Statistical Modelling of Post-Stroke Aphasia Recovery

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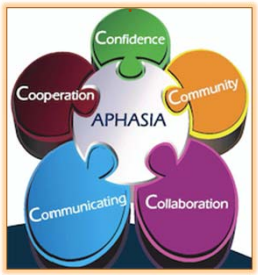
BACKGROUND

Aphasia is a communication disorder caused by damage to the language centers of the brain due to Traumatic Brain Injury or Stroke.

The Western Aphasia Battery Aphasia Quotient (AQ) is a standardised test battery used to measure change in impairment. It has high test-retest reliability but is negatively affected by a ceiling effect.

Maximal Potential Recovery (MPR) is calculated from the AQ by dividing the improvement in AQ (from baseline) by the maximum achievable improvement.

The MPR was introduced to overcome the ceiling effect of the AQ.



AIM

This research assesses the use of MPR to model post-stroke aphasia recovery to determine the most statistically appropriate model.

METHODS

Secondary analysis of data fom an Australian randomised controlled trial (N=59) was used to compare competing statistical models.

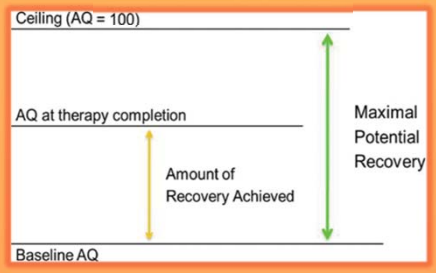
This dataset was used to develop the models with different outcome measure: AQ and MPR.

Normalised residual plots and Quantile-Quantile (Q-Q) plots were compared across the two models to determine the optimal aphasia measure.

APHASIA QUOTIENT

- Rating of aphasia disability level calculated from the Western Aphasia Battery language assessment
- Ranging from/to:
  - 0 (severely speech impaired)
  - 100 (speech unimpaired)
- Classified according to severity:
  - Severe: 0-30
  - Moderate: 31-61;
  - Mild: 62-93.7
  - No aphasia: > 93.8

MPR illustration



MAXIMAL POTENTIAL RECOVERY

- Calculated from the Aphasia Quotient score as:

$$MPR = \frac{AQ_i - AQ_1}{100 - AQ_1}$$

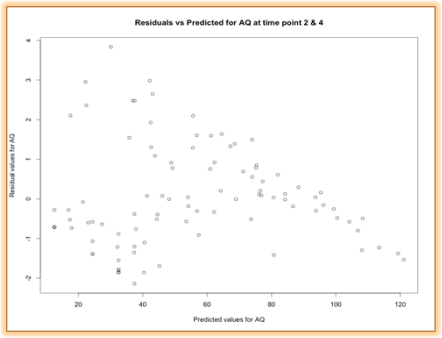
Where AQ_i denote the AQ score of a patient at time point i (i.e. 1, 2 or 4 and AQ_1 the AQ score at Baseline (i.e. time point 1).

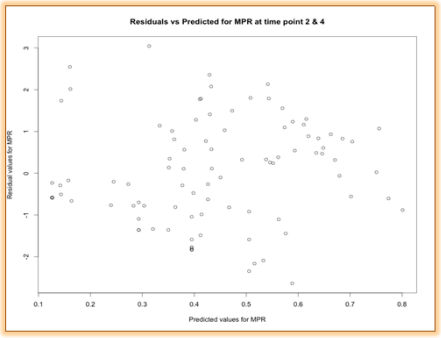
AQ = Group + Time Point + Group*Time Point + Baseline AQ

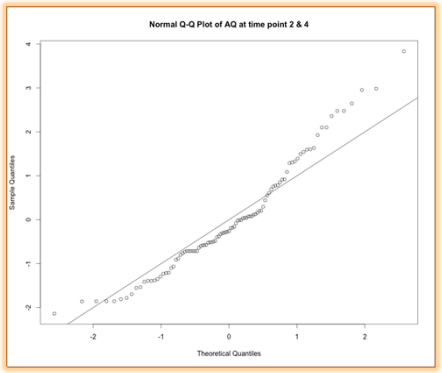
COEFFICIENTS	ESTIMATE	P-VALUE	SIGN.
Intercept	0.3408	0.7782	
Treatment group	0.2219	0.7783	
Time point 2	12.1774	0.001	0.1 %
Time point 4	32.1326	5.6e-07	0.1 %
Baseline AQ	0.9833	<2e-16	0.1 %
Treatment group * Time point 2	11.6465	0.0252	5 %
Treatment group * Time point 4	4.7104	0.5342	

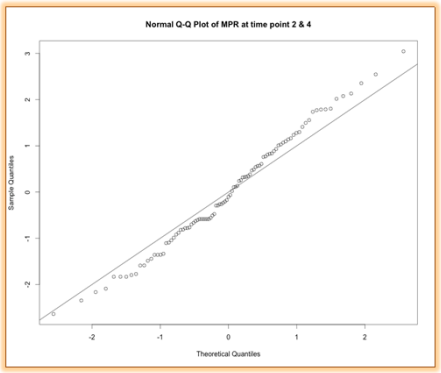
MPR = Group + Time Point + Group*Time Point + Baseline AQ

COEFFICIENTS	ESTIMATE	P-VALUE	SIGN.
Intercept	- 0.0692	0.0007	0.1 %
Treatment group	- 0.0481	0.0506	10 %
Time point 2	0.1956	3.1e-05	0.1 %
Time point 4	0.4642	3.9e-09	0.1 %
Baseline AQ	0.0035	2.3e-06	0.1 %
Treatment group * Time point 2	0.2148	0.00243	1 %
Treatment group * Time point 4	0.1586	0.1018	









SUMMARY

The MPR plot depicting normalised residuals vs predicted values illustrates a more constant variance than the corresponding AQ plot, which appears to be over-estimating the AQ values (ranging from approximately 10 to 120). The Q-Q plot for MPR shows a more normal distribution giving rise to a better model fit. Clinically this means the MPR provides a more reliable estimate of aphasia recovery that is less affected by the natural heterogeneity of the condition. However, further research using simulated data should be conducted to verify these results.