



UNIONE EUROPEA
Fondo europeo di sviluppo regionale



Regione
Lombardia



POR FESR 2014-2020 / INNOVAZIONE E COMPETITIVITÀ

Action1 POR FESR 2014-2020

Public Presentation of the pre-commercial procurement procedures
related to the development of new technological solutions
for the realization of a

**Robotic exoskeleton for motor rehabilitation in
neurological patients with upper limb motor deficit**

Tender code: ARCA_132

Peppino Tropea, PhD, Casa Cura Policlinico
Dott. Massimo Caprino, Casa Cura Policlinico

Milano, 11 Luglio 2018

Problem Description and Innovative Need

Problem:

Cerebrovascular diseases are the most frequent cause of adult-onset disability among people in the Western world

WHO 2008, Lozano, Naghavi et al. 2013, Murray, Vos et al. 2013, Murray, Barber et al. 2015

Cerebrovascular diseases consequences affected upper limb
in 77% of survivors

73-88% acute patients

55-75% chronic patients



Lawrence, Coshall et al. 2001, Franceschini et al. 2009

Problem Description and Innovative Need



**Standard
Rehabilitation**
Traditional (and actual)
practice

- PT personalizes the rehabilitation therapy
- Human-Human Interaction
- Soft intrusiveness



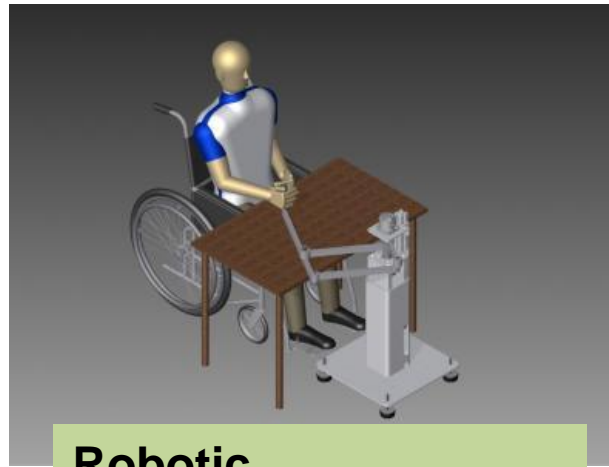
Problem Description and Innovative Need



Standard Rehabilitation

Traditional (and actual) practice

- PT personalizes the rehabilitation therapy
- Human-Human Interaction
- Soft intrusiveness



Robotic Rehabilitation

Innovative (and actual) practice

- Task oriented
- Repeatable
- Able to measure activities

Problem Description and Innovative Need



Standard Rehabilitation

Traditional (and actual) practice

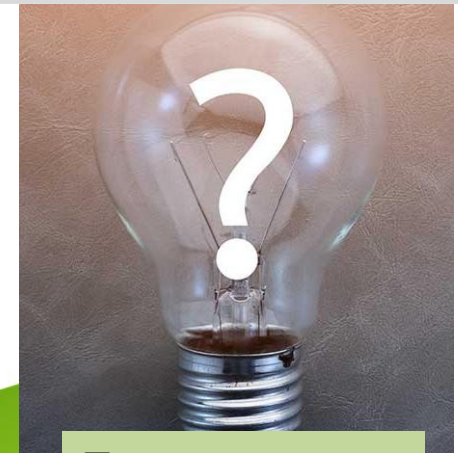
- PT personalizes the rehabilitation therapy
- Human-Human Interaction
- Soft intrusiveness



Robotic Rehabilitation


Innovative (and actual) practice

- Task oriented
- Repeatable
- Able to measure activities



Future Rehabilitation

Effects of Robot-Assisted Therapy for the Upper Limb After Stroke: A Systematic Review and Meta-analysis

Neurorehabilitation and
Neural Repair
1–15
© The Author(s) 2016
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1545968316666957
nnr.sagepub.com


Janne M. Veerbeek, PhD^{1,2,3}, Anneli C. Langbroek-Amersfoort, MSc⁴,
Erwin E. H. van Wegen, PhD^{1,2,3}, Carel G. M. Meskers, PhD, MD^{1,2,3,5},
and Gert Kwakkel, PhD^{1,2,3,5,6}

Background:


Robot technology for post-stroke rehabilitation is developing rapidly. A number of new randomized controlled trials (RCTs) have investigated the effects of robot-assisted therapy for the paretic upper limb (RT-UL)

Methods:

To systematically review the effects of post-stroke RT-UL
Meta-analyses of 38 RCTs trials (N = 1206) showed significant but small improvements in motor control (~2 points FMA arm) and muscle strength of the paretic arm and a negative effect on muscle tone

Review

Effects of Robot-Assisted Therapy for the Upper Limb After Stroke: A Systematic Review and Meta-analysis

Neurorehabilitation and
Neural Repair
1–15
© The Author(s) 2016
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1545968316666957
nnr.sagepub.com


Janne M. Veerbeek, PhD^{1,2,3}, Anneli C. Langbroek-Amersfoort, MSc⁴,
Erwin E. H. van Wegen, PhD^{1,2,3}, Carel G. M. Meskers, PhD, MD^{1,2,3,5},
and Gert Kwakkel, PhD^{1,2,3,5,6}

Results:


No effects were found for upper limb capacity and basic ADL

Shoulder/elbow robotics showed small but significant effects on motor control and muscle strength, while elbow/wrist robotics had small but significant effects on motor control

Conclusions:

Effects on motor control are small and specific to the joints targeted by RT-UL, whereas no generalization is found to improvements in upper limb capacity

Effects of Robot-Assisted Therapy for the Upper Limb After Stroke: A Systematic Review and Meta-analysis

Neurorehabilitation and Neural Repair
1–15
© The Author(s) 2016
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1545968316666957
nnr.sagepub.com


Ja
E
an

These limited findings could mainly be related to

- poor understanding of robot-induced motor learning
- inadequate designing of RT-UL trials
- inappropriate patients' selection
- inadequate timing of treatment
- very poor personalization of rehabilitation treatment


Results:
No effect
Shoulder
and mu
effects on

motor control
significant

Conclusions:

Effects on motor control are small and specific to the joints targeted by RT-UL, whereas no generalization is found to improvements in upper limb capacity

Effects of Robot-Assisted Therapy for the Upper Limb After Stroke: A Systematic Review and Meta-analysis

Neurorehabilitation and Neural Repair
1–15
© The Author(s) 2016
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1545968316666957
nnr.sagepub.com


Ja
E
ar

These limited findings could mainly be related to

- poor understanding of robot-induced motor learning
- inadequate designing of RT-UL trials
- inappropriate patients' selection
- inadequate timing of treatment
- very poor personalization of rehabilitation treatment

Results:

No effect

Shoulder

and mu

effects o

motor control
significant

Conclusions:

Effects on motor control are small and specific to the joints targeted by RT-UL, whereas no generalization is found to improvements in upper limb capacity

Problem Description and Innovative Need

Problem:

Cerebrovascular diseases are the most frequent cause of adult-onset disability among people in the Western world

WHO 2008, Lozano, Naghavi et al. 2013, Murray, Vos et al. 2013, Murray, Barber et al. 2015

Cerebrovascular diseases consequences affected upper limb
in 77% of survivors

73-88% acute patients

55-75% chronic patients



Lawrence, Coshall et al. 2001, Franceschini et al. 2009

Problem Description and Innovative Need

Problem:

Cerebrovascular diseases are the most frequent cause of adult-onset disability among people in the Western world

WHO 2008, Lozano, Naghavi et al. 2013, Murray, Vos et al. 2013, Murray, Barber et al. 2015

Cerebrovascular diseases consequences affected upper limb
in 77% of survivors

73-88% acute patients

55-75% chronic patients



Lawrence, Coshall et al. 2001, Franceschini et al. 2009

Innovative need:

Robotic exoskeleton for motor rehabilitation in neurological patients with upper limb motor deficit

Functional and Performance Requirements of the Innovative Solution

- It must be a mechatronic **exoskeleton** for motor therapy to neurological patients with **upper-limb motor impairment**
- The device must allow the
 - *Therapist to plan*
 - *Patient to carry out*a **wide range of movements**, customized to the individual's specific kinematic performance



Functional and Performance Requirements of the Innovative Solution

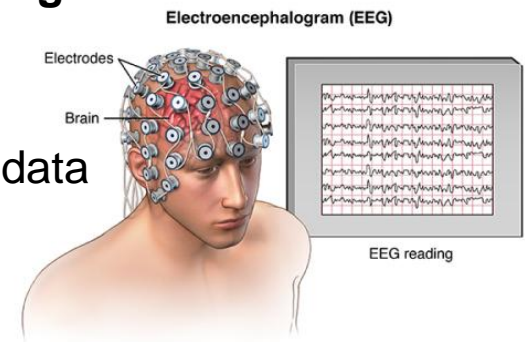
- The exoskeleton must **physically interact** with patients exercising forces or executing movements in accordance with rehabilitation exercises defined by clinicians
 - *Usability*
 - *Acceptability*
 - *Wearability*
- In order to provide quantitative evaluation of
 - *Specific physio-pathological mechanisms*
 - *Spontaneous recovery*
 - *Functional abilities*



the exoskeleton must be able to **measure** patients' clinical values during active and passive movements
(angular excursions, range of motion, stiffness, smoothness, ...)

Functional and Performance Requirements of the Innovative Solution

- The device must be integrated with technologies for measure and analysis of **electro physio-pathological signals**
 - *EEG data*
 - *EMG data*
- **in order to adapt the therapy** based on these data (EEG and/or EMG), as well as cinematic, biomechanical and clinical parameters

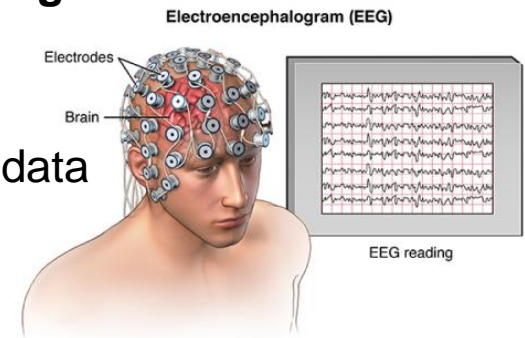


Functional and Performance Requirements of the Innovative Solution

- The device must be integrated with technologies for measure and analysis of **electro physio-pathological signals**

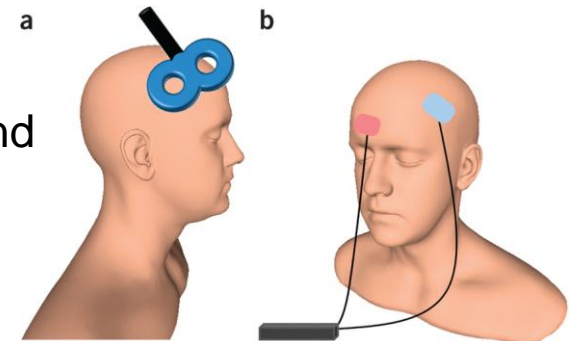
- *EEG data*
 - *EMG data*

→ **in order to adapt the therapy** based on these data (EEG and/or EMG), as well as cinematic, biomechanical and clinical parameters



- The device **should** be integrated with technologies and treatments for neuromodulation:

- *Transcranial current stimulation (tDCS)*
 - *Transcranial magnetic stimulation (TMS)*



Optional Requirements of the Innovative Solution

- The device **can** allow through an effective assessment of the patient's functional motor deficit ***a customized therapeutic intervention*** for a **better comprehension** of the learning/recovery mechanisms of the central and peripheral nervous system

- Rehabilitation protocols **could** be based on
 - ***Virtual reality***
 - *Augmented reality*



The Innovative Solution

The mechatronic exoskeleton must be:

➤ **Specific**

- for upper-limb motor rehabilitation
- for motor therapy to neurological patients

➤ **Able to**

- exert forces or impose movements (as-needed)
- measure forces and torques exerted by the patient
- measure biomechanics variables

➤ **Integrated**

- with technologies for the electrophysiological measurements
- with TMS e tdCS

➤ **Autonomously adaptable based on**

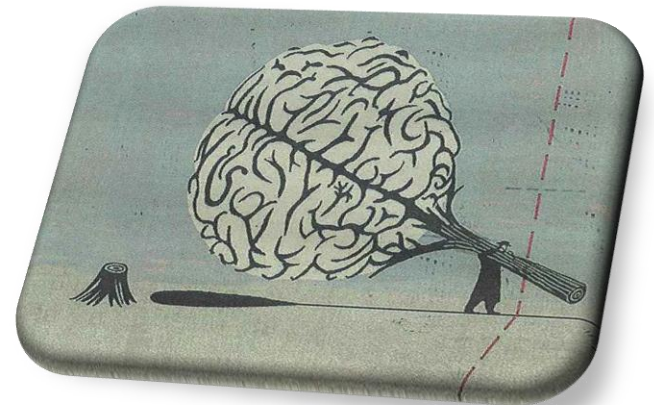
- patient's cinematic and biomechanical
- patient's spontaneous recovery
- patient's electro physio-pathological signals

Technological Need Promoter – Casa di Cura del Policlinico (CCP)



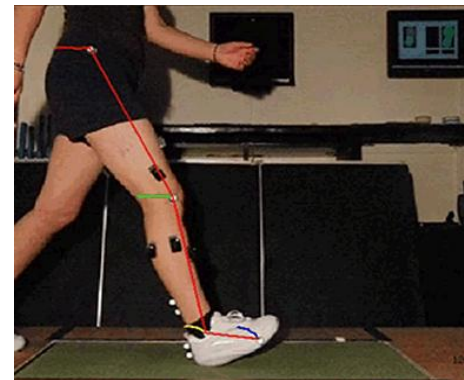
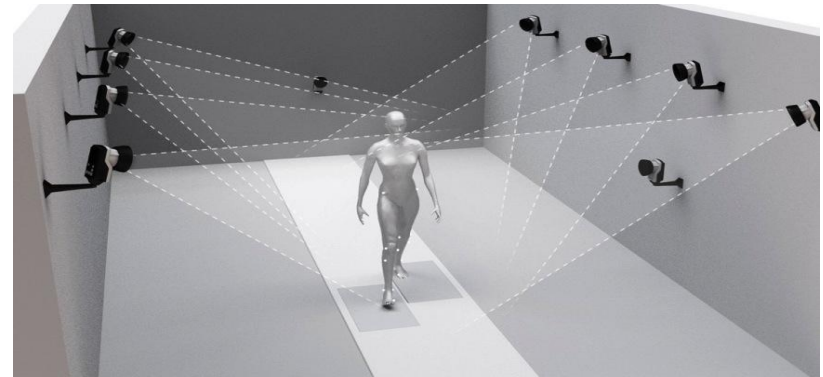
Technological Need Promoter – Casa di Cura del Policlinico (CCP)

- Intensive Neurological Rehabilitation dedicated to patients with High Complexity clinical assistance needs (Ordinary Recovery and Day Hospital)
- CCP is a fully integrated multi-specialty Clinical Centre (148 beds), accredited by the Italian National Health System, and economically supported by Regione Lombardia.
- It provides both inpatient and outpatient services, mainly directed to neurological patients.
- Hospital Units of the Departments provide for Rehabilitation in
 - Neurology
 - Cardiology
 - Pulmonology
 - Orthopedics



Technological Need Promoter – Casa di Cura del Policlinico (CCP)

- The prototype will be tested at the premises of the **MOTION LAB** belonging to the Casa di Cura del Policlinico
- The lab is dedicated to the collection, analysis and interpretation of human movement data on individuals with neurological pathologies
- Equipment:
 - 3D kinematic test (Vicon)
 - 2 Force platforms (AMTI)
 - Energy cost analysis (Vyntus CPX)
 - 32chs EMG (OTB)
 - IMU sensors (mHealth)
 - 64chs EEG



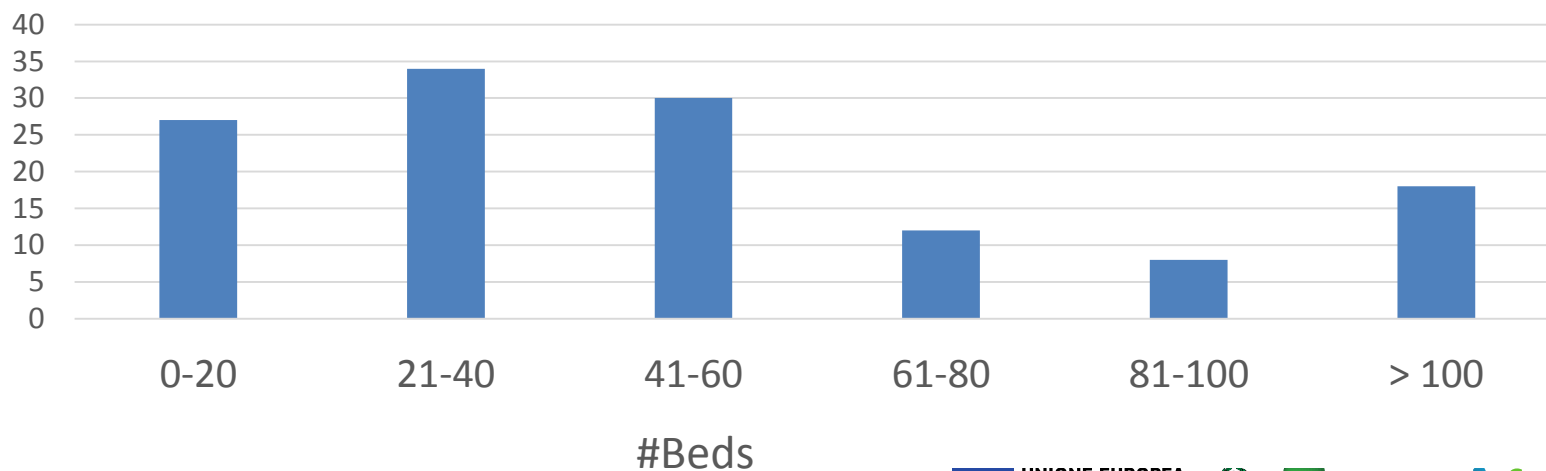
Health System's services impact

Health System's services impact

Rehabilitation Hospitals in Lombardia Region

Casa di cura privata accreditata	55
IRCCS privato	17
IRCCS pubblico	1
Ospedale a gestione diretta	52
Ospedale classificato o assimilato (ai sensi dell'art. 1, ultimo comma, della Legge 132/1968)	4
Total Lombardia Region	129

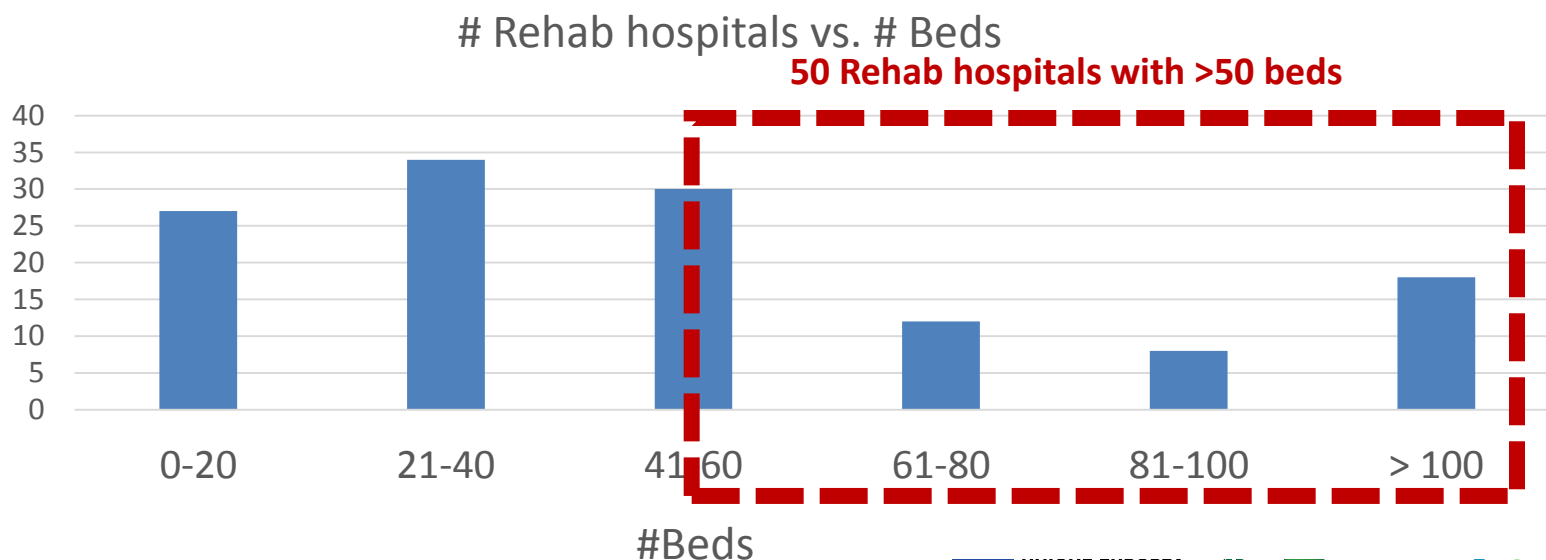
Rehab hospitals vs. # Beds



Health System's services impact

Rehabilitation Hospitals in Lombardia Region

Casa di cura privata accreditata	55
IRCCS privato	17
IRCCS pubblico	1
Ospedale a gestione diretta	52
Ospedale classificato o assimilato (ai sensi dell'art. 1, ultimo comma, della Legge 132/1968)	4
Total Lombardia Region	129



Open Data Regione <https://dati.lombardia.it>





UNIONE EUROPEA

Fondo europeo di sviluppo regionale



Regione
Lombardia



POR FESR 2014-2020 / INNOVAZIONE E COMPETITIVITÀ