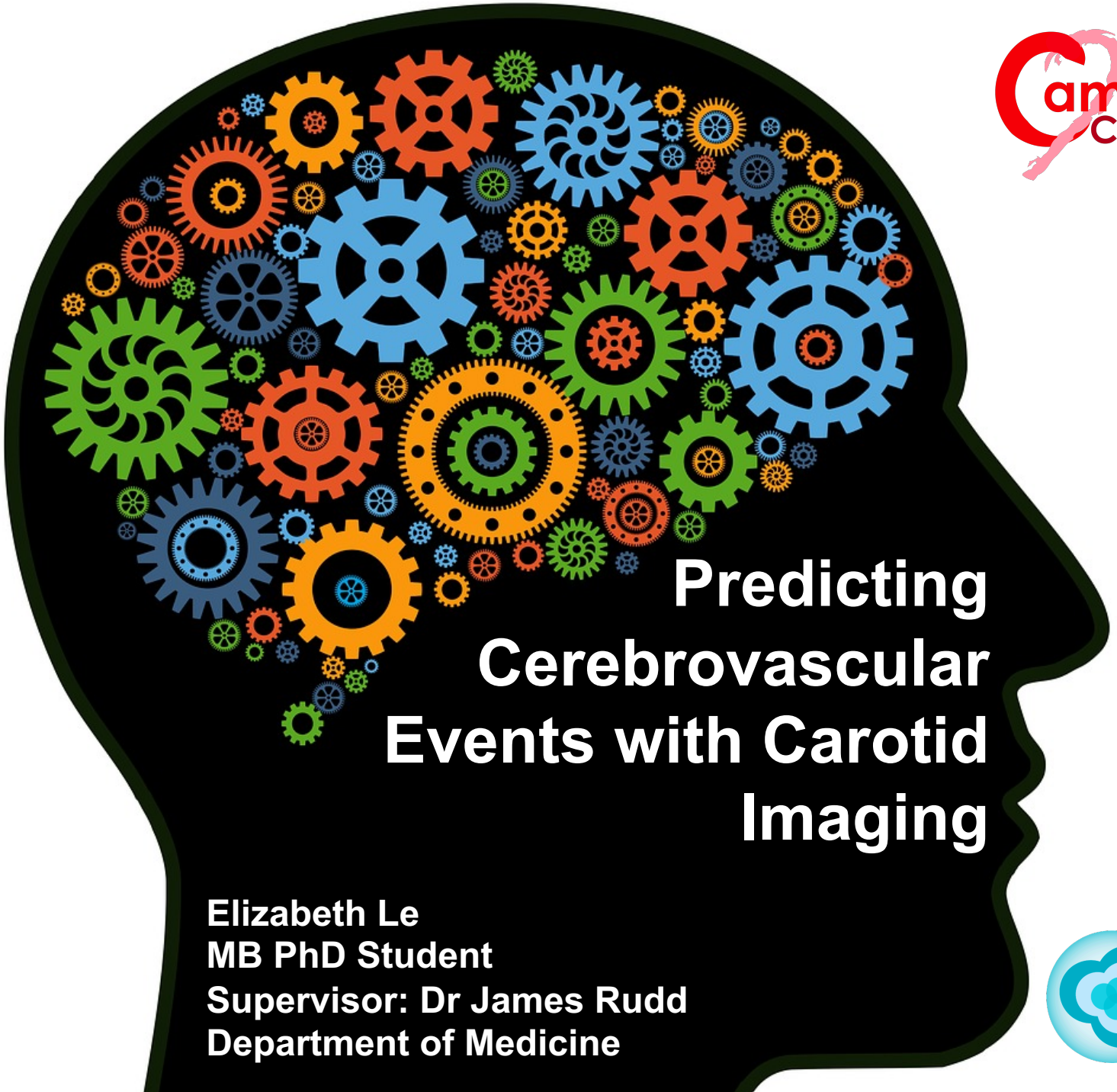


Predicting Cerebrovascular Events with Carotid Imaging

Elizabeth Le
MB PhD Student
Supervisor: Dr James Rudd
Department of Medicine

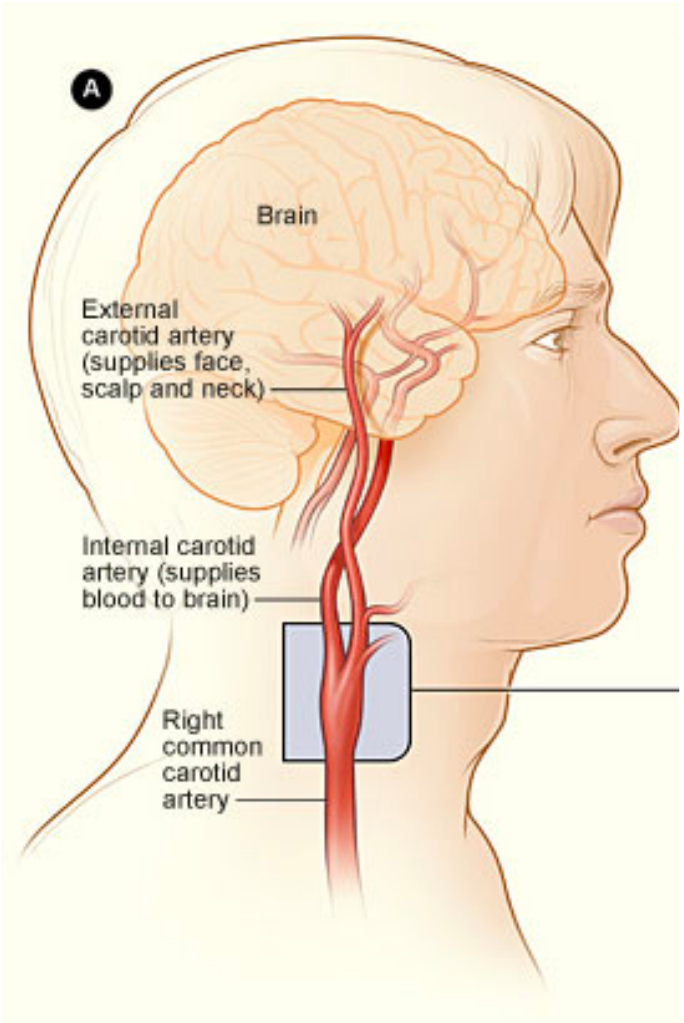
Cambridge Cardiovascular

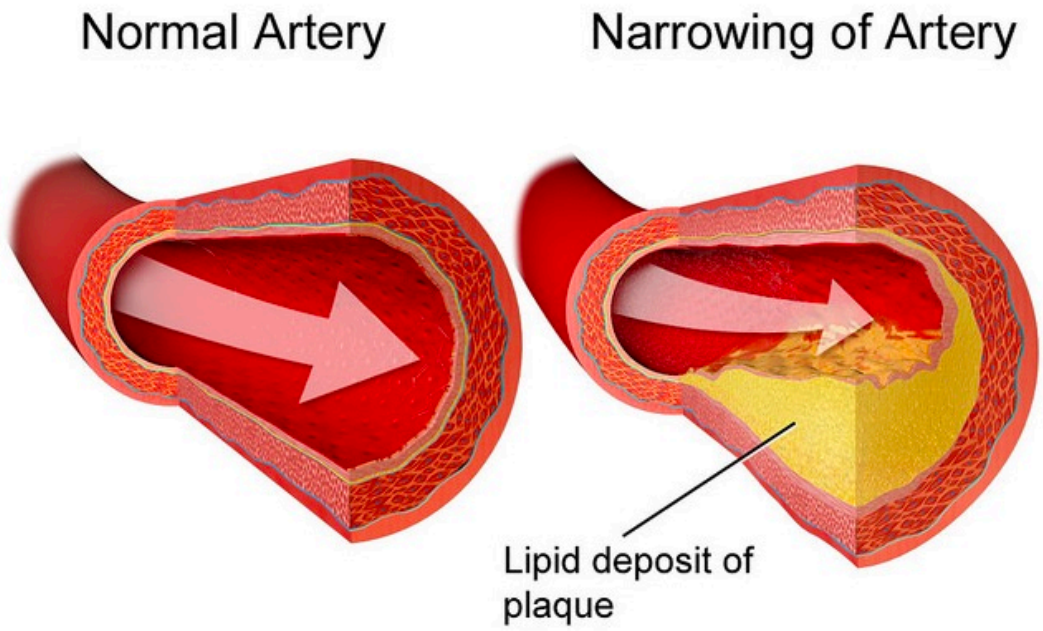
cmih
centre for mathematical imaging in healthcare

85% ischaemic stroke

15% haemorrhagic stroke

Carotid Atherosclerosis





Fundamental Questions

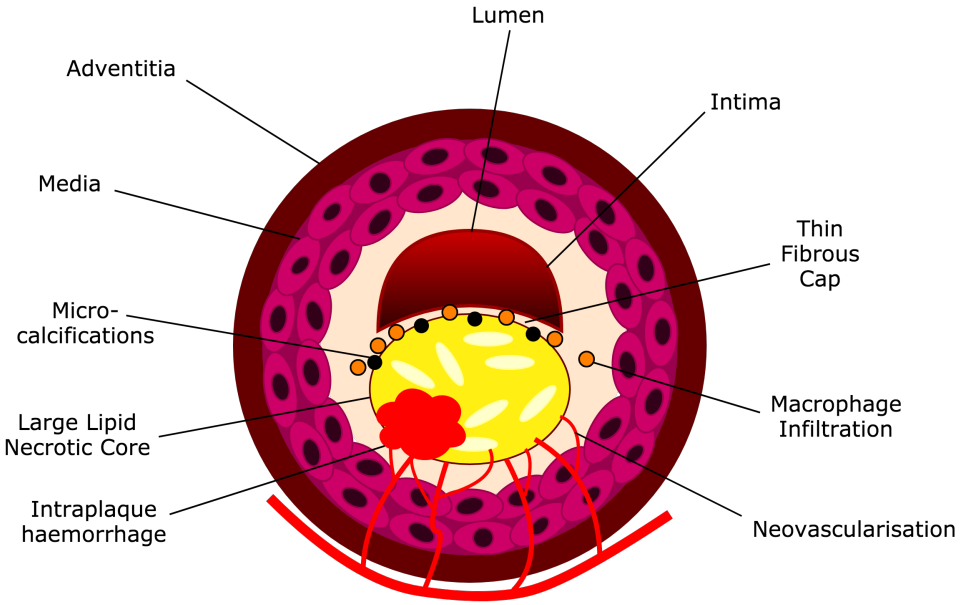
Who will have a stroke?

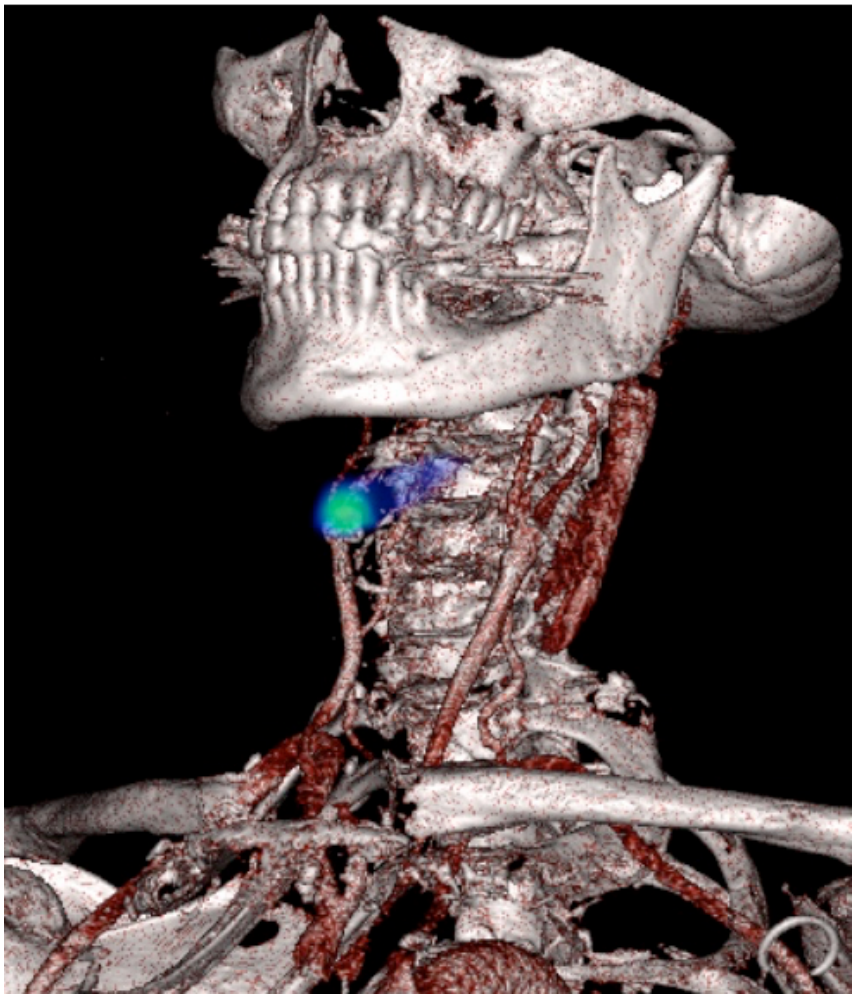
'Vulnerable Patient'

Where is the high-risk plaque?

'Vulnerable Plaque'

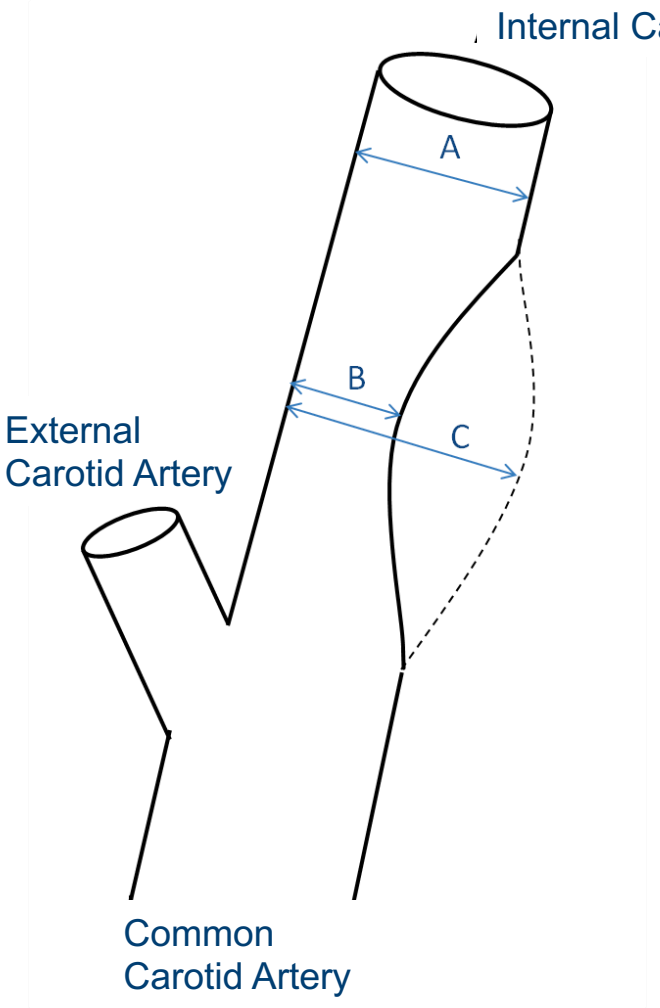
Vulnerable Plaque Features





Nicholas Evans, Department of Medicine
Wellcome Image Award winner 2017

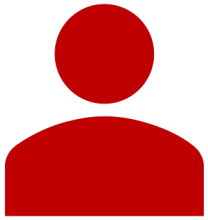
Measuring Carotid Stenosis



$$NASCET = \left(\frac{A - B}{A}\right) x\ 100$$

$$ECST = \left(\frac{C - B}{C}\right) x\ 100$$

Carotid Surgery Criteria



Symptomatic Patient:
Previously had a stroke or TIA

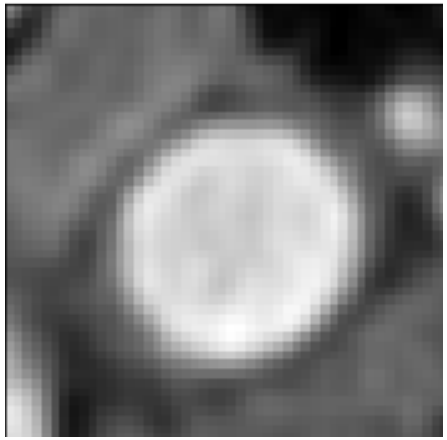
NASCET 50-99% OR
ECST 70-99%

Recommend Carotid Surgery

Asymptomatic Patient:
Never had a stroke or TIA

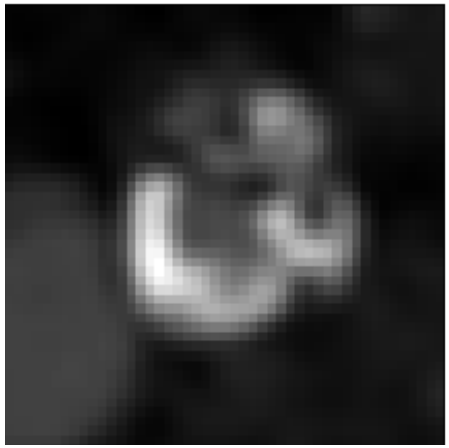
NASCET 50-99%

Join a Clinical Trial

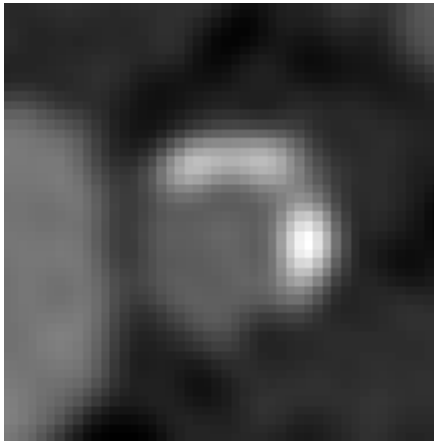


Asymptomatic

Symptomatic



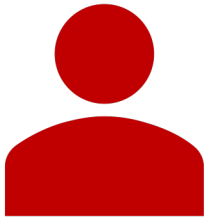
Asymptomatic



Symptomatic

Contrast Computed Tomography

Cambridge Carotid Dataset



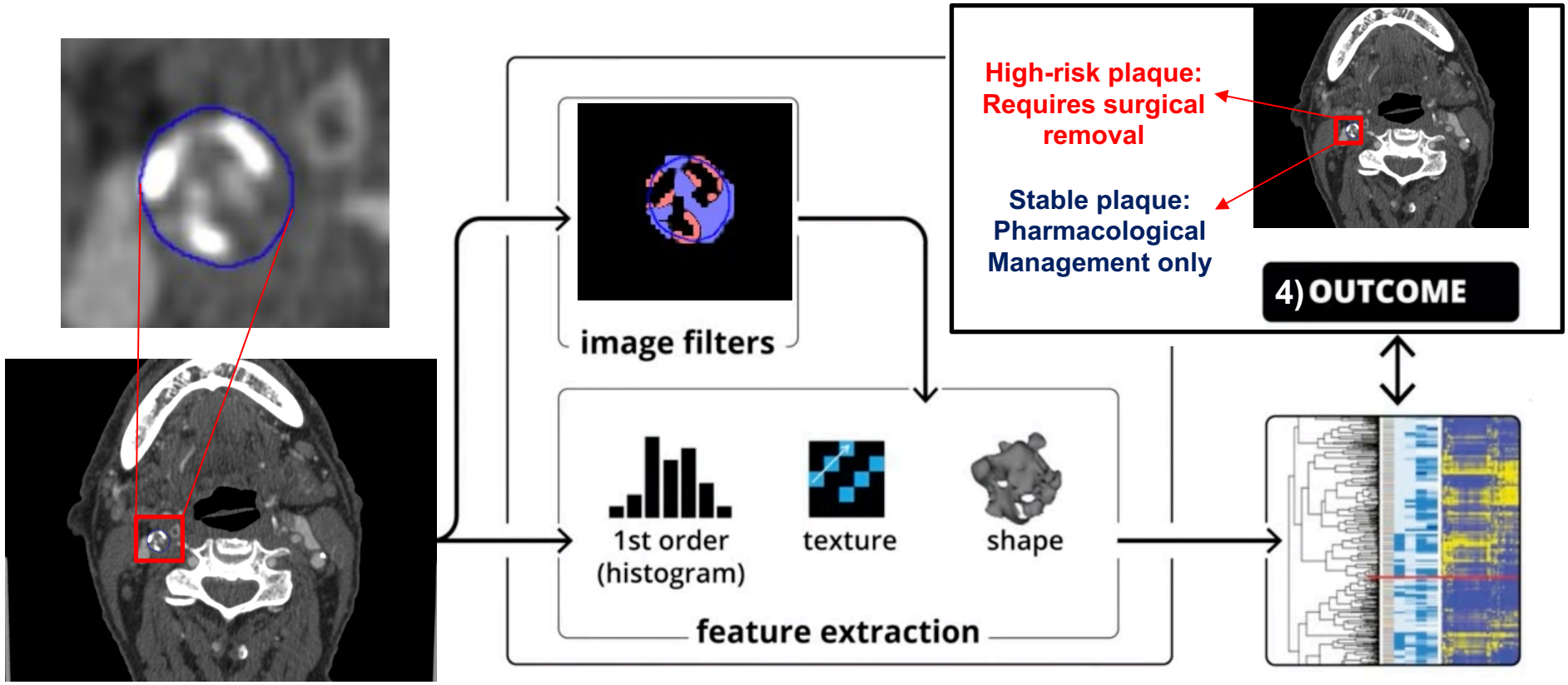
41 Symptomatic Patients

82 Symptomatic Carotids

25 Asymptomatic Patients

50 Asymptomatic Carotids

Carotid Texture Analysis



1) Image segmentation: ROI around vessel wall

2) TexRAD and PyRadiomics Toolbox

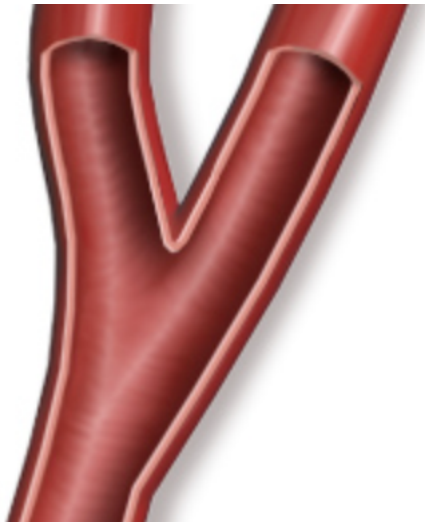
3) Statistical Data Analysis and Machine Learning

UNIVERSITY OF CAMBRIDGE

van Griethuysen, J. J. M., Fedorov, A., Parmar, C., Hosny, A., Aucoin, N., Narayan, V., Beets-Tan, R. G. H., Fillon-Robin, J. C., Pieper, S., Aerts, H. J. W. L. (2017). Computational Radiomics System to Decode the Radiographic Phenotype. Cancer Research

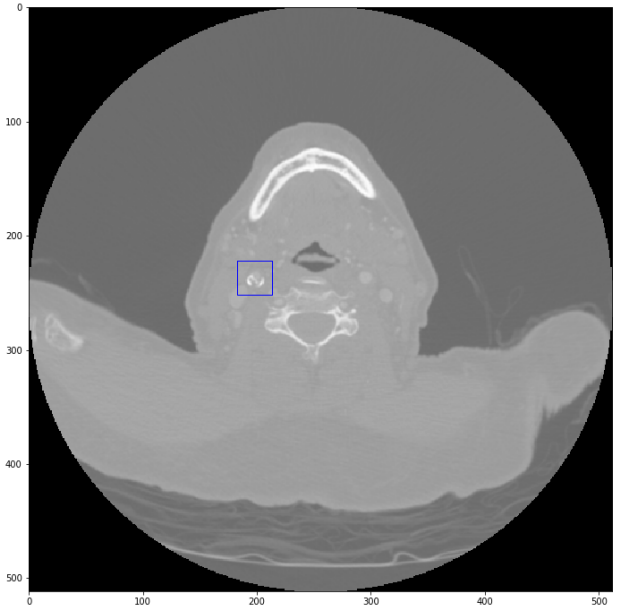
Preliminary Findings

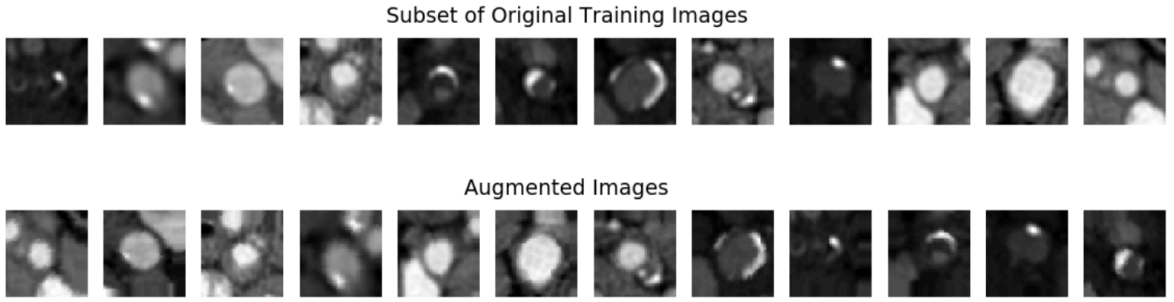
Asymptomatic Carotids
Increased image homogeneity



Symptomatic Carotids
Increased image heterogeneity

Deep Learning with Carotids

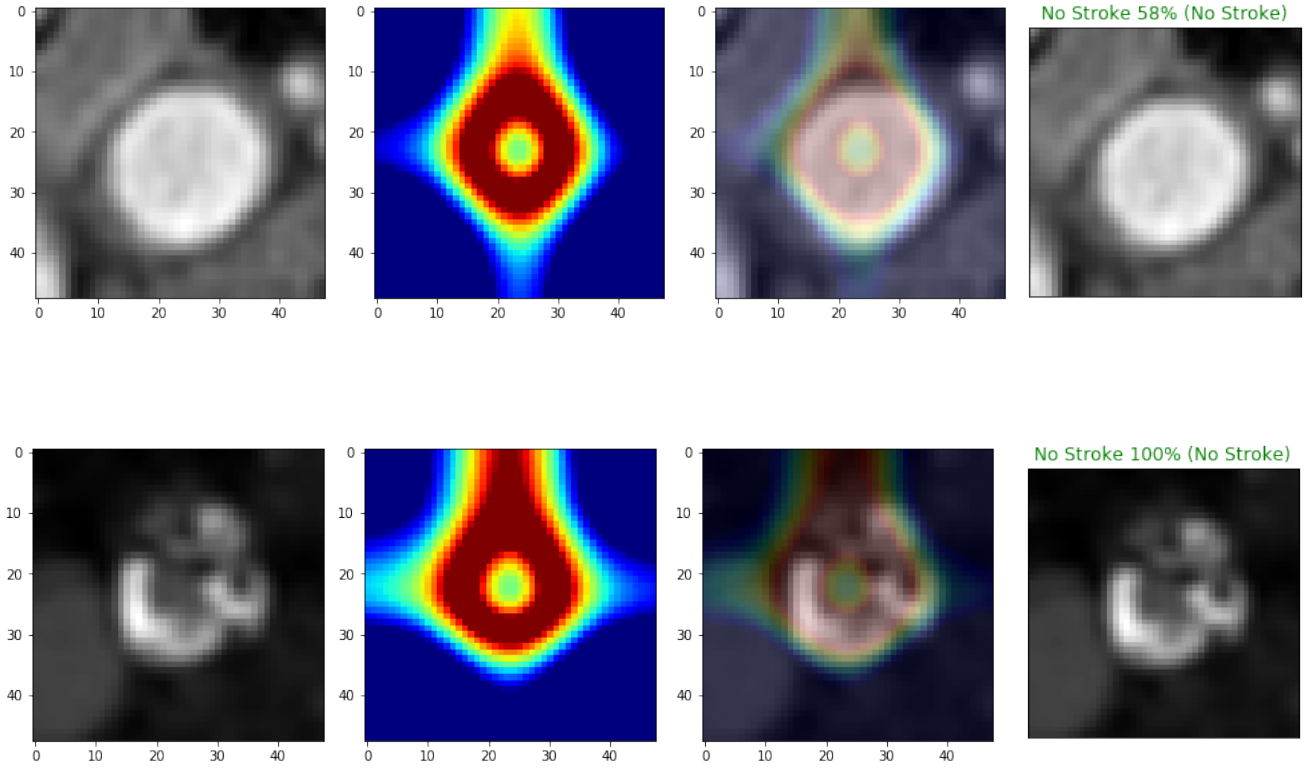




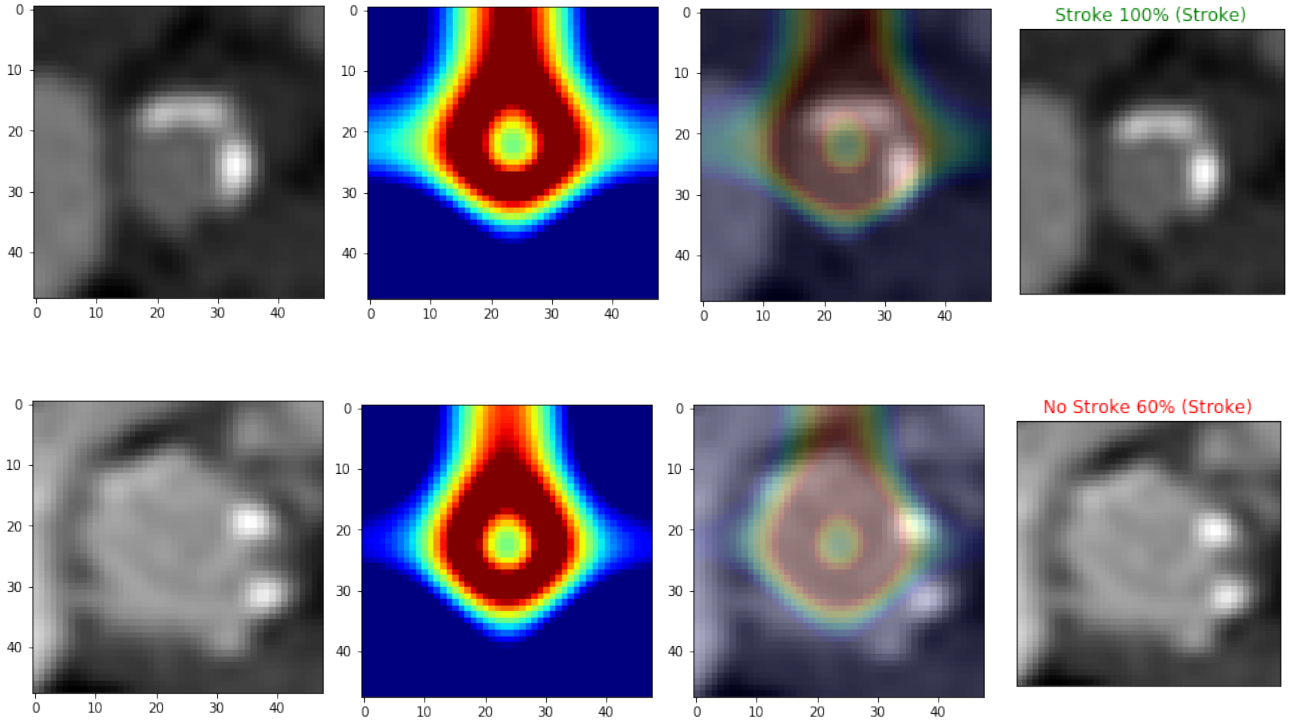
Transfer learning with
modified VGG16 architecture

100 Epochs
75% training, 25% testing
92% validation accuracy

Asymptomatic Carotids

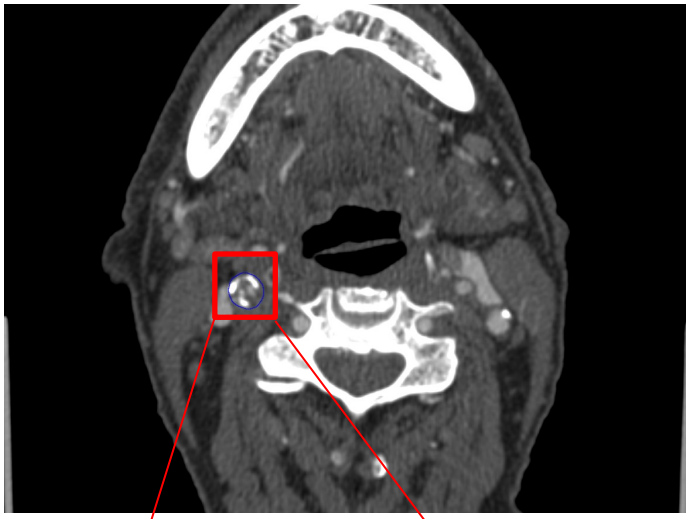


Symptomatic Carotids



Potential in Medicine and Industry

- ✓ Carotid imaging contains further information that can be exploited by texture analysis and machine learning.
- ✓ A non-invasive biomarker for prediction of the vulnerable plaque
- ✓ Easy to integrate into the imaging workflow. No additional radiation.
- ✓ Still further work to be done



High-risk plaque:
Requires surgical removal

Stable plaque:
Pharmacological
Management only

Coming Next...

1. **External validation**
    - Acquire external carotid dataset for testing

2. **Biological and functional imaging correlation:**
    - Preliminary work in Department of Medicine indicates correlation with angiogenesis
    - Cambridge carotid dataset has FDG PET imaging

3. **Prospective, multi-centre validation:**
    - Have texture parameters as clinical endpoints

Thank you to all

Dr J Rudd
Prof C Schonlieb
Dr B Glocker
Prof F Gilbert
Prof M R Bennett
Prof D Newby
Dr MC Williams
Dr Jonathan Weir-McCall
Dr F Joshi
Dr J Tarkin
Dr N Evans
Dr E Warburton
Dr Y Huang
Mr M Chowdhury
Mr P Coughlin
Ms H Pavey
Mr B Ganeshan
Mr M Hayball

cmih
centre for mathematical imaging in healthcare

UNIVERSITY OF CAMBRIDGE
School of Clinical Medicine

BioMedIA

MRC Medical Research Council