Scientific Evidence for New Technologies
Drivers for New Technologies

Societal drivers
- Ageing of population
- Cost of health care
- Burden in daily life

Technological drivers
- Available technology
- Fast growing
- Home use

Clinical drivers
- Unused recovery potential
- Evidence-based knowledge
Usage of New Technologies

motor learning  brain injury  therapy  assessments  daily activities

New technologies for enhanced and effective therapy ... ... and assessing recovery progress

Scientific Evidence for New Technologies
Potential influence of New Technologies

Advanced Rehabilitation Technology

- Movement & sensory input
- Muscle strength
- Improved performance
- Neuroplasticity
- Motor Learning

Varied, goal oriented repetitions at limit of performance & Feedback from successful performance

Principles of New Technologies
## Contents

1. Robot-assisted Therapy
2. Non-actuator Devices
3. Functional Electrical Stimulation (FES)
4. Virtual Reality
5. Brain Stimulation

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**Scientific Evidence for New Technologies**
1

ROBOT-ASSISTED THERAPY
Robot-Assisted Therapy: Lower Extremity

Walking improvements
Positive effect on gait speed, walking distance and basic activities of daily living

Rehabilitation Time
on-ambulatory patients in early rehabilitation profit most from robot-assisted therapy

Dependency
Every fifth dependency in walking could be avoided using robotic-assisted training

Effectiveness
Robotic therapy in combination with conventional therapy is more effective than physiotherapy alone

(Mehrholz et al. 2013)
Robot-Assisted Therapy: Upper Extremity

**Proximal Improvements**

**Significant effect** on motor function of shoulder and elbow, muscle strength and pain reduction

(Veerbeek et al. 2014)

**Transfer to Daily Life**

Improves generic activities of daily living and arm function

(Mehrholz et al. 2012)

**Distal Improvements**

Elbow and wrist training enhance motor function and muscle strength

(Veerbeek et al. 2014)

**Risk**

No increased risk of injury with intensive training

(Mehrholz et al. 2012)

**Recovery Time**

Robotic therapy improves motor function in a shorter time than physiotherapy

(Sale et al. 2014)
Cost effectiveness

- Conventional gait training therapy costs are low
- Robot-assisted therapy fixed costs (device purchase price) are high
- In the long term robot-assisted therapy is cost effective

(Morrison 2011, Wagner et al. 2011)
Cost effectiveness II

- Costs for 5 weeks of robot-assisted training with a moderate-to-low cost device can be recovery by a dehospitalization of 1.2 days earlier. Any further reduction would result in money savings (Stefano et al. 2014).

> "Robotic technology can be a valuable and economically sustainable aid in the management of poststroke patient rehabilitation.,” Stefano et al. 2014

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2

NON-ACTUATOR DEVICES
Clinical Evidence of Non-Actuator Devices

Effectiveness

- **Matches gains of conventional therapy**
  
  (Prange et al. 2014)

Range of Motion

- **Increases range of motion for hand and arm movements**
  
  (Kloosterman et al. 2010, Krabben et al. 2012)

Functionality

- **Arm weight support improves and movements important for functional ability**
  
  (Bartolo et al. 2014)

Undesired Synergies

- Possibly **reduces abnormal coupling** between shoulder and elbow
  
  (Krabben et al. 2012)
3

FUNCTIONAL ELECTRICAL STIMULATION (FES)
Clinical Evidence of FES

Wrist and Hand

**Positive effect on muscle strength and motor function**

(Arantes et al. 2007)

**Pain**

Significant reduction of pain

(Wilson et al. 2014)

**Functionality**

Improves upper extremity function and motor processing

(Ring and Weingarden 2007)

**Spasticity**

Decreased spasticity

(Daly and Ruff 2007, Hara 2008)

**Walking Speed**

Surface-applied and implanted FES increases walking speed

(Kottink 2007, Veerbeek et al. 2014)
Clinical Evidence of Virtual Reality

Cognitive aspects

- **Supports cognitive rehabilitation**
  
  (Rose et al. 1998)

Motivation

- **Increases self confidence and motivation**
  
  (Riva 1998)

Environment

- **VR environments stimulates neuroplastic change and enhances learning effects**
  
  (Rose et al. 1998)

Upper Extremity

- **Improves upper extremity function and motor processing**
  
  (Kuttuva et al. 2006)

Lower Extremity

- **Improves walking speed and muscle strength, therefore improving overall quality of life**
  
  (Sviestrup 2004)
5

BRAIN STIMULATION
Clinical Evidence of Brain Stimulation

Pain

Relieves 20-58% of chronic pain

(Fregni et al. 2006)

Severely impaired

Improvements even for patients with severe motor deficits

(Hummel et al. 2006, Boggio et al. 2006)

Optimal Effect

Best gains if paired with relevant behavioral experiences

(Gladstone and Black 2000)

Motor Function

Improves motor function which can last for several weeks

(Fregni et al. 2006)

Scientific Evidence of New Technologies
International Industry Society in Advanced Rehabilitation Technology (IISART)

General Information
info@iisartonline.org
www.iisartonline.org
Literature

[22] Gladstone and Black 2000, Enhancing recovery after stroke with noradrenergic pharmacotherapy: a new frontier?
Slide 2 – Audience
Background:  http://www.iisd.ca/ymb/climate/wcc3/pix/1sept/DSC_6266%20full%20room.jpg

Slide 3 – Reasons for New Technologies
Left:  http://www.unece.org(typo3temp/pics/8346dcaa95.jpg
Middle (upper):  http://emergingtech.tbr.edu/sites/default/files/styles/flexslider_full/public/NewTech_0.jpg?itok=WghHlgJO
Middle (lower):  http://timpexelectronics.com/wp-content/uploads/2014/03/Electronics-0000166421891-1100x732.jpg
Right:  http://www.nature.com/sc/journal/v41/n12/fig_tab/3101518f1.html

Slide 4 – Usage of New Technologies
1st image (motor learning):  http://www.vi-hotels.com/typo3temp/pics/s_1ad5acb5b7.jpg
3rd image (therapy):  Hocoma

Slide 5 – Usage of New Technologies II
Images:  Presentation slides

Scientific Evidence for New Technologies