

The Norington Lecture

Dr Bradney W Norington, CBE

First President, Australian College of Rehabilitation Medicine

Australian Father of the Year, 1981

The important things to realise in rehabilitation
are remaining abilities, not disabilities



THE UNIVERSITY OF
AUCKLAND
Te Whare Wananga o Tamaki Makaurau
NEW ZEALAND

PREP2: Tailoring upper limb rehabilitation after stroke

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Predictors of stroke outcome

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

Predictors of motor outcome

Modified Rankin Scale	
Grade	Description
0	No symptoms
1	Minor symptoms
2	Some restriction in lifestyle
3	Significant restriction in lifestyle
4	Partly dependent
5	Fully dependent
6	Dead

Motor function

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

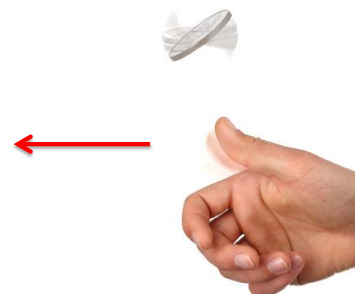
Veerbeek et al. 2012



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

ARAT SCORE	
6 month prediction	Correct
< 10	86%
10 - 56	47%
57	61%
Overall	59%



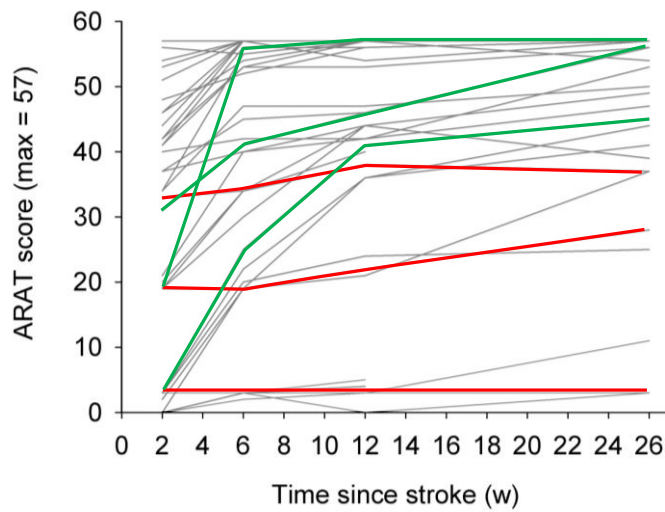
Nijland et al., Physical Therapy, 2013

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



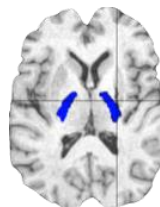
Will my hand
get better?



Stinear et al., Brain, 2012

Functional outcomes

- Biomarkers of the corticospinal tract can be useful
- Functional integrity
 - Transcranial magnetic stimulation
- Structural integrity
 - MRI



Kim & Weinstein, NNR, 2017

Biomarkers in clinical practice

- Efficient
- Accessible
- Categories not regression

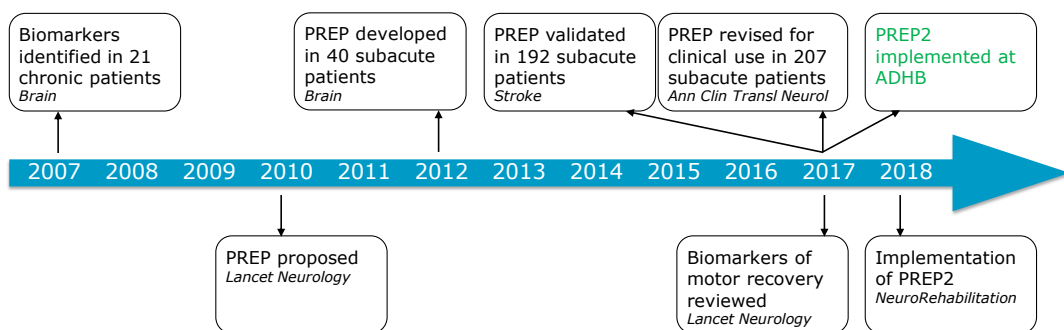
Probability of arm recovery at 6 months = $1/(1 + e^{-1.119 + 2.807 \text{ FM-FE} + 2.149 \text{ MI-SA}})$

Probability of moving a cup across the table at 6 months = $1/(1 + e^{-4.8167 - 0.0533 \text{ age} - 0.1240 \text{ NIHSS}})$

Kwah & Herbert, Brain Sci, 2016

- Accounting for variance \neq making individual predictions

Development of PREP2



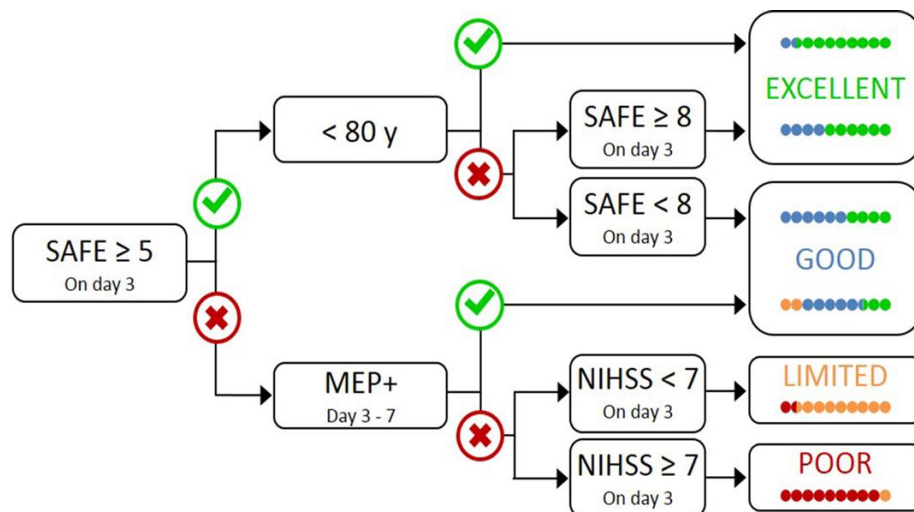
PREP2 algorithm

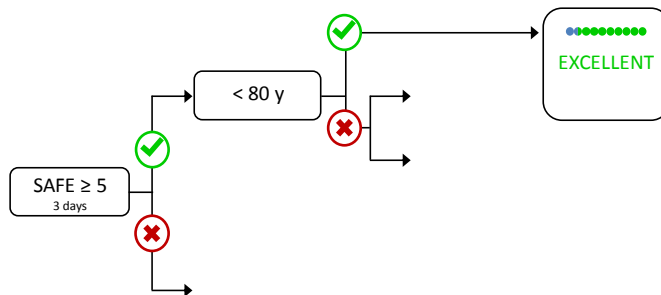
- Hypothesis-free cluster analysis to identify categories of upper limb functional outcome

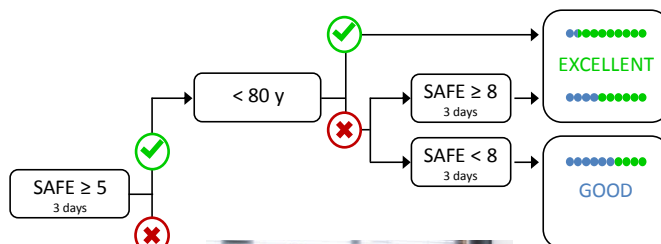
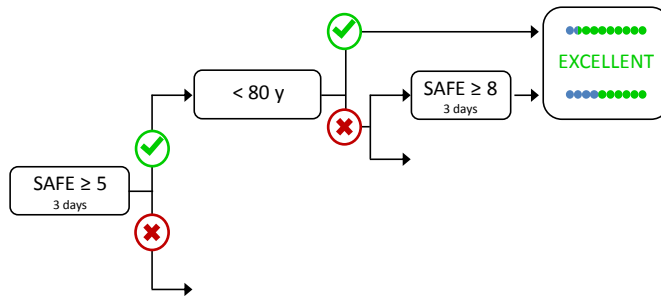
Outcome	Median	Minimum	Maximum	N
Excellent	57	50	57	113
Good	42	34	48	55
Limited	22	13	31	16
Poor	0	0	7	23

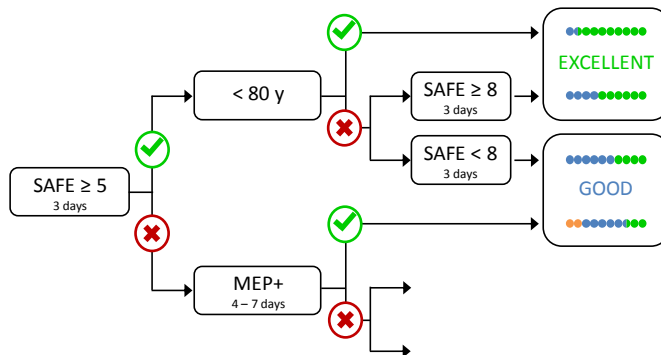
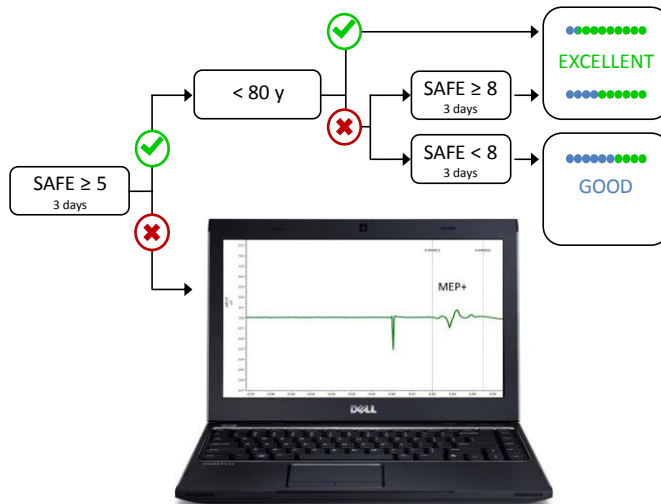
- Hypothesis-free CART analysis to create a decision tree for predicting outcome, including factors:

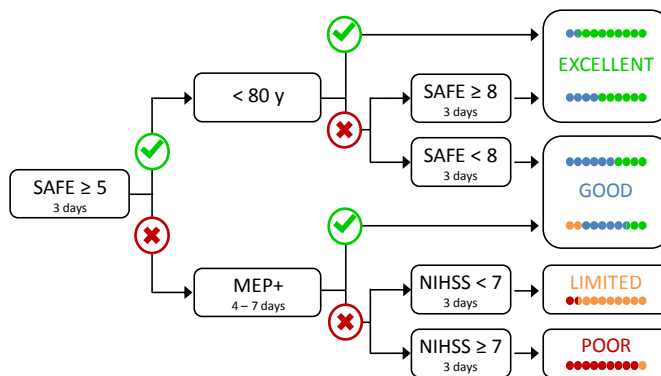
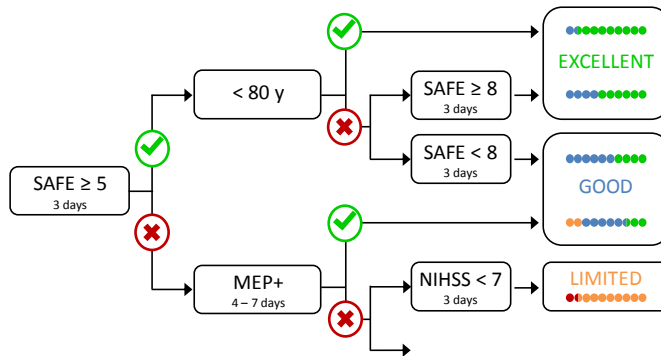
age	sex	hand affected	SAFE score
thrombolysis	previous stroke	NIHSS score	MEP status (MEP+, MEP-)
UL therapy dose	stroke type	stroke location	CST damage with 5 MRI biomarkers











Accurate for 75% of patients



Prediction	Goal	Rehabilitation	Functional goals
Excellent	Promote normal use	<ul style="list-style-type: none"> • Strength • Coordination • Fine control 	<ul style="list-style-type: none"> • Avoid compensating with other hand • Shower as you normally would • Use both hands normally to make breakfast
Good	Promote function	<ul style="list-style-type: none"> • Strength • Coordination • Fine control 	<ul style="list-style-type: none"> • Avoid compensating with other hand • Putting on shoes and socks



Prediction	Goal	Rehabilitation	Functional goals
Limited	Promote movement	<ul style="list-style-type: none"> • Maintaining strength • Flexibility • Task adaptation • Bilateral practice 	<ul style="list-style-type: none"> • Use both hands to wash face • Showering skills • Lifting a cup with both hands
Poor	Promote compensation	<ul style="list-style-type: none"> • Maintaining flexibility • Preventing shoulder instability or pain • Compensation 	<ul style="list-style-type: none"> • Learn to write with other hand • Using one arm for upper body dressing • Using one hand to tie shoes



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 patients with a poor prognosis



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



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

PRESTO 
 Predict Stroke Outcomes



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





Conclusions

Biomarkers for patient selection in trials



Biomarkers in clinical practice



Personalised rehabilitation



Better outcomes



JULIUS BRENDEL
TRUST



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

www.presto.auckland.ac.nz

PRESTO 
Predict Stroke Outcomes