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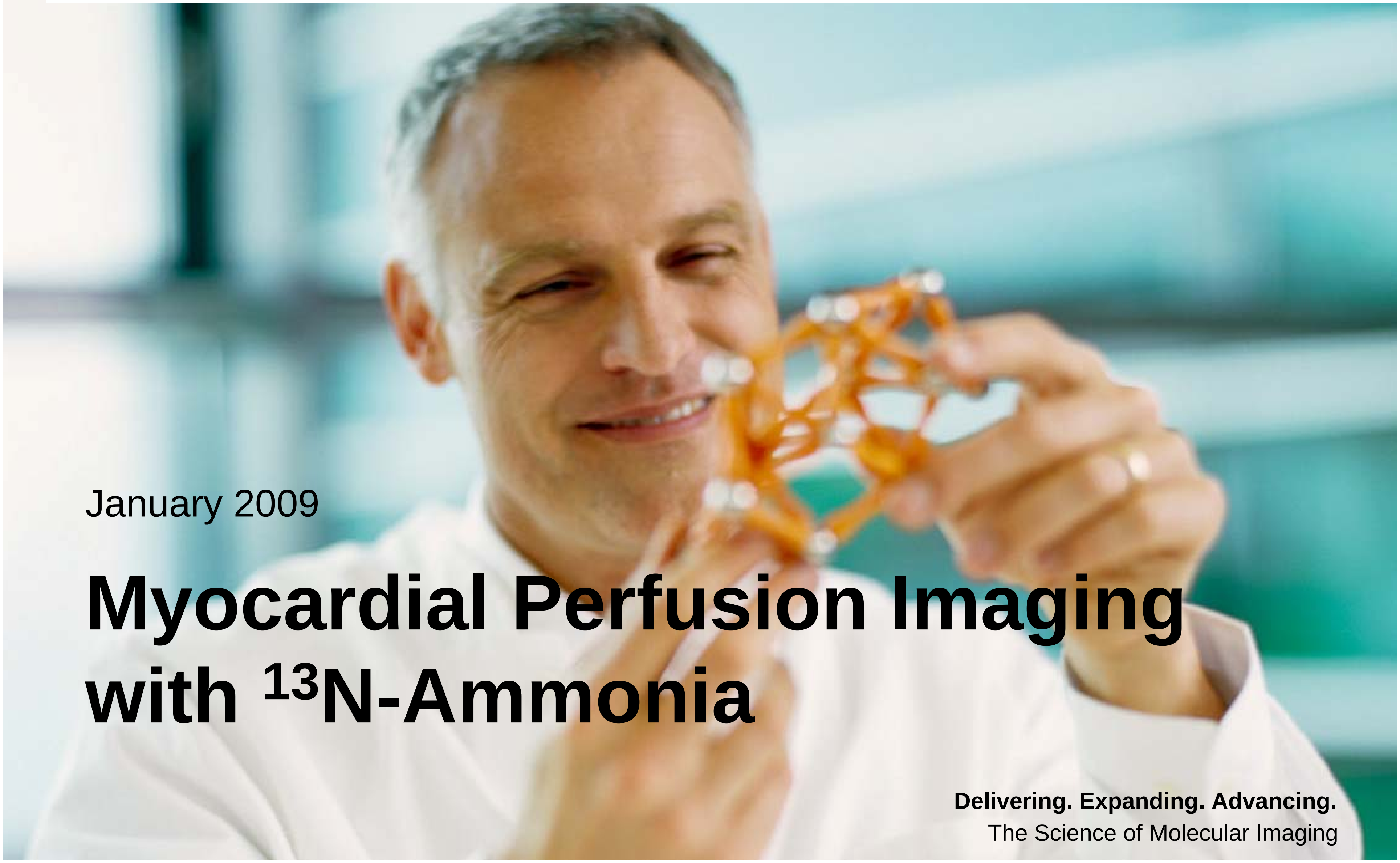

January 2009

Myocardial Perfusion Imaging with ^{13}N-Ammonia

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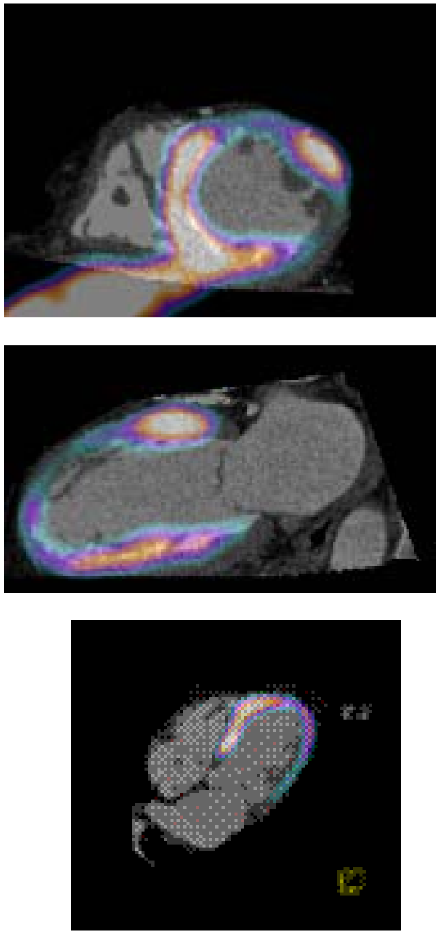
Role of PET in Myocardial Perfusion Imaging

PET Myocardial Perfusion Imaging with ^{13}N-Ammonia or ^{82}Rubidium

- Rest and/or stress-induced ischemia evaluation
- Rest and/or stress-induced evaluation of ejection fraction
- Higher sensitivity for Coronary Artery Disease compared to SPECT
  - Improved resolution
  - Higher count rate
  - Improved attenuation correction



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PET vs SPECT

- Higher sensitivity with PET compared to SPECT (93% vs 76%)[1]
- Higher specificity with PET compared to SPECT (83% vs 53%)[2]
- Compared accuracy of ^{82}Rb PET and ^{99m}Tc-MIBI compared to coronary angiography in two patient populations with similar clinical profiles[3]
- PET showed higher diagnostic accuracy (89% vs 79%) using 70% angiographic stenosis as threshold for CAD[3]
- PET was more sensitive for diagnosing multi-vessel CAD (71% vs 48%)[3]
- Cardiac PET resulted in 30% reduction in cost vs SPECT (reduction in downstream interventions, CABG) with no difference in clinical outcome[4]

1. Go et al. A Prospective Comparison of Rubidium-82 PET and Thallium-201 SPECT Myocardial Perfusion Imaging Utilizing a Single Dipyridamole Stress in the Diagnosis of Coronary Artery Disease. JNM 1990; 31:1899-905
2. Stewart et al. Comparison of rubidium-82 PET and thallium-201 SPECT imaging for detection of coronary artery disease. A J Cardiol 1991; 67:1303-10
3. Bateman et al. Diagnostic accuracy of rest/stress ECG-gated rubidium-82 myocardial perfusion PET: comparison with ECG-gated Tc-99m sestamibi SPECT. J Nucl Cardiol 2006; 13:24-33
4. Merhige et al. Impact of Myocardial Perfusion Imaging with PET and 82Rb on Downstream Invasive Procedure Utilization, Costs, and Outcomes in Coronary Disease Management. JNM 2007; 48(7):1069-1078

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PET vs SPECT cont

Diagnostic accuracy of myocardial perfusion imaging with SPECT and PET compared with coronary angiography

- Patients underwent CA, stenoses were graded as diameter reduction >/=50%
- CA findings between both groups did not significantly differ

	Sensitivity	Specificity
SPECT localization of stenosis	77%	84%
PET localization of stenosis	97%	84%
SPECT detection of ischemia		74%
PET detection of ischemia		91%

- Conclusion: MPI by ^{13}N-Ammonia PET is more sensitive in the detection and localization of coronary stenoses, and more specific in the detection of ischemia than MPI by ^{99m}Tc-MIBI SPECT.[5]

5. Husmann et al. Diagnostic accuracy of myocardial perfusion imaging with single photon emission computed tomography and positron emission tomography: a comparison with coronary angiography. Int J Cardiovasc Imaging, Original Paper, Dec 2007

PET tracers

Agent	Physical half-life	Mean positron range	Production
^{13}N-Ammonia	9.8 min	0.7 mm	Cyclotron
^{82}Rubidium	75 sec	2.4 mm	Generator
^{15}O-Water	2.0 min	1.1 mm	Cyclotron

- Short T ½ perfusion agents - ability to use higher doses per study –
- ^{82}Rb - 60 mCi ^{13}N NH_3 - 20 mCi

- Low radiation exposure with short T ½ perfusion agents –
- ^{82}Rb - 0.9 mSv ^{13}N NH_3 -1.6 mSv

Source: Table of Isotopes, 7th edition, CM Lederer and VS Shirley. John Wiley and Sons, New York, 1978

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Performance ^{13}N-Ammonia versus ^{82}Rubidium

TABLE 1 [6]

Summary of Published Literature with Regard to Diagnostic Accuracy of PET

Reference	No. of patients	Women	Prior CAD	PET radiotracer	Sensitivity	Specificity	PPV	NPV	Accuracy
Sampson et al. (*22*)*	102	0.42	0	^{82}Rb	0.93	0.83	0.80	0.94	0.87
Bateman et al. (*21*)	112	0.46	0.25	^{82}Rb	0.87	0.93	0.95	0.81	0.89
Marwick et al. (*23*)	74	0.19	0.49	^{82}Rb	0.90	1	1	0.36	0.91
Grover-McKay et al. (*24*)	31	0.01	0.13	^{82}Rb	1	0.73	0.80	1	0.87
Stewart et al. (*20*)	81	0.36	0.42	^{82}Rb	0.83	0.86	0.94	0.64	0.84
Go et al. (*19*)	202	NR	0.47	^{82}Rb	0.93	78	0.93	0.80	0.90
Demer et al. (*25*)	193	0.26	0.34	^{82}Rb /^{13}N-ammonia	83	0.95	0.98	0.60	0.85
Tamaki et al. (*26*)	51	NR	0.75	^{13}N-ammonia	0.98	1	1	0.75	0.98
Gould et al. (*27*)	31	NR	NR	^{82}Rb /^{13}N-ammonia	0.95	1	1	0.90	0.97
Weighted summary	877	0.29	0.35		0.90	0.89	0.94	0.73	0.90

*Study using PET/CT (in which CT was used for attenuation correction only).
PPV = positive predictive value; NPV = negative predictive value; NR = not reported.
(Reprinted with permission of (*28*).)

6. Di Carli et al. Clinical Myocardial Perfusion PET/CT. JNM May 2007; 48:783-793

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^{13}N-Ammonia advantages over ^{82}Rb PET

- Better image quality due to shorter range of positron
- Physical exercise possible
- ^{82}Rb requires immediate infusion/acquisition during pharmacological stress
  - Uncomfortable for patient
  - Increased risk of motion artifacts
- ^{13}N-Ammonia allows a short recovery prior to acquisition
  - 5 minutes or to when patients near ~10% of baseline HR
  - Leads to fewer motion artifacts

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Why Ammonia?

Limitations of ammonia

- Reduced uptake in the lateral wall of the LV[7]
- Occasional intense liver uptake[7]
- Occasional lung uptake in patients with pulmonary disease[7]
- Complex logistics

Overall, these issues are uncommon and it is considered the best PET perfusion tracer due to several factors:

- Relatively long T-1/2
- High first pass extraction[7]
- Low background
- Low positron energy

7. Tamaki. Wahl et al. Principles and Practice of PET. Philadelphia, PA: Lippincott, William & Wilkins; 2002:320-333.

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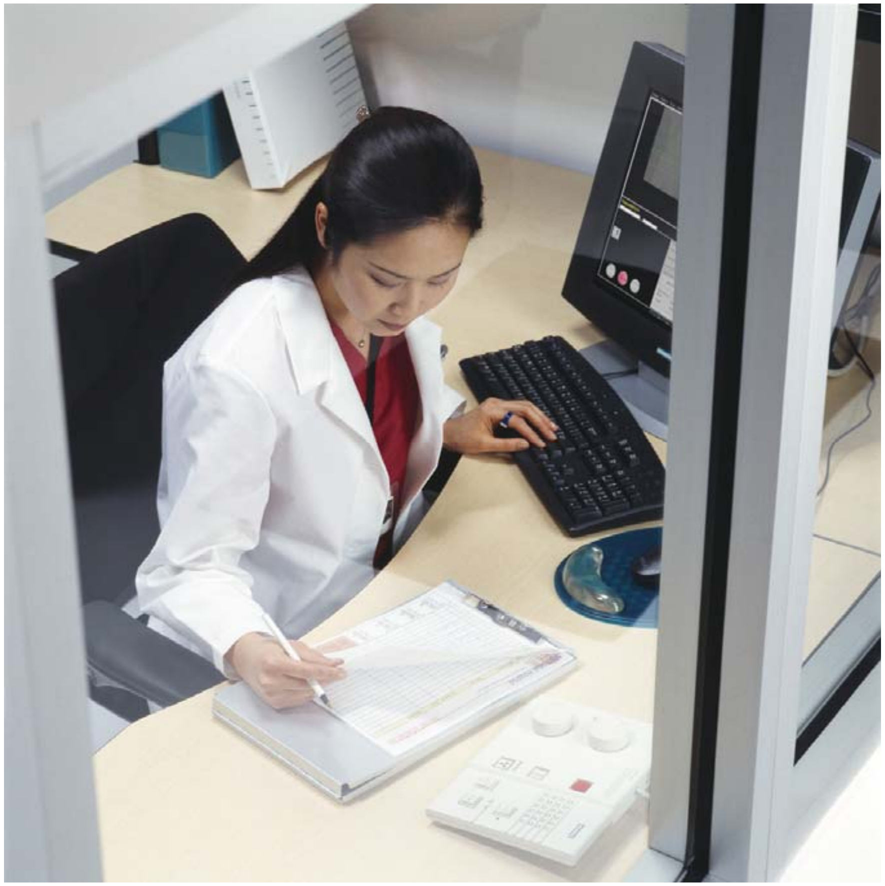
PET Myocardial Perfusion Billing Codes

- 78491 PET, myocardial perfusion single study
- 78492 PET, myocardial perfusion multiple studies
- A9526 13N-Ammonia, per study dose



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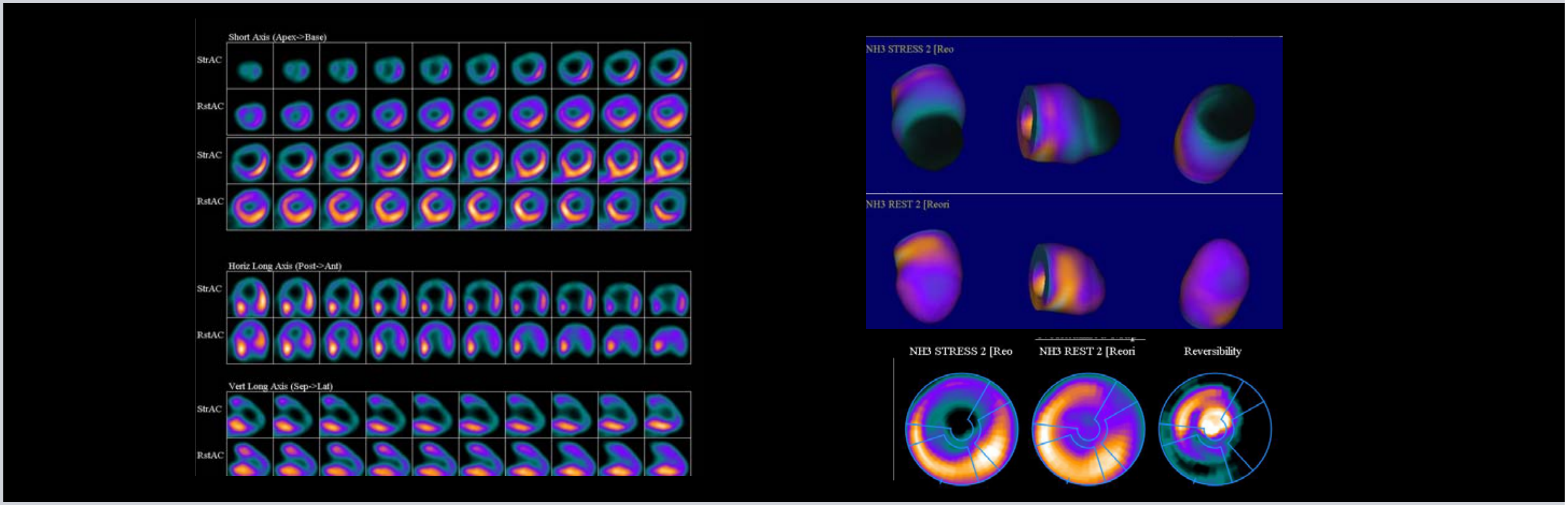
Severe but reversible ischemia



71 yr old male patient with type II diabetes presented with chest pain and dyspnoea.
Echo: normal LV, EF 60%, no wall motion abnormalities.
^{13}N NH_3 dynamic myocardial perfusion PET•CT study performed at rest and during adenosine stress, showed severe but reversible ischemia involving whole of LAD territory (anterior wall, septum). Inferior wall appeared normal. There was significant post-stress LV dilatation suggesting advanced disease. CFR polar maps showed decreased values in the inferior wall suggesting subclinical disease in RCA and Lt circumflex. Coronary angio revealed 3-vessel disease (LAD: proximal 50%, mid 75-90%, distal 75%; LCX: mid 75%; RCA: multiple 75%)

Source: Data courtesy of Technical University of Munich, Germany

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PET•CT cardiac perfusion and viability mismatch study

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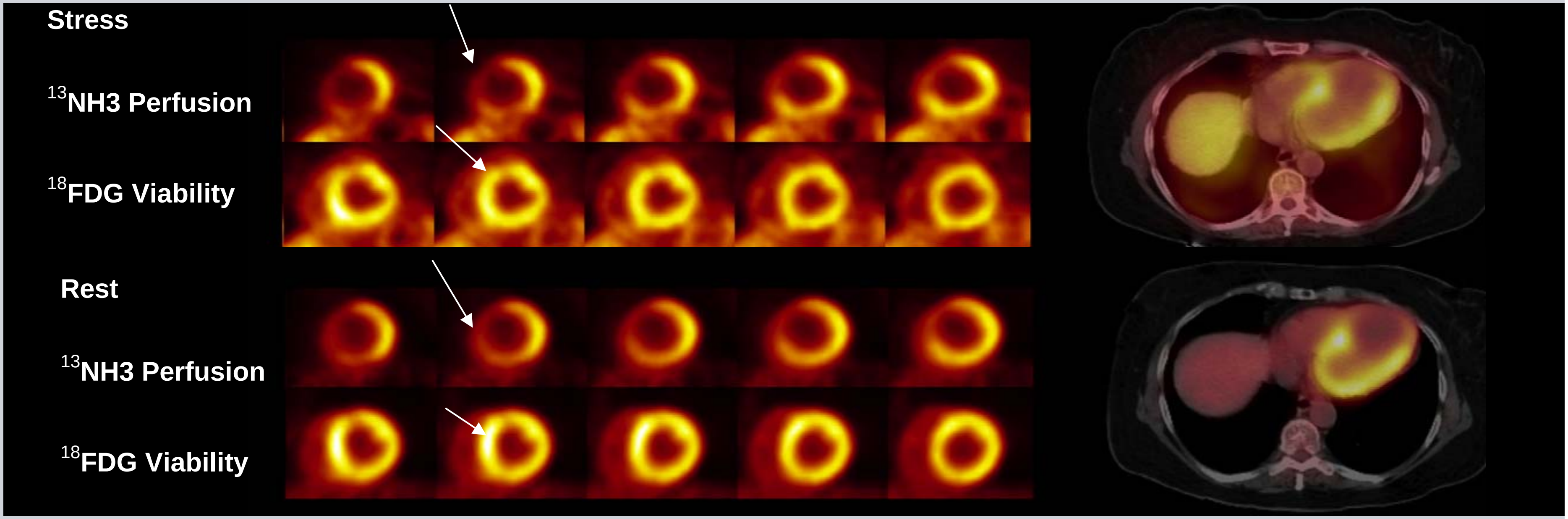

Perfusion-viability mismatch in $^{13}N\text{-}NH_3$ PET perfusion and ^{18}F-FDG PET viability study

Mismatch indicative of ischemic but viable myocardium Patient identified as a candidate for revascularization.

Source: Data Courtesy of University of Michigan

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Expanding the value of PET

Advancing a new paradigm for molecular imaging

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