

# A Composite Hemodynamic Imaging Score For Risk Stratification In Cerebral Amyloid Angiopathy



**Ashwati Vipin (PhD)**, Abilash Elango (MSc), James Xiao Yuan Chen (BEng), Rasyiqah Binte Shaik Mohamed Salim (BEng), Qiu Bocheng (MEng), Jessie Leuk Siew Pin (PhD), Klaus Eickel (PhD), Matthias Gunther (PhD), Jan Petr (PhD), Vincent Chung Tong Mok (FRCP), Nagaendran Kandiah (FRCP)

Contact: [ashwati.vipin@ntu.edu.sg](mailto:ashwati.vipin@ntu.edu.sg)

Can a non-invasive hemodynamic score derived from multi-echo arterial spin labelling stratify risk of cerebral amyloid angiopathy(CAA)? In this cross-sectional cohort of 319 participants, a cognition-weighted hemodynamic risk score comprising arterial transit time, cerebral blood flow and blood-brain-barrier time-of-exchange discriminated Probable CAA from Normal controls with high discriminative performance. A non-invasive perfusion-based hemodynamic score may provide clinically reliable CAA risk stratification, potentially informing screening prior to anti-amyloid therapy.

| INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | METHODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | RESULTS   CONCLUSIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Figure 1: Participant breakdown and cohort selection                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Figure 2: Discriminative performance of the composite hemodynamic score for Probable CAA.                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Cerebral amyloid angiopathy (CAA) shares common pathobiology with and is a key risk factor for Amyloid Related Imaging Abnormalities (ARIA), which is a serious side-effect of anti-amyloid therapy (AAT).</p> <p>CAA is a progressive cerebrovascular disorder characterised by vascular amyloid deposition, hemodynamic dysfunction, and elevated risk of cognitive impairment and cerebral haemorrhage.</p> <p>CAA risk profiling may in turn help identify individuals at risk for ARIA.</p> | <ul style="list-style-type: none"><li>319 participants were included across four diagnostic groups: non-CAA non-small vessel disease(SVD) controls, Probable CAA, Possible CAA, and non-CAA SVD</li><li>ME-ASL-derived hemodynamic measures of arterial transit time (ATT), cerebral blood flow (CBF), and time of exchange (<math>T_{ex}</math>, surrogate measure of blood brain barrier permeability), alongside age, were used to construct an integer-weighted composite risk score</li></ul> | <p>The hemodynamic risk score discriminated Probable CAA from Normal controls with AUC=0.853 (sensitivity=66.7%; specificity=92.6%; cross-validated AUC=0.844), comparable to machine learning classifiers (all DeLong <math>p&gt;0.05</math>).</p> <p>A non-invasive, ME-ASL hemodynamic risk score provides robust stratification across the CAA spectrum, demonstrating CAA-specific construct validity and comparable performance to data-driven classifiers.</p> | <p>Participants with Baseline MRI Scan* (n=1214)</p> <p>Excluded for Age &lt; 50 (n=309)</p> <p>Participants with Eligible Age ≥ 50 (n=905)</p> <p>Excluded for No Cognitive Impairment(n=319)</p> <p>Participants with Cognitive Impairment (n=586)</p> <p>Excluded for No ME-ASL data (n=267)</p> <p>Participants with ME-ASL data (n=319)</p> <p>Figure 3: Distribution of the composite hemodynamic score across diagnostic groups.</p> <p>A Hemodynamic Score Distribution Across Groups Cutoff = 3.02</p> <p>B Hemodynamic Score Distribution Across Groups Cutoff = 3.02</p> | <p>ROC – Raw Integer-weighted Risk Score (AUC = 0.853)</p> <p>Figure 2. Discriminative performance of the composite hemodynamic score for Probable CAA.</p> |

Charidimou, A. *et al.* The Boston criteria version 2.0 for cerebral amyloid angiopathy: a multicentre, retrospective, MRI–neuropathology diagnostic accuracy study. *The Lancet Neurology* 21, 714–725 (2022).

Vipin, A. *et al.* Cerebral haemodynamics and white matter hyperintensities: findings using non-invasive brain imaging. *J Prev Alzheimers Dis* 13, 100479 (2026).

Greenberg, S. M. *et al.* Cerebral amyloid angiopathy and Alzheimer disease — one peptide, two pathways. *Nat Rev Neurol* 16, 30–42 (2020).