

Redefining the diagnosis of Apical Hypertrophic Cardiomyopathy (ApHCM)



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SCMR
Society for Cardiovascular
Magnetic Resonance



EACVI
European Association of
Cardiovascular Imaging
European Society of Cardiology

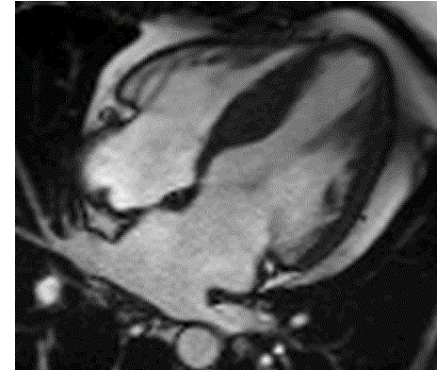
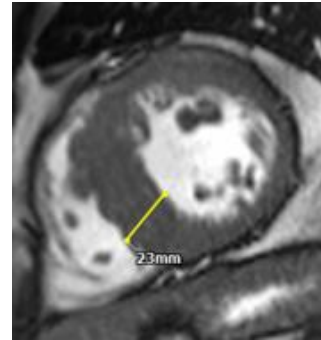
DOI

- **No conflicts to declare**



Hypertrophic cardiomyopathy (HCM)

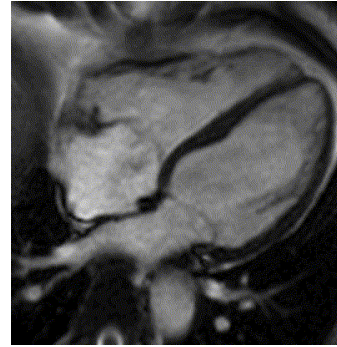
- Defined by unexplained left ventricular hypertrophy
- Diagnosis is made with a left ventricular maximum wall thickness (MWT) $>15\text{mm}$
- Despite age, size, ethnicity and segment....
- Unchanged for 40 years



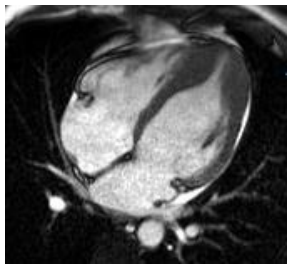
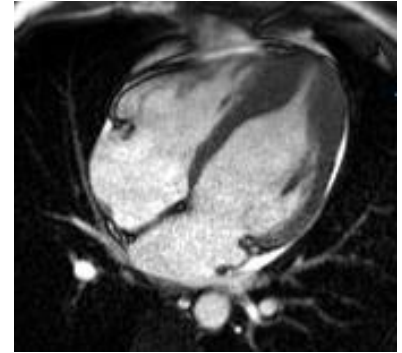
The problem of Apical HCM (ApHCM)

- Apex is naturally thinner than the base in normal hearts
- 15mm is not appropriate
- Apical HCM is 10% of HCM – behaves differently

Healthy



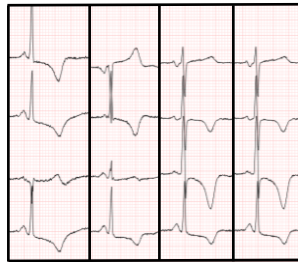
ApHCM



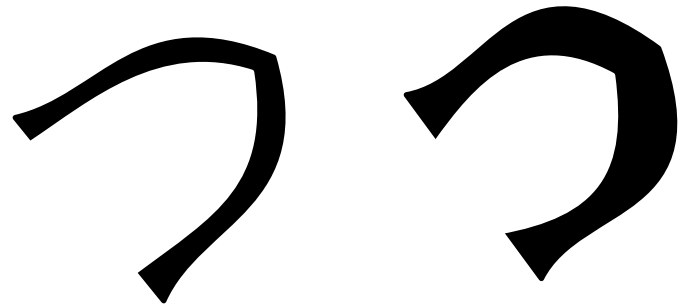
Apical cavity
systolic obliteration



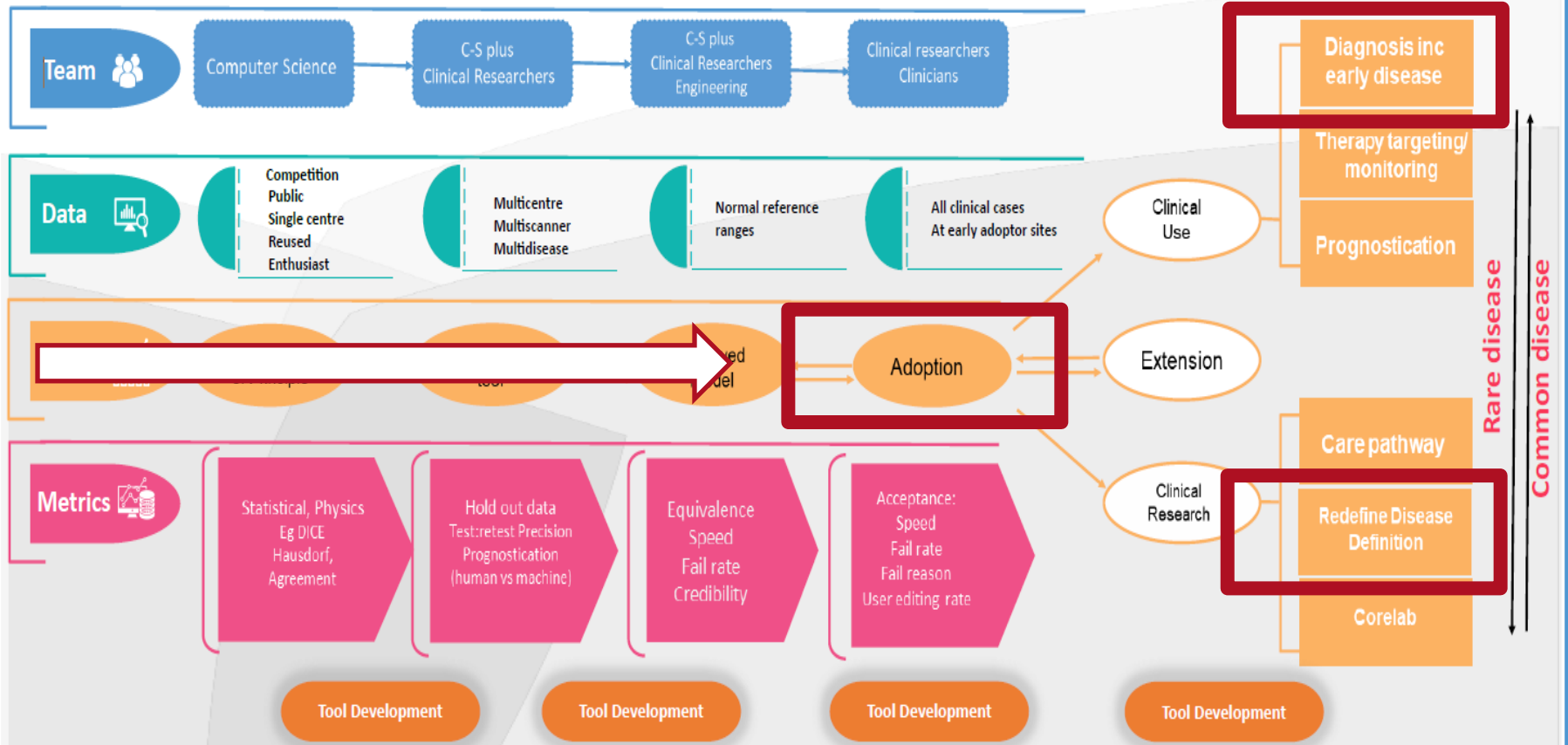
Loss of apical
tapering



Characteristic ECG
changes



CMR Quantitative AI tool development



Using AI to redefine the disease

Define normal and the upper limit

- Large dataset of healthy volunteers - UK Biobank
- Analysis with validated machine learning

Create a classification model

- Define upper limit of normal
- For segment, age, sex and body surface area (BSA)

Validate criteria

- 104 apical HCM patients
- 100 healthy volunteers

Defining normal

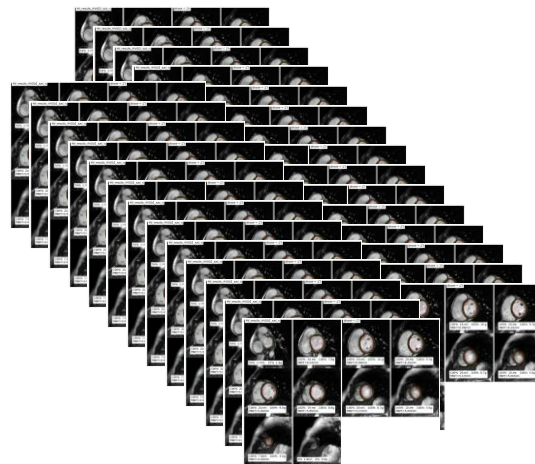
biobank^{uk}

49,861 volunteers
with CMR



4112 *healthy**
volunteers with
CMR

Machine learning - more *precise*
than expert clinicians



*No self-reported disease or medication use.

Previously validated machine learning model

Davies et al.
Journal of Cardiovascular Magnetic Resonance (2022) 24:16
<https://doi.org/10.1186/s12968-022-00846-4>


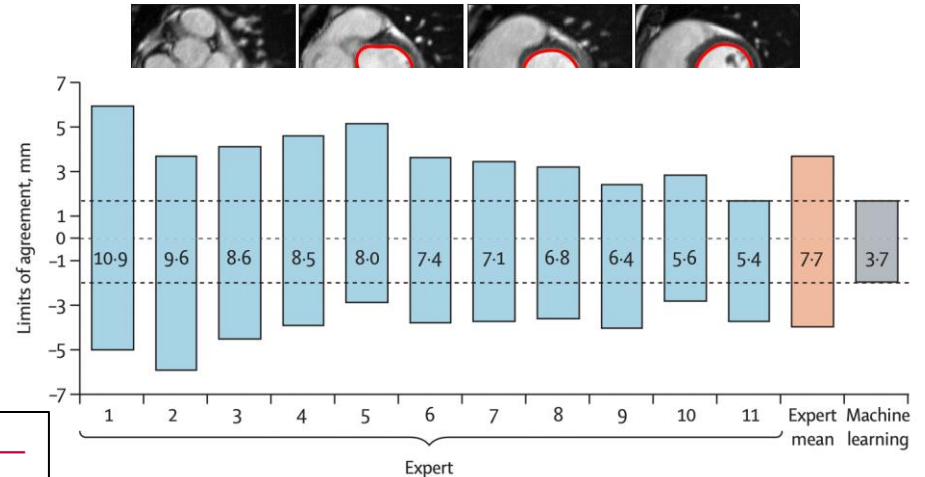
Journal of Cardiovascular
Magnetic Resonance

RESEARCH **Open Access**

Precision measurement of cardiac structure and function in cardiovascular magnetic resonance using machine learning

Rhodri H. Davies^{1,2,3}, João B. Augusto^{1,2}, Anish Bhuvu^{1,2}, Hui Xue⁴, Thomas A. Treibel^{1,2}, Yar Rebecca K. Hughes^{1,2}, Wenjia Bai⁵, Clement Lau^{2,6}, Hunain Shiwani^{1,2}, Marianna Fontana¹, Anna Herrey², Luis R. Lopes^{1,2}, Viviana Maestrini⁹, Stefania Rosmini^{1,2}, Steffen E. Petersen², Daniel Rueckert¹⁰, John P. Greenwood¹¹, Gabriella Captur^{1,3}, Charlotte Manisty^{1,2}, Erik Sch James C. Moon^{1,2*}

Check for updates

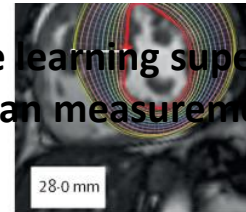
Diagnosis and risk stratification in hypertrophic cardiomyopathy using machine learning wall thickness measurement: a comparison with human test-retest performance

THE LANCET
Digital Health

João B Augusto, Rhodri H Davies, Anish N Bhuvu, Kristopher D Knott, Andreas Seraphim, Mashael Alfarhi, Clement Lau, Rebecca K Hughes, Luis R Lopes, Hunain Shiwani, Thomas A Treibel, Bernhard L Gerber, Christian Hamilton-Craig, Ntobeko A B Ntusi, Gianluca Pontone, Milind Y Desai, John P Greenwood, Peter P Swoboda, Gabriella Captur, João Cavalcante, Chiara Bucciarelli-Ducci, Steffen E Petersen, Erik Schelbert, Charlotte Manisty, James C Moon



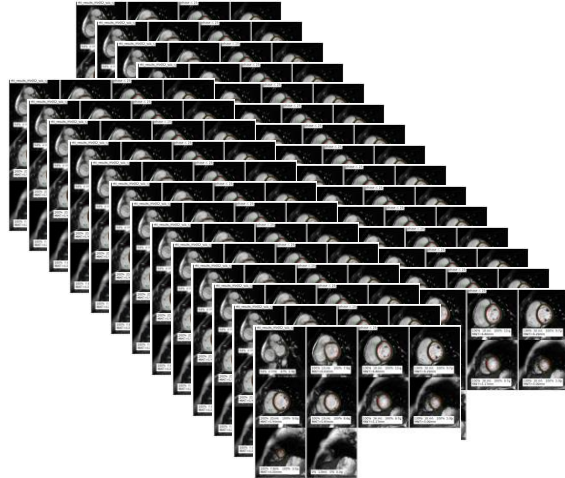
Machine learning superior to human measurement



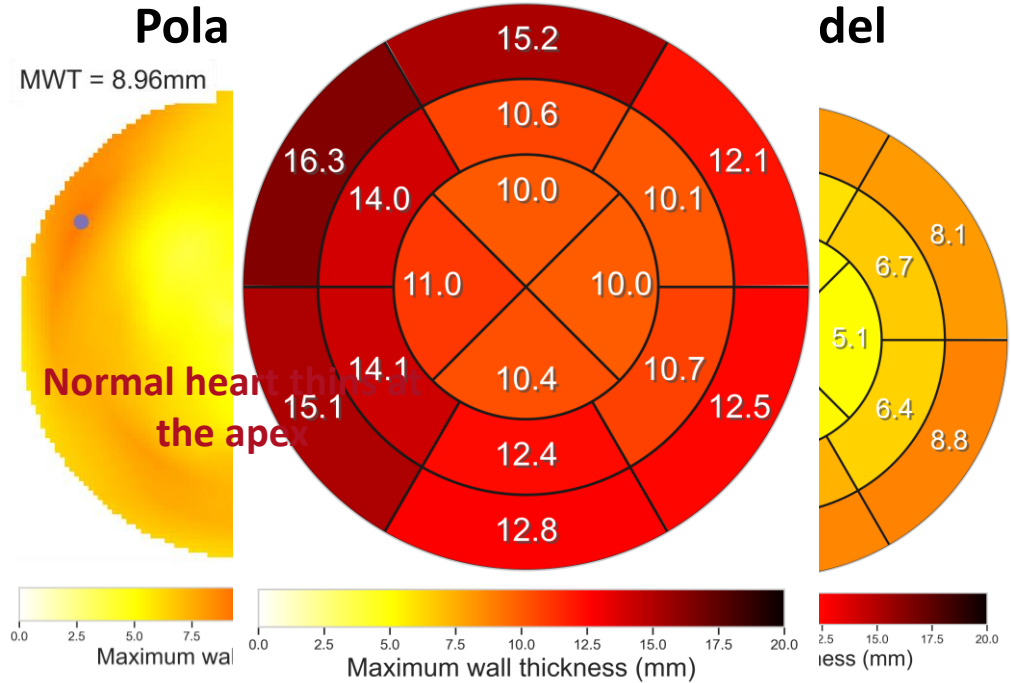
Dr Rhodri H Davies

Defining normal and the upper limit

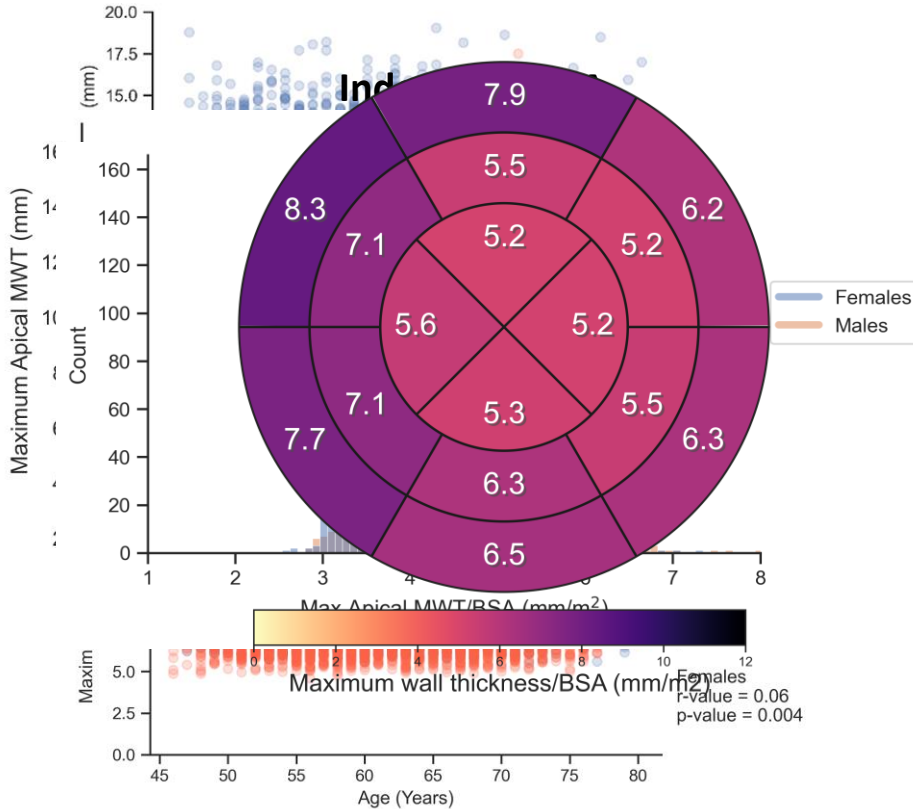
4112 *healthy*
volunteers with CMR



Mean + 3 Standard Deviations (95% CI)



Creating a classification model



Age strongly influences Basal MWT

For the final model, adjusted for BSA only, Sex minimally influences Apical MWT when indexed to BSA

Age minimally influences Apical MWT

- Age
- BSA
- Sex

Performance of new criteria

Classic criteria

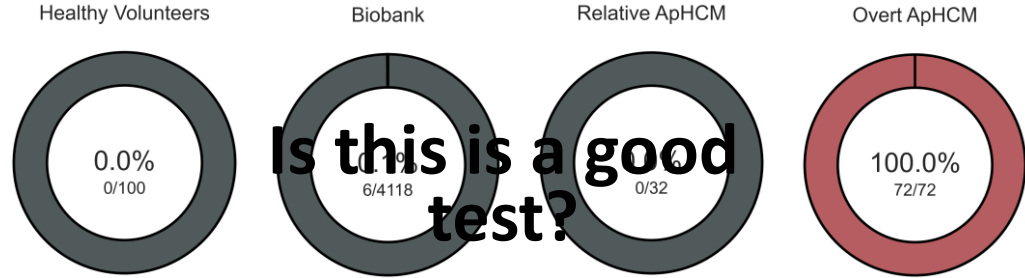
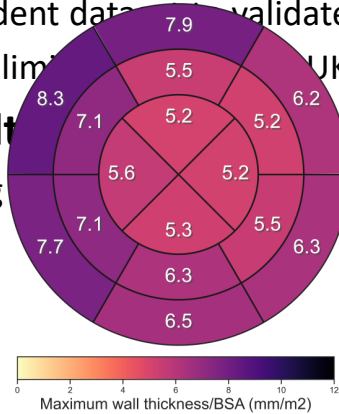
- 104 ApHCM patients
- 32 Relative ApHCM with a MWT >15mm
- 72 Overt ApHCM with a MWT >15mm

• 100 healthy volunteers locally

- Independent data to validate the criteria
- Mitigate limitations of UK Biobank

Indexed upper limit criteria

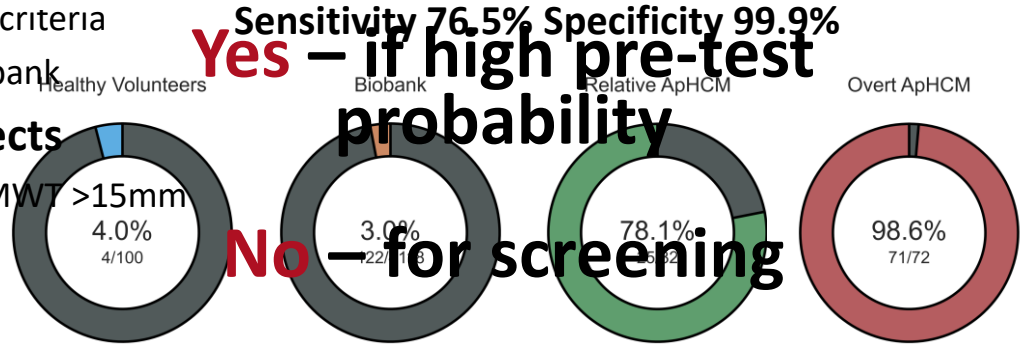
• 100 healthy subjects including 60 for MWT >15mm



Is this a good test?

Yes – if high pre-test probability

No – for screening

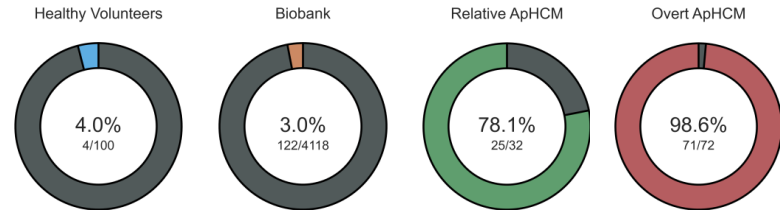
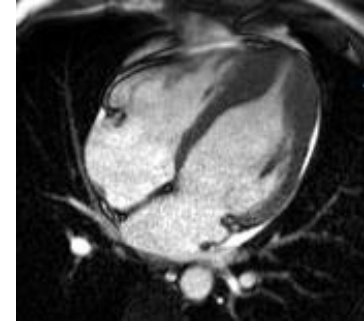
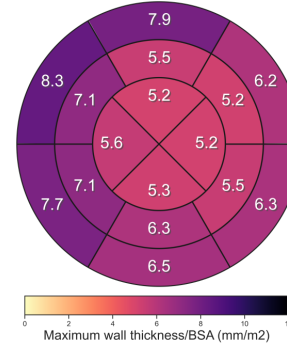


Sensitivity 92.9% Specificity 97.1%

Summary

- Machine learning is available and has enabled us to *redefine* disease classification
- **5.6mm/m²** (~11mm) is a clinically practical threshold. Easy to apply but excellent performance
- New criteria increases the % of apical HCM patients diagnosed from **69%** to **92%**

Paper submitted (Under review)



SCAN ME

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