

The Evolution of FFR Before and After PCI

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Disclosure 1

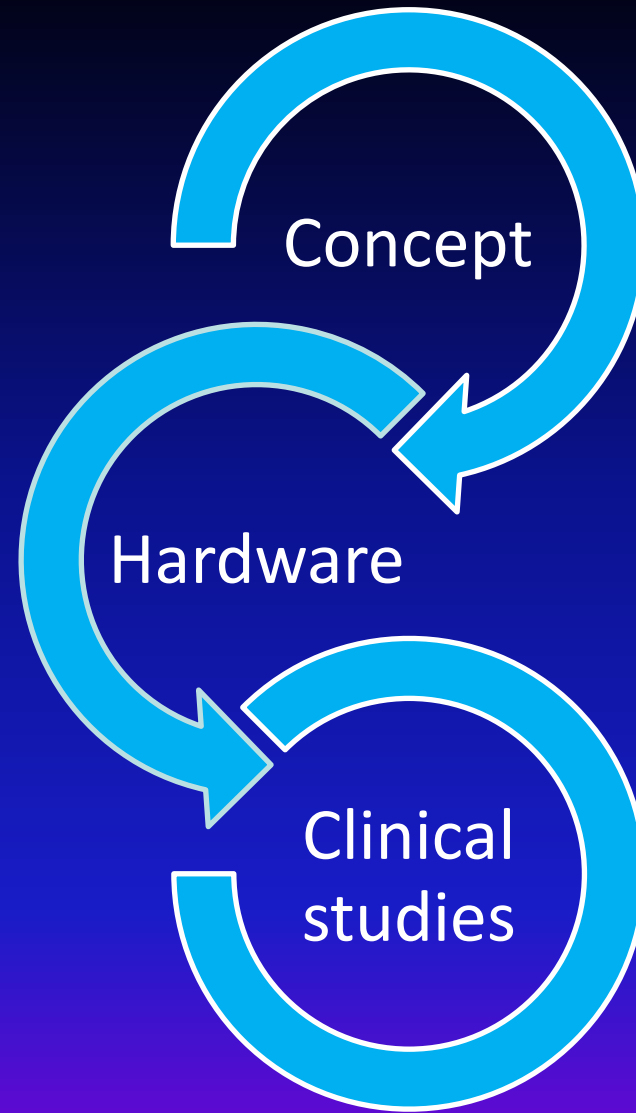
Morton J. Kern, MD

Within the past 12 months, the presenter or their spouse/partner have had a financial interest/arrangement or affiliation with the organization listed below.

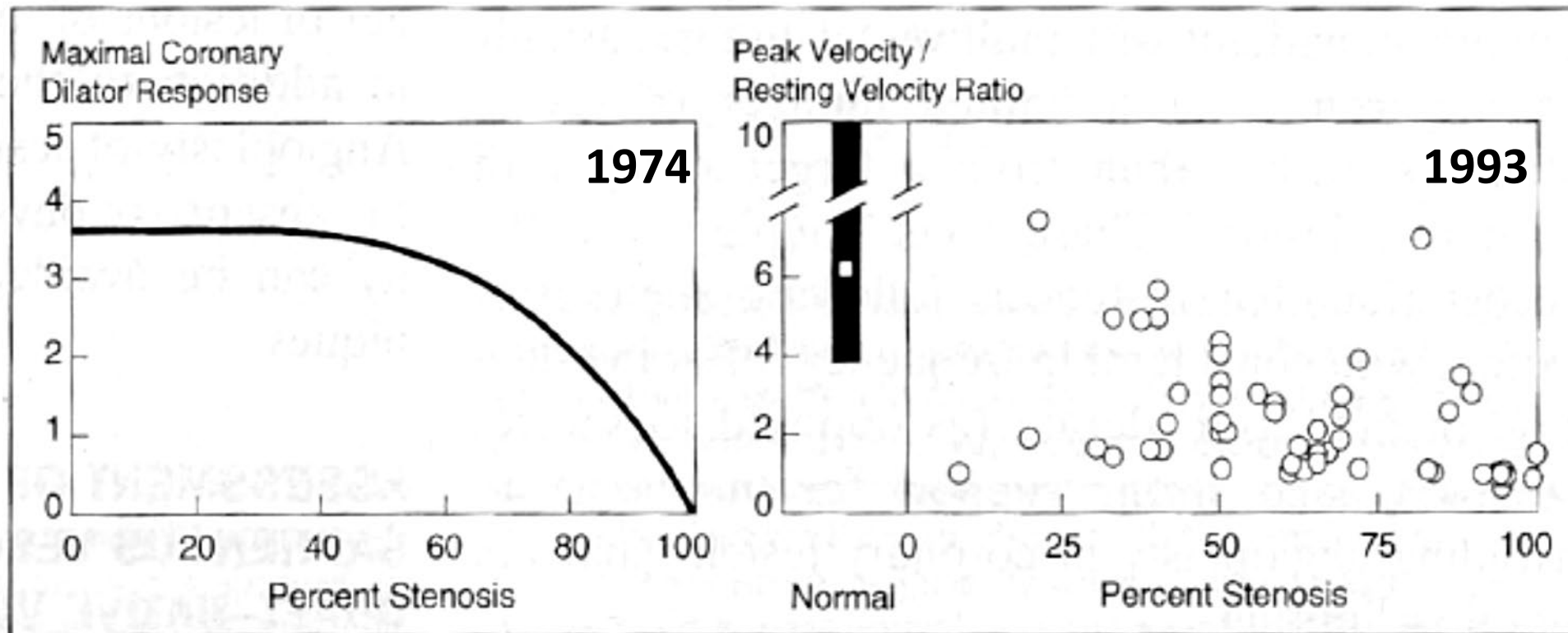
<u>Company Name</u>	<u>Relationship</u>
Abbott Medical Inc.	Speaker
Philips	Speaker
CathWorks	Speaker, consultant
Acist Medical Inc.	Speaker
Boston Sci Co.	Speaker
Opsens	Speaker, Consultant
Zoll	Speaker



Evolution of FFR



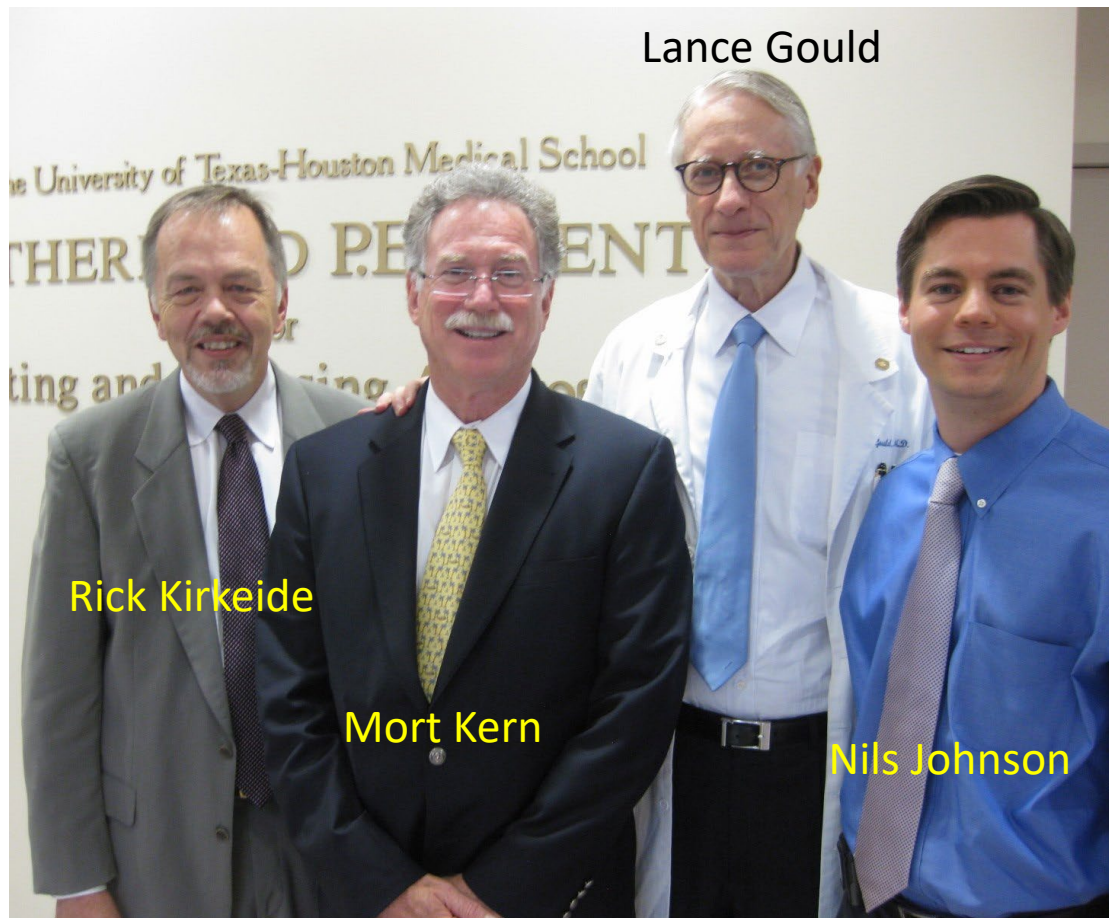
In 1974, KLG - Coronary Physiology (CFR) predicts anatomy.....in Dogs.
In 1993, Marcus, White and Wilson find that Coronary Physiology (CFR) does NOT predict anatomy.....in patients.



On the shoulders of a giant...

2013 Mar 1

2023 Feb 17



Lance Gould

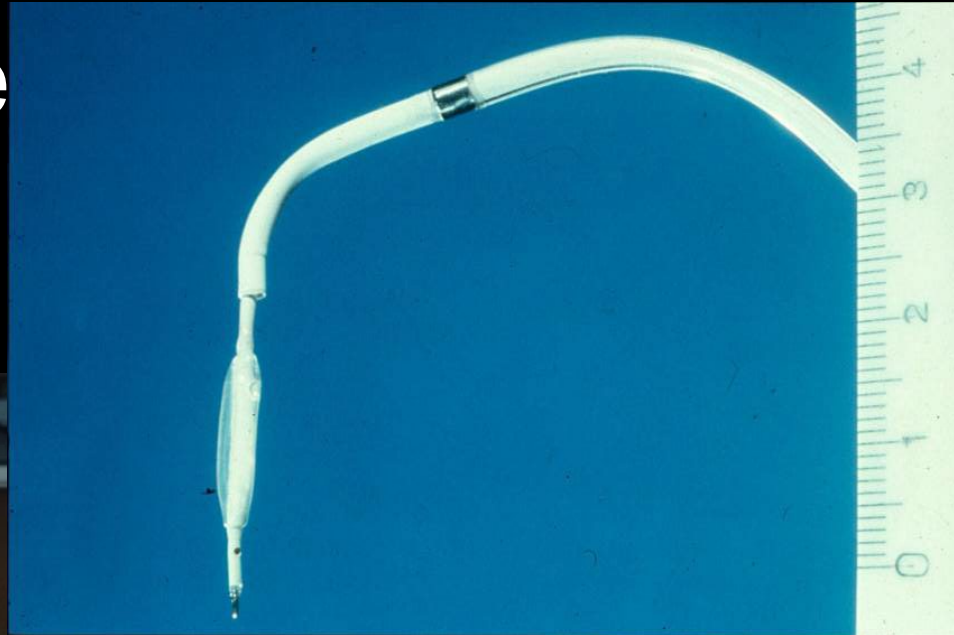
Rick Kirkeide

Mort Kern

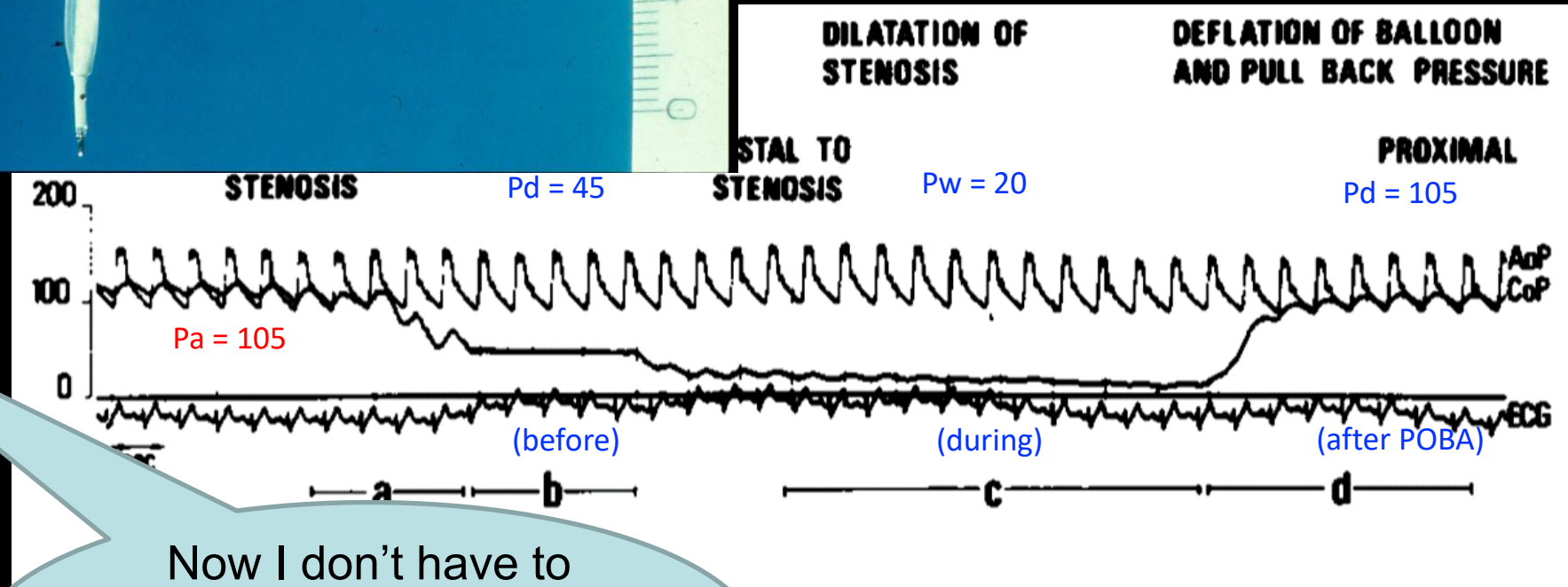
Nils Johnson



Translucency
needed



Measurements were
very imprecise.



Now I don't have to
mark the screen with a
crayon to know about
the lesion



Historical View - St. Louis University Cath Lab

Dr. Meno Nassi, PhD, CEO Cardiometrics asked me,

“Do you think there is a use for a Doppler flow wire?”

MJK to myself: (...I had just made a Judkins Doppler catheter, and put the flow wire through it and found I could measure flow everywhere...oh s@#\$!, I just obsoleted myself....)

MJK to Meno: “...(jumping for joy) ...Well, I don’t know, ...maybe, ... let me just test it out for a while...”

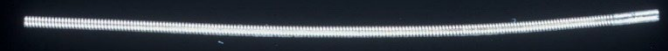
1991 – Intracoronary Doppler Guidewire



Doppler 8F Judkins catheter



1F tracking catheter



0.018" Doppler guidewire

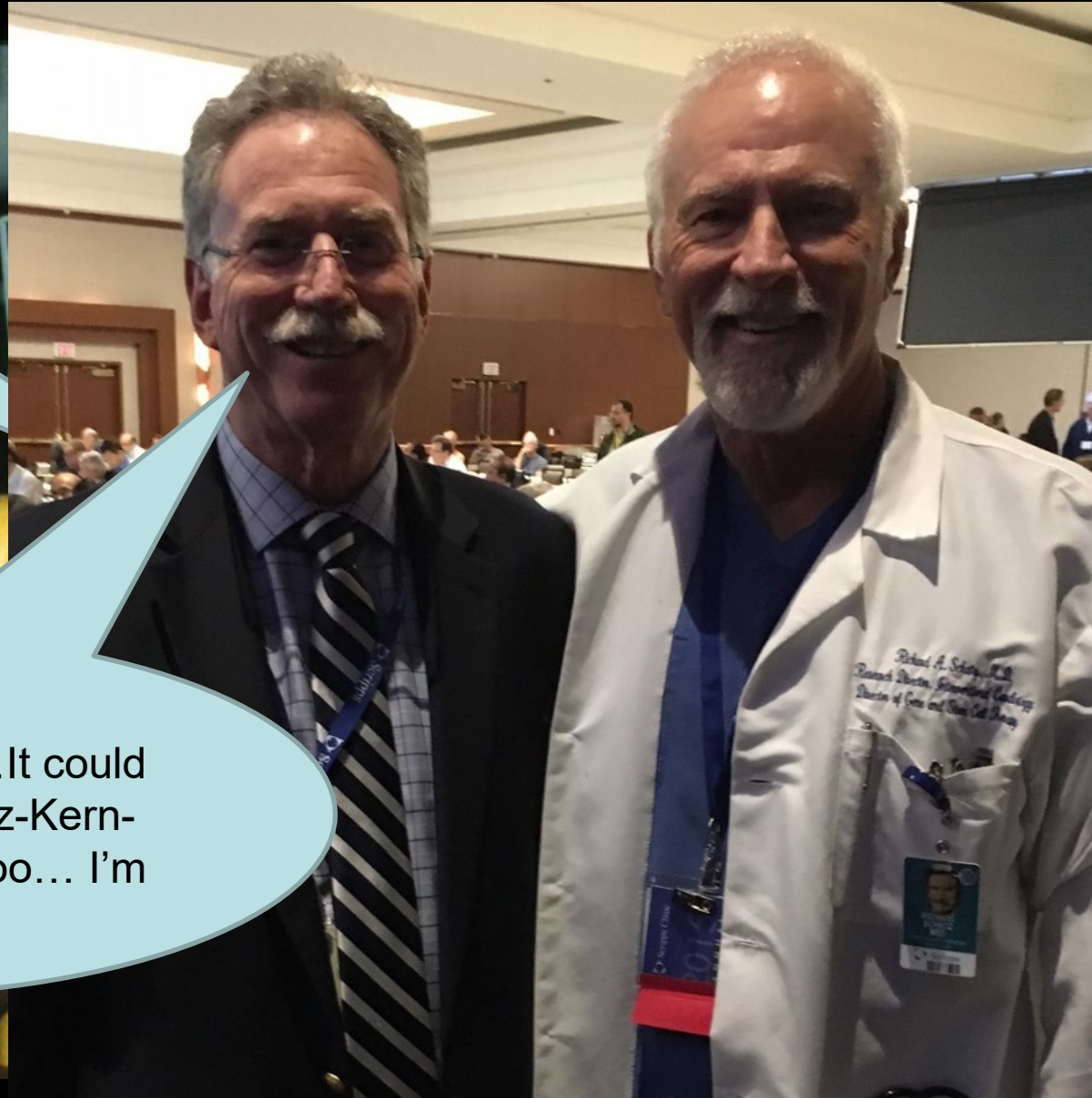


And then came stents and marginally better angiography...bye, bye pressure and flow

Damn, This thing won't bend around the artery curve...

Richard, I was on the 6th floor...It could have been the Palmaz-Kern-Shatz Stent...but noooo... I'm not jealous...

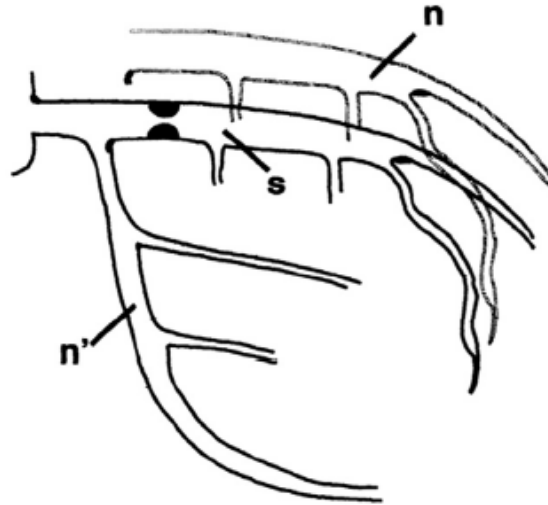
Oh hell you just broke it...Hey that one strut makes it flex...I got an idea ...



1993 – The birth of FFR

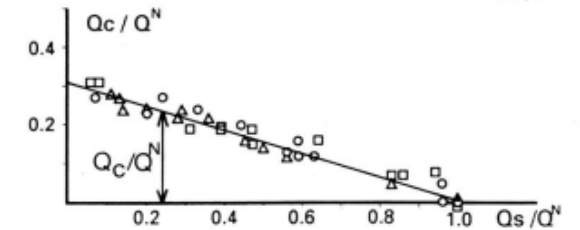
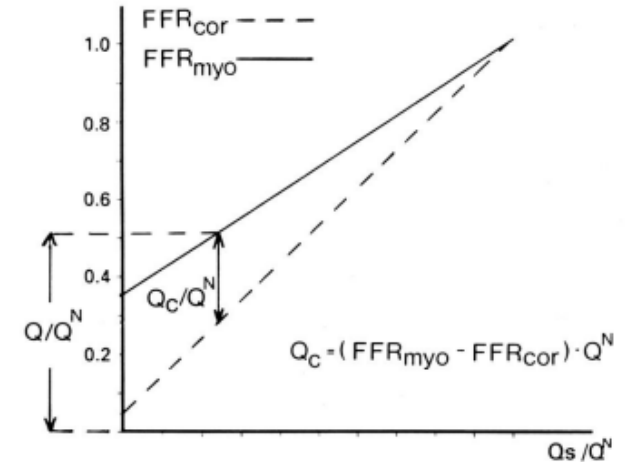
Nico Pijls

Bernard DeBruyne



$$RFR = \frac{\text{MAX FLOW}_s}{\text{MAX FLOW}_{n'}}$$

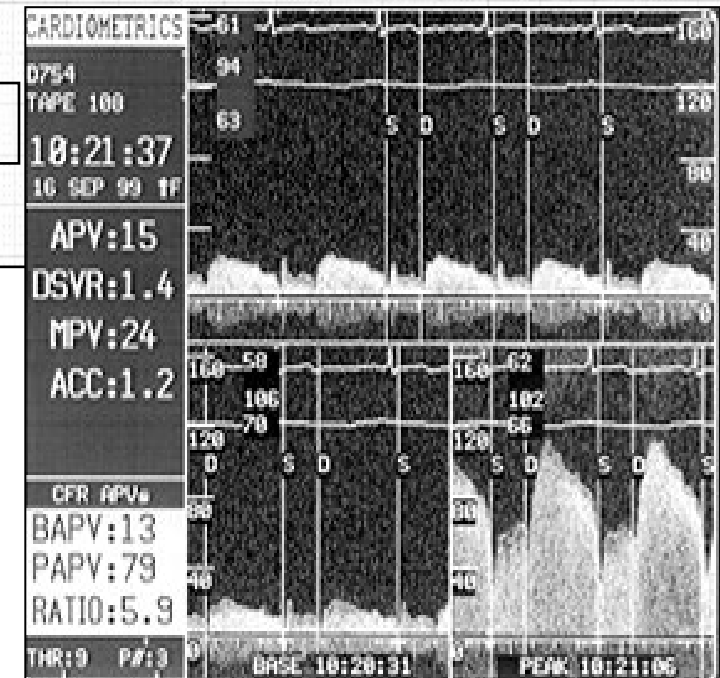
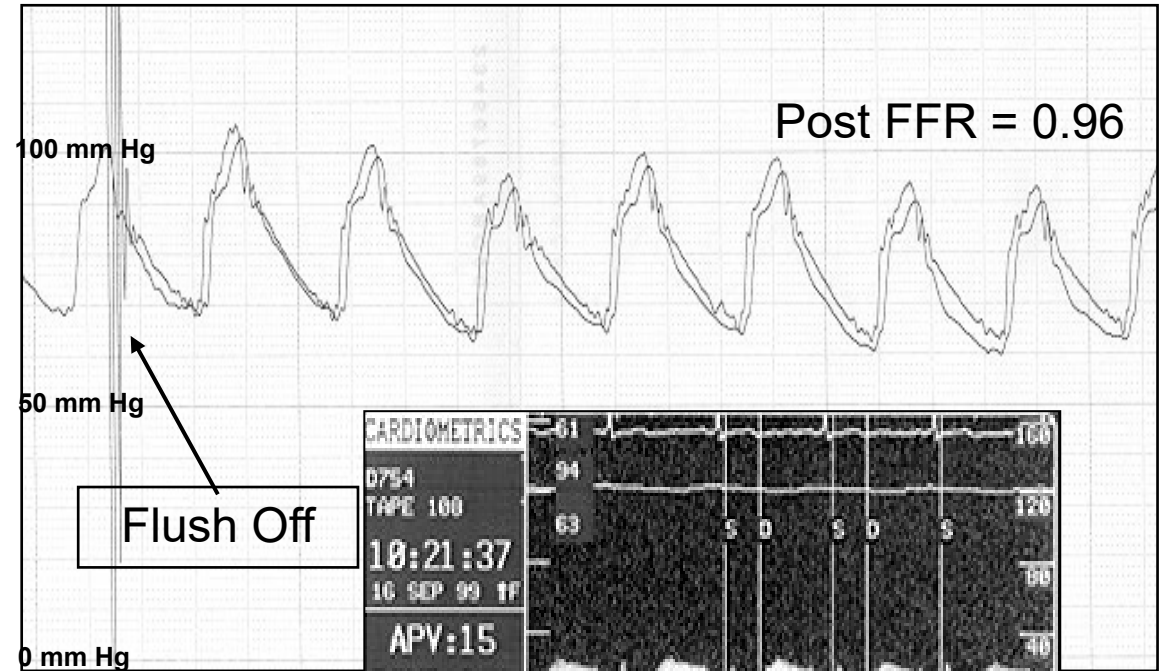
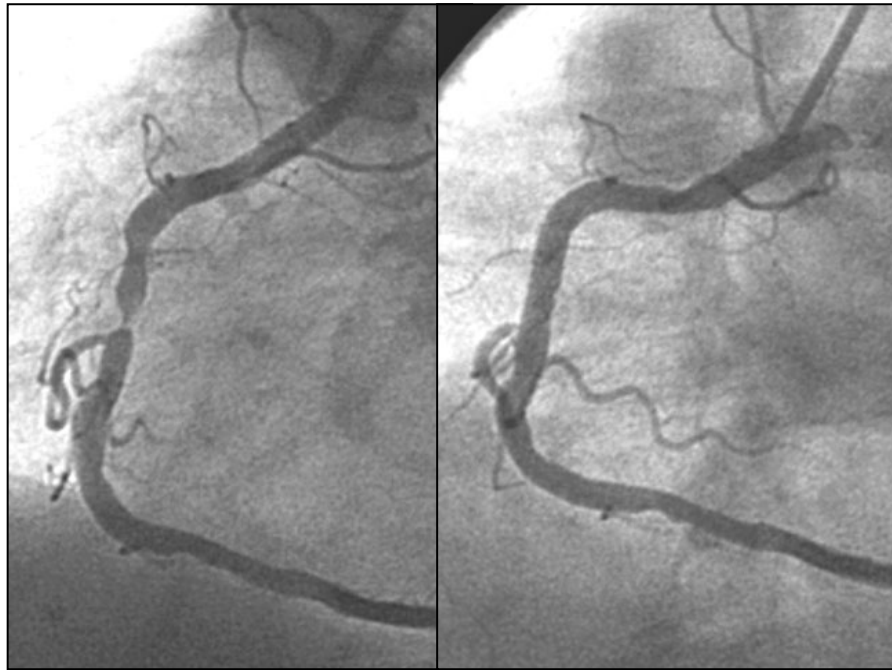
$$FFR = \frac{\text{MAX FLOW}_s}{\text{MAX FLOW}_n}$$



$$FFR = P_d / P_a \text{ @ hyperemia}$$



1994 – Live Demonstrations of Pressure and Doppler flow wires





1994

At the first coronary physiology demonstration course, Einthoven, January 1994, with 90 European interventionists attending.

BDB to Audience: "We have just shown normal FFR across this 60% lesion..".

MJK to Audience: "...and also normal coronary flow reserve as well..."

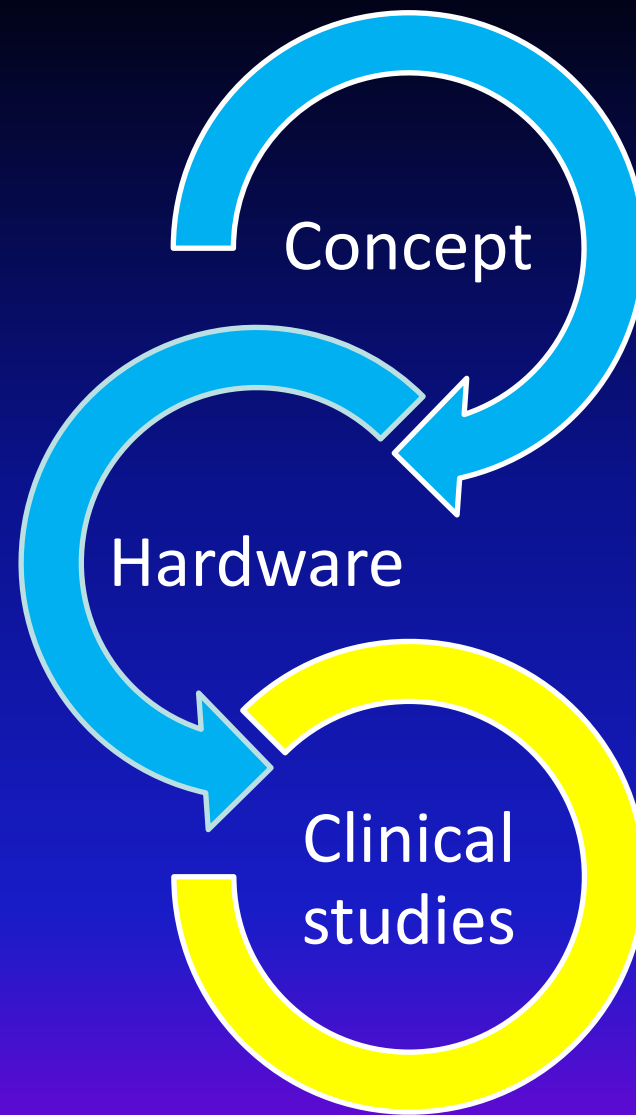
Nico Pijls to PWS: "What would you like to do now, Patrick?"

Patrick Serruys: "Stent it, of course,... it looks bad..."

MJK: "Patrick, really?...
...well, you've passed the course...(just not this one.)"



Evolution of FFR



Comparison of Hard Endpoints: FFR-Guided PCI vs Angio-Guided PCI and Medical Therapy in Large Trials (>500 Patients)

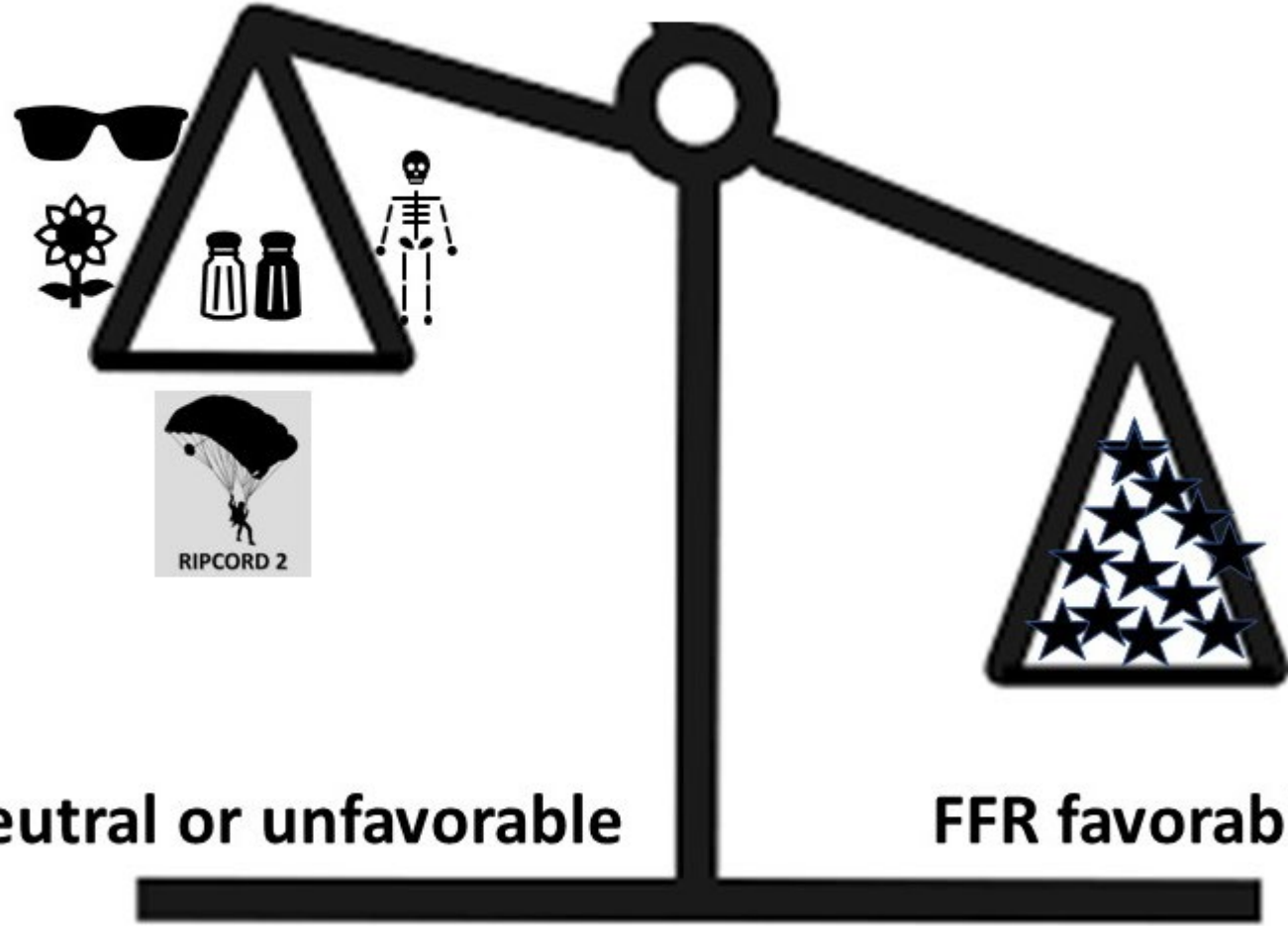
1 st Author Yr	Trial Outline	Events	FFR-Guided PCI (%)	Angio-Guided PCI (%)	Med Ther	HR (95% CI)	P Value
Pijls 2010	RCT of FFR-guided PCI versus angiography-guided PCI in 1,005	All-cause mortality	2.6	3.8	-	0.67 (0.33–1.34)	0.25
Völz 2020							0.03
Parikh 2020							0.02
Fröhlich 2014							<0.001
Iannaccone 2019							<0.0001
Omran 2019							0.31
Park 2013							<0.001
Li 2013							0.37
De Backer 2016							
Zimmermann 2019							<0.01
Xaplanteris 2017	5-yr follow-up	All MI	8.1			12.0	0.89
		Spontaneous MI	6.5			10.2	0.003
		Death or M	11.			16.	0.007
							0.28
							0.12
							0.12
							0.02
							0.346
							0.015
							0.011
							0.89
							0.03
							0.04
							0.98 (0.55–1.75)
							0.66 (0.43–1.00)
							0.62 (0.39–0.99)
							0.72 (0.50–1.03)

...when performed in the right patients and the right lesions, FFR-guided PCI works [...on hard endpoints].

From Adjedj J and Guillon B. FFR-Guided Revascularization in Stable “Intermediate” Lesions - Room for Improvement and Good Reasons to Do So. JACC 2022:420-421.



FFR PCI Outcome Trials



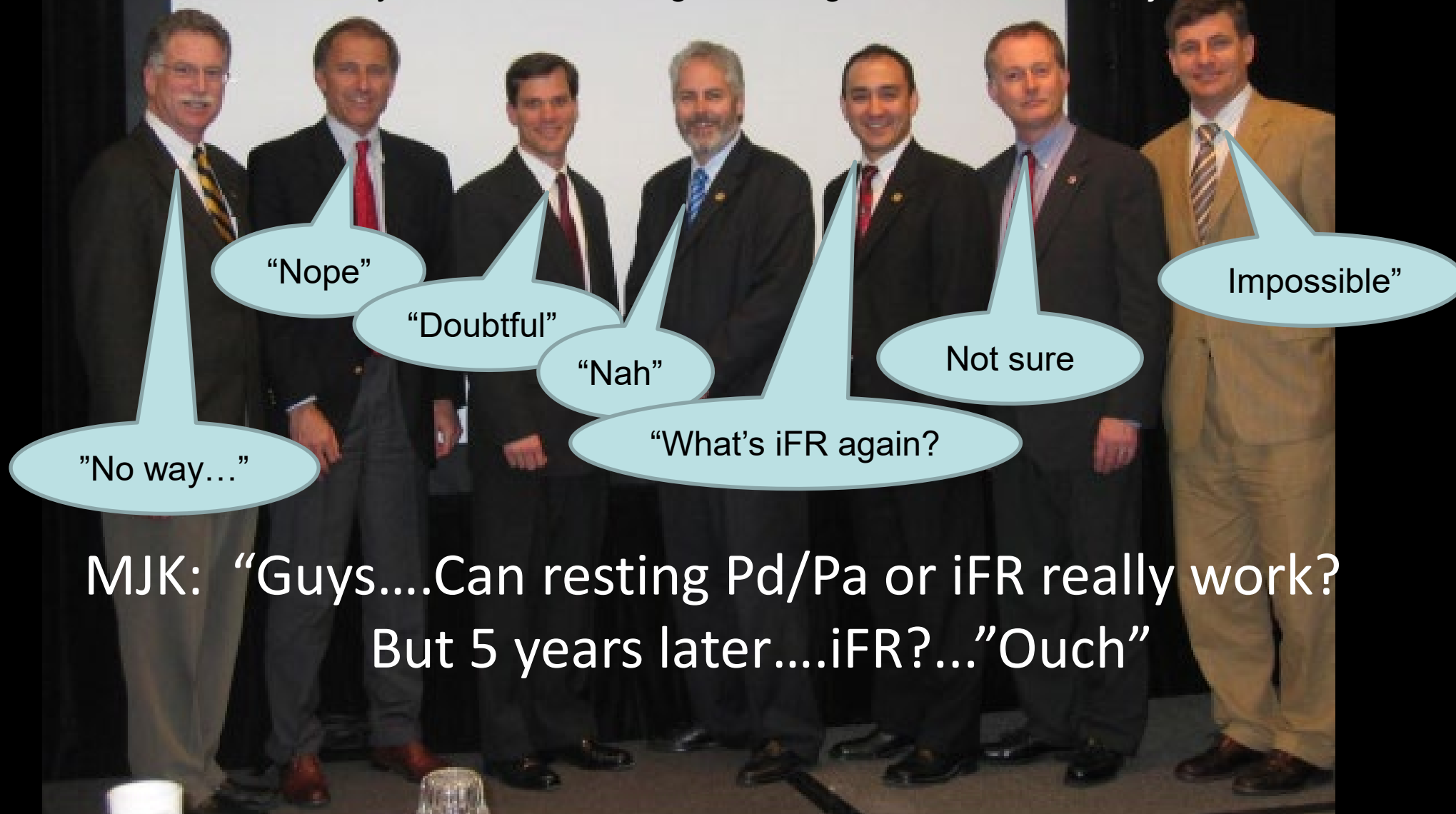
FFR neutral or unfavorable

FFR favorable



Commemoration of FAME studies at TCT, 2012

Kern DeBruyne Fearon Hodgson Higano Feldman Pijls



MJK: "Guys....Can resting Pd/Pa or iFR really work?
But 5 years later...iFR?..."Ouch"



The New Kids - iFR Studies

M Gotberg and J Davies
 March 18, 2017, Washington, DC

DEFINE FLA

Functional Lesion Assessment of intermediate stenosis to guide...

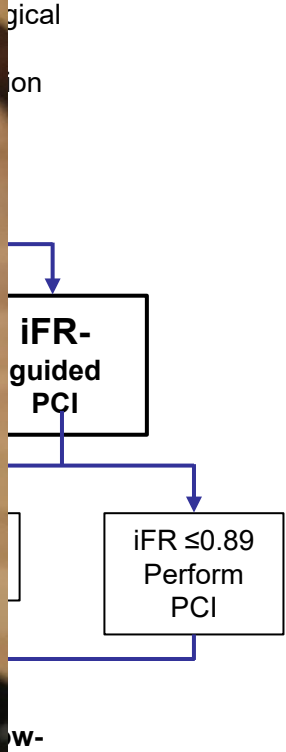
- Investigator-initiated and -led
- 49 sites across 17 countries
- **Enrollment:** 2500
- **Follow-up:** 5 years



- **Location:** Denmark, Iceland and Sweden
- **Estimated enrolment:**
- **Follow-up:** 5 years
- **Primary endpoint**
- **RCCT Design**



reported at 1-year

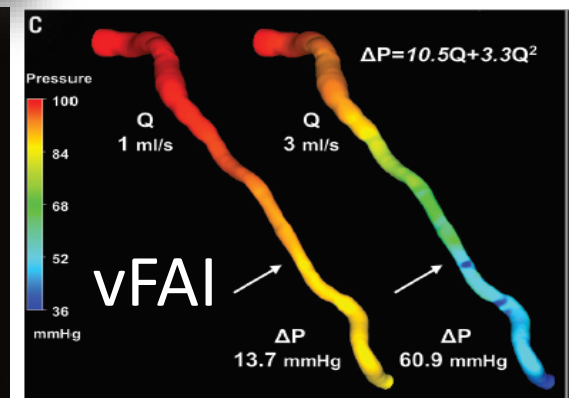
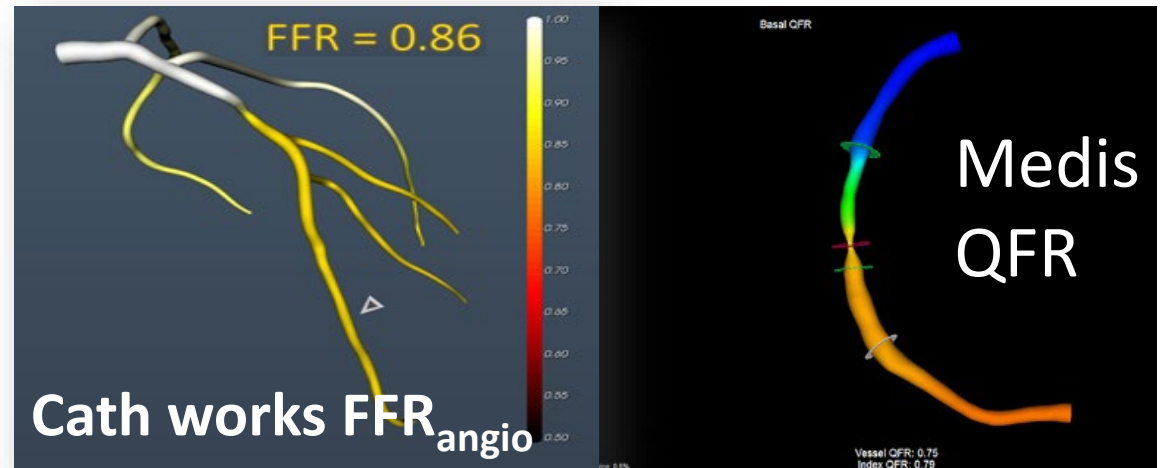
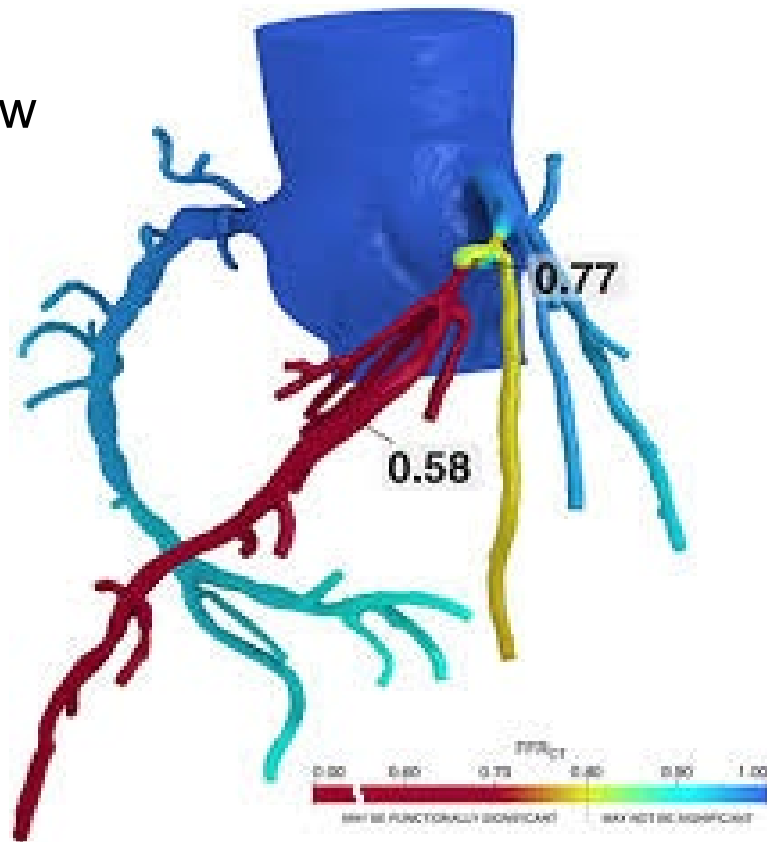


Methodologies for Angiographic derived FFR

Outside the Lab
FFRCT

Inside the Lab
CFD or fastflow angio-FFR software

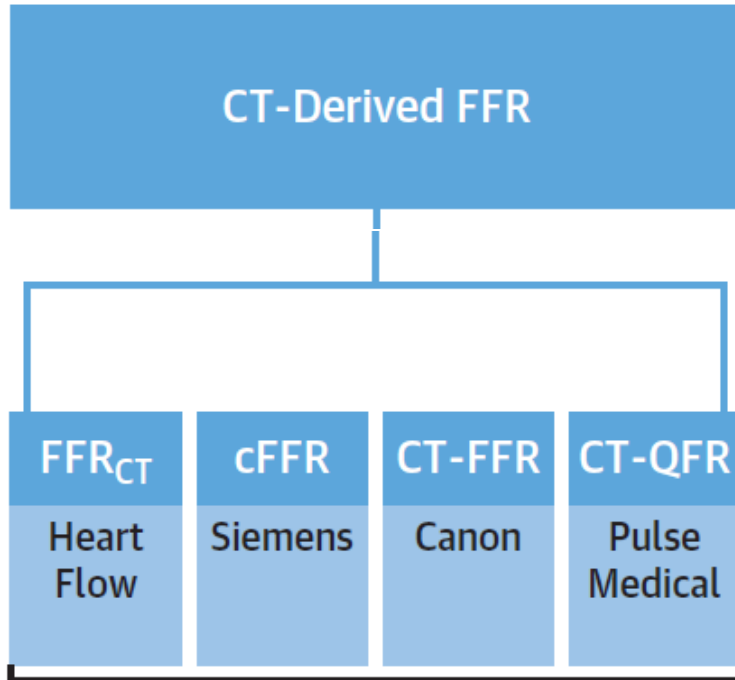
HeartFlow



2024 Coronary Physiological Assessment Tools

Outside the Cath Lab

CT-Derived FFR

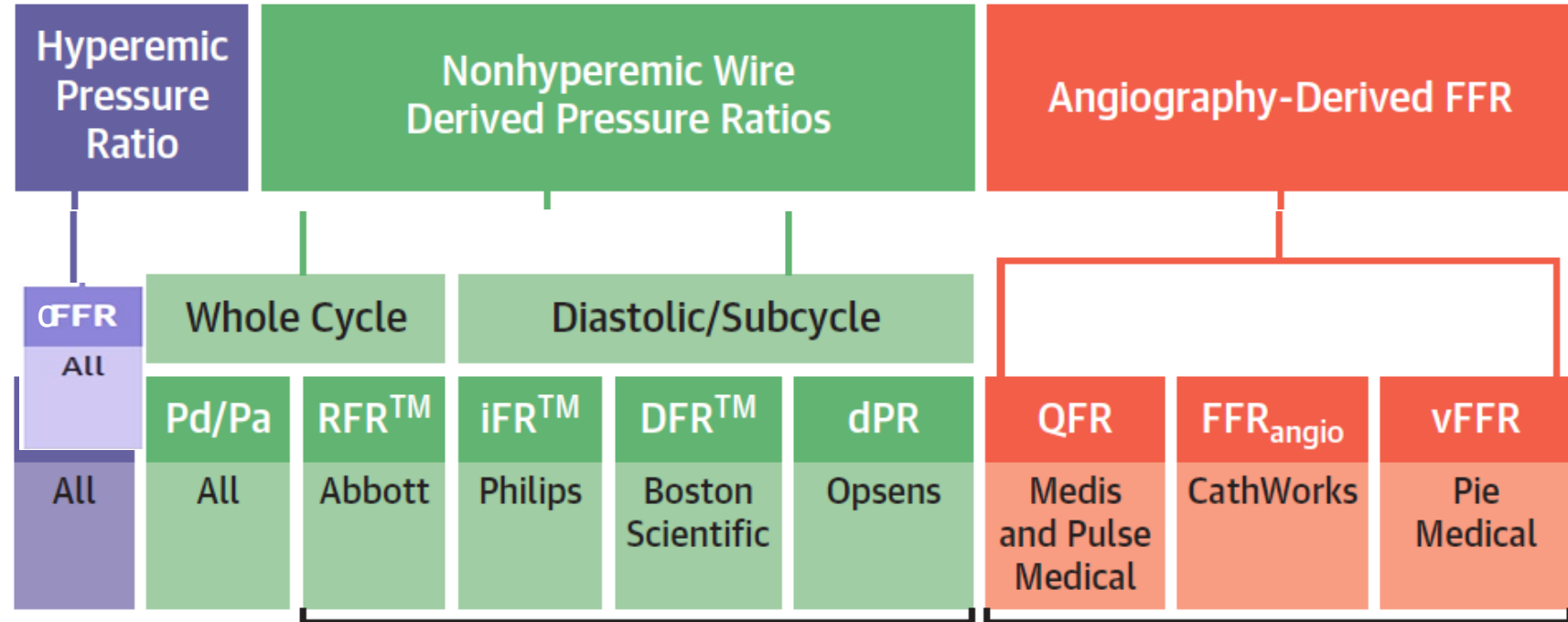


In the Catheterization Laboratory

Hyperemic Pressure Ratio

Nonhyperemic Wire Derived Pressure Ratios

Angiography-Derived FFR

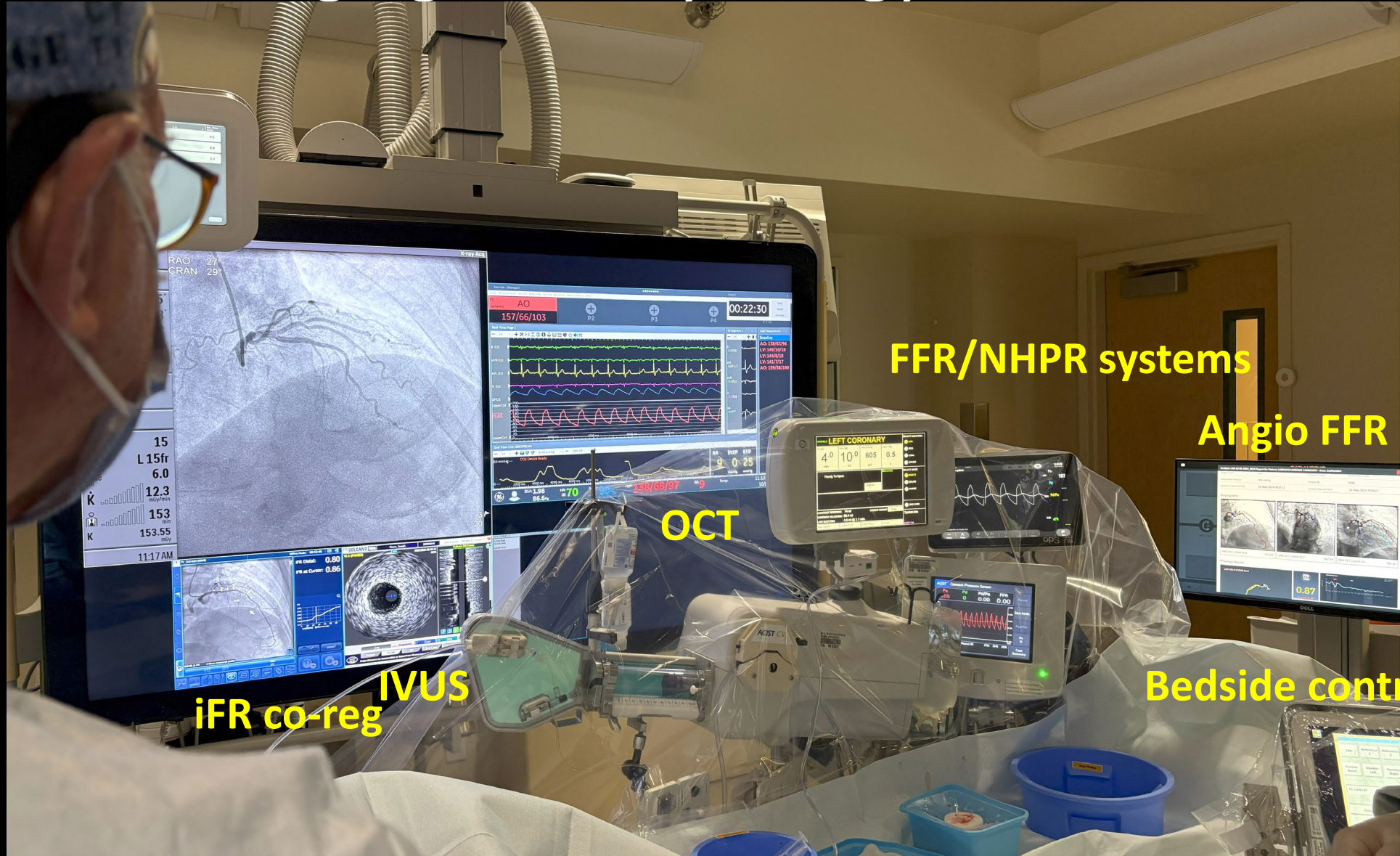


Coronary Microvascular Assessment
Absolute TD Flow, CFR, IMR, RRR, RFR, MRR

IVUS/OCT derived FFR,
Angio-IMR



Integrated Imaging and Physiology in the Cath lab 2024



FFR/NHPR systems

Angio FFR

OCT

IVUS

iFR co-reg

Bedside controls

