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Predictors of Functional and Motor Outcomes following Upper Limb Robot-assisted Therapy after Stroke

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Objective
Upper limb recovery is one of the main goals of post-stroke rehabilitation due to its importance in activities of daily living (ADL). Robot-assisted therapy (RT) provide high-intensive, repetitive, task-specific and interactive treatment of the impaired upper limb. Although the efficacy of RT is well established in literature, the impact of the initial status of the patient on the effects of RT is still understudied. In this study, we aim to identify whether demographic and clinical characteristics of stroke patients may influence the functional and motor outcomes after RT. The identification of predictors will help to identify patients who can benefit more from RT, and to optimise the treatment planning.

Methods
A retrospective study was carried out on a database of 189 patients who conducted upper limb goal-directed tasks with the Rapael Smart Glove(Neofect®, Gyeonggi-do, Republic of Korea) at our institution between January 2015 and March 2018. The exclusion criteria were as follows: Less than 20 sessions of RT; non-stroke lesion; Bilateral lesion; age <18 or >85 years; MMSE<15; and incomplete data. From the 189 patients, 48 satisfied the inclusion criteria. The RT was administered 5 days/week over 4 weeks and each session lasted 30 minutes. All patients had conventional occupational complex therapy for 30 minutes/day during hospital stay. The primary outcome measures were the Functional Independence Measure (FIM) and Manual Function Test (MFT). The potential predictors were the demographic records and clinical assessment scores: initial Mini–Mental State Examination (MMSE); initial MFT scores of affected upper extremity(MFT-A); initial FIM; Modified Ashworth Scale for the Upper Extremity (MAS-UE). We assessed twice for each, at baseline and after the intervention. Statistical analysis were done using correlation analysis and regression analysis prepared by Web-R.org., and the chosen level of statistical significance was <0.05.

Results
Demographic data and clinical characteristics of the enrolled patients are displayed in Table 1. Correlation analysis showed that age and initial MMSE were correlated with final FIM, and the MAS-UE and initial MFT-A were correlated with the final MFT (Table 2). Regression analysis showed that the initial MMSE score was significant predictor of final FIM, and MAS-UE, initial MFT-A and OTR were significant predictors of final MFT (Table 3).

Conclusion

Stroke patients with preserved cognitive function appear to have a higher probability of achieving clinically significant functional outcomes after upper limb RT. In addition, stroke patients with less spasticity and more strength of affected upper extremity and earlier intervention during the acute stage appear to be achievable a clinically significant motor function after upper limb RT. Further studies on a larger number of patients with a long-term follow up are recommended in order to evaluate other potential predictors and to validate the Results.

Table 1. Demographic and Clinical Characteristics of Subjects (n=48)

Variables	Values
Age (years)	58.48±14.20
Gender (male/female)	30/18
Subtype (ischemic/haemorrhagic)	18/30
Lesion side (right/left)	25/23
MAS-UE (scale)	0.65±0.76
Initial MMSE	22.83±6.43
Initial MFT of affected upper extremity	12.81±8.99
Initial FIM	75.44±21.43
OTR (days)	167.13±183.60
DRM (days)	66.08±14.83
Session count (times)	33.58±7.80

Values are mean ± standard deviation.
MAS-UE, Modified Ashworth Scale for the Upper extremity ; MMSE, Mini–Mental State Examination; MRC, Medical Research Council scale for muscle strength; FIM, Functional Independence measure; OTR, onset-to-robot-assisted therapy time ; DRM, duration of hospital stay in department of rehabilitation medicine

Table 2. Correlation between Clinical Characteristics and Outcome Measure

Variable	Final FIM (Pearson's Coefficient, r)	Final MFT of affected upper extremity (Pearson's Coefficient, r)
Age	-0.54***	0.07
Gender	-0.18	0.07
Subtype	-0.06	-0.24
Lesion side	-0.23	0.19
MAS-UE	-0.18	-0.54***
Initial MMSE	0.54***	-0.05
Initial MFT of affected upper extremity	0.10	0.80***
OTR	-0.06	-0.23
DRM	0.03	-0.29
Session count	-0.24	-0.18

*** $P < 0.005$
FIM, Functional Independence measure; MFT, Manual Function Test; MAS-UE, Modified Ashworth Scale for the upper extremity ; MMSE, Medical Research Council scale for muscle strength; OTR, onset-to-robot-assisted therapy time ; DRM, duration of hospital stay in department of rehabilitation medicine

Table 3. Predictors of Final FIM & MFT after Robot-assisted Therapy Using Multivariate Regression Analysis

Variable	Final FIM	Final MFT of affected upper extremity
Initial MMSE (score)	1.66 (<0.001)	-
MAS-UE (scale)	-	-2.44 (0.022)
Initial MFT of affected upper extremity (score)	-	0.69 (<0.001)
OTR (days)		-0.01 (0.034)

Values are β (P<0.05)

FIM, Functional Independence measure; MFT, Manual Function Test; MMSE, Mini–Mental State Examination; MAS-UE, Modified Ashworth Scale for the Upper extremity; OTR, onset-to-robot-assisted therapy time