

Stroke Audit Machine Learning (SAMueL)

Investigating variation in clinical decision-making with explainable AI

Michael Allen¹, Kerry Pearn¹, Anna Laws¹, Keira Pratt-Boyden¹,
Peter McMeekin³, Martin James^{1,2}

¹University of Exeter Medical School ²Royal Devon University Healthcare NHS
Foundation Trust, and the Sentinel Stroke National Audit Programme (SSNAP)

³Northumbria University

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About us

Who are we?

- ▶ We are modellers, data scientists, and qualitative researchers, based at the University of Exeter and Northumbria university.
- ▶ We work almost exclusively on the emergency stroke pathway (about the first 12 hours after stroke onset).
- ▶ We have worked extensively with the NHS on planning of emergency stroke services:
 - ▶ We have worked on informing the number and location of *thrombolysis* and *thrombectomy* centres for NHS England, NHS Scotland, NHS Wales, NHS Northern Ireland, and including bespoke modelling for NHS East of England.
- ▶ We work closely with the Sentinel Stroke National Audit Programme (SSNAP)

Our current main interests

- ▶ Understanding the between-hospital variation in use of thrombolysis.
- ▶ Modelling outcome after stroke and treatment with thrombolysis/thrombectomy:
 - ▶ Survival, disability (modified Rankin Scale), life expectancy, utility, QALY.
- ▶ Modelling the pre-hospital stroke pathway (selection of patients likely to be suitable for thrombectomy), and how that will affect outcomes and patient flows (including potential destabilisation of the regional emergency stroke care system).
- ▶ Modelling the potential impact of *Mobile Stroke Units*, especially on whether they are likely to improve or worsen equity of access to emergency stroke care.
- ▶ Geographic modelling (as needed).

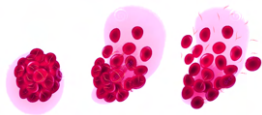
Geographic modelling

Treatments for stroke

Thrombolysis aims to break down a clot by activating the body's own clot breakdown mechanisms.

Thrombolysis is given as an injection followed by an infusion (*drip*).

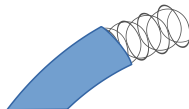
Thrombolysis is available at all hospitals routinely admitting emergency stroke patients.



Thrombectomy physically removes the clot.

Thrombectomy uses a mesh clot removal device guided under a CT scanner by a specialist operator.

Thrombectomy is only available at specialist centres

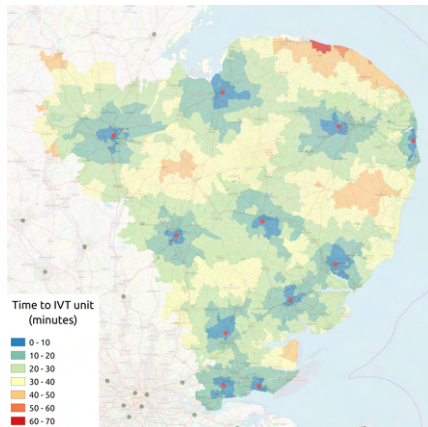


Both treatments are time-critical and lose effectiveness over the first hours after a stroke.

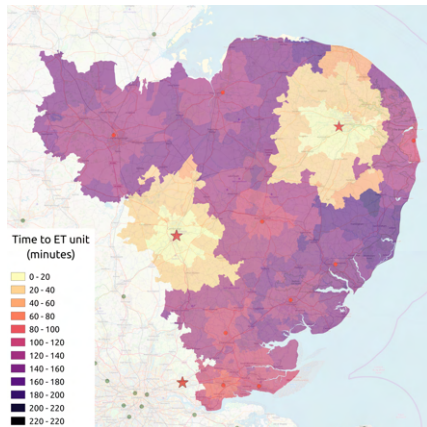
Note: Thrombolysis is often the *gateway* to thrombectomy. Without local thrombolysis, a patient will often not be considered for thrombectomy.

Example of the challenges of geography in emergency stroke care

Time to thrombolysis

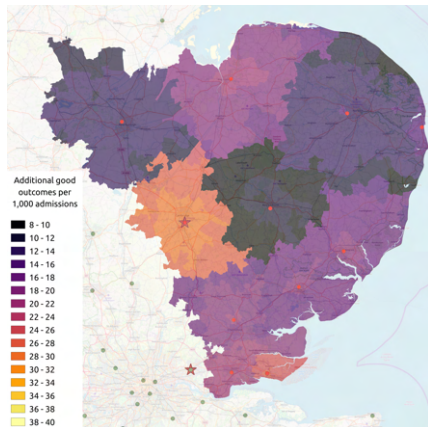


Time to thrombectomy

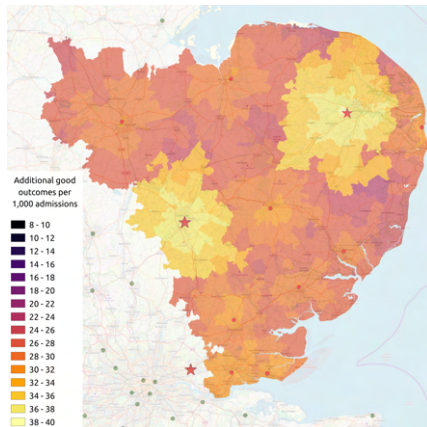


And the impact on patient outcomes...

Outcome with modelled provision in 2018



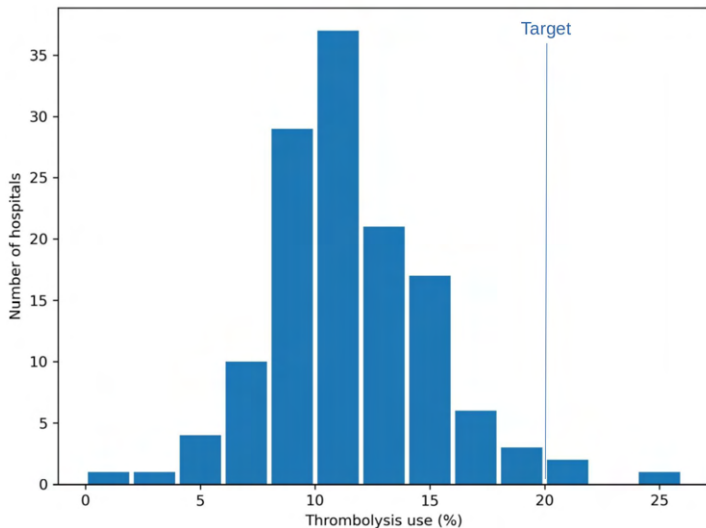
Outcome if 20% patients thrombolysed and region has two thrombectomy centres



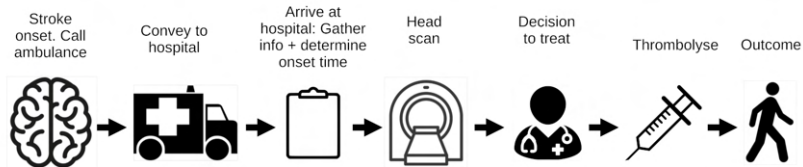
Since our earlier work, Peterborough has significantly improved use of thrombolysis, which also enables more patients to be considered for thrombectomy at Cambridge.

Clinical pathway modelling and machine learning

Why does use of thrombolysis vary so much between hospitals, and why is it so short of the NHS target?



Breaking down the emergency stroke pathway into key steps



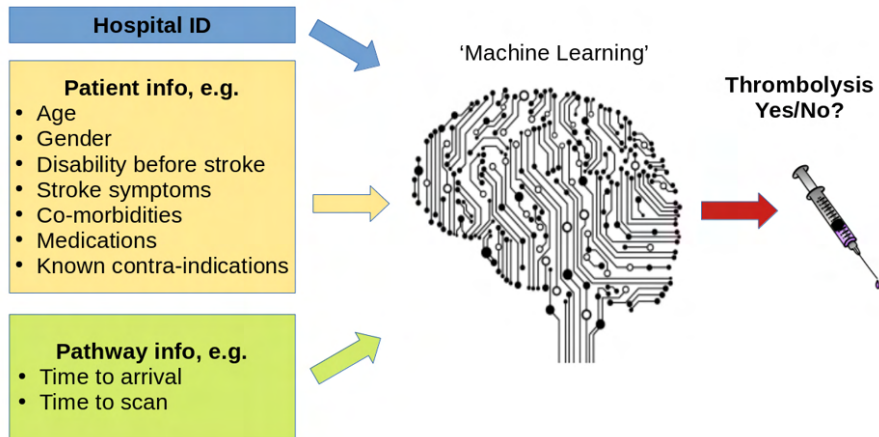
We can model key changes to pathway:

- ▶ What if the pathway were faster?
- ▶ What if hospital determined the stroke onset time in more patients?
- ▶ What if clinical decision-making was like that of *benchmark* hospitals? (Predict what treatment a patient would receive at other hospitals).

We model these changes with a hospital's own patient population, to allow for inter-hospital variation in patient population characteristics.

Learning clinical decision making at each hospital

- ▶ By using machine learning, we are able to predict what treatment any patient would likely receive at any hospital.
- ▶ We may then ask *"What treatment would this patient receive at another hospital?"*



Skipping a lot of work

Why do hospitals differ so much in use of thrombolysis?

Though differences in patient population explain some of the differences in thrombolysis use (and so units should not all have the same expected thrombolysis use), hospitals also differ in their willingness to use thrombolysis.

All hospitals would give thrombolysis to this patient:

- ▶ Onset to arrival = 80 mins
- ▶ Arrival to scan = 20 mins
- ▶ Moderate-to-severe stroke (NIHSS = 15)
- ▶ No prior disability level
- ▶ Onset time is known precisely

But only 6 out of 10 hospitals would give thrombolysis to the same patient except them having an estimated stroke onset time and a mild pre-stroke disability (able to look after themselves, but unable to do all of their previous activities).

Why are we here?

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- ▶ We want our work to have the best impact for patients.
- ▶ We are looking for teams that we can share our work with (in the early stages) so that we can use the feedback to refine our work.
- ▶ You get some (hopefully!) useful analysis, and we get to improve how we share our analysis.