Application of Robotic Therapy

in

Upper Limb Training

for

Stroke Patients

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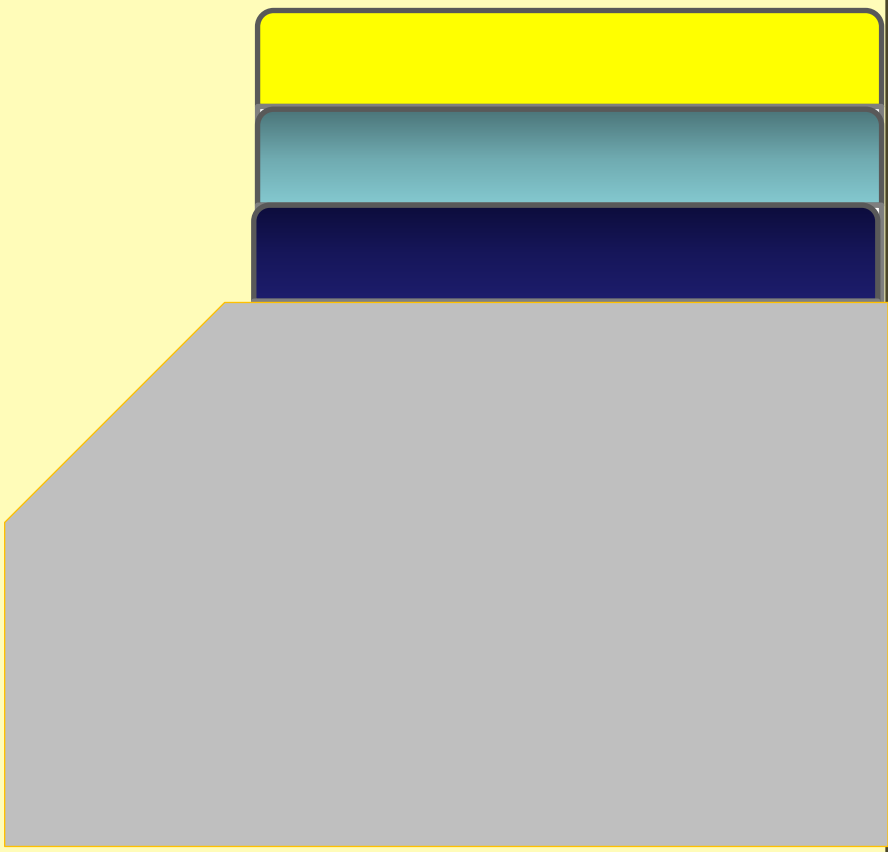
Hospital Authority

Hong Kong

新界西·醫院聯網
New Territories West Cluster

Outline



Stroke Rehabilitation

- A major health issue in Hong Kong

- Entails various degrees of motor and functional deficits, adversely affecting survivors' community living and quality of life

- Functional training of the paretic limbs has been a focus.

- Majority (70-80%) of stroke survivors fail to attain full recovery in the paretic arm (Khandare et al, 2013)

Evidence-Canadian Best Practice Recommendation for stroke Care (2012)

1. Stroke patients should receive through an individualized treatment plan, a minimum of 3 hours of direct task-specific therapy for a minimum of 5 days per week (Evidence Level A)

2. Repetitive & intense task-oriented therapy is effective in promoting recovery in both acute and late phase of stroke rehabilitation (Evidence Level A).

3. Higher intensity in terms of longer, more frequent training is associated with better rehabilitation outcomes.

There is strong (Level 1a) evidence that repetitive task specific training techniques improve measures of upper extremity function.

1. Repetitive task
2. Specific Movement
3. High intensity of training

Liepert et al, 2000

Neuroplasticity / brain Plasticity

Definition: The capability of the brain to reorganize by forming new neural connections throughout life.

- It allows the neurons in the brain to compensate for injury and disease and to adjust their activities in response to new situations or to change in the environment (***Dr. H. El Sharkawy***)

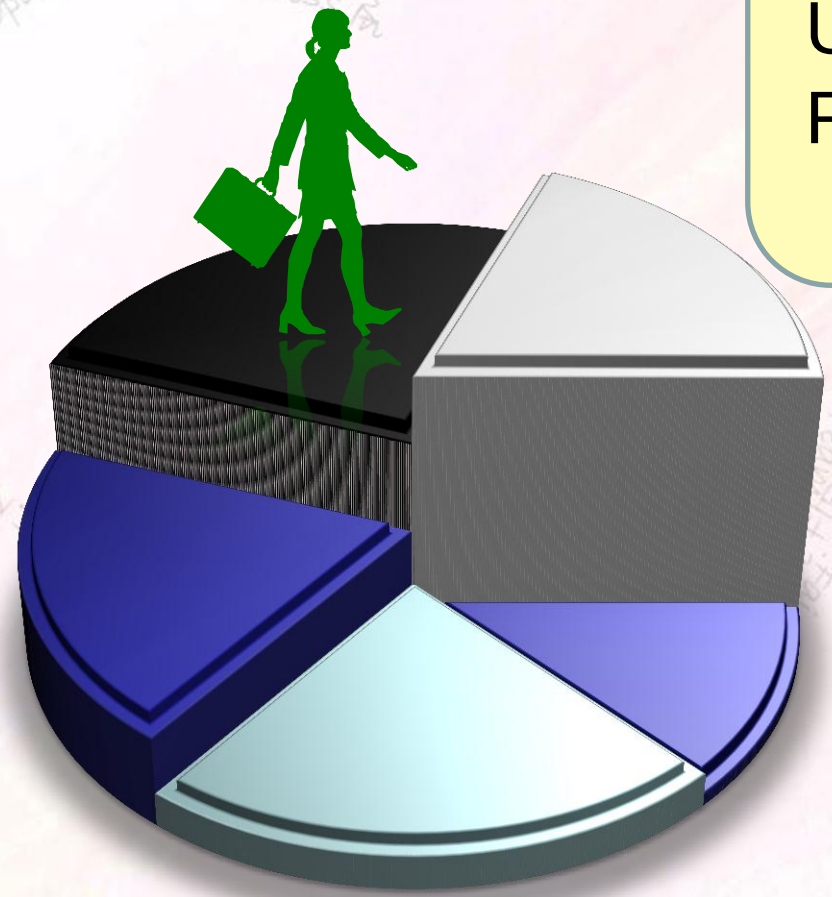
- Motor recovery programs should include meaningful, repetitive, intensive and task-specific movement training in an enriched environment to promote neural plasticity (***T Nao & Shin, 2013***)

Upper Limb Training: OT Approach

Conventional Rehabilitation Training for Paretic upper limb

Advanced Technology Rehabilitation Training for paretic upper limb

Recent Development in Upper limb Stroke Rehabilitation

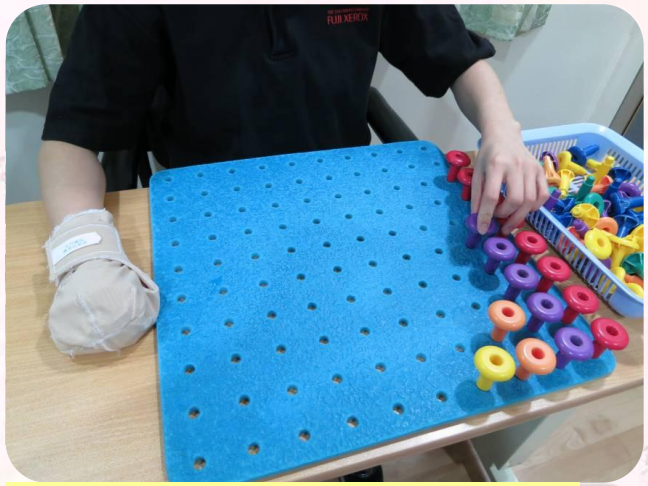


Evidence - EBRSR: 10. Upper Extremity Intervention

Norine Foley MSc, Robert Teasell MD, Jeffrey Jutai PhD CPsych, Sanjit Bhogal MSc, Elizabeth Kruger

1

Constraint-induced movement therapy is a beneficial treatment approach for those stroke patients with some active wrist and hand movement.



Constraint-induced Therapy

Evidence - EBRSR: 10. Upper Extremity Intervention

Norine Foley MSc, Robert Teasell MD, Jeffrey Jutai PhD CPsych, Sanjit Bhogal MSc, Elizabeth Kruger

2

There is preliminary evidence that virtual reality therapy may improve motor outcomes post stroke

Virtual Reality

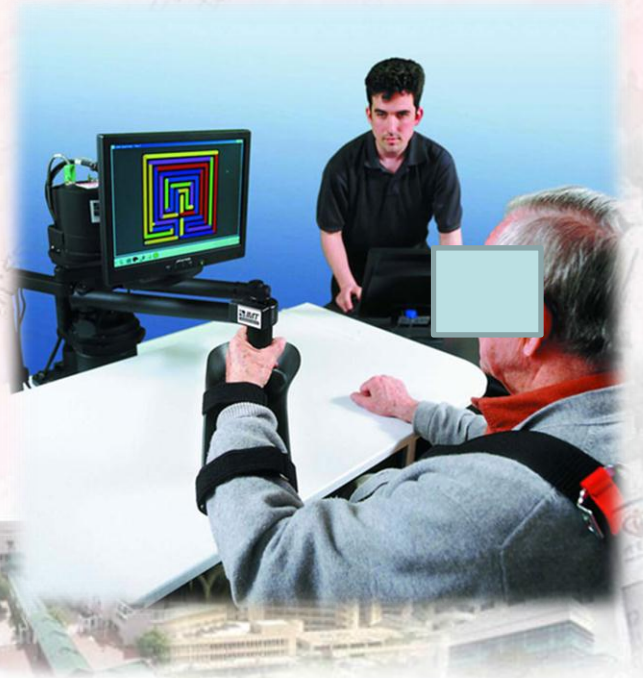
Evidence - EBRSR: 10. Upper Extremity Intervention

Norine Foley MSc, Robert Teasell MD, Jeffrey Jutai PhD CPsych, Sanjit Bhogal MSc, Elizabeth Kruger

3

Sensorimotor training with robotic devices improves functional and motor outcomes of the shoulder and elbow.

Last updated July 2012
www.ebrsr.com



Robotic Therapy

Robotic Therapy in Upper Extremity

An upper limb robotic therapy in rehabilitation is an external device that assists or guides movement with the intention of improving function

Presents virtual reality (VR) games and tasks to the patient that can be adjusted to level of ability, interest and specific movement problems

Theoretical Benefit of Robots Therapy in Upper Extremity

Point 1 Robot will allow the patient to achieve a task

Point 2 Repetitive goal orientated practice requiring attention

Point 3 Tasks can be adjusted to provide success at the limit of performance

Jane Burridge, 2013

Theoretical Benefit of Robots Therapy in Upper Extremity

Point 4

Motivating and varied – VR / games (less boring)

Point 5

Allows intensive and safe training

Point 6

Appropriate for all levels of ability

Jane Burridge, 2013

Theoretical Benefit of Robots Therapy in Upper Extremity

Point 7

Robotics is an area of interest in stroke rehabilitation
Several studies have reported improvements in strength and motor function with robotic treatment (Burgar, Lum, Shor, & Machiel Van der Loos, 2000; Finley et al., 2005).

Effects of robot-assisted therapy on stroke rehabilitation in upper limbs: Systematic review and meta-analysis of the literature

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Pages 479–496
(2012)

Nahid Norouzi-Gheidari, MSc, OT;* Philippe S. Archambault, PhD; Joyce Fung, PhD
School of Physical and Occupational Therapy, McGill University, Montreal, Quebec, Canada; Feil/Oberfeld/CRIR Research Centre, Jewish Rehabilitation Hospital, Laval, Quebec, Canada

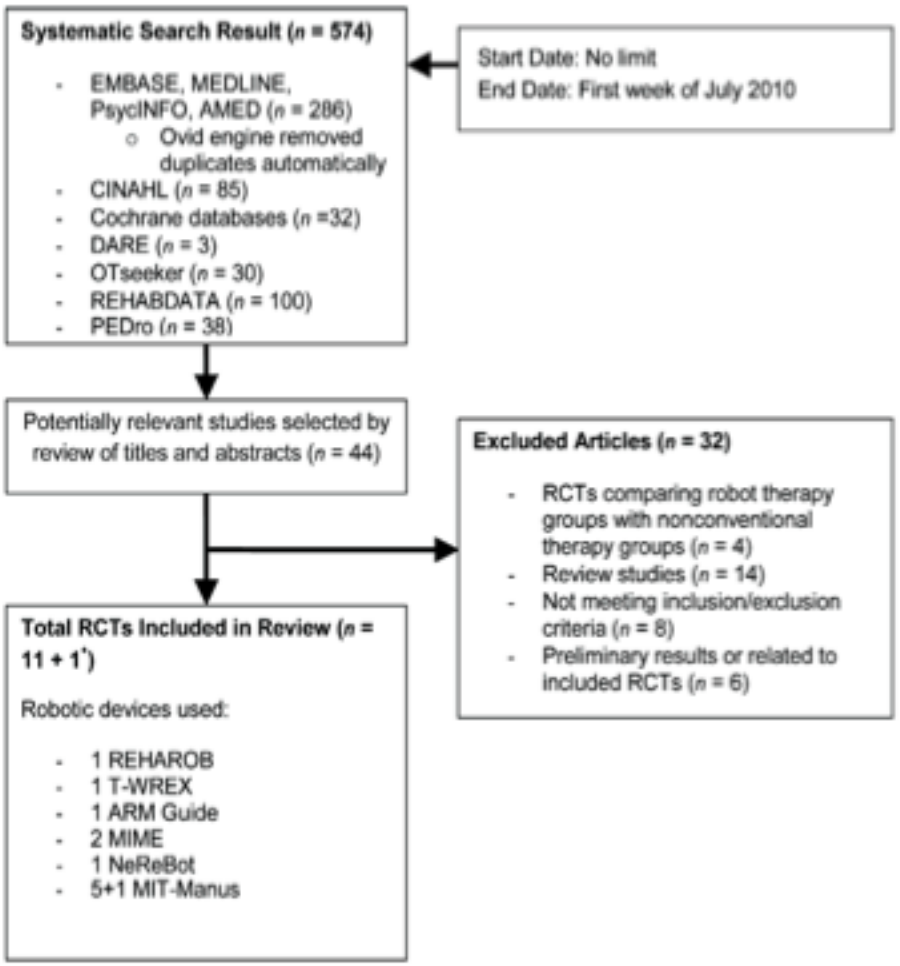


Table 1.
Characteristics of selected randomized controlled trials.

Study	N (Sex) RT (M/F)	N (Sex) CT (M/F)	Age (yr) Mean ± SD (Range) RT	Age (yr) Mean ± SD (Range) CT	Months/[weeks]/*day/** Poststroke Mean ± SD or (Range) RT	Months/[weeks]/*day/** Poststroke Mean ± SD or (Range) CT	Stroke Stage at Admission	Robotic Device	Outcome Measures of Interest
Pazekas et al. [1]	[illegible]	15 (10/5)*	56.6 ± ?	55.9 ± ?	23.2 ± ?	9.5 ± ? (1.1–44)	Not Stated (Subacute/ Chronic)	REHAROB	F-M (s/e/c), FIM (self-care)
Housman et [illegible]						112.4±128.5	Chronic	T-WREX	F-M (UL)
Kahn et [illegible]						103.1 ± 48.2	Chronic	ARM Guide	Ch-McM (arm)
Lum et al. [illegible]						28.8 ± 6.3	Chronic	MIME	F-M (UL), FIM (self-care)
Lum et al. [illegible]						[10.662.7]wk	Subacute	MIME	F-M (UL), FIM (self-care), MSS, MPS
Masiero et al. [6]	17 (10/7)	18 (11/7)	63.4 ± 11.8	68.8 ± 10.5	[≤1 week]	[≤1 week]	Acute	NeReBot	F-M (s/e/c, w/h), FIM (self-care)
Aisen et al. [7]§	10 (5/5)	10 (6/4)	58.5 ± 8.3	6[illegible]	[illegible]4.1]wk	[3.34.2]wk	Acute	MIT-Manus	F-M (UL), FIM (self-care), MSS, MPS
Volpe et al. [8]§	6 (4/2)	6 (3/3)	54 ± 7.3	66					M (s/e/c, h), FIM f-care), MPS
Volpe et al. [9]	30 (16/14)	26 (14/12)	62 ± 11	67					M (s/e/c, h), FIM otor), SS, MPS
Volpe et al. [10]	11 (8/3)	10 (7/3)	62 ± 3	60					M (s/e/c, h), MPS
Rabadi et al. [11]	10 (5/5)	10 (5/5)	79.5 ± 6.2						M (UL), M (motor), SS, MPS
Lo et al. [12]¶	49 (47/2)	50 (48/2) 28 (27/1)	66 ± 11 (44–95)	64 ± 11 (28–86) 63 ± 12 (42–88)	3.6 ± 4.0 (0.6–19.8)	4.8 ± 4.0 (0.5–15.7) 6.2 ± 5.0 (0.5–23.6)	Chronic	MIT-Manus	F-M (UL)

Conventional Therapy

VS

Robotic Assisted Therapy

Result

Point 1

When the duration/intensity of conventional therapy is matched with the robot-assisted therapy, no difference in motor recovery, ADL, strength, and motor control.

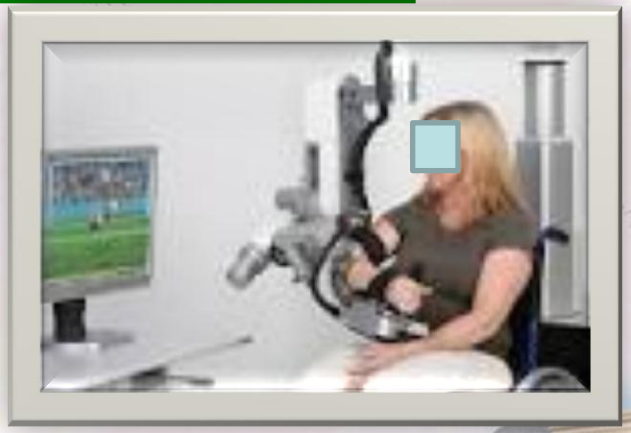
Point 2

Extra session of robotic therapy in addition to regular therapy are more beneficial than regular therapy alone

Local Experience in Robotic Therapy for Stroke Patients

Armeo Spring

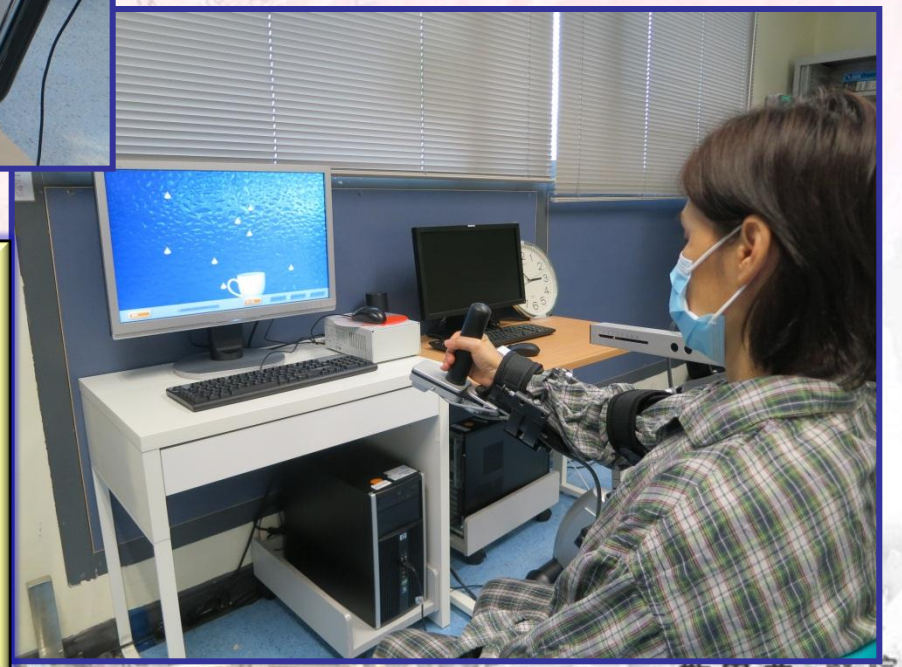
Armeo Power



ReoGo

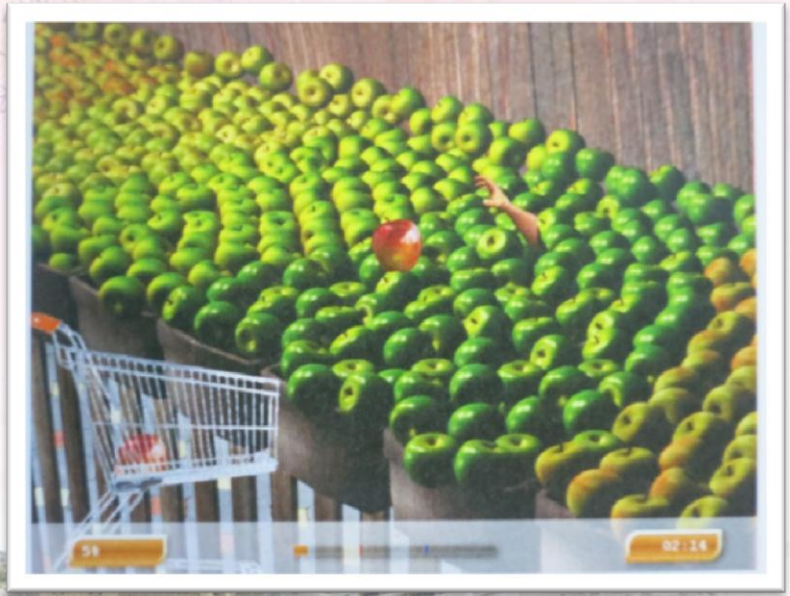
Application of Robotic Therapy in Upper Limb

Exoskeleton Device
Gravity-supported
UL Exercise



Computer enhanced upper limb exercise, task relevance and feedback

Functional Activities



Properties of the selected exercise

General configuration

- Parameters
- Difficulty level
- Time limit
- Repetitions
- Autogrip
- Autowrist

Local Studies Sharing

1. Tuen Mun Hospital
   Occupational Therapy Department

2. Kowloon Hospital
   Occupational Therapy Department

3. Caritas Medical Centre
   Occupational Therapy Department

Robotic Training Program in Tuen Mun Hospital

Rehabilitation Stroke Unit

Inclusion Criteria

Principal diagnosis in stroke

The Functional Test for the Hemiplegic Upper Extremity (Hong Kong) Level II to level VI

Exclusion Criteria:

MAS score for shoulder and elbow equal or more than 2

Pilot Study in Tuen Mun Hospital

Rehabilitation Stroke Unit

- Time : February 2010 to July 2011
- Number of subject : 41
- Intervention : Conventional Therapy + Robotic therapy
- Outcome measure: The Functional Test for the Hemiplegic Upper Extremity (Hong Kong) FTHUE

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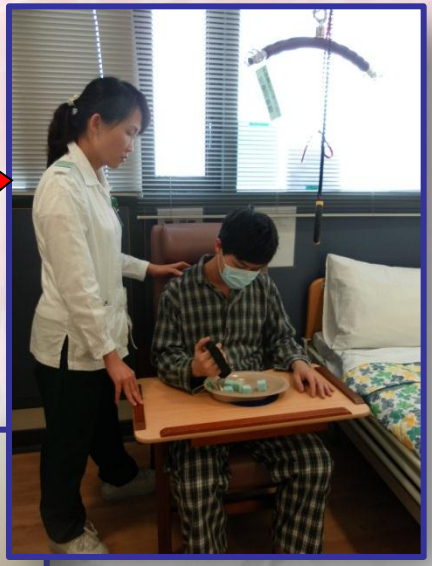
Result

- 32 Subjects have increased FTHUE level.
- FTHUE level II to level IV patients showed greatest improvement among different groups of upper limb level after completing the Robotic Arm Training

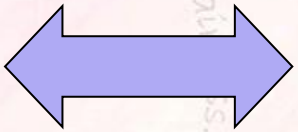
Program Implementation

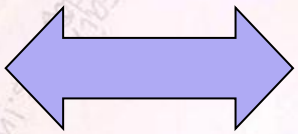
Attend training session 5 days per week

Duration : 30 minutes Armeo Spring training and functional training



A Associated reactions	Level 2
B Hand into lap	
C Arm clearance during shirt tuck	Level 3
D Hold a pouch	
E Stabilize a jar	Level 4
F Simulated wringing a rag	
G Blocks and Box	Level 5
H Eat with a spoon	
I Box on Shelf	Level 6
J Drink from glass	
K Key turning	Level 7
L1 Use chopsticks (dominant hand)	
L2 Clip cloth peg (non dominant hand)	





Functional Activities

Rain Mug (1D)

Vegetable Grater (1D)

Jump(1D)

Snow Balls (1D)

Stove Cleaning (2D)

Window Mopping (2D)

Fish Catching(2D)

Fruit Shopping (2D)

Egg Cracking (2D)

Flower Watering (2D)

Popping Air Bubbles (2D)

Picnic (2D)

Reveal Panorama (3D)

Reveal Picture (3D)

Chase Ballon (3D)

Local Studies Sharing – Caritas Medical Centre

N	26
Sex	Male=8 (31%)
Age	77.85±10.85
Hemi	Right =11 (43%)
No. of sessions	6.3 (average)

N=26	Pre	Post	P value
FM Score	49.00 (±18.16)	55.57 (±15.64)	0.002
UE	29.69 (±9.99)	32.04 (±7.81)	0.027
Wrist	6.19 (±3.94)	7.31 (±3.61)	0.005
Hand	9.38 (±5.16)	11.27 (±4.68)	0.004
Coordination	4.19 (±1.26)	4.84 (±1.41)	0.000
FTHUE	4.85 (±1.99)	5.69 (±1.76)	0.008
MBI	51.35 (±18.88)	64.27 (±17.76)	0.014

Patients More Engaged & Motivated Patients

gainentertainment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	7	16.3	16.3	16.3
	2.00	4	9.3	9.3	25.6
	3.00	12	27.9	27.9	53.5
	4.00	20	46.5	46.5	100.0
	Total	43	100.0	100.0	

satis

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	7	16.3	16.3	16.3
	3.00	8	18.6	18.6	34.9
	4.00	28	65.1	65.1	100.0
	Total	43	100.0	100.0	

relax

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	7	16.3	16.3	16.3
	2.00	4	9.3	9.3	25.6
	3.00	14	32.6	32.6	58.1
	4.00	18	41.9	41.9	100.0
	Total	43	100.0	100.0	

enjoyment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	10	23.3	23.3	23.3
	2.00	2	4.7	4.7	27.9
	3.00	11	25.6	25.6	53.5
	4.00	20	46.5	46.5	100.0
	Total	43	100.0	100.0	

Source: Caritas Medical Centre

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The Efficacy of Robotic Therapy on Improving Hemiplegic Upper Limbs Function by Using a Stratified Protocol of the Armeo Robotic Devices

Kowloon Hospital

Objectives:

(1)To develop a treatment protocol based on Armeo Robotic Therapy, that benefit the stroke patients at different levels of upper limb function (FTHE-HK)

(2) To test the pre and post treatment intervention effect on patients based on (1)

- 48 subjects and classified into three treatment groups.
- According to the level of Functional Test for the Hemiplegic Upper Extremity.
- Group 1 is functional level 2.
- Group 2 is functional level 3 and 4.
- Group 3 is functional level 5 and 6.
- The outcome measures includes Fugl Meyer Assessment, grip power and the data gathered from the robotic device.

Training modules for Group 1 : UL functional level 2

Minimum Motion of the level 2			
Some beginning voluntary motion of the shoulder and elbow			
Therapy Plan with autogrip on, total 45 min. program			
Game	Workspace	Level	Time
Rain Mug Vegetable Grater Window mopping Stove cleaning Popping air	1D 1D 2D (frontal plane) 2D (hori. plane) 2D (frontal plane)	4 level 4 level V easy & easy & medium V easy & easy & medium Easy	3 min @ 3 min @ 3 min @ 3 min @ 3min

Training Modules for Group 2 : UL functional level 3-4

Minimum Motion of the level	
Level 3	30-60° shoulder flexion 60-100° elbow flexion 3-5lb gross grasp
Level 4	>60° shoulder flexion, > 100° elbow flexion and some extension, 3-5lb gross grasp,1/2 – 3 lb lateral pinch

Therapy Plan with autogrip on, 45 min session			
Game	Workspace	Level	Time
Rain Mug Vegetable Grater Window Mopping Fruit shopping Egg Cracking Stove Cleaning Fish catching	1D 1D 2D (frontal) 2D (frontal) 2D (frontal) 2D (horizontal) 2D (frontal)	Hard Hard Easy & Medium & hard V. easy & easy & medium V. easy & easy & medium Easy & Medium & hard Medium	3 min 3 min 3 min @ 3 min @ 3 min @ 3 min @ 3 min

Training Modules for Group 3 : UL functional level 5-6

Minimum Motion of the level	
Level 5	Mass flexion and extension combination pattern of shoulder and elbow >5lb of grasp >3lb of lateral pinch some release
Level 6	Isolated control in the shoulder, elbow & wrist against gravity >5lb of grasp >3lb of lateral pinch

Therapy Plan with autogrip off, 45 min			
Game	Workspace	Level	Time
Rain mug Vegetable Grater Flower watering Popping air bubble Stove cleaning Reveal Panorama Chase Balloon Shelf Goal Keeper Moonhuhu	1D 1D 2D (frontal) 2D (frontal) 2D (horizontal) 3D (functional ex.) 3D (functional ex.) 3D (functional ex.) 3D (game) 2D (game)	Hard Hard Easy Easy Medium & hard Medium & hard Medium& hard Medium& hard Medium& hard Medium	3 min 3 min 3 min 3 min 3 min @ 3 min @ 3 min @ 3 min @ 3 min @ 1.min @

Paired T-Test
(Post-Tx /3 wk after Tx with Pre-Tx)

	FMA UL	FMA Hand	S Flexion	S Abd	E Flexion	Supination	Pronation	Grip
Gp1	.000/.000	.001/.001	.000/.000	.001/.002	.011/.012	.004/.004	.067/.001	.010/.004
Gp2	.000/.003	.000/.001	.000/.033	.000/.021	.056/.209	.000/.019	.000/.003	.000/.003
Gp3	.025/.007	.002/.001	.109/.025	.247/.476	.678/.672	.001/.000	.082/.033	.319/.316

All have significant difference in FMA by T-test

Change of AROM not sig. in proximal joints for gp3, as indicated in RED

The gain of AROM is more sig. in gp1 and gp 2

中風病人上肢康復治療新法

機械臂+打機練肌肉

新科技令患者更投入

患者右手回復七成

訓練一月 中風手臂靈活

中風手指再執筆寫書法

恢復中風病人上肢功能

機械臂治療見效

引入機械臂亞洲第一部

九龍醫院非傳統療法

Practice of task-oriented & functionally relevant actions

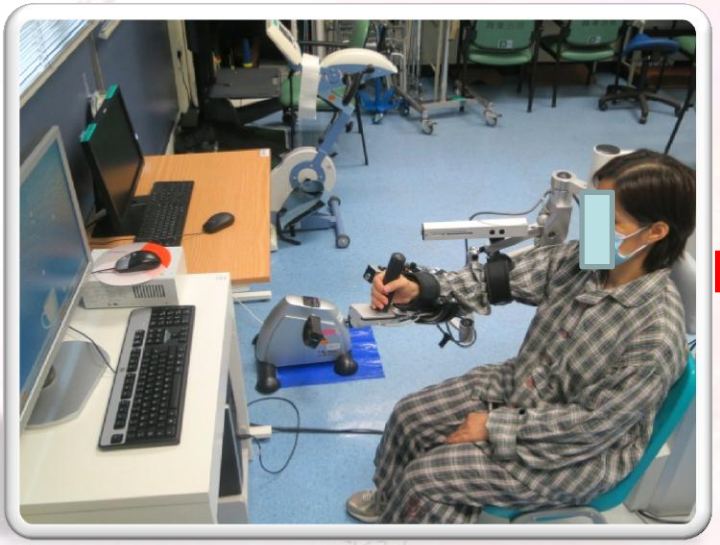
Feeding

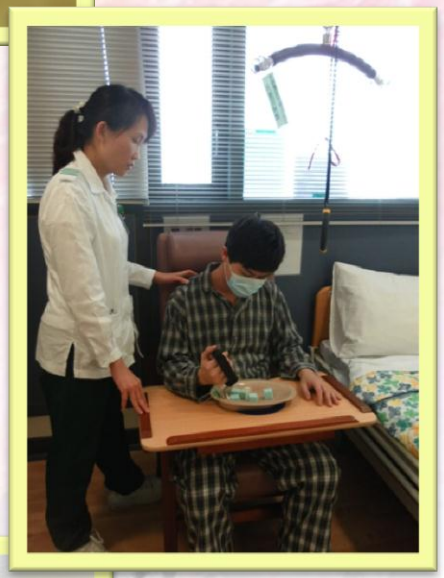
ATM, handling $

Grab for Support in Transfer / Ambulation

Dressing, Buttoning …

IADL – Cooking, Opening door





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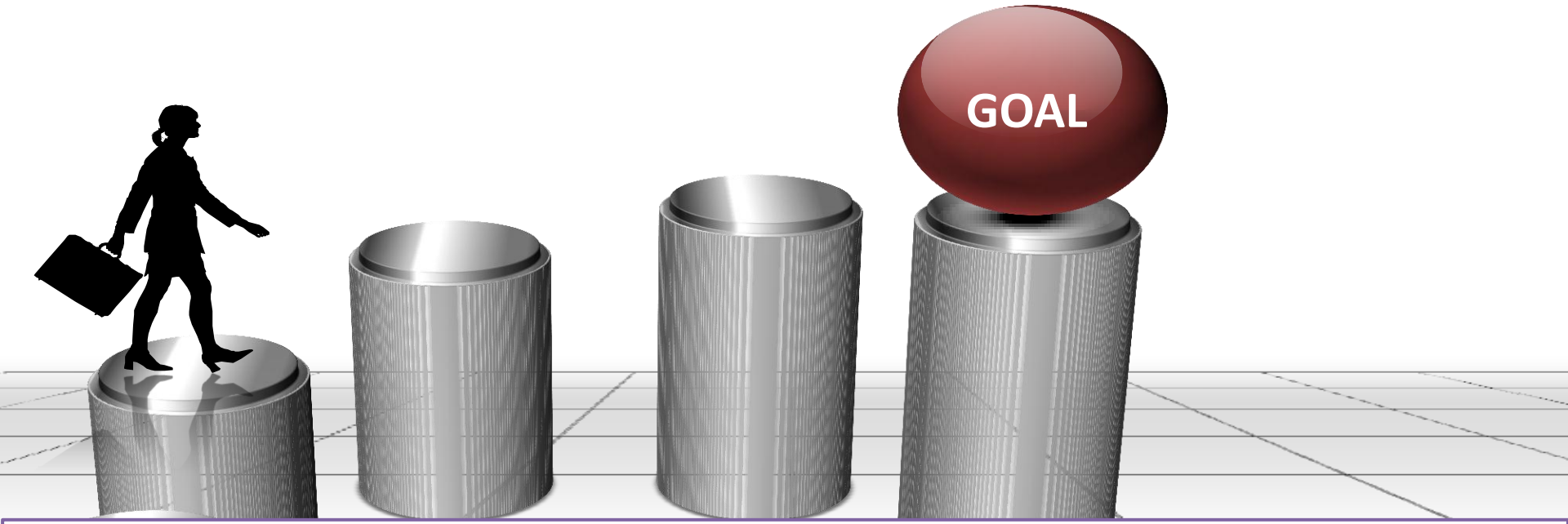
Robotic Therapy – Added Value

- More ‘reproducible’ motor experience
- Less demanding for therapists’ adjustment/hands on intervention
- More interesting and motivating to patients
  Increase collaboration, motivation, and effort by the patients
- Increased variety of therapeutic modalities for patients.

Future Development



- Conventional → Robotic therapy?
- Robotic + Conventional therapy
- Specific patient group: Minimal Proximal Control
- Robotic therapy for distal control: new equipment (e.g. Hand of Hope)
- Carry over effect: motor gain → functional gain

Acknowledgement

- Tuen Mun Hospital
  Occupational Therapy Department
- Kowloon Hospital
  Occupational Therapy Department
- Caritas Medical Centre
  Occupational Therapy Department

Thank You

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