Predicting upper limb recovery after stroke: The PREP2 algorithm

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Predictors of stroke outcome

- Stroke severity
- Age
- Co-morbidities
- Stroke lesion volume
- Leukoaraiosis

<table>
<thead>
<tr>
<th>Modified Rankin Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
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<tr>
<td>6</td>
</tr>
</tbody>
</table>
Motor function

- Commonly impaired
- Critical for regaining independence
- Upper limb, age and stroke severity

Veerbeek et al. 2012
Prediction is difficult

- Clinicians aren’t good at predicting outcomes based on clinical assessment alone
- Patients with similar acute performance can have very different outcomes
Mrs Smith

- 62 yo
- Right MCA ischaemic stroke 4 days ago
- MRC grades 0 to 1 throughout her left upper limb
- Works on a computer

Will my hand get better?
Development of PREP2

- **Biomarkers identified in 21 chronic patients**
  - Brain
  - 2007

- **PREP developed in 40 subacute patients**
  - Brain
  - 2008

- **PREP validated in 192 subacute patients**
  - Stroke
  - 2009

- **PREP revised for clinical use in 207 subacute patients**
  - Ann Clin Transl Neurol
  - 2010

- **PREP validated in 192 subacute patients**
  - Stroke
  - 2011

- **PREP implemented at ADHB**
  - 2012

- **PREP proposed**
  - Lancet Neurology
  - 2013

- **Biomarkers of motor recovery reviewed**
  - Lancet Neurology
  - 2014

- **Implementation of PREP2**
  - NeuroRehabilitation
  - 2015

- **2016**
- **2017**
- **2018**
SAFE ≥ 5
3 days

SAFE score out of 10
SAFE ≥ 5
3 days

< 80 y

SAFE ≥ 8
3 days

EXCELLENT

SAFE ≥ 5
3 days

< 80 y

SAFE ≥ 8
3 days

EXCELLENT
SAFE ≥ 5
3 days

SAFE ≥ 8
3 days
EXCELLENT

SAFE < 8
3 days
GOOD

< 80 y
SAFE ≥ 5
3 days

SAFE > 5
3 days

< 80 y
SAFE ≥ 8
3 days

SAFE ≥ 8
3 days

SAFE < 8
3 days

SAFE < 8
3 days

MEP+
4 – 7 days

NIHSS < 7
3 days

NIHSS < 7
3 days

EXCELLENT

GOOD

LIMITED
SAFE ≥ 5
3 days

< 80 y

SAFE ≥ 8
3 days

SAFE < 8
3 days

MEP+
4 – 7 days

NIHSS < 7
3 days

NIHSS ≥ 7
3 days

EXCELLENT

GOOD

LIMITED

POOR

Accurate for 75% of patients
<table>
<thead>
<tr>
<th>Prediction</th>
<th>Goal</th>
<th>Rehabilitation</th>
<th>Ward Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>Promote normal use</td>
<td>• Strength</td>
<td>• Avoid compensating with other hand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Coordination</td>
<td>• Shower as you normally would</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fine control</td>
<td>• Use both hands normally to make breakfast</td>
</tr>
<tr>
<td>Good</td>
<td>Promote function</td>
<td>• Strength</td>
<td>• Avoid compensating with other hand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Coordination</td>
<td>• Putting on shoes and socks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fine control</td>
<td></td>
</tr>
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<td>Prediction</td>
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<td>----------------------------------------------------</td>
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<tr>
<td>Limited</td>
<td>Promote movement</td>
<td>• Maintaining strength</td>
<td>• Use both hands to wash face</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Flexibility</td>
<td>• Showering skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Task adaptation</td>
<td>• Lifting a cup with both hands</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Bilateral practice</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>Promote compensation</td>
<td>• Maintaining flexibility</td>
<td>• Learn to write with other hand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Preventing shoulder instability or pain</td>
<td>• Using one arm for upper body dressing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Compensation</td>
<td>• Using one hand to tie shoes</td>
</tr>
</tbody>
</table>
What happens after 3 months?

- PREP2 predictions accurate at 2y for 80% of participants
  - About 10% do better than expected
  - About 10% do worse than expected

- PREP2 category stayed stable between 3m and 2y for 83% of participants

- PREP2 category changed for 17% of participants
  - all with a Good or Excellent prediction

- PREP2 predictions are accurate at both 3m and 2y after stroke
Who is PREP2 for?

- New upper limb weakness after stroke
  - Previous stroke
  - Haemorrhagic stroke
  - Thrombolysis and thrombectomy

Stinear et al. 2017
Why use the PREP2 algorithm?

- Improves clinician confidence
- Enables tailoring of rehabilitation
- Improves rehabilitation efficiency
- Reduction in length of stay
  - 6 days (1 to 12 days)

Stinear et al. 2017
Why does length of stay drop?

- Therapists more confident to let mildly affected patients go
- Therapists tailor therapy more appropriately
  - Good prognosis – less passive movement
  - Poor prognosis – less task specific training
- Therapists more confident to move to compensation for severely affected patients
What are the risks?

- Safety
  - *TMS approved by physician*

- Negative predictions
  - *Preparation and skill, patient support*

- Being wrong
  - *Careful language, not wrong by much*
What are the costs?

• Implementation
  • Leadership, stakeholder engagement, initial training, resources

• Clinical use
  • Therapist time

• Ongoing training
  • New staff and refreshers for existing staff
How we can help

- Training
- Resources
- www.presto.auckland.ac.nz
PREP2 at ADHB

- Phased approach to implementation
- Training and education for all clinical teams
- All assessments carried out by allied health therapists
- Documentation developed
- Information travels with the patient
Predictions using TMS and NIHSS

PREP2: SAFE SCORE <5 AT ADHB

- **Good**: 19 patients
- **Limited**: 4 patients
- **Poor**: 16 patients
Staff feedback

‘Patients and family always ask what their recovery will look like and now I feel more confident about providing that information’

For those with a good prediction with little movement: ‘it gives real motivation’

Realistic expectation setting

For those with a poor or limited prediction it highlights the importance of giving information about shoulder care early

Targeted treatment
Mrs Smith

- 62 yo
- 4 days post stroke
- MRC grades 0 to 1 throughout her left upper limb
- Works on a computer

- MEP+ therefore a GOOD prognosis
- At 12 weeks: ARAT score of 47
  Returned to work part-time
Thanks

Patients and their families
Dr Marie-Claire Smith
Dr Suzanne Ackerley
Professor Winston Byblow
Professor Alan Barber
Allied health, nursing and medical teams at ADHB