WEBINAR

# The role of robot-assisted therapy in patients after acquired brain injury

Clinical experiences of intensive comprehensive neurorehabilitation program

**Kristýna Hoidekrová**
Head of Research and Science team
Rehabilitation Centre Kladrub, yExternal Lecture of First Faculty of Medicine Charles University, Czech Republic

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# The role of robot-assisted therapy in patients after acquired brain injury: clinical experiences of intensive comprehensive neurorehabilitation program


**Kristýna Hoidekrová**

Rehabilitation Centre Kladruby

First Faculty of Medicine at Charles University

Faculty of Biomedical Engineering at Czech technical university in Prague


The presentation was intended only as a professional material for the Gloreha webinar.

# Specialized programs

## Spinal cord injury unit (2021)

- 40 rehabilitation beds
- (115/ year, average age 49)
  - Part of national chain of  spinal cord units
  - Neurourological outpatient for SCI
  - Testing orthotics and prosthetics showroom
  - Individual integrated protocol for wheelchair measurement and prescription
- **Robot-assisted rehabilitation (RAR) from 2009**

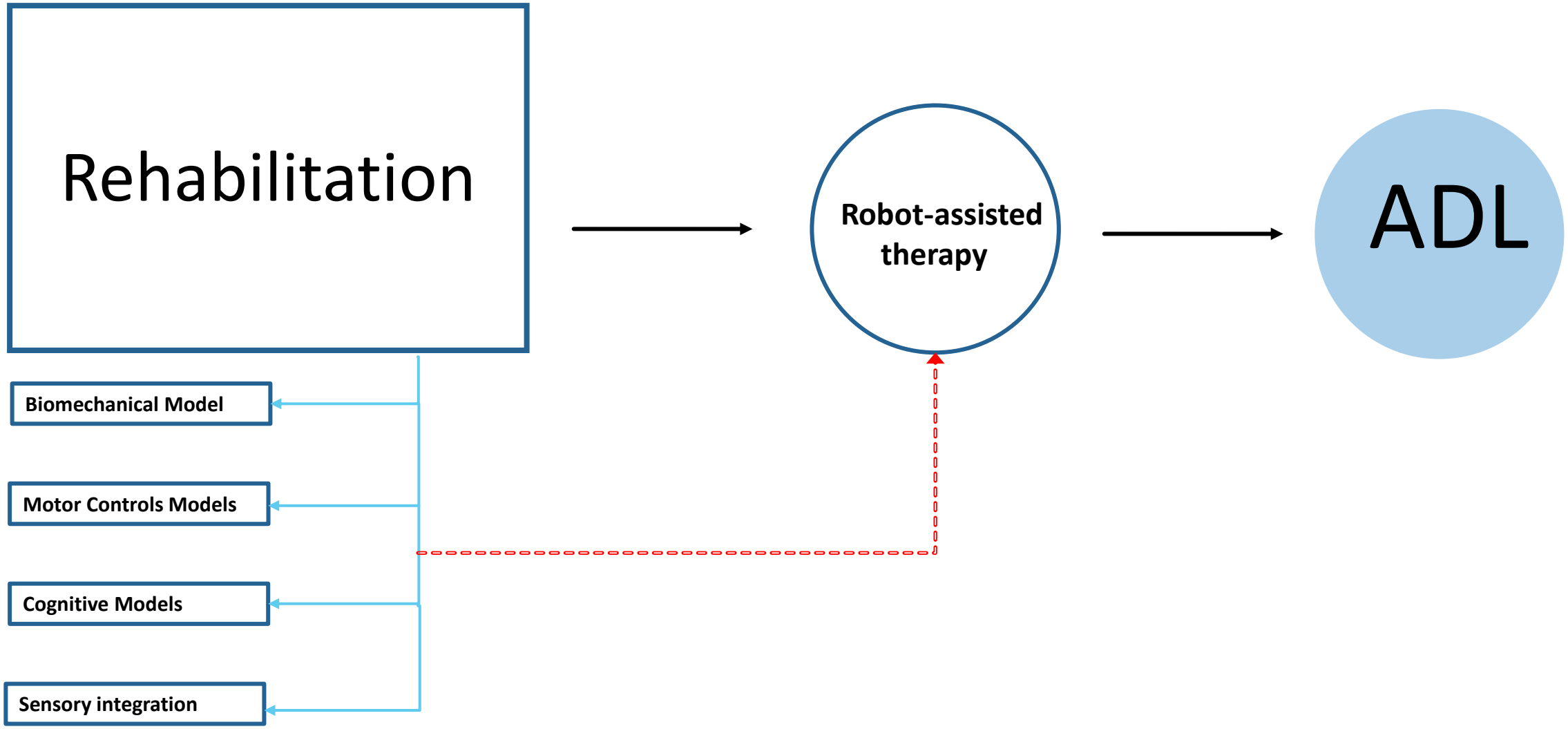
## Stroke/TBI unit (2021)

- 30 beds (SIRUP)+ 30 beds (standard intensity)
- SIRUP- Specialized Intensive Repetitive Utility Program
  - Completed pilot study under coverage of Health Insurance Company Association on high intensity program and robotic intervention (24monts)
  - „Effectiveness of High intensity treatment versus standard intesity treatment“- recalculation thru GAS scoring and functional category
- **Robot-assisted rehabilitation (RAR) from 2010**

**Other diagnosis**

- amputees, peripheral nerve injury, post surgery, lower back pain- 190 beds

# Transfer to clinical practice



# Approaches in Rehabilitation

## HANDS OFF

- task-oriented therapy
- the patient is an active recipient of therapy and a therapist in the position of a lecturer
- explicit and implicit model of learning

## HANDS ON

- traditional rehabilitation techniques
- neurodevelopmental methods or manual therapies
- explicit model of learning

# Specifics of Robot-assisted Rehabilitation

- intensity, periodicity and motivation support
- *task-oriented therapy* (high intensity therapy) and the training of repetitive movements

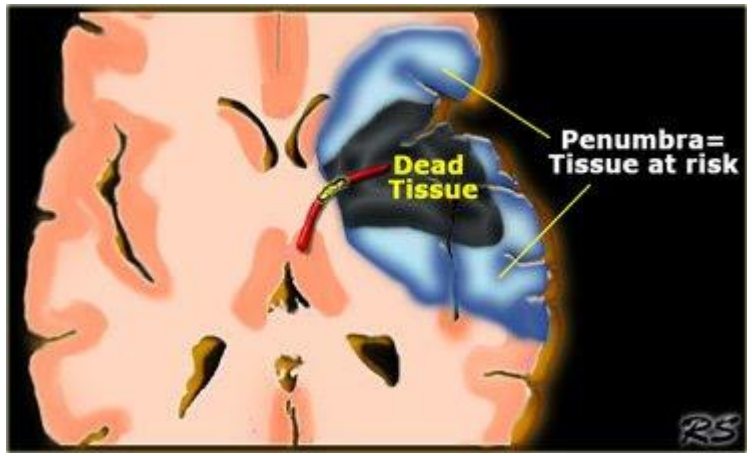
**Neuroplasticity**

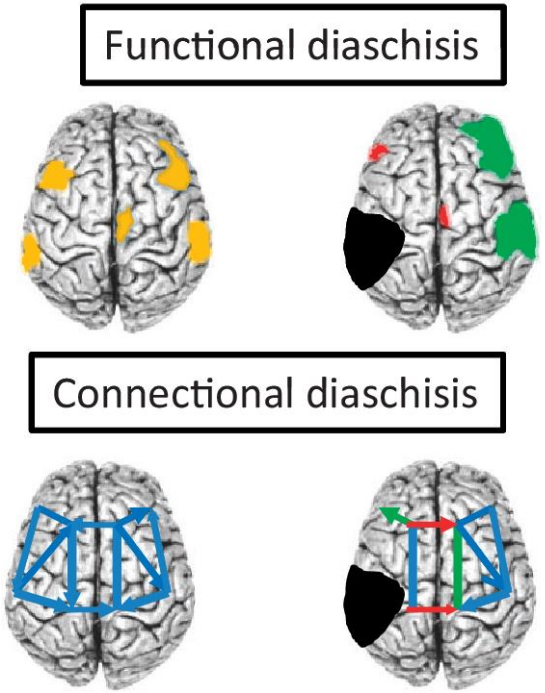
# Neuronal plasticity and RAR

- A complex process involving a combination of spontaneous and learning-dependent processes

  - Restitution, substitution, solution of diaschisis, reactivation of deeferenced and deaferenced area, reorganization, unmasking inhibited existing networks, regeneration, dendric sprouting, neurogenesis etc.

- **Penumbra x Diaschisis**

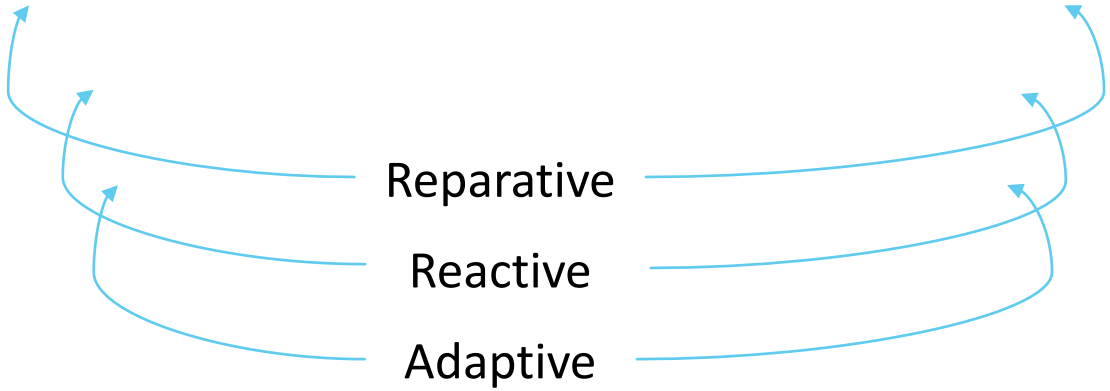


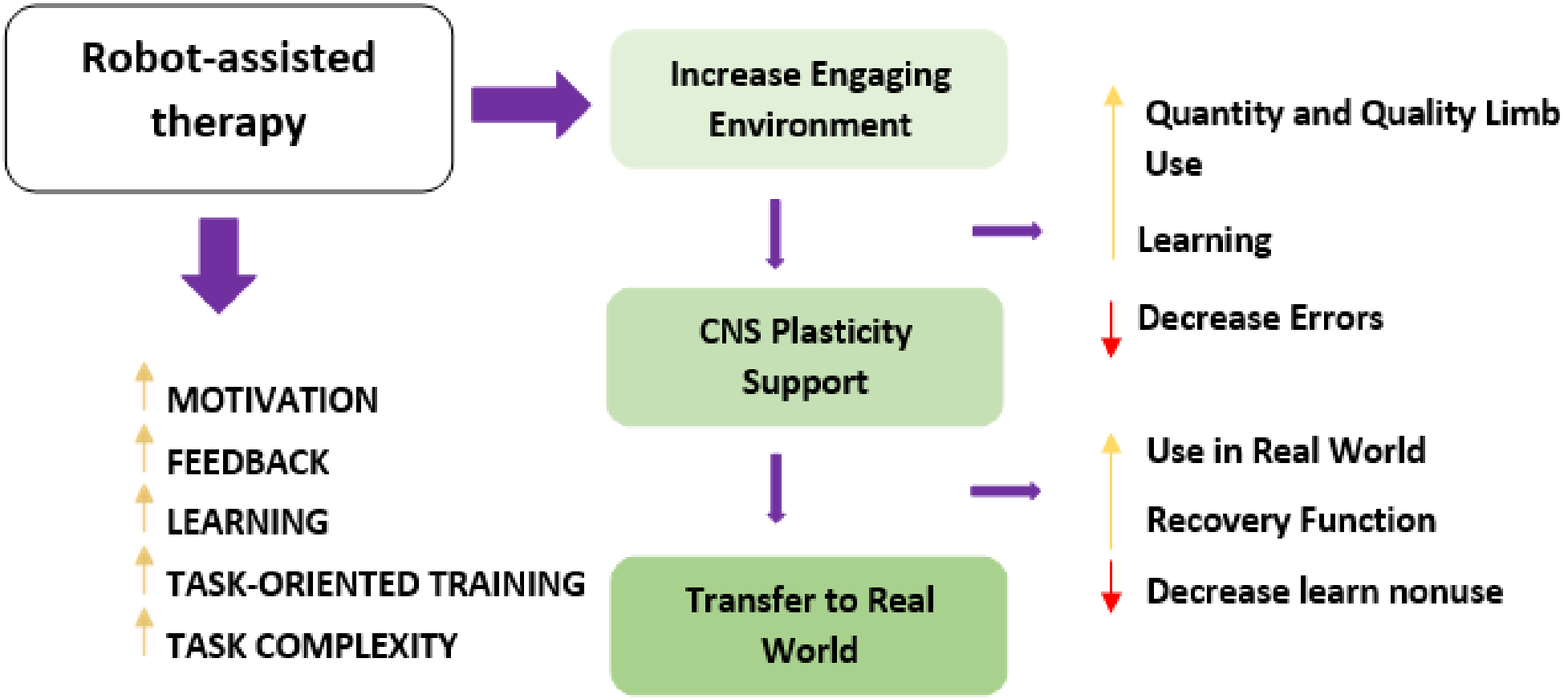

Pictures are available in Brain: a journal of neurology 2014 and http://www.radiologyassistant.nl/images/thmb_484156d177d49TEK-stroke-2.jpg

# Levels of neuroplastic changes


# Types of plasticity after stroke



# Cortical Reorganization with Robot-assisted therapy



# Where can Robot-assisted rehabilitation be used?

## UTILIZATION

- Neurology
- Orthopedics
- Pediatrics
- Geriatrics
- Surgery
- Rheumatology
- Traumatology
- Psychiatry

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- Psychiatry

## The MOST COMMON CI

- Spasticity, according to MAS > 3
- Epilepsy
- Severe visual deficit
- Severe cognitive deficit
- Acute inflammation
- Damage to the skin cover
- Fractures
- Scalds
- Other life-threatening conditions

# Types of RAR

**1) Location**

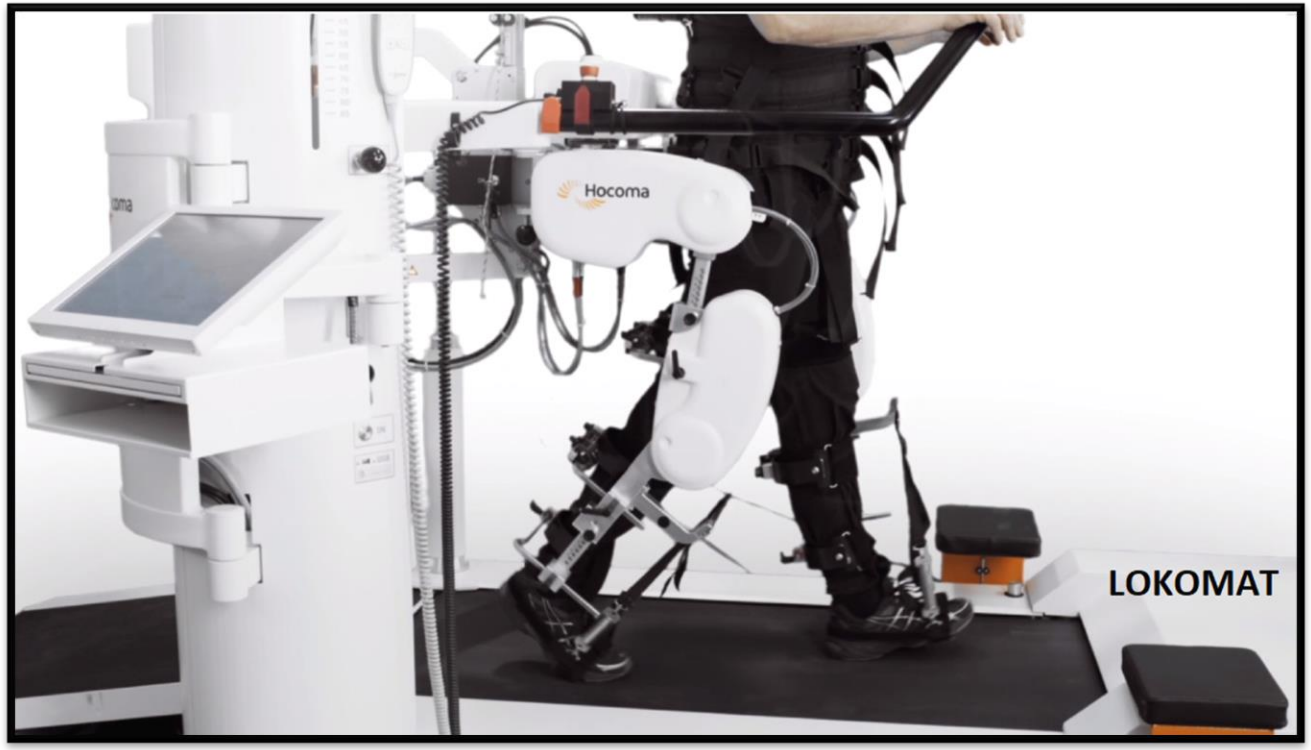
- **UL**
- **LL**

**2) Construction**

- EXOSKELETON - copies the upper limb
- END- EFFECTOR - the end point  is often terminated by a handle
  - in interaction with the patient is only at the distal point

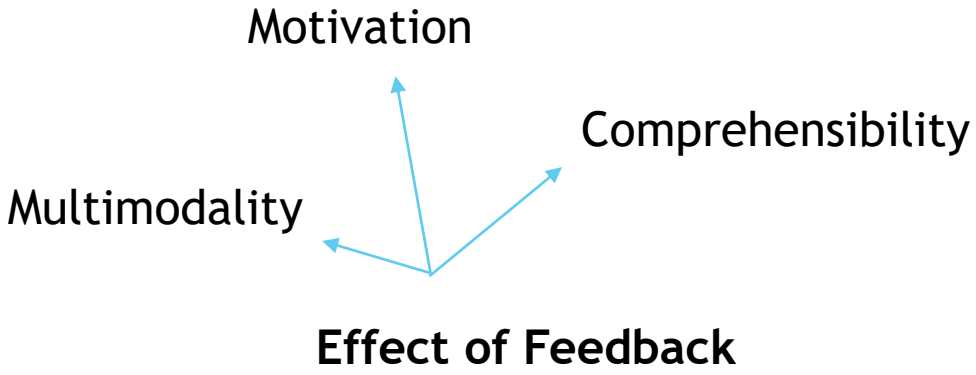
# Which is an exoskeleton and an end-effector?


G-EO System

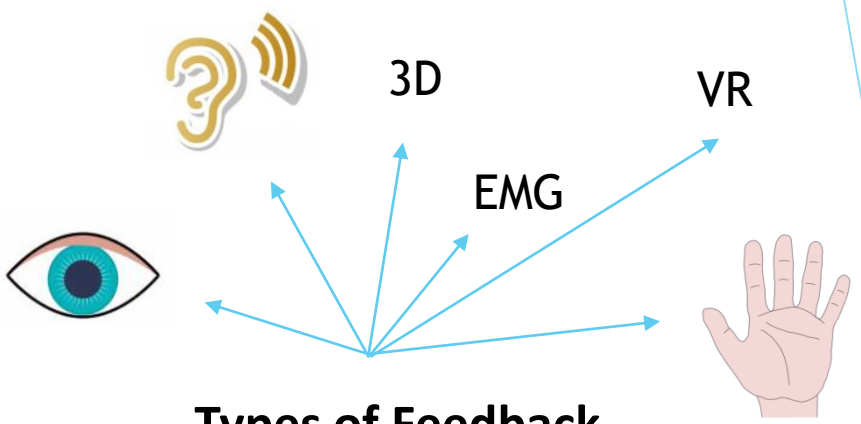



LOKOMAT

**3) Feedback -** !!!Biofeedback is a very important part of RAR and it is the keypoint of monitoring the patient's motor response!!!!




**Effect of Feedback**




**Types of Feedback**

**4) Depending on the complexity and focus**

- The device offers both, unimanual and bimanual approach
- It is only point-to-point training or task oriented training etc.

# Robot-assisted Rehabilitation

## BENEFITS

- Repetitive training
- High frequency
- Effectiveness of therapeutic time
- Economy increase motivation
- Ergonomics - patient x therapist

## DISADVANTAGES

- The human element is missing
- Element of socialization
- Cost
- Space
- Trained staff

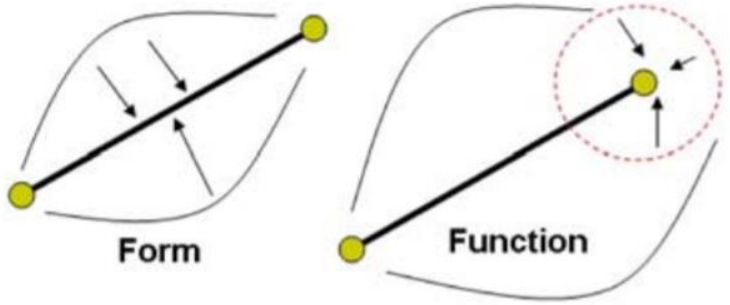
# RAR vs. conventional therapy

| | |
|---|---|
| **Bimanual training** | training involving use of both arms for identical activities in a simultaneous but independent manner |
| **Biofeedback** | force and position feedback: special force sensors on a force platform can measure the weight under each foot and the centre of pressure of the body. Information (feedback) about the weight distribution between the legs and the centre of pressure can be provided to the patient with **visual or auditory** feedback. |
| **CIMT** | involves many repetitions of task-specific training of the affected limb with restraint of the unaffected limb |
| **EMG biofeedback** | the use of external electrodes that are applied to muscles to capture electrical potentials of motor units. Instrumentation converts the recorded potentials into visual or auditory information |
| **Mental practice with motor imagery** | mental practice of a physical action that aims to improve movement |
| **Mirror therapy** | use of a mirror alongside the unaffected limb so that the mirror image seems to be the affected limb |
| **Therapeutic approaches based on neurophysiological theories** | Eg. Bobath approach, PNF, sensory stimulation according to Affolter, Rood, sensorimotor stimulation, less used Perfetti method |

# Functional RAR

- Phases of approach, gripping, manipulation

- 3 modes:
  - form mode
  - function mode
  - normal mode (no forces)

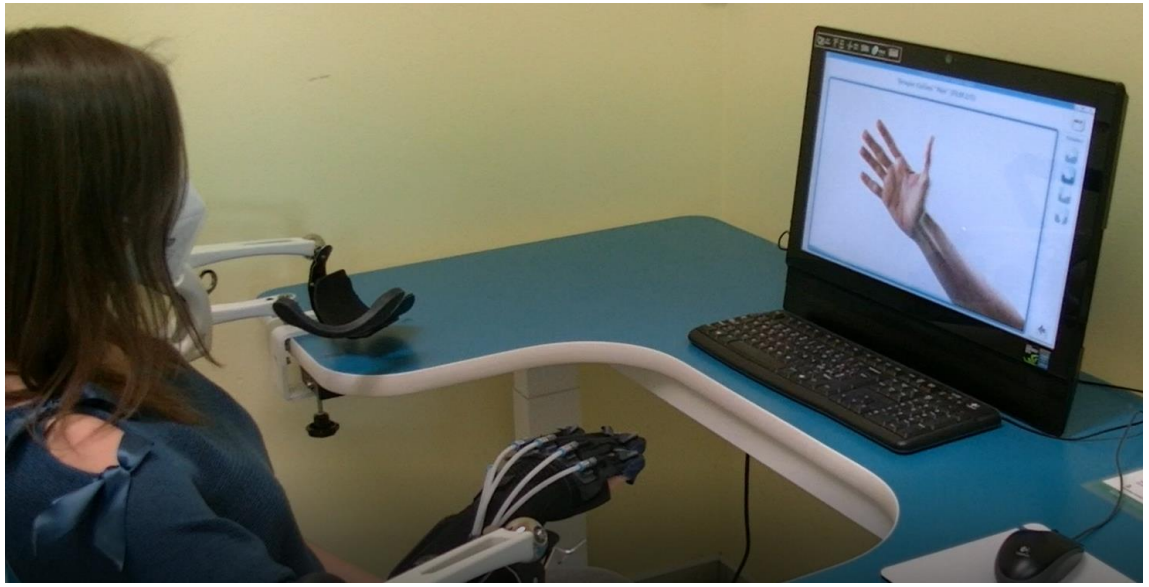



- Assistance
  - Guided (0%)
  - Initiated (25%)
  - Step initiated (50%)
  - Follow Assist (75%)
  - Free (100%)

# Action – observation therapy in RAR

- Action observation (AO) is defined as a dynamic state
- The brain matches an observed action to its motor counterpart
- Activation of cortical areas

conventional Mirror therapy



Action observational therapy in the form of robot-assisted therapy - Gloreha

# GLOREHA Idrogenet®

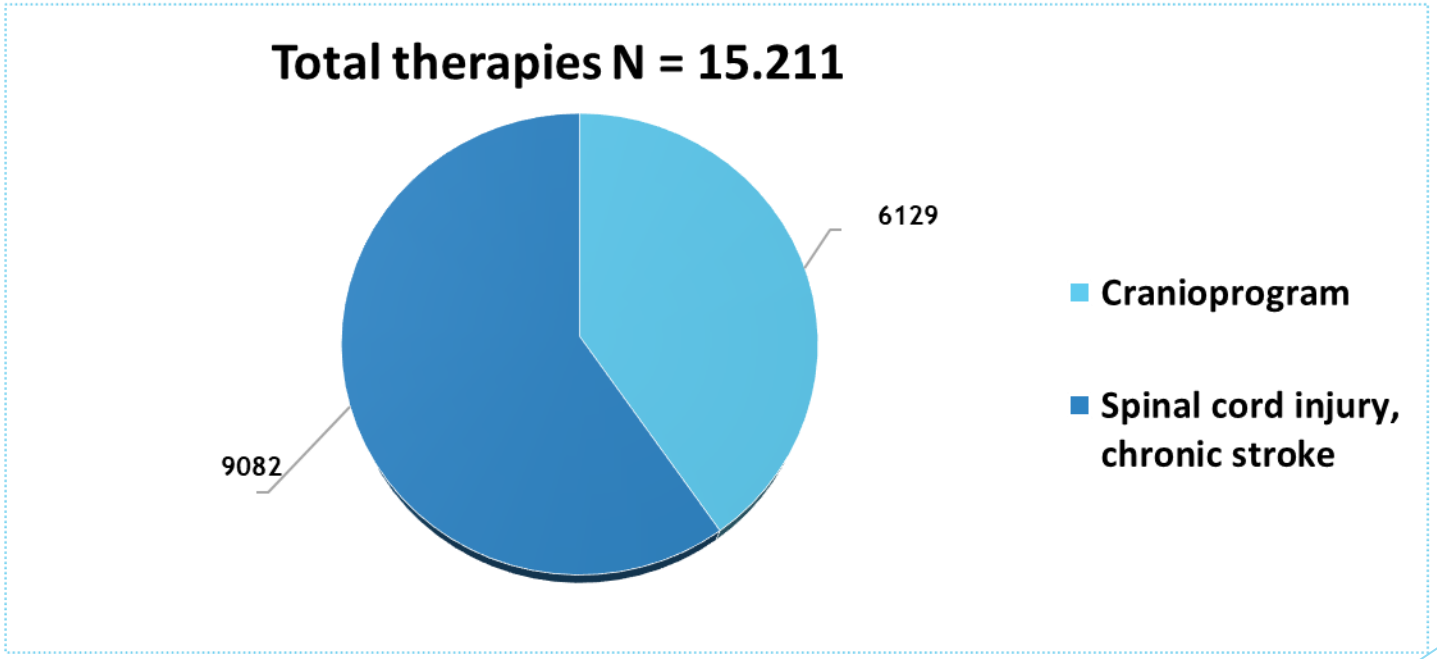
- Gloreha Workstation

- Gloreha Sinfonia

- Gloreha Aria

# Gloreha - our studies, results and protocols

- Multicentric and monocentric studies
- **In total 15.211 therapies** in 2014 – 2021
- **6.129 therapies** in Cranioprogram (acute and subacute stroke)
- **9.082 therapies** in spinal cord injury, chronic stroke and other diagnosis



# Gloreha in clinical practice

**Severe paresis**

Fingers MAS ≤ 3

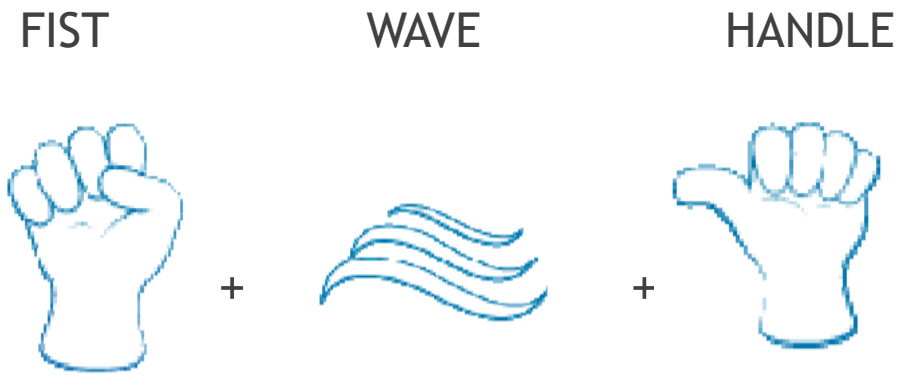
No active movement

Pain (PS = 8 – 10)

Pain with oedema

Sweating

↓ Proprioceptive




Action observation + premotor learning
Passive mobilization
Multidigital movements
Slow movements (≤ 50%)
Flexion and extension pause (± 5sec.)
Gradation of joint ranges
Each exercise for min. 8 minutes

**Goals**

↓Muscle tone

↓Oedema

↓Pain

↑Range of motion

↑Blood + lymphatic circulation

↑Joint mechanics

Norm sensitivity

Prevention of Contractures

# Gloreha in clinical practice

**Moderate paresis**

Fingers MAS ≤ 2

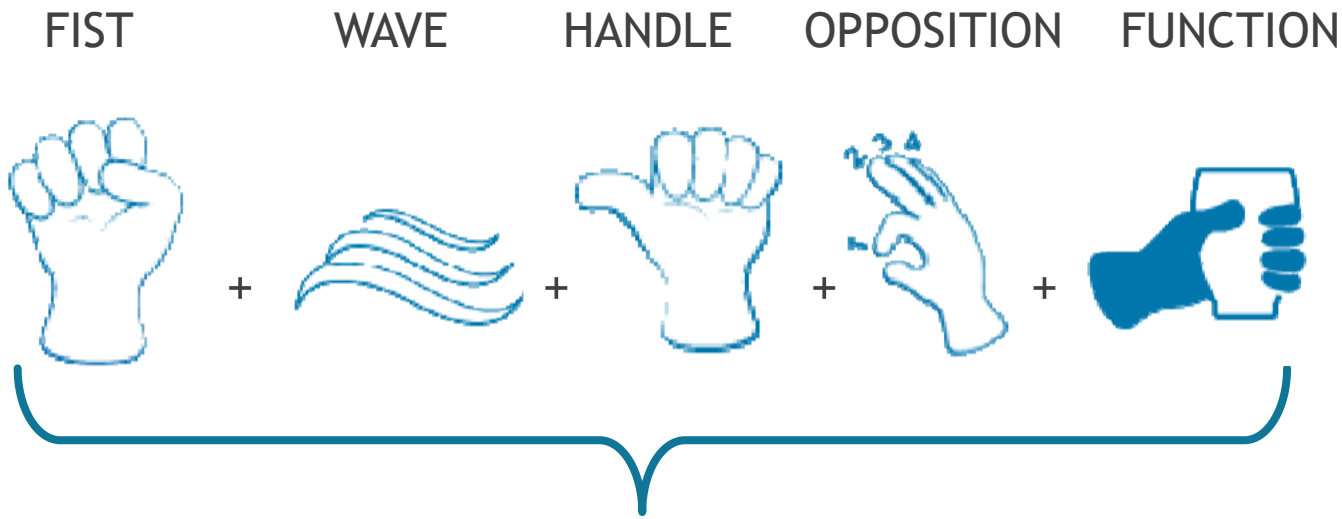
Weak flexion – no extension

Moderate pain and oedema (PS 4-7)

Sweating

Absence of initiation of movement

Hypo/Hyper-sensitivity




Action observation + premotor learning
Passive mobilization multidigital movements
Opposition thumb
Functional exercise
Slow movements (≤ 70%)
Extension Pause (± 5sec.)
Gradation of joint ranges
Each exercise for minimal 5 minutes

**Goals**

↓Muscle tone

↓Oedema

↓Pain

↑Range of motion

↑Blood + lymphatic circulation

↑Joint mechanics

Norm sensitivity

Prevention of contractures

↑ Initiation of movement

# Gloreha - Immediate effects

Befor Gloreha therapy

After Gloreha therapy

# Gloreha in clinical practice

**Mild paresis**

Fingers MAS ≤ 2/1+

Weak flexion and extension

Mild pain and oedema (PS 1-3)

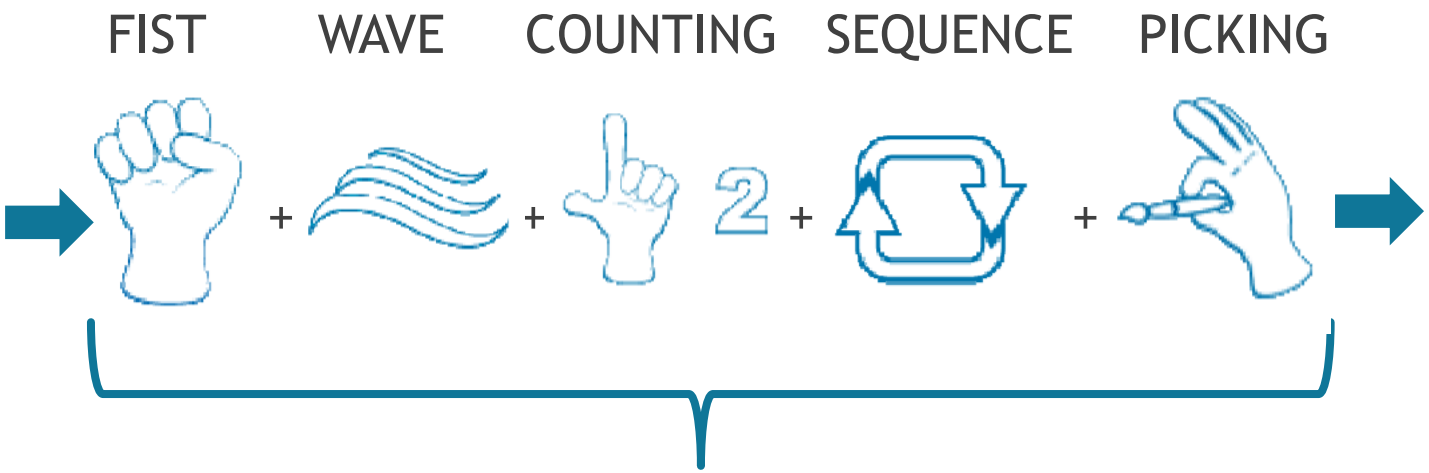
Sweating

Weak initiation of movement

Weak muscle power

Weak function

Hypo/Hyper-sensitivity




Action observation + premotor learning
Less passive mobilization multidigital movements
More isolated finger and functional movements
Faster movements (≤ 90%)
Optimal range of motion
Each exercise for minimal 5 minutes

**Goals**

↓Muscle tone

↓Oedema

↓Pain

↑Range of motion

↑Blood + lymphatic circulation

↑Joint mechanics

↑Active movement

↑Function

↑Muscle power

↑Selected motor control

↑Coordination

↑ Dexterity

Norm sensitivity

Prevention of contractures

# Gloreha in clinical practice

**Plegia**

Fingers MAS = 0

No muscle power

No active movement

Sweating

Pain

Oedema

Hypo/Hyper-sensitivity

Neglected

Outside the body scheme


Action observation + premotor learning

FAST movements = 100%

Optimal of joint ranges

Passive mobilization multidigital and unidigital

No flexion and extension pause

Each exercise for 3-4 minutes

**Goals**

↑Muscle tone

↑Attention to UL

↓Oedema

↓Pain

Normosensitivity

Keep range of motion

Include to the body scheme

# EFFECTIVENESS OF UPPER LIMB TRAINING WITH GLOREHA FOR STROKE SURVIVORS WITH MODERATE TO SEVERE UPPER LIMB DISABILITY: A RANDOMIZED CONTROLLED TRIAL, PRELIMINARY RESULTS

Jakub Petioky[1]; Luciano Bissolotti[2,3]; Benedetta Chioda[2]; Kristyna Hoidekrova[1]

1/ Rehabilitation Department, Rehabilitation Centre Kladruby, Kladruby, Czech Republic
2/ Rehabilitation Service, Fondazione Teresa Camplani Casa di Cura Domus Salutis, Brescia, Italy
3/ LARIN: Neuromuscular and Adapted Physical Activity Laboratory, Brescia, Italy

## BACKGROUND

Recovery of upper limb function after stroke is still one of the major heats for clinicians involved in the rehabilitation process. The acute to subacute phase after stroke is the optimal time window to promote the recovery of upper limb function. The dose and content of training provided conventionally during this phase is however, unlikely to be adequate to drive functional recovery, especially in the presence of severe motor disability. The current study concerns an approach to address this shortcoming, through evaluation of the Gloreha Idrogenet® (GI), a robotic device that enables intensive and repetitive practice of hand and fingers by stroke survivors with moderate to severe upper limb impairment, with the aim of improving the distal upper limb function.

## METHODS AND DESIGN

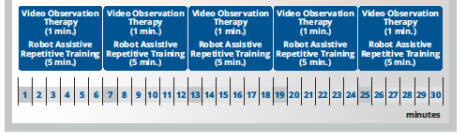
A prospective, assessor-blinded, two groups parallel RCT will be conducted with 50 stroke survivors with moderate to severe upper limb disability who are undertaking inpatient rehabilitation.

### DESIGN OF THERAPY

**Evaluation timig:**
before the 1st app. (T0), after the 20th app. (T1)
and after 26 weeks (T2)

**Sessions duration:** 30 minutes per session

### THERAPY DESIGN (TIME AXIS)




### DEMOGRAPHICAL CHARACTERISTICS OF GT PATIENTS (N = 33)

| Clinical Variables | Average (SD) |
|---|---|
| Age (years) | 55.2 (14.7) |
| Sex (male) | 58 % |
| Time post stroke (days) | 40.2 (10.7) |
| Affected hemisphere (Left) | 39 % |
| Ischemic stroke | 79 % |

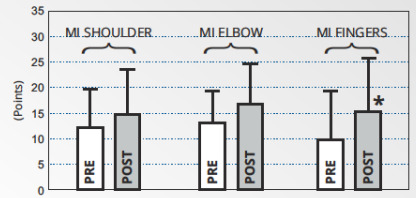
## PRELIMINARY RESULTS

The total of 33 post stroke patients at the Rehabilitation Center Kladruby and Domus Salutis Rehabilitation Clinic received a 20-session Gloreha Treatment (GT) added to task oriented physiotherapy and occupational therapy. The treatment was 5 sessions a week with 30 minutes per session of video observation therapy and robotic assistive treatment composed by 5 different types of hand exercises. The primary outcome measures were Motor Assessment Scale (MAS) for Basic and Advanced Activities and Motricity Index (MI) at a time of T0 and T1 for GT.

### MOTOR ASSESSMENT SCORE - AVERAGE (SD)

| | PRE | POST | T test |
|---|---|---|---|
| **Basic activities** | **0.7 (1.4)** | **1.8 (2.3)** | **p = 0.06** |
| **Advanced activities** | **0.2 (0.5)** | **1.2 (1.9)** | **p = 0.008** |

### MOTRICITY INDEX UPPER LIMB




Variation of upper limb performance according to Motricity Index at time T0 (PRE) and time T1 (POST).

## CONCLUSION

The T test revealed a significant improvement of Advanced hand activites according to MAS classification, p value < .01. No one of the patients reported adverse effects during Robotic Treatment with Gloreha. MI showed a significant improvement only for fingers' subscore (p value 0.019), while shoulder and elbow motor scores showed a clinical but not statistically significant improvement.

The relevant improvement of finger motor score is revealing the specificity of effect derived by GT as elbow and shoulder are not directly involved by the treatment.

The study provided a promising preliminary evidence for the effectiveness of GT in providing an additive effect to upper limb rehabilitation in subacute stroke patients. The treatment procedure was well tolerated by patients as everyone completed the 20-session course. The ongoing randomized controlled study will be performed under current circumstances.

**Contacts:**
Luciano Bissolotti: luciano.bissolotti@ancelle.it
Jakub Petioky: jakub.petioky@rehabilitace.cz

Kladruby

Fondazione Teresa Camplani Casa di Cura DOMUS SALUTIS

# HOME BASED FUNCTIONAL EVALUATION OF UPPER EXTREMITY STROKE SURVIVALS AFTER 6 MONTHS DISCHARGE FROM HIGH INTENSITY NEUROREHABILITATION PROGRAM AT REHABILITATION CENTRE KLADRUBY

**Hoidekrova Kristyna[1,2]; Petioky Jakub[1,3]**

1/ Rehabilitation Centre Kladruby, Rehabilitation, Kladruby, Czech Republic
2/ Faculty of Physical Education and Sport, Rehabilitation, Charles University, Prague, Czech Republic
3/ Spin-off Company and Research Results Commercialization Center of the First Faculty of Medicine, Charles University, Prague, Czech Republic

## BACKGROUND AND AIMS

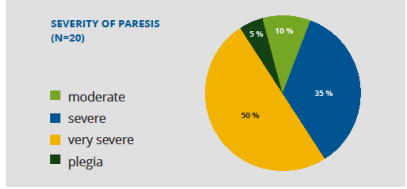
The aim of the work was to evaluate a current condition upper extremity (UE) of stroke survivals after 6 months discharge from high intensity neurorehabilitation program at Rehabilitation Centre Kladruby (RUK), who underwent video-observation therapy combine with robot assistive therapy to improve hand function.

## MATERIAL AND METHOD

The study included patients with a diagnosis of first stroke in the subacute phases, who were hospitalized in intensive comprehensive neurorehabilitation program at RUK. All stroke patients were screened for eligibility. Inclusion criterion were moderate to severe hand movements impairment equivalent to a score two or three of a possible six points on the Motor Assessment Scale (MAS) items 7, able to follow commands, either with verbal instructions, demonstration or other non-verbal cues. 20 patients were screened at a time T0 (admission), T1 (after 1 month) and T2 (after 6 months post discharge in home environment). All participants signed written informed consent before entering the study. This trial was approved by ethical Committee of RUK.

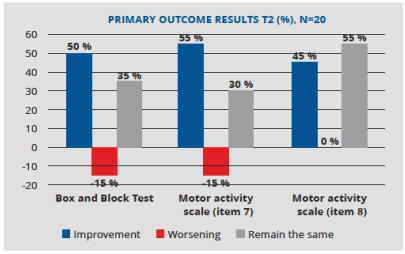
**CLINICAL CHARACTERISTICS OF THE STUDY GROUP AT ADMISSION (N = 20)**

| Clinical Variables | Average (SD) |
|---|---|
| Age (years) | 52 (10.0) |
| Sex (male) | 30 % |
| Time post Stroke (days) | 308.5 (53.4) |
| Stroke (ischemic) | 85 % |
| Affected hemisphere (Left) | 45 % |



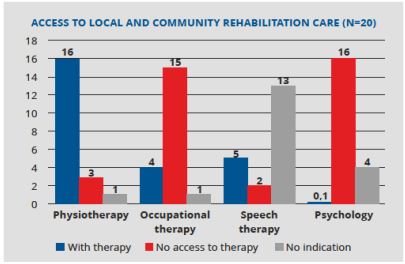

## RESULTS

Primary outcome measures showed up improvement in 50 % patients and worsening in 15 % for Box and Block Test (BBT), MAS in item 7 showed up improvement in 55 % patients and worsening in 15 %, MAS in item 8 showed up improvement in 45 % patients and 55 % patients remain the same at a time T2.

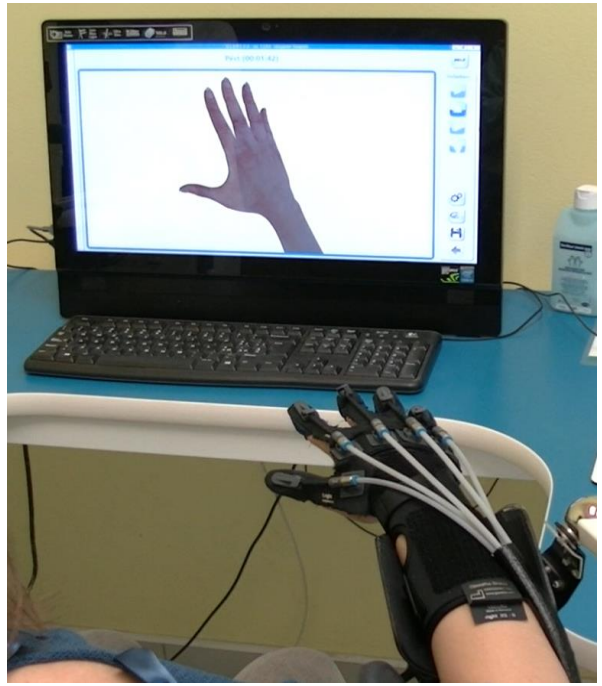



## CONCLUSION

During Home based functional evaluation of UE at a time T2 was taken as well dataset about access to local and community rehabilitation care. Data showed up none to minimum access for psychology and just poor speech language pathology care. Occupational therapy was accessible for 21 % stroke survivals and conventional physiotherapy and physical therapy for 84,2 % stroke survivals. Despite this findings stroke survivals are improving after intensive inpatients neurorehabilitation in home settings with poor access to rehabilitation in long term evaluation. Our thought is that access to early intensive neurorehabilitation could contribute to continuous hand function improvement even in home environment.

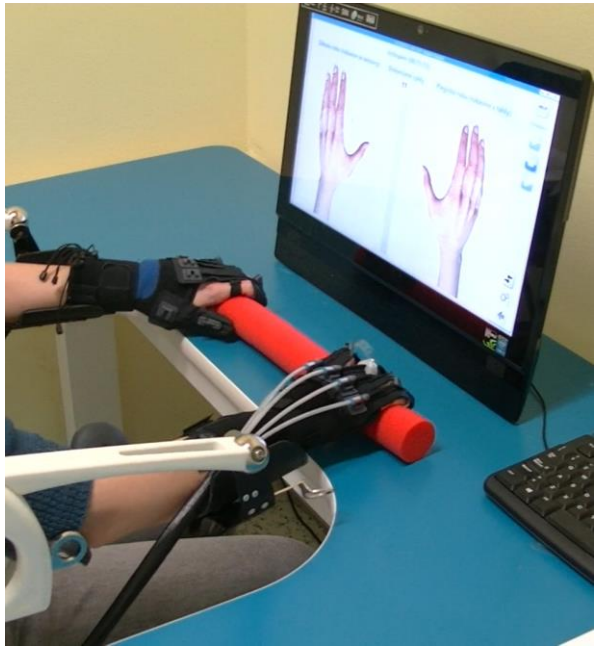


# Gloreha – bimanual or unimanual approach in recovery UL function?



- **AIMS:** The main aim of the study was to evaluate and compare the effectiveness of two therapeutic approaches using robot-assissted glove Gloreha Sinfonia to perform Activity of daily living in patients after acquired brain injury.

- Empirically quantitative research, a monocentric randomized controlled study

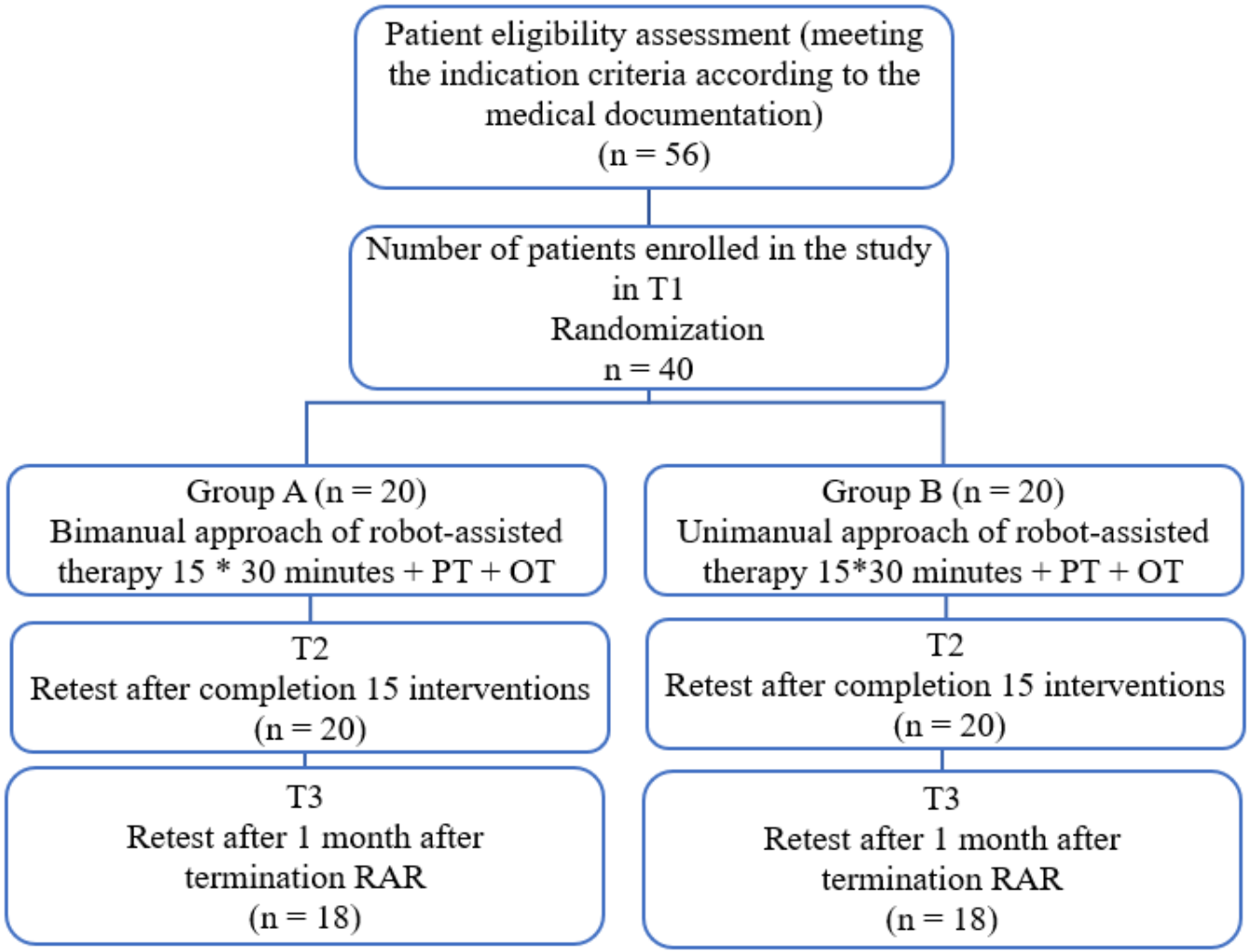


- single-blind study

- Assessment T1 (initial testing), T2 (after 15x reps), T3 (after 1 month)

- EU MAL, MAS, ARAT, BBT and MI

# Gloreha – bimanual or unimanual approach in recovery UL function?




**RESULTS in T1**

Motor Assessment Scale (p = 0,038)

Motor Activity Log (p = 0,07)

Motricity Index shoulder (p = 0,05)

Motricity Index total (p = 0,08)

**RESULTS in T2**

Motor Assessment Scale (p = 0,044, p = 0,015)

Motor Activity Log (p = 0,1)

Motricity Index elbow (p = 0,027)

Motricity Index total (0,075)

# Cranioprogram of RC Kladruby

# Criteria, multidisciplinar meeting and assessments

- Age ≥ 18
- dg. stroke and TBI

- Inclusion in the program -> minimal interventions of 2 or more rehabilitation specialization (physiotherapy, occupational therapy, clinical speech therapy and psychology)

- in a state to handle the intensity of the program

- Cooperation among therapists and patient, the patient has a cooperating family with the aim of releasing it best into the home environment
- Internal stabilization

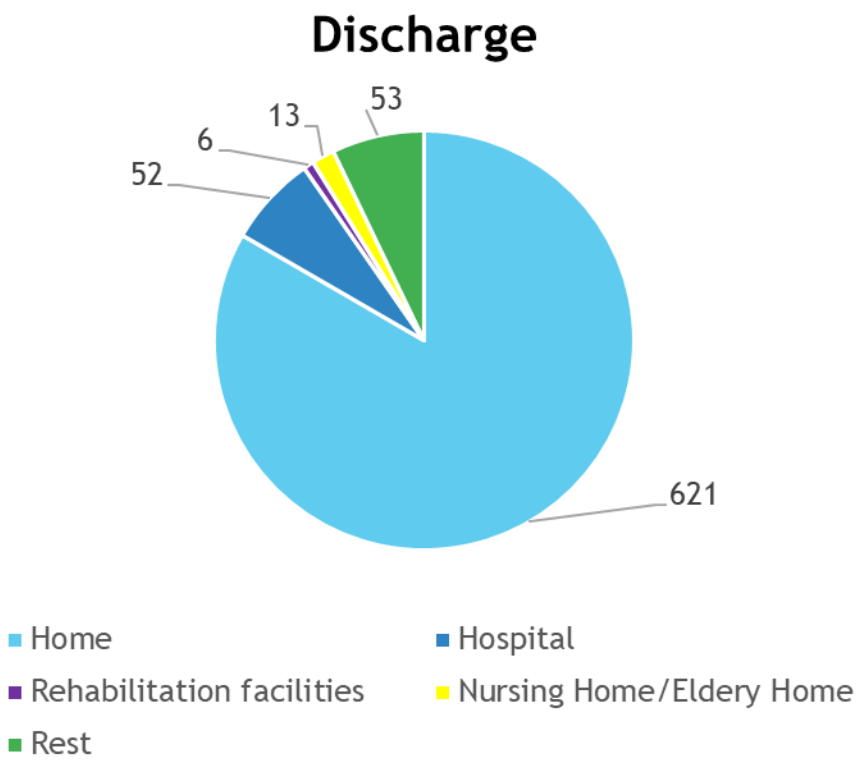
- with percutaneous endoscopic gastrostomy but without artificial lung ventilation

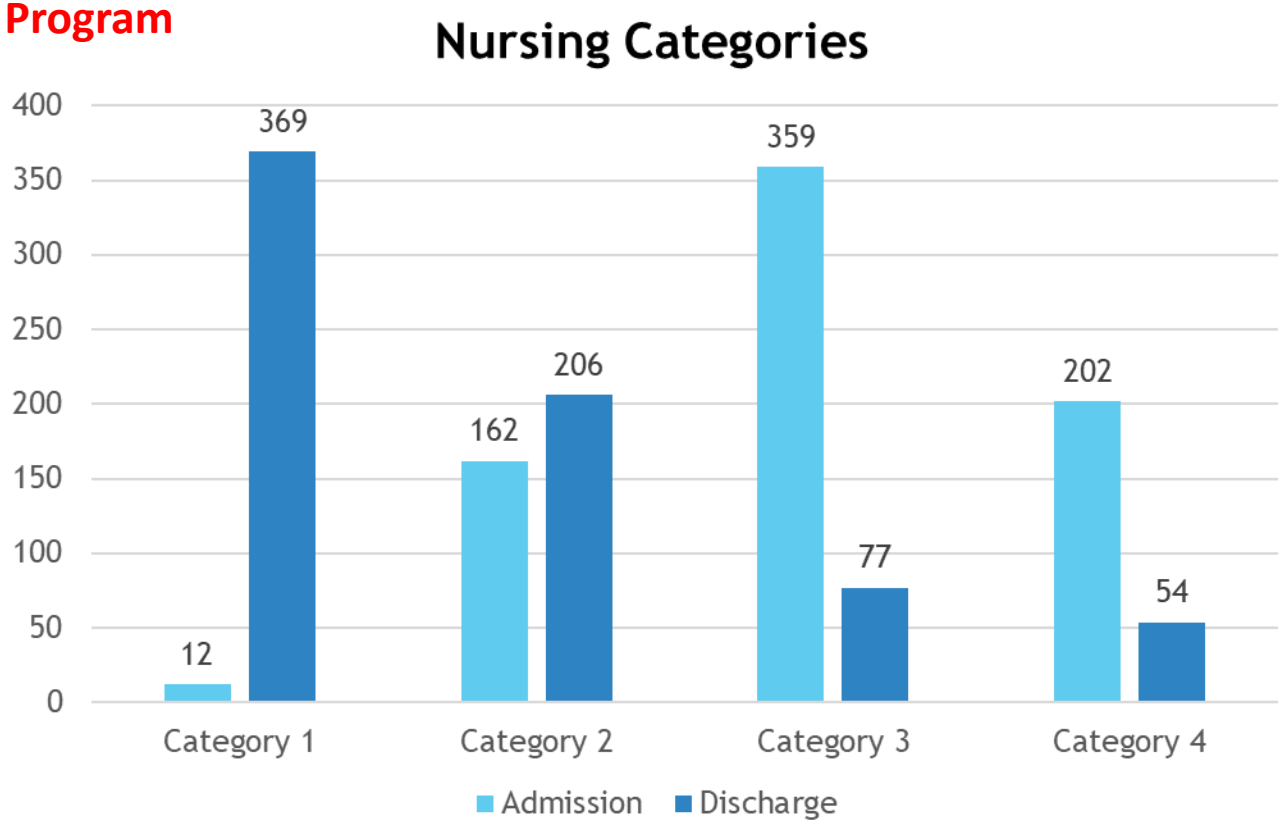
# Cranioprogram in numbers

**735 Patients during June 2015 - March 2021**

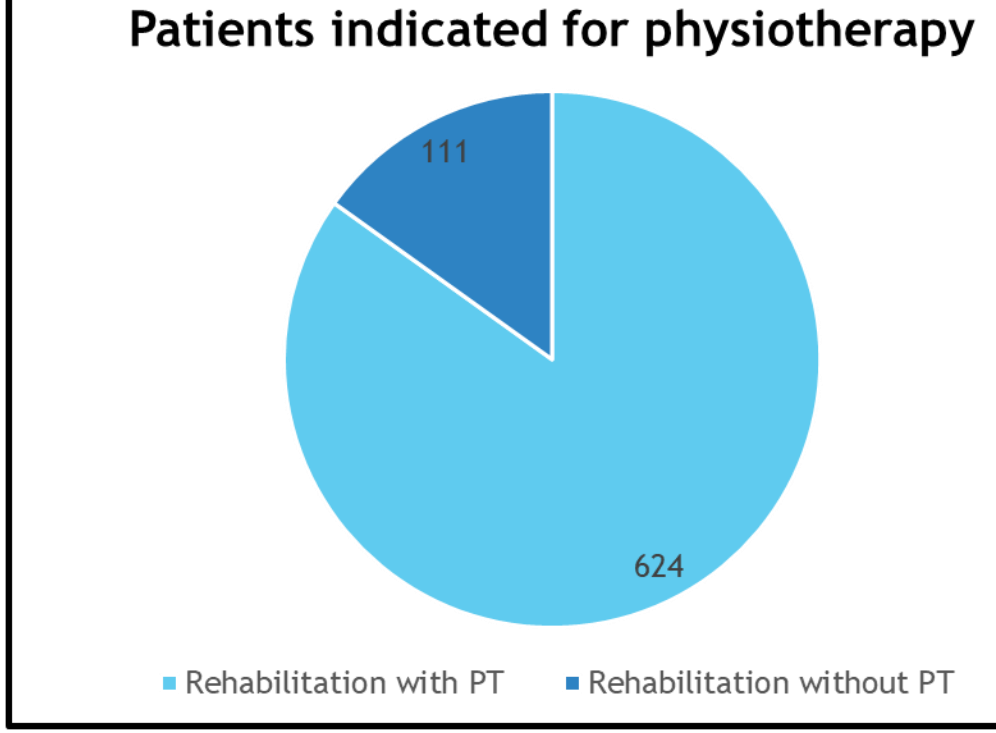
**Length of stay: 66,32 (±19.16)**

**30 beds in Specialized Intensive Repetitive Utility Program**



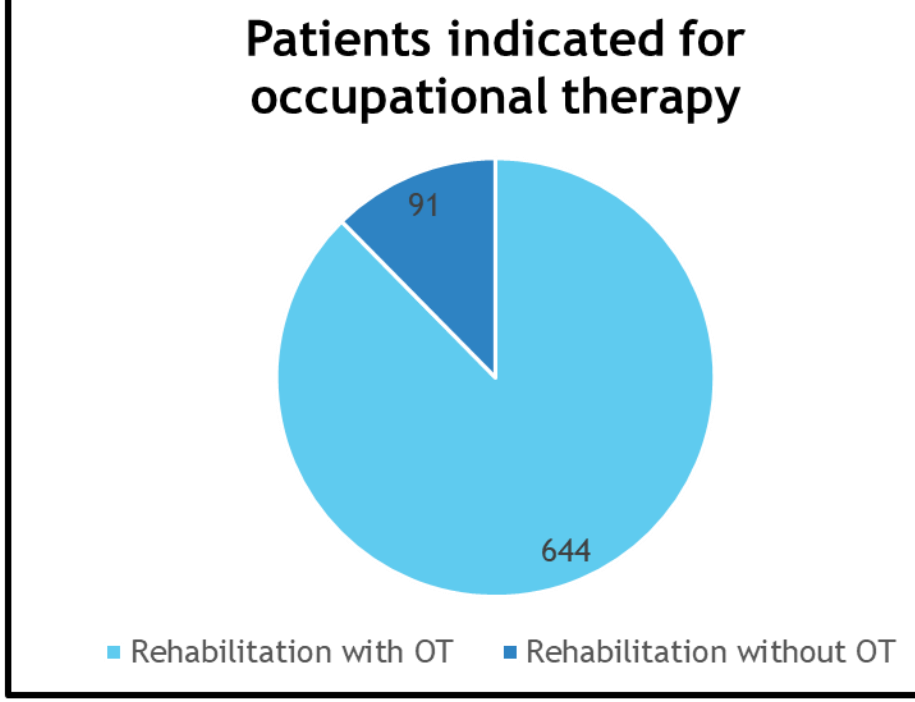
# Physiotherapy




- **Frequency**: 2*30min or 1* 60 / 5 days per week individual
  Group of beginners in the gym
  Group of advanced in the gym
  Group - beginners in the pool
  Group - advanced in the pool

- **Most common deficits:** verticalization, gait, prevention of pain shoulder syndrom, spasticity management
  pathological movements of UL/LL
- **Type of intervention**: conventional techniques (NDT, neuromobilization, PNF, GSC, etc.)
  physical therapy (high induction magnet, ultrasound, functional electrostimulation ect.)
  **Robot-assisted therapy for LL and verticalization**
  education and recommandation of aids (wheelchair, wheeler, etc.)
  positionig of limbs

# Occupational therapy




- **Frequency:** 2*30min or 1* 60 / 5 days per week individual

  Group therapy of gripping

  Group therapy of graphomotor skills

  OT handcrafts (carpentry, ceramics, weaving, clothing and art)

- **Most common deficits**: unself-sufficiency, immobility, malfunction of UL and apraxia

  hemiparetic shoulder pain syndrome

  muscle tone imbalance, spasticity management

  neglect syndrome

- **Type of intervention:** conventional techniques (neurodevelopment, CIMT, air splint, MT etc.)

  Novafon – oscillation therapy

  **Robot-assisted therapy for UL and cognitive function therapy**

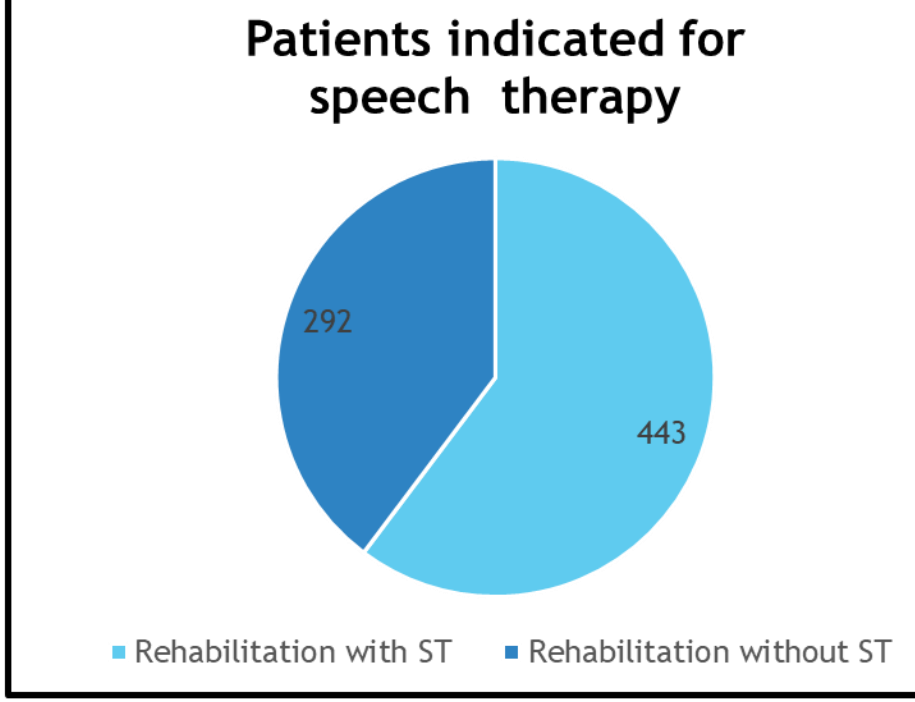
  education and consultation

# Speech therapy

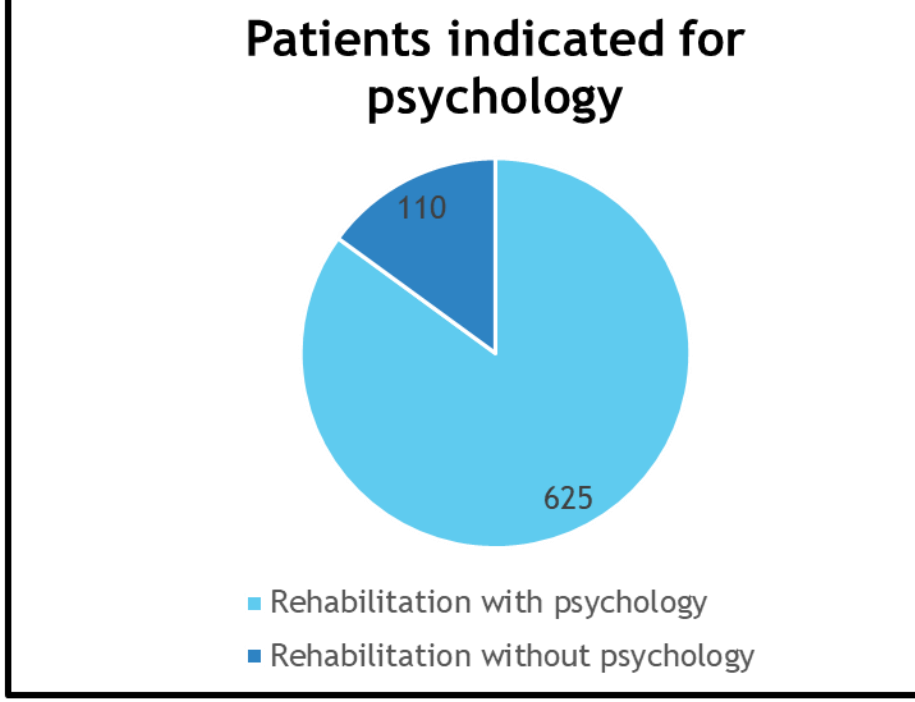
- **Frequency:** 2*30min / 5 days per week individual
  dysphagic or aphatic group

- **Most common deficits**: aphasia, dysphagia, agraphia, dysarthria,
  speech apraxia and alexia

- **Type of intervention:** conventional techniques
  Novafon – oscillating therapy
  **Rehaingest – visual biofeedback for swallowing**
  VitalStim – electrostimulation for swallowing
  education and consultation



# Psychology




- **Frequency**: 1*30min / 5 days per week in group
  individual therapy according to patient´s needs

- **Most common deficits**: memory, executive function
  attention, insight
  strategy creation
  neglect syndrome

- **Type of intervention: PC cognitive training**, psychotherapy
  supportive therapy, relaxation, education, family therapy

# Daily schedule of cranio-patient

| Start | End | Therapy | Therapist | Place |
|---|---|---|---|---|
| **7:30** | 8:00 | **Occupational therapy** | Markéta | In room |
| **8:00** | 8:30 | **Cognitive training** | Petra | Building C, 0. floor |
| **8:30** | 9:00 | **Prisma adaptation** | Ludmila | Building C, 0. floor |
| **9:00** | 9:30 | **Physiotherapy** | Dan | Building B, 2. floor |
| **9:30** | 10:00 | **Splint JAS** | Thomas | Building B, 1.floor |
| **10:00** | 10:30 | **Group – stroke begginers in gym** | Markéta | Building B, 1.floor |
| **11:00** | 11:30 | **Group of graphomotor skills** | Hana | Building B, 1.floor |
| **11:45** | 12:15 | **Lunch with speech therapist** | Ondrej | In room |
| **13:00** | 13:30 | **Reoambulator** | Dan | Building B, 2. floor |
| **13:30** | 14:30 | **Physiotherapy** | Roman | Building B, 1.floor |
| **14:30** | 15:00 | **Gloreha** | George | Building B, 1.floor |
| **15:00** | 15:30 | **Occupational therapy** | Ondrej | Building B, 1. floor |
| **15:30** | 16:00 | **Art Handcrafts** | Irena | Building B., -1. floor |
| **16:00** | 17:00 | **Relaxation (Monday, Wednes)** | Viktor | Building C, 2. floor |
| **16:00** | 17:00 | **Swimming pool (Tuesday, Thursday)** | Marek | Building C, 0.floor |

# Telerehabilitation and distance therapy

- **Telerehabilitation** uses the therapist's direct interactions with the patient in real time through communication technologies (**on-line mode, synchronous model**)

- **Distance therapy**, store-and-forward therapy (**asynchronous model of telerehabilitation in off-line mode**) records, archives and then evaluates the obtained data

- https://eambulance.distancni-terapie.cz/
- https://www.distancni-terapie.cz/
- https://www.artak.cz/

# Conclusion

- Thanks to new technological possibilities and implementation of robotic and sensory systems with biofeedback into common clinical practice, it is possible to perform accurate and reproducible therapies and measurements.
- Prevention of falls and fear of it, increase the quality of life and increase self-sufficiency
- Repetitive, intensive and high-frequency therapies can be administered using robot-assisted systems, devices with biofeedback, virtual reality and PC scoring (therapeutic games).
- The conclusion of most clinical trials is that robot-assisted therapy is not superior to other therapies, a combination of conventional therapy and robot-assisted therapy is always important.

# Thank you for your attention

Kristyna.hoidekrova@rehabilitace.cz

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