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Stroke outcome modelling

Predicting disability outcomes and utility after treatment of stroke with thrombolysis or thrombectomy

In this app we describe how we estimate the change in disability levels for a patient population if we know the time between when stroke symptoms began and when treatment was received. The details behind the process are given in full in this online book: https://samuel-book.github.io/stroke_outcome/intro.html.

Until now, modelling the outcome from stroke reperfusion treatment was a dichotomous affair, with a patient classified as either being disability free, or with stroke related disabilities. The method described here aims to provide a more granular disability outcome, describing the resulting disability as one of six levels (ranging from disability free, to death). The outcomes across all patients in the population are averaged to find a single value for the expected benefit of treatment.

Background information

Stroke types and treatments

Patients can have an ischaemic stroke, which is caused by a blood clot, or a haemorrhaegic stroke, which is caused by a bleed in the brain. We refer to the latter as an intra-cerebral haemorrhage (ICH).

Patients with ischaemic stroke can be further defined by the location of the clot. The clot can be either:

- a large-vessel occlusion (LVO), or
- a non-large-vessel occlusion (nLVO).

There are two types of treatment available for ischaemic stroke. Both of these aim to achieve reperfusion, which is the restoration of the blood supply to the cut-off areas of the brain. The treatments are intravenous thrombolysis (IVT), a clot-busting medication, and mechanical thrombectomy (MT), which physically removes the clot.

- Patients with an LVO can be treated with IVT and/or MT.
- Patients with an nLVO can be treated with IVT.

The benefit received by the patient from either treatment (IVT and/or MT) are time dependent, such that the sooner they are administered, the better the outcome, with each treatment having no effect after a specified duration (6.3 hours for IVT, and 8 hours for MT). In other words, the sooner a patient recieves reperfusion treatment the fewer stroke related disabilities they could end up with.

Modified Rankin Scale (mRS) and utility-weighted mRS

Disability levels may be measured in various ways. In this project we are using the modified Rankin Scale (mRS). It is a commonly used scale for measuring the degree of disability or dependence in the daily activities of people who have suffered a stroke. The scale runs from 0-6, running from perfect health without symptoms to death.

In addition to mRS, we may calculate utility-weighted mRS (UW-mRS). UW-mRS incorporates both treatment effect and patient perceived quality of life as a single outcome measure for stroke trials. UW-mRS scores are based on a pooled analysis of 20,000+ patients, from Wang et al. (2020).

mRS Score	Utility	Description
0	0.97	No symptoms.
1	0.88	No significant disability. Able to carry out all usual activities, despite some symptoms.
2	0.74	Slight disability. Able to look after own affairs without assistance, but unable to carry out all previous activities.
3	0.55	Moderate disability. Requires some help, but able to walk unassisted.
4	0.20	Moderately severe disability. Unable to attend to own bodily needs without assistance, and unable to walk unassisted.
5	-0.19	Severe disability. Requires constant nursing care and attention, bedridden, incontinent.
6	0.00	Dead.

How to use this app

Go to the "Interactive demo" in the left sidebar. There you can change the patient population and the treatment times to see the resulting effect on mean population outcomes.

To change between light mode and dark mode or to make the display wider, change the settings under the Menu in the top right of the screen.

Acronym reference

Acronym	Full name
IVT	**I**ntra**v**enous **T**hrombolysis
MT	**M**echanical **T**hrombectomy
LVO	**L**arge-**v**essel **o**cclusion
nLVO	**N**on-**l**arge-**v**essel **o**cclusion
ICH	**I**ntra-**c**erebral **h**aemorrhage
mRS	**m**odified **R**ankin **S**cale

Limitations

The app currently only performs calculations for ischaemic stroke. Options for haemorrhaegic stroke are in place for future use but currently go unused.

The timeline of defining the times to treatment by summing a series of other parameters are shown only for illustrative purposes. There are no plans to amend the timeline to include real-life factors such as time delays due to unavailability of hospital staff or beds.

Currently the changes in mRS and utility that are highlighted in "Results" do not always precisely match the equivalent values calculated in Part 3 of "Details of the Calculation". This is due to rounding errors and will be made consistent in a later version of the app.