EARTO Report on Research and Innovation in Rehabilitation

WG Healthcare Special Interest Group Working Document

6 February 2026

Introduction

Rehabilitation is defined by the World Health Organisation (WHO) as "a set of interventions designed to optimise functioning and reduce disability in individuals with health conditions in interaction with their environment."[1] It is a **critical component of healthcare, enabling patients to recover from injuries or illnesses, regain daily functioning, and improve their quality of life**. While mortality rates for many conditions have declined due to advances in healthcare, morbidity associated with illness and disease remains a significant societal challenge. Rehabilitation plays an essential role in addressing this ongoing burden.

Globally, one in three people may benefit from rehabilitation[2]. However, rising demand—combined with persistent shortages in health and social care staffing—risks overwhelming existing services, deepening inequalities, and generating substantial socioeconomic consequences. The WHO's "Rehabilitation 2030: Call to Action"[2] underscores this **unmet global need** and highlights the importance of strengthening health systems. Rehabilitation technologies offer a pathway to reduce these supply–demand pressures and constitute a key mechanism through which several priorities of the Call to Action can be advanced.

Rehabilitation technologies include solutions that:

a. **Identify health problems** that could benefit from rehabilitation (e.g., digital symptom-screening tools);
b. **Determine the type, intensity, and duration** of rehabilitation required (e.g., data-informed triage pathways);
c. **Deliver or support rehabilitation interventions** (e.g., exoskeletons);
d. **Monitor patient progress** during and after rehabilitation (e.g., sensor-based tracking devices);
e. **Motivate sustained rehabilitation** practice beyond inpatient care (e.g., mobile applications and avatar-based coaching).

These technologies support multiple user groups across diverse settings. For example, clinicians using digital tools to stratify patients; nurses assessing fall risk before discharge; response-centre staff monitoring vulnerable individuals at home; occupational therapists using sensor feedback to support daily activities; physiotherapists delivering remote rehabilitation; carers providing assistance to older adults; and patients themselves tracking progress toward rehabilitation goals.

The field is expanding rapidly, driven by advances in artificial intelligence, robotics, virtual and augmented reality, and related disciplines. Europe and other regions are investing heavily in research and development (R&D) to accelerate innovation in rehabilitation technologies[3,4].

EU programmes such as Horizon 2020 and Horizon Europe have supported numerous projects, including robotic rehabilitation (RETRAINER[5]) and virtual reality–based cognitive rehabilitation (vCARE[6]). Additional initiatives—such as human brain research in Europe and in similar programmes in the United States, Japan, and China—demonstrate the global momentum behind these technologies[7]. Professional societies are also contributing evidence, for example on the use of exoskeletons and robot-assisted therapy[8]. Collectively, these developments illustrate how rehabilitation technologies are transforming the assessment of rehabilitation needs and the delivery of services.

Despite this progress, significant barriers prevent widespread implementation and scaling. Addressing these challenges is essential to fully realise the potential of rehabilitation technologies. This report examines key obstacles faced by developers, healthcare providers, and end users in Europe and presents recommendations to accelerate the development and deployment of rehabilitation technologies.

[1] https://www.who.int/news-room/fact-sheets/detail/rehabilitation
[2] https://www.who.int/initiatives/rehabilitation-2030
[3] https://www.england.nhs.uk/ourwork/clinical-policy
[4] https://www.who.int/europe/news-room/events/item/2025/01/30/default-calendar/ageing-is-living--working-for-a-lifetime-of-health-and-well-being
[5] REaching and grasping Training based on Robotic hybrid AssIstance for Neurological patients: End users Real life evaluation | RETRAINER
[6] Virtual Coaching Activities for Rehabilitation in Elderly | vCare
[7] https://research-and-innovation.ec.europa.eu/research-area/health/brain-research_en
[8] https://now.aapmr.org/virtual-reality-robotic-applications-in-rehabilitation

RTO Assessment of Systemic Gaps in Rehabilitation Capacity

There is a substantial **gap between the need for rehabilitation and the availability of services**, even in European countries with high levels of healthcare investment. Demand for rehabilitation is increasing rapidly due to several structural drivers:

- **Demographic shifts** (e.g., growing numbers of older adults in Europe)
- **Changing prevalence of health conditions** (e.g., rising chronic disease burden, mental health problems, cognitive decline, and insufficient prevention of neuro-cardiovascular risks)
- **Advances in medical care** (e.g., earlier detection and improved treatment leading to greater survivorship in conditions such as cancer)
- **Climate change impacts** (e.g., increased injuries associated with extreme weather events, landslides, and flooding)
- **Sociopolitical instability** (e.g., casualties linked to war and violence).

Rehabilitation technologies alone cannot close these systemic gaps. However, they can significantly improve the efficiency and reach of rehabilitation services, by supporting overstretched health systems, mitigating workforce shortages, and enhancing patient engagement, adherence, and continuity of care.

Barriers identified

There are several **barriers that hinder a complete innovation journey for rehabilitation** technologies. These barriers occur **across the entire development pipeline**: design, research, prototype development, clinical validation, cost-effectiveness evaluation, regulatory submission, market access, and scale-up. For many rehabilitation scenarios, the requirement for personalised rehabilitation solutions also creates a significant obstacle, as it limits the applicability of standard medical-technology development and commercialisation pathways. Below, we outline some of the key challenges.

1. Technology Development

1.1 Rehabilitation technologies need to be designed according to the needs of end users (patients, carers/families, clinicians, and the wider healthcare system) and with a clear understanding of where they fit within the care pathway. We observe frequent **gaps in understanding the full ecosystem in which a technology will ultimately be deployed**. For example, while developers may consider user needs and user experience at the device level, factors such as staff attitudes, workflow integration, or reimbursement models are often overlooked. These omissions can create downstream barriers to implementation and scaling.

1.2 Considerable attention is often given to user interfaces, but less to **system integration**. In practice, multiple technologies may need to be used by the same individual or service, yet the **degree of interoperability is typically low**. As a result, end users lack a unified platform for accessing technologies, and services cannot link data streams to adapt rehabilitation plans or monitor outcomes effectively.

1.3 These issues can be particularly challenging for vulnerable populations (e.g., individuals with learning difficulties, cognitive impairments, children, or older adults), who are often the primary beneficiaries of such technologies. In many cases, **human-factors** considerations are insufficiently addressed. For technologies not originally developed for these groups, adaptation requires rigorous investigation.

1.4 At the European level, the interpretation of Medical Device Regulation **(MDR) requirements** is often unclear, and when regulatory approval is required, obtaining it can be difficult and costly—even for simple, low-risk technologies. In addition, health technology assessment (HTA) functions under both national and EU frameworks: EU processes coordinate aspects of clinical assessment, while final decision-making remains national.

2. Technology Testing and Validation

2.1 Although there has been a proliferation of rehabilitation technologies, most have not been rigorously tested for safety or clinical effectiveness. Evidence frequently relies on small case reports, observational studies, or pilot studies that are underpowered, prone to bias, or reliant on multiple endpoints leading to false-positive findings. **Few technologies have undergone robust evaluation** using randomised controlled trials (RCTs).

2.2 Some developers and researchers have conducted preliminary cost–benefit analyses, but very few have produced **cost-effectiveness models suitable for decision-makers**, e.g., models incorporating quality-adjusted life years (QALYs) or broader societal perspectives such as reductions in disability allowances or sick leave.

2.3 A core challenge in validating rehabilitation technologies is that the clinical issues they address are highly heterogeneous. Technologies often need to be personalised to a patient's clinical condition, functional abilities, and life circumstances. Consequently, there is no "blockbuster" rehabilitation platform for a clinical indication area that can be widely deployed using standardised, validated protocols across diverse patient cohorts. More research is needed on **personalisation frameworks** and how to evaluate personalised rehabilitation technologies.

2.4 Despite these challenges, some rehabilitation techniques have achieved rigorous validation through innovations in RCT designs for complex interventions and through the development of transdiagnostic outcome measures[9,10]. Research timelines can be shortened when funders support integrated research programmes that include multiple parallel studies (e.g., an RCT combined with an implementation study), rather than sequentially funded small projects. **Multi-stage, multi-component rehabilitation studies** are costly and time-consuming but represent essential investments for faster, sustained uptake of rehabilitation technologies.

3. Technology Implementation and Sustainability

3.1 For rehabilitation technologies to be effective, they must be **embedded within the user's ecosystem**. This often requires individual behavioural change and cultural adaptation within care pathways.

3.2 End-user and stakeholder scepticism is common. Concerns relate to cyber-security threats, data privacy, and uncertainty about safety and efficacy in rehabilitation. Research is therefore needed to **understand user attitudes** and how these concerns can be addressed.

3.3 Training requirements for the effective use and maintenance of technologies are often not incorporated into research and innovation activities. Clinicians, for example, need to understand how specific technologies support rehabilitation outcomes before they can prescribe them confidently.

3.4 Reimbursement models for providing access to rehabilitation technologies remain unclear. Purchasers—whether hospitals, rehabilitation centres, municipalities, or individuals—often lack the information required to assess technologies based on maturity and evidence levels. Companies may claim effectiveness based on small case studies or RCTs, yet these represent fundamentally different levels of evidence. Research is needed on how to support purchasers in making informed decisions.

3.5 To enable start-ups and innovators to scale, new models are needed to support the development and deployment of rehabilitation technologies. Traditional rehabilitation technologies were developed by single companies operating in vertically integrated business models. By contrast, emerging rehabilitation technologies—sensorized, intelligent, and connected—require components that no single company can fully develop or manufacture. Creating **open technology platforms**, supported by public funding, can accelerate development by providing shared hardware and software building blocks that multiple companies can adapt. These platforms reduce cost and complexity, enabling faster market entry and wider patient access.

Main conclusions

Demand for rehabilitation is increasing rapidly, while the provision of rehabilitation services remains severely constrained by limited resources. Rehabilitation technologies offer an important **pathway to improving access to patient-centred rehabilitation**, optimising service delivery and healthcare resource allocation, and improving outcomes. However, significant **systemic barriers** remain that hinder the development, evaluation, and equitable scaling of these technologies.

- Rehabilitation **remains under-prioritised and under-funded**, both in healthcare service provision[11] and in research and innovation[12]. Health policy research shows that rehabilitation is not yet firmly embedded in health research and policy agendas and that persistent evidence gaps and limited financing strategies reflect a systemic under-investment in rehabilitation research relative to medical need[12,13]. For example, among the 112 topics included in EU Horizon Europe calls (primarily within Cluster Health for the period 2021–2025), only three explicitly mention rehabilitation. Furthermore, the 2025 Health Cluster work programme highlights habilitation and rehabilitation for disabilities within the destination *"Staying healthy in a rapidly changing society"*, yet these areas have not been funded to date under Horizon Europe[14].
- Research and innovation funding often prioritises the development of **novel technologies over the optimisation, adaptation, implementation, and scaling** of existing solutions. This imbalance risks inefficient use of public funding, leading to technologies that are insufficiently validated, poorly integrated into practice, or ultimately abandoned due to lack of funding for proper validation.
- **Insufficient stakeholder engagement** by technology developers and researchers can result in rehabilitation technologies that are not fit for purpose. This frequently leads to downstream implementation challenges and inefficient use of resources.

[9] https://pmc.ncbi.nlm.nih.gov/articles/PMC8628341/?utm_source=chatgpt.com
[10] https://www.tandfonline.com/doi/full/10.1080/09638288.2017.1339298
[11] https://www.bmj.com/content/384/bmj.q60
[12] https://link.springer.com/article/10.1186/s12961-022-00903-5
[13] https://pmc.ncbi.nlm.nih.gov/articles/PMC11070479
[14] wp-4-health_horizon-2025_en.pdf (page 19)

- Commercial pressures and shareholder interests may incentivise rapid market entry of rehabilitation technologies without rigorous, independent scientific evaluation. **Inadequate assessment of safety and efficacy** increases the risk of bias and undermines trust in these technologies.
- The absence of clear, evidence-based **procurement guidance for rehabilitation technologies** leads to opportunistic purchasing decisions. Such practices are unlikely to represent value for money and pose particular risks for healthcare systems operating under significant financial constraints.

Taken together, these conclusions point to a clear **need for targeted, system-level action**. While the challenges identified span policy, funding, research design, market dynamics, and implementation practices, they also highlight specific leverage points where coordinated interventions could have a meaningful impact. The following recommendations build directly on the preceding analysis and conclusions, focusing on measures that can strengthen the development, evaluation, deployment, and scaling of rehabilitation technologies in a sustainable, evidence-based, and equitable manner.

Recommendations

Based on our assessment and the barriers identified, we propose the following recommendations to improve the quality, reach, and impact of rehabilitation technologies in support of health and care systems in the EU and globally.

1. Strengthening the rehabilitation innovation ecosystem. Develop and support a dynamic innovation ecosystem to design, evaluate, and implement rehabilitation technologies. Procurement-driven innovation should be considered, whereby enabling end users to act as early adopters can stimulate the rehabilitation technology ecosystem. Committing funding to the uptake and adoption of emerging rehabilitation technologies would promote investment by both new and established companies, driving growth in the health technology sector. Such funding could be provided by the EC (e.g. through pre-commercial procurement programmes), regional governments, and public or private reimbursement agencies, including insurance providers.

2. Building skills and capabilities across the innovation lifecycle. Develop and share infrastructure to upskill technology developers, procurers, and researchers in (1) understanding user needs and experiences; and (2) designing and conducting high-quality research to assess the clinical and cost-effectiveness of rehabilitation technologies. This need is underscored by the fact that many Cochrane Reviews of rehabilitation interventions call for improvements in the quality of clinical trials.

3. Promoting technology-enabled rehabilitation service delivery. Service commissioners should encourage providers to use digital technologies to augment or replace selected elements of rehabilitation pathways and to deliver rehabilitation remotely, including in patients' homes (e.g. via telerehabilitation).

4. Supporting large-scale, longitudinal rehabilitation research. Research and innovation (R&I) funders should recognise the value of large-scale research programmes and acknowledge that such initiatives require sufficient time to deliver meaningful results. Rehabilitation should be integrated across the continuum of care in anticipated actions. Small-scale, short-term pilot studies may fail to produce implementable solutions and can delay real-world deployment. In contrast, well-funded, multi-stage studies can accelerate technology development, validation, and implementation. The value of such approaches has been demonstrated in Horizon 2020, where large-scale pilots[15] (LSPs) addressed societal challenges and supported digital innovation and policymaking, including in healthcare data sharing and Internet of Things (IoT) platforms[16].

5. Balancing innovation speed with sustained clinical validation. R&I leaders in technology-driven industries should balance rapid innovation and early testing with longer-term clinical validation and implementation to meet shareholder expectations while avoiding "boom-and-bust" technology cycles. This highlights the importance of funding the full lifecycle of technology development, testing, and deployment.

6. Establishing evidence-based procurement guidance. Develop clear procurement guidelines for rehabilitation technologies that are grounded in robust evidence of clinical and cost-effectiveness. Such guidance would also support reimbursement agencies, insurance providers, and individuals purchasing technologies directly, enabling more informed and value-based decisions.

7. Enabling proportionate and supportive regulatory pathways. Regulators should recognise their role in enabling—or inadvertently constraining—the development and evaluation of rehabilitation technologies. A more nuanced, proportionate approach is needed to balance potential risks with anticipated benefits.

8. Embedding user-centred and pathway-aware design. Rehabilitation technologies should be designed around end-user needs and with a clear understanding of their position within patient care

[15] Internet of Things Large Scale Pilots – Towards an Interconnected Society | Shaping Europe's digital future
[16] The Internet of Things in European healthcare | Shaping Europe's digital future

pathways. Early and sustained involvement of users and other stakeholders should be an integral part of technology development and evaluation.

9. Supporting modular and interoperable rehabilitation technology architectures. Create conditions that allow rehabilitation "software" to be customised while enabling mass production of assisting and monitoring "hardware" that can be shared across healthcare sectors. While rehabilitation technologies must adapt to diverse clinical needs, bespoke hardware for every patient is neither practical nor scalable. Developing common technological "building blocks" with adaptable software layers and interoperable hardware components can support scalability. This may require targeted funding calls to drive standardisation efforts and encourage compliance with open interface standards where available.

Taken together, the barriers identified in this report translate into a set of interconnected challenges spanning the full rehabilitation technology lifecycle—from design and validation to implementation and scale-up. These challenges are not isolated but systemic, arising at the interface between technology development, healthcare delivery, regulation, funding, and market dynamics. The recommendations that follow are therefore structured to respond to these challenges in a coherent manner, targeting key leverage points across the innovation ecosystem. Collectively, they aim to strengthen system readiness, improve evidence generation and decision-making, and support the sustainable and equitable deployment of rehabilitation technologies within health and care systems.

EARTO remains ready to provide additional input on the above-mentioned considerations and topics and to further discuss the implications of this input for the healthcare industry, RTOs and the complete health RD&I ecosystem with all involved stakeholders.

EARTO - European Association of Research and Technology Organisations
Founded in 1999, EARTO promotes RTOs and represents their interest in Europe. EARTO network counts over 350 RTOs in more than 32 countries. EARTO members represent 228,000 highly-skilled researchers and engineers managing a wide range of innovation infrastructures.

RTOs - Research and Technology Organisations
From the lab to your everyday life. RTOs innovate to improve your health and well-being, your safety and security, your mobility and connectivity. RTOs' technologies cover all scientific fields. Their work ranges from basic research to new products and services' development. RTOs are non-profit organisations whose core mission is to produce, combine and bridge various types of knowledge, skills and infrastructures to deliver a range of research and development activities in collaboration with public and industrial partners of all sizes. These activities aim to result in technological and social innovations and system solutions that contribute to and mutually reinforce their economic, societal and policy impacts.

EARTO Working Group Healthcare: *the WG is composed of 100 experts coming from 38 RTOs in 19 European countries. This WG is looking at the implementation of the EU RD&I Framework Programmes (Horizon Europe) addressing the healthcare sector, and especially medical technology, pharmaceuticals, biotech. Its members are conducting technological research for biomedical and medical applications, both for large companies and SMEs. They strongly support the emergence and the growth of spin offs in healthcare technologies. This WG is also looking at how RTOs can be involved in and benefit from projects under the European Digital Programme as well as the EU4Health programme, and also about the specific role of RTOs in Institutionalised Partnerships such as the Innovative Health Initiative.*

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