

# Function or structure: Where should we invest?

## Session 3: Are we entering the dark ages of innovation?

### IS3R Interim Meeting

Rotterdam, NL

November 11, 2018



Elizabeth Burnside, MD

**Thomas M. Grist, MD, FACR, FISMRM**

**University of Wisconsin - Madison**



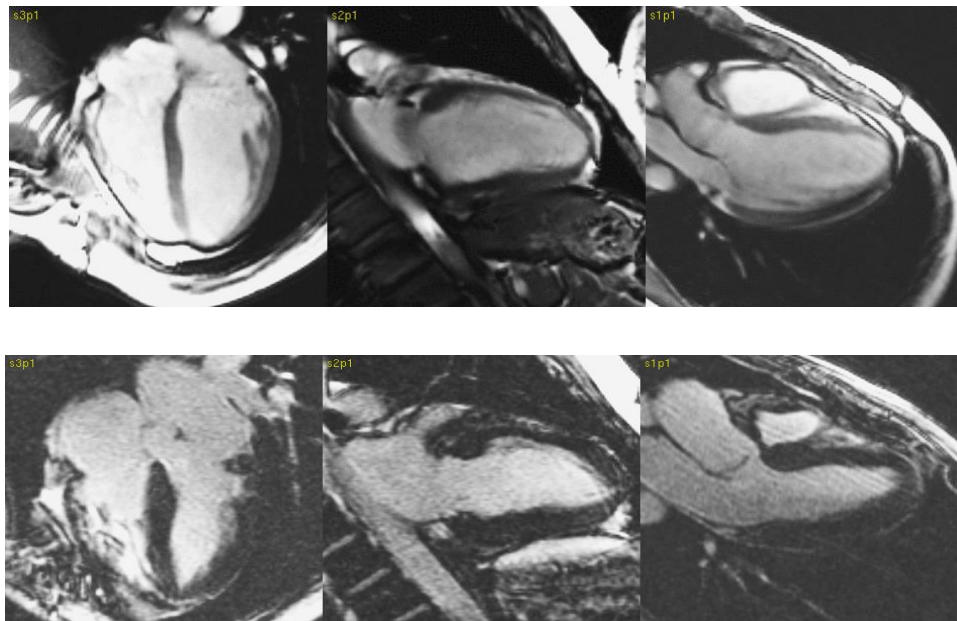
Scott Reeder, MD, PhD



**School of Medicine  
and Public Health**  
UNIVERSITY OF WISCONSIN-MADISON

# Function or structure: Where to invest?

- First impressions
- Functional imaging
  - How do we define it?
  - Why should we invest?
- Structural imaging
  - How do we define it?
  - Why should we invest?
- The answer

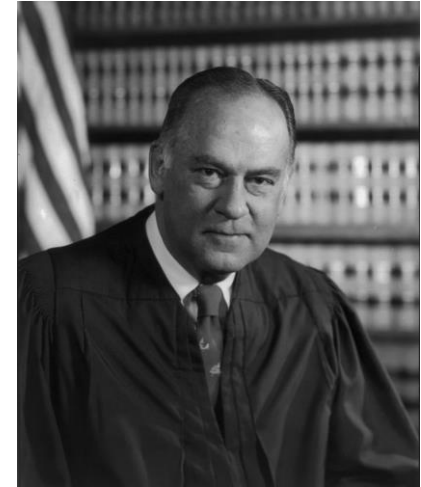


# Definitions

- What is functional imaging?

1964 Jacobellis vs. Ohio

“I shall not today attempt further to define the kinds of material I understand to be embraced within that shorthand description of [" functional imaging "], and perhaps I could never succeed in intelligibly doing so. But *I know it when I see it*, .....[“

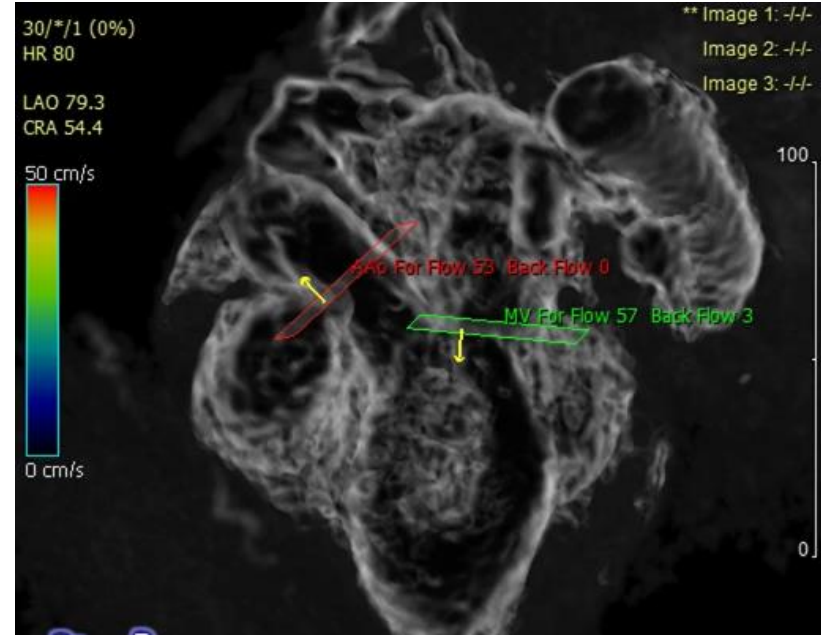
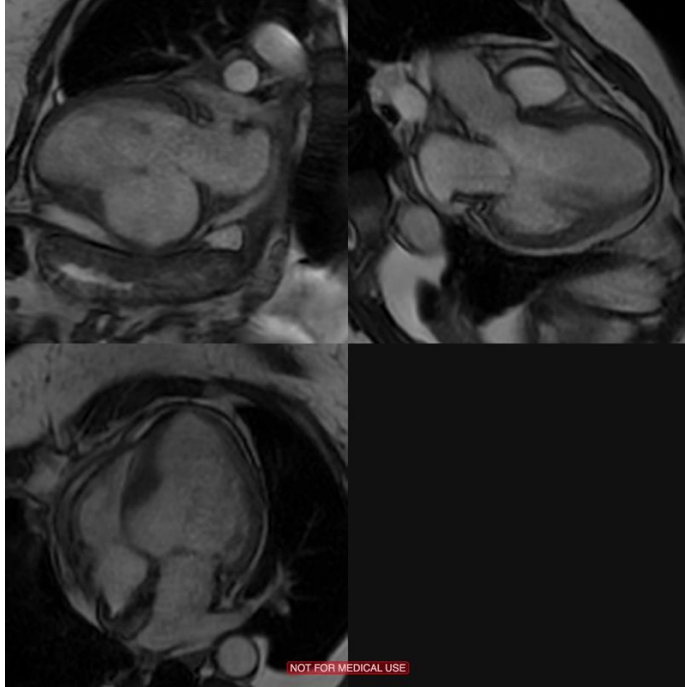


Potter Stewart  
US Supreme Court Justice




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# Functional: Imaging pathophysiology and metabolism

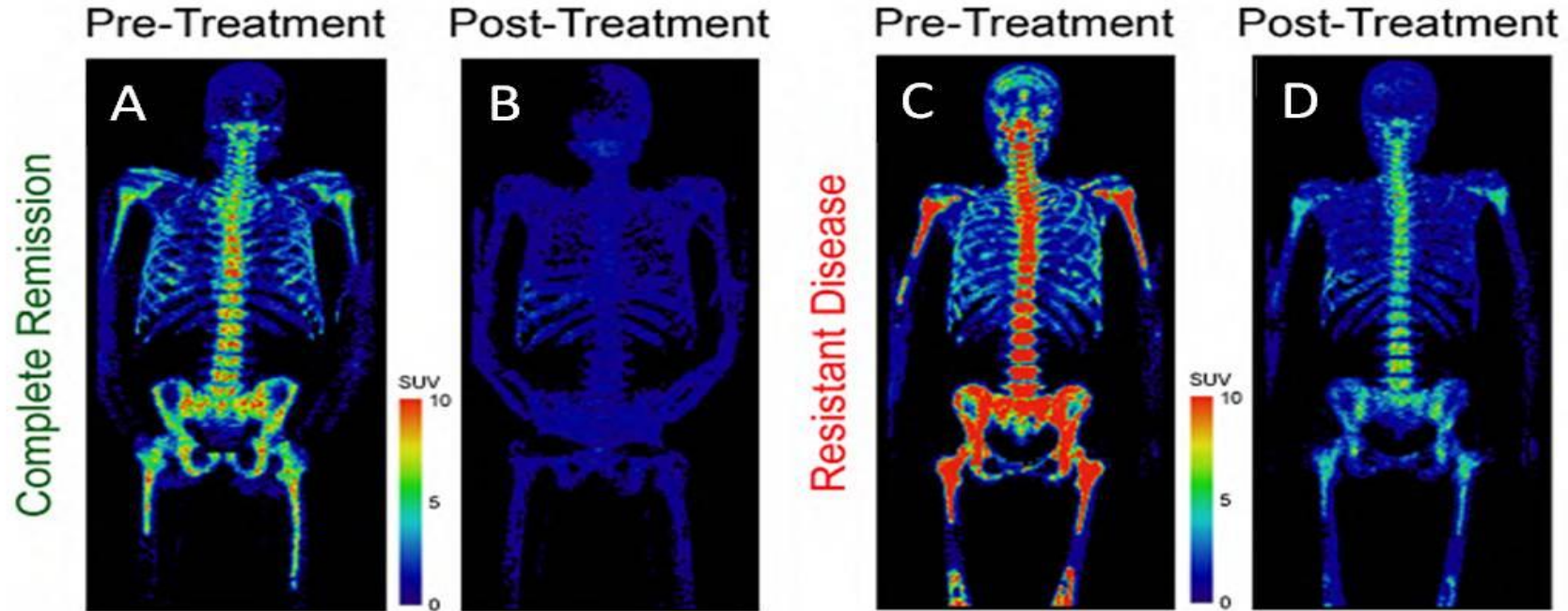


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The PROMISE of  
PRECISION medicine

# Functional Imaging: $^{18}\text{F}$ FLT uptake in treatment monitoring



# The efficacy of diagnostic imaging

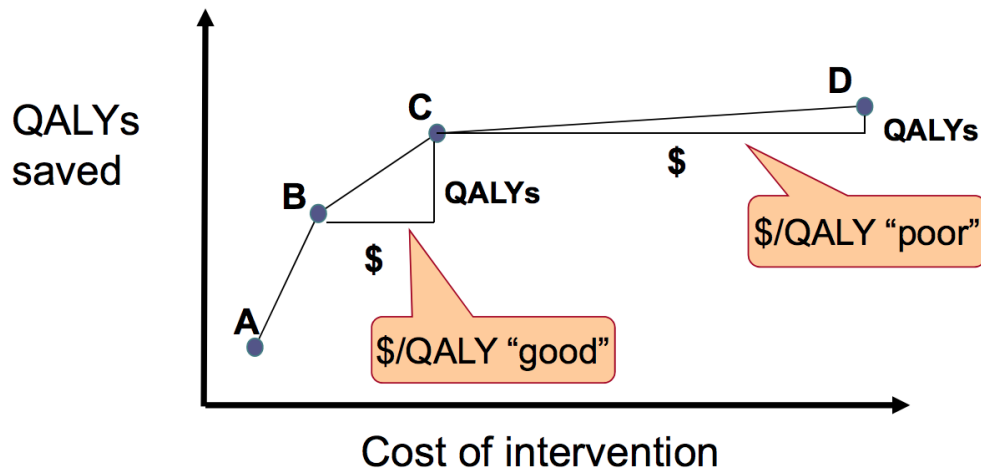
DG Fryback, JR Thornbury - Medical decision making, 1991 - journals.sagepub.com

The authors discuss the assessment of the contribution of diagnostic imaging to the patient management process. A hierarchical model of efficacy is presented as an organizing structure for appraisal of the literature on efficacy of imaging. Demonstration of efficacy at ...

☆ 🔖 [Cited by 1075](#) [Related articles](#) [All 8 versions](#)

## “Flat of the curve medicine”

It may be “cost-effective” to go from A to B or B to C, but change in practice from C to D is not.



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# Caution: The perils of functional imaging

JOURNAL OF MAGNETIC RESONANCE **61**, 571–578 (1985)

## Resonators for *in Vivo* $^{31}\text{P}$ NMR at 1.5 T

THOMAS M. GRIST AND JAMES S. HYDE

National Biomedical ESR Center, Department of Radiology, Medical College of Wisconsin,  
8701 Watertown Plank Road, Milwaukee, Wisconsin 53226

Received October 10, 1984

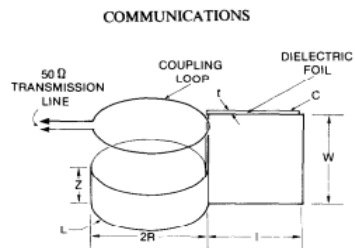
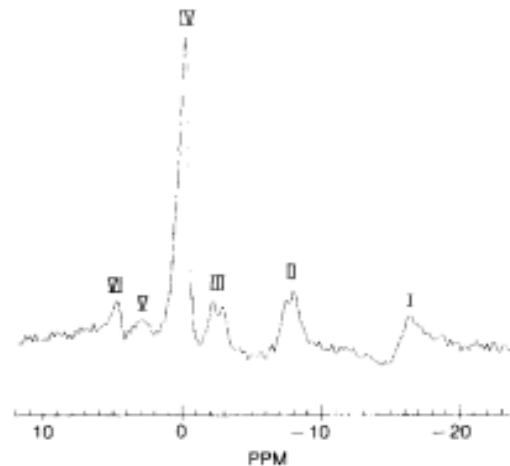



FIG. 1. The NMR loop-gap resonator.  $R$  = radius,  $Z$  = resonator height,  $t$  = gap thickness,  $l$  = capacitor length, and  $W$  = capacitor width.

## COMMUNICATIONS





# Function or structure: Where to invest?

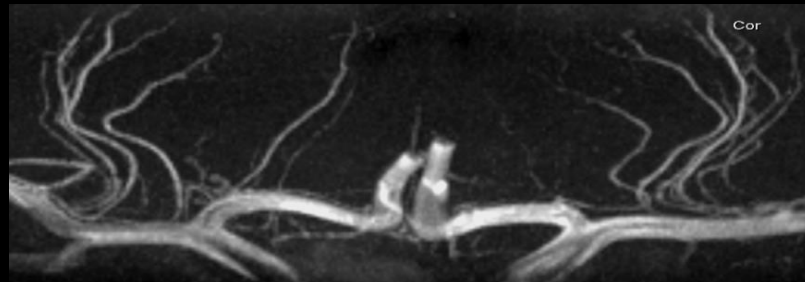
- Functional imaging
  - How do we define it?
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- Structural imaging
  - How do we define it? 
  - Why should we invest?
- The answer
  - Macrostructure “Anatomical” Imaging
  - Microstructure Imaging

# Clinical TOF 1.5T vs 7T



0.7x0.7x0.7 mm<sup>3</sup>

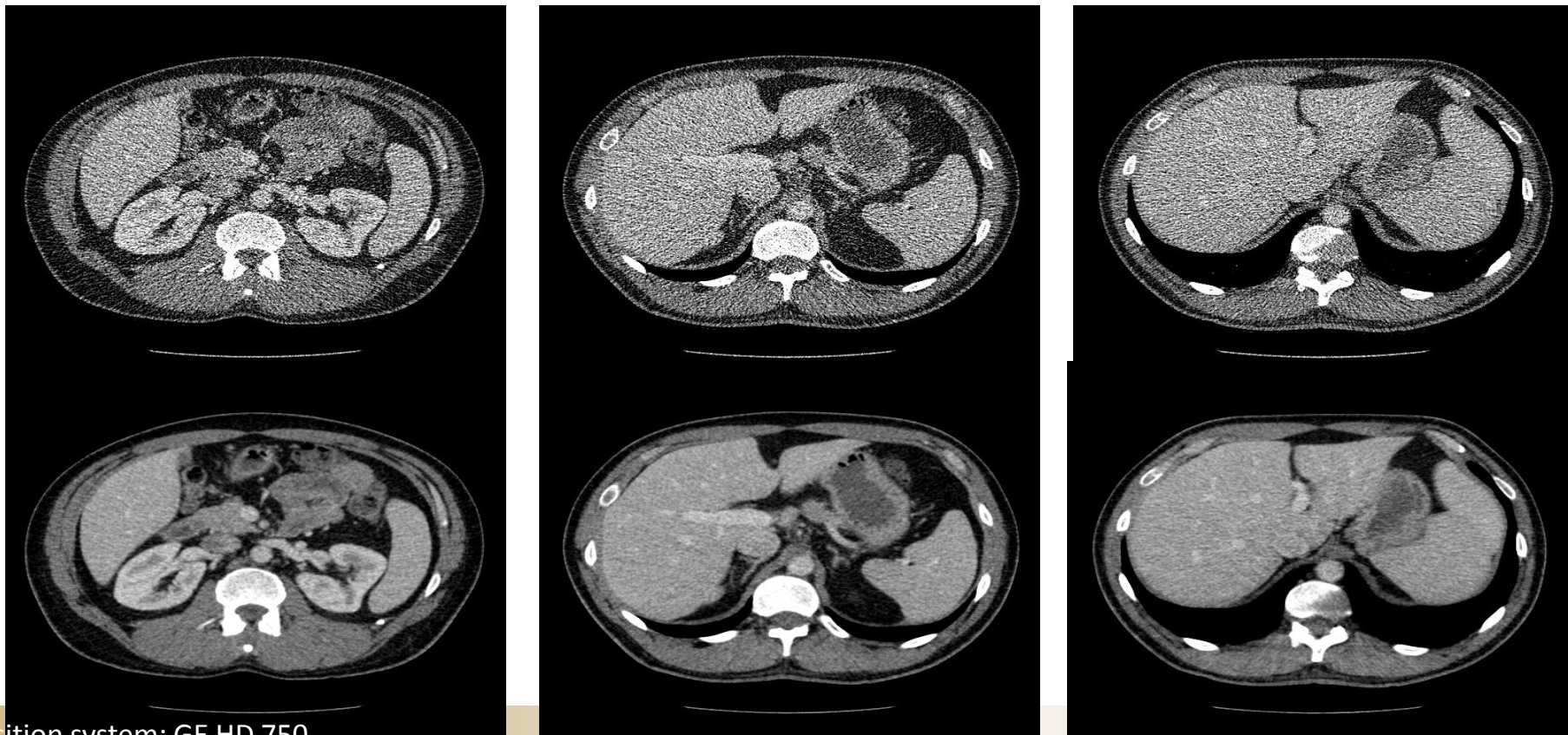
1.5T




0.2x0.2x0.3 mm<sup>3</sup>

7T

# Do more with less: Deep learning for low dose CT reconstruction



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- Structural imaging
  - How do we define it?
  - Why should we invest?  Its our history, our culture, and what makes our field attractive to new entrants
- The answer

# Coronary stent restenosis: MDCT

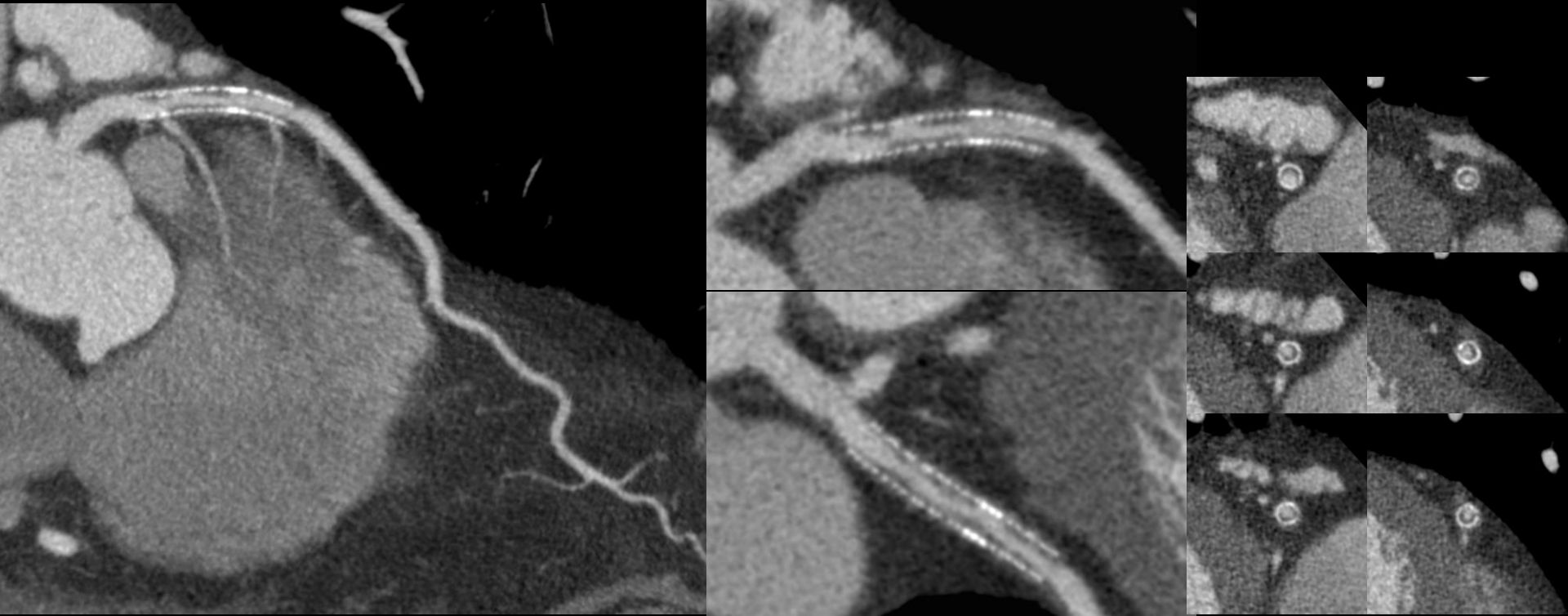
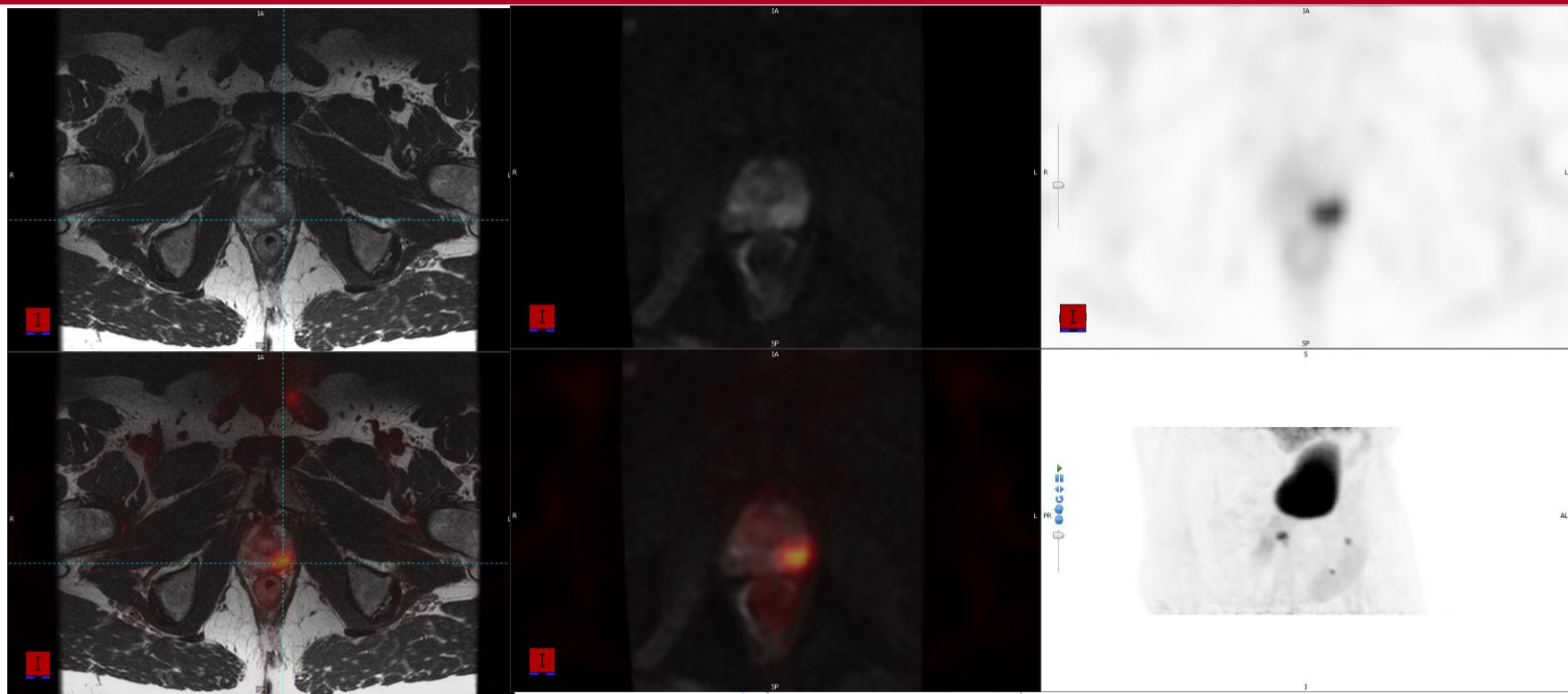



Image courtesy of Canon Medical Systems Corporation

# PET/MRI: MRI Diffusion and $^{18}\text{F}$ DCFPyL PET



Courtesy of Steve Cho, University of Wisconsin - Madison

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  - How do we define it?
  - Why should we invest?  Better functional imaging
- The answer

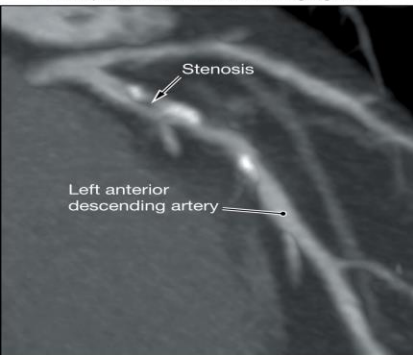


## From: Diagnostic Accuracy of Fractional Flow Reserve From Anatomic CT Angiography

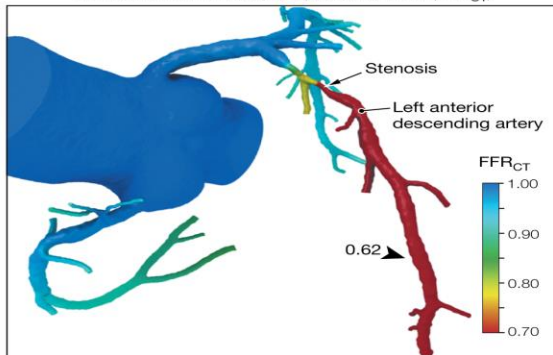
JAMA. 2012;308(12):1237-1245. doi:10.1001/2012.jama.11274

### A Study patient with ischemia

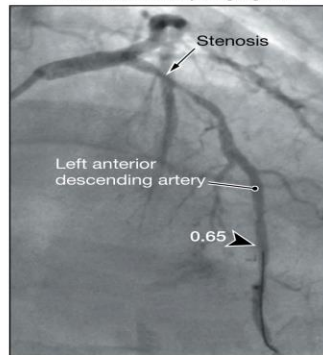
Multiphase reformat of CT angiogram



Fractional flow reserve computed from CT ( $FFR_{CT}$ )

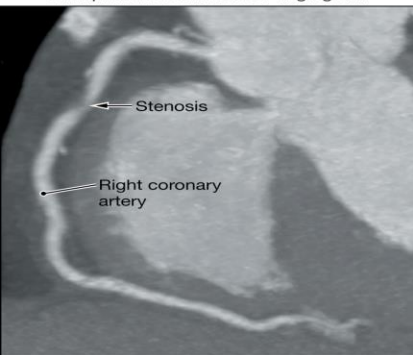


Invasive coronary angiogram

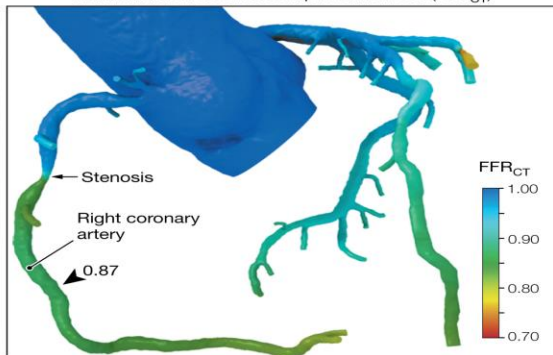


### B Study patient without ischemia

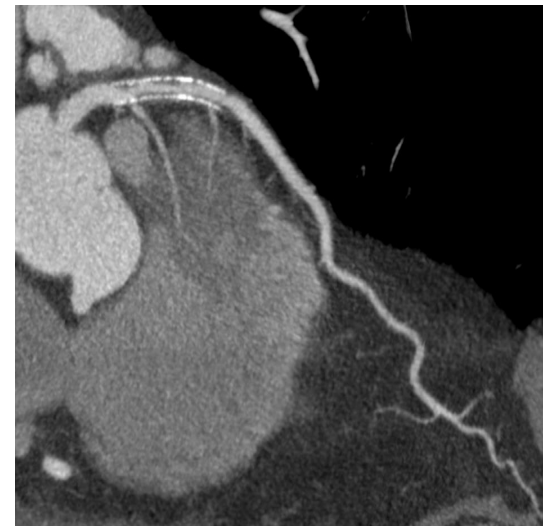
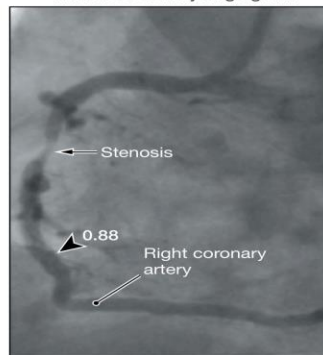
Multiphase reformat of CT angiogram



Fractional flow reserve computed from CT ( $FFR_{CT}$ )




Invasive coronary angiogram

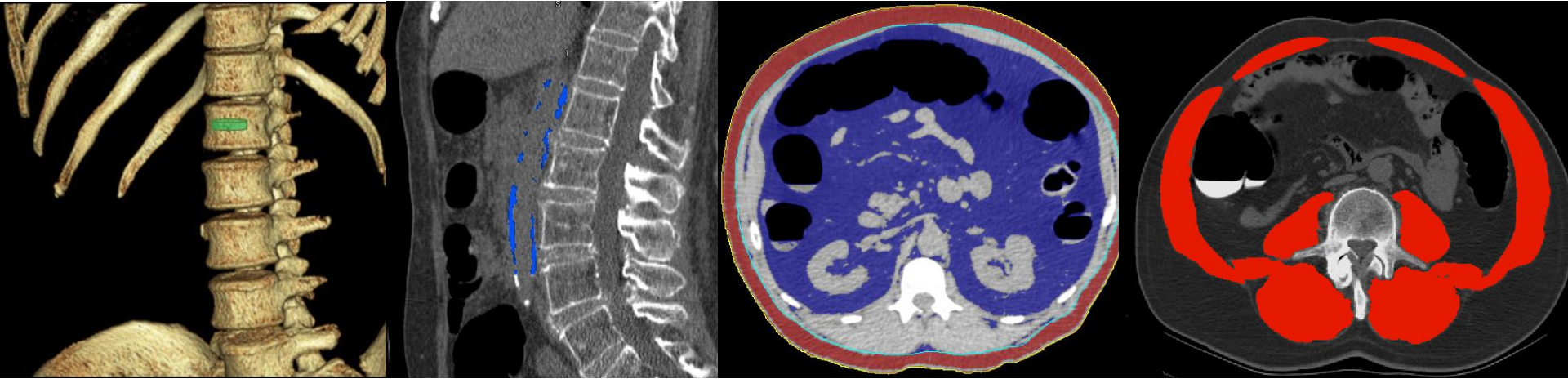




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  - The answer
- The POTENTIAL of  
POPULATION imaging

# Automated CT interpretation for opportunistic cardio-metabolic screening



Courtesy of Perry Pickhardt, MD, University of Wisconsin - Madison

# BMD Screening for Osteoporosis

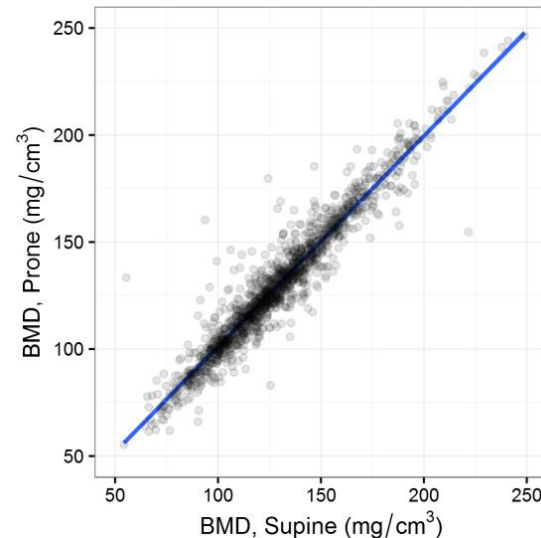
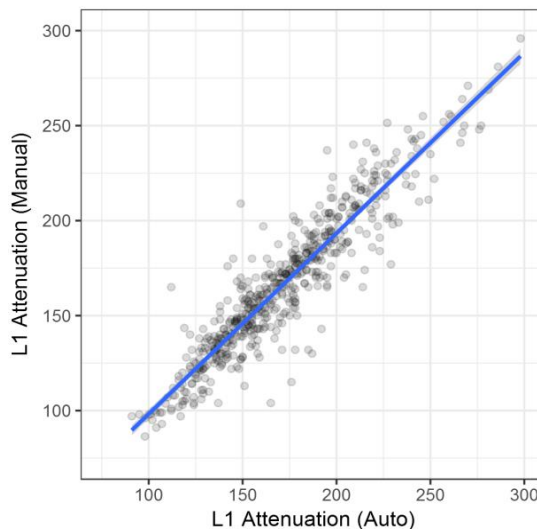


# Automated Interpretation at Abdominal CT

- Preliminary work from L1 HU:



99.8% success rate



# The answer: Where should we invest?

## Function

## Structure

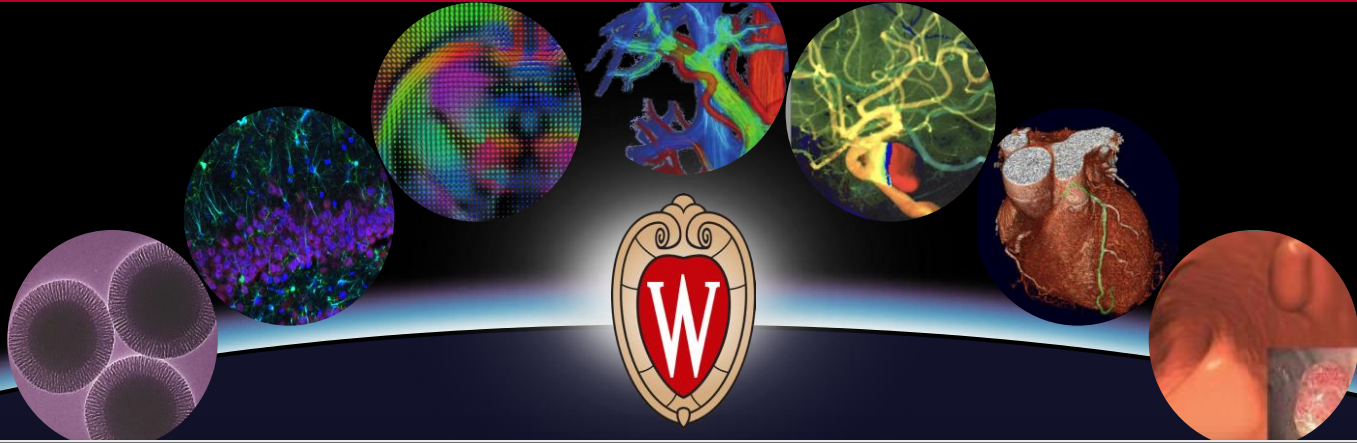


**BOTH!**



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# University of Wisconsin



Department of Radiology



30/\*/1 (0%)

HR 80

LAO 79.3

CRA 54.4

50 cm/s



0 cm/s

\*\* Image 1: -/-

Image 2: -/-

Image 3: -/-

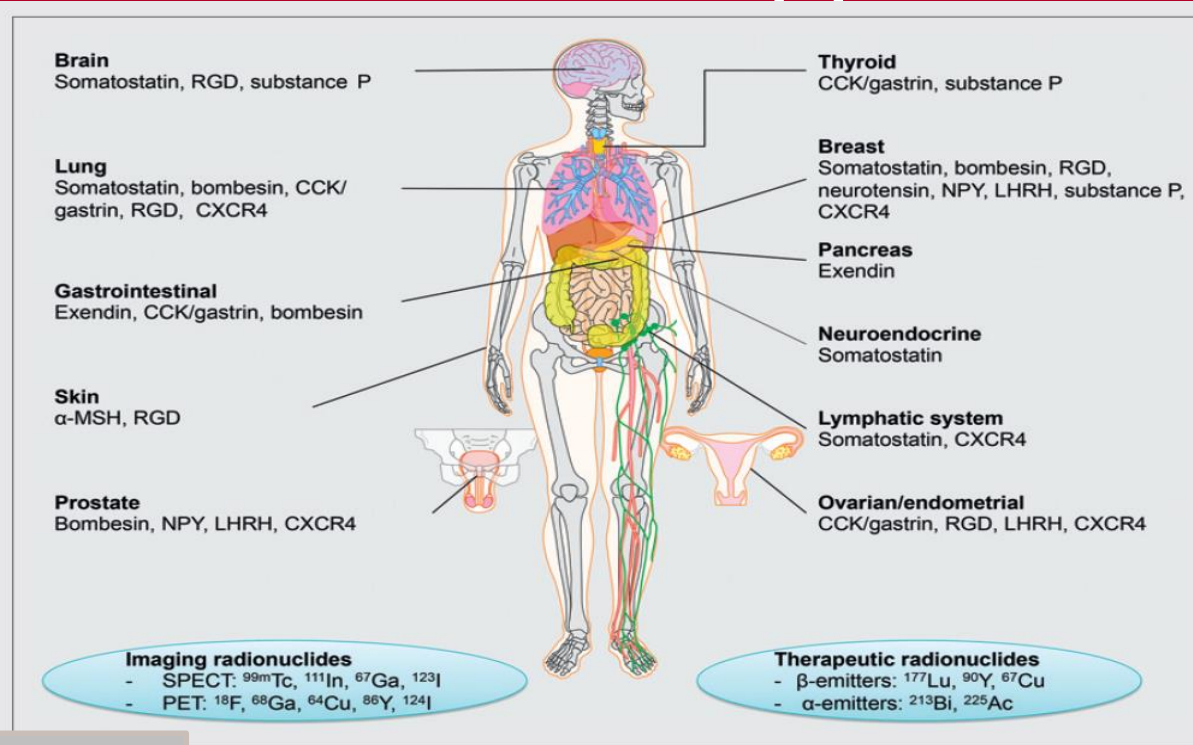
100

AAo For Flow 53 Back Flow 0

MV For Flow 57 Back Flow 3

0

# Theranostic Applications



**FIGURE 1.** Examples of radiopeptide families, radionuclides, and their applications for imaging of tumors. RGD = arginylglycylaspartic acid.