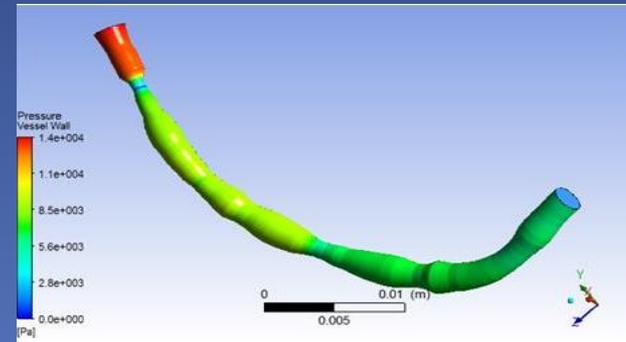
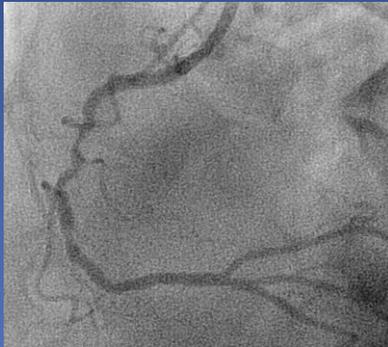


# The role of visualisation in models and decision making: *Heart disease and its management* *M2D, Exeter 2017*



**Professor Julian Gunn**

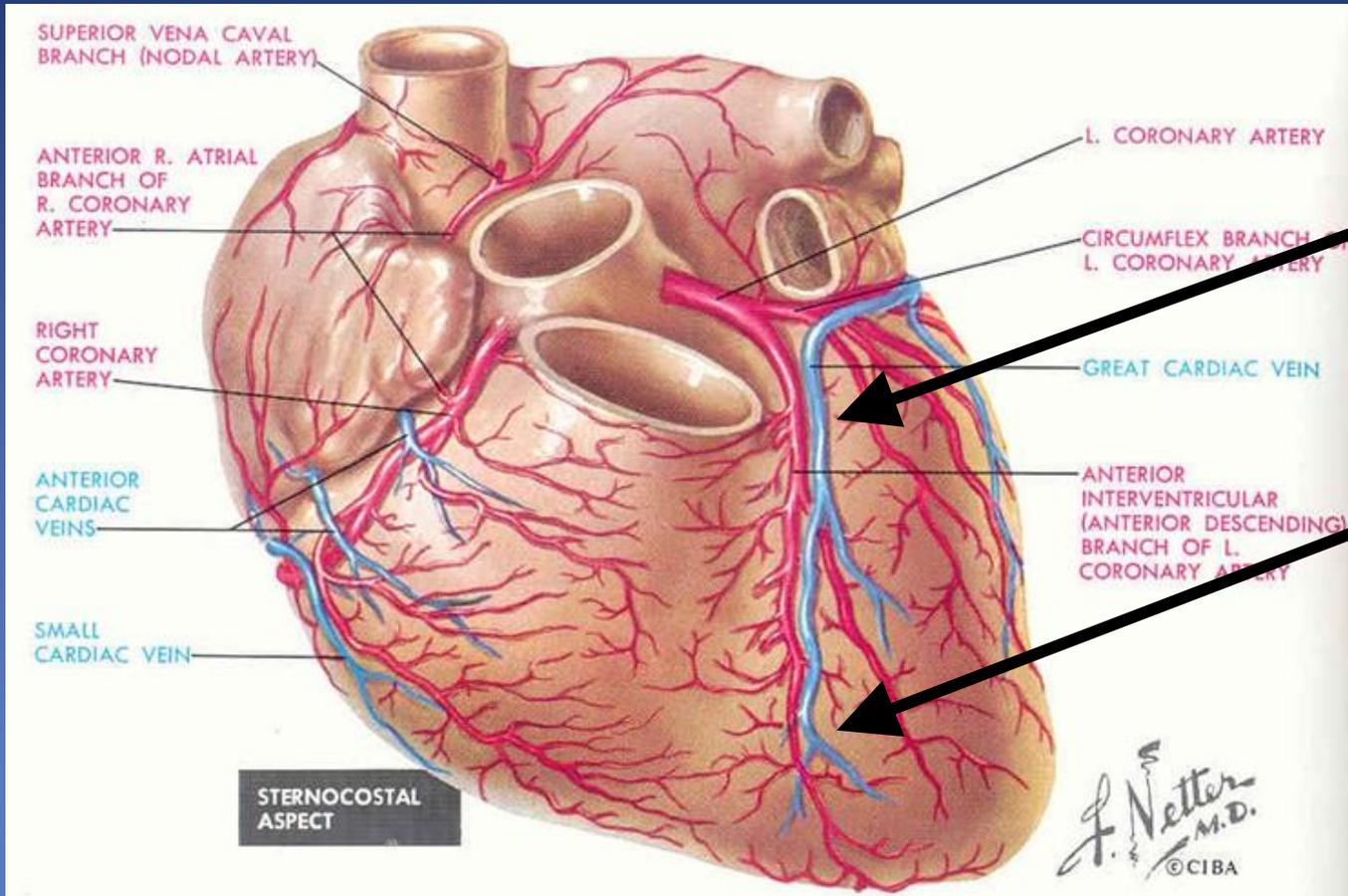
Dept Infection, Immunity and Cardiovascular Disease,  
University of Sheffield

# Heart disease

- Ischaemic heart disease
- Heart failure
- Valve disease
- Rhythm disturbances
- Congenital abnormalities

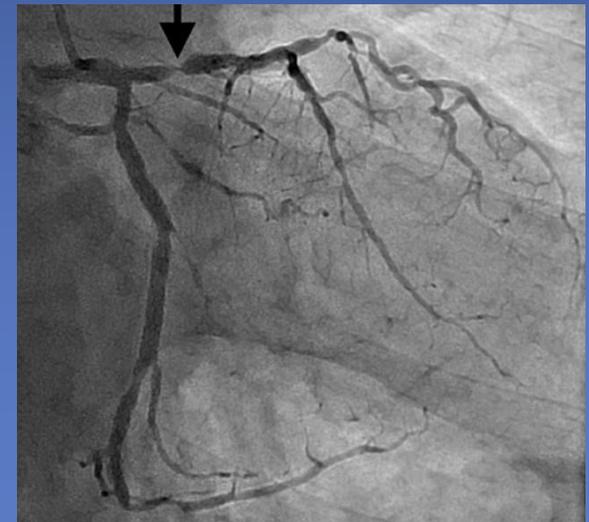
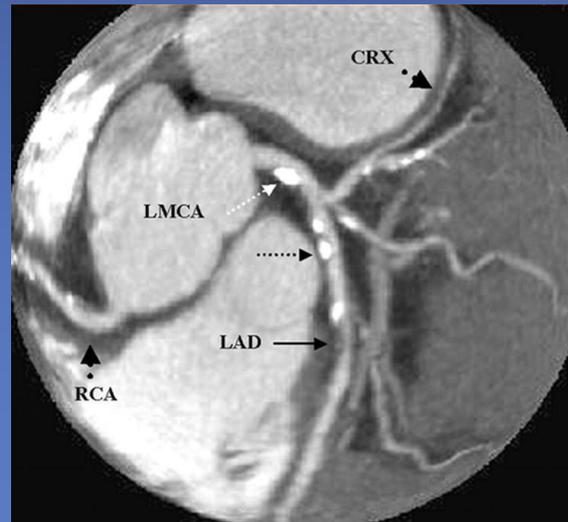
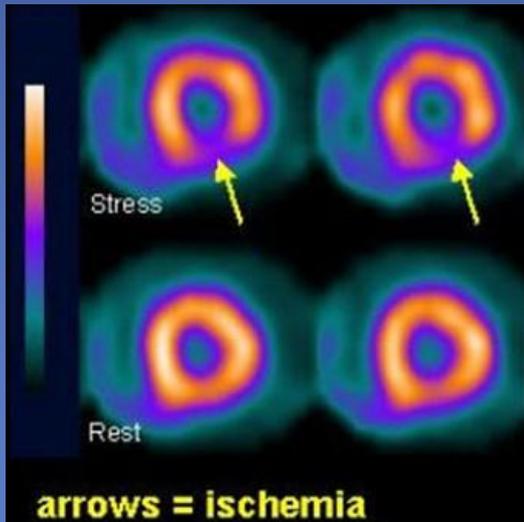
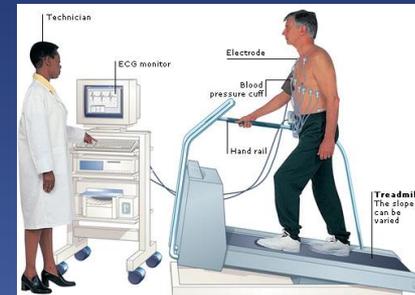
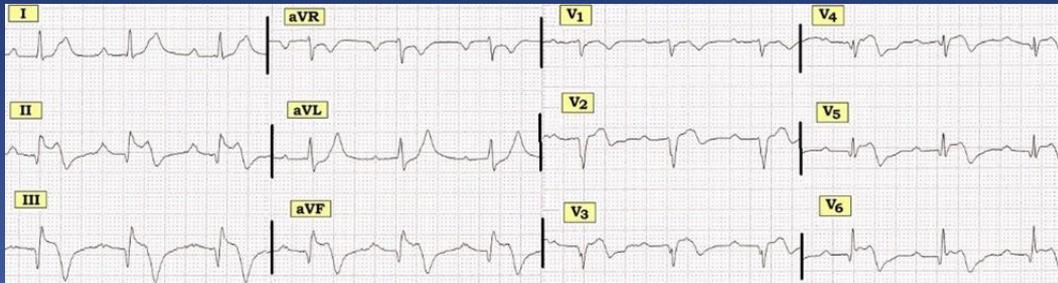


# Ischaemic heart disease



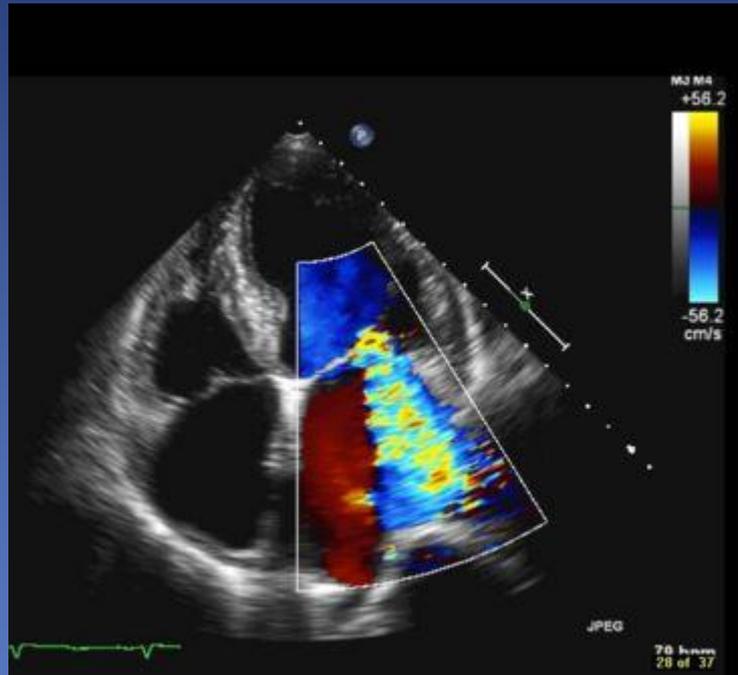
Mismatch of oxygen demand and supply

# IHD

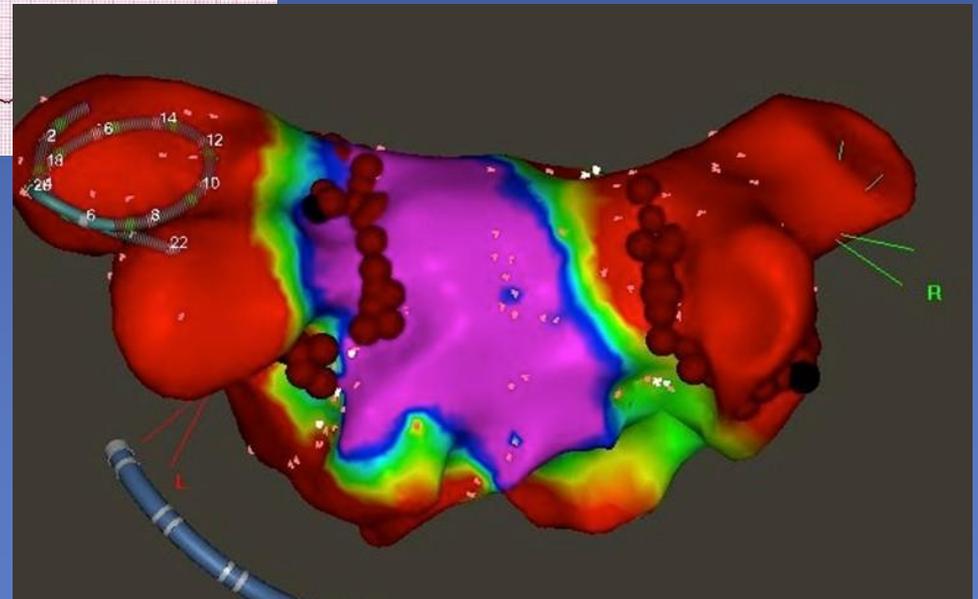
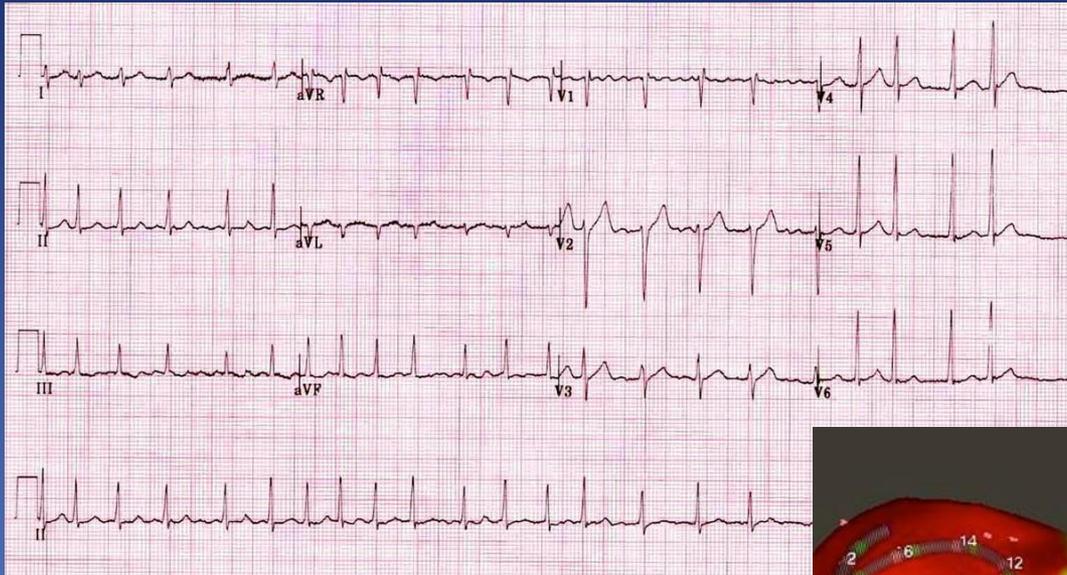




# Valve disease

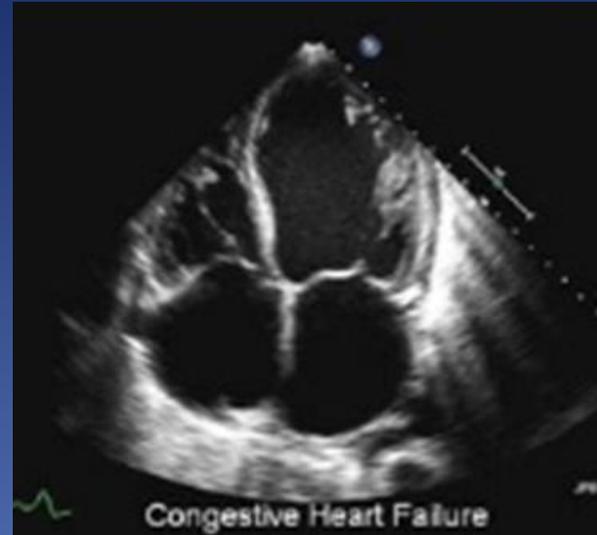
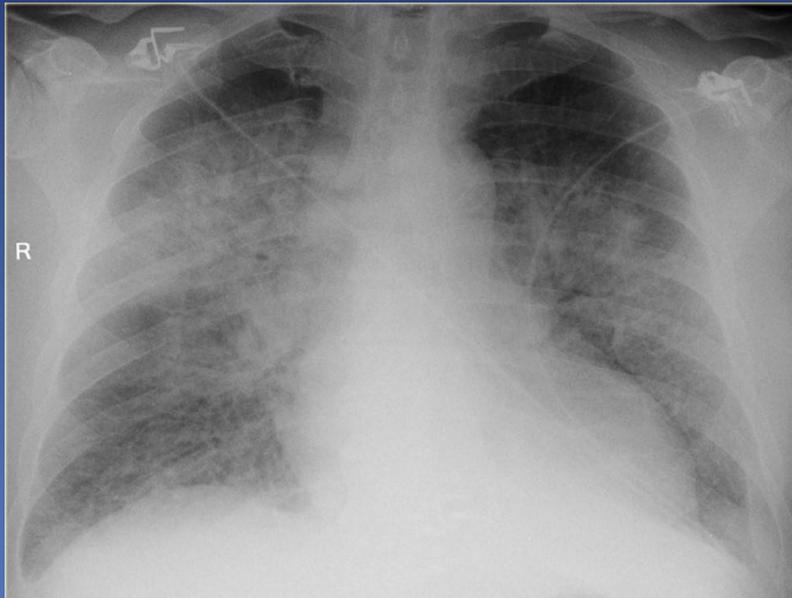


# Arrhythmias





# Heart failure





# Guidelines and evidence

**NHS**  
National Institute for Health and Clinical Excellence

**Quick reference guide**

Issue date: July 2011

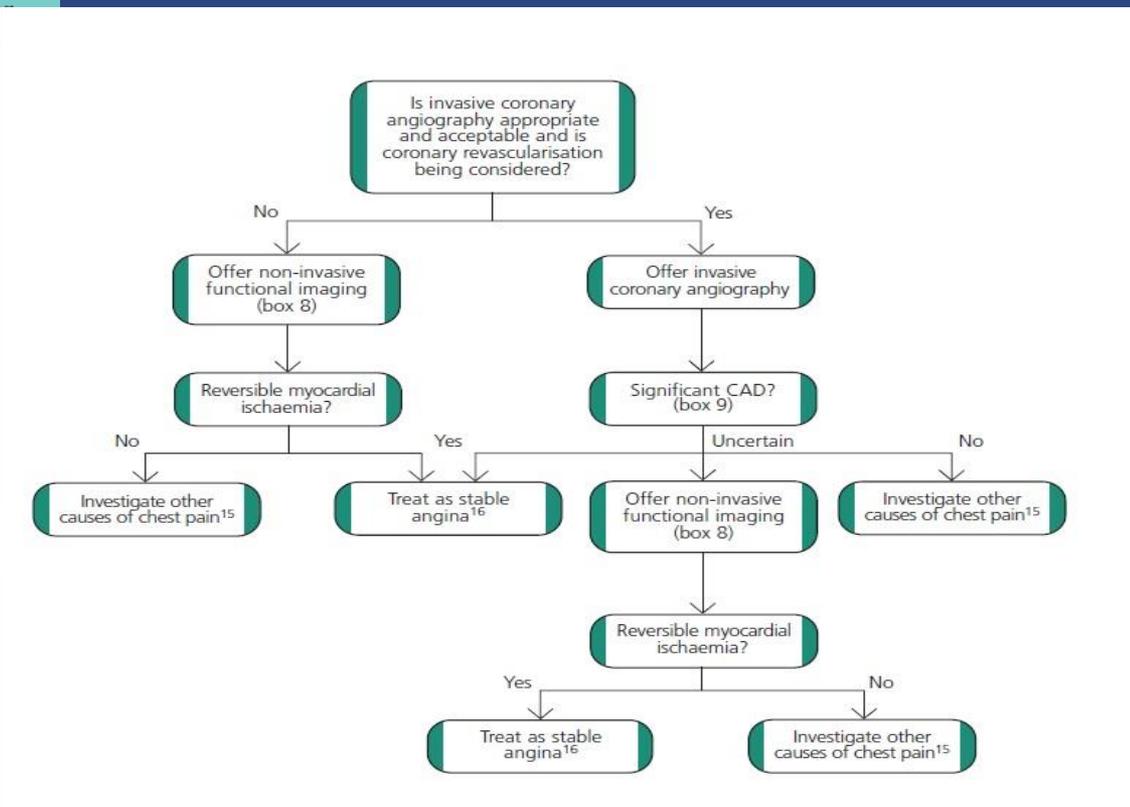
**Management of stable angina**

This guideline partially updates NICE technology appraisal guidance 73

**December 2012**  
Licensing information for nicorandil has been updated. In this document the change is marked with black strikethrough

**NHS Evidence**  
accredited provider  
NICE evidence standards 1/12  
www.nhs.uk/evidence

NICE clinical guideline 126  
Developed by the National Clinical Guideline Centre



Group C (High risk)



The  
University  
Of  
Sheffield.

Sheffield Teaching Hospitals **NHS**  
NHS Foundation Trust

# Lifestyle





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# Comorbidity





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# Setting



# Organisational issues



So heart disease is very visual.  
It is very image-heavy.  
Few models exist in routine practice (yet).  
Many uncertainties at every level.  
Many sources of patient information load.

How do we cope with this?



# New developments



MDT meeting  
The 'Heart Team'

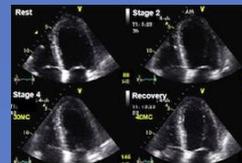
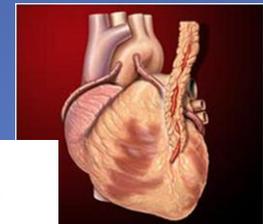
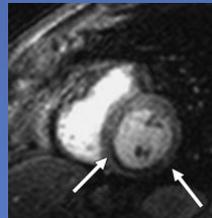
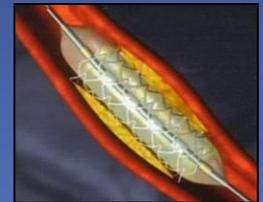
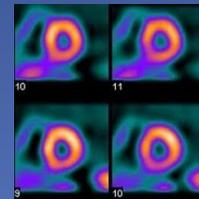
# What are doing?

- ‘Model dependent realism’ (Hawking S, The Grand Design, 2010)
- Models are how we function
- In everyday life
- Scientifically, clinically, for our patient, for the heart
- We construct models of the world around us
- We test hypotheses with them – mentally (virtually) and experimentally
- Computational models are a formal extension of this



The University Of Sheffield.

# Example: IHD



# Help is at hand: FFR

$$FFR = \frac{\text{Distal Coronary Pressure (Pd)}}{\text{Proximal Coronary Pressure (Pa)}} \quad (\text{During Maximum Hyperemia})$$





# Key point: interpretation of the angiogram

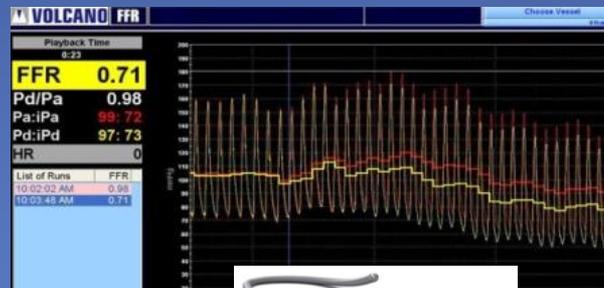


+



Or, better .....

+

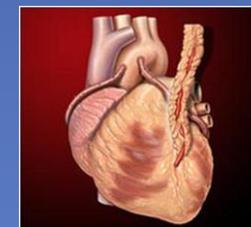
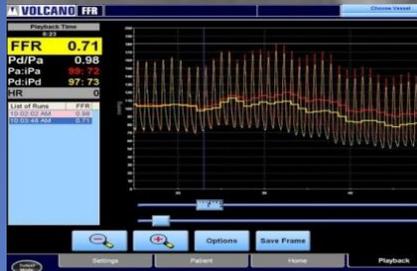
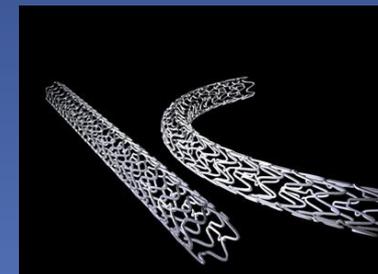


## Physiological assessment (FFR)

- reduces deaths/heart attacks
- reduces stent implantation
- saves money



# Current best practice





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Sheffield.

Sheffield Teaching Hospitals **NHS**  
NHS Foundation Trust

But ..

250,000      Angiograms  
90,000        PCIs



6,000,000    Cardiac catheters  
4,000,000    PCIs



**<5% have FFR**

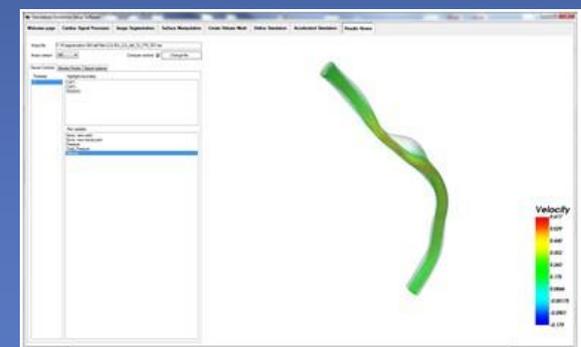
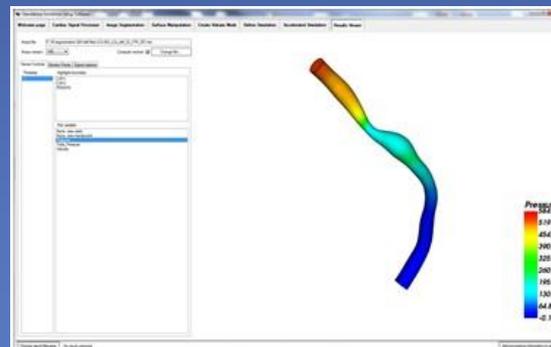
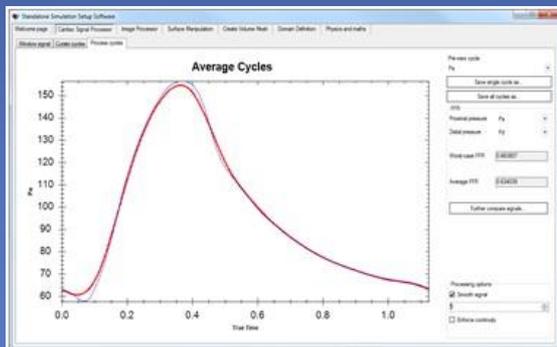
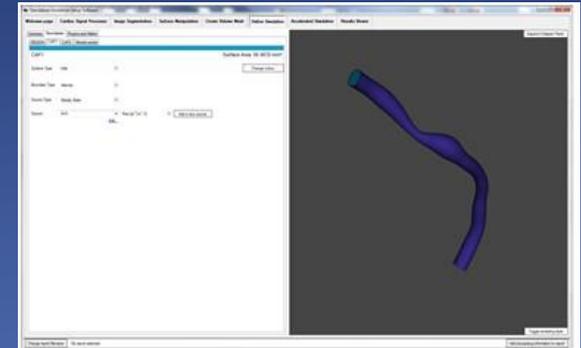


# Why so few FFRs?



- I know best!
- It takes too long!
- I can't be bothered!
- I haven't got time!
- It's expensive!
- I can stent that!
- I don't trust it!

# Virtual (computerised) FFR Modelling blood flow from the images

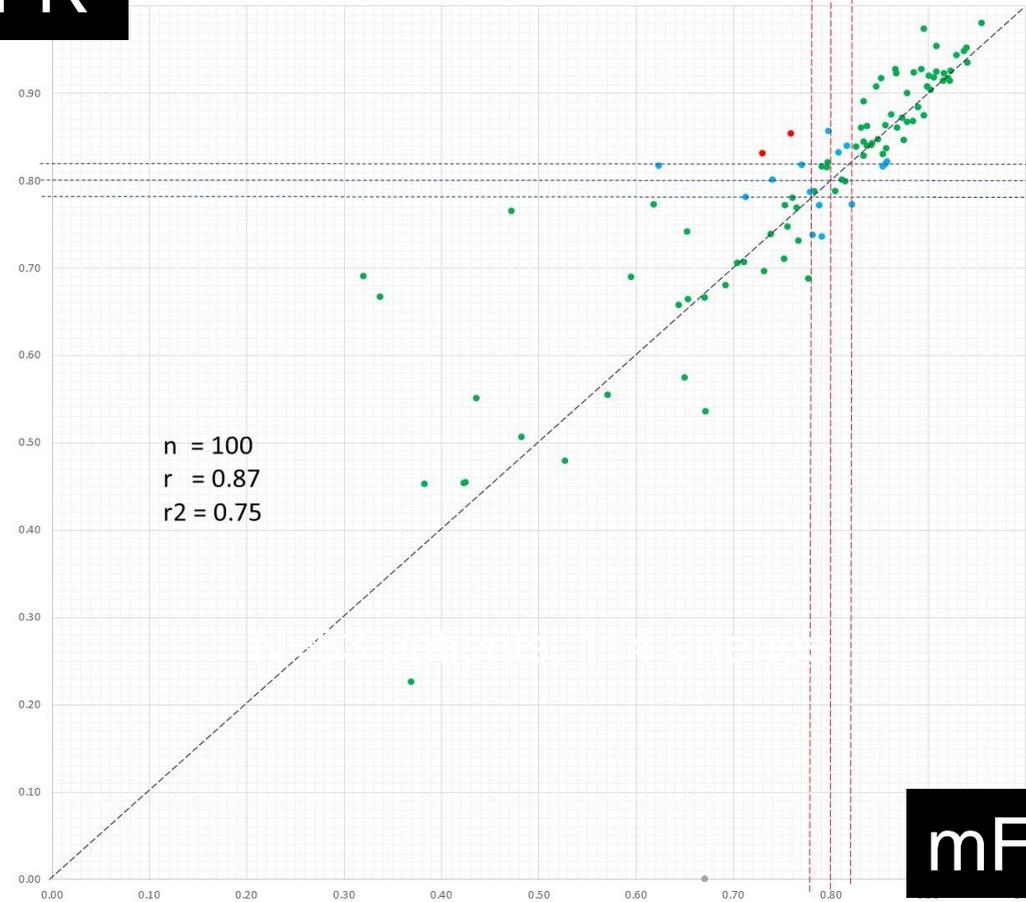


An angiogram is performed (a). The vessels are segmented (b) into 3-D virtual arteries (c). Pressure and boundary condition data are selected and applied (d). After simulation ( $\approx 3$  min), the pressure and flow results are visualised (e & f). The vFFR can be reported at any point.

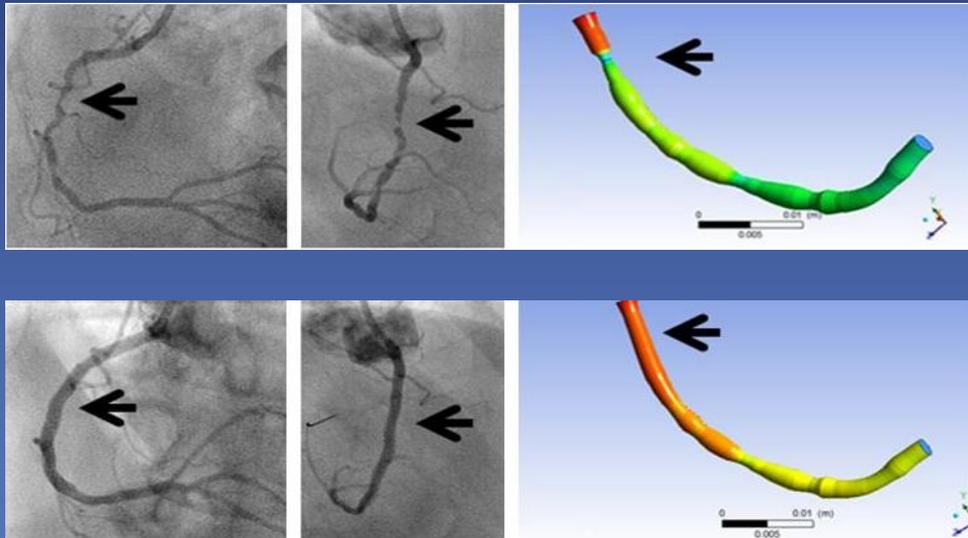
# Accuracy/ uncertainty of vFFR vs mFFR

vFFR

vFFR (personalised NARMAX) vs mFFR  
incorporating 'grey zone' 0.78-0.82



# Virtual (modelled) FFR

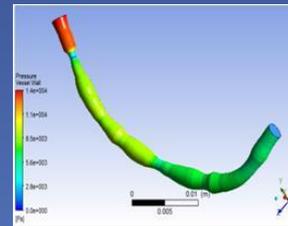
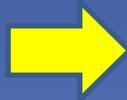
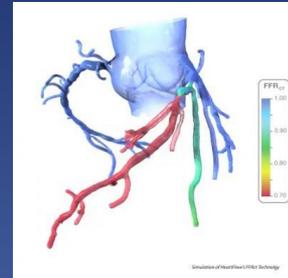
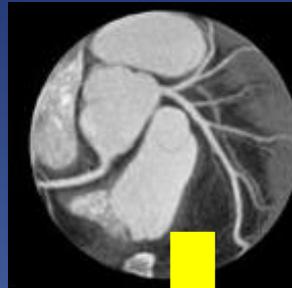


- \* physiology from anatomy
- \* treat/ don't treat
- \* objective
- \* applicable to all (not 5%)
- \* no invasive wire
- \* no drugs
- \* no additional time
- \* cheap
- \* anywhere in the world
- \* virtual stenting
- \* benefits of FFR
- \* without disadvantages



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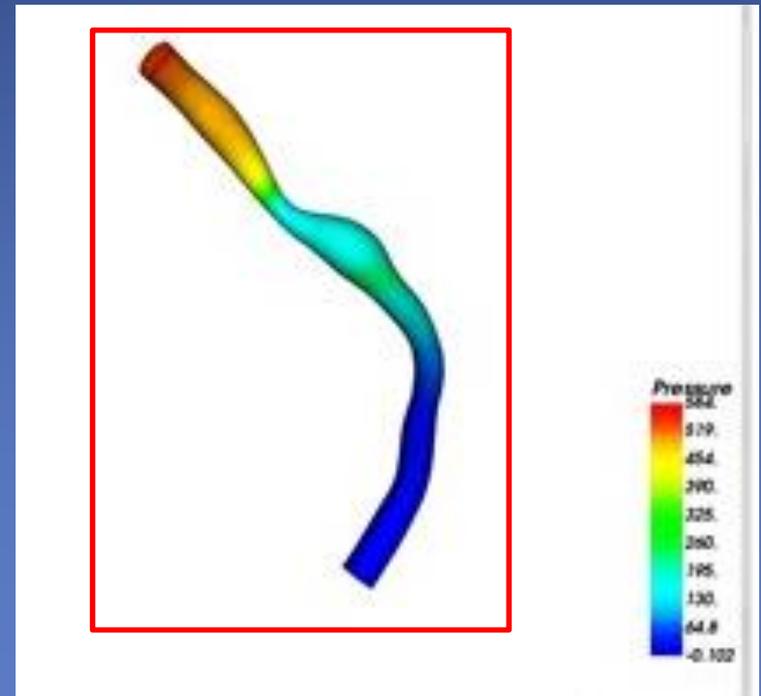
# Our ideal



vFFR



# Communicating and understanding the model



## Challenges in images and models

- Anatomy vs physiology
- High vs low resolution
- Look at different things
- Co-registration
- Disparate IT systems
- Lacking context
- Whole patient function
- Rules drawn from groups not individuals
- Availability – local issues
- Intra and inter-observer variability
- Subjective interpretation
- Reliance on human vision
- Belief in technology
- Accuracy, uncertainty?
- Context
- Rubbish in, rubbish out
- Useful tool or ultimate arbiter?
- Cost

# Conclusions

- Medicine/ Cardiology is highly visual
- Types of images variable
- Uncertainty under-represented/ not discussed
- We construct our 'own' models
- Formal modelling is a new phenomenon
- As yet untried and untested
- How to handle models unknown
- Their impact unknown

# Thanks



J.Gunn@Sheffield.ac.uk