

Introduction

Prior studies have revealed that the majority of acute hemiparetic patients recover a very predictable (adjusted $R^2=0.85$) 70% of their maximum potential recovery on the Fugl-Meyer Upper Extremity Motor exam (FM-UE) at 3 months.¹ This has been termed "proportional recovery." A small subset of severely-affected patients make little or no recovery. We examined a cohort of first-time hemiparetic stroke patients to determine if the recovery trajectory among proportional recoverers was uniform during the first week.

Methods

The Performance and Recovery in Stroke (PARIS) registry is a prospective natural history examination of neurological deficits following first-time ischemic stroke at Columbia University Medical Center between 2002 and 2008, part of Columbia's NINDS-sponsored Specialized Program of Translational Research in Acute Stroke (SPOTRIAS). The database is comprised of English- and Spanish-speaking patients, ≥ 18 years of age, presenting on admission with a new deficit in motor function, and a positive MRI diffusion-weighted image for stroke. Those with prior clinical stroke or other known neurological disease affecting motor function were excluded.

Patients who were able and willing to sign consent to participate in the study were enrolled. Age, demographics, past medical history, medications, and vascular risk factors were collected as well. Baseline examination, performed between 24-72 hours of stroke onset, included a neurologic examination, the NIHSS Score, hand dynamometry, 9 hole peg test, and the Fugl-Meyer Scale. Follow-up exams were performed at 1 week and 3 months. Radiographic data on infarct topography and volume were also obtained at stroke onset. Lesion volume was calculated using the NIH freeware Medical Imaging Processing Analysis and Visualization (MIPAV) program. Lesion location was categorized into small subcortical only, large deep subcortical, or cortical only. Only one patient received thrombolytic treatment and were discharged to acute inpatient rehabilitation. See Table 1 for patient demographics.

Methods (cont'd)

We assessed 30 patients with first-ever hemiparetic stroke using the Fugl-Meyer upper extremity score (max score = 66) at 24-72 hours (FM_{init}), 1-week (FM_{1wk}), and 3 months (FM_{3mo}). Patients who did not demonstrate proportional recovery ($0.70 \times$ initial impairment) were excluded from analysis. The distribution of recovery at 7 days among the proportional recoverers was characterized and contrasted with recovery at 90 days using the Shapiro-Wilk test for normality and Sarle's binomial coefficient. Cluster analysis was then used to assess the distribution of recovery rates at 7 days. Tests of differences and association were performed to assess if the early recovery-rate groups differed significantly in clinical and demographic characteristics.

Demographics & Clinical Characteristics (N=30)		
Age, y	Mean (SD)	62.1 (10.4)
	Median	63
Male, n (%)		22 (73.3)
Race, n (%)		
	White	3 (10.0)
	Black	11 (36.7)
	Hispanic	12 (40.0)
	Asian	1 (3.3)
	Other	3 (10.0)
Hypertension, n (%)		22 (73.3)
Diabetes, n (%)		11 (36.7)
Dyslipidemia, n (%)		12 (40.0)
Atrial Fibrillation, n (%)		4 (13.3)
Antiplatelet use, n (%)		11 (36.7)
Statin use, n (%)		7 (23.3)
Smoking, n (%)		7 (23.3)
Thrombolytic treatment, n (%)		1 (3.3)
Stroke subtype, n (%)		
	Small vessel	17 (56.6)
	Large vessel	3 (10.0)
	Cardioembolic	9 (30.0)
	Cryptogenic	1 (3.3)
Infarct Location, n (%)		
	Small (<2cm ³) subcortical only	20 (66.6)
	Large (>2cm ³) deep subcortical ± cortical	3 (10.0)
	Cortical only	7 (23.3)
DWI volume (cm ³)	Mean (SD)	3.5 (8.0)
	Median	0.9
Baseline NIHSS Score	Mean (SD)	6.2 (3.3)
	Median	5
Baseline FM-UE	Mean (SD)	37.1 (22.9)
	Median	46
1-Week FM-UE	Mean (SD)	42.4 (24.4)
	Median	57.5
3-Month FM-UE	Mean (SD)	52.9 (19.5)
	Median	63
Hospital stay (days)	Mean (SD)	5.8 (2.5)
	Median	5
Admitted to Acute Rehabilitation, n (%)		11 (36.7)

Table 1: Demographics and Clinical Characteristics

Results

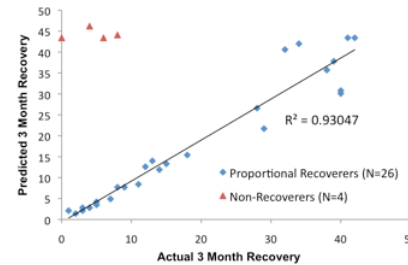


Figure 1: Observed vs. Predicted Recovery at 3 months

With an expected proportional recovery of 70%, a strong correlation ($R^2 = 0.93$) was identified between predicted ($0.70 \times$ initial impairment) vs. observed recovery percentages, with non-recoverers ($n = 4$) removed (Figure 1), replicating previous findings.¹ Among the proportional recoverers, there was a bimodal distribution of recovery at 7 days (Figure 2). Cluster analysis identified patients who achieved virtually all of their total recovery at 7 days, termed fast-to-recovery (FTR), ($n = 13$, percent recovery= 0.89 ± 0.19 ; 95% CI: 0.79 - 1.00) and patients who achieved virtually none their total recovery at 7-days, termed slow-to-recovery (STR), ($n = 13$, percent recovery = -0.23 ± 0.77 , 95% CI: $-0.65 - 0.19$), but went on to achieve the expected recovery at 90 days. The dichotomy in rate of recovery is shown graphically (Figure 3).

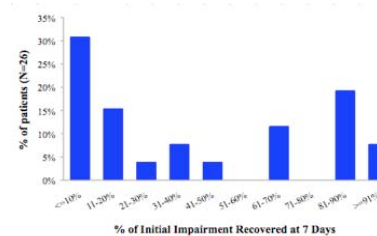


Figure 2: Histogram of Patient Recovery at 7 Days

Results (cont'd)

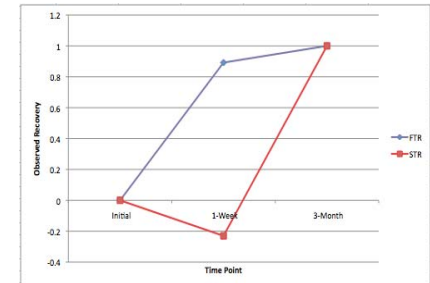


Figure 3: Fast-to-Recovery (FTR) and Slow-to-Recovery (STR) Trajectories

Discussion and Conclusions

Patients who display proportional recovery at 3-months appear to follow 1 of 2 trajectories: either recovering approximately 90% of their total recovery by 1 week (FTR) or making marginal recovery early, and only later achieving their total expected recovery (STR). The consequence of this dichotomy is that some patients at 1 week who appear to be non-recoverers may yet achieve a much higher potential. These findings have important implications for rehabilitation strategies after stroke. Future work must address the biological correlates of this rate of recovery variability.

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¹Prabhakaran et al. *Neurorehabilitation and Neural Repair* 2008; 22(1):64-71.