Predicting recovery after stroke to facilitate shared decision making

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No competing interests to declare
Predictions of specific outcomes after a stroke

• Importance
• Our approach and methodology
• Accuracy of models
• Refinement
• Limitations
• Use in clinical practice
• Future plans
Predicting stroke outcomes: Importance

• Help patients and families prepare for the future
Current models

Six simple variables:

- **Age**
- **Living alone pre-stroke**
- **Independent in everyday activities pre-stroke**
- **Glasgow Coma Scale; normal verbal score (5-able to talk but not confused)**
- **Able to lift both arms**
- **Able to walk without the help of another person (aids acceptable)**

**Predict**

- **Survival**
- **Independence (mRS)**

**Used in research & audit**

**Do not predict recovery of specific functions**

### NIHSS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a.</td>
<td>Level of Consciousness (Alert, drowsy, etc.)</td>
<td>0 = Alert, 1 = Drowsy, 2 = Stuporous, 3 = Coma</td>
</tr>
<tr>
<td>1b.</td>
<td>LOC Questions (Month, age)</td>
<td>0 = Answers both correctly, 1 = Answers one correctly, 2 = Incorrect</td>
</tr>
<tr>
<td>1c.</td>
<td>LOC Commande (Open/closet eyes, make fist/let go)</td>
<td>0 = Opens both correctly, 1 = Opens one correctly, 2 = Incorrect</td>
</tr>
<tr>
<td>2.</td>
<td>Best Gaze (Eyes open - patient follows stimulus)</td>
<td>0 = Normal, 1 = Partial gaze only, 2 = Forced deviation</td>
</tr>
<tr>
<td>3.</td>
<td>Visual Field (Introduce visual stimuli/threat to pt's visual field quadrant)</td>
<td>0 = No visual loss, 1 = Partial Hemianopia, 2 = Complete Hemianopia, 3 = Bilateral Hemianopia (Blind)</td>
</tr>
<tr>
<td>4.</td>
<td>Facial Paresis (Show teeth, raise eyebrows and squeeze eyes shut)</td>
<td>0 = Normal, 1 = Minor, 2 = Facial, 3 = Complete</td>
</tr>
<tr>
<td>5a.</td>
<td>Motor Arm - Left</td>
<td>0 = No drift, 1 = Drift, 2 = Can't resist gravity, 3 = No effort against gravity, 4 = No movement, X = Unstable (Dont resist or limb amp)</td>
</tr>
<tr>
<td>5b.</td>
<td>Motor Arm - Right</td>
<td>Left</td>
</tr>
<tr>
<td>6a.</td>
<td>Motor Leg - Left</td>
<td>0 = No drift, 1 = Drift, 2 = Can't resist gravity, 3 = No effort against gravity, 4 = No movement, X = Unstable (Dont resist or limb amp)</td>
</tr>
<tr>
<td>6b.</td>
<td>Motor Leg - Right</td>
<td>Right</td>
</tr>
<tr>
<td>7.</td>
<td>Limb Ataxia (Finger-nose, heel down shin)</td>
<td>0 = No ataxia, 1 = Present in one limb, 2 = Present in two limbs</td>
</tr>
<tr>
<td>8.</td>
<td>Sensory (Pin prick to face, arm, trunk, and leg compare side to side)</td>
<td>0 = Normal, 1 = Partial loss, 2 = Severe loss</td>
</tr>
<tr>
<td>9.</td>
<td>Best Language (Name item, describe a picture and read sentences)</td>
<td>0 = No aphasia, 1 = Mild to moderate aphasia, 2 = Severe aphasia, 3 = Mute</td>
</tr>
<tr>
<td>10.</td>
<td>Dysarthria (Evaluate speech clarity by patient repeating listed words)</td>
<td>0 = Normal articulation, 1 = Mild to moderate slurring of words, 2 = Next to unintelligible or voice, X = Intubated or other physical barrier</td>
</tr>
<tr>
<td>11.</td>
<td>Extinction and Inattention (Use information from prior testing to identify neglect or double simultaneous stimuli testing)</td>
<td>0 = No neglect, 1 = Partial neglect, 2 = Complete Neglect</td>
</tr>
</tbody>
</table>

**TOTAL SCORE**
Our approach

To develop statistical models which predict:

• Specific outcomes
  • Survival
  • Ability to walk, talk, self-care, live at home
  • Absence of severe pain, depression or anxiety

• Useful in shared decision-making
Realistic Medicine: “The patient’s needs, wishes and preferences are discussed and planned at every stage of care.” (Scottish Government, 2016)
Methods

• Refinement of the Six Simple Variable Model
• Development Cohort – FOOD trials, CLOTS trials and IST3
  • Patient recruited on days 0-3
  • Followed up to death or 6 month outcome

<table>
<thead>
<tr>
<th></th>
<th>Recruited on Days 0-3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>CLOTS</td>
<td>8228</td>
</tr>
<tr>
<td>FOOD</td>
<td>1854</td>
</tr>
<tr>
<td>IST3</td>
<td>3035</td>
</tr>
<tr>
<td>ALL</td>
<td>13117</td>
</tr>
</tbody>
</table>
Baseline variables

- Age
- Independent before stroke
- Lives alone before stroke
- Can lift arms after stroke
- Can walk after stroke
- Can talk after stroke
- Sex
- Diabetes
- Overweight

7 day variables

- Symptomatic ICH
- PE / DVT
- Independence
- Recurrent stroke
- Can lift arms
- Can walk
- Worsening neurologically
- Major extra cranial bleed
- Myocardial infarction
- Pneumonia
- Antibiotics
- Enteral tube feeding

Outcomes at 6 months (measures)

- Death
- Unable to perform ADLs (IST Simple Qs)
- mRS = 4-6 (Oxford handicap scale)
- Unable to wash/dress (EQ5D-3L)
- Unable to walk (EQ5D-3L)
- Major problems speaking (IST3 question)
- Extremely anxious/depressed (EQ5D-3L)
- Extreme pain (EQ5D-3L)
Methods

- Logistic regression
- Multivariate analysis
- Removed sequentially variables not statistically significant ($p<0.05$)
- Discrimination with area under ROC curves
- Seven models built; 4-8 baseline variables in each
<table>
<thead>
<tr>
<th>Number of baseline variables</th>
<th>Outcome at 6 months</th>
<th>Area under the curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Can walk</td>
<td>0.81</td>
</tr>
<tr>
<td>8</td>
<td>Living at home</td>
<td>0.80</td>
</tr>
<tr>
<td>7</td>
<td>OHS 0-3</td>
<td>0.79</td>
</tr>
<tr>
<td>5</td>
<td>Can talk</td>
<td>0.79</td>
</tr>
<tr>
<td>8</td>
<td>Alive at 7 days</td>
<td>0.73</td>
</tr>
<tr>
<td>6</td>
<td>No severe pain/discomfort</td>
<td>0.61</td>
</tr>
<tr>
<td>4</td>
<td>No severe anxiety/depression</td>
<td>0.60</td>
</tr>
</tbody>
</table>
Refinement with 7 day variables

• Added 7 day variables into our models
  • Stroke recurrence
  • Neurological worsening

• No overall improvement in model accuracy
Limitations

• Predictors of some outcomes are not available in existing datasets
  • e.g. pain and depression

• Some outcomes not available in existing datasets
  • e.g. cognitive function

• Trial datasets may limit generalisability

• Models not yet tested in external dataset
What can we tell patients and carers?

- Our models predict ‘good’ outcomes
  - e.g Will walk

- Patients and carers need to know the likelihood of a ‘bad’ outcome
  - Will not walk

- Negative predictive value (NPV)
  - The likelihood of a ‘bad’ outcome when predicted to have a ‘bad’ outcome
Will I be able to walk?

In 17% (2199/12657) of patients we could predict that they would not be able to walk – and we would be right in 80% (NPV=80%) – wrong in 20% - Is this accurate enough?
We could predict that they would not be able to walk – and we would be right in 95% (NPV=95%), and wrong in only 5%

but we could only be this certain in 0.7% (88/12657) of patients.
Conclusions and future work

• Reasonable accuracy in predicting 6 month outcomes
  • Walking, living at home, self care, talking, alive at 7 days
  • Addition of 7 day variables does not improve accuracy

• Further refinement and external validation
  • Ongoing; further trial data and independent cohort

• Involve patients and carers in shared decision making
  • Are predictions useful in decision making?
  • How accurate do they need to be?
  • App to support information delivery and decision-making
Thank you

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