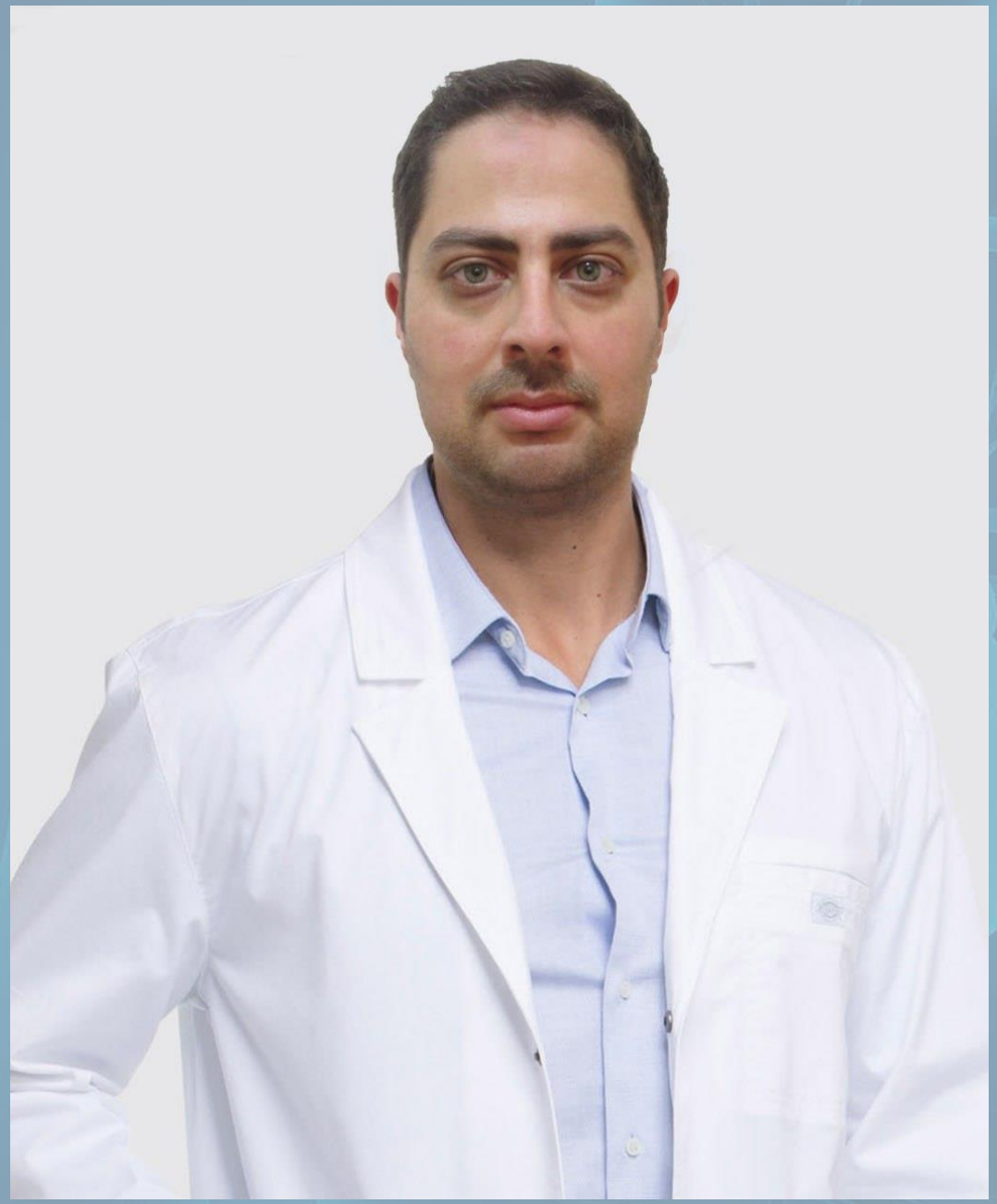

God is love


25th
International Iranian congress of nuclear medicine
Celebrating the 65 year with nuclear medicine in Iran
TEHRAN
ESPINAS
PALACE HOTEL
MAY 1-3,2025



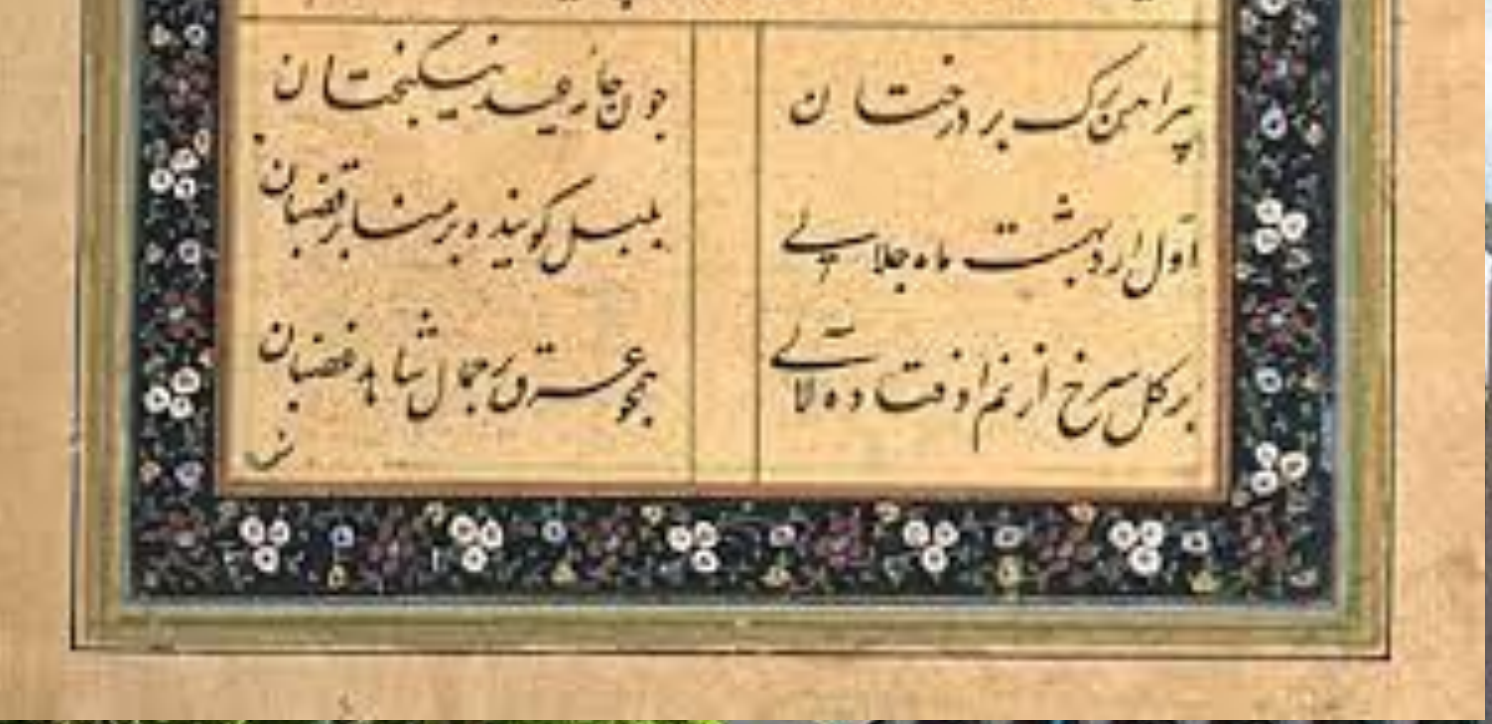
DR.MOHAMMADALI GHODSIRAD

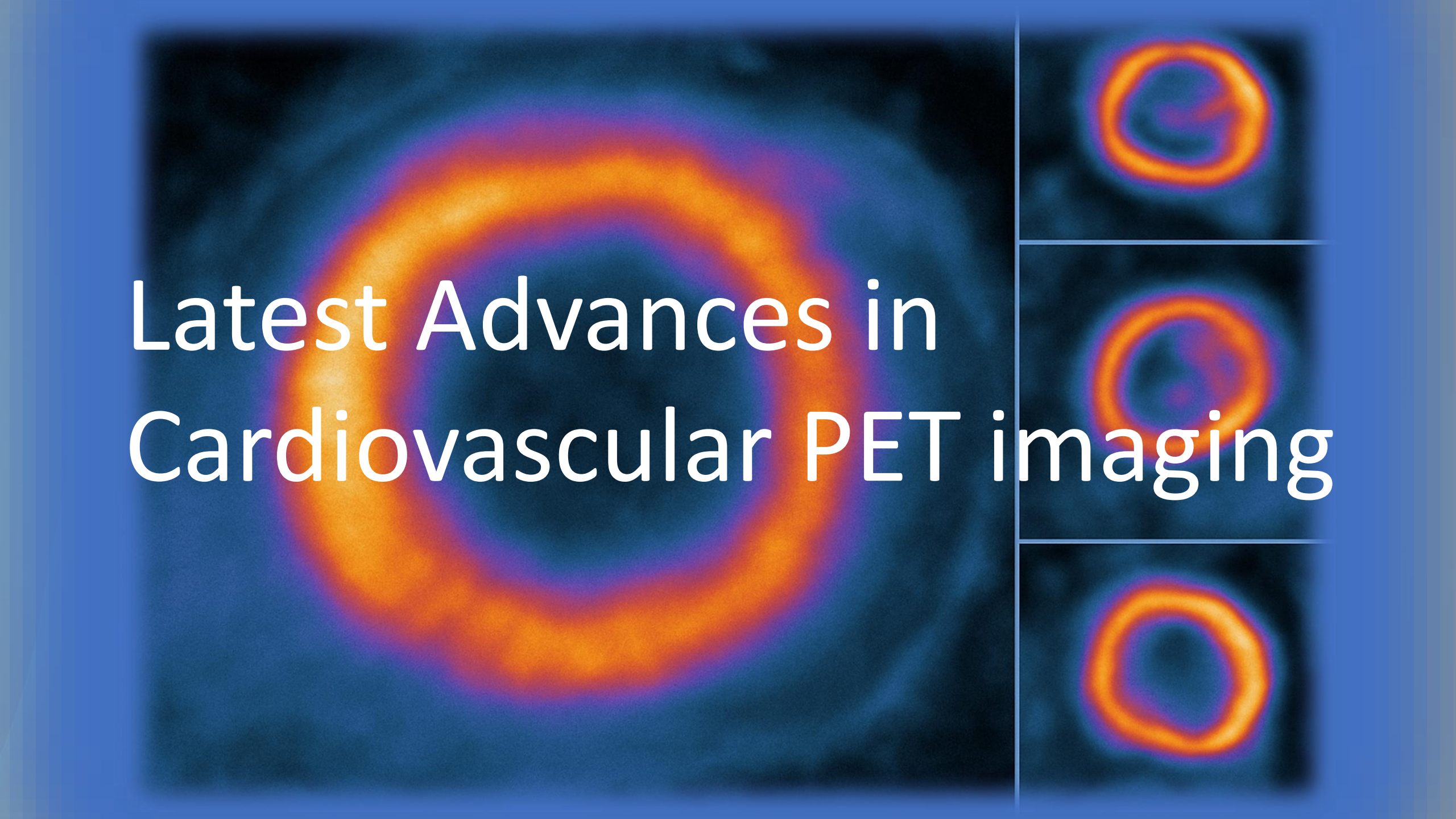
NUCLEAR MEDICINE SPECIALIST

ASSISTANT PROFESSOR OF NUCLEAR MEDICINE

FELLOW OF THE ASIAN NUCLEAR MEDICINE BOARD (FANMB)

FELLOW OF EUROPEAN BOARD OF NUCLEAR MEDICINE(FEBNM)



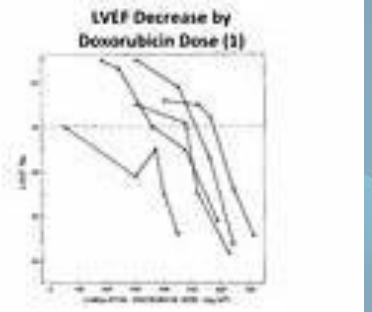

Latest Advances in
Cardiovascular PET imaging


Introduction

1970 to 1980

Gated Blood Pool Imaging
-Serial cardiac function in cancer treatment.

Planar MPI
-Stress-Redistribution TI-201 for CAD detection.

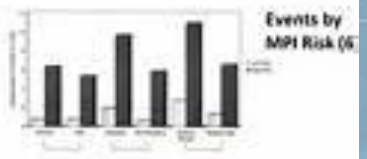


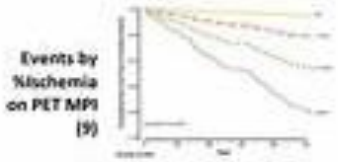
1980 to 1990

Gated SPECT MPI
-Tc99m-sestamibi/tetrofosmin

Vasodilator Stress

PET MPI
-N13-ammonia
-Rubidium-82
-O15-water

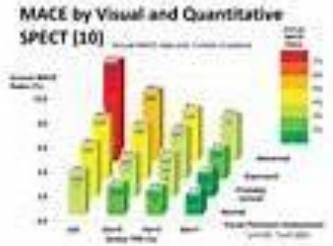




1990 to 2000

Solid-State Detector SPECT
-Efficiency, reduced dose
-Quantitation
-Attenuation correction

Viability Imaging
-Tc99m/TI-201 SPECT
-FDG/Perfusion PET



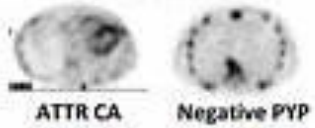
2000 to Present

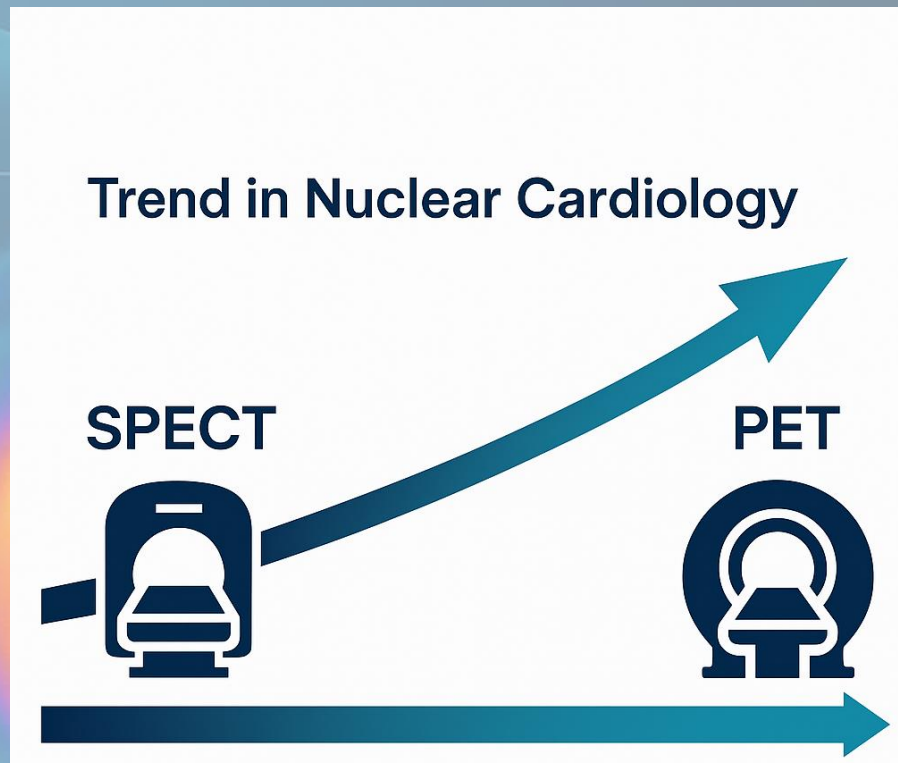
PET Absolute MBF
-MFR assessment
-Coronary microvascular dysfunction

Tc99m-PYP ATTR Cardiac Amyloid Imaging
-Importance of SPECT and benefits of CT
-Optimal timing and visual grade

FDG/Perfusion PET for Sarcoidosis
-Specific patterns for inflammation/scar
-Prognostic value

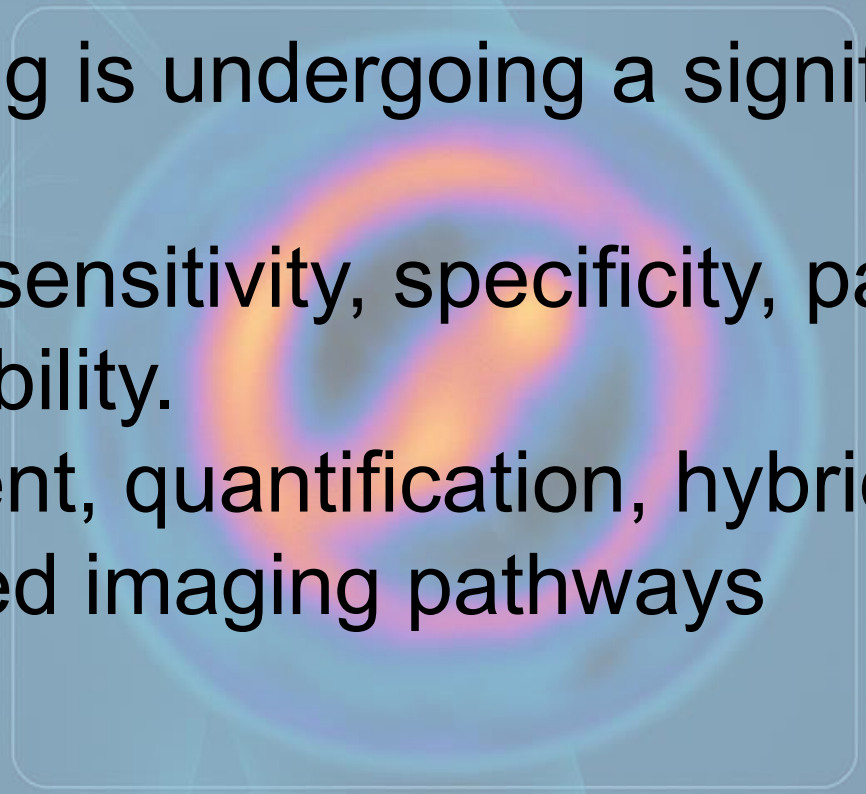
Radionuclide Imaging for CV





Introduction

- Cardiovascular PET imaging is undergoing a significant transformation.
- Recent advances improve sensitivity, specificity, patient comfort, and clinical applicability.
- Focus on tracer development, quantification, hybrid imaging, AI, and personalized imaging pathways



Recent Data on Imaging Modalities (2022)

Imaging Modality	Number of Exams (Approximate)
SPECT MPI	1.3 million
PET MPI	212,000
Stress Echocardiography	202,000
Coronary CT Angiography (CCTA)	119,000
Stress MRI	4,000

PET MPI Studies:

- Increased by approximately 25% from 2018 to 2022.
- Reflects growing adoption due to advantages like higher diagnostic accuracy and lower radiation exposure.

SPECT MPI Studies:

- Remain more prevalent in total numbers.
- However, there's a gradual decline in usage, attributed to factors such as longer imaging times and lower image resolution compared to PET.


Cardiolite®
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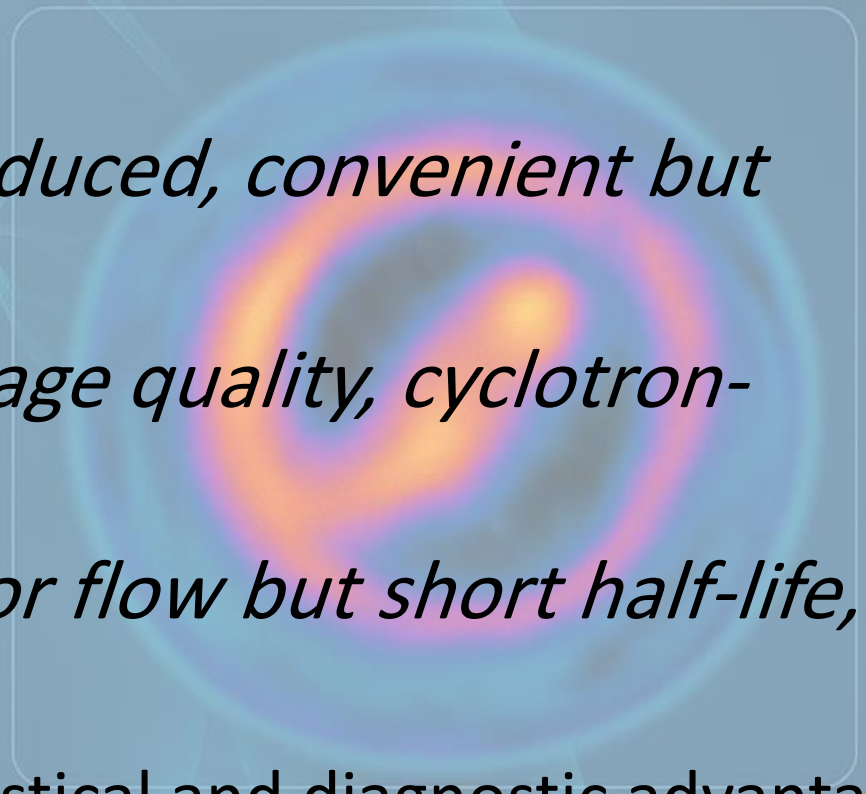
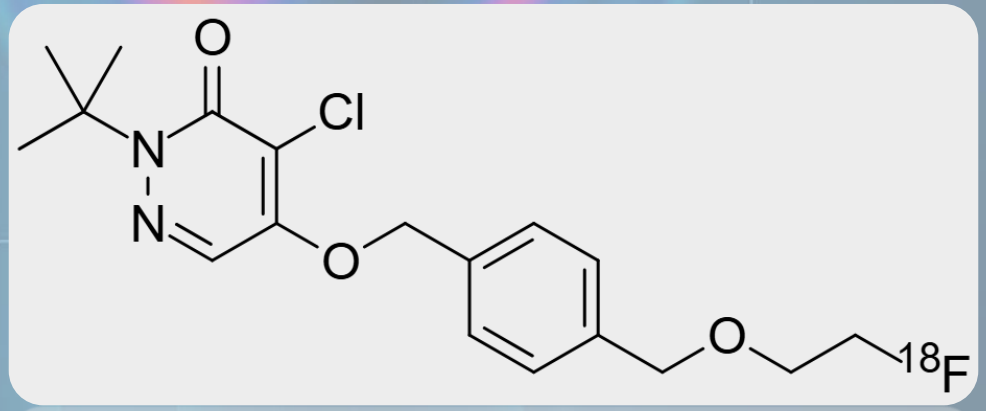
PET Radiotracers – An Overview



- ***Rubidium-82:*** *Generator-produced, convenient but expensive.*
- ***N-13 Ammonia:*** *Excellent image quality, cyclotron-dependent.*
- ***O-15 Water:*** *Gold standard for flow but short half-life, complex logistics.*
- Move toward F-18 tracers for logistical and diagnostic advantages

Flurpiridaz F-18 – A Game Changer

- FDA approval in 2024.
- Binds mitochondrial complex-1, not flow-dependent like Rubidium.
- Longer half-life (110 min): centralized production and distribution possible.
- Superior resolution and stress imaging capabilities.
- Ideal for exercise stress PET.



- Developed by GE Healthcare.
- First PET MPI tracer developed specifically for SPECT-like operational settings.
- Improved image quality in overweight and female patients.
- Designed for stress-first protocols to reduce radiation.

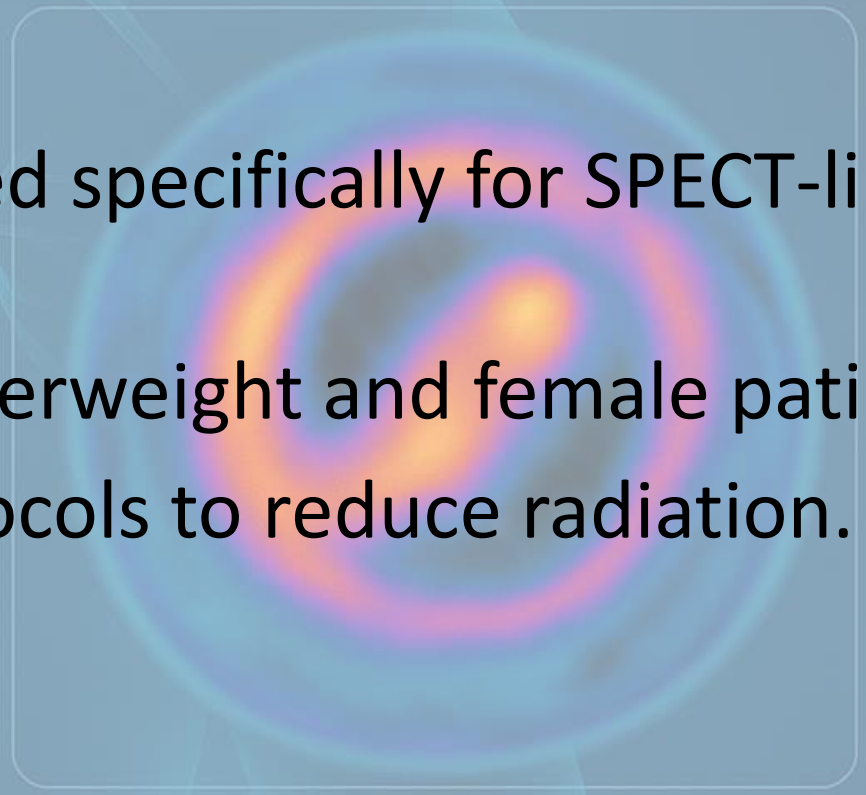
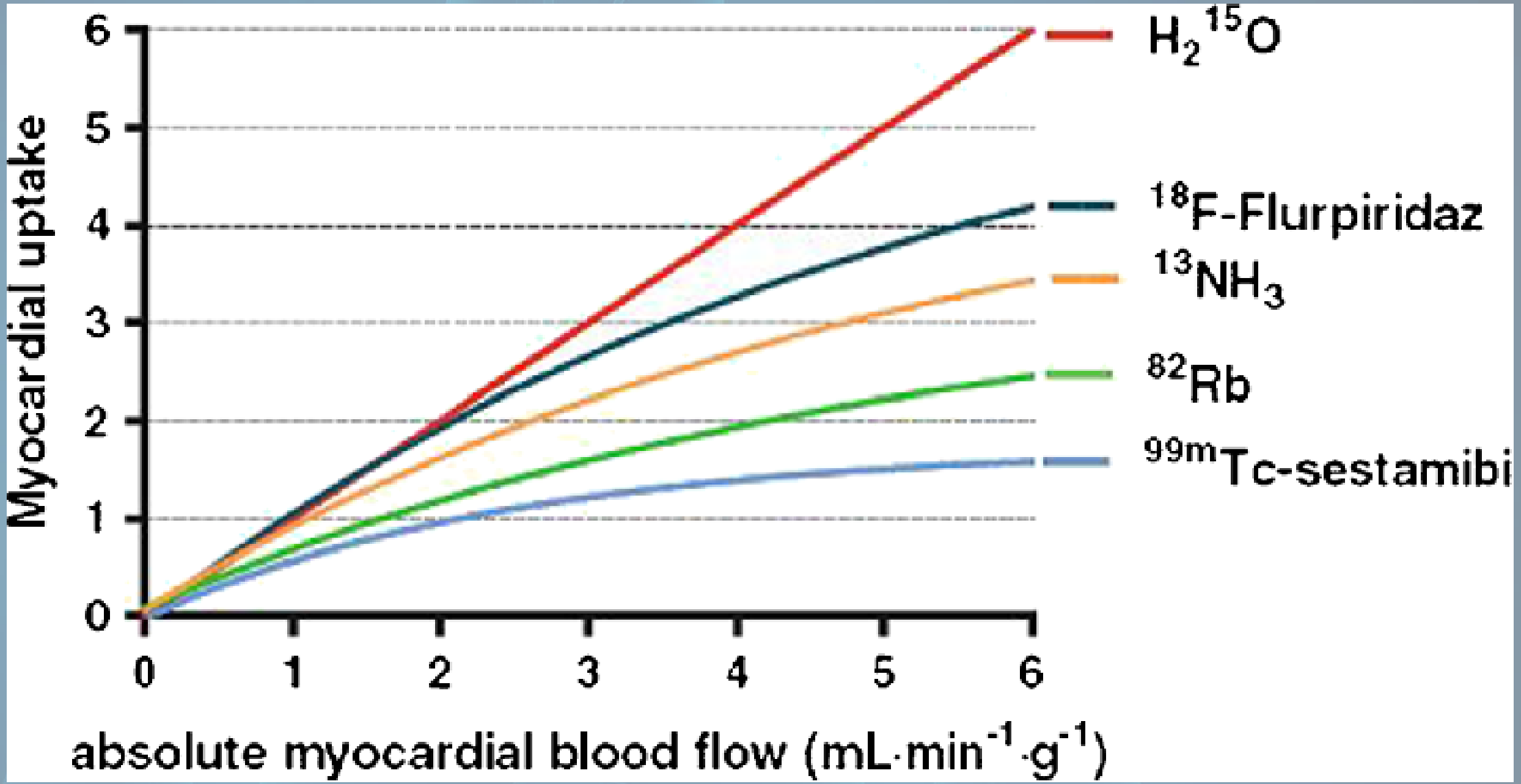
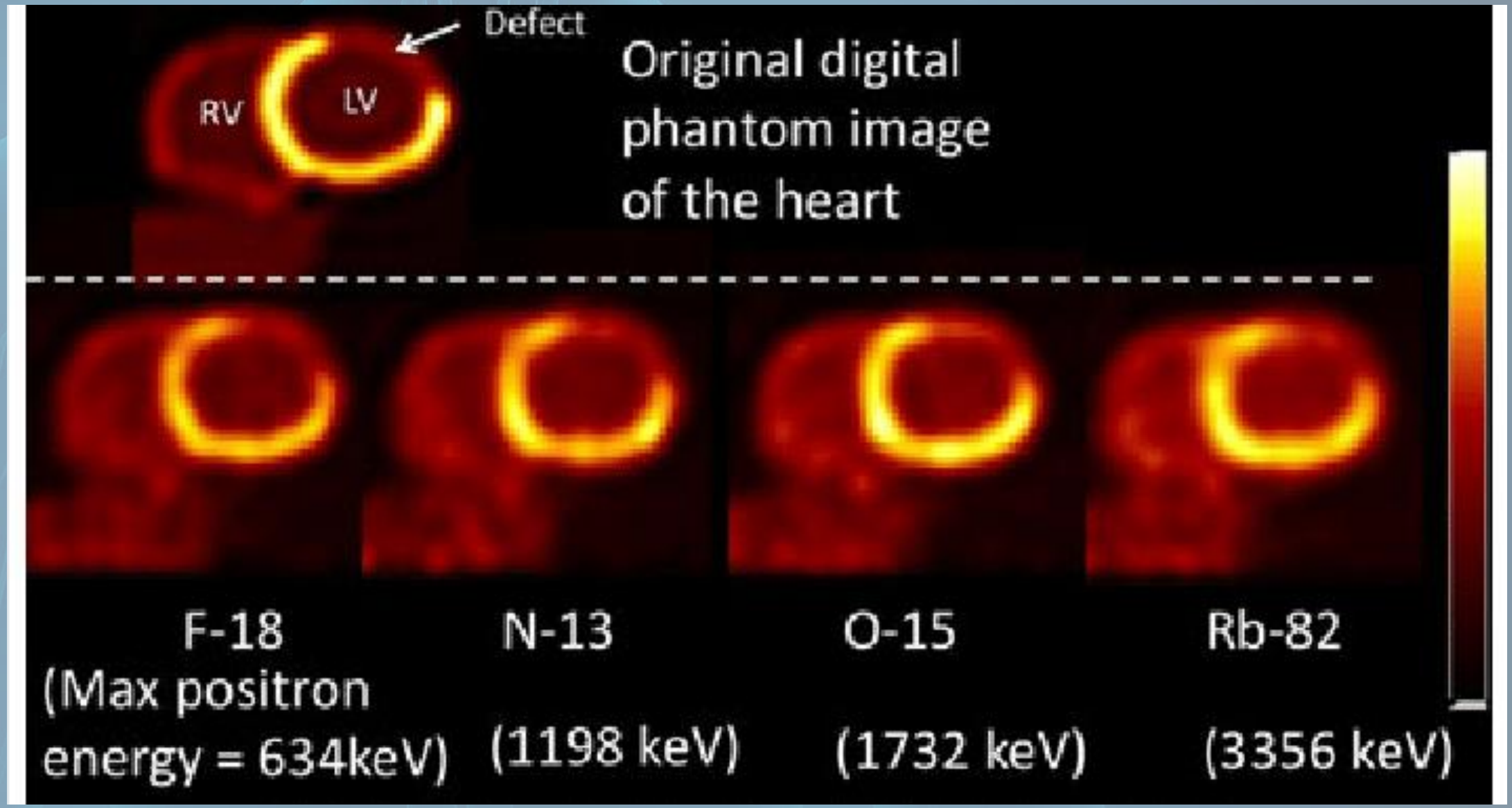
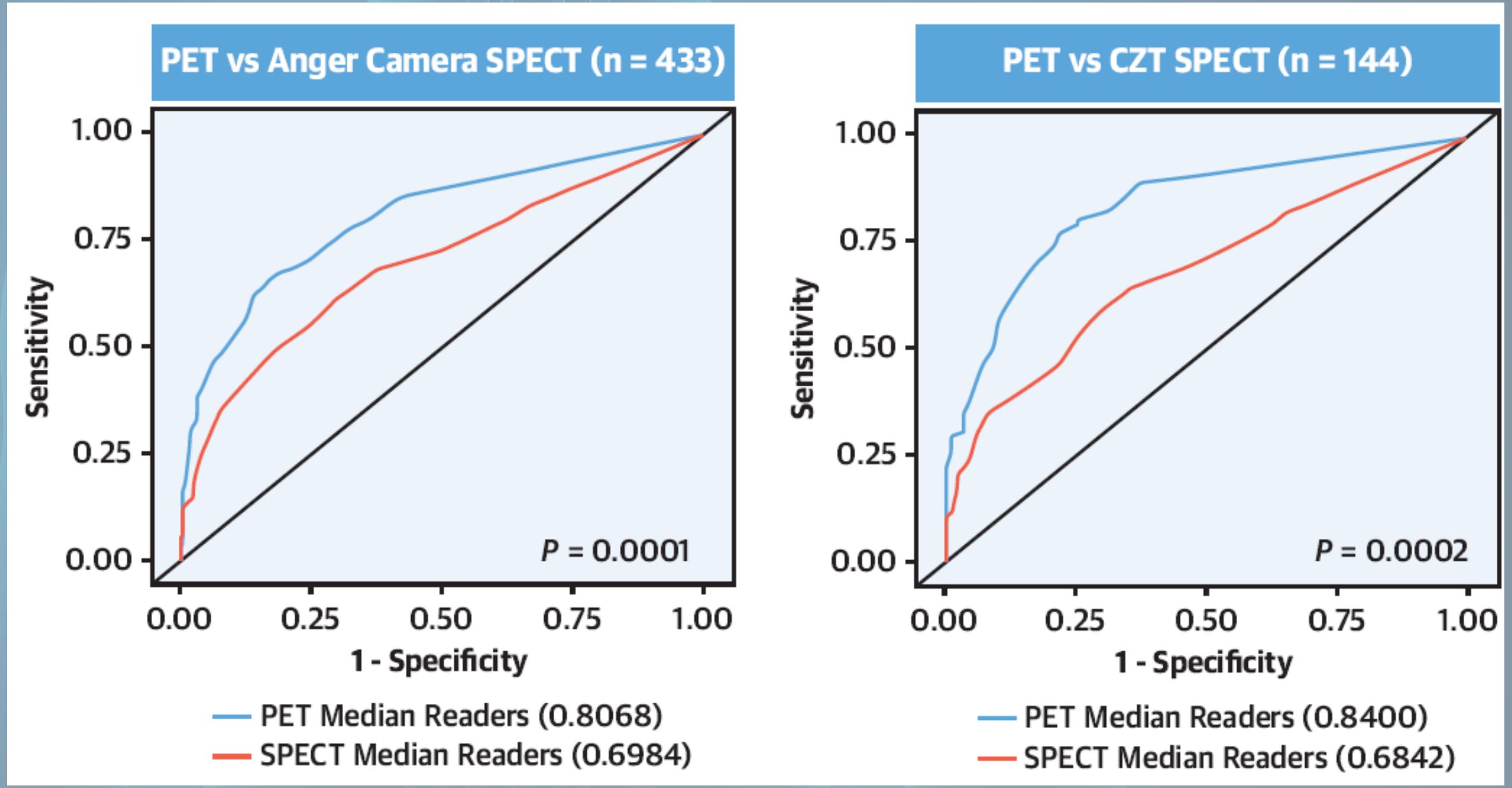


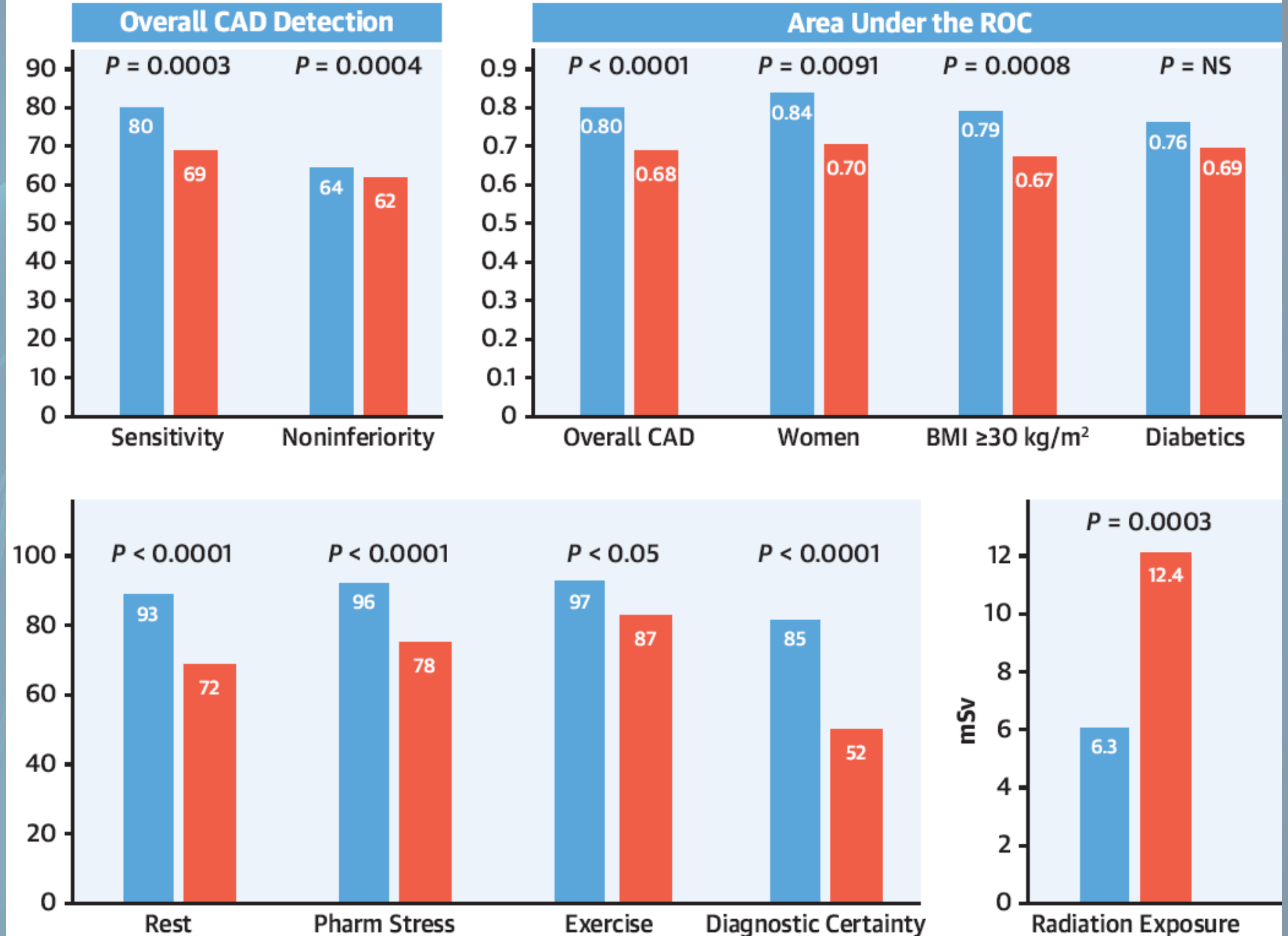
Table 1 – PET tracers used for myocardial perfusion imaging

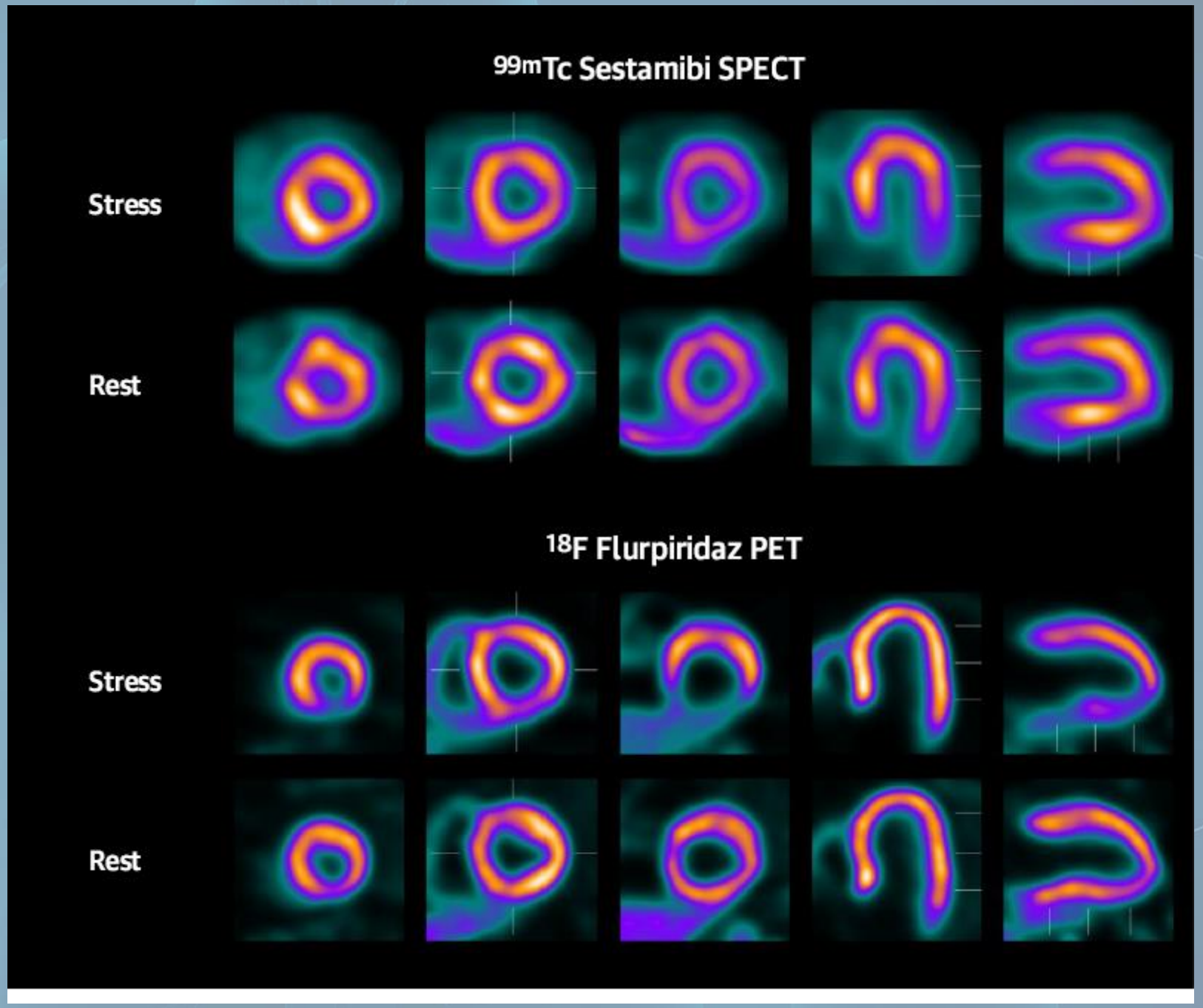
Tracer	Half-life	Production	First-pass myocardial extraction	Kinetics	Limitations
^{15}O-water	2.1 min	On-site cyclotron	100%	Diffusion	Requires cyclotron, complicated administration, sub-optimal imaging
^{13}N-ammonia	10 min	On-site cyclotron	80%	Diffusion/active transport	Requires cyclotron
^{82}Rubidium	72 s	Generator	70%	Na+/K+ cotransporter	Expensive, sub-optimal imaging
^{18}F-flurpiridaz	110 min	Centralized radiopharmacy	94%	Mitochondrial complex	Long half-time for same day procedure

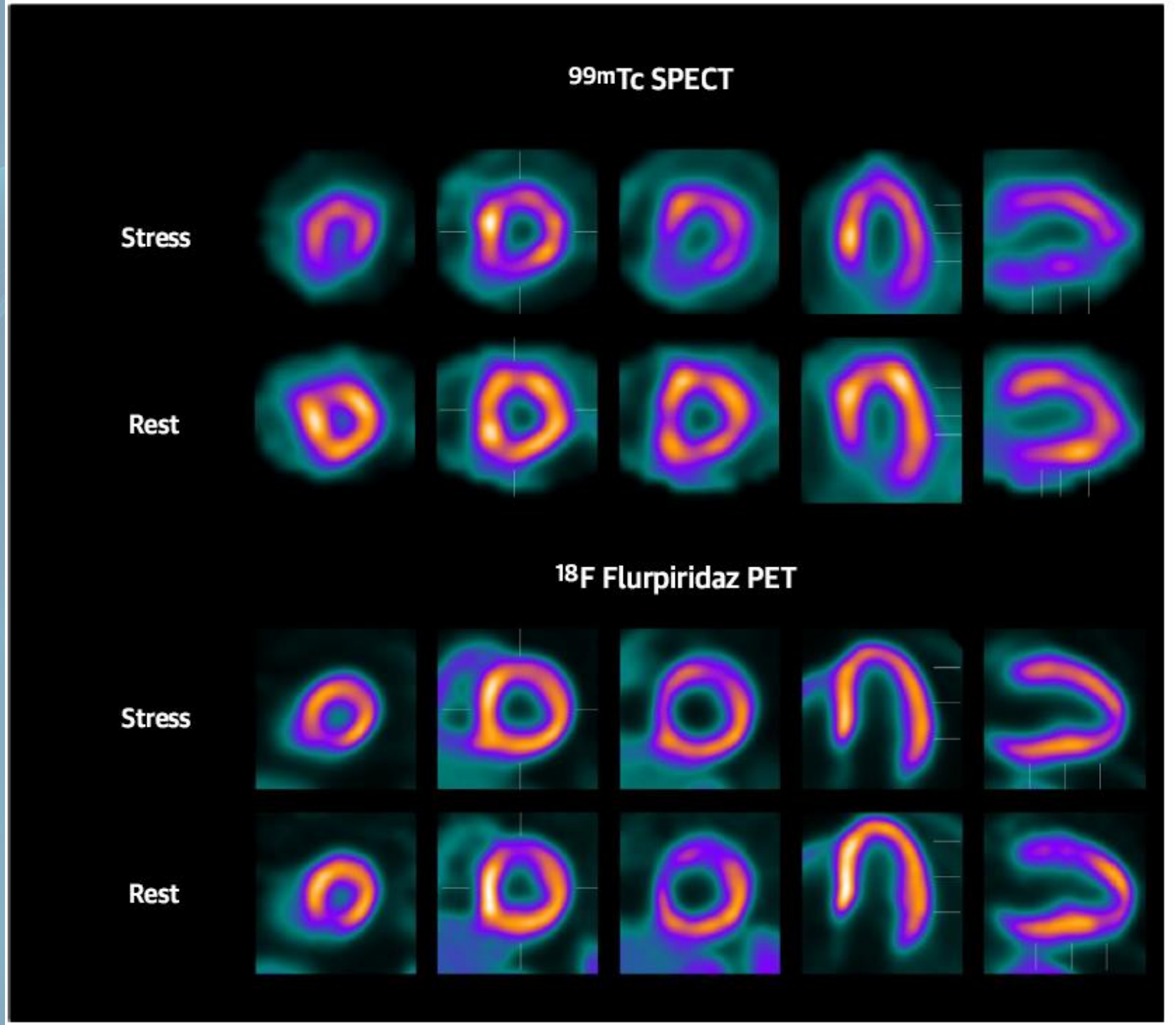

Myocardial uptake
0
1
2
3
4
5
6
absolute myocardial blood flow (mL·min-1·g-1)
H2 15O
18F-Flurpiridaz
13NH3
82Rb
99mTc-sestamibi


Defect
RV
LV
Original digital phantom image of the heart
F-18 (Max positron energy = 634keV)
N-13 (1198 keV)
O-15 (1732 keV)
Rb-82 (3356 keV)

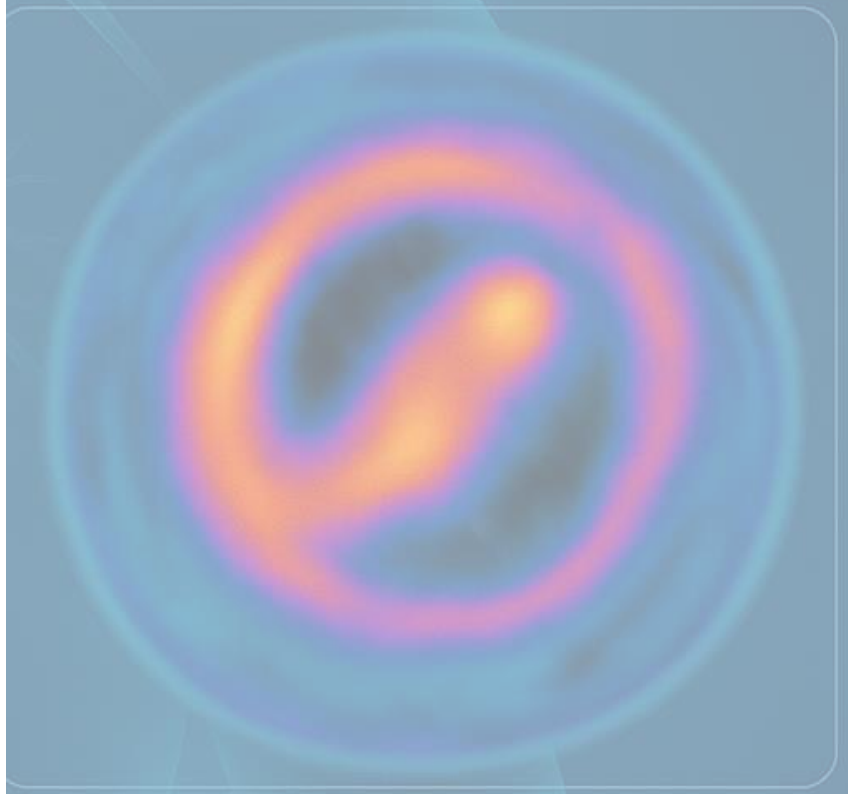

PET vs Anger Camera SPECT (n = 433)
1.00
0.75
0.50
0.25
0.00
Sensitivity
P = 0.0001
0.00
0.25
0.50
0.75
1.00
1 - Specificity
PET Median Readers (0.8068)
SPECT Median Readers (0.6984)
PET vs CZT SPECT (n = 144)
1.00
0.75
0.50
0.25
0.00
Sensitivity
P = 0.0002
0.00
0.25
0.50
0.75
1.00
1 - Specificity
PET Median Readers (0.8400)
SPECT Median Readers (0.6842)

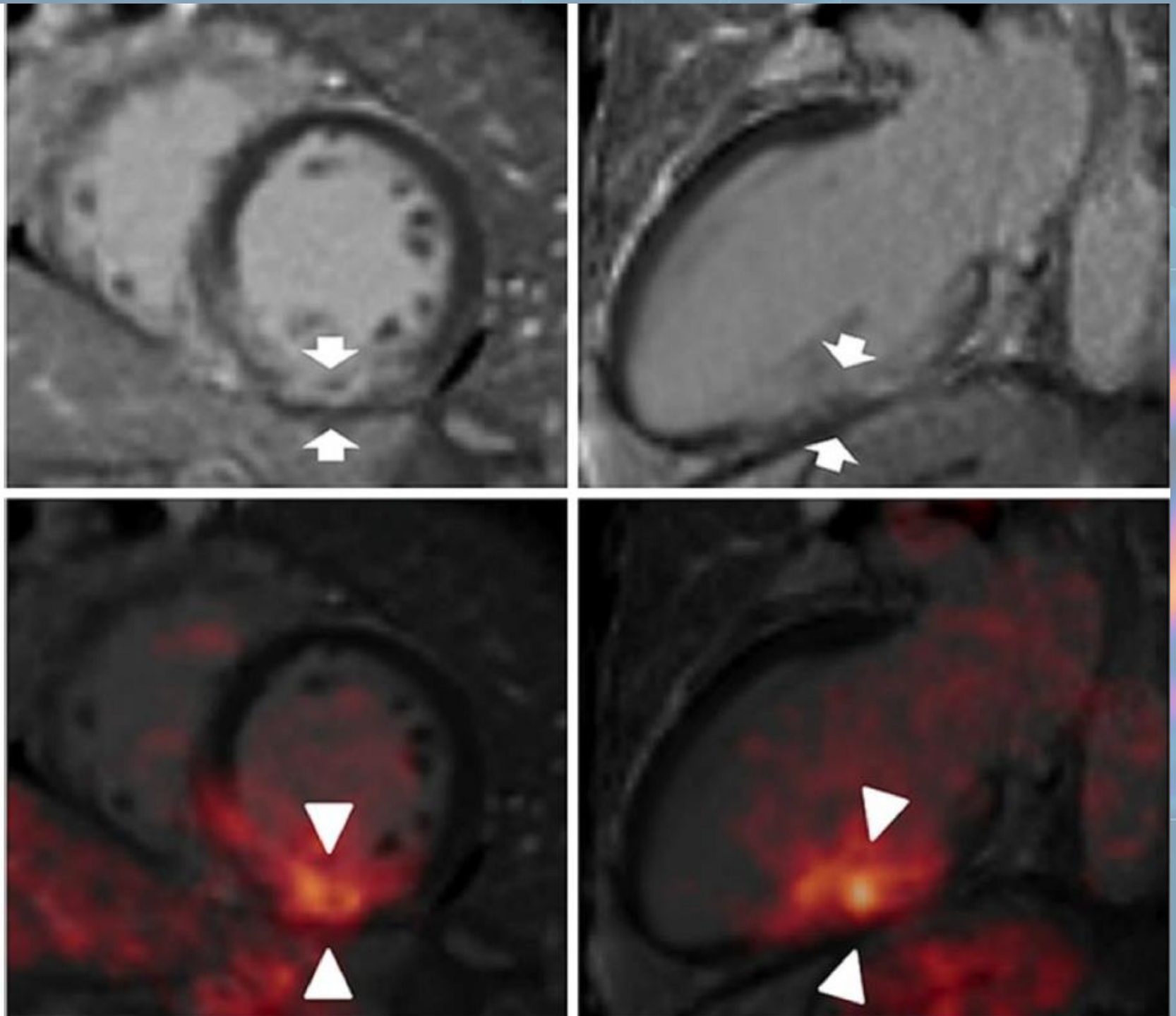

Overall CAD Detection
P = 0.0003
P = 0.0004
90
80
70
60
50
40
30
20
10
0
80
69
64
62
Sensitivity
Noninferiority
Area Under the ROC
P < 0.0001
P = 0.0091
P = 0.0008
P = NS
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.80
0.68
0.84
0.70
0.79
0.67
0.76
0.69
Overall CAD
Women
BMI ≥30 kg/m²
Diabetics
P < 0.0001
P < 0.0001
P < 0.05
P < 0.0001
100
80
60
40
20
0
93
72
96
78
97
87
85
52
Rest
Pharm Stress
Exercise
Diagnostic Certainty
P = 0.0003
12
10
8
6
4
2
0
mSv
6.3
12.4
Radiation Exposure


^{99m}Tc Sestamibi SPECT
Stress
Rest
^{18}F Flurpiridaz PET
Stress
Rest

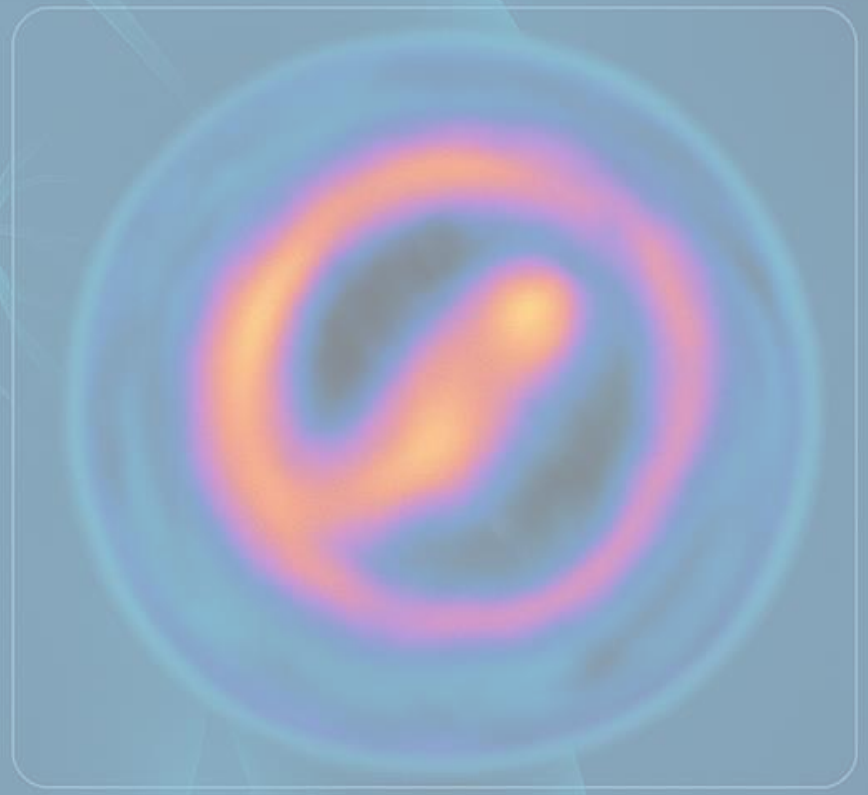

99mTc SPECT
Stress
Rest
18F Flurpiridaz PET
Stress
Rest

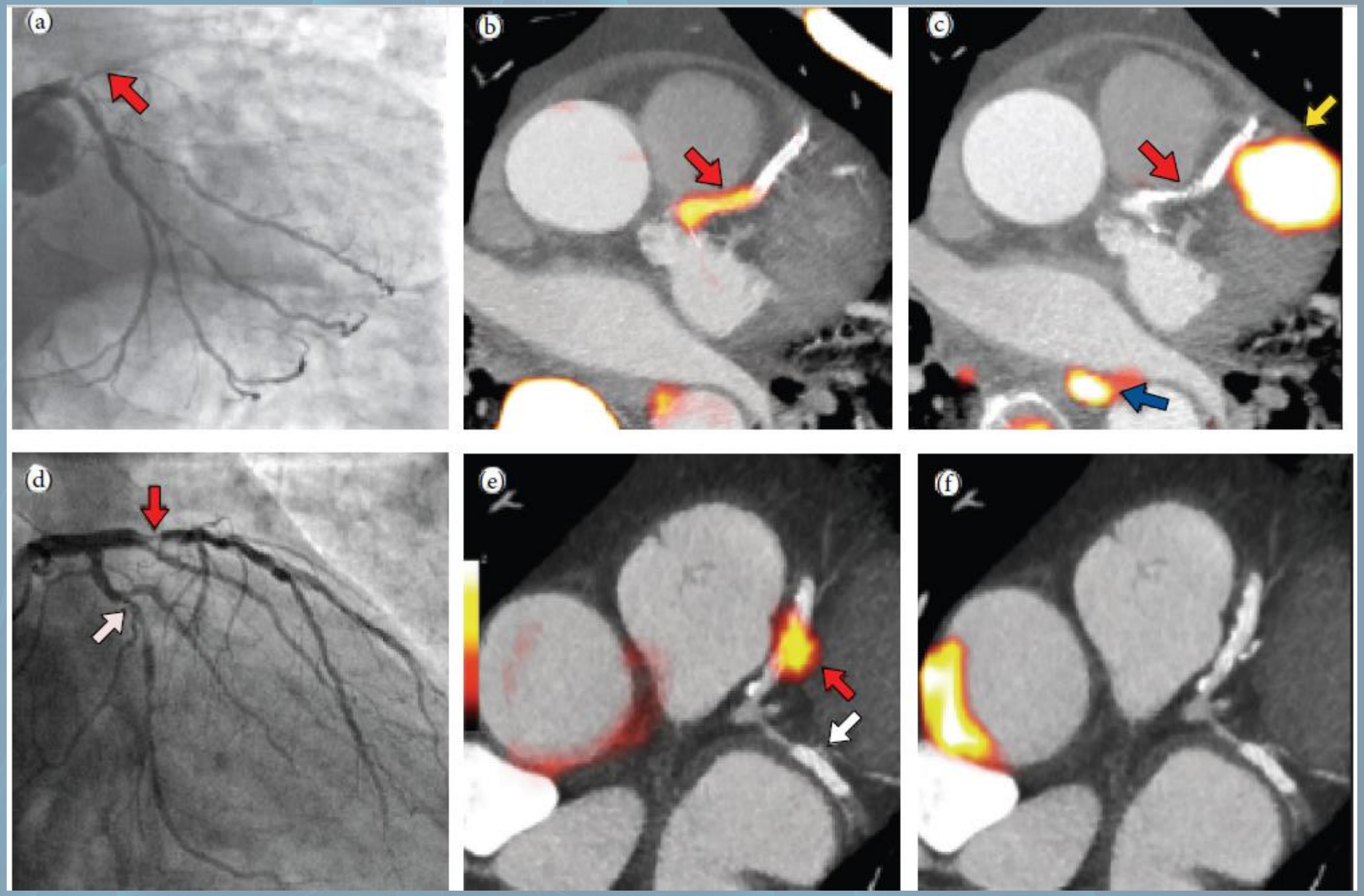

fdg

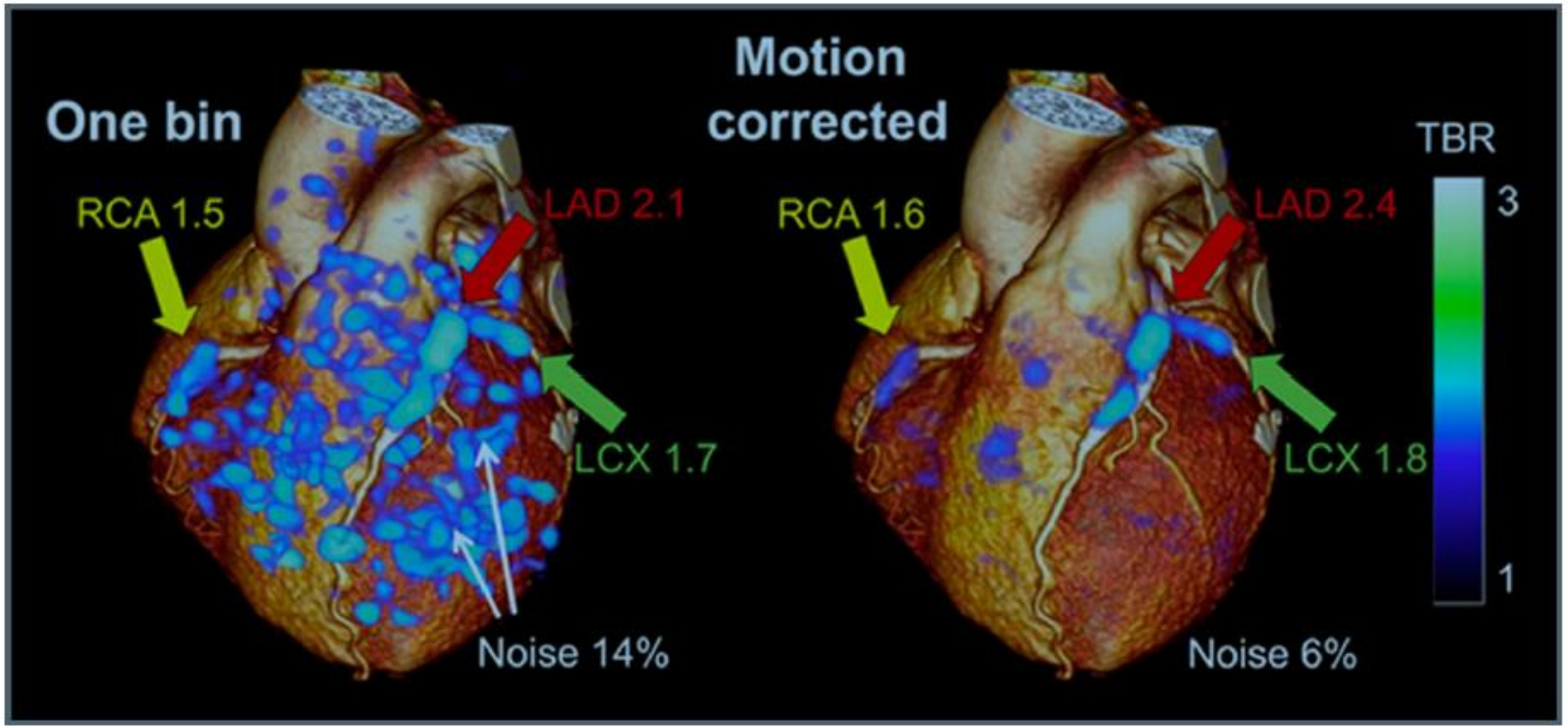


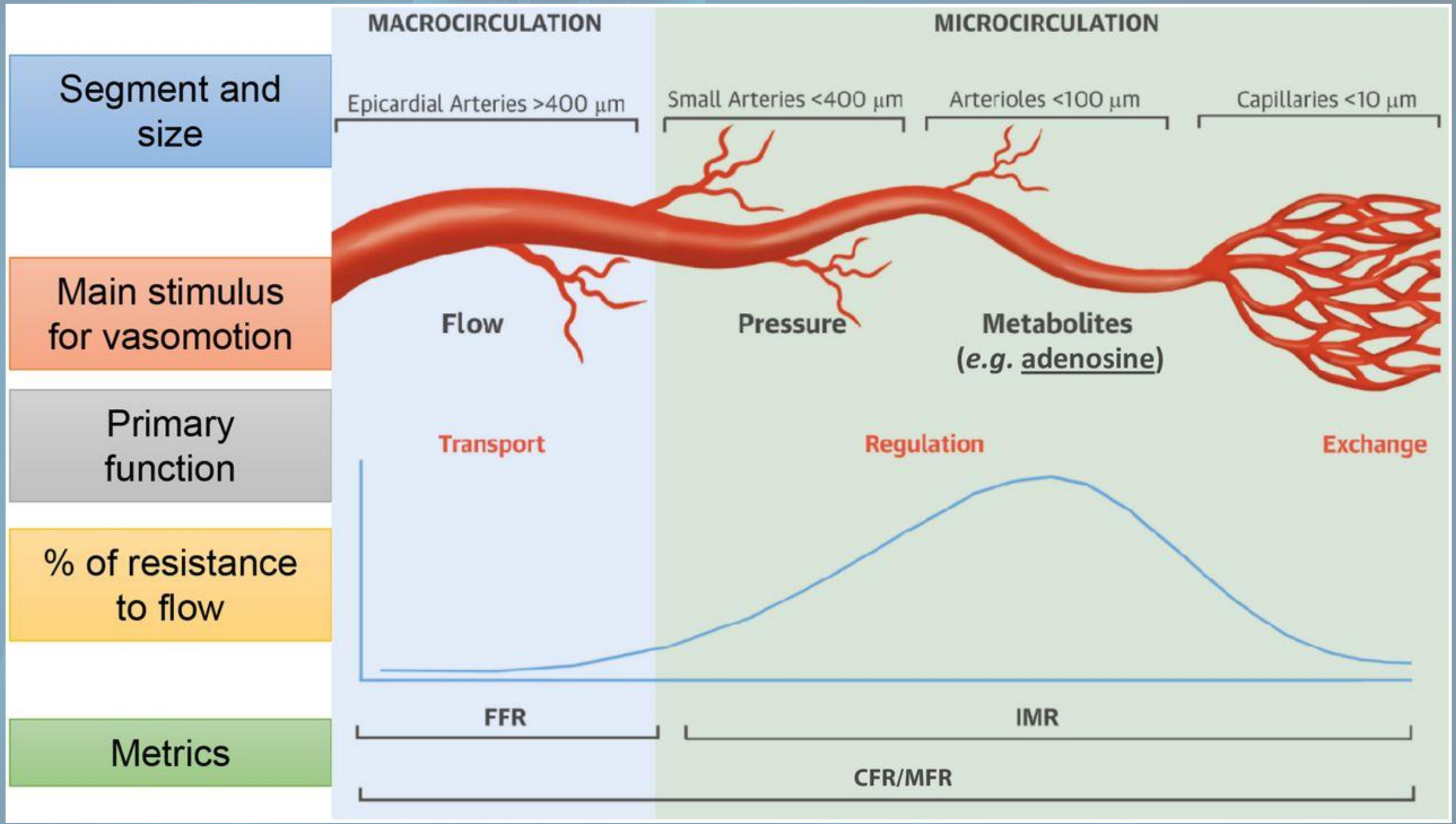



NAF




a
b
c
d
e
f

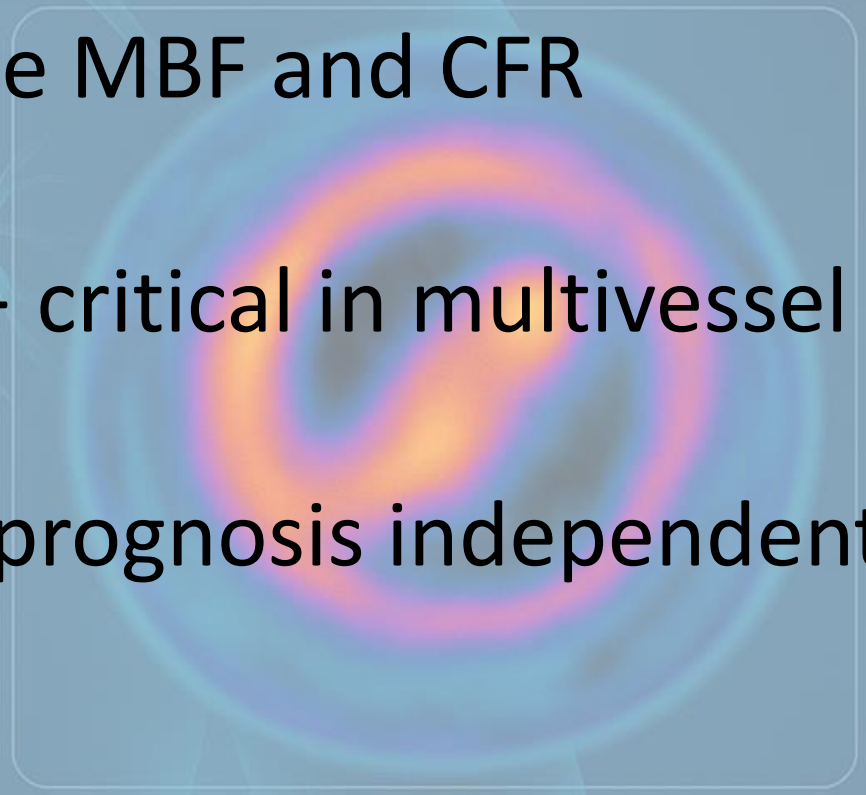

One bin
RCA 1.5
LAD 2.1
LCX 1.7
Noise 14%
Motion corrected
RCA 1.6
LAD 2.4
LCX 1.8
Noise 6%
TBR
3
1

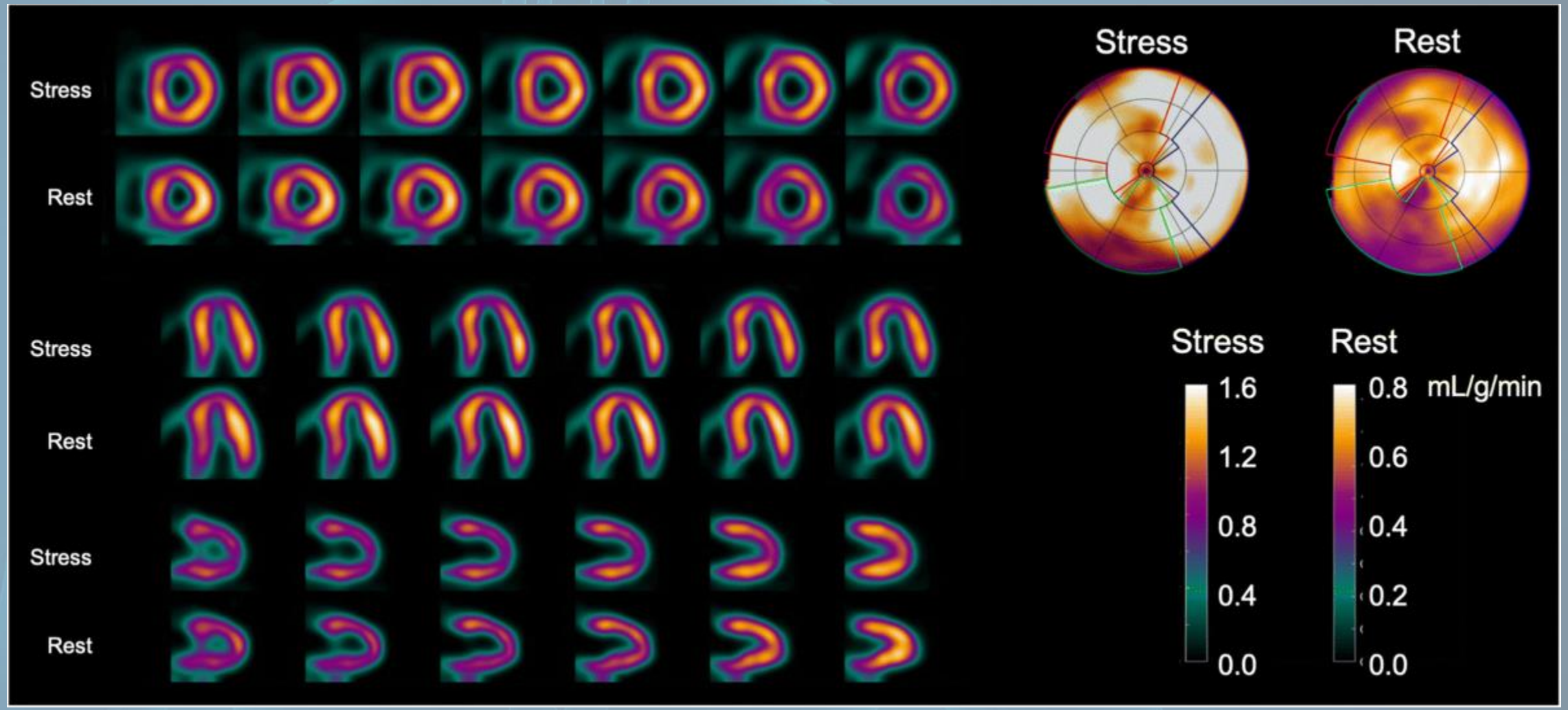

MACROCIRCULATION
MICROCIRCULATION
Segment and size
Epicardial Arteries >400 μm
Small Arteries <400 μm
Arterioles <100 μm
Capillaries <10 μm
Main stimulus for vasomotion
Flow
Pressure
Metabolites
(e.g. adenosine)
Primary function
Transport
Regulation
Exchange
% of resistance to flow
Metrics
FFR
IMR
CFR/MFR

Myocardial blood flow (MBF) and coronary flow reserve (CRF)

- **Clinical Applications of MBF Measurement**
- Diagnosis of microvascular angina.
- Risk assessment in diabetes, obesity, CKD populations.
- Better guidance for revascularization decisions.

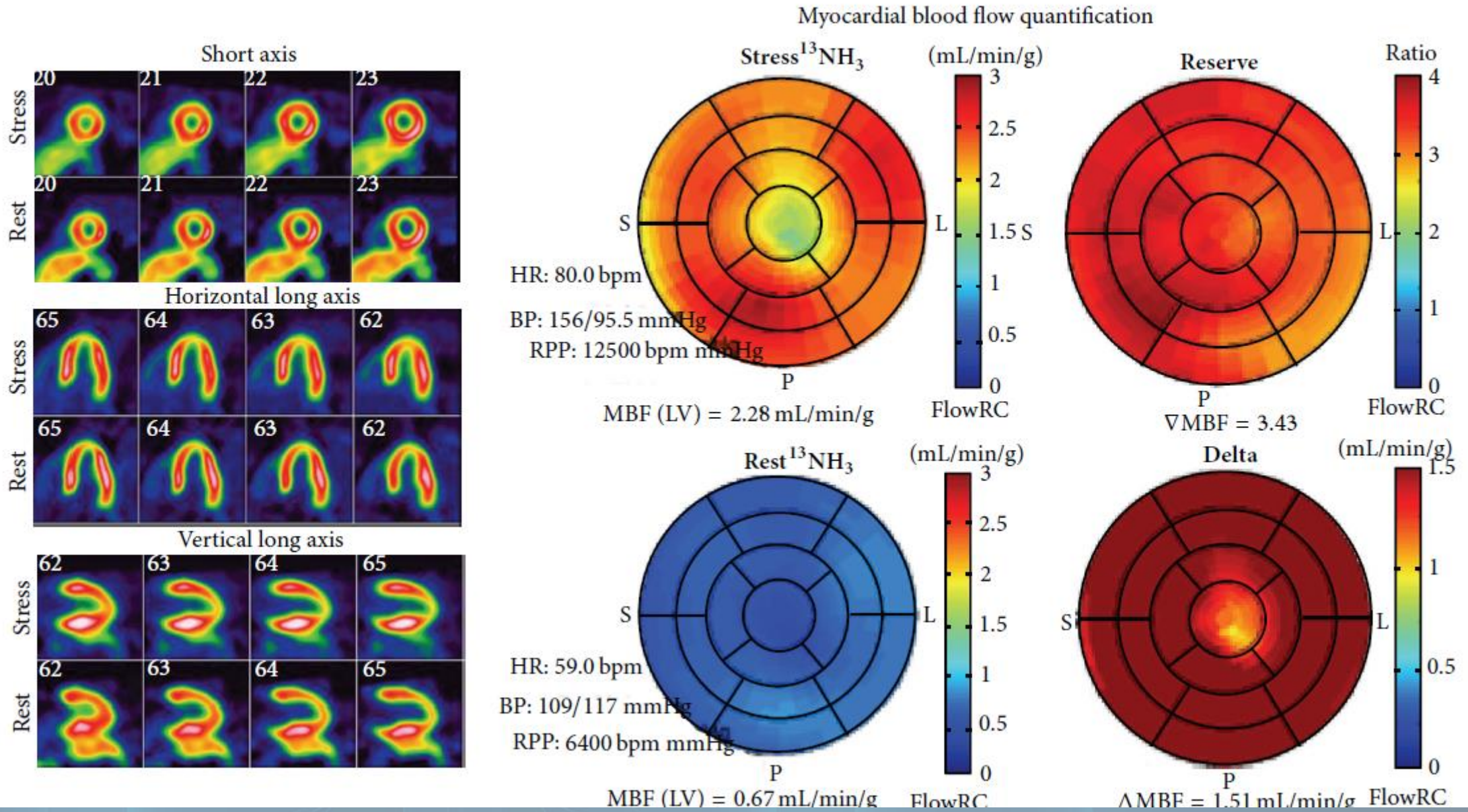
- PET uniquely enables absolute MBF and CFR measurements.
- Identify balanced ischemia — critical in multivessel disease.
- MBF quantification linked to prognosis independent of anatomical severity.




Stress
Rest
Stress
Rest
Stress
Rest
Stress
Rest
Stress
Rest
Stress
1.6
1.2
0.8
0.4
0.0
Rest
0.8
0.6
0.4
0.2
0.0
mL/g/min

Subgroup (n)	MBF rest (ml/g/min)	MFR (stress/rest ratio)
Age < 50 (30)	**1.05 ± 0.23**	**2.66 ± 0.67**
Age 50–59 (45)	0.99 ± 0.21	2.73 ± 0.69[a]
Age 60–69 (73)	0.99 ± 0.22[a]	2.66 ± 0.54
Age ≥ 70 (58)	1.08 ± 0.23	2.39 ± 0.56[a]

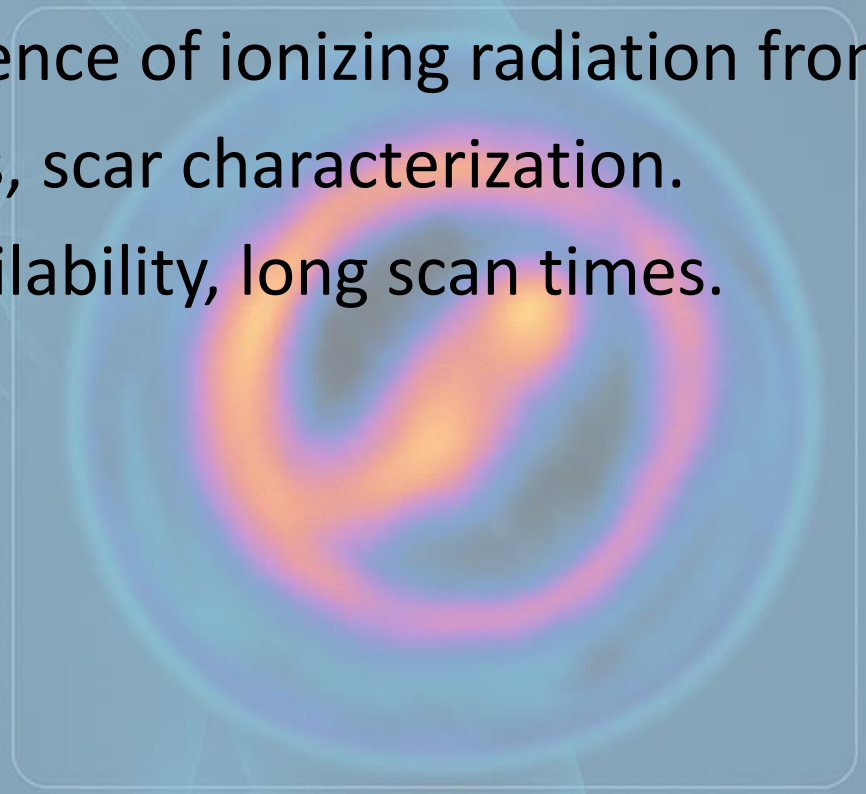
1 more row • Khordad 21, 1397 AP


Short axis
Stress
Rest
20
21
22
23
Horizontal long axis
65
64
63
62
Vertical long axis
62
63
64
65
Myocardial blood flow quantification
Stress $^{13}NH_3$
(mL/min/g)
3
2.5
2
1.5
1
0.5
0
S
L
P
FlowRC
HR: 80.0 bpm
BP: 156/95.5 mmHg
RPP: 12500 bpm mmHg
MBF (LV) = 2.28 mL/min/g
Reserve
Ratio
4
3
2
1
0
∇MBF = 3.43
Rest $^{13}NH_3$
HR: 59.0 bpm
BP: 109/117 mmHg
RPP: 6400 bpm mmHg
MBF (LV) = 0.67 mL/min/g
Delta
1.5
0.5
ΔMBF = 1.51 mL/min/g

- Patients without known prior history of cardiac disease who present with symptoms suspicious for myocardial ischemia;
- Patients with known CAD, in whom more specific physiological assessment is desired;
- Identifying an increased suspicion for multivessel CAD;
- Situations with a disparity between visual perfusion abnormalities and apparently normal coronary angiography, in order to assess possible microvascular dysfunction;
- Heart transplant when there is a question of vasculopathy.

PET/MRI – The Emerging Modality

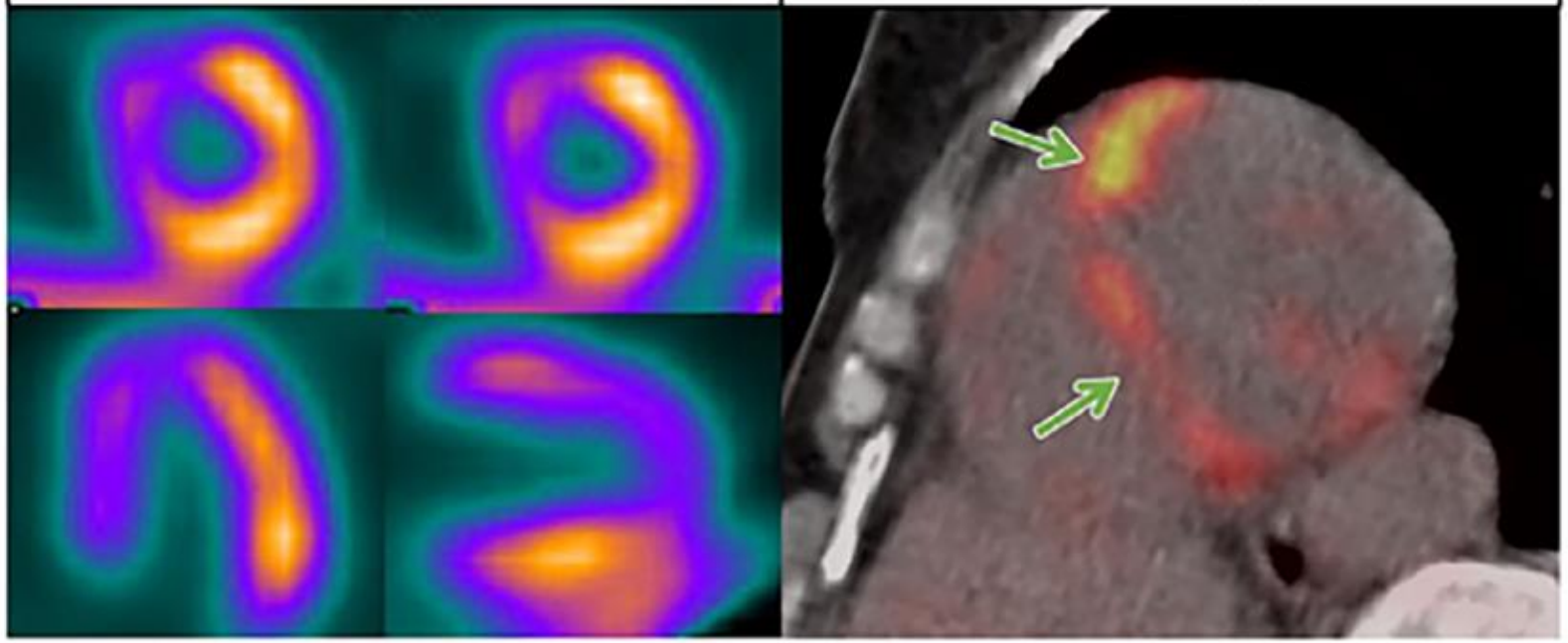
- Superior soft-tissue imaging, absence of ionizing radiation from MRI.
- Better myocardial edema, fibrosis, scar characterization.
- Challenges: high cost, limited availability, long scan times.



SPECT and PET/CT

SESTAMIBI SPECT

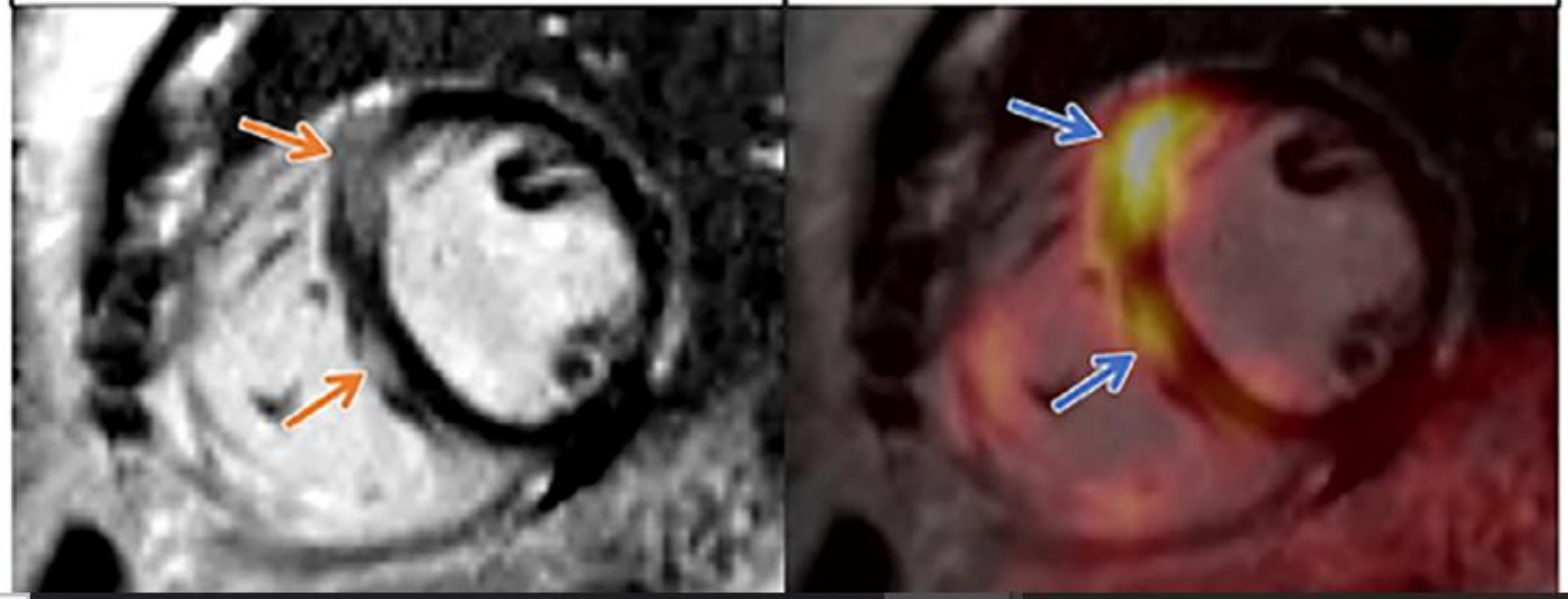
^{18}F-FDG PET/CT



COMBINED PET/MRI

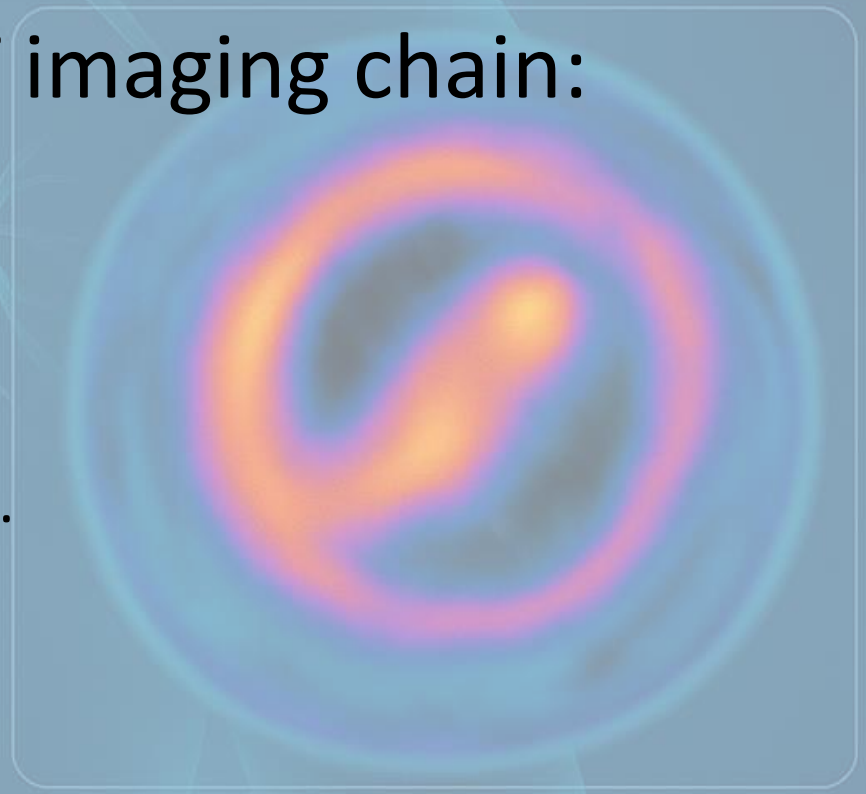
CARDIAC MRI LGE

^{18}F-FDG PET/MRI (FUSED WITH LGE)

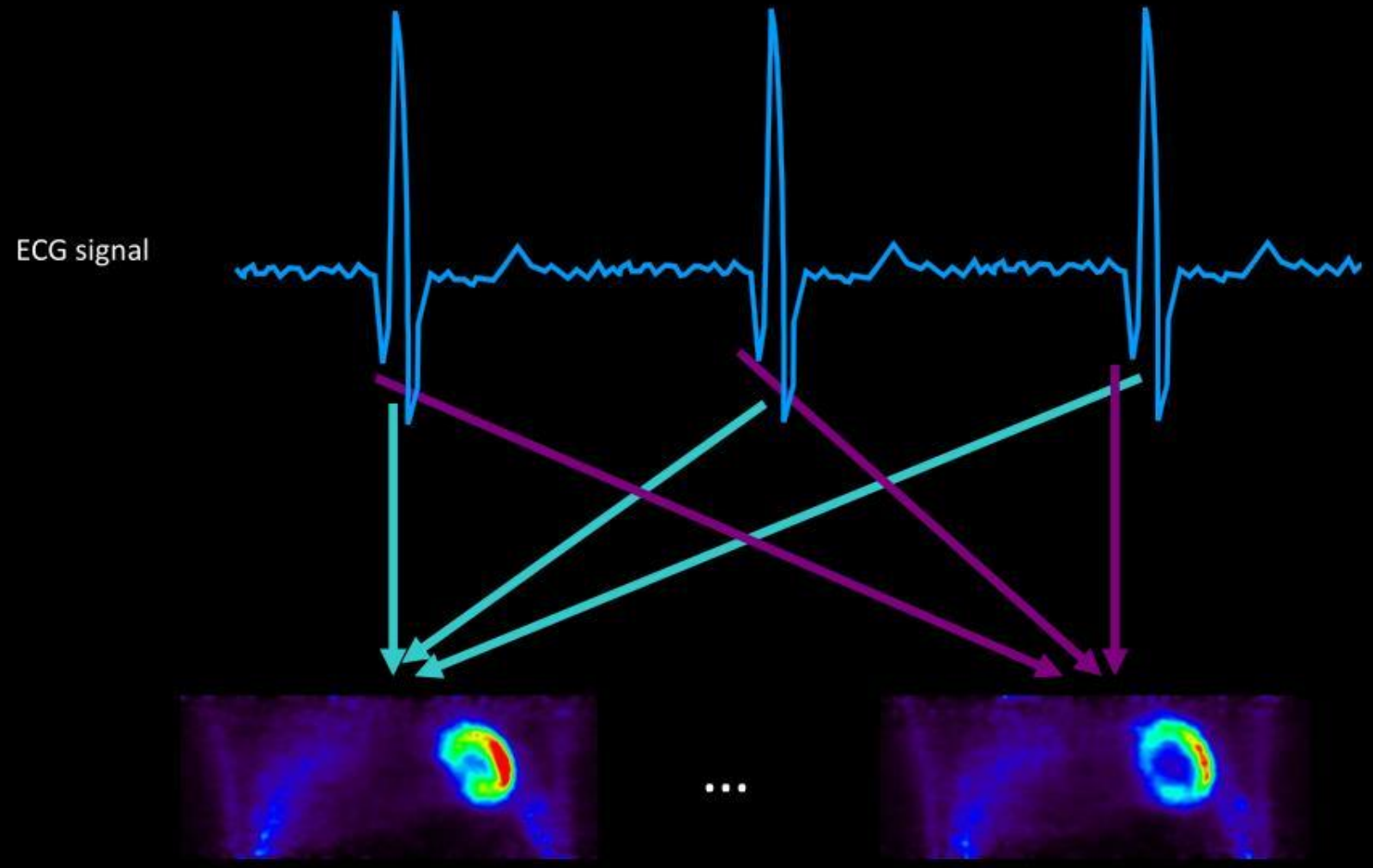


Artificial Intelligence in PET Imaging

- AI now applied across PET imaging chain:
  - Motion correction.
  - Automated segmentation.
  - Quantitative analysis.
  - Risk prediction algorithms.

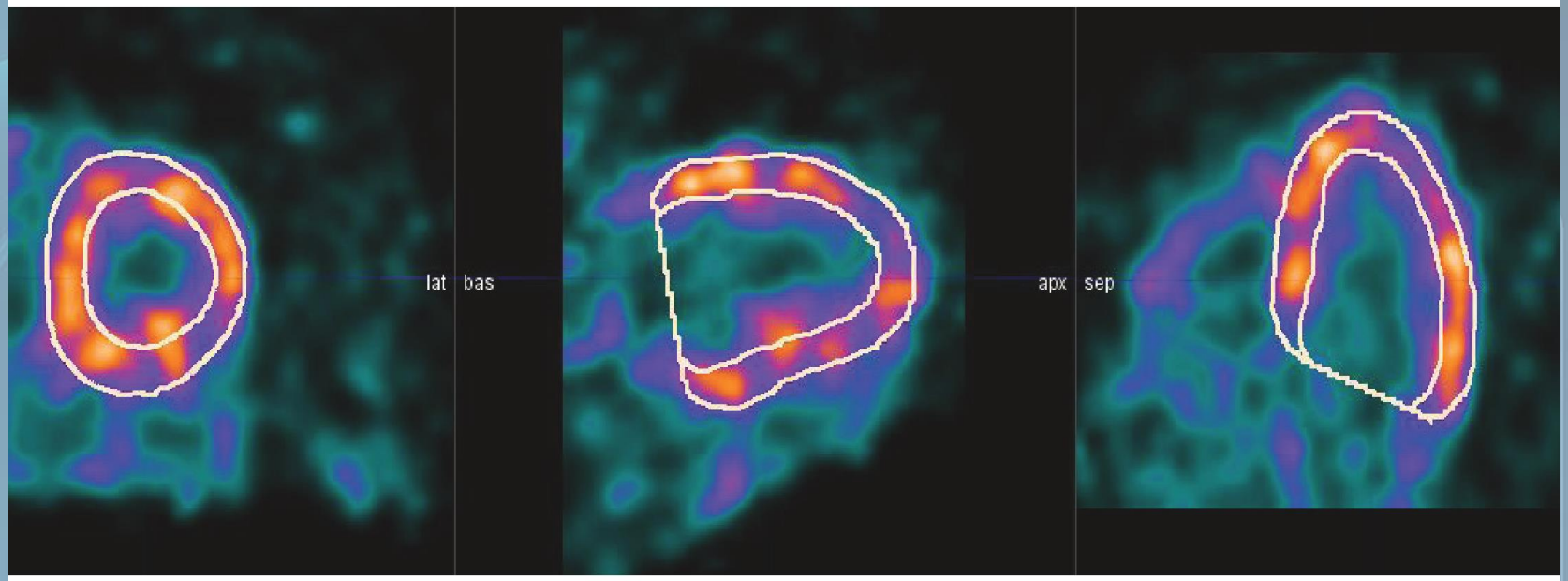


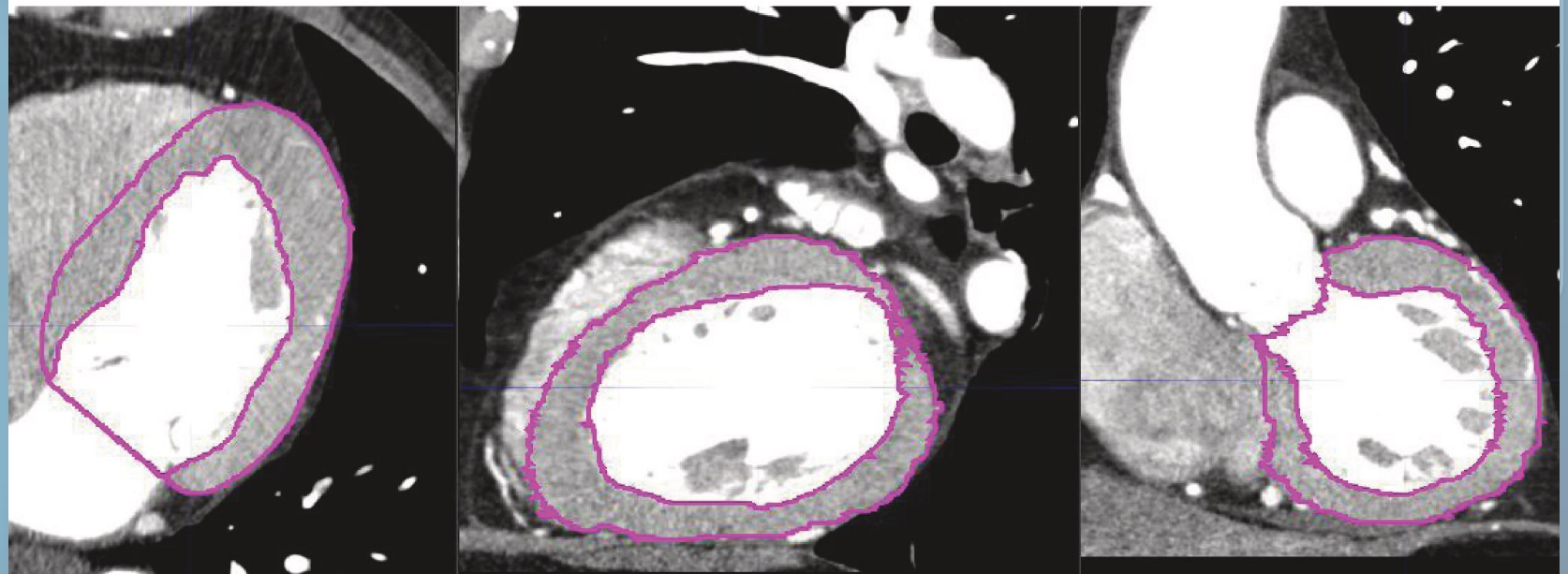
Step 1: Gating

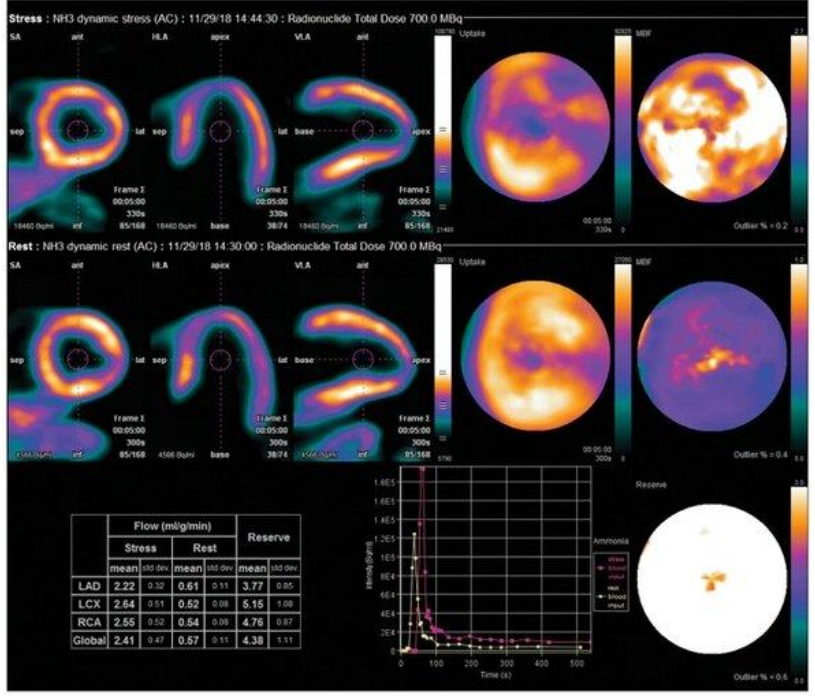


Series of images reconstructed from cardiac gated PET acquisition

Contours and Segmented PET

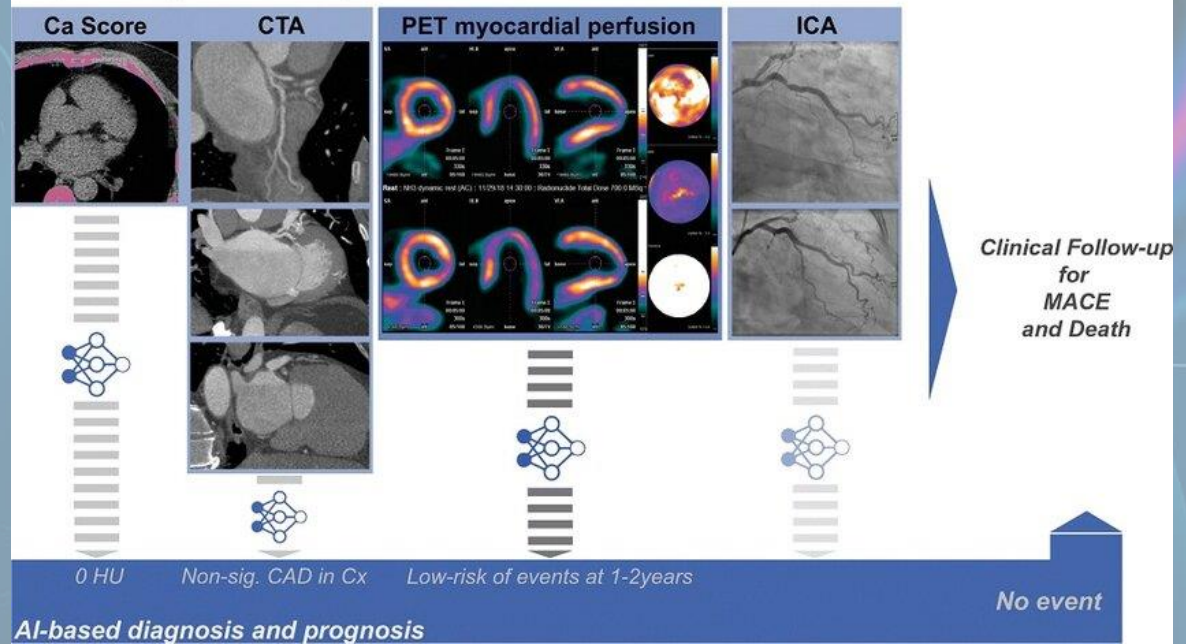






	Flow (ml/g/min)				Reserve	
	Stress		Rest			
	mean	std dev	mean	std dev	mean	std dev
LAD	2.22	0.32	0.61	0.11	3.77	0.85
LCX	2.64	0.51	0.52	0.08	5.15	1.08
RCA	2.55	0.52	0.54	0.08	4.76	0.87
Global	2.41	0.47	0.57	0.11	4.38	1.11

Diagnostic approach to suspected CAD




خاک من وقتست که باد شمال
می ببرد سوی یمین و شمال
عمر با فسوس برفت آنچه رفت
دیگرش از دست مده بر مجال
گر بمثل جام جم است آدمی
سنگ اجل بشکندش چون سفال
ایکه درونت به کنه تیره شد
ترسمت آئینه نگیرد صقال
زندهٔ دل مرده مدانی که کیست
آنکه ندارد بخدای اشتغال
پادشهان بر در تعظیم او
دست برآورده برای سؤال
بار خدائی که درون صدف
دُر کند از قطرهٔ آب زلال
فهم نبی رفت و نبودش طریق
وهم نبی گشت و نماندش مجال
بر دل عشاق جمالش خوش است
تلخی هجران بامید وصال
بنده دگر بر که کند اعتماد
گر نکند بر کرم ذوالجلال
هر که بگفتار نصیحت کنان
گوش ندارد بخرد گو مشال
گر قدمت هست چو مردان برو
ور عملت نیست چو سعدی بنال
کاشی سیاه
خاک نگار مقدم
کتیبه نویسی
Mohammadhossein Nikoopour