

TOR VERGATA
UNIVERSITÀ DEGLI STUDI DI ROMA



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School

Siracusa, Italy

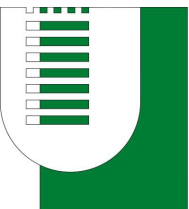
Advanced telerehabilitation: when and how

Nicola Manocchio¹, Alessandro Giustini², Giulia Vita¹, Calogero Foti¹

1. Physical and Rehabilitation Medicine, Tor Vergata University, Rome, Italy

2. Chair of European Robotic Rehabilitation School-Rome, Italy

E-mail: nicola.manocchio@uniroma2.it



20th EMRSS Anniversary

The background features abstract, overlapping green geometric shapes, primarily triangles and polygons, in various shades of green, creating a modern, layered effect. A dark green rounded rectangle is positioned in the center-left, containing white text.

Authors have
nothing to disclose

Dominant technologies in PRM today



Core Technologies

Virtual reality, NIBS, **telerehabilitation**, and **robotics** are the cornerstone technologies in PRM. They enable **highly intensive, specific, and tailored interventions**, significantly **enhancing rehabilitation**

outcomes across a wide range of



Intensified Interventions

These technologies allow for **more frequent and targeted training sessions**.

Virtual reality, for instance, can simulate real-world scenarios for motor and cognitive re-education, while robotics provide precise and repetitive exercises

WHAT IS TELE-REHABILITATION?



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



- “Telerehabilitation is the application of **information and communications technology** to deliver **rehabilitation services** over a distance by **linking a healthcare provider to a beneficiary, caregiver**, or any person(s) responsible for delivering care to the beneficiary, for the purposes of **screening, assessment, intervention, consultation/coaching and/or supervision/monitoring**”

- *World Federation for NeuroRehabilitation*





WHAT IS TELE-REHABILITATION?



- ▶ In Italy, there is an official definition of telerehabilitation approved by the State-Regions Conference on November 18, 2021
 - ▶ “...telerehabilitation is the remote provision of services aimed at **enabling, restoring, improving, or maintaining the psychophysical functioning** of people of **all ages** with **disabilities** or disorders, whether **congenital or acquired, temporary or permanent**, or at **risk of developing them**, using **digital communication technologies**, as a **continuation, integration, or alternative** to traditional methods and within an **individual rehabilitation project** with **in-person reassessment** sessions when necessary...”

ADVANCED TELEREHABILITATION?



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



- ▶ Telerehabilitation definition is **unhelpfully broad** because it includes a wide range of interventions ranging from **real-time supervised and monitored sessions** to **unsupervised training with telephone calls** as a way to follow-up participants.
- ▶ The term **Advanced Telerehabilitation** should describe any more advanced telehealth technology (*real time videoconferencing, web-based interactive platforms or smartphone applications*) than phone contact alone



ADVANCED TELEREHABILITATION?



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



01

Consumer and Medical Wearables

Wearables and smartphone apps continuously monitor activity, symptoms, and adherence. They provide **real-time data** that can be used to prompt exercises and detect functional decline

02

Remote Data Upload

These devices can **upload data** to cloud platforms, allowing clinicians to **review progress** during teleconsults or outpatient visits

ADVANCED TELEREHABILITATION?



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



03

Enhanced Adherence

Providing reminders and feedback, wearables and apps significantly improve **patient adherence** to Individual Rehabilitation Projects, leading to better long-term outcomes

04

AI implementation

AI algorithm (based on range of motion and speed) may enable **real time feedback** as well as **positive encouragement** during practice

ADVANCED TELEREHABILITATION?



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy

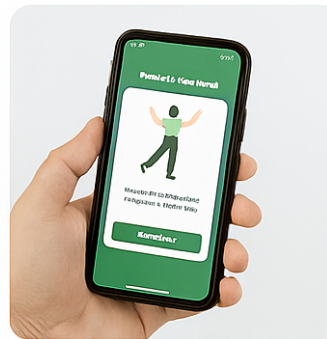


Tools for Telerehabilitation



Videoconferencing platforms

- Zoom, Teams, dedicated medical platforms



Mobile apps

- Exercise programs, reminders, feedback
- Smartwatches, activity trackers, heart rate monitors



Telemonitoring devices

- Spirometers, oximeters, BP monitors
- Spirometers, oximeters, BP monitors



VR & AR

- Immersive training and motivation

ADVANCED TELEREHABILITATION?

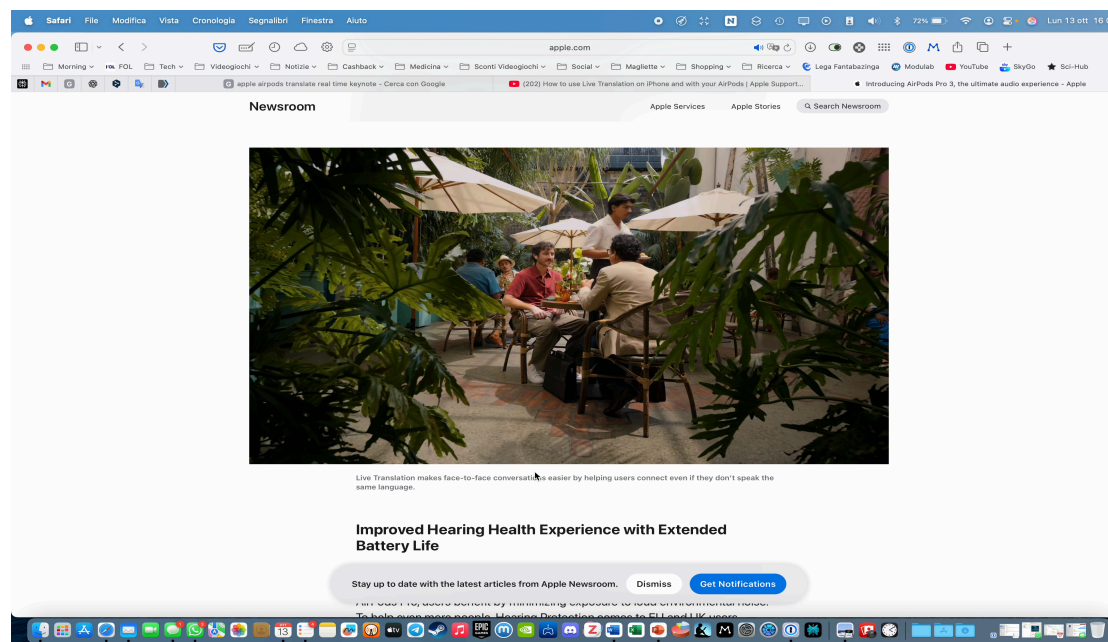


E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



Chance for developing international rehabilitation services

- Bring together expertise from around the worlds
- Help people in low income countries
- Reduce travel needs



AREAS OF APPLICATION



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



Neurological Applications

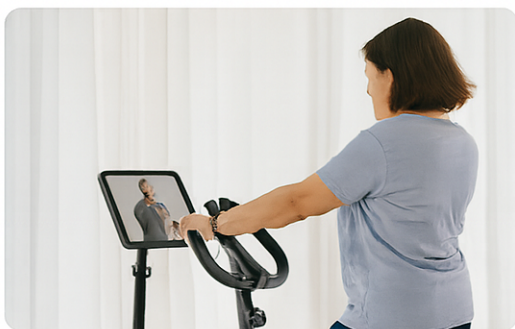


Stroke

- Remote motor and cognitive training
- Improved continuity of care after hospital discharge

Parkinson's Disease

- Motor exercises (balance, coordination)
- Support for speech therapy and voice rehabilitation



Multiple Sclerosis (MS)

- Home-based adapted exercise programs
- Patient education and self-monitoring



Cognitive training technologies

Apps and Software for Cognitive Training



Apps and software targeting aphasia, attention, and executive functions enable additional therapeutic repetitions in hospital and home settings. They offer adaptive difficulty and automated feedback, enhancing cognitive recovery.



Optimized Dosage



These tools provide a **scalable and efficient way to increase treatment time** for patients with mild cognitive impairment



Scientific Evidence in Stroke

Review > [J Clin Med.](#) 2024 Dec 26;14(1):50. doi: 10.3390/jcm14010050.

Telerehabilitation and Its Impact Following Stroke: An Umbrella Review of Systematic Reviews

Bayan Alwadai ^{1 2}, Hatem Lazem ^{1 3}, Hajar Almoajil ⁴, Abigail J Hall ¹, Maedeh Mansoubi ^{1 5},
Helen Dawes ^{1 5}

- **AIM:** To evaluate the impact of telerehabilitation on motor function, balance, gait, ADLs, and quality of life in post-stroke patients.
- **Sample size:** over 14,000 patients across 28 reviews
- **Main benefits:**
 - Motor function (mainly upper limb)
 - Balance and gait
 - ADLs and quality of life
 - Adherence and satisfaction
 - Cost
- **CONCLUSION:** Telerehabilitation is effective and well accepted in subacute and chronic stroke patients.

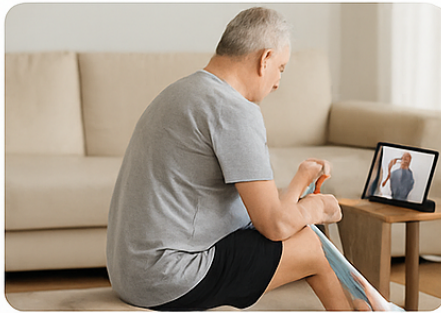




AREAS OF APPLICATION



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa - Italy



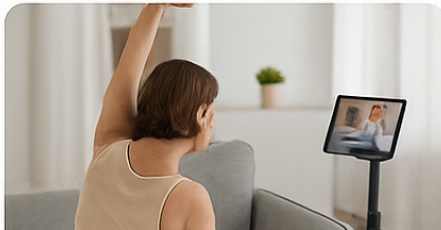
Orthopedic / Musculoskeletal

- Post hip/knee prosthesis
- Shoulder and chronic low back pain



Cardiorespiratory

- COPD and chronic heart failure telerehabilitation
- Exercise training and functional monitoring at home



Oncological

- Post-mastectomy rehabilitation
- Telerehabilitation for lymphedema management and adapted exercise

Scientific Evidence in Orthopedic Disabilities

Meta-Analysis > J Telemed Telecare. 2024 Jun;30(5):795-808.

doi: 10.1177/1357633X221097469. Epub 2022 May 12.

The effectiveness of telerehabilitation in patients after total knee replacement: A systematic review and meta-analysis of randomized controlled trials

Mei Po Tsang ^{1 2}, Gene Chi Wai Man ², He Xin ², Yau Chun Chong ³, Michael Tim-Yun Ong ², Patrick Shu-Hang Yung ²

➤ AIM

- Compare telerehabilitation vs. in-person rehab after total knee replacement
- Focus on pain and physical function outcomes

Sample size: 1,800 patients (11 RCTs)

➤ RESULTS:

- Telerehab **comparable** to in-person rehabilitation for pain and function

➤ CONCLUSION:

- Telerehabilitation is as effective as conventional rehab
- **Preferred option** due to cost-effectiveness and accessibility



Scientific Evidence in Pulmonary Re-education

Meta-Analysis > [Cochrane Database Syst Rev.](#) 2021 Jan 29;1(1):CD013040.

doi: 10.1002/14651858.CD013040.pub2.

Telerehabilitation for chronic respiratory disease

Narelle S Cox^{1 2}, Simone Dal Corso³, Henrik Hansen⁴, Christine F McDonald^{1 5 6},
Catherine J Hill^{1 7}, Paolo Zanaboni^{8 9}, Jennifer A Alison^{10 11}, Paul O'Halloran¹²,
Heather Macdonald¹³, Anne E Holland^{1 14 2}

➤ AIM

- To determine the effectiveness and safety of telerehabilitation for people with chronic respiratory disease
- **Sample size:** 1904 participants (mostly COPD patients, 15 RCTs)

➤ RESULTS:

- no difference in 6-Minute Walking Distance (6MWD) and QoL compared to in person-rehabilitaiton

➤ CONCLUSION:

- Telerehabilitation is as effective as centre-based rehab
- Better adherence and safety



Scientific Evidence in Cancer

> [JMIR Cancer](#). 2024 Aug 21:10:e56969. doi: 10.2196/56969.

Telemedicine Applications for Cancer Rehabilitation: Scoping Review

Patricia Goncalves Leite Rocco ^{# 1}, C Mahony Reategui-Rivera ¹, Joseph Finkelstein ^{# 1}

METHODS

- 21 studies
- Mostly ≤65 years, balanced gender
- Technologies: web-based, phone/SMS, apps with exercise programs
- Exercises: home-based aerobic (90%), resistance (61%), flexibility (33%)

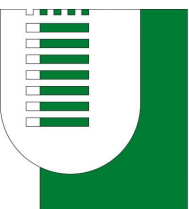
RESULTS

- Improved functional capacity, cognition, QoL
- Reduced pain, fatigue, anxiety, hospital stay
- High feasibility, acceptability, but limited cost-effectiveness evidence

CONCLUSION

- Telerehabilitation for cancer is **beneficial, feasible and safe**





Cochrane Evidence



Trusted evidence.
Informed decisions.
Better health.

Cochrane Database of Systematic Reviews

[Qualitative Review]

Factors that influence the provision of home-based rehabilitation services for people needing rehabilitation: a qualitative evidence synthesis

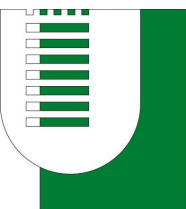
Marcela Velez^{1,2}, Luz Helena Lugo-Agudelo¹, Daniel F. Patiño Lugo¹, Claire Glenton³, Ana M Posada¹, Luisa Fernanda Mesa Franco¹, Stefano Negrini^{4,5}, Carlotta Kiekens⁶, Maria Alejandra Spir Brunal¹, Anne-Stine Bergquist Roberg⁷, Kelly Mariana Cruz Sarmiento¹

¹Facultad de Medicina, Universidad de Antioquia, Medellín, Colombia. ²Department of Health Research Methods, Evidence and Impact, McMaster University, Hamilton, Canada. ³Department of Health and Functioning, Western Norway University of Applied Sciences, Bergen, Norway. ⁴Department of Biomedical, Surgical and Dental Sciences, University La Statale, Milano, Italy. ⁵Laboratory of Evidence Based Rehabilitation, IRCCS Istituto Ortopedico Galeazzi, Milan, Italy. ⁶IRCCS MultiMedica, Milan, Italy. ⁷TRS National Resource Centre for Rare Disorders, Sunnaas Rehabilitation Hospital, Oslo, Norway

Contact: Marcela Velez, cmarcela.velez@udea.edu.co.

Editorial group: Cochrane Effective Practice and Organisation of Care Group.

Publication status and date: New, published in Issue 2, 2023.



Cochrane Evidence



Trusted evidence.
Informed decisions.
Better health.

Cochrane Database of Systematic Reviews

[Qualitative Review]

Factors that influence the provision of home-based rehabilitation services for people needing rehabilitation: a qualitative evidence synthesis

Marcela Velez^{1,2}, Luz Helena Lugo-Agudelo¹, Daniel F. Patiño Lugo¹, Claire Gileton³, Ana M. Pocada¹, Luisa Fernanda Mesa Franco¹, Stefano Negrini^{4,5}, Charlotte Kiekens⁶, Maria Alejandra Spir Brunali¹, Anne-Stine Bergquist Roberg⁷, Kelly Mariana Cruz Sarmiento¹

¹Facultad de Medicina, Universidad de Antioquia, Medellín, Colombia. ²Department of Health Research Methods, Evidence and Impact, McMaster University, Hamilton, Canada. ³Department of Health and Functioning, Western Norway University of Applied Sciences, Bergen, Norway. ⁴Department of Biomedical, Surgical and Dental Sciences, University La Statale, Milano, Italy. ⁵Laboratory of Evidence Based Rehabilitation, IRCCS Istituto Ortopedico Galeazzi, Milan, Italy. ⁶IRCCS MultiMedica, Milan, Italy. ⁷TRIS National Resource Centre for Rare Disorders, Sunnaas Rehabilitation Hospital, Oslo, Norway

Contact: Marcela Velez, cmarcela.velez@udea.edu.co

Editorial group: Cochrane Effective Practice and Organisation of Care Group.

Publication status and date: New, published in issue 2, 2023.



E. M. R. S. S.

Euro Mediterranean
Rehabilitation Summer School

Siracusa, Italy



- Patients, family members and providers see telerehabilitation as an **opportunity** to make services **more available**
- Providers point to practical problems when assessing whether patients are performing **their exercises correctly**
- Providers and patients also describe **interruptions from family members**
- Providers complain of a **lack of equipment** and patients refer to **usability issues and frustration with digital technology**
- Patients see telerehabilitation **affordable and cost-saving** if the equipment has been **provided**

What competencies do patients and therapists need for telerehabilitation?



ORIGINAL RESEARCH article

Front. Rehabil. Sci.

Sec. Strengthening Rehabilitation in Health Systems

Volume 6 - 2025 | doi: 10.3389/fresc.2025.1640416

Competency Requirements for Patients and Therapists in Telerehabilitation Aftercare: A Qualitative Study



Anna Lea Stark-Blomeier ^{1,2}



Stephan Krayter ³



Christoph Dockweiler ²

- “... Digital services, such as app-based training or therapist-led video calls, are increasingly being used in rehabilitation and aftercare as alternatives that are more flexible in terms of space and time. **However, such systems place various demands on users...**”

What competencies do patients and therapists need for telerehabilitation?



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



REHABILITATION WORKING GROUP

- Specialist in Physical and Rehabilitative Medicine
- Physiotherapist
- Occupational therapist
- Orthopaedic technician
- Speech therapist
- Dietician
- Educational therapist
- Psychologist
- Others (music therapy, dance therapy, specialized therapy with the help of animals)



What competencies do patients and therapists need for telerehabilitation?



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



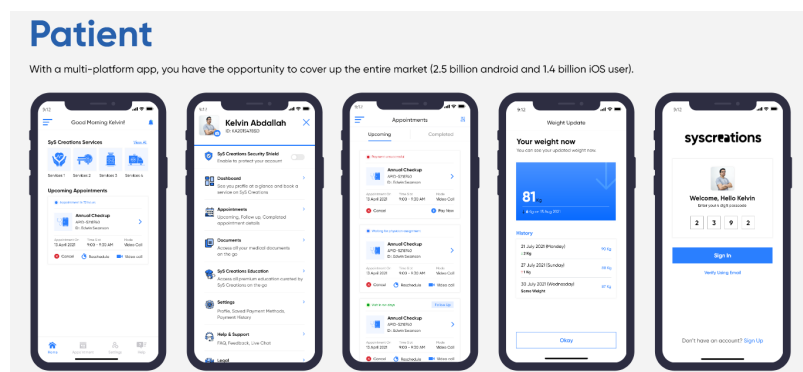
Core knowledge

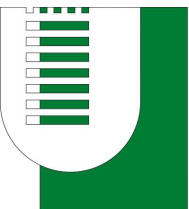
Application knowledge

- download, access, troubleshoot the platform
- content libraries knowledge to build IRPs

Impact knowledge

expected benefits, limitations, and potential side effects of a tele-IRP





What competencies do patients and therapists need for telerehabilitation?



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



Essential skills

Social skills

clear remote communication, relationship building, empathy and sustaining motivation

Cognitive skills

concentration, situational awareness, adaptation between analog/digital

Physical and Professional

- sufficient motor/visual abilities for exercises
- PRM and therapists: digital delivery of cues/corrections, strong understanding of patients' health and home context

What competencies do patients and therapists need for telerehabilitation?



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



Experiences and preparation

Prior tech experience

- Use of technologies/health apps eases patient training
- repeated exposure builds confidence (“practice makes perfect”)

Effective onboarding

- early introduction during in-stay rehabilitation
- institutionalizing processes and informing all professionals support success

What competencies do patients and therapists need for telerehabilitation?



ORIGINAL RESEARCH article

Front. Rehabil. Sci.

Sec. Strengthening Rehabilitation in Health Systems

Volume 6 - 2025 | doi: 10.3389/freesc.2025.1640416

Competency Requirements for Patients and Therapists in Telerehabilitation Aftercare: A Qualitative Study



Anna Lea Stark-Blomeier ^{1,2}

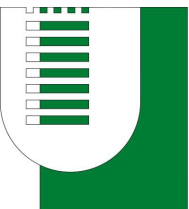


Stephan Krayter ³



Christoph Dockweiler ²

- “... **telerehabilitation is a heterogeneous field of practice that varies in terms of therapy content (depending on the indication), digital tools available (various apps or video conferencing platforms) and user groups (e.g. demographic characteristics, differences between the user group of therapists and patients)...**”



Journal of
Clinical Medicine

Review

Opportunities Offered by Telemedicine in the Care of Patients Affected by Fractures and Critical Issues: A Narrative Review

Giulia Vita ^{1,2,†}, Valerio Massimo Magro ^{1,†}, Andrea Sorbino ¹, Concetta Ljoka ¹ , Nicola Manocchio ^{1,2,*} 
and Calogero Foti ^{1,2,*} 

► Paper available here



Opportunities Offered by Telemedicine

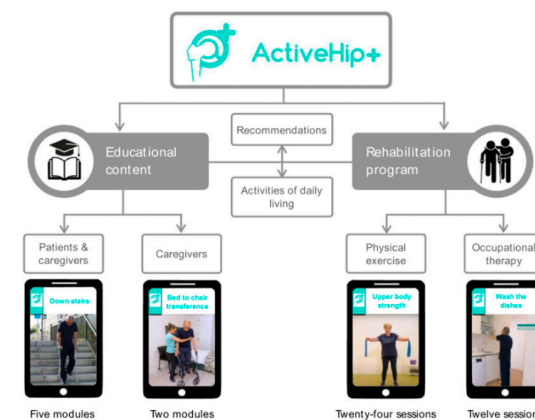
Tele rehabilitation apps

- ActiveHip+ is an **educational and telerehabilitation** app for patients who have undergone surgery after a hip fracture or require hip replacement
- ActiveHip+ provides **specific training and counseling** to their caregivers
- ActiveHip+ **primary declared aim** is to **enhance the functional recovery** of patients who have undergone surgery, thereby promoting their independence in performing ADLs and ultimately improving their overall QoL

Original Research

Is a telerehabilitation programme for older adults with hip fracture associated with burden of family caregivers who provide support?

María Fernández-González¹, Mario Lozano-Lozano^{1,2,3}, Lydia Martín-Martín^{1,2,3}, Mariana Ortiz-Piña¹, Miguel Martín-Matillas⁴, and Patrocinio Ariza-Vega^{1,2,5}



Opportunities Offered by Telemedicine

Tele rehabilitation apps

- KiReS (Kinect Telerehabilitation System) is a **Kinect-based telerehabilitation system**
- The system offers an **intuitive and motivating interface for patients**, providing valuable feedback to improve the rehabilitation process
- KiReS assists PRM and physiotherapists in designing, managing, and evaluating physiotherapy protocols and sessions, offering smart data and real-time monitoring



Article

A Telerehabilitation System for the Selection, Evaluation and Remote Management of Therapies

David Anton ^{1,*}, Idoia Berges ², Jesús Bermúdez ², Alfredo Goñi ² and Arantza Illarramendi ²



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy





E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



What about tele-rehabilitation for people with upper limb fractures???

Our experience at Tor Vergata University Hospital





Our experience at Tor Vergata University Hospital



- **Patient:** male, 9 years old
- **Diagnosis:** fracture of the left elbow olecranon during recreational-sport activity
- **Orthopedic treatment:** partial immobilization with bandaging
- **First PRM evaluation:** the patient reported functional impairment 3 months after the traumatic event
- **Physical examination**
 - **Left elbow:**
 - Supination: 15° deficit
 - Pronation: 15° deficit
 - Flexion: 20° deficit
 - Extension: 30° deficit



Our experience at Tor Vergata University Hospital



IRP: EDUCATION + MOTOR RE-EDUCATIONAL PROGRAM

3 times/week, 45 minutes sessions

- Shoulder and wrist mobilization
- Passive/active-assisted elbow re-education
- Functional re-education with flexbar
- Proprioceptive re-education with powerball
- Postural and respiratory (breathing therapeutic exercises) re-education

DELIVERY METHODS

- Cold/Hot water immersion for pain control and tissue relaxation during exercises
- Exercises in all positions: supine, prone, side-lying, sitting, standing



Our experience at Tor Vergata Hospital



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



IRP: EDUCATION + MOTOR PROGRAM

3 times/week, 45 minutes sessions

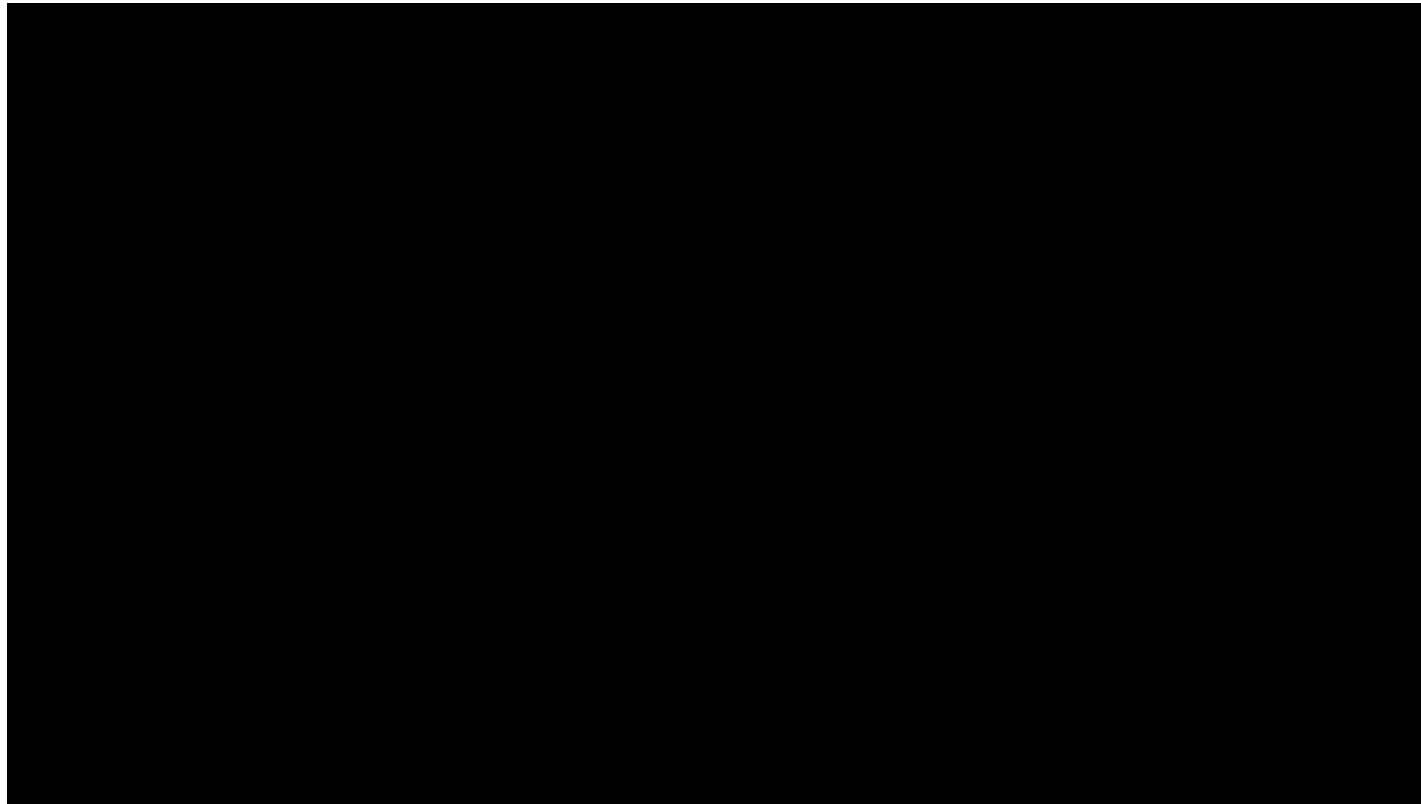
- Shoulder and wrist mobilization
- Passive/active-assisted elbow
- Functional re-education with
- Proprioceptive re-education
- Postural and respiratory (breathing exercises) re-education

DELIVERY METHODS

- Cold/Hot water immersion for pain control and tissue relaxation during exercises
- Exercises in all positions: supine, prone, side-lying, sitting, standing



Our experience at Tor Vergata University Hospital





Our experience at Tor Vergata University Hospital



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



SUPINATION IN SITTING POSITION

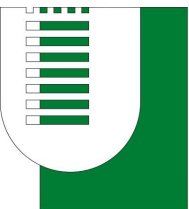
INITIAL ASSESSMENT
15° SUPINATION DEFICIT



SEVEN-WEEK ASSESSMENT



Manocchio N & Giustini A - Advanced telerehabilitation: when and how, 18.10.2025



Our experience at Tor Vergata University Hospital

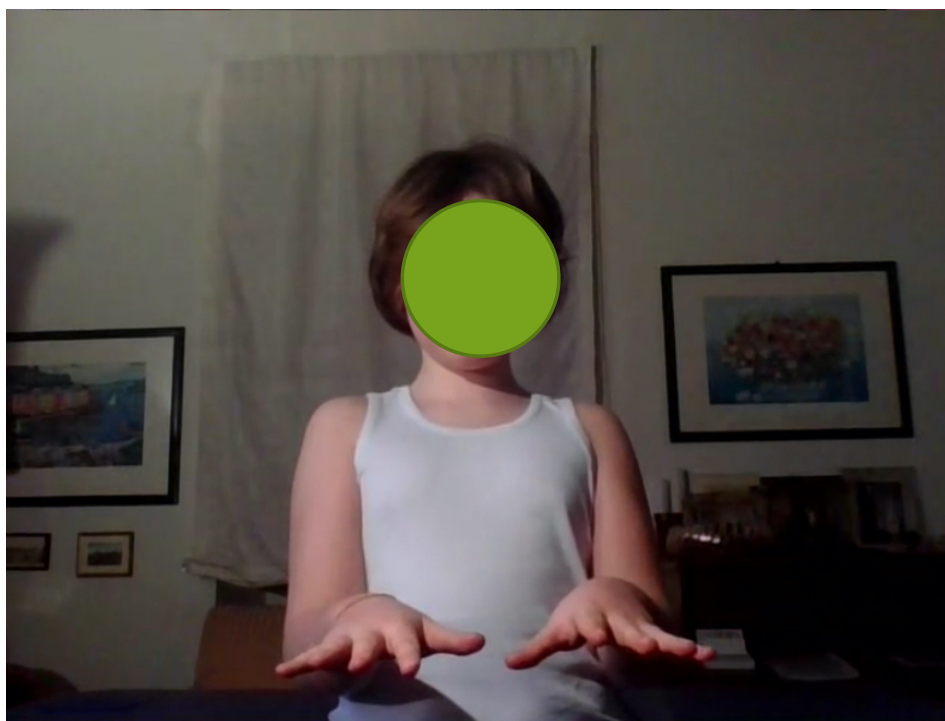


E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy



PRONATION IN SITTING POSITION

INITIAL ASSESSMENT
15° PRONATION DEFICIT



SEVEN-WEEK ASSESSMENT





Our experience at Tor Vergata University Hospital

ELBOW EXTENSION

INITIAL ASSESSMENT
30° EXTENSION DEFICIT



SEVEN-WEEK ASSESSMENT



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy





Our experience at Tor Vergata University Hospital

ELBOW FLEXION



INITIAL ASSESSMENT
20° FLEXION DEFICIT



SEVEN-WEEK ASSESSMENT





Our experience at Tor Vergata University Hospital

Final PRM assessment

- **Physical examination:**
 - Recovery of proprioception and basic coordination
 - Recovery of joint mobility and function
- **Reconditioning Treatment:**
 - Adapted physical activity with non-contact sports (swimming)





Our experience at Tor Vergata University Hospital

Final PRM assessment

- **Physical examination:**
 - Recovery of proprioception
 - Recovery of joint mobility
- **Reconditioning Treatment**
Adapted physical activity (swimming)



Conclusion

Accessibility → reaches patients in rural or remote areas

Continuity of care → ensures follow-up after discharge

Patient empowerment → promotes autonomy and active participation

Home-based rehabilitation → comfort, safety, and convenience

Real-time monitoring → clinical data and functional progress

Not a replacement, but an extension of traditional rehabilitation



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Italy



Conclusion

Tools for Telerehabilitation



Videoconferencing platforms

- Zoom, Teams, dedicated medical platforms



Mobile apps

- Exercise programs, reminders, feedback
- Smartwatches, activity trackers, heart rate monitors



VR & AR

- Immersive training and motivation



Telemonitoring devices

- Spirometers, oximeters, BP monitors
- Spirometers, oximeters, BP monitors



Potential limits

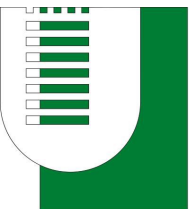
- For patients using **app-based programs**: motivation and independent training may need to be constantly stimulated
- For patients using **video call programs**: following of therapist's instructions and an active participation is mandatory and could not be possible in certain conditions



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School
Siracusa, Italy

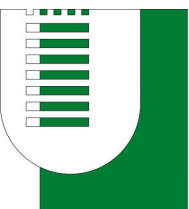


Thank you for your attention!



Thank you for your attention!

E-mail: nicola.manocchio@uniroma2.it



TOR VERGATA
UNIVERSITÀ DEGLI STUDI DI ROMA



E. M. R. S. S.
Euro Mediterranean
Rehabilitation Summer School

Siracusa, Italy

Advanced telerehabilitation: when and how

Nicola Manocchio¹, Alessandro Giustini², Giulia Vita¹, Calogero Foti¹

1. Physical and Rehabilitation Medicine, Tor Vergata University, Rome, Italy

2. Chair of European Robotic Rehabilitation School-Rome, Italy

E-mail: nicola.manocchio@uniroma2.it