Robotic Therapy

Commission Training 2011/2012 in Advance Stroke Rehabilitation
7 Jan 2012
Helen LUK, Senior Physiotherapist
Clare CHAO, Physiotherapist I
Queen Elizabeth Hospital
Content

• Theory
  – Development of Robotic Therapy
  – Theory behind of the Robotic Therapy
  – Clinical Practice in Robotic Therapy

• Demonstration
  – Lokomat System
  – Armeo System
Development of Robotic Therapy

1. Increase Service Demand
   - More Ideal Physiological Movement Pattern and Continuous Monitoring

2. Highly Impaired Individuals
   - Required multiple therapists
   - Excessive physical demands on the therapists

3. Robotic Therapy
   - Measure and track the patient’s impairments over the course
   - Automate and assist interventions

4. Labour Intensive
   - Occupational Safety and Health Consideration

5. Increase need of rehabilitation service due to aging issue
Robotic Therapy in Stroke Rehabilitation

Upper Limb Function
Lower Limb Function
Prevalence of Physical Impairments

• Only 5 to 20% reach complete functional recovery on arm function (Nakayama 1994)

• Three months after stroke, 20% of patients remain wheelchair bound and approximately 70% walk at reduced velocity and capacity (Jorgensen 1995).

• Restoration of walking ability and gait rehabilitation is therefore highly relevant for patients who are unable to walk independently after stroke (Bohannon 1991)
Upper Limb Rehabilitation

Occupational Therapist

Physiotherapy
Upper Limb Robotic

MIT-Manus (In-Motion Robot)

Arm-Guide (Assisted Rehabilitation and Measurement Guide)

MIME (Mirror Image Motion Enabler)
MIT-Manus (In-motion)

- Developed at the Massachusetts Institute of Technology MIT in early 1990s
- Allow subjects to execute reaching movements in the horizontal plane
- The device can assist or resist the subject and monitor arm position and applied forces
- Manus interacts with subject is intended to be safe, stable and compliant throughout the training paradigm
MIT-Manus (In-motion)

• Double blinded study, RCT
• 96 acute stroke subjects
• Robotic group demonstrated significant greater gain in elbow and shoulder motor function
• No significant differences were between group in Fugl-Meyer score and FIM or MSS
• Similar results revealed in chronic subjects
In this setting, the ARM-GUIDE was pointed toward the selected target; after receiving a visual cue, the subject was instructed to try and reach toward the target as fast as possible.

If the hand velocity of the subject followed a predetermined hand trajectory, then the motor on the ARM-GUIDE provided no assistance.

However, if the subject reached either too fast or too slow, the device resisted or assisted the movement, respectively.
ARM-Guide

• RCT
• Both groups improved in Chedoke-McMaster and Rancho Los Amigos Tests
• Improved in Active range of reach and reaching speed and demonstrated decreased passive resistance to movement
• No significant between groups
MIME (Mirror Image Motion Enabler)

Passive-relaxed as the robot moved the limb toward a target

Active-assisted-triggered initiation of the movement with volitional force toward the target and “worked with the robot”

Active-constrained-provided a viscous resistance in the direction of the desired movement and spring-like restoring forces perpendicular to the movement direction as the subject attempted to reach toward the target with maximal effort

Bilateral-attempted bilateral mirror image movements while the robot assisted the affected limb by continuously moving the affected forearm to the contralateral forearm’s mirror image position and orientation
MIME

• Bimanual exercise
• The device simultaneously moves (mirrors) the affected limb passively, steered by the non-paretic limb
Study by Lum 2006

• RCT
• Treatment groups
  – 1. The robot-unilateral group (n = 9) performed exercises that progressed from the easiest exercise modes (passive) to the most challenging (active-constrained). No bilateral exercise was performed.
  – 2. The robot-bilateral group (n = 5) practiced the same 12 reaching movements, but only in bilateral mode. Rhythmic circular movements were also performed.
  – 3. The robot-combined group (n = 10) spent approximately half the treatment time in the unilateral mode and the other half in the bilateral mode. This group received essentially the same robotic treatment as the earlier chronic subjects.
  – 4. The control group (n = 6) received an equivalent intensity and duration of conventional therapy targeting proximal upper-limb function based on NDT. The procedures used in the control group were identical to those used in the chronic study. An occupational therapist blinded to group assignments
## Results

<table>
<thead>
<tr>
<th>Clinical Scale*</th>
<th>Robot-Combined</th>
<th>Robot-Unilateral</th>
<th>Robot-Bilateral</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Posttreatment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Subjects</td>
<td>10</td>
<td>9</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Proximal Ashworth (15)</td>
<td>-0.7 ± 0.7</td>
<td>0.9 ± 0.6</td>
<td>-0.4 ± 0.4</td>
<td>-1.3 ± 0.7</td>
</tr>
<tr>
<td>Distal Ashworth (30)</td>
<td>-0.4 ± 0.2</td>
<td>0.0 ± 0.8</td>
<td>-1.0 ± 0.6</td>
<td>0.7 ± 0.6</td>
</tr>
<tr>
<td><strong>Proximal FM (42)</strong></td>
<td><strong>5.3 ± 1.2†</strong></td>
<td>4.3 ± 1.4</td>
<td>2.4 ± 1.5</td>
<td>2.5 ± 0.6</td>
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<tr>
<td>Distal FM (24)</td>
<td>2.3 ± 0.4</td>
<td>3.6 ± 1.3</td>
<td>1.4 ± 0.7</td>
<td>3.3 ± 1.9</td>
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<tr>
<td><strong>MSS synergy (20)</strong></td>
<td><strong>4.0 ± 1.0†</strong></td>
<td>0.8 ± 0.9</td>
<td>2.0 ± 2.6</td>
<td>0.7 ± 1.1</td>
</tr>
<tr>
<td>Motor Power (70)</td>
<td>8.2 ± 1.0</td>
<td>10.1 ± 2.4</td>
<td>3.2 ± 1.0</td>
<td>9.3 ± 1.3</td>
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<tr>
<td>FIM (63)</td>
<td>3.1 ± 1.7</td>
<td>3.7 ± 1.0</td>
<td>0.8 ± 0.6</td>
<td>3.2 ± 1.4</td>
</tr>
<tr>
<td><strong>6-Month Follow-Up</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Subjects</td>
<td>6</td>
<td>7</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Proximal Ashworth (15)</td>
<td>-0.2 ± 0.5</td>
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<td>-2.0 ± 0.8</td>
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<td>-1.2 ± 0.8</td>
<td>0.8 ± 0.7</td>
</tr>
<tr>
<td>Proximal FM (42)</td>
<td>6.0 ± 1.4</td>
<td>7.3 ± 2.0</td>
<td>4.4 ± 1.3</td>
<td>7.6 ± 1.2</td>
</tr>
<tr>
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</tr>
<tr>
<td>Motor Power (70)</td>
<td>17.2 ± 2.1</td>
<td>17.9 ± 3.4</td>
<td>11.2 ± 3.2</td>
<td>14.2 ± 2.3</td>
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<tr>
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<td>5.0 ± 1.4</td>
<td>5.2 ± 1.7</td>
</tr>
</tbody>
</table>

Note: Negative score changes on Ashworth scale indicate reduced tone. Entries are mean ± standard error of the mean.

*Numbers in parentheses indicate highest possible score.

†Significant difference from control, \( p < 0.05 \).

‡Significant difference from unilateral group, \( p < 0.05 \).

• Robot-combined training group had significant greater gains than control
• Gains in robot and control groups were equivalent at the 6-month FU
• No significant differences found between the robot-combined and robot-unilateral
Robotic Therapy

• Mode of training
  – Active/Active assisted
  – Passive
  – Resisted

• By varying force, decreasing assistance, increasing resistance and expanding movement amplitude

• Bimanual exercise
  – MIME
  – Bi-Manu-Track
## Electromechanical and robot-assisted arm training for improving arm function and activities of daily living after stroke (Review)

<table>
<thead>
<tr>
<th>Journal</th>
<th>Subject</th>
<th>Intervention</th>
<th>Outcome</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amirabdollahian 2007</td>
<td>31, first stroke</td>
<td>ABC and ACB Baseline, robot, sling suspension</td>
<td>Fugl-Meyer Scale</td>
<td></td>
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<tr>
<td>Daly 2005</td>
<td>13, &gt;12 month after stroke</td>
<td>Control: FNMES for 12 weeks (5hr/5days) Exp: 1.5 hours Imoition robot training</td>
<td>FM Arm motor ability test Motor control measures</td>
<td></td>
</tr>
<tr>
<td>Fasoli 2003</td>
<td>12, stroke within past 1 to 5 years</td>
<td>1. Sensorimotor robotic therapy 2. Progressive-resistive exercise robotic therapy</td>
<td>Modified Ashworth Scale FM Medical Research Council score of motor power Motor Status Scale</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Subject</td>
<td>Intervention</td>
<td>Outcome</td>
<td>Remarks</td>
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<td>------------------------------------------------------------------------------</td>
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<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Fazekas 2007</td>
<td>30,</td>
<td>Control: 30 minutes Bobath for 20 days Exp: same therapy with 30 robot therapy</td>
<td>• modified Ashworth score of shoulder adductors and elbow flexors;</td>
<td>• range of motion of shoulder and elbow;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Fugl-Meyer Scale, shoulder and elbow subsection (0 to 36);</td>
<td>• Fugl-Meyer Scale, shoulder and elbow subsection (0 to 36);</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Rivermead Motor Assessment, arm score;</td>
<td>• Rivermead Motor Assessment, arm score;</td>
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<td></td>
<td></td>
<td></td>
<td>• Functional Independence Measure, self-care subsection</td>
<td>• Functional Independence Measure, self-care subsection</td>
</tr>
<tr>
<td>Hesse 2005</td>
<td>44, 4to 8 weeks after</td>
<td>Control: standard inpatient rehab Exp: Bi-manu-track robotic</td>
<td>FM MRC (motor) Modified Ashworth Scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td>stroke</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Subject</td>
<td>Intervention</td>
<td>Outcome</td>
<td>Remarks</td>
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<td>--------------</td>
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<td>------------------------------------------------------------------------------</td>
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<td>--------------------------</td>
</tr>
<tr>
<td>Lum 2002</td>
<td>30, &gt; 6 months post stroke</td>
<td>Control: 55 PT Exp: MIME robot( 24 session for 55 minute)</td>
<td>FM</td>
<td>BI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FIM</td>
<td>Strength Reach</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>FIM</td>
<td></td>
</tr>
<tr>
<td>Lum 2006</td>
<td>30 , 1to 5 months post stroke</td>
<td>Robot-unilateralMIME Robot-bilateral Half in unilateral and half in bilateral Control: NDT</td>
<td>FM</td>
<td>MSS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FIM</td>
<td>MAS</td>
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<tr>
<td>Masiero 2007</td>
<td>35</td>
<td>NeRebpt twice a day for 5 Control: to unimpaired arm</td>
<td>FM</td>
<td>FIM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MAS</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Trunk control test</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Motor strength</td>
</tr>
<tr>
<td>Volpe 2000</td>
<td>56</td>
<td>Mit-Manus for 1 hour/day for 25 sessions Control: to unimpaired</td>
<td>FM</td>
<td>Motor power scale</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MSSFIM</td>
</tr>
</tbody>
</table>
Electromechanical and Robot-assisted arm training versus all other intervention

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>Robotic therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities of daily living</td>
<td>×</td>
</tr>
<tr>
<td>Six studies of 216 subjects</td>
<td></td>
</tr>
<tr>
<td>Subgroup analysis between acute and subacute phase</td>
<td>√</td>
</tr>
<tr>
<td>Impaired arm function: motor function</td>
<td>√</td>
</tr>
<tr>
<td>Seven studies of 229 subjects</td>
<td></td>
</tr>
<tr>
<td>Motor strength</td>
<td>√</td>
</tr>
<tr>
<td>Five studies of 186 subjects</td>
<td></td>
</tr>
<tr>
<td>Drop outs rate</td>
<td>Not significant</td>
</tr>
<tr>
<td>Safety issue</td>
<td>No report</td>
</tr>
</tbody>
</table>
Quantifying Impairment Using Robotic Device

MIT-Manus

- Track changes in smoothness during arm movements
- The ability to execute continuous arm movements
- By testing through point-to-point linear movements or draw circle
- The result is through analyze the numbers of corrective movements made and shape of the velocity profile and other metrics of smoothness

ARM-Guide

- Evaluate passive tissue properties
- measured forces against the rail perpendicular to the desired movement
- is comparable to the forces generate by synergy patterns
- Determine that the deficits are attributable to spasticity and weakness
Overall Comments

• Studies found that proximal arm function improved rather than distal arm function
• Devices used emphasize proximal tasks
• No different changes detected in wrist and hand function
Characteristic of Robot for Upper Limb Training
Weakness

- Only 5% of persons who receive intensive therapy for severe upper limb weakness poststroke regain functional use of their paretic upper limb (JRRD 2006)
- Constraint-induced movement therapy CIMT appears to be a promising therapy, that required certain residual motor function
- Robotic provide **early** training platform for severe motor deficit
Progressive Resistance

• For subjects able to reach the target independently, the robot provided guidance, gently opposing inappropriate (lateral) motions not directed toward the target

• Progressive resistive exercise offered resistance to the desired movement
Continuous Passive Motion

• Altered the inhibitory state of the CNS and subsequently affected behavioral responses (JRRD 2006)
• Alter motor outcome, spasticity, shoulder joint integrity, pain and disability
Activity Dependent Plasticity

- Active participation
- Recovery of undamaged brain from functional inactivation caused by the damage
- Activation of undamaged regions of brain in opposite hemisphere and reorganization of synaptic connections
- Specific motor recovery
Performance Based Progressive Therapy

• Continuous challenge by reinforcing nominal trajectory

• Four performance: ability to initiate movement, speed, coordination and movement extent

• Provide motivation, positive reinforcement and knowledge of results
Advantage of Robotic

• In moderately to severely impaired populations that require more “hands-on” treatment, low-cost versions of robotic therapy devices versions of robotic therapy devices can be used independently of facilitating repetitive movement training

• Robotic UL is at least as effective as an equivalent dose of hands-on therapy in subacute and chronic stroke population
Lower Limb Robotic
Lower Limb Robotic

• Body weight-supported locomotive training is used in recent 10 years
• The training for stroke demonstrated improved EMG activation pattern, more natural walking characteristics, functional improvement in walking ability
• Reductions in spasticity, increase cardiopulmonary efficiency
Drawback of manual-assisted locomotive training

• Large physical demands on therapists
• Limits the consistency and duration of training session
• More health care cost basis
Development of Robotic Therapy

Gait Trainer

Lokomat Training System
Electromechanical Gait Trainer

- Developed in Germany
- In this setting, the subject’s feet are strapped to two footplates, which in turn are connected to a linkage system that moves the foot through a trajectory quasi-similar to the gait cycle. The foot is always connected to the platforms, and the positioning and loading of the foot on the Gait Trainer is comparable to the stance and swing phases of the gait cycle, with a ratio of 60% and 40% for each phase, respectively.
- Step velocity is modulated between 0 to 1.12m/s
- Level of assistance varies from no assistance to total active
- Biofeedback during training
Electromechanical Gait Trainer

- Randomized crossover design
- 30 stroke subjects
- Treatment ABA and BAB
  - (A- 15-20 minutes on gait trainer)
  - (B-walking exercise on BWS treadmill)
- Manual facilitation of bilateral lower limbs by therapists
- No different across groups in FAC, Rivermead score
Lokomat System

- Developed since mid 1990s in Switzerland
- This system is comprised of a treadmill, a body weight–support system, and two lightweight robotic arms that attach to the subject’s legs (Figure 4).
- The Lokomat is fully programmable, including control of knee and hip kinematic trajectories, the amount of assistance the system provides to the subject, and the speed at which the subject ambulates.
- This high-level dynamic control is achieved by small direct current (DC) motors and linear ball screw assemblies at the hip and knee joints that are tightly synchronized with the timing of the treadmill. Hip and knee angles are monitored through high-precision potentiometers while dorsiflexion is provided at the ankle of the subject through two passive elastic straps.
- Unloading of the patient is achieved by connecting the shoulder straps on a harness to a counterweight system. Furthermore, force sensors mounted in series with the motors sense the amount of resistance/assistance the subject is generating while walking in the device, which can be used as biofeedback for motivational purposes.
- The Lokomat is an FDA-approved medical device.
## Different Between Gait Trainer and Lokomat System

<table>
<thead>
<tr>
<th>Gait Trainer</th>
<th>Lokomat System</th>
</tr>
</thead>
<tbody>
<tr>
<td>• No direct control of trunk, hip and knee</td>
<td>• Direct control the hip and knee joints</td>
</tr>
<tr>
<td>• Hyperextension may occur unless otherwise controlled by a therapist or trainer</td>
<td>• Trunk is supported</td>
</tr>
<tr>
<td>• Un-natural cutaneous inputs normally experienced during gait because the subject’s feet are attached to the pedals</td>
<td>• Body weight support system allow dynamical vertical displacement</td>
</tr>
<tr>
<td></td>
<td>• Able to offer physiological gait pattern</td>
</tr>
<tr>
<td></td>
<td>• Facilitate natural proprioceptive stimulation</td>
</tr>
</tbody>
</table>
We included 17 trials with a total of 837 patients in this review and found evidence that the use of electromechanical-assistive devices in combination with physiotherapy in rehabilitation settings may improve walking function after stroke.

Furthermore, adverse events, drop-outs and deaths do not appear to be more frequent in those patients who received electromechanical or robotic-assisted gait training.

This indicates that the use of electromechanical-assisted gait training devices might be safe and acceptable to most patients included in the trials which this review analysed.
Cochrane Review 2011

Electromechanical-assisted training for walking after stroke (Review)

Walking Ability

- Increase the chance to walk independently
- Statistically significant in regaining independent walking between patient treated in acute/subacute phase compared with chronic subjects

Walking Performance

- Did not significantly increase velocity
- Did not increase walking capacity of patient after stroke
How the Brain Work with Robot?
How the Robotic Work?
Recover from stroke
Plasticity of brain

Plastic changes can occur at the cortical level in a number of ways.

First, it has been repeatedly demonstrated that enriched environments and skill learning in adult animals are associated with growth of dendrites, increases in dendritic spines, and synaptogenesis.

Second, long-term potentiation and long-term depression are mechanisms of changing synaptic efficacy in hippocampus and neocortex under certain conditions. Indeed, motor skill learning in animal models is accompanied by changes in the strength of connections within primary motor cortex. Furthermore, there is evidence that these mechanisms may operate in human motor learning as well.

Third, cortical maps are maintained at least in part by -aminobutyric acid and can be altered intentionally by pharmacologic manipulations and unintentionally by lesions. The link between change in brain structure and change in behavior is firmly established.
Plasticity of brain

Stimulus from environment or by motor skill learning

- Increase growth of dendrites...
- Change in strength connection in primary cortex
Physiotherapy Technique in Rehabilitation

- Bobath Technique
- Repetition Task
- Specific Training
- Proprioceptive Neuromuscular Facilitation
- Acupuncture
- Robot-assisted System
Motor Learning

- Sensory, motor stimulus
- Brain
- Encoding
- Environmental stimulus
- Retention
- Consolidation
- Training schedule
- Intense Training (high repetition)
Learning of Upper Limb Function

- **Sequence of muscle activation**
- **Control the upper limb primarily to meet kinematic specification**
- **Compensate for movement-by-movement variation of mechanical loads**
- **Visually relevant coordinate hand motions**

**Brain**
Experience in Queen Elizabeth Hospital 2010
QEH Experience

• Robot-assisted Training launch since Jan and Oct 2011 respectively
  – Lokomat: Locomotive training system
  – Armeo: sling suspension upper limb training system

• Preparation: venue preparation
Space

<table>
<thead>
<tr>
<th>Space requirements</th>
<th>Height [cm]</th>
<th>Space [cm]</th>
<th>Room height min.: 240 cm (247cm with extension)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodway</td>
<td>280</td>
<td>295</td>
<td>550 x 350</td>
</tr>
<tr>
<td>h/p/cosmos</td>
<td>260</td>
<td>275</td>
<td>480 x 355</td>
</tr>
</tbody>
</table>

Space: 240 x 120 cm
Lokomat System

Body-weight support system

Software and biofeedback

Treadmill System synchronize with Orthotic device
Training

Two days intensive training for the system

3 months practice

Pass the quiz and practical examination

Certified User for the system
Experience Sharing

- Labor intensive
- New case:
  - 30-45 minutes fitting and set up
  - Fine tune the parameter
  - 20-30 minutes training
  - Continuous monitor the performance of patient

- Subsequent case:
  - 10-20 minutes set up
  - 30-45 minutes training
  - Stand-by supervision

- Emergency drill
Experience Sharing

- High demand from the public
- Screening for the suitability
  - More “physical disabled” patients which needed heavy assistance in gait training
  - TBI, SCI and stroke cases
  - Free from contra-indications
- Only limited session (6-7 patients per day)
- Tight schedule
  - Patient needed to be on-time, otherwise.....
Contra-indications

- Orthosis not adapted for lower limb(s) of the patient
- Body weight greater than 135kg
- Severely fixed contractures
- Bone instability (e.g. non-consolidated fractures, unstable spinal column, severe osteoporosis)
- Open skin lesions in area of lower limbs and torso
- Circulatory problems
- Cardiac contraindications
- Uncooperative / (self)-aggressive behavior (e.g. transitory psychotic syndrome)
- Severe cognitive deficits
- Patients with (long-term) infusions
- Mechanically ventilated patients
- Patients with extremely disproportionate growth of the legs and/or spinal column (e.g. bone or cartilage dysplasia)
- Severe vascular disorders of lower limbs
- Patients who are required to stay in bed due to inflammatory/ infectious disorders e.g. osteomyelitis
- Hip, knee, ankle arthrodesis
Practical Procedure

**Measurement and Fitting**
- Harness/Cupping
- Leg Length

**Transportation and Unload the patient**
- Unload
- Fitting for Orthotic Legs

**Setting and adjustment of parameter**
- Longitudinal and lateral setting
- Treadmill and Orthotic Co-efficient adjustment
  And gait pattern adjustment
Training Protocol

BWS 50%
Slow speed

BWS 30%
Increase Speed

Full Weight Bear
Decrease guidance force
Subjects

- Thirty-two patients were recruited from Oct 2010 to Dec 2011

<table>
<thead>
<tr>
<th>Condition</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVA</td>
<td>10</td>
</tr>
<tr>
<td>Spinal Cord Injury</td>
<td>7</td>
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<tr>
<td>Traumatic Brain Injury</td>
<td>6</td>
</tr>
<tr>
<td>Multiple Sclerosis</td>
<td>4</td>
</tr>
<tr>
<td>Others (cerebellar degeneration,</td>
<td>7</td>
</tr>
<tr>
<td>Parkinson’s disease, etc)</td>
<td></td>
</tr>
</tbody>
</table>
Result

Walking Ability
- Improved in MFAC

Walking Endurance
- Increase distance
- Increase time

Gait Pattern
- Improved in more symmetrical pattern
- Improved in trunk control
Case Sharing

- Dx: ICH in 2010 with operation done
- F/33
- 4 limb involved
- In-patient
- Start Lokomat training once the cognitive function improved
- Progression
  - Walk with two fair assistance
  - Improve in trunk extension
  - Improve in bilateral legs symmetrical movement pattern in walking
Case Sharing

- Dx: Traumatic Brain Injury in 2007
- F/35
- Four limb involvement
- OPD training in QEH 2010

On admission
- Walk with quadripod
- Need two to three heavy assistance
- Poor trunk extension

After a year of training
- Walk with quadripod
- Need two fair assistance
- Improve trunk control
- Increase self initiation in swing phase
- Decrease abnormal muscle tone
Armeo Training

Self-initiated, active and repetitive movement therapy

“I can’t over-emphasize how important it is that the effort in the Armeo therapy is self-initiated. In hands-on therapy, the initiation often comes from the therapist. With Armeo Therapy, it’s coming from the patient’s own brain.”

Louise Ruts LaFlôz,
Head of Therapies, Würzburger
Contra-indication

- Orthosis cannot be fitted to the relevant arm - upper arm length: 220-310 mm, forearm length from elbow to grip axis: 292-394 mm (not applicable for ArmeoBoom)
- Bone instability (non-consolidated fractures, severe osteoporosis),
- Pronounced, fixed contractures affecting the relevant extremity
- Open skin lesions in the area of the relevant upper extremity
- Paraesthesia
- Shoulder joint subluxation or pain in the shoulder joint
- Severe spasticity
- Severe spontaneous movements, e.g. ataxia, dyskinesia, myoclonic jerks
- Non-stable vital functions: Pulmonary or cardio-circulatory contraindications (instability or instrumental support for these functions)
- Need for long-term infusion therapy
- Severe postural instability
- Contraindicated sitting position
- Confused or non-cooperative patients
- Severe cognitive deficits
- Patients requiring isolation due to infections
- Severe visual problems (patient is not able to see displayed elements on the computer screen)
Training Program

- Functional joint movements
- Grip control training
- Eye-hand Coordination training
- 3-Dimension spatial coordination training
# Robotic Therapy in QEH

<table>
<thead>
<tr>
<th>Patient Perspective</th>
<th>Therapist Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Enjoy</td>
<td>• Decrease physical demand in gait training</td>
</tr>
<tr>
<td>• Feel interesting</td>
<td>• Provide early functional training to more disabled patient clientele</td>
</tr>
<tr>
<td>• Willing to do</td>
<td>• Only limited number of patients can be served</td>
</tr>
<tr>
<td>• Feel useful</td>
<td></td>
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</tbody>
</table>
Bring Home Message

Empowered by advance technology

Interventions

Problem Identification

Therapist
Thank You