cell dyscrasias, lymphoproliferative neoplasms, and occasionally chronic inflammatory or immune-mediated diseases

- May be composed of whole immunoglobulin molecules or subunits, light-chains (Bence Jones proteins), or heavy-chains

http://medical-dictionary.thefreedictionary.com

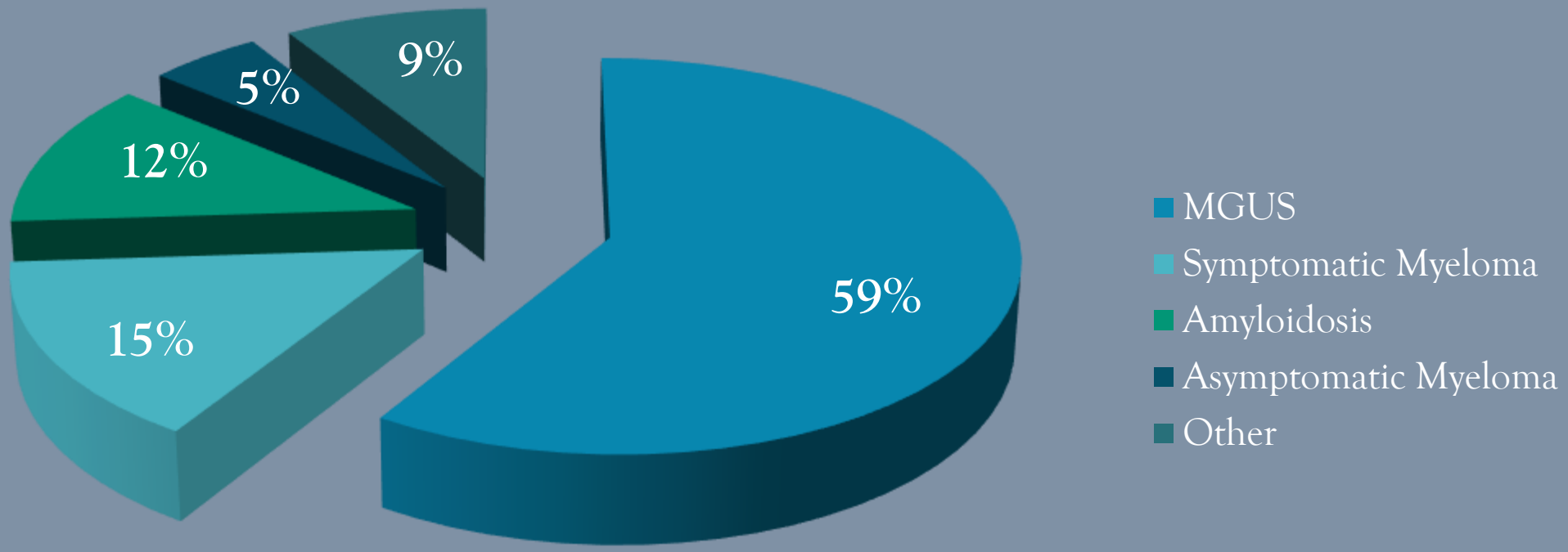
MM Background

2021 WHO Classification of Plasma Cell Neoplasm

- Monoclonal gammopathy of undetermined significance (MGUS)
- Multiple Myeloma
  - -Asymptomatic (Smoldering)
  - -Nonsecretory
  - -Plasma Cell Leukemia
- Plasmacytoma
  - -Solitary plasmacytoma of bone
  - -Extramedullary (extraosseous) plasmacytoma
- Immunoglobulin deposition Disease (Amyloidosis, Heavy and Light Chain Disease)
- Lymphoma
  - -Waldenstrom's Macroglobulinemia
  - -Castleman's Disease
- Osteosclerotic Myeloma (POEMS Syndrome)

MM Background

PLASMA CELL DYSCRASIAS



MM Background

Risk Factors Include:

- Precursor plasma cell abnormalities (ex: monoclonal gammopathy of unknown significance (MGUS) and plasmacytoma)
- Radiation exposure
- Petroleum product job exposure
- Family history/genetics
- Higher incidence if elderly, male, African American

MM Background

SEER Data

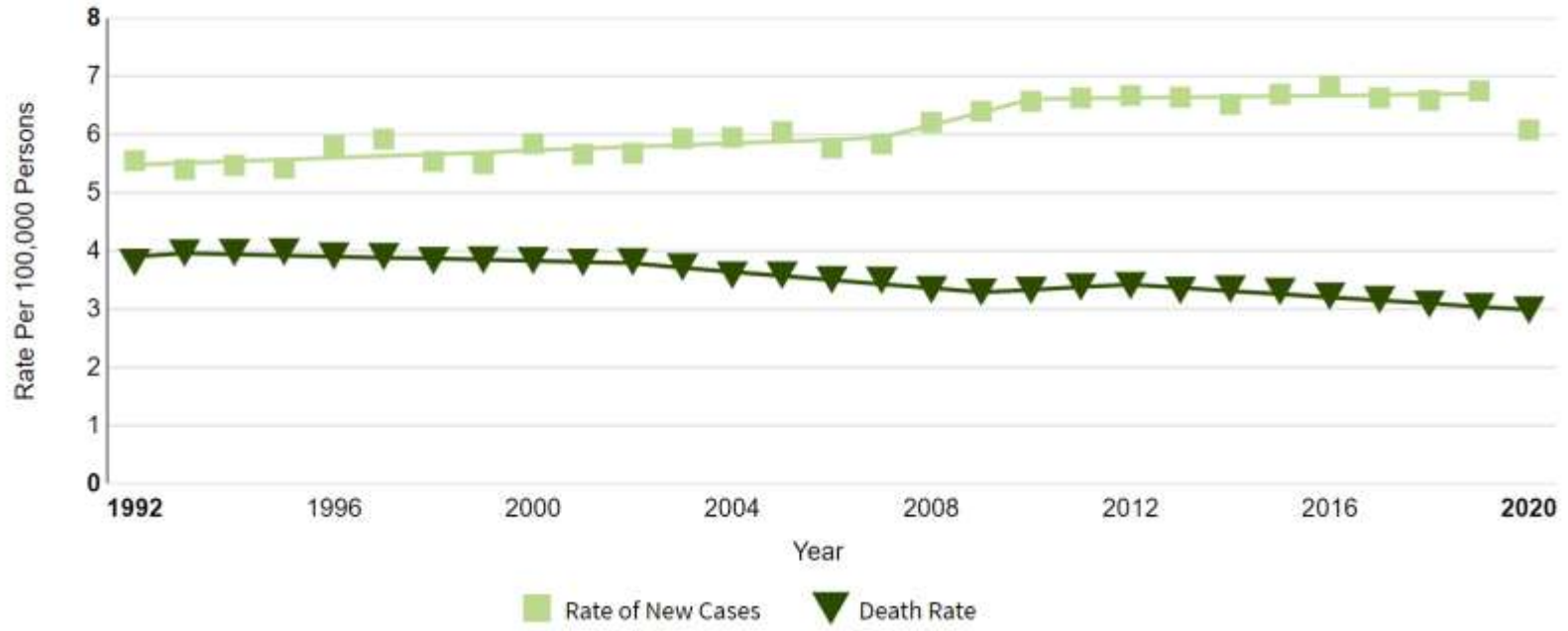
Estimated New Cases in 2023	35,730
% of All New Cancer Cases	1.8%

Estimated Deaths in 2023	12,590
% of All Cancer Deaths	2.1%

5-Year Relative Survival

59.8%

2013–2019

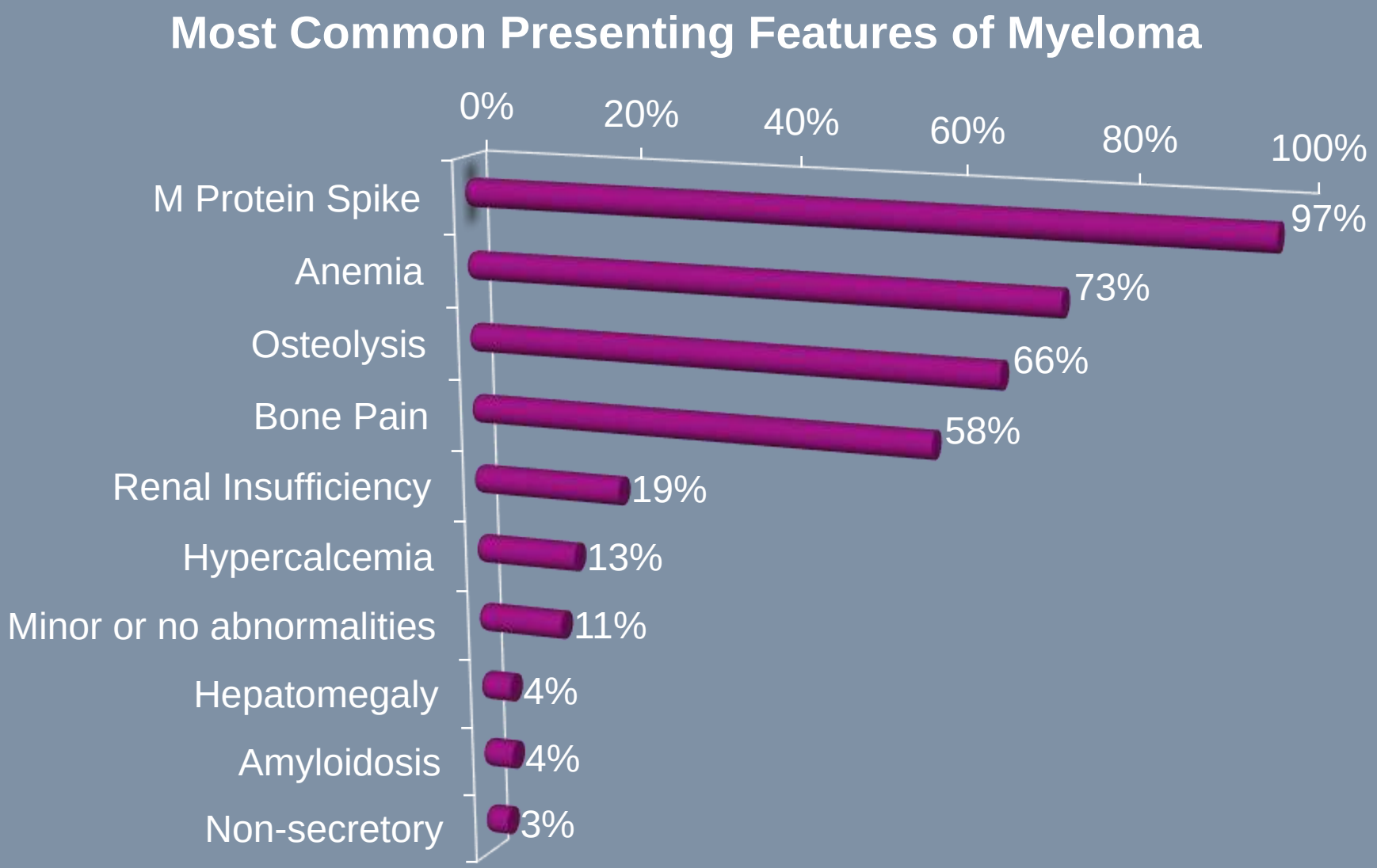


MM Background

Initial Presentation

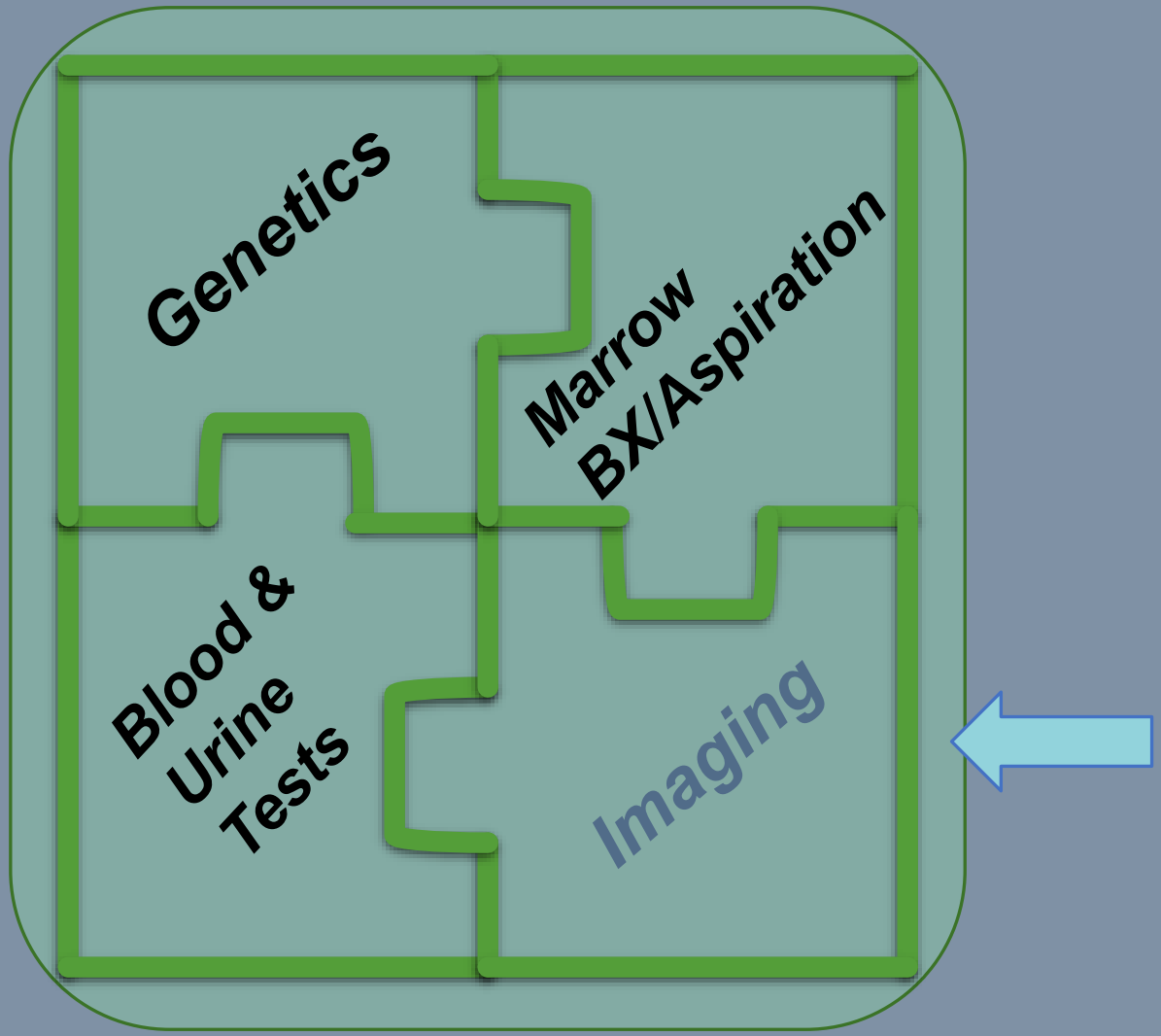
- Early - asymptomatic & incidental DX
- Later – symptomatic
- Up to 1/3rd may be asymptomatic
- Nonsecretory MM – 3% have no detectable M-protein

MM Background



Imaging of MM

Parameters of MM DX & TX



Clinical Criteria for Diagnosis of MM

- Symptomatic (Active):
  PC > 10% on BMBX or from plasmacytoma
  M-Protein (serum or urine) spike
  Evidence of end-organ damage – Hypercalcemia, Abnormal Renal Function, Anemia, Bone Lesions

- Asymptomatic (Smoldering/Indolent):
  PC > 10% on BMBX
  AND/OR
  M-Protein > 30 g/L
  AND
  No evidence end-organ damage

PC = Plasma Cells

Clinical Criteria for Diagnosis of MM

- **Tissue/Cell Evaluation**
  - Flow cytometry
  - Gene expression profiling (GEP) analyses of CD138(+) plasma cells & unseparated marrow BX samples from random post-iliac crest site or imaging-defined FL; risk group and molecular subgroup

- **Traditional Lab Markers of Aggressiveness in MM**
  - Serum/Urine:
    - -M-protein
    - -Beta-2-microglobulin (B2M) level correlates with cell mass/turnover
    - -Igs and free light chain concentrations
    - -Albumin
    - -Lactate dehydrogenase (LDH) - often associated with presence of EMD
    - -C-Reactive protein (CRP)
    - -Creatinine
    - -Calcium

- **Genetics in MM**
  - Cytogenetic abnormalities (CAs) occur frequently in MM, and reversal of abnl with Rx improves survival.

Staging of MM

Durie-Salmon Plus Staging System

- Same staging as Durie-Salmon Staging System with additional advanced imaging (MRI, FDG-PET/CT) findings

Stage I: < 4 focal lesions
Stage II: 5-20 focal lesions and/or moderate diffuse spine involvement on MRI
Stage III: 20+ focal lesions and/or severe spine involvement

Subclassification:
A < 2 mg/dL (normal renal function)
B > 2 mg/dL (abnormal)

Imaging of MM

- Most will have already had conventional imaging with radiographs (bone survey) and/or contrast-enhanced CT or MRI for comparison.

- Tc-99m MDP/HDP Bone Scans – not useful for osteolytic lesions (in general); Treated lesions may show uptake from an osteoblastic process.

Imaging of MM

MRI & FDG-PET/CT can show:

- Diffuse marrow infiltration
- Macrofocal (≥ 5 mm) lesions
- Diffuse & macrofocal disease
- Extramedullary disease (EMD)

Imaging of MM

Some Important Points on Imaging:

- MRI & FDG-PET can show focal lesions before x-ray/CT (FDG earliest) & effective response to TX before irreversible osteolysis occurs.

- Lesions on MRI may show persistent long-term abnormality, while FDG uptake can resolve earlier indicating response to treatment at an earlier timepoint.

- Radiographs & CT lesions may never resolve anatomically making it difficult to determine if active or treated

Imaging of MM

Important Points with FDG-PET/CT:

- Provides both functional & anatomic information
- Can effectively monitor short-term response to therapy
- Typically, corresponds very well to clinical response, labs, bone marrow, etc.
- VERY useful for nonsecretory disease
- Active focal lesion number & their SUV values provide prognostic information
- Localize occult infection & EMD
- Greatest sensitivity/specificity with combined MRI & FDG-PET/CT – complementary

Bone Destruction – CT, Radiographs

- Osteoclastic activity is unbalanced

- Detection of Osteolytic Lesions (MR can't adequately detect osteolysis)
  (# may alter staging)

- Manifested on imaging as:
  - Osteoporosis
  - Osteolytic lesions
  - Pathologic fractures

- Techniques used:
  - Skeletal survey (plain film; considered gold standard)
  - MDCT
  - CT of PET

Bone Destruction

Plain Film:

- Advanced disease before can identify – requires 30-70% demineralization for detection; Therefore, significant underestimation for DX & staging
- Cannot determine cause of osteoporosis
- May be painful & tiring procedure from various imaging positions
- Lower cost
- Lower radiation dose

Bone Destruction

WBLDCT:

- n=39
- Identified more osteolytic lesions than MBS
- Greater diagnostic confidence
- Restaging in 18 instances

Gleeson TG, et al. Accuracy of whole-body low-dose multidetector CT (WBLDCT) versus skeletal survey in the detection of myelomatous lesions, and correlation of disease distribution with whole-body MRI (WBMRI).

Marrow Infiltration of Myeloma

Plain Film:

-Does not evaluate marrow

CT:

-High false negative rate for marrow infiltrative processes

FDG-PET:

-Needs further studying regarding marrow uptake

-Marrow uptake can be nonspecific – chemotherapy, anemia, colony-stimulating factor, tumor infiltration, etc.

Lutje S, et al. Role of radiography, MRI, and FDG-PET/CT in diagnosing, staging, and therapeutical evaluation of patients with multiple myeloma. Ann Hematol. 2009;88:1161-1168.

MRI in Myeloma

- Gold standard for identification of bone marrow disease; superior to MBS & PET
- Likely better delineates diffuse disease: hypointense on T1 & hyperintense on STIR
- WB more accurate than spine-only
- Diffusion-weighted and ADC evaluation

Lutje S, et al. Role of radiography, MRI, and FDG-PET/CT in diagnosing, staging, and therapeutical evaluation of patients with multiple myeloma. Ann Hematol. 2009;88:1161-1168.

Imaging of MM – FDG-PET/CT

Imaging of MM – FDG-PET/CT

PET/CT imaging typically occurs at 60 minutes after FDG injection (similar dose as with any other FDG PET oncologic imaging) with imaging from the top of the head to the feet - to include entire marrow space and all soft tissues looking for EMD and/or infection.

What to look for:

CT – underlying osteopenia, osteolytic (sclerotic in the case of POEMS), breakout lesions (cortical breakthrough with a soft tissue component), fractures, AVN.

PET – any of the above the is metabolically active or not, bone marrow involvement, EMD, occult infection in these immunocompromised patients

Imaging of MM – FDG-PET/CT

Osteopenia, Osteolytic Lesions

Multifocal or Solitary

Metabolically active or not

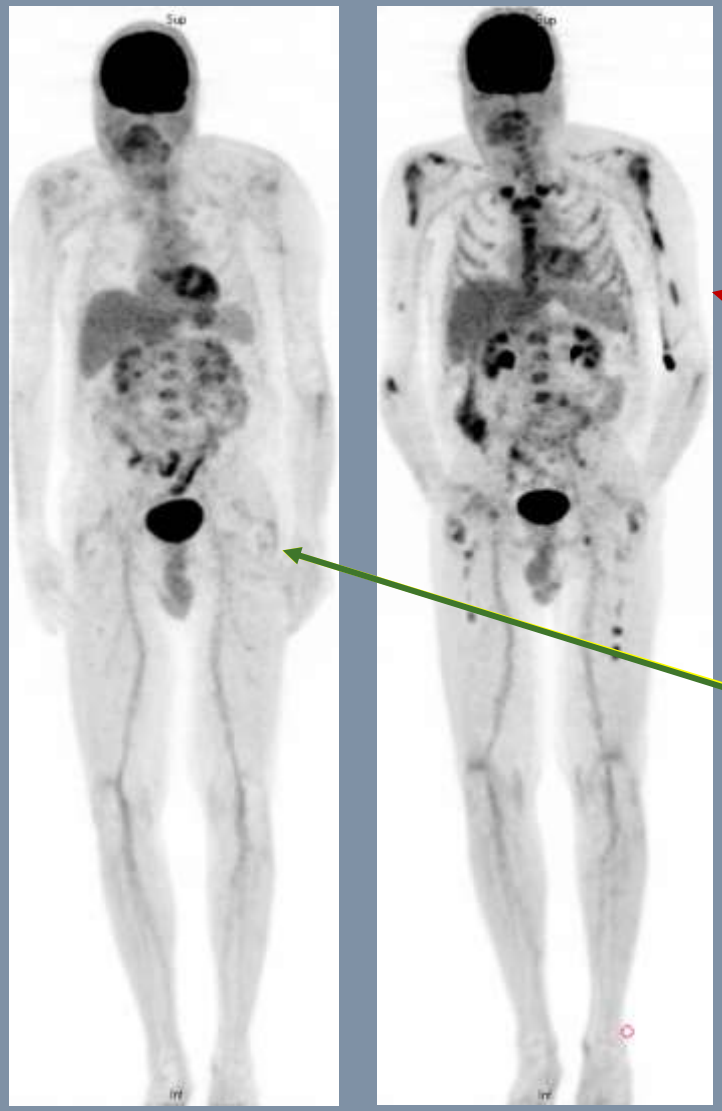
Any breakout lesions

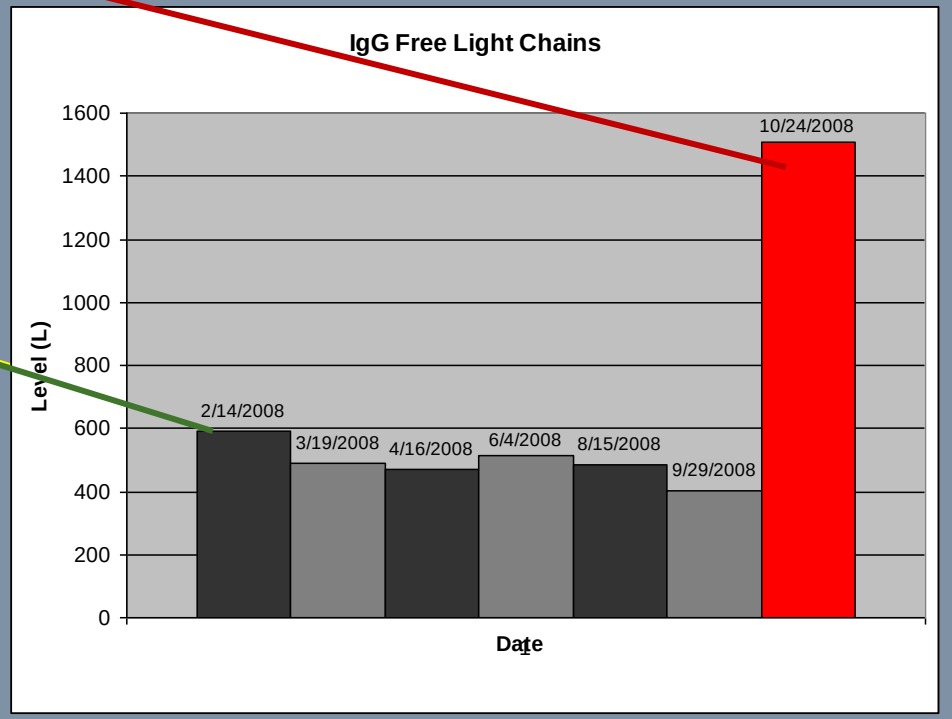
Measure largest at a minimum

Provide SUV values

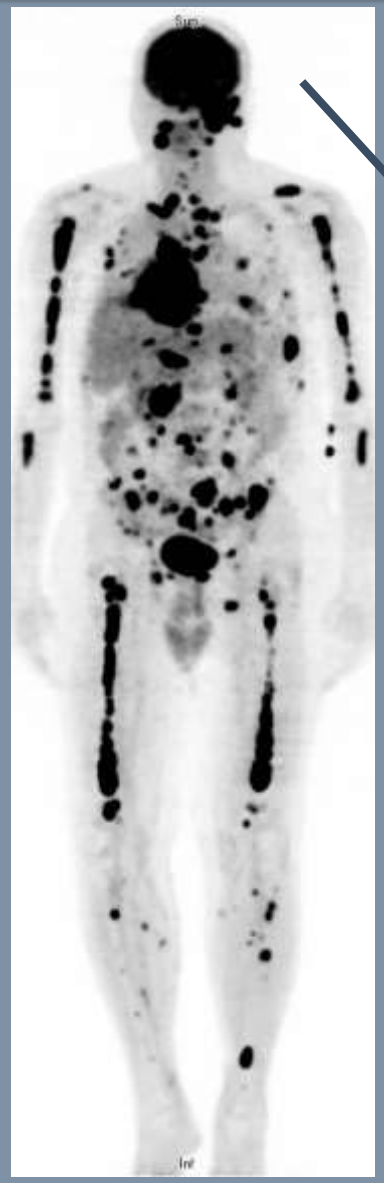
Imaging of MM – FDG-PET/CT

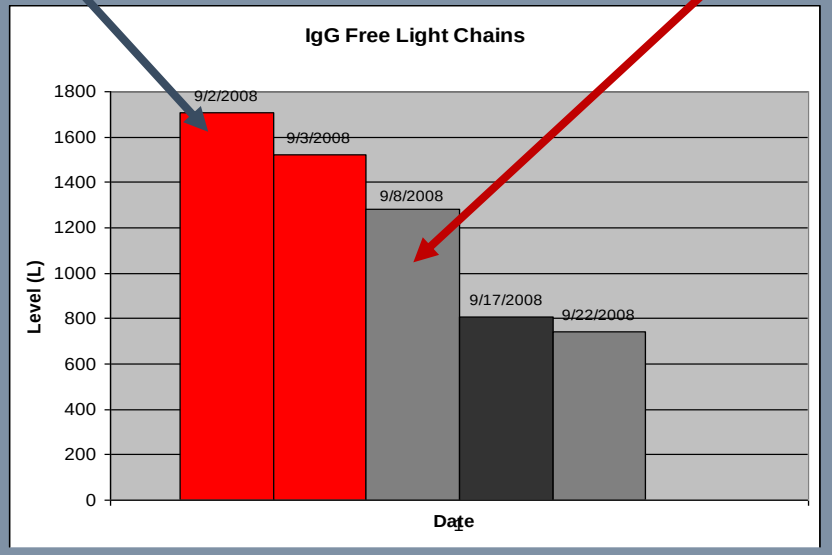
Comparison with Baseline/Subsequent Images & Labs

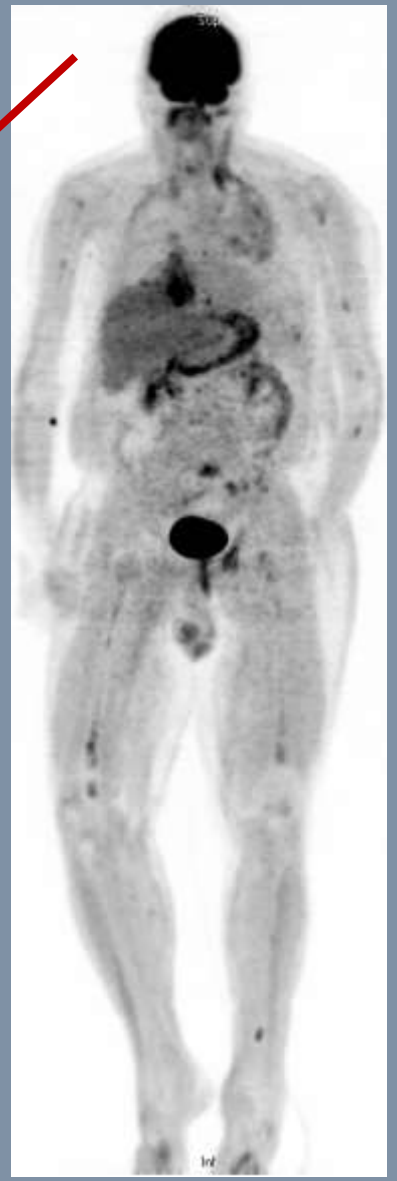




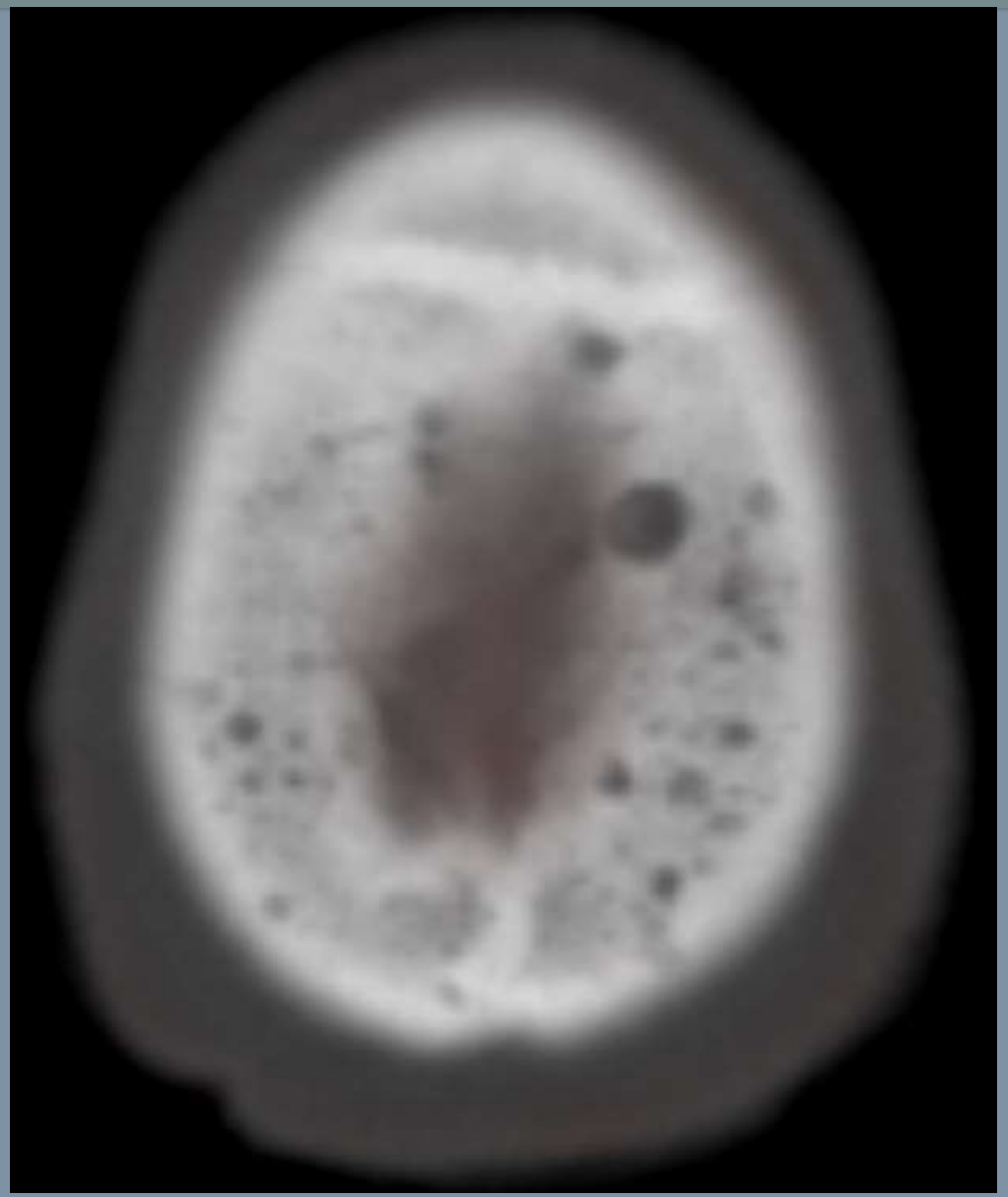
Imaging of MM – FDG-PET/CT



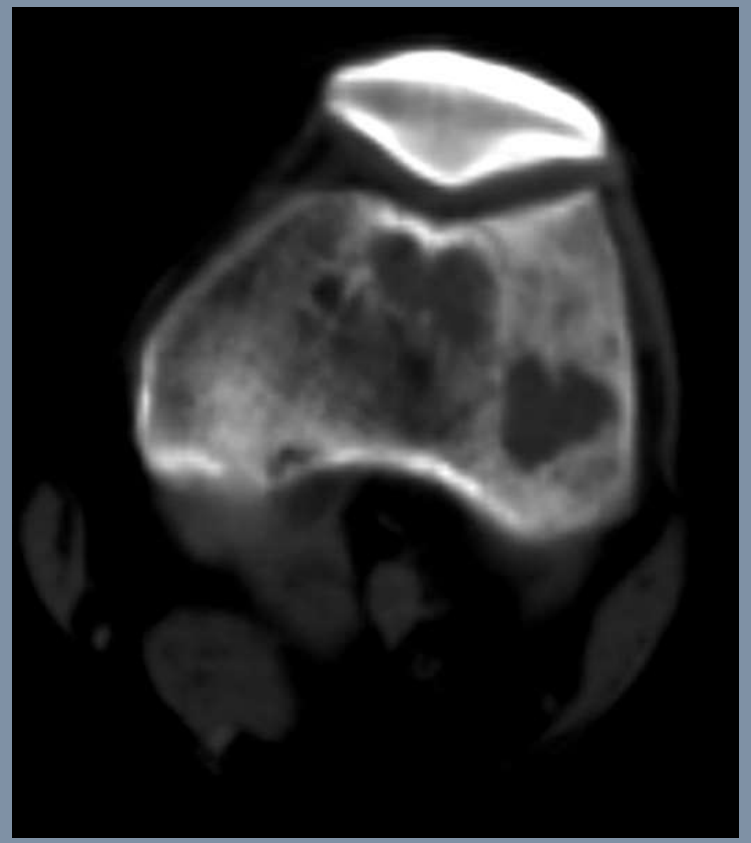




Imaging of MM – FDG-PET/CT

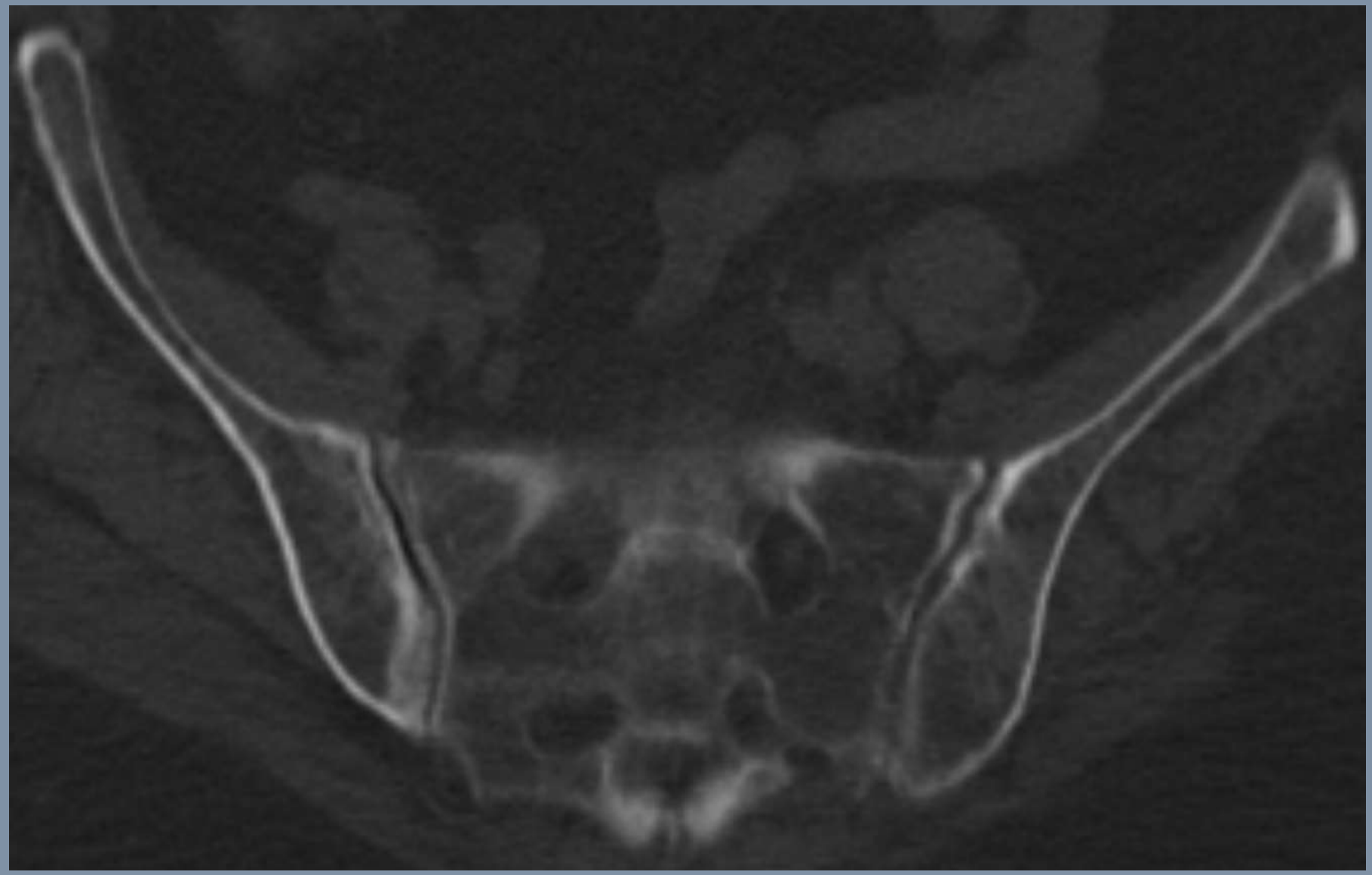


Osteolytic Lesions



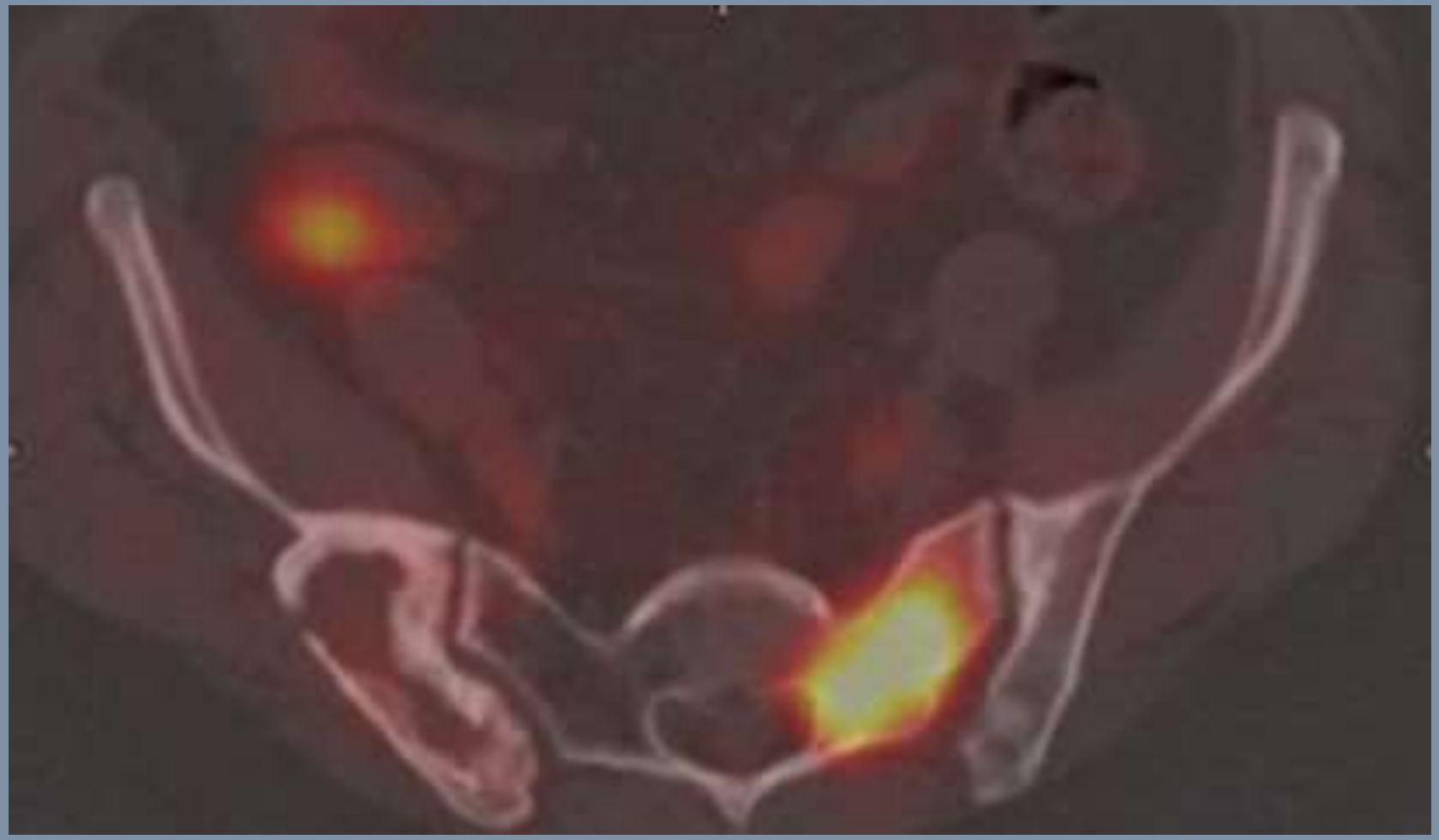
Imaging of MM – FDG-PET/CT

Diffuse Osteopenia with Additional Tiny Osteolytic Lesions



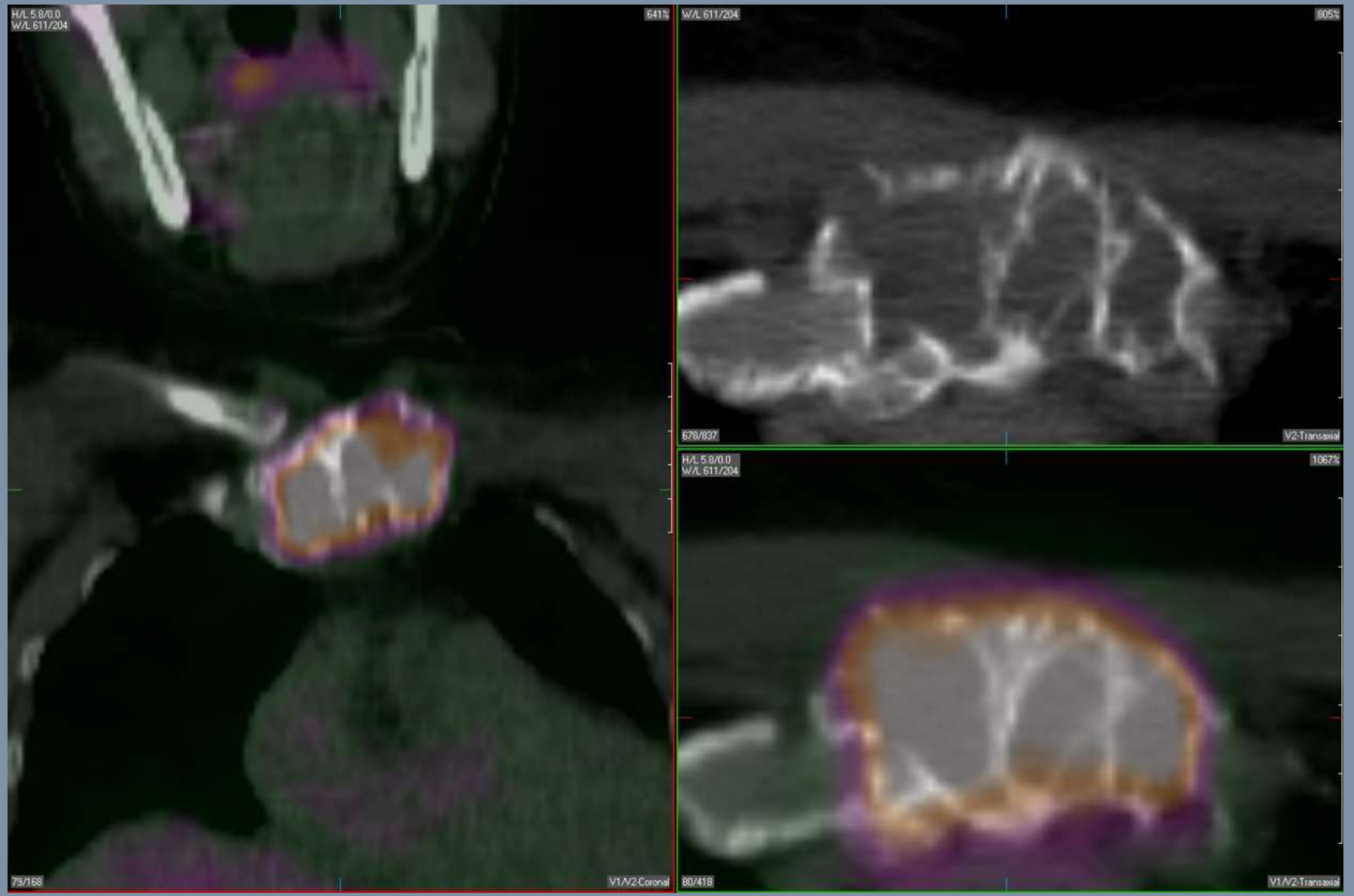
Imaging of MM – FDG-PET/CT

Metabolically active OL



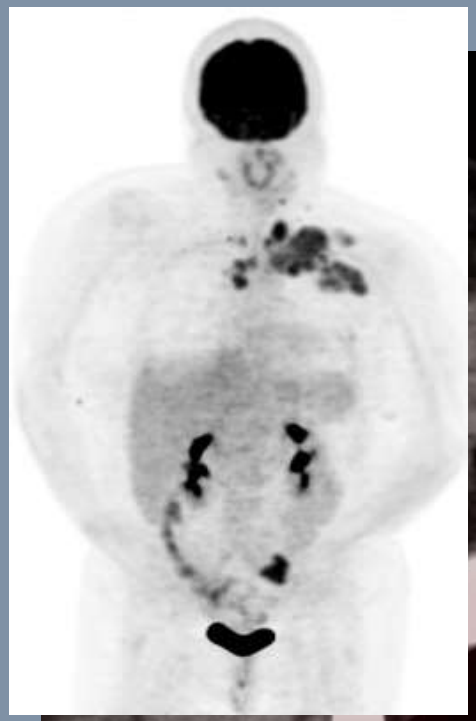
Imaging of MM – FDG-PET/CT

Expansile OL



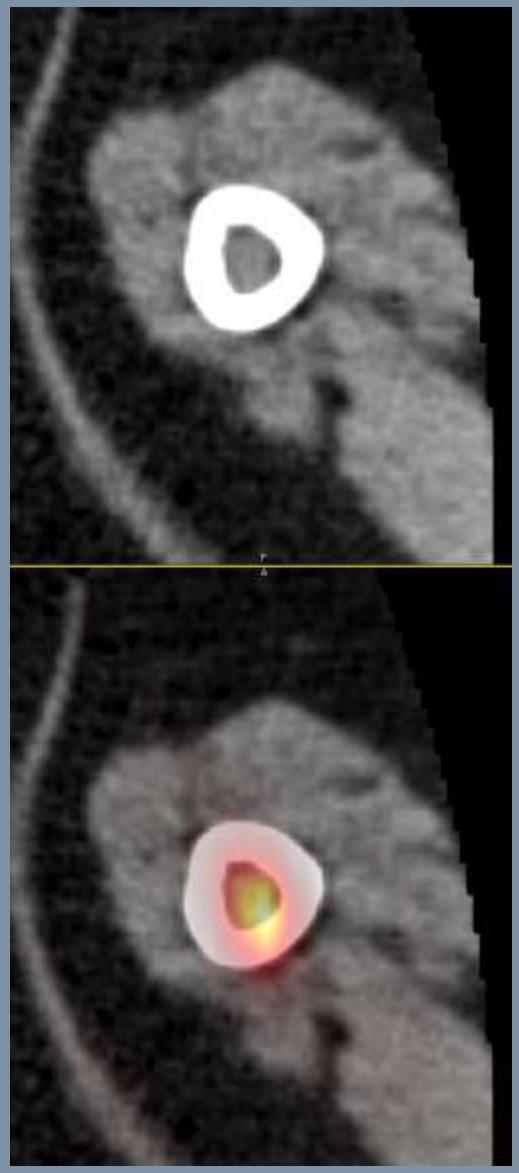
Imaging of MM – FDG-PET/CT

Breakout Lesion



Imaging of MM – FDG-PET/CT

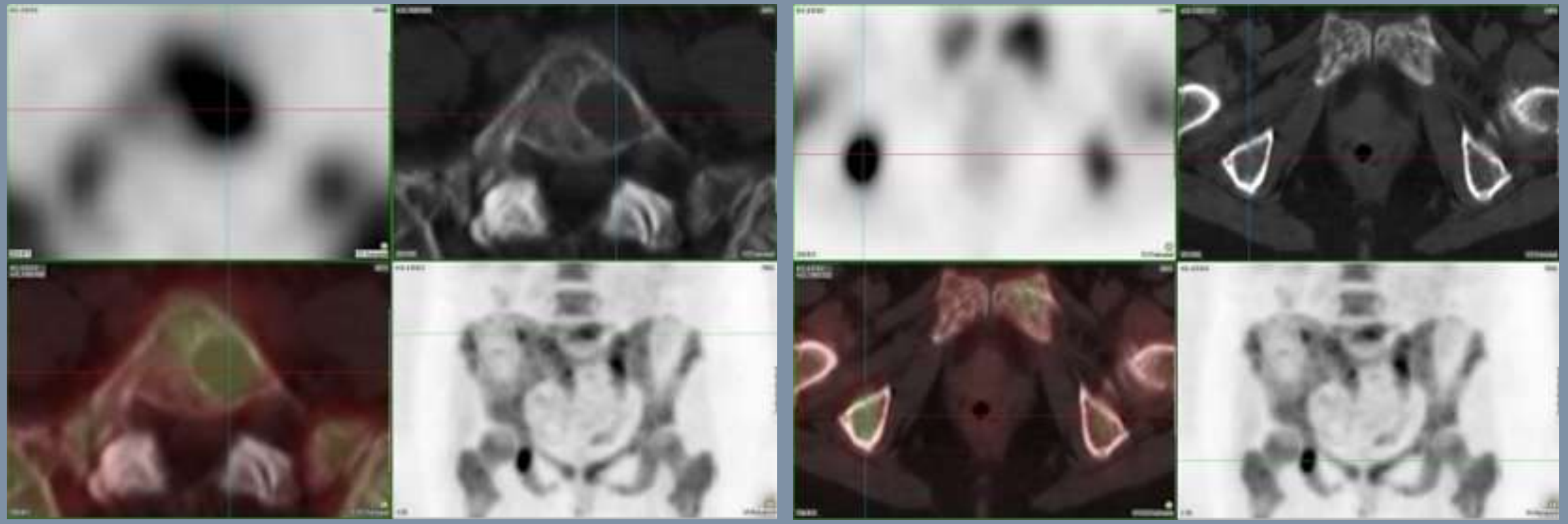
Intramedullary



Imaging of MM – FDG-PET/CT

Number, Size, and SUV values of Focal Lesions

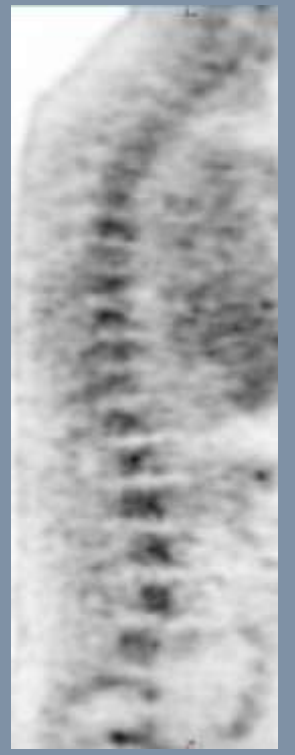
Focal = Active Bony Lesions With Uptake Above Background Marrow

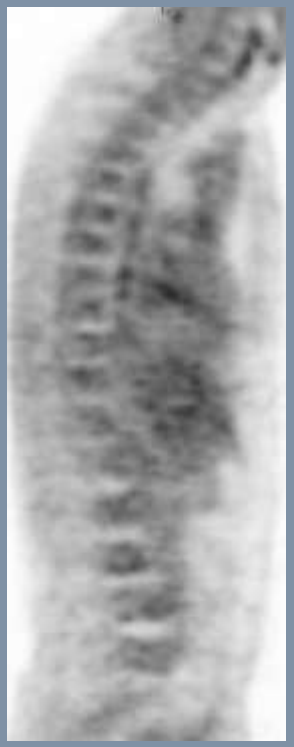


Imaging of MM – FDG-PET/CT

- Pattern of Red Marrow Uptake
  - Homogeneous vs heterogeneous
  - Measure at L4 or L5 for background activity to compare to
  - Can identify FL even with background diffuse marrow involvement

may be difficult if treatment effect

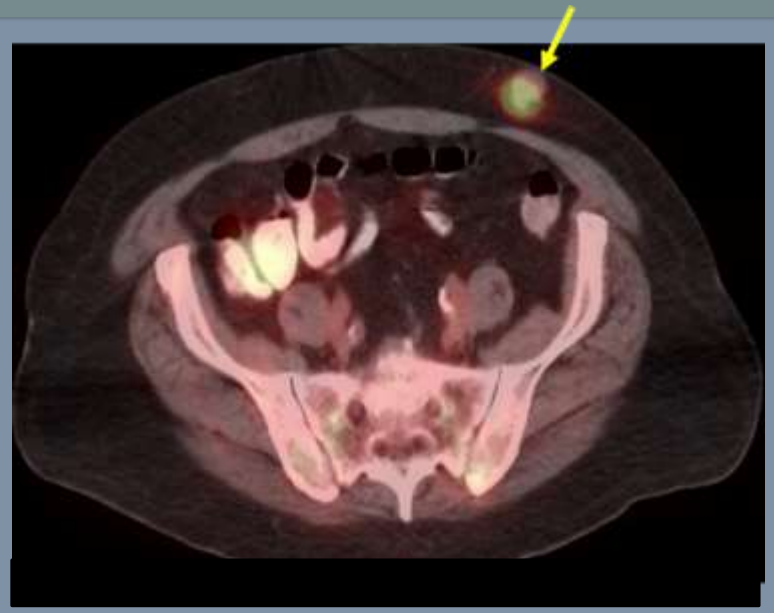




Background Marrow – Measured at L4 or L5 as Standard

Mild, Moderate, or Severe Marrow Uptake

Extramedullary Disease (EMD)



Presence of EMD portends poorer prognosis

Varettoni M et al. Incidence, presenting features, and outcome of extramedullary disease in multiple myeloma: a longitudinal study on 1003 consecutive patients.

An elevated LDH level suggests presence of EMD and high tumor mass.

Dimopoulos et al. High serum lactate dehydrogenase level as a marker for drug resistance and short survival in multiple myeloma.

Imaging of MM – FDG-PET/CT

- FDG-PET/CT detected EMD in 6% of the pts in 33 sites.

- No EMD was detected by MBS.

-Only 1% by MRI.

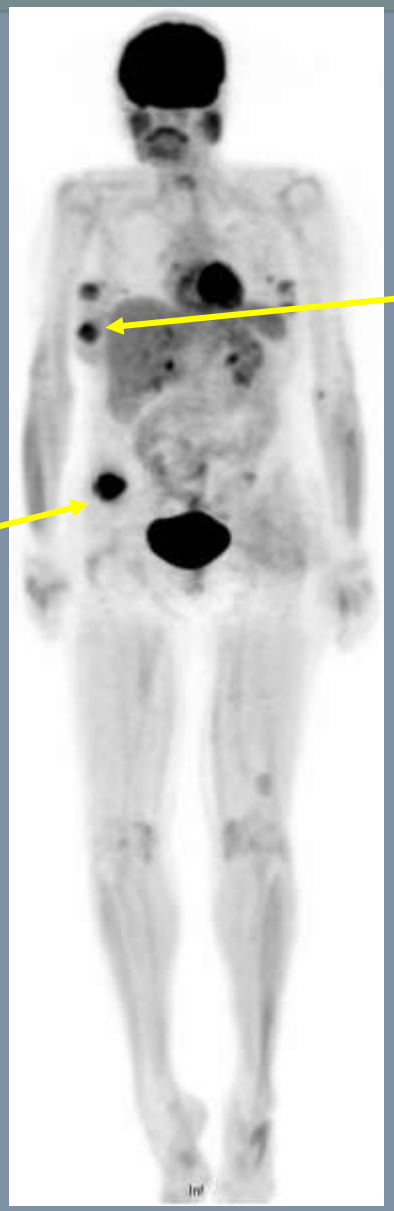
- EMD was strongly associated with the level of LDH (P=0.028).

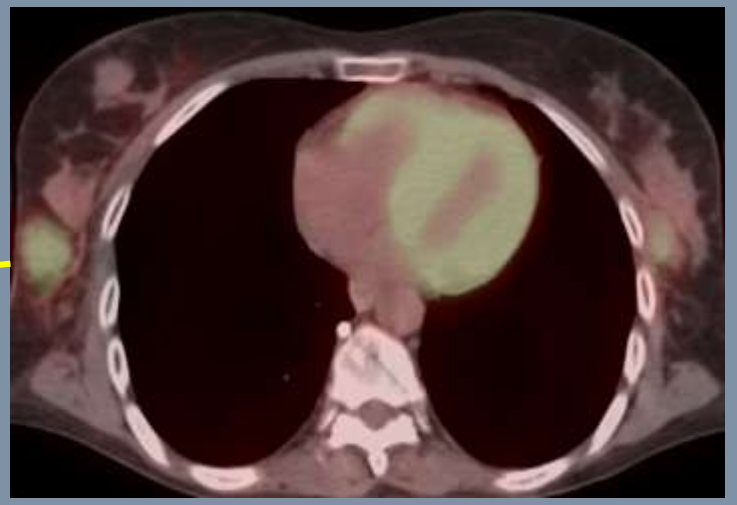
Most Common Locations for EMD:

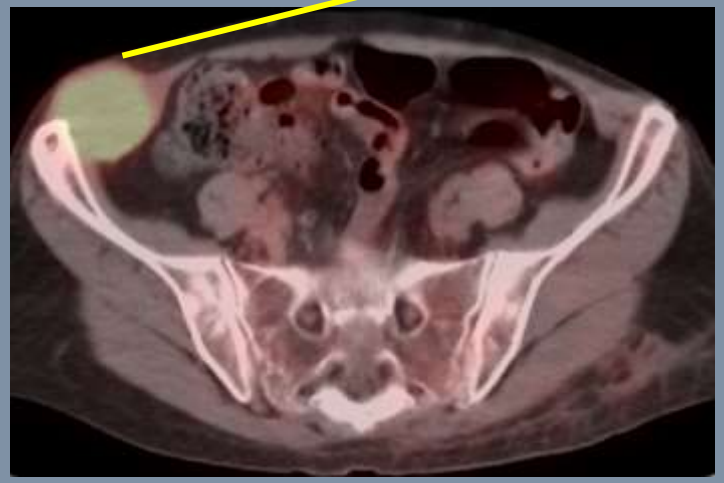
Location	No. Locations	Patient ID
Nodes	8	2,5,6,7,9,10,11,17
Pleura	5	2,11,13,14,15
Subcutaneous Nodule	5	1,6,15,18,19
Liver	3	3,8,10
Spleen	3	4,16,19
Muscle	3	2,3,6
Paraspinal	2	4,19
Pancreas	1	9
Pericardium	1	15
Retrocardiac Mass	1	12
Total Locations:	33	
Total No. Patients	19	

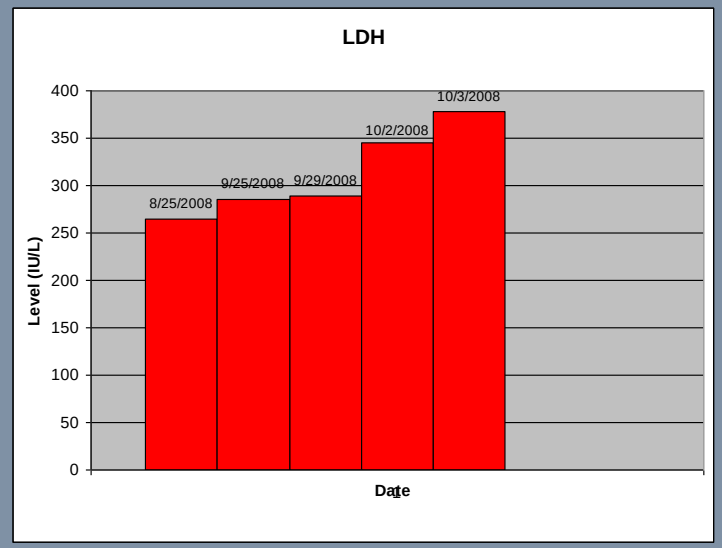
Imaging of MM – FDG-PET/CT

4/18/2024



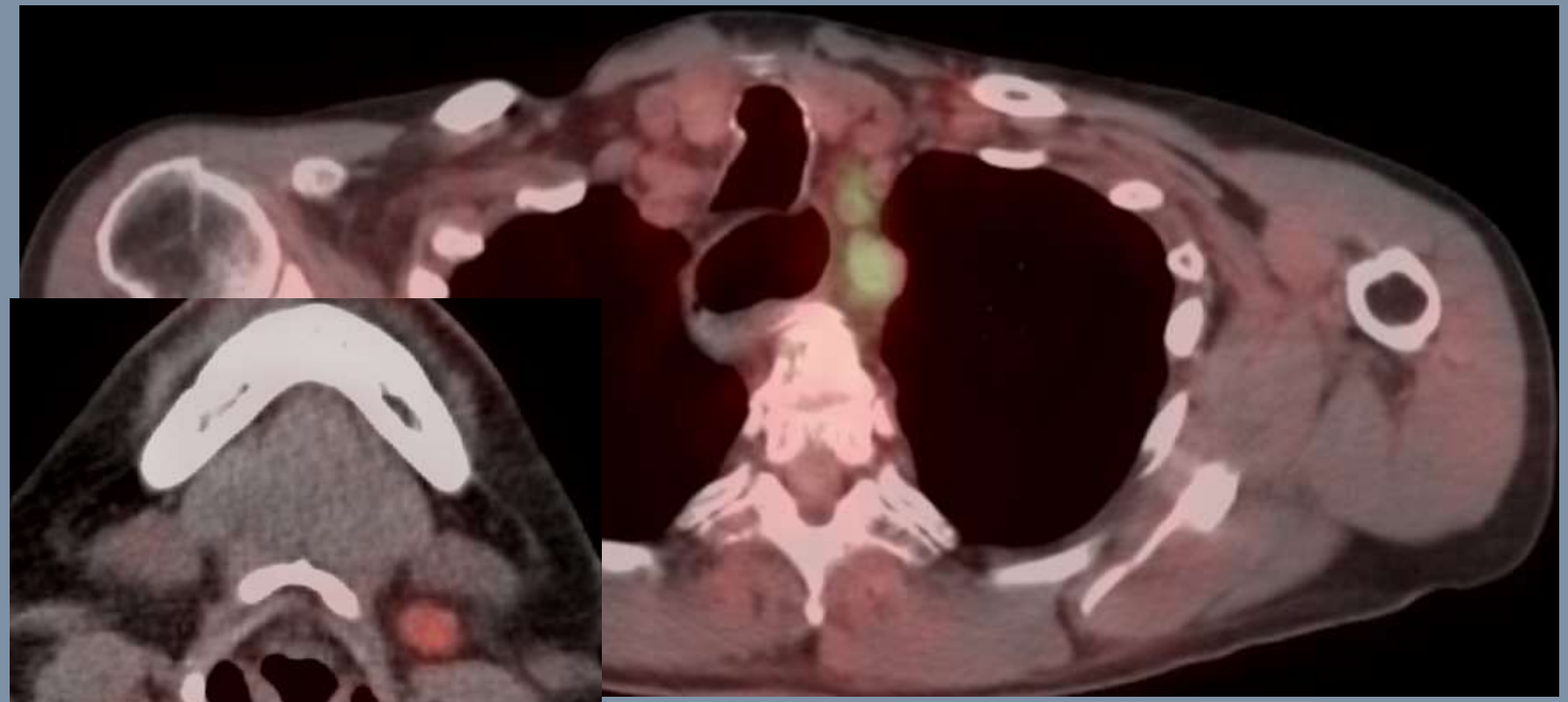




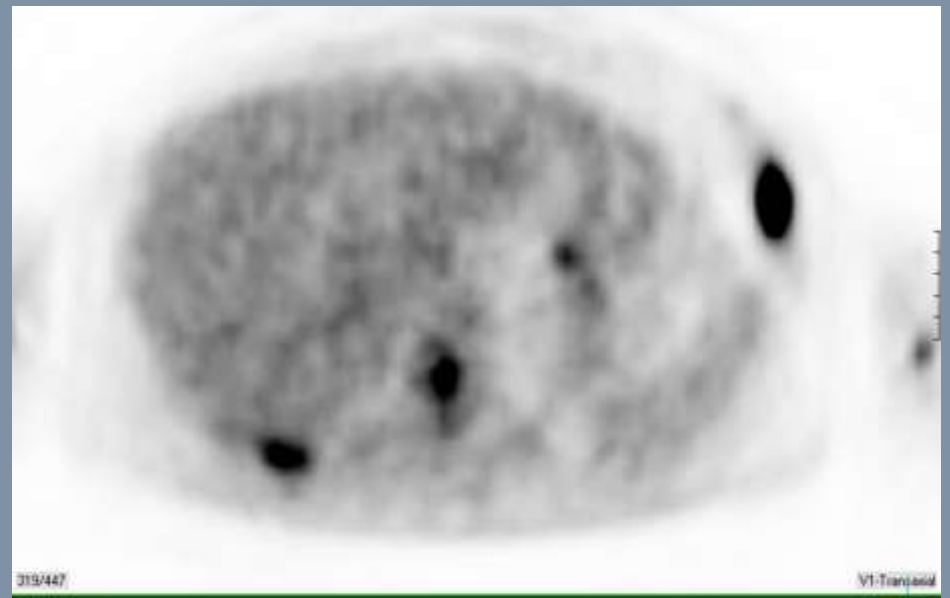


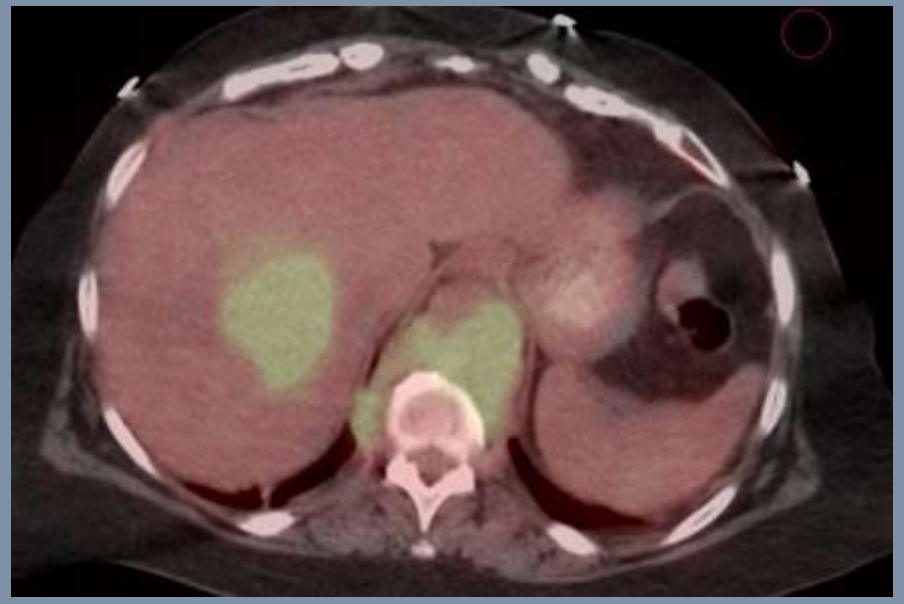
Imaging of MM – FDG-PET/CT

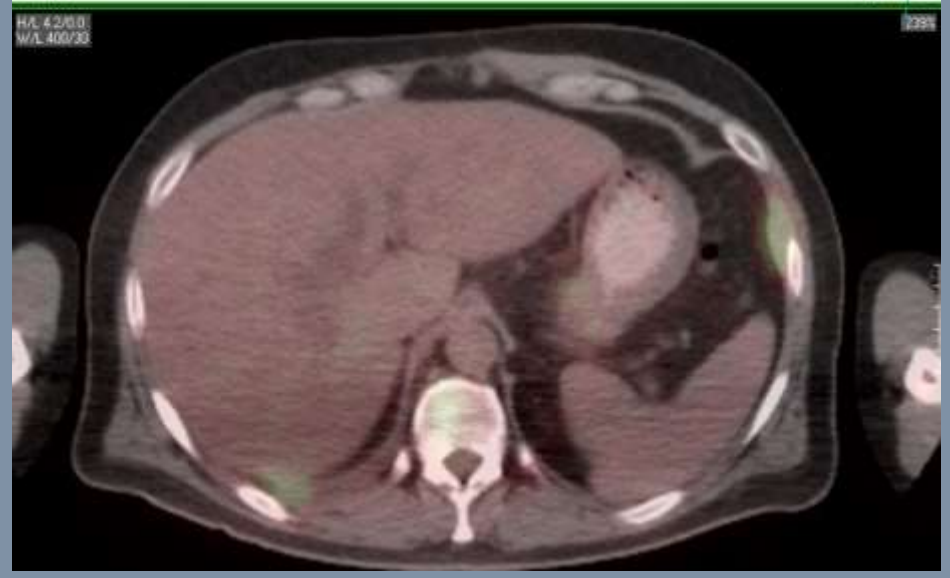
Location, size, and SUV values for extramedullary disease (EMD)

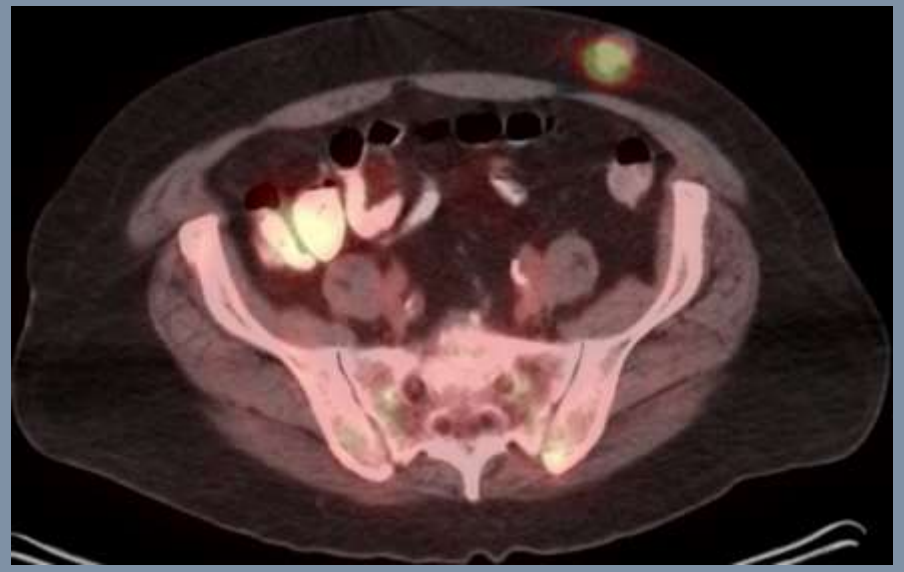


Imaging of MM – FDG-PET/CT









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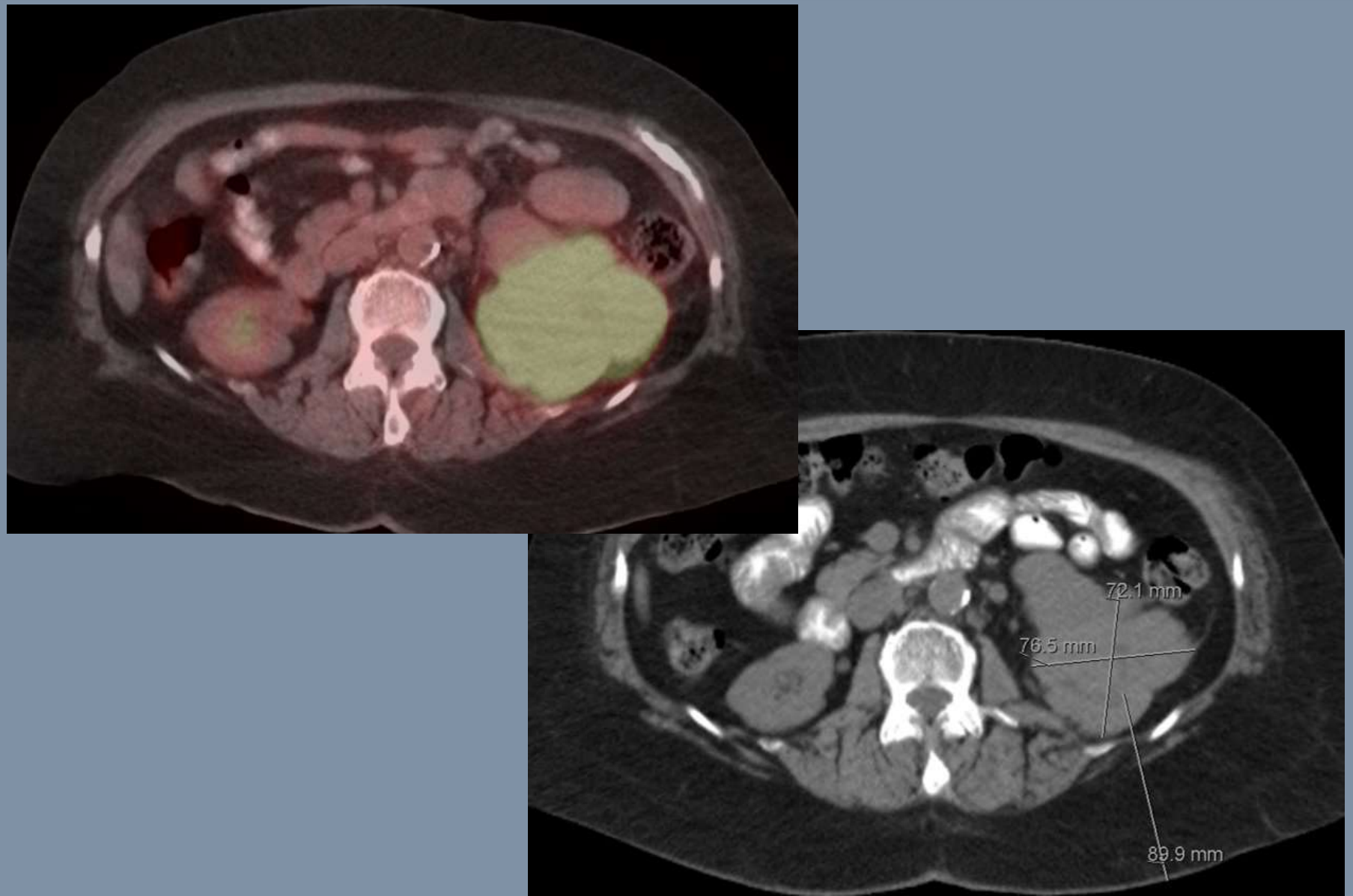
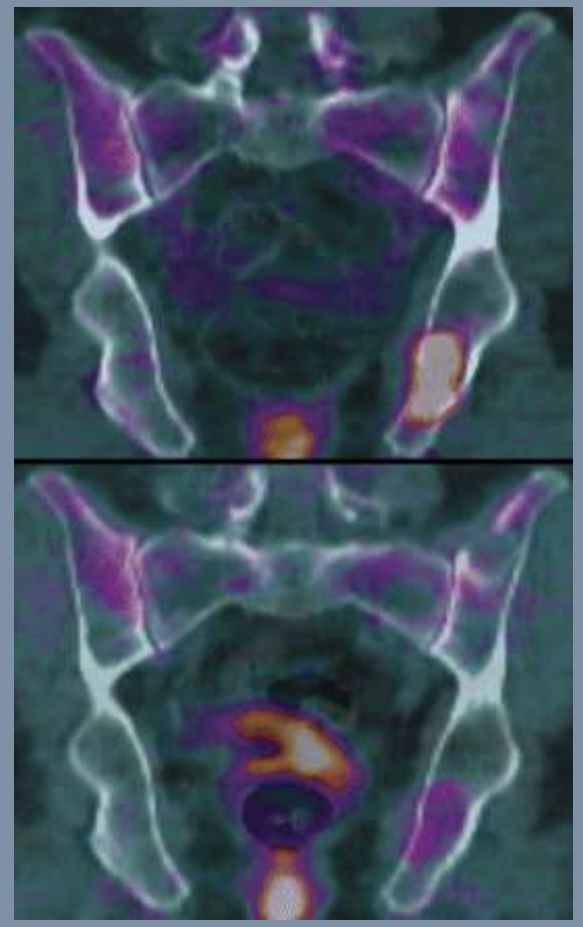


1st prognostic data for FDG-PET/CT

F18-fluorodeoxyglucose positron emission tomography in the context of other imaging techniques and prognostic factors in multiple myeloma

Blood 2009

Twyla B. Bartel, Jeff Haessler,
Tracy LY Brown, John D Shaughnessy, Jr,
Frits van Rhee, Elias Anaissie, Terri Alpe,
Edgardo Angtuaco, Ronald Walker,
Joshua Epstein, John Crowley, Bart Barlogie



Imaging of MM – FDG-PET/CT

- Of the various imaging methods, PET (specifically PET-FL number) correlates most closely with lab prognostic variables
- At baseline, PET-FL number, PET-FL Max SUV value, & (+) EMD identifies a subgroup with inferior prognosis
- The presence of more than 3 FDG-avid FLs, related to fundamental features of myeloma biology and genomics, was the leading independent parameter associated with inferior overall & event-free survival.
- FDG-PET/CT provides best monitoring of short-term response to therapy FDG-PET/CT imaging should be part of a comprehensive imaging strategy for pts with MM & for their management
- Greatest sensitivity/specificity with combined MRI & FDG-PET/CT – complementary

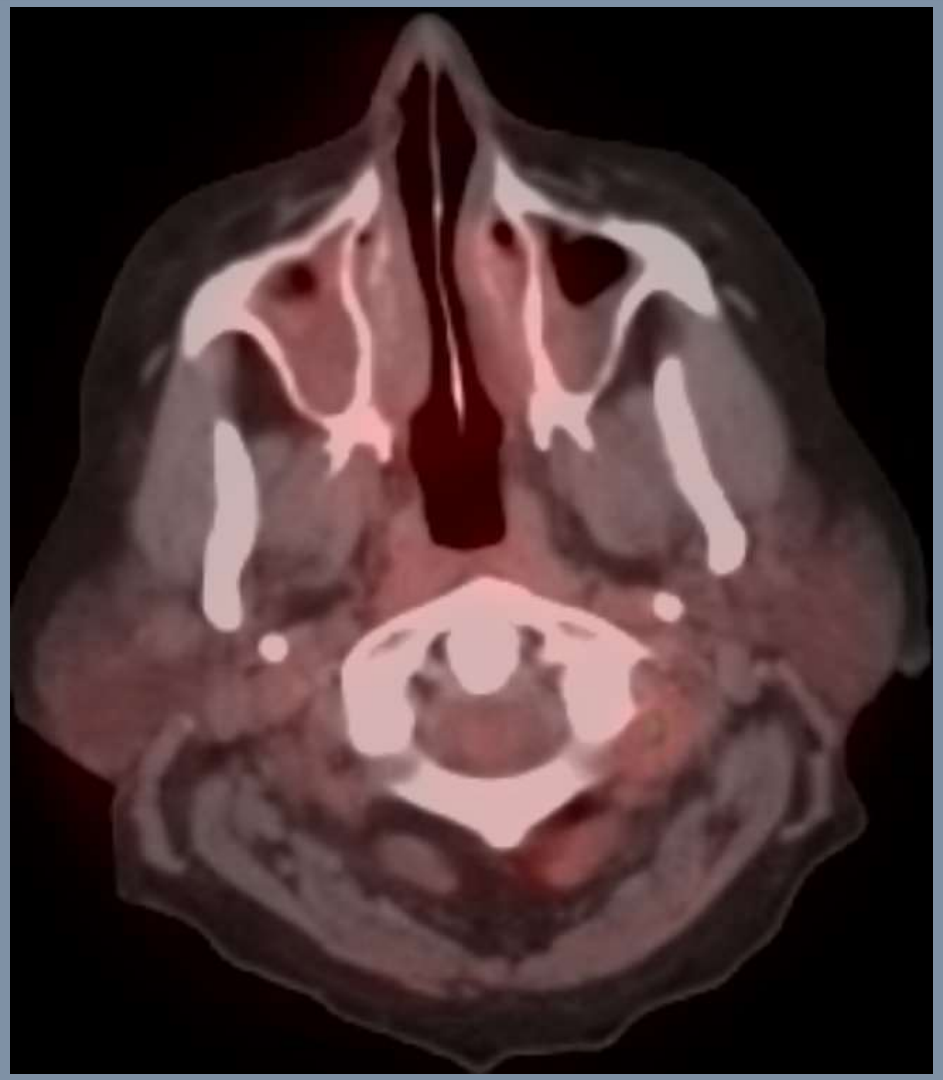
Imaging of MM – FDG-PET/CT

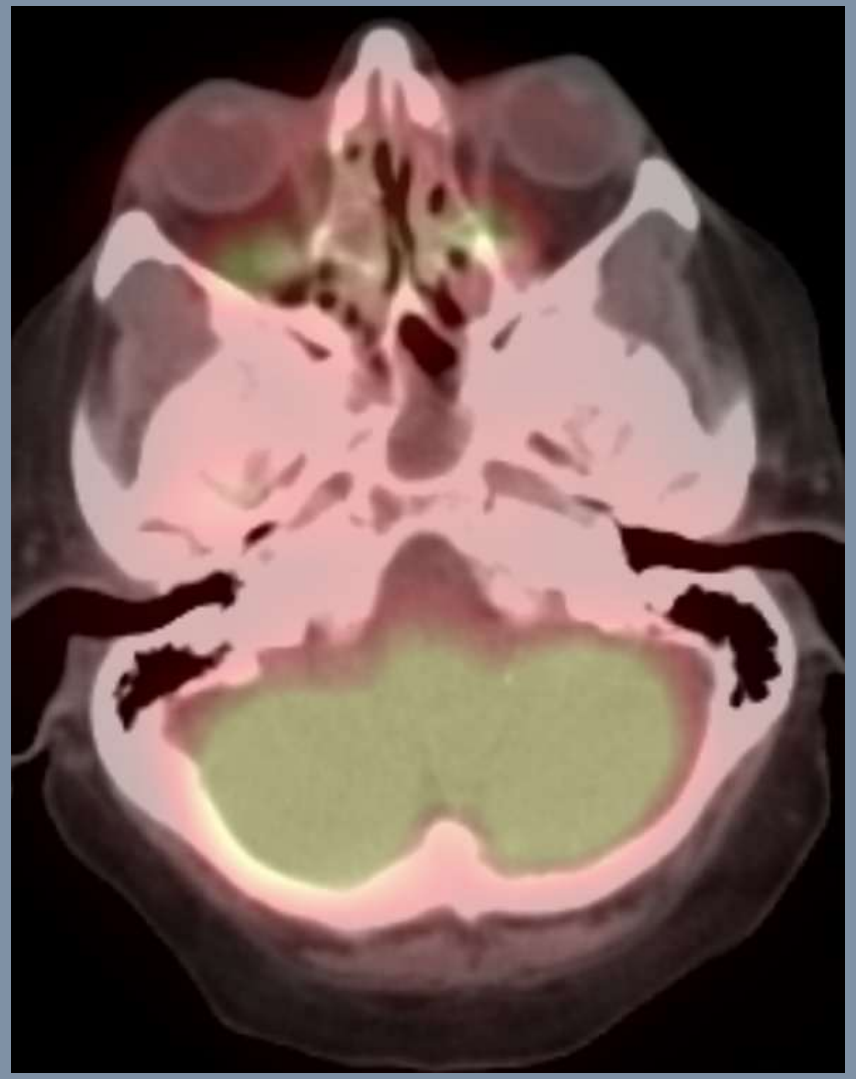
Evaluate for Any Occult Infection

- Retrospective by Mahfouz T et al.
- N = 248 with known MM for staging (N = 143 with 165 infections identified)
- 99 respiratory tract (pneumonia, sinusitis)
- 26 bone/joint/soft tissue (discitis, osteomyelitis, cellulitis, septic arthritis)
- 18 vascular (deep septic thrombophlebitis, catheter infection, septic emboli)
- 10 peridontal disease
- 12 gastrointestinal (colitis, intra-abdominal abscess, diverticulitis, esophagitis)
- Useful if suspected infection even in severe immunocompromised patients, and negative diagnostic work-up
- A negative FDG-PET study along with other negative work-up would suggest no infection
- Changed management in 46%

Mahfouz T, Miceli MH, Saghafifar F, et al. 18-F-Fluorodeoxyglucose positron emission tomography contributes to the diagnosis and management of infections in patients with multiple myeloma: a study of 165 infectious episodes. J Clin Oncol. 2005;23:7857-7863.

Imaging of MM – FDG-PET/CT





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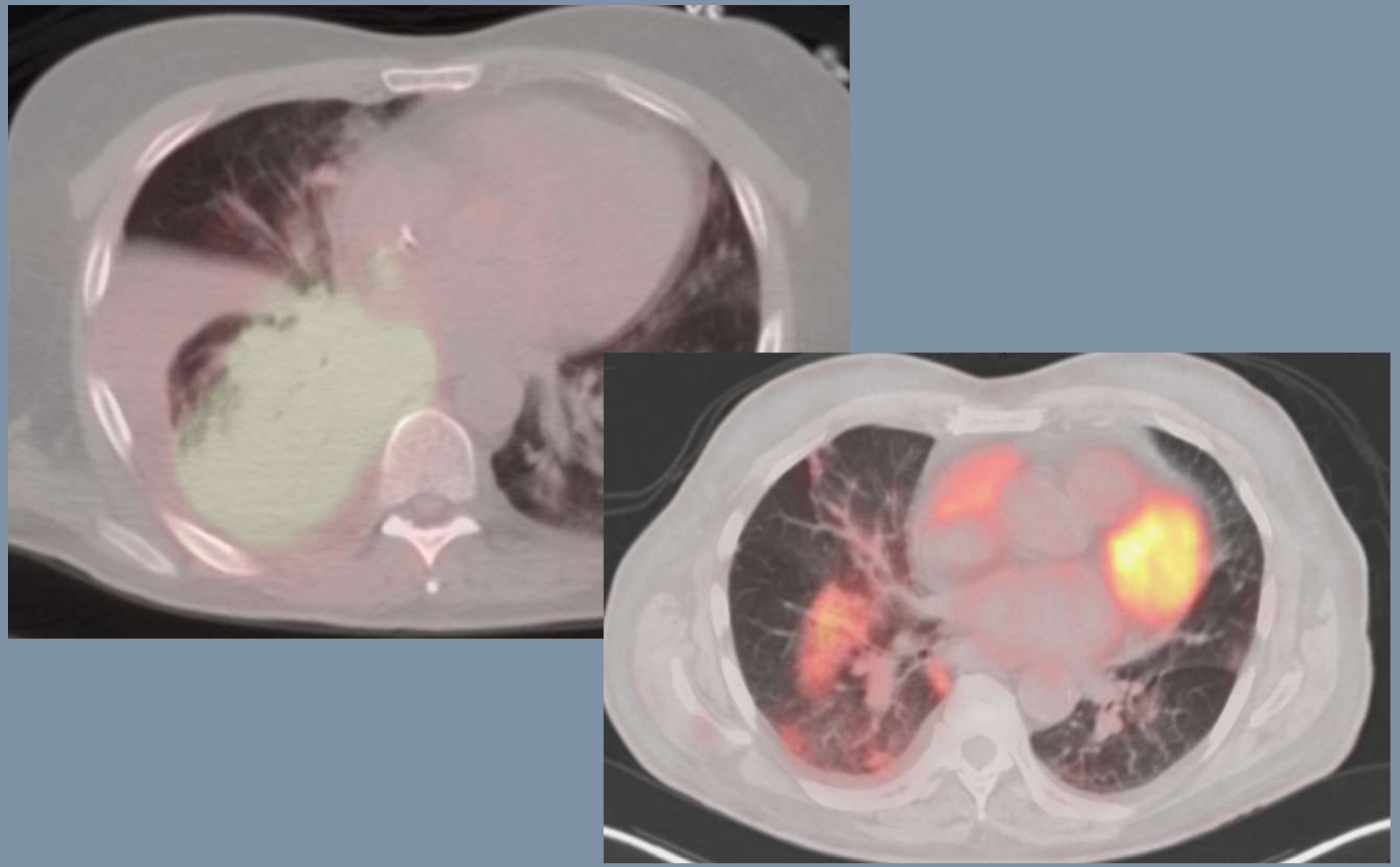

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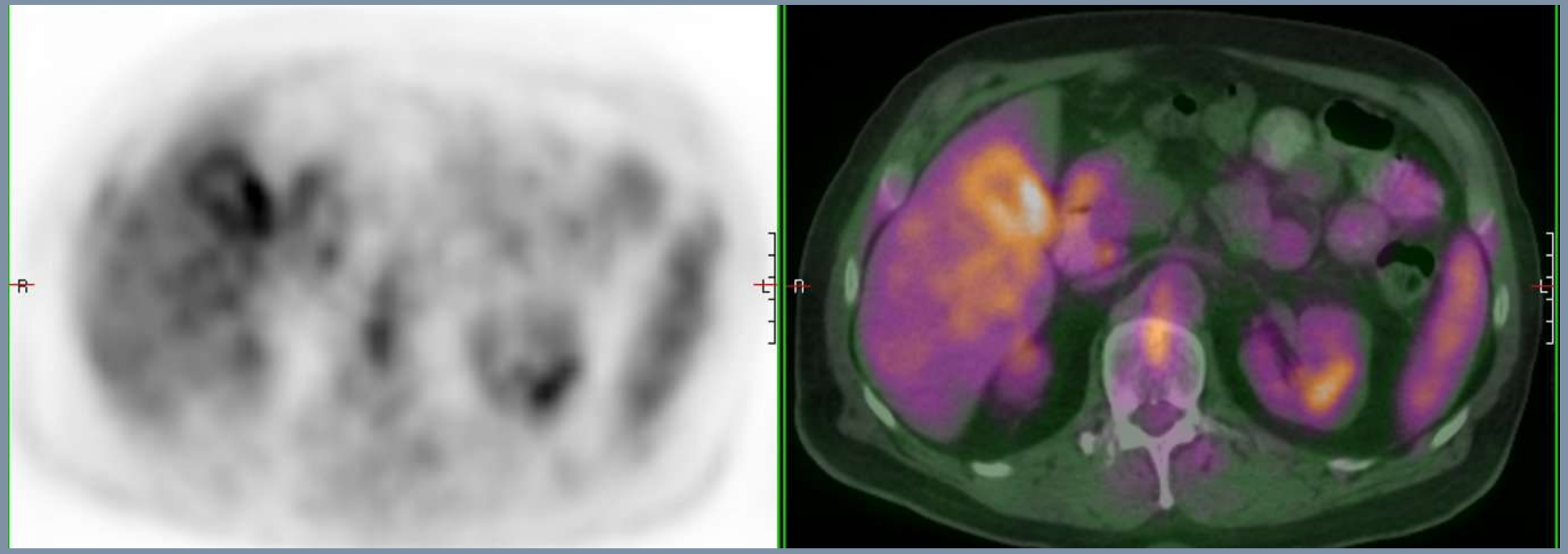

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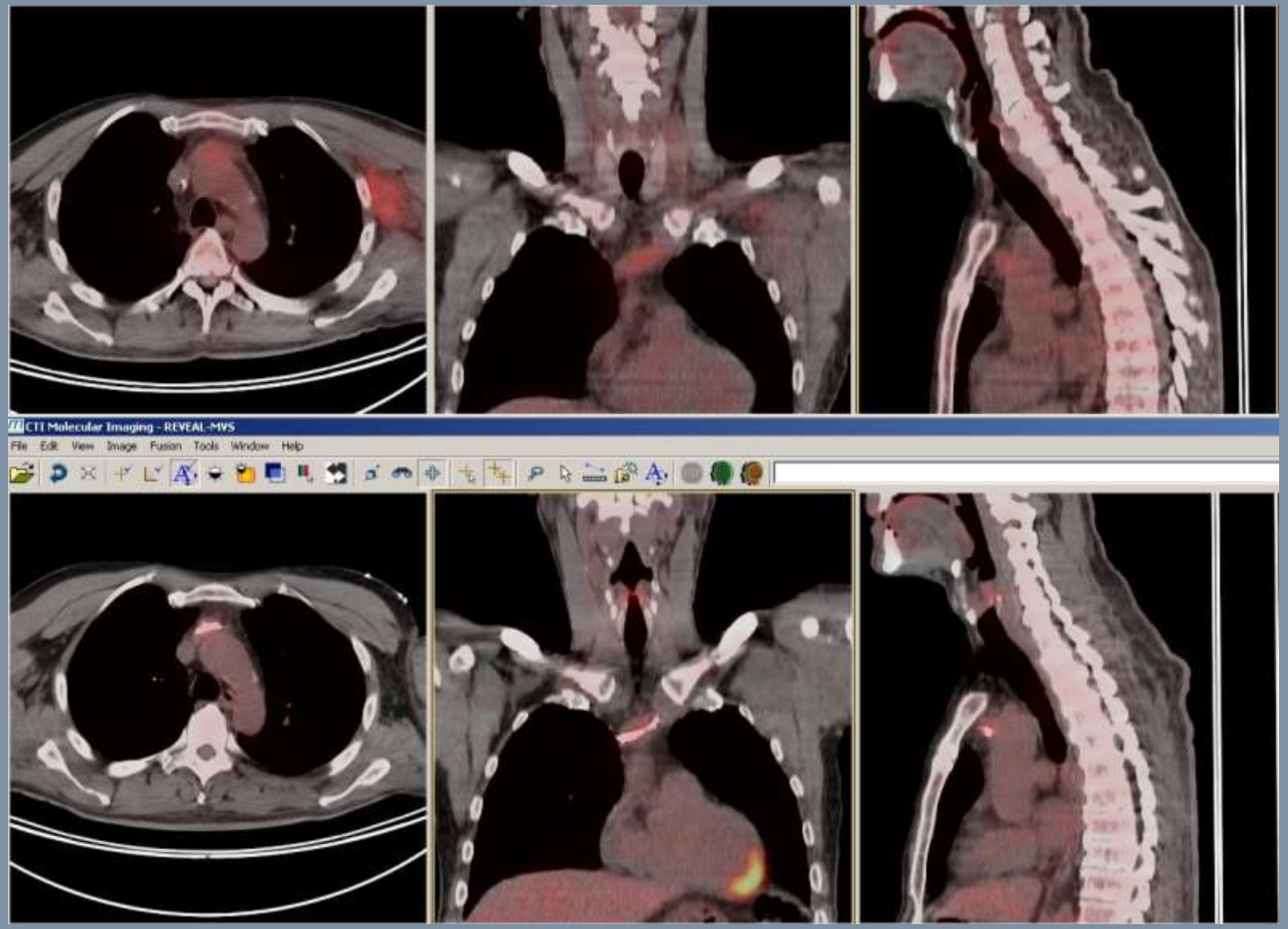

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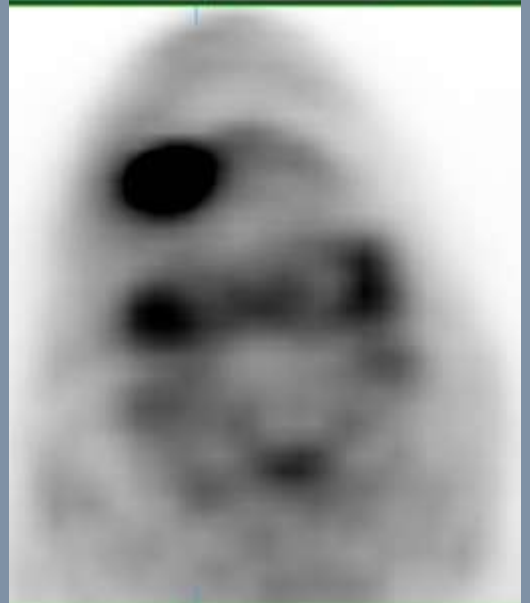

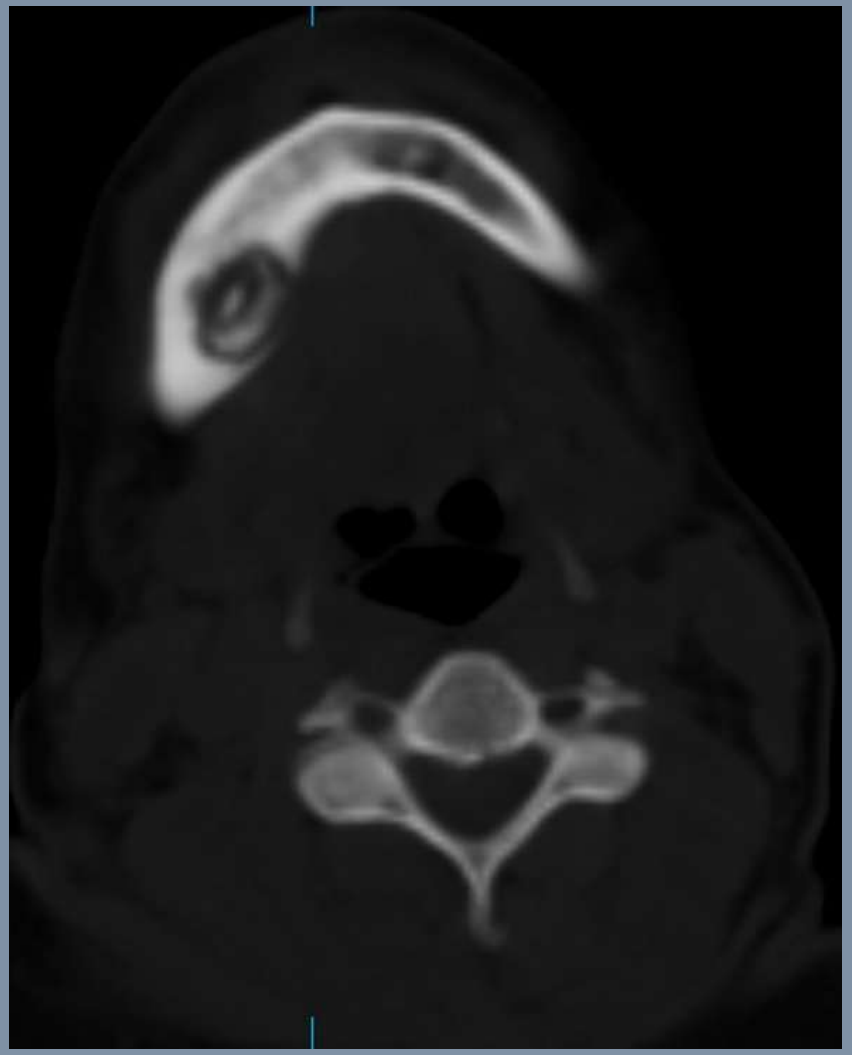

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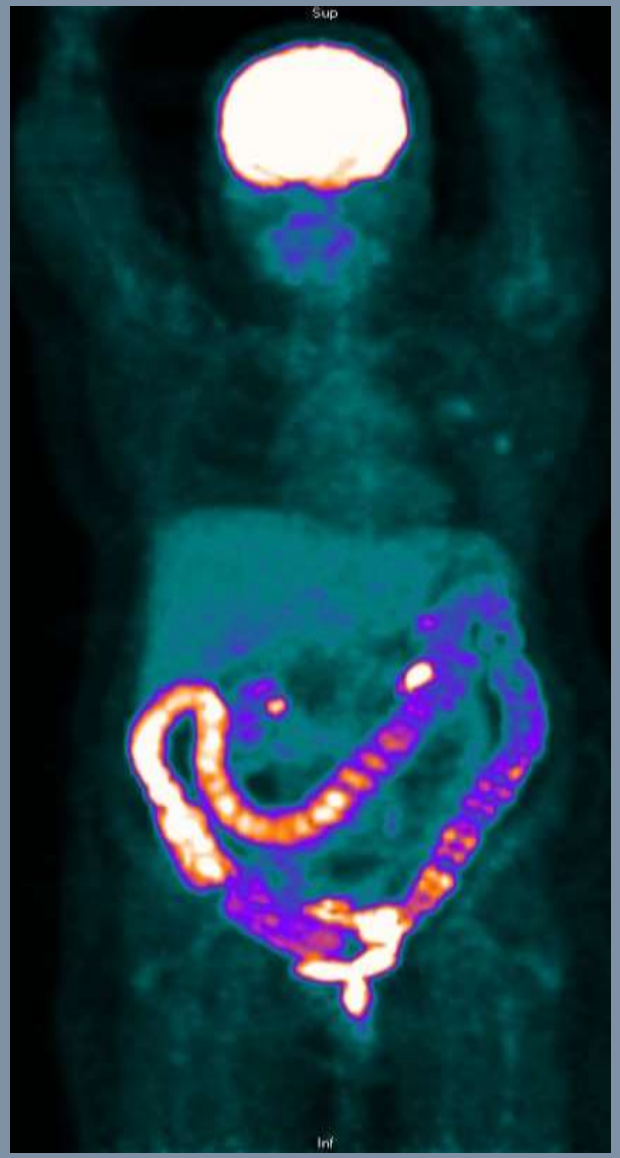

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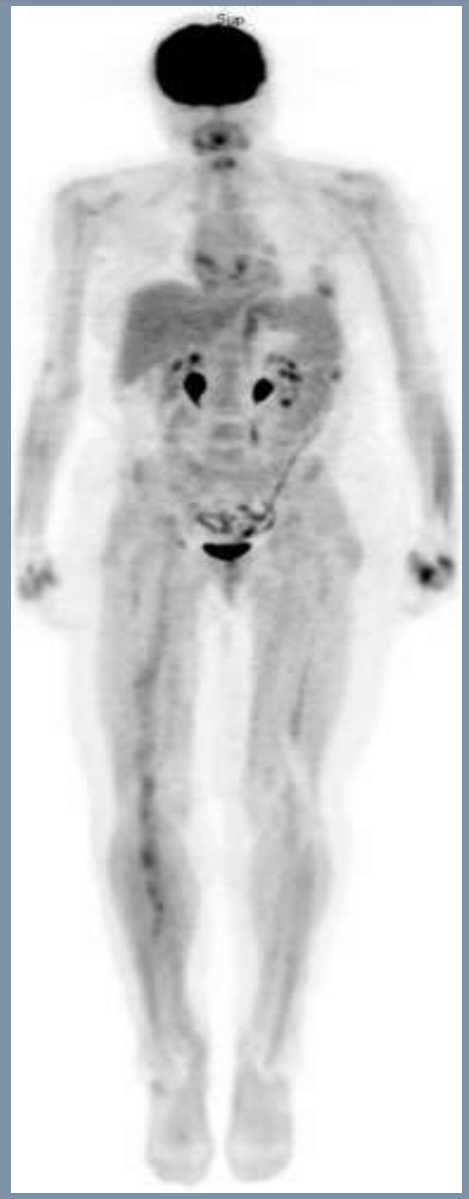

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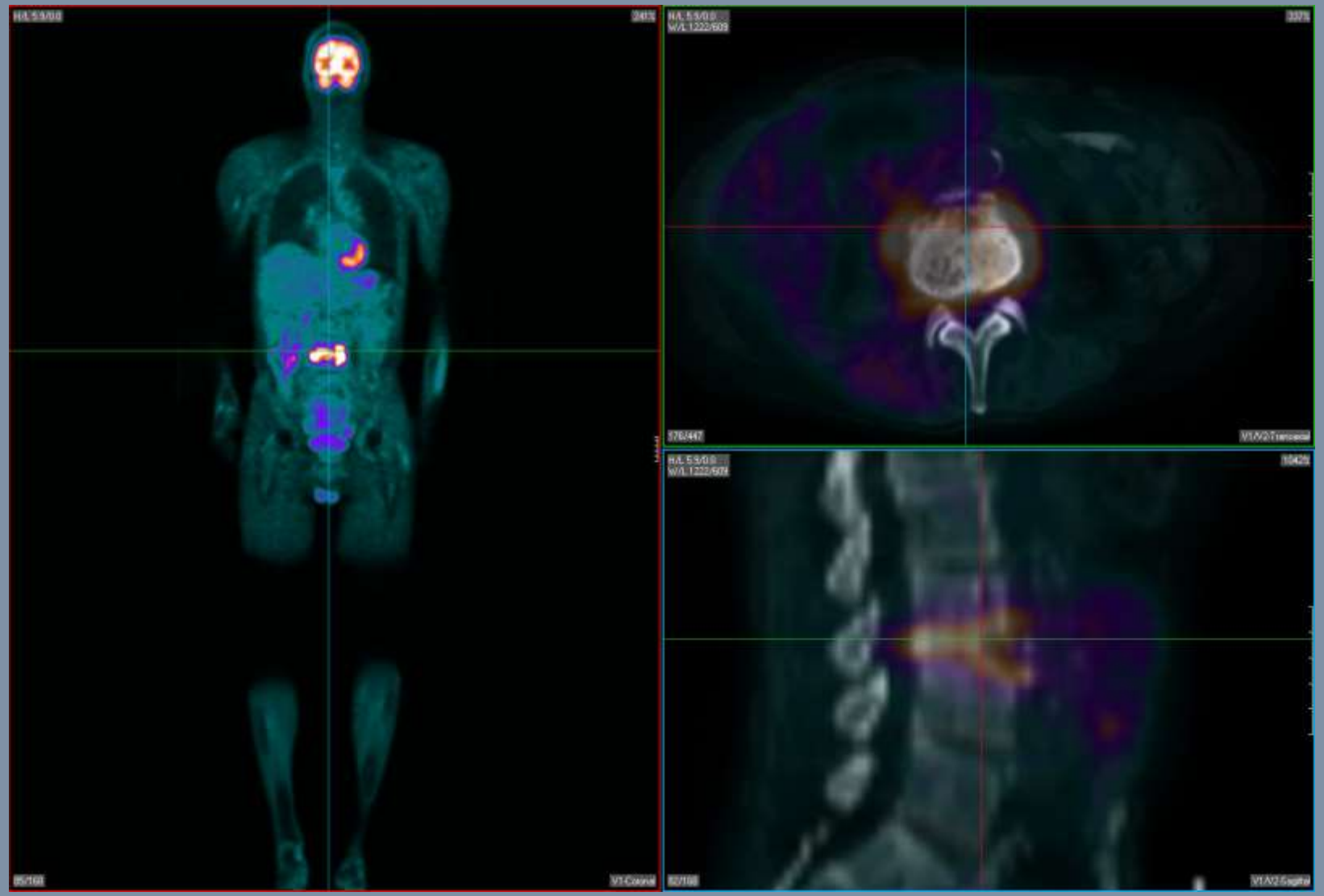

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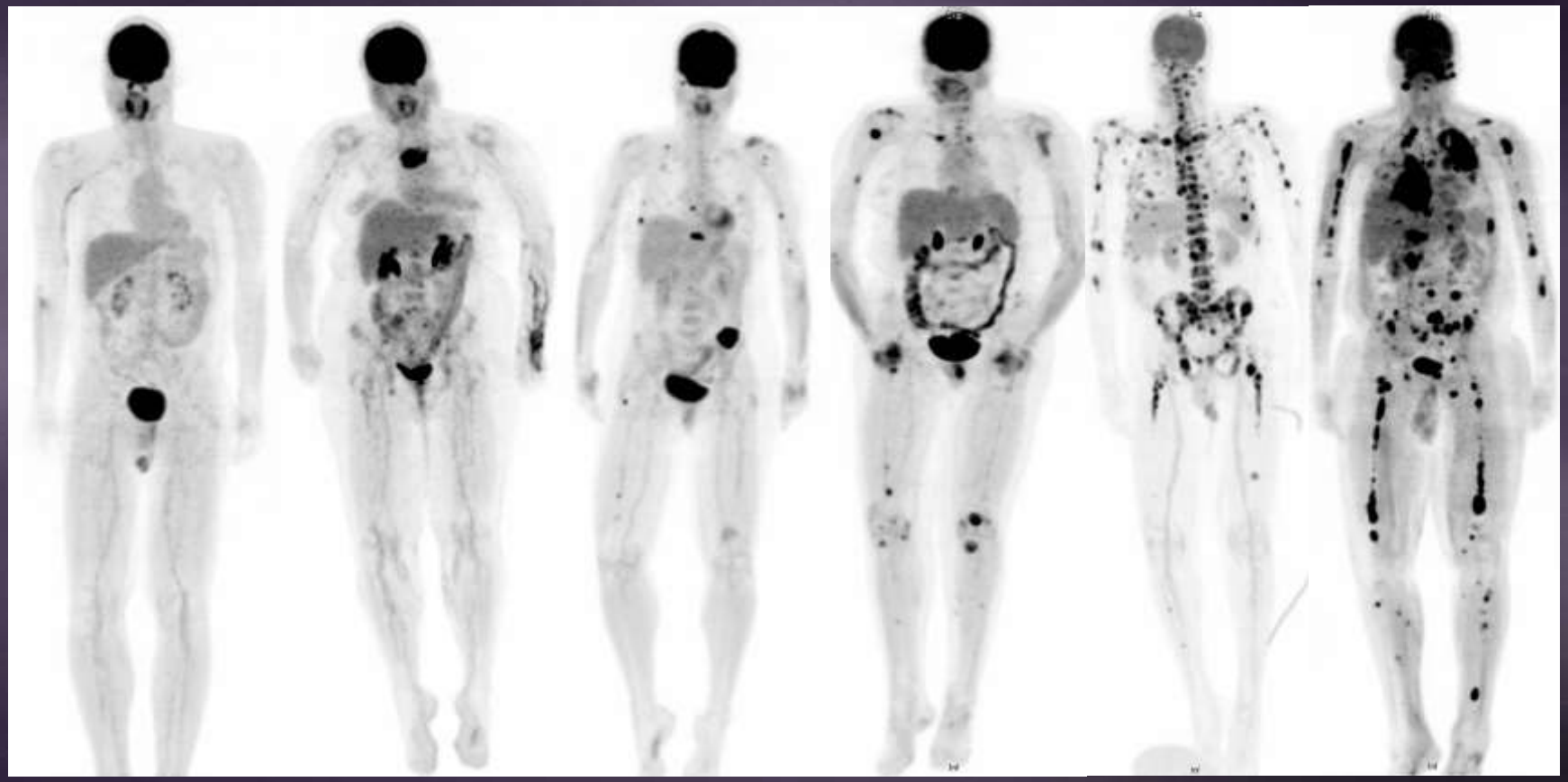
thank you



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