

## The $FFR_{CT}$ RIPCORDER Study

Does the routine availability of computer tomography (CT)-derived fractional flow reserve ( $FFR_{CT}$ ) influence management strategy of patients with stable chest pain compared to CT angiography alone?

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# Potential conflicts of interest

Speaker's name: **Nick Curzen**

I have the following potential conflicts of interest to report:

Honorarium:

HeartFlow, ST. JUDE MEDICAL, VOLCANO

Institutional grant/research support:

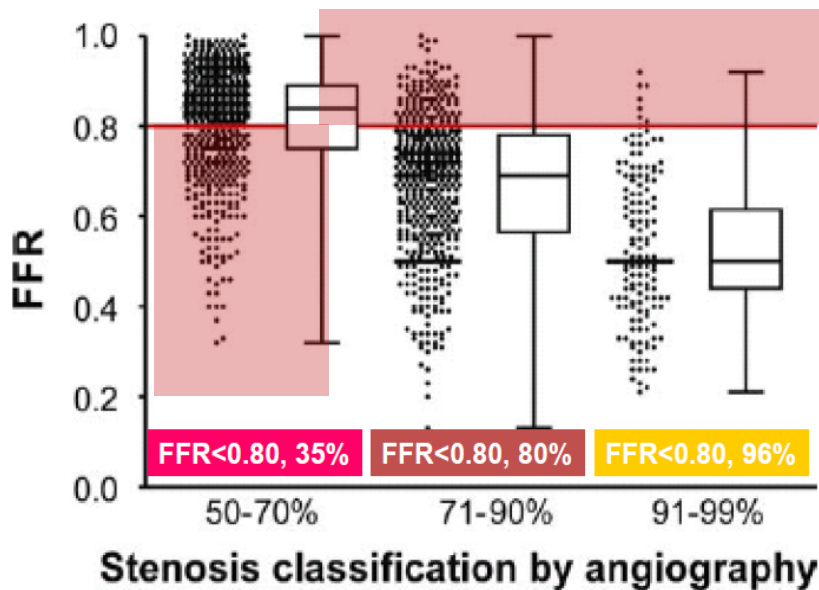
BOSTON SCIENTIFIC, Haemonetics, HeartFlow, MEDTRONIC

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# Background

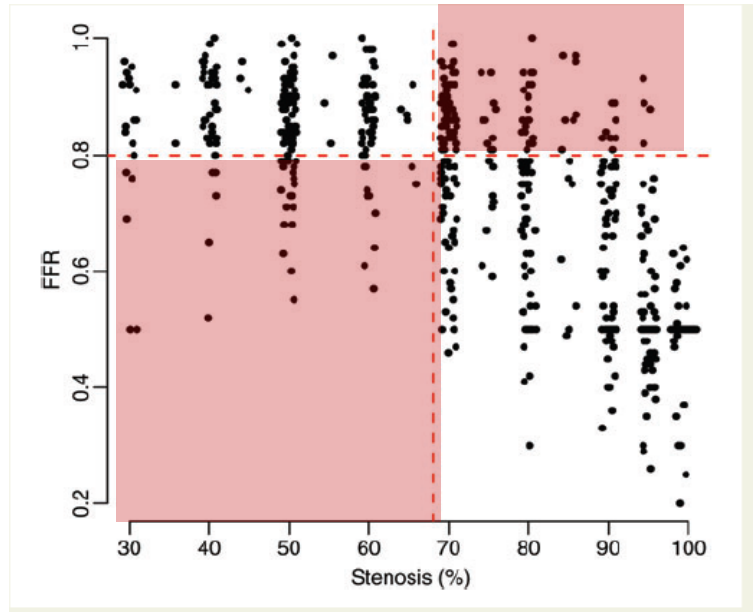
- Invasive fractional flow reserve (FFR) is a well validated & reproducible tool for detection of lesion-level ischaemia. <sup>1</sup>
- In patients with multivessel disease an FFR-directed PCI strategy is associated with better clinical outcomes compared to angiography-directed PCI (FAME; FAME 2) <sup>1,2</sup>
- In RIPCORD, when invasive FFR was available, management was altered in 26% of cases when compared to angiographic assessment alone because of a mismatch between angio- & FFR-derived analyses of lesion “significance” <sup>3</sup>
  
- Computed tomography (CT)-derived fractional flow reserve (FFR<sub>CT</sub>) is a novel diagnostic technique that allows derivation of FFR from raw data acquired during CT coronary angiography<sup>4</sup>
- Previous studies have demonstrated excellent diagnostic accuracy for this test
- As yet, however, there are no data to compare the management of patients with stable angina using CT angiography alone versus angiography with FFR<sub>CT</sub>

1. *Expert Rev Cardiovasc Ther* 2013;11:1051-9
2. *JACC* 2014;64:1641-54
3. *Circulation: Cardiovascular Interventions* 2014;7:248-55.
4. *Nature Reviews Cardiol* 2014, 11: 252

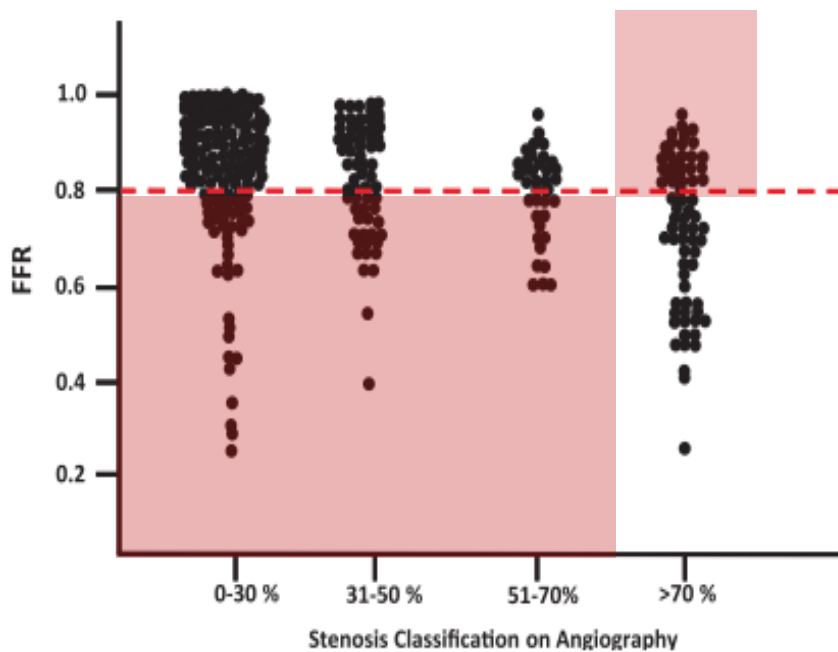


Stenosis classification by angiography

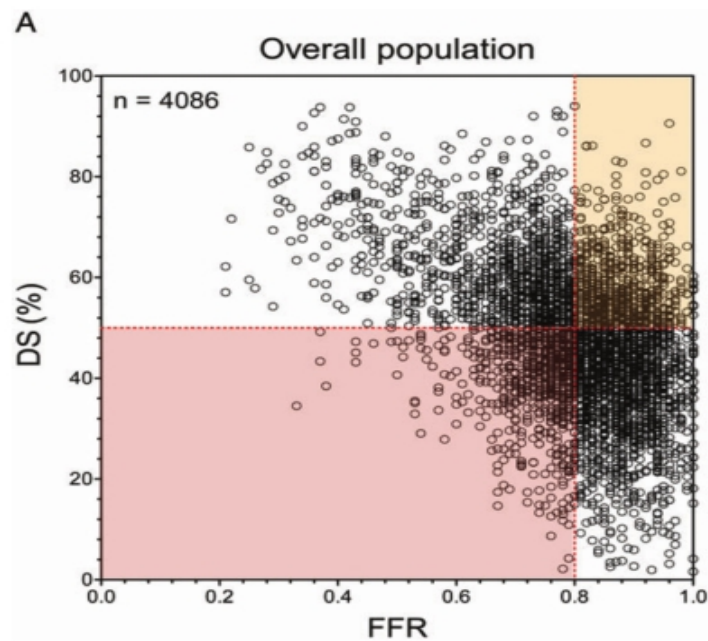
Tonino et al *JACC* 2010



Berry et al *Eur Heart J* 2014



Curzen et al *Circ Interven* 2014



Toth et al *EJH* 2014

# Hypothesis: Proof of Concept

In the assessment of patients with stable chest pain, the availability of non-invasive **FFR<sub>CT</sub>** in addition to coronary anatomy from the CT angiogram:

(1) would lead to a substantial change in the interpretation of lesion-specific “significance”

(2) that this would consequently lead to a change in the management plan in a manner similar to that seen in RIPCORD.

## Primary Endpoint

The difference between the management based upon interpretation of the CT angiogram alone compared to the management incorporating the non-invasive  $FFR_{CT}$  data.

## Secondary Endpoints

1. The correlation between vessels labelled as “significant” based upon interpretation of the CT angiogram alone versus when  $FFR_{CT}$  data are available
2. Comparison between individual coronary arteries labelled as targets for revascularisation based upon the CT angiogram alone compared to  $FFR_{CT}$

# Methods

- Three experienced interventional cardiologists (ICs) reviewed 200 consecutive cases of stable angina recruited into the NXT study of FFR<sub>CT</sub>.<sup>5</sup>
- In each case the ICs reviewed the CT angiogram in detail, reported the degree of stenoses in the coronaries and then, by consensus, came to a plan of management based upon the anatomic appearances, using 4 options:  
**(1) Optimal medical therapy (OMT); (2) PCI + OMT; (3) CABG + OMT; (4) more information required** (ie meaning invasive FFR needed)
- FFR<sub>CT</sub> data for each case was then revealed, and the ICs then asked to again describe (a) which vessels were significant & (b) make a second management plan based upon these data

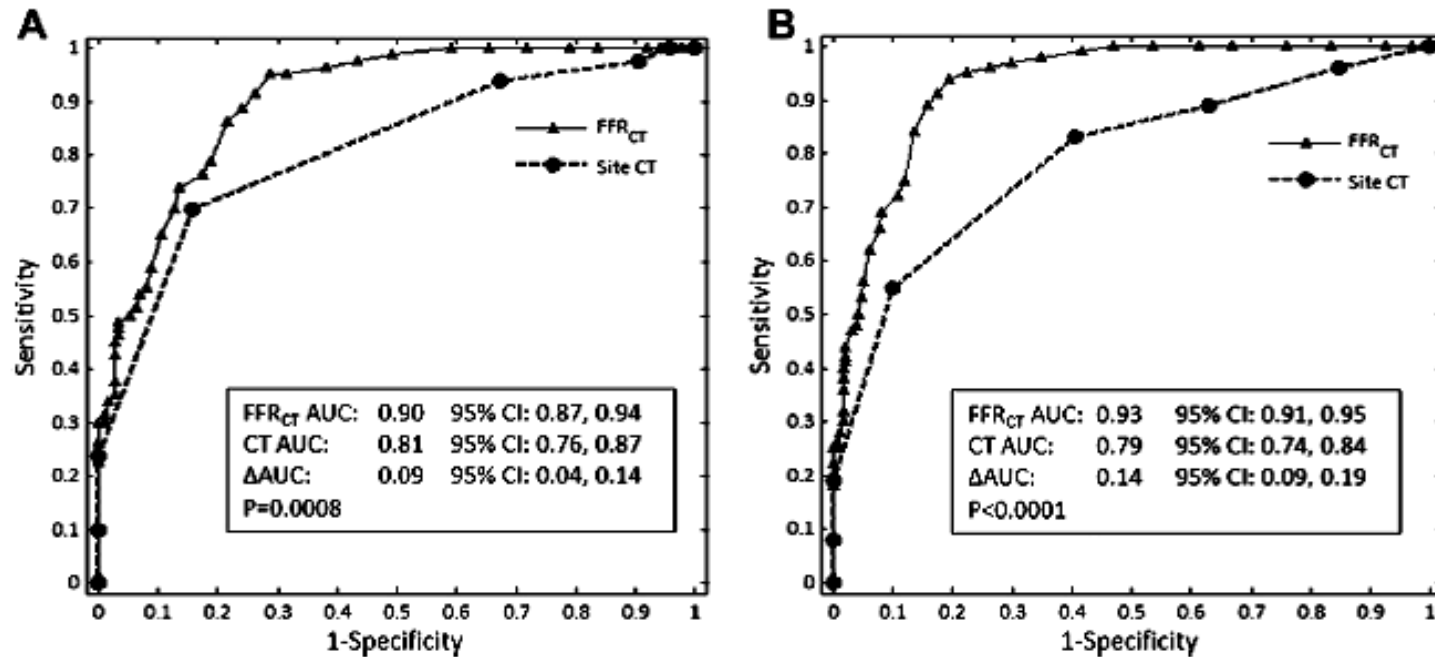
5. JACC 2014; 63: 1145

## Diagnostic Performance of Noninvasive Fractional Flow Reserve Derived From Coronary Computed Tomography Angiography in Suspected Coronary Artery Disease

The NXT Trial (Analysis of Coronary Blood Flow Using CT Angiography: Next Steps)

JACC 2014

- N=254
- CTA + FFR<sub>CT</sub> versus invasive angio + FFR



**Figure 5** AUC of FFR<sub>CT</sub> Versus Coronary CTA for Demonstration of Ischemia (FFR  $\leq 0.80$ ) on a Per-Patient and Per-Vessel Basis

(A) Per-patient; (B) per-vessel. In the per-patient analysis, a FFR<sub>CT</sub>  $\leq 0.80$  was diagnostic of ischemia, and stenosis  $>50\%$  at coronary CTA was anatomically obstructive. N = 251 for subjects and 484 for vessels. AUC = area under the receiver-operating characteristic curve; other abbreviations as in Figures 2 and 3.



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5. *JACC* 2014; 63: 1145

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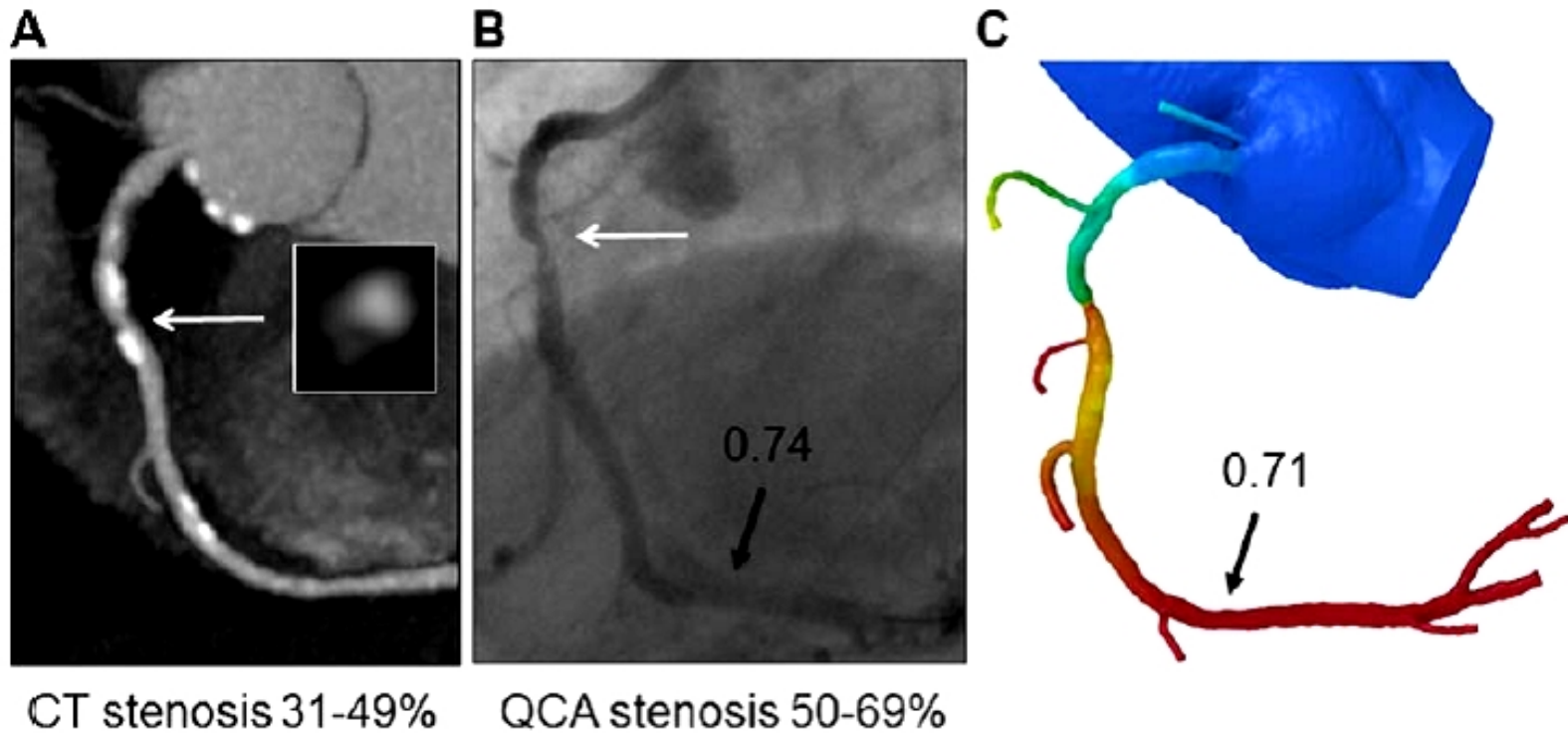
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5. *JACC* 2014; 63: 1145

# Noninvasive Fractional Flow Reserve Derived From Computed Tomography Angiography for Coronary Lesions of Intermediate Stenosis Severity

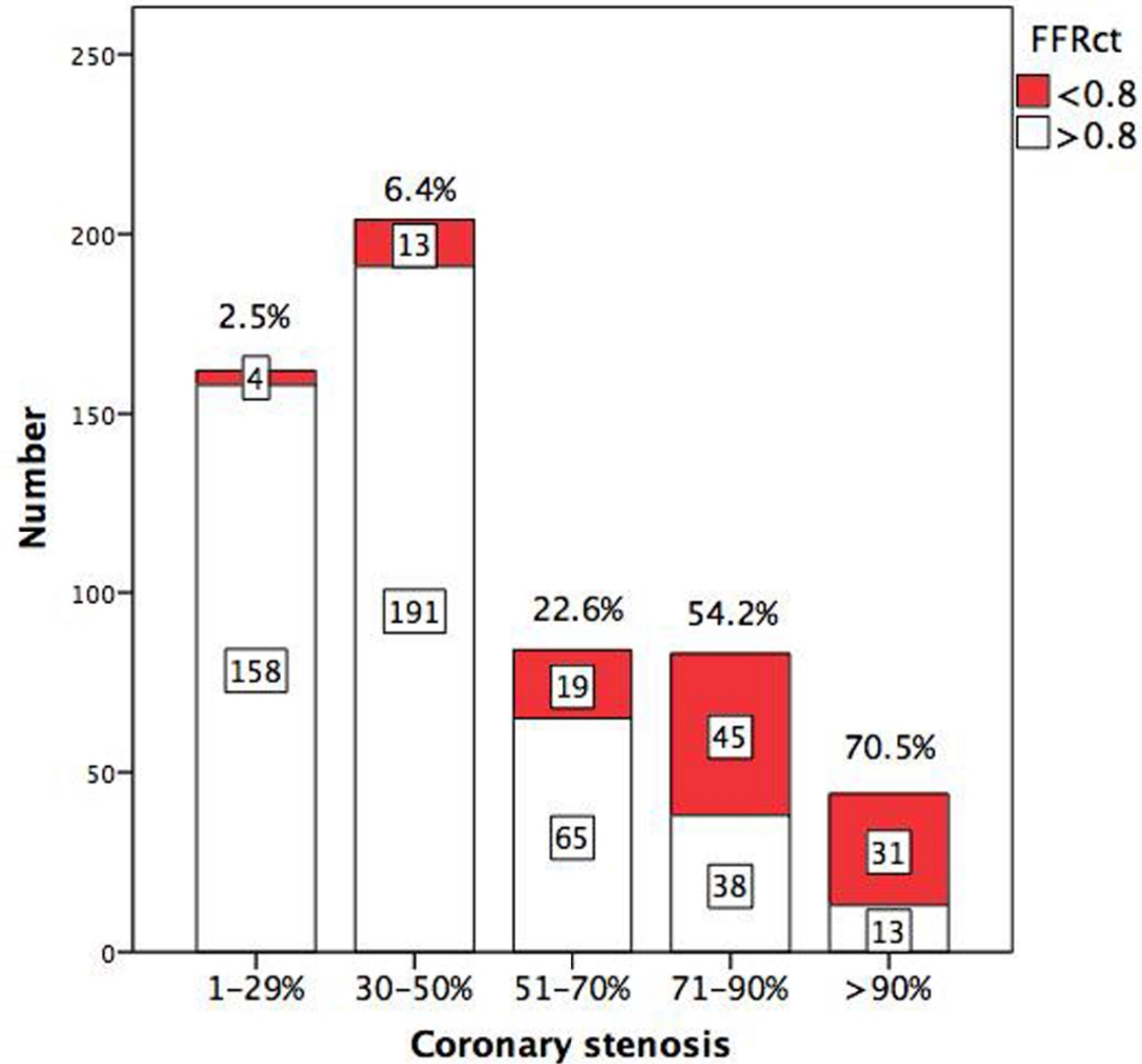
## Results From the DeFACTO Study

*Circ Cardiovasc Imaging* 2013



# Results

Degree of angiographic stenosis on CT versus FFR<sub>CT</sub> >/<0.8



# Results

Management options chosen based upon CT angio alone and after FFR<sub>CT</sub> data revealed  
 n=200

	CT Angio Alone	With FFR <sub>CT</sub>	% change
More data	38 (19.0 %)	0	-
OMT	67 (33.5 %)	113 (56.5 %)	+ 23 %
PCI	87 (43.5 %)	78 (39.0 %)	- 5%
CABG	8 (4.0 %)	9 (4.5 %)	+ 0.5 %

P<0.001 by Chi-squared test

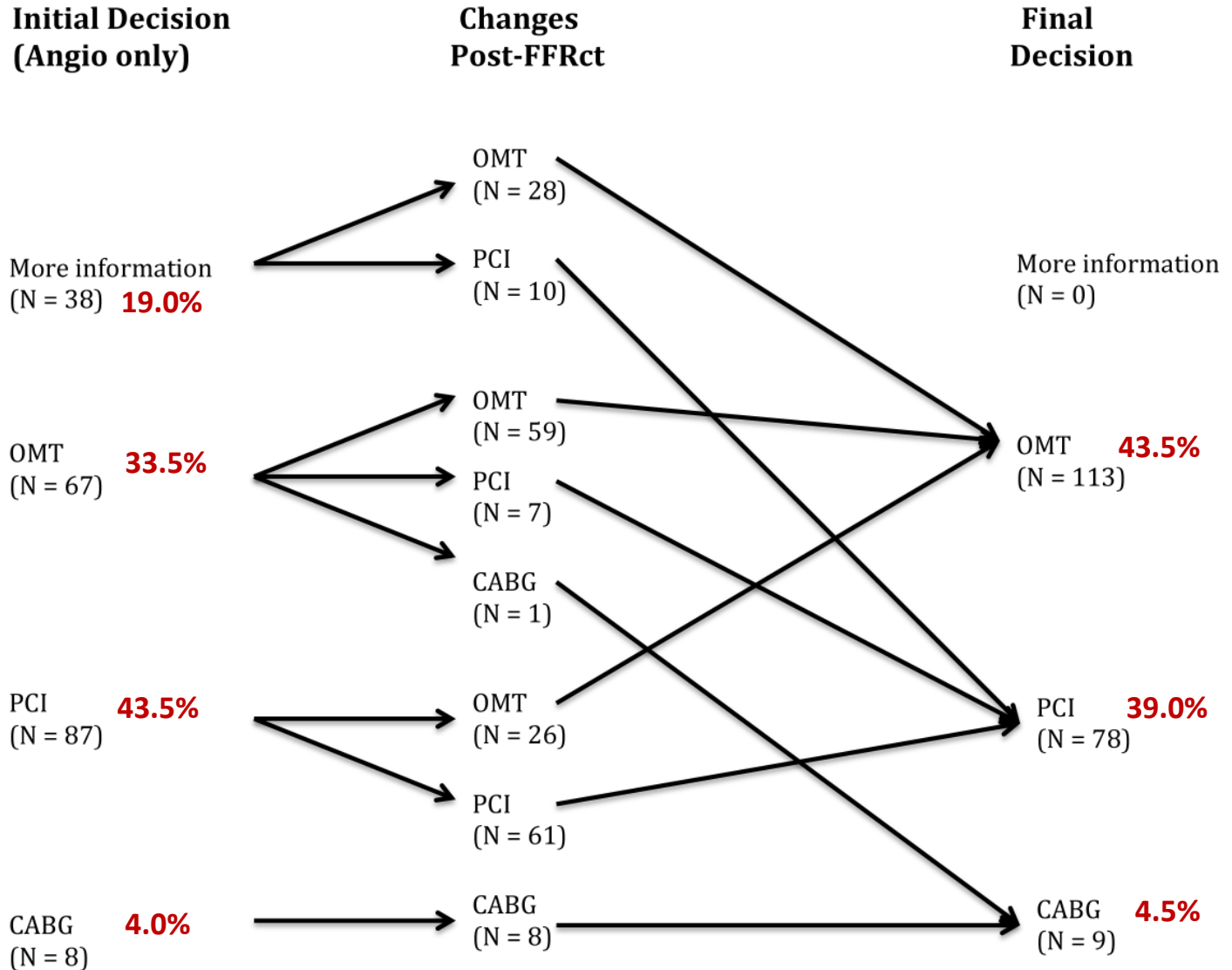
Overall there was a change in management in 72 (36%) of cases

In 16 cases (18%) of angio-directed PCI cases the vessel(s) specified as PCI target changed after FFR<sub>CT</sub>

# Results

n= 200 cases

Detailed description of change in angio-directed management after FFR<sub>CT</sub> revealed



# CONCLUSIONS

- This study demonstrates a mismatch between CT angiographic assessment of lesion severity & the **FFR<sub>CT</sub>**-derived estimate of ischaemia
- The addition of **FFR<sub>CT</sub>** data to CT angiography alone led to a change in management in 36% of cases in this study
- These results are consistent with those of the invasive RIPCORD study
- If this novel proof of concept result can be confirmed in large scale trials, this suggests that non-invasive **FFR<sub>CT</sub>** can be used as a clinically relevant tool that mimics the well-described ability of invasive FFR to refine management decisions for patients with chest pain that are made based upon ICA alone.
- This would have important implications for routine clinical practice.
- **FFR<sub>CT</sub>** may have potential as a default method for assessment of coronary anatomy and physiology in angina patients in order to define their management