Upper Extremity Robotic Intervention for Acute Pediatric UE Impairment

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BACKGROUND

- Motor Learning strategies commonly integrated into occupational therapy include practice, repetition and functional context.
- Emerging research in pediatric and motor learning suggests need for grading error to maximize motor learning
- Additional evidence to support need for variability of practice to improve generalization of skills to other contexts
- The intensity of practice and number of repetitions needed for development and improvement of motor skills is difficult to achieve in a typical therapy session

PURPOSE

To determine if motor training with the ReoGo for 60 minutes, 5x per week in additional to standard of care occupational therapy would lead to greater improvement in upper extremity motor function.

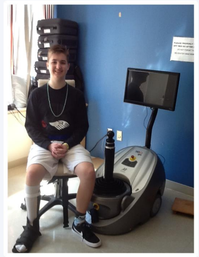
METHODS

Patient 1	Patient 2	Patient 3
Female, 12 y.o	Female, 17 y.o	Male, 14 y.o
Spinal cord infarct with resultant incomplete spinal cord injury	Neurofibroma with lesion in pons, 2 in auditory canal and 1 in lumbar region	Left MCA stroke, HX of Moya Moya
Dominant, RUE affected	Non-dominant, LUE affected	Dominant, RUE affected
Inpatient Rehab LOS = 31 days	Inpatient Rehab LOS =	Inpatient Rehab LOS = 39 days

Standard of Care OT
90 minutes therapy (1 60 minute, 1 30 minute session)
Functional task training (ADLs, IADLs, reaching, grasping, handwriting and keyboarding/computer-use)
Weight-bearing
Therapeutic exercises
Electrical Stimulation (NMES)
Splinting
Therapeutic Taping

ReoGo	
60 minutes of standard of care OT, 60 minutes of ReoGo 5x per week. Sessions followed ReoGO suggested sessions and progression with changes made based on individual therapist clinical decision making.	
Guided	The patient is led by the robot, but must attend and follow along with movement if possible (passive mode).
Initiated	The patient correctly initiates the movement and then is guided through the rest of the movement.
Step-Initiated	The patient correctly initiates the movement and is then guided for a short distance, requiring the patient to correctly initiate multiple times throughout the movement in order to complete it.
Follow Assist	The patient is guided at a very slow rate and may move more quickly along the correct motion path by applying force in correct direction.
Free Mode	The patient completely controls the movement (active mode).

- Outcome Measures: Wee-Fim, Fugl-Meyer Upper Extremity, UE AROM measurements with goniometry, UE manual muscle testing, gross grasp dynamometry, Box and Blocks test.
- Outcome measures completed at admission, weekly (Mondays) and discharge; except Wee-Fim completed at admission and discharge only.

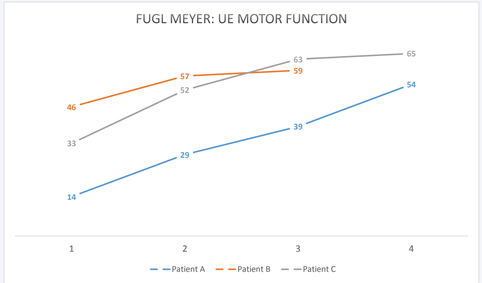


RESULTS

Wee-Fim	Patient 1		Patient 2		Patient 3	
	Admission	*Discharge*	*Admission*	*Discharge*	*Admission*	*Discharge*
Eating	5	6	7	7	4	7
UB Dressing	2	6	4	6	3	5
LB Dressing	2	4	4	6	4	5
Bathing	3	6	4	6	3	5
Grooming	3	6	4	6	3	5
Toileting	2	6	5	6	3	7

Fugl Meyer:

- Admission to discharge improvement in FMA Upper Extremity
  - Patient 1: 14/66 to 54/66
  - Patient 2: 46/66 to 59/66
  - Patient 3: 33/66 to 65/66
- Minimal dectable change = 5.2 points on FMA Upper Extremity (Wagner et al 2008)
- Minimally clinically important difference = 10 point increase on FMA Upper Extremity (Shelton et al 2001)
- Improvements were noted across all sub-tests of the FMA Upper Extremity including improvements in volitional movement within synergies, mixing synergies and out of synergy patterns as well as improvements at wrist, hand and overall UE coordination and speed.



Not reported graphically however additional gains were noted across all outcome measures. Notable improvements include:

- Patient 2 and 3 discharged will full UE AROM against gravity at all ranges, all joints and 5/5 strength as measured by MMT.
- Patient 3 gross grasp dynamometry increased from RUE average 27.9 lbs to 61.5

DISCUSSION

- Motor learning key principles: practice, error, variability
- Practice: Increased number of repetitions.
  - ReoGO allows average 210 functional arm movements in 23 minutes.
  - Traditional care averages 85 functional arm movements in 36 minutes (Journal of Neurological Physical Therapy, 2007)
- Error: Options for errorless and errored learning.
  - Begin with errorless learning to improve new learning
  - Progress to opportunities for error and problem-solving
- Variability: Variety of exercises, customizable exercises, customizable sessions, various accessories. Games offer additional variety of motor sequences and plans.
- Consistent with results out of Boston (2008): 12 children, age 4-12 with hemiparesis from CP or TBI. Outpatient robotic therapy for 60 minutes, 2x per week for total of 8 weeks.
  - Statistically significant improvements in upper limb coordination and quality of movement on QUEST and FMA.
  - Smaller impact on spasticity and strength.
  - Parental questionnaires revealed large gains in quantity and quality of paretic arm use during daily activities
- Limitations with case series: Small sample, each patient with different etiology of hemiparesis, variable length of stay and this variable intervention length, different primary therapist with each patient
- Limitations with ReoGO: Challenge with pediatric population (seat, positioning)

CLINICAL RELEVANCE

- Implementing 1 hr of ReoGO therapy, 5 days a week in addition to 60 minutes of standard of care occupational therapy was feasible for staff and patients in an inpatient rehab setting.
  - OTR necessary for setting-up program, progressing program. Daily execution of program did not require OTR. Opportunities for group.
- Adding ReoGO robotic therapy might lead to improvements in UE recovery in adolescents with hemiplegia after neuologic incident. Recovery may include improved functional use of paretic UE and overall independence with ADLs and IADLs due to high repetitions, high variability of motor movements and flexible error allowed by the technology.

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