Supplemental Material

Our analysis of the robotic therapy studies with chronic patients depends on the observation that 99% of acute patients who qualified for a PR study, and who then had a FM score < 40 in the chronic stage, are non-fitters. We then assume that people who qualified for a robotic therapy study in the chronic phase and had a FM score < 40 would have been classified as non-fitters had they been tracked from the acute phase.

How plausible is this assumption? There are two types of subjects who enrolled in the robotic therapy studies: those who would have qualified to be in a PR study and those who would not have qualified. Our assumption clearly holds for the former group. However, this is potentially a small percentage of stroke patients – around 7% of consecutively admitted patients qualified to be in the Winters et al. 2015 study. On the other hand, it may be that people who qualify for robotic therapy studies have a high representation from this group. This would be expected if the inclusion/exclusion criteria for PR studies and robotic therapy studies were similar.

Table S1 compares the inclusion/exclusion criteria for the PR and robotic therapy studies we analyzed, plus a recent study of PR by Stinear et al. 2017 that generalized the PR results to a broader population. The inclusion/exclusion criteria for the Winters et al. 2015 study were:

1) First-ever ischemic stroke in the anterior circulation

The majority of robotic therapy studies we examined enrolled only subjects who had experienced a first-ever stroke (Table S1). In addition, Stinear et al. 2017 studied PR in a more clinically relevant sample of patients with stroke, including those with previous stroke and intracerebral hemorrhage. They found the same pattern of upper extremity PR (the pattern of fitters and non-fitters) and the same predictive value of MEP. In their study, 18% had previous stroke and only 39% had anterior circulation stroke.

2) Minimum level of daily activity (premorbid Barthel Index of ≥19)

This corresponds to requiring that subjects were not "totally dependent" before stroke (Shah et al. 1989). It is unlikely that a person who was totally dependent before stroke, then had a stroke and did not qualify for a PR study, would then months later qualify for a robotic therapy study. We note also that other PR studies did not have this exclusion criterion (see Table S1).

3) No severe cognitive or communication impairment

The large majority of robotic therapy studies we analyzed required that participants have no severe cognitive or communication impairment, as would be expected since they were required to interact with a robotic training system (Table S1).

Thus, we conclude that the inclusion/exclusion criteria for PR studies and robotic therapy studies were similar. This makes it likely that participants in the chronic phase robotic therapy studies had a high representation from the group of subjects who would have qualified for PR studies in the acute phase.

What about the other type of subject – those who would not have qualified for the PR study but then qualified for robotic therapy studies? This group mainly would be expected to be people who had severe cognitive or communication impairment in the acute phase, and therefore did not qualify for the PR study, but recovered enough cognition and communication to later qualify for a robotic study. Severe cognition or communication deficits are present initially in ~50% of stroke patients (Nys et al. 2007, Middleton et al. 2014) but recovery is typically poor for people with initially severe deficits (Middleton et al. 2014, Ramsey et al. 2017, Marchi et al. 2017). So, this group would be expected to be a minority of the robotic therapy study participants. Nonetheless, for this group an interesting question is whether we would expect their upper extremity motor recovery to follow a different pattern than non-fitters who qualified for a PR study. Cognitive and upper extremity motor impairment are associated, and this link may be causal because cognitive components enhance motor learning (Mullick et al. 2015, Marchi et al. 2017). Thus, early, severe cognitive impairment may increase chronic arm impairment, and a small fraction of individuals included in robotic therapy studies may have a second cause of upper extremity impairment beyond lack of CST integrity. We acknowledge this as a potential caveat to our analysis.

Supplemental References

Marchi NA, Ptak R, Pietro M Di, Schnider A, Guggisberg AG. Principles of proportional recovery after stroke generalize to neglect and aphasia. *Eur J Neurol*. 2017;24(8):1084-1087.

Middleton LE, Lam B, Fahmi H, Black SE, McIlroy WE, Stuss DT, Danells C, Ween J, Turner GR. Frequency of domain-specific cognitive impairment in sub-acute and chronic stroke. *NeuroRehabilitation*. 2014;34(2):305-12

Mullick AA, Subramanian SK, Levin MF. Emerging evidence of the association between cognitive deficits and arm motor recovery after stroke: A meta-analysis. *Restor Neurol Neurosci*. 2015;33(3):389-403

Nys GM, van Zandvoort MJ, de Kort PL, Jansen BP, de Haan EH, Kappelle LJ. Cognitive disorders in acute stroke: prevalence and clinical determinants. Cerebrovasc Dis. 2007;23(5-6):408-16.

Ramsey LE, Siegel JS, Lang CE, Strube M, Shulman GL, Corbetta M. Behavioural clusters and predictors of performance during recovery from stroke. *Nat Publ Gr*. 2017;1:1-10.

Shah S, Vanclay F, Cooper B. Improving the sensitivity of the Barthel Index for stroke rehabilitation. *Journal of Clinical Epidemiology*. 198; 42, 703-709.

Stinear CM, Byblow WD, Ackerley SJ, Smith M, Borges VM, Barber PA. Proportional motor recovery after stroke: implications for trial design. *Stroke*. 2017;48(3):795-798.

Winters C, van Wegen EEH, Daffertshofer A, Kwakkel G. Generalizability of the proportional recovery model for the upper extremity after an ischemic stroke. *Neurorehabil Neural Repair*. 2015;29(7):614-622.

	PR studies									Chronic phase robotic therapy studies												
Inclusion\exclusion criteria	2	3	4	21	30	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
First-ever stroke	x	x		x		x				x	x				x	x	x	x	x		X	
Ischemic anterior circulation	x	x																				
No cerebellar stroke			x																			
Minimum level of daily activity (premorbid Barthel Index of ≥19)	x										x				x	x						
No severe visual impairment		x		x		x	x		x	x	x							x			x	
No severe sensory loss		x			x								x				x				x	
No severe cognitive or communication impairment	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x
No contraindications to TMS and/ or MRI		x	x		x																	x
No excessive spasticity					x	x			x	x		x	x					x	x	x		x
No severe depression/psychiatric disorder					x	x				x			x					x				x
No severe pain or severe orthopedic problems				x	x	x	x		x	x		x	x				x	x		x	x	x
Minimum level of muscle power/tone/passive range						x	x	x		x	x	x	x	x	x	x	x		x	x	x	x

Table S1: Inclusion/exclusion criteria for the PR studies whose data we scanned [2,3] , a recent study that showed PR applied to a broader range of stroke patients [4], and the chronic phase robotic therapy studies we analyzed [21,30-48]. All studies required age >18 year and some level of upper extremity impairment (UEFM <66). The reference numbers correspond to those in the reference section in the main text.