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THERAPY

THE MAGAZINE FROM THERA-TRAINER



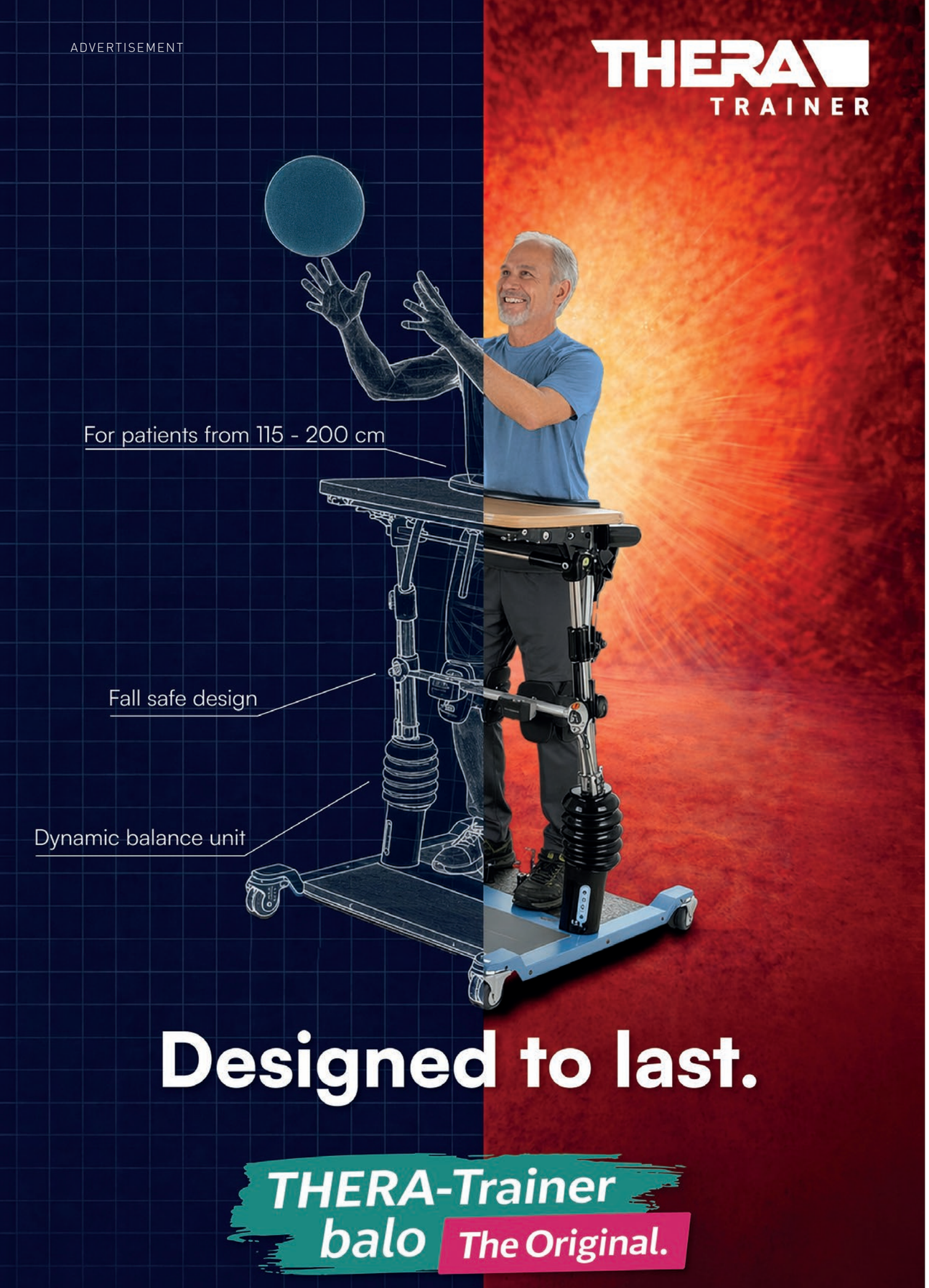
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FOREWORD

From Knowledge to Action

Dear readers,

Movement seems like something we can take for granted – until it is lost. Only then does it become apparent just how complex the interaction between motor control, sensory processing, cognition, balance and adaptability truly is. This becomes particularly evident in walking: what appears automatic in everyday life is the result of highly interconnected processes throughout the nervous system.

This issue of THERAPY takes up precisely this perspective. It spans the spectrum from the neurophysiological foundations of walking, movement and cognition through to fall prevention, exergaming, robotics and technology-assisted rehabilitation. One question runs through many of the contributions: How can scientific findings be translated in such a way that they genuinely make a difference in everyday therapeutic practice?

Evidence alone does not change care. Nor does a new technology. What matters is whether both can be integrated into clinical decision-making, meaningful treatment pathways and sustainable care structures. Modern rehabilitation technologies in particular only realise their full value when they enable the right patients, at the right time, to engage in training that is sufficiently intensive, specific and transparent.

For me, it is precisely this connection between science, clinical practice and implementation that makes modern rehabilitation so fascinating. It requires us to question established routines, place new findings in context and understand technology not as an end in itself, but as a tool for better care.

I hope you find this issue insightful – and that it provides as many impulses as possible to help turn knowledge into action.

Best regards,
Jakob Tiebel



Walking is networking



Fall prevention in geriatrics



Safe verticalisation, active training



When movement becomes possible again

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THERAPY & PRACTICE

When the brain and body train together

How one facility is redefining rehabilitation with the OmniCycle® Connect

Accelerated Care Plus (ACP)



She was determined to get out of her wheelchair.

At a long-term care facility in Schaumburg, Illinois, USA, a former world traveler's determination to leave her wheelchair behind captures everything modern rehabilitation technology can make possible when the right tool engages the brain and the body together.

As a former airline employee, she had visited more than 30 countries. When the therapy team at Bella Terra Schaumburg asked where she wanted to go on the facility's OmniTour™ – a virtual cycling environment that immerses patients in real-world destinations—she didn't hesitate. Her choice: Buenos Aires.

Within moments, she was cycling. Her legs turned the pedals of an OmniCycle® Connect while the OmniTour filled with the streets of one of her favorite cities in the world. Karin O'Donnell, a Clinical Program Consultant with Accelerated Care Plus (ACP), was there for the session. What struck O'Donnell wasn't just the resident's smile. It was what she said before the session ended: she was determined to get out of her wheelchair.

This session is just one example of the opportunities the OmniCycle Connect creates for residents – and highlights the foundation around which the Bella Terra Schaumburg team has structured their approach.

A gym built around the patient

Bella Terra Schaumburg is a 150-plus-bed skilled nursing and long-term care facility in Schaumburg, Illinois. It serves a mixed census of subacute, long-term, and memory care residents. When the facility remodeled its first floor, rehabilitation received prime real estate — a bright, open gym visible from the main entrance. At its center sit two OmniCycle Connect units that are in use from the first group therapy warm-up of the morning to the last restorative session of the afternoon, serving skilled patients, long-term residents, and everyone in between.

Accessible by design

The OmniCycle Connect is built for patients of all abilities. Motor-assist technology automatically adjusts to the patient's effort, supporting those with significant deficits while progressively challenging those nearing discharge. Assisted, active-assisted, active, and isokinetic exercise modes allow therapists to match the intervention to each individual, whether that means a gentle active-assisted session for a frail long-term resident or a high-resistance challenge for a patient preparing to go home.

Bluetooth enables both units to connect to the OmniTour, allowing the team to layer cognitive and motivational challenges. But the foundation of the tool is the cycle itself.

Biofeedback as a clinical tool

The OmniCycle Connect's biofeedback interface displays real-time performance data throughout each session. Left-right limb symmetry, active engagement percentage, motor output, and duration are all visible to the patient and therapist via touchscreen.

Rick Camacho, MOT, OTR/L, Director of Rehabilitation at the facility, has seen how that visibility changes motivation. When patients finish a session and see the difference in output between their stronger and weaker sides, education hap-

Getting them to keep showing up is where outcomes are made or lost.



pens naturally. Patients leave with a clearer understanding of their own deficits and a concrete goal for the next session. That understanding, Camacho notes, empowers them to want to do more.

Dual-Task training: engaging the whole patient

Cycling's benefits extend well beyond the musculoskeletal. Aerobic cycling increases blood flow to the brain, with associated improvements in coordination, planning, and memory.[1] The OmniCycle Connect's biofeedback interface adds a cognitive aspect to every session, allowing patients to monitor their own performance and self-regulate their effort throughout.

By pairing the OmniCycle Connect with the virtual cycling environment, the cognitive demand increases further. Patients process dynamic visual information, make navigational choices, and often engage in conversation with staff or fellow patients. Camacho describes the combination of physical resistance and mental engagement as the most impactful way to use the technology.

The OmniCycle Connect delivers on all of these. But the case for the technology at Bella Terra Schaumburg is also a human one.

Motivation, socialization, and the long game

In post-acute rehabilitation, getting patients to show up is only half the challenge. Getting them to keep showing up is where outcomes are made or lost. With two OmniCycle Connect units running simultaneously in a shared OmniTour environment, group therapy sessions become a social experience as much as a clinical one. Camacho recalls one session in which two residents, one from the memory care unit, began chatting about places they had visited; a conversation prompted by their shared experience. On subsequent visits, they looked for each other, knowing the gym was where they would meet. For the therapy team, that kind of connection is just the cherry on top.

The moment that started it all

Rehabilitation technology is evaluated on clinical specifications: exercise modes, biofeedback capabilities, adaptability across patient populations, and documentation support. The OmniCycle Connect delivers on all of these. But the case for the technology at Bella Terra Schaumburg is also a human one. The resident and former world traveler who chose Buenos Aires – cycling through familiar streets, her legs moving against resistance she could see and feel – stated her goal without hesitation.

She was determined to get out of that wheelchair. And the team at Bella Terra Schaumburg had exactly the right tools to help her try.

Accelerated Care Plus (ACP) | www.acplus.com

Camacho describes the combination of physical resistance and mental engagement as the most impactful way to use the technology.

Info:

Accelerated Care Plus (ACP) is a leading provider of rehabilitation technology and clinical programs for post-acute care settings. The OmniCycle Connect and OmniTour are exclusively available through ACP for skilled nursing and assisted- and independent-living markets in the United States. The OmniCycle Connect is the U.S. market version of the THERA-Trainer tigo. For more information, visit acplus.com.

Source

[1]Leyland, L. A., Spencer, B., Beale, N., Jones, T., & van Reekum, C. M. (2019). The effect of cycling on cognitive function and well-being in older adults. PloS one, 14(2), e0211779. https://doi.org/10.1371/journal.pone.0211779

SCIENCE

Exercise exercises the brain too

What the largest evidence synthesis to date reveals about cognitive-motor training

Jakob Tiebel

It is well established that physical activity promotes physical health. A comprehensive scientific analysis now reveals just how closely physical activity is linked to cognitive performance. The umbrella review by Singh et al., published in the British Journal of Sports Medicine in 2025, brought together 133 systematic reviews comprising 2,724 randomised controlled studies and a total of 258,279 participants. This makes it one of the largest evidence syntheses to date on the influence of physical activity on cognition (Singh et al., 2025).

Across different age groups, health conditions and forms of exercise, physical training significantly improved global cognition, memory and executive function. The average effects were greatest for global cognition and generally fell within the small-to-moderate range:

- Global cognition: SMD = 0.42
- Memory: SMD = 0.26
- Executive functions: SMD = 0.24

Movement also improves memory, attention and executive functions.

The positive results remained robust even when reviews of low or critically low methodological quality were excluded from the analyses. Physical activity is therefore relevant not only to mobility, strength and endurance, but also makes a measurable contribution to cognitive health across various life stages and health conditions (Singh et al., 2025).

Even low-intensity physical activity can have a beneficial effect on cognitive function

One finding of particular relevance to clinical practice concerns training intensity. The effects tended to be even greater for low- and moderate-intensity interventions than for high-intensity programmes. Cognitive enhancement therefore does not necessarily require maximal physical exertion. Even training programmes tailored to individual physical capacity can provide relevant cognitive stimulation (Singh et al., 2025).



Exergames directly combine physical activity with cognitive challenges.

In terms of individual training sessions, the researchers found no clear-cut differences attributable to training frequency, session duration or weekly training volume. Programmes with a total duration of one to three months, however, demonstrated greater cognitive improvements in subgroup analyses than longer-term interventions. This suggests that even modest and consistently implemented training periods can trigger meaningful changes (Singh et al., 2025).

Exergames with particularly interesting results

Among the forms of exercise examined, exergames achieved the greatest pooled effects on global cognition and memory. Exergames are digital training games in which tasks are completed not merely by pressing a button, but through active physical movements (Singh et al., 2025).

These findings are of particular interest in the field of rehabilitation. Exergames can combine physical activity with cognitive demands such as attention, reactvity, perception, working memory and decision-making. It is precisely these skills that are required for individuals to move safely through complex activities of daily living.

Walking, climbing stairs or avoiding an obstacle are not purely motor processes. At the same time, information from the environment must be processed, movements planned, balance maintained and actions adjusted at short notice as required. Successful mobility is therefore always dependent on cognitive performance as well.

The connection to the THERA-Trainer senso

The THERA-Trainer senso specifically applies this principle. The interactive training system combines stepping movements and weight shifts with visual and auditory tasks. Integrated sensors detect movements and contact on the training platform. Users complete tasks by, for example, performing targeted steps, shifting their centre of gravity, or responding to changing shapes, colours and signals (Keifert et al., 2023).



In this way, the senso precisely replicates the connection between physical activity and cognitive load for which the umbrella review shows particularly compelling findings. During an exercise session, motor and cognitive demands must be managed in parallel. Balance, coordination and stepping movements are linked to attention, reaction, decision-making and the processing of visual information.

The focus is therefore not on isolated single-muscle training, nor on purely seated cognitive exercises. Training with the THERA-Trainer senso challenges the body and brain within a single activity.

The training software continuously adapts the level of difficulty to the individual's performance level. This allows patients to train within an appropriate challenge level. Interactive feedback, a range of therapeutic games and documentable training progress support individual, progressive training design (THERA-Trainer, n.d.).

From playful engagement to therapeutic task

The playful nature of the senso is not an end in itself. Exergames can enable a high number of repetitions, provide immediate feedback and direct attention towards a concrete goal. The movement is often performed implicitly: rather than focusing exclusively on correct movement execution, the patient directs their attention towards the task within the game.

This allows movements to be practised under conditions that more closely resemble typical activities of daily living. The individual must divide their attention, respond to changes and adapt their movements accordingly. In this way, training with the THERA-Trainer senso can create dual-task situations that place concurrent demands on cognitive and motor processes (Keifert et al., 2023).

Therapy can be tailored to focus on specific goals, for example:

- Balance control under conditions of divided attention
- Targeted and rapid step reactions
- Coordination of perception and movement
- Response to changing environmental stimuli
- Cognitive flexibility and decision-making ability
- Stability in dual-task situations

The THERA-Trainer senso therefore provides a structured technical environment in which physical activity is not separated from cognitive challenge. It is this combination that appears particularly relevant in light of current research findings.

Scientifically compelling and clinically applicable

The umbrella review by Singh et al. examined exercise and exergames in general terms and does not provide isolated evidence of efficacy for any single training device. Their findings, however, provide a robust scientific foundation for the training principle underlying the THERA-Trainer senso: cognitive function can be enhanced through physical activity – and it is specifically the combination of movement and interactive cognitive tasks that demonstrates the most promising therapeutic effects.

The senso translates this principle into practical use within rehabilitation. It enables tailored, motivating and quantifiable training that simultaneously challenges perception, decision-making and movement This creates favourable conditions for the targeted training of cognitive-motor skills and their subsequent transfer into activities of daily living.

Targeted training of body and mind, together.

Conclusion

The most comprehensive evidence synthesis on exercise and cognition to date shows that physical activity not only improves physical function but also supports global cognition, memory and executive functions. Of particular interest are the findings on low- to moderate-intensity training modalities and movement-based exergames.

The THERA-Trainer senso translates these findings into a modern therapeutic training concept. The interactive combination of stepping movements, balance, attention and reaction challenges both the body and the brain. This transforms movement into targeted cognitive-motor training, with direct relevance to mobility, independence and the management of complex activities of daily living.

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SCIENCE

How the brain monitors our movements

How the brain controls hand and whole-body movements – and what insights this provides for postural control and rehabilitation.

Jakob Tiebel



When the body acts without our conscious observation

Picture yourself standing in the kitchen, reaching for a cup. You might be careful not to knock over the hot kettle. However, how you shift your weight, which grip you select, or which muscle activates first largely remains outside your conscious awareness. Nevertheless, you perceive the movement as unmistakably your own: it is you who reaches for the cup – not someone else, not by chance.

Researchers refer to this experience as the sense of agency: the feeling of being the author of one's own actions.

A research team led by Oliver Kannape and Olaf Blanke at EPFL Lausanne examined this phenomenon, in a study published in the journal iScience in 2026, from a perspective that had received little scientific attention until now. The key question was: Does the brain use the same monitoring system, regardless of whether we are moving our hand or our whole body? Or do body part-specific systems exist – for instance, one for the hand and another for the trunk?

The idea behind it

From everyday experience, it initially appears plausible that hand movements and whole-body movements are controlled differently. After all, they differ markedly in their complexity, degrees of freedom, and the muscle groups involved.

Fundamental motor research has, however, provided evidence for decades that movements are represented in the brain, at least in part, at a more abstract level. So a signature remains recognisable in its characteristic features, even when it is drawn not with the hand but, for example, with the foot in the sand. The motor scientist Karl Lashley described this phenomenon as early as the 1930s as *motor equivalence*.

The team led by Kannape applied this idea to the experience of one's own agency. This study was the first to examine, in the same participants and within the same experimental task, how the sense of agency changes when a comparable target movement is performed using the hand versus the whole body.

The methodological key: the THERA-Trainer coro

To compare hand and whole-body movements, the researchers required an experimental setup that would allow both movement types to be examined under conditions as similar as possible: safe, reproducible and precisely measurable.

For this purpose, they used the THERA-Trainer coro. The participants stood upright and were secured at the pelvis. The device's spring elements enabled controlled displacements in all directions and subsequently returned the body to its starting position. At low resistance, this mechanism functioned effectively as a joystick.

Integrated inertial sensors captured the tilt of the frame at a sampling rate of 30 measurements per second. Additionally, a joystick was mounted directly onto the device. This allowed participants to perform the same task using either the hand or a shift of the entire body, without altering position, gaze direction or the experimental environment.

The coro therefore functioned not only as a safety system, but also as a standardised interface for the controlled recording of whole-body movements.

Postural control is more than just muscle strength and reflexes.

THERA-Trainer coro: a bridge between neuroscientific knowledge and clinical application.

The experiment

22 healthy adults steered a cursor towards a target point, either by means of a joystick or by tilting the body in the coro. In a substantial proportion of trials, the displayed direction of movement was covertly altered by 7.5 to 30 degrees. Participants then assessed whether the visible movement corresponded to their actual hand or body movement.

In half of the trials, an additional cognitive dual task was introduced. This allowed the researchers to examine whether cognitive load influences the perception of one's own movement.

The results

With unaltered feedback, participants correctly identified their movement in approximately 90 per cent of cases. No significant difference was found between hand movements and whole-body movements.

The individual perceptual thresholds were also closely correlated with one another: individuals who reliably detected deviations in hand movements generally also detected them in whole-body movements. The strong correlation of r = 0.71 points to a shared mechanism of action control that is largely independent of the effector involved.

Differences emerged primarily under more demanding movement conditions. Under these more demanding conditions, perception proved more sensitive during whole-body movements. The researchers suggest that, in such situations, the brain relies more heavily on body-part-specific information, such as vestibular and proprioceptive signals.

In an additional task without visual feedback, participants steered towards the target even more accurately using the body than using the hand. The mean deviation was 18 millimetres for whole-body movement, compared with 26 millimetres for hand movement.

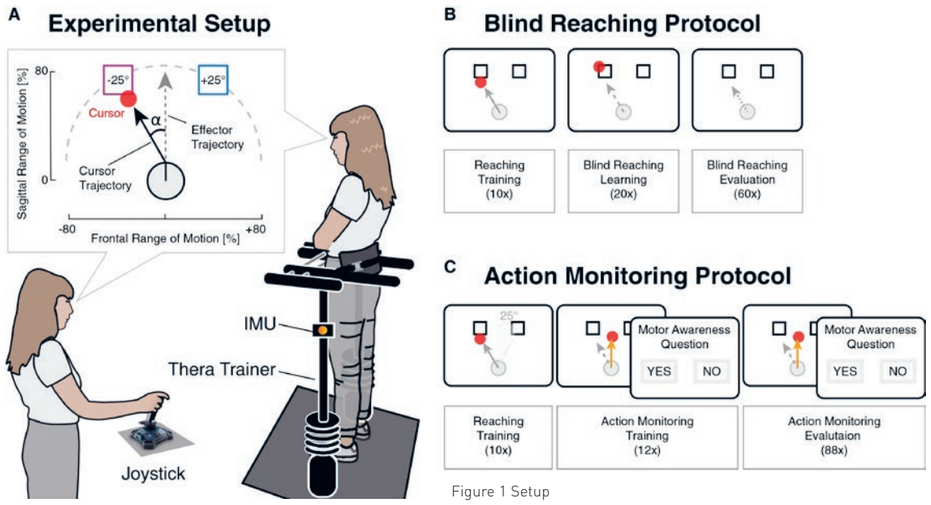


Figure 1 Setup

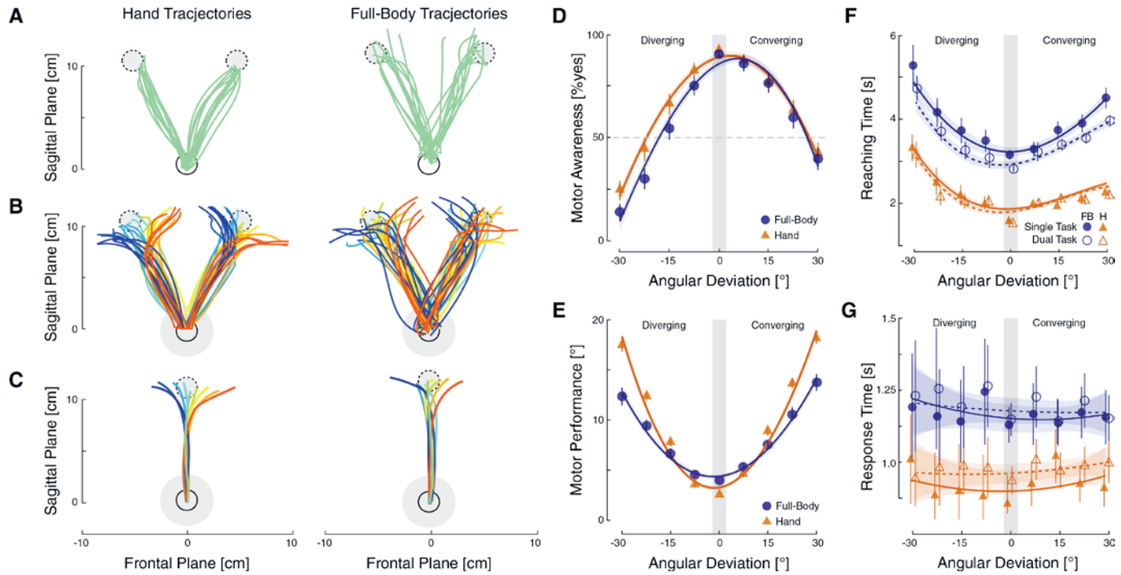


Figure 2 Motor performance

Significance for research and rehabilitation

The findings support a hierarchical model of movement control: the brain initially monitors actions according to their goal, largely independent of the body part executing the movement. It is only under conditions of increased demand that specific sensory feedback signals gain greater importance (sensory weighting). For rehabilitation, this supports a task-oriented approach. After neurological injury, it is therefore advisable not to focus exclusively on training individual muscles or movement segments, but rather to train goal-directed actions under varying sensory and cognitive demands.

The study also demonstrates the potential of the THERA-Trainer coro as a research platform. The device enables whole-body movements to be safely standardised, precisely captured, and combined with visual or cognitive tasks. This opens up further potential applications, for example in the assessment of balance disorders, dual-task demands, or changes in postural control over the course of neurological rehabilitation.

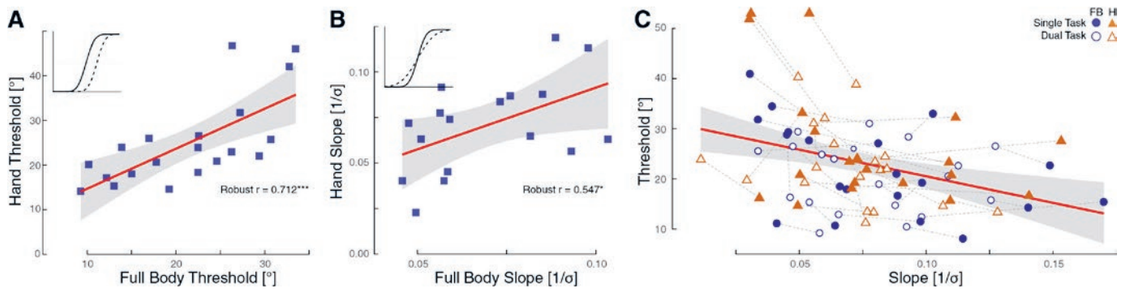


Figure 3 Motor awareness and psychophysics

What do these findings mean for postural control therapy?

The study was conducted with healthy adult participants and therefore does not permit direct recommendations for therapeutic practice. However, it provides plausible starting points for neurological and geriatric rehabilitation.

Task-oriented training of postural control

The findings suggest that movements are initially monitored according to their goal, largely independent of the body part executing them. For therapy, this supports a task-oriented approach: The focus lies on functional goals such as targeted weight transfer, reaching a target point or postural stabilisation — rather than the isolated activation of individual muscles.

An external attentional focus can support this goal-orientation, for example through tasks such as: "Move the cursor to the target" or "Shift your weight to the affected side".

Using the trunk as a precise effector

In a task without visual feedback, participants steered towards the target even more accurately using the body than using the hand. The trunk is therefore not only responsible for stability, but can also be employed with precision and purpose.

Weight shifts can accordingly be trained as differentiated movement tasks. The THERA-Trainer coro enables such movements to be performed safely, recorded via sensor technology, and documented in a comparable manner throughout treatment.

Incorporating proprioceptive awareness

Postural limitations may encompass sensory and perceptual components in addition to motor ones. What matters is not only whether a movement is successfully executed, but also whether patients adequately perceive its direction and extent.

Visual feedback can be used to support this perception and to reveal discrepancies between intended, executed and perceived movement. Whether targeted feedback manipulations are diagnostically or therapeutically effective in neurological patient groups, however, must be investigated separately.

Gradually increasing task demands

Under more demanding movement conditions, body-part-specific sensory information became increasingly significant. This suggests a systematic progression for therapy: from stable, visually supported tasks towards higher sensory, coordinative and cognitive demands.

Possible variations include altered bases of support, reduced visual input, head movements or additional cognitive tasks. This is contingent upon the demands being tailored to the functional level and safety profile of patients.

Safety creates room for manoeuvre

Fear of falling can diminish movement, encourage avoidance strategies and prevent full exploitation of functional boundaries. A secure training environment enables larger weight shifts and more demanding tasks to be trialled, without the fear of falling dominating movement.

The THERA-Trainer coro combines this safety with measurable whole-body movements and the possibility of incorporating visual or cognitive tasks.

Key message for clinical practice

Postural control encompasses more than muscle strength and balance reactions. It is based on the interplay of movement target, sensory feedback, body awareness and cognitive processing. Rehabilitation should integrate these components within functional tasks of progressively increasing demand.

The THERA-Trainer coro offers a controlled environment in which whole-body movements can be performed safely, directed with precision and quantitatively recorded.



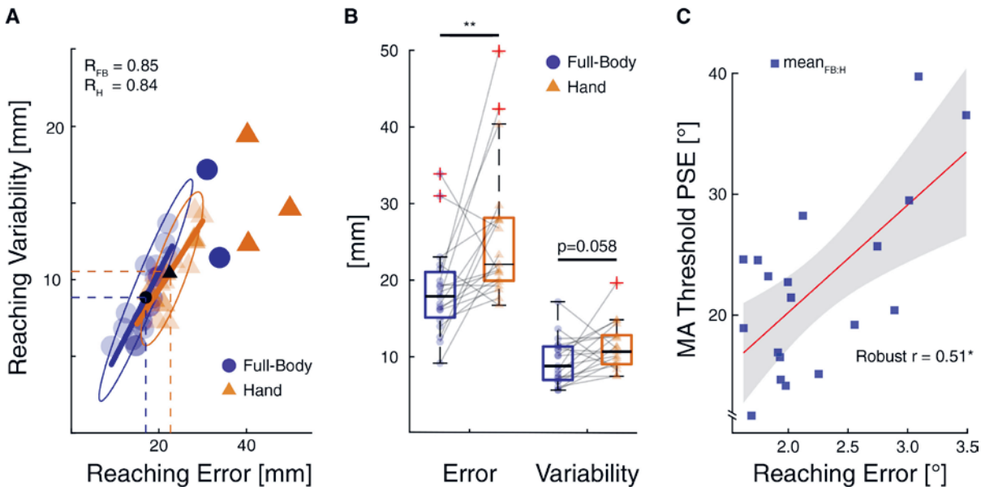


Figure 4 Blind reaching

When everything runs smoothly, the brain operates on an abstract representation of movement.

Conclusion

The sense of being the author of one's own action does not appear to be tied to a specific body part. The first crucial factor is whether the outcome of a movement corresponds to the intended goal. Under more challenging conditions, the brain augments this abstract control with specific sensory input.

The THERA-Trainer coro enabled this comparison to be examined experimentally, as it allowed whole-body movements to be captured safely, reproducibly and with precise measurement control.

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SCIENCE

Moving individually despite dementia: A combined training program that works in nursing homes



A recent study published in the Journal of Aging Research & Lifestyle shows that a 10-week, individually tailored exercise program led by physiotherapists is feasible for nursing home residents living with dementia.

Dennis Boer

Exercise Training for Nursing Home Residents with Dementia: Current Evidence and Challenges

Dementia is highly prevalent among nursing home residents and affects between 42% and 84%, depending on the country and type of facility. [1] In addition to cognitive impairments, the condition is frequently associated with reduced mobility, decreased muscle strength, impaired balance, and lower endurance. [2] These factors increase dependence in everyday activities as well as the risk of falls. [3]

Guided exercise programs are therefore widely used and recommended by both professional societies and patients. However, training programs for people with dementia vary substantially in their content, intensity, supervision, and dosage, which complicates comparisons across studies and weakens the evidence base. [4] Moreover, many interventions do not meet international guidelines regarding training frequency, duration, and the combination of endurance, strength, balance, and flexibility components – raising concerns about their therapeutic validity. [5] Low adherence further limits their potential effectiveness.

Exergaming – combining physical exercise with interactive, cognitively stimulating elements – may help increase engagement and adherence. However, the feasibility of a guideline-based, therapist-supervised program incorporating exergaming components has so far been insufficiently examined for nursing home residents with dementia.

Study Design and Intervention

The aim of the presented study was therefore to assess the feasibility of such an intervention before evaluating its effectiveness in subsequent research.

Between February and June 2025, a single-arm observational feasibility study was conducted across two sites of a nursing home organization in Haarlem, the Netherlands. The study design followed the extended CONSORT guidelines for feasibility studies. Residents diagnosed with dementia who were able to walk at least 50 meters with or without a walking aid and who had a generally positive attitude toward exercise such as cycling were included, ensuring that participation in the study and the exercise program was voluntary.

The intervention spanned ten weeks and comprised four weekly training sessions. Two of these were 45-minute group classes focusing on strength, balance, and flexibility. In addition, participants completed two individual 20-minute exergaming cycling sessions on a THERA-Trainer tigo 562, using virtual, interactive cycling routes provided by BikeLabyrinth.

Feasibility Criteria

Primary feasibility criteria included completion of at least 80% of clinical assessments, an adherence rate above 75%, and the absence of serious intervention-related adverse events. Secondary outcomes included the recruitment rate, participant ratings of the training sessions, and caregivers' experiences in supporting the intervention.

Results of the Feasibility Study

The intervention met all predefined feasibility criteria and demonstrated high adherence and acceptance compared with previously published exercise programs for individuals with dementia. Participation rates were well above those reported in earlier meta-analyses (62.3%) [6] and higher than adherence observed in therapist-led programs (73–75%). [7,8]

The recruitment process, however, proved challenging due to strict inclusion criteria and organizational factors. Since many training components can be performed even with limited mobility, adjusting the criteria—such as requiring only the ability to independently rise from a chair—could improve future recruitability. The sessions were generally rated as pleasant or very pleasant. No serious adverse events occurred, and fewer than 10% of the minor events were considered possibly related to the intervention, primarily fatigue. Whether fatigue should be categorized as an adverse event is debatable, as it represents a typical response to moderately intensive exercise. [9]

Conclusion

The 10-week training program—combining traditional exercises with exergaming cycling—demonstrates that such an approach is feasible, safe, and consistently experienced as positive by nursing home residents with dementia.

Table 1: Characteristics of eleven nursing home residents with dementia participating in an observational study on a 10-week exercise program.

Characteristics	Median and range	Number (%)
Age	84 (71-96)	
Gender (female)		8 (84.2%)
Length of stay (months)	16 (2-95)	
Dementia type		
Alzheimer's disease		6 (54.5%)
Vascular		1 (9.1%)
Mixed Alzheimer's diseaseand vascular		1 (9.1%)
Other		3 (27.3%)
Use of walking aid (yes)	3 out of 11	
Rolling walker	3 (100%)	

Info

Read the Original Publication
https://www.sciencedirect.com/science/article/pii/S2534773X25000436



Dennis Boer is a physiotherapist and junior researcher whose work focuses primarily on physiotherapy for nursing home residents with dementia. He is affiliated with the aged care organisation Kennemerhart in the Haarlem region of the Netherlands, and with Leiden University Medical Center.

Figure 1: Study flow including recruitment, study length and study procedures

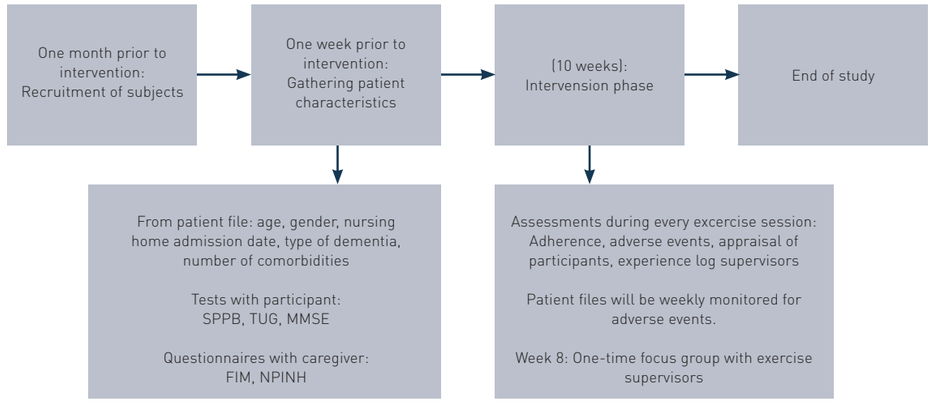
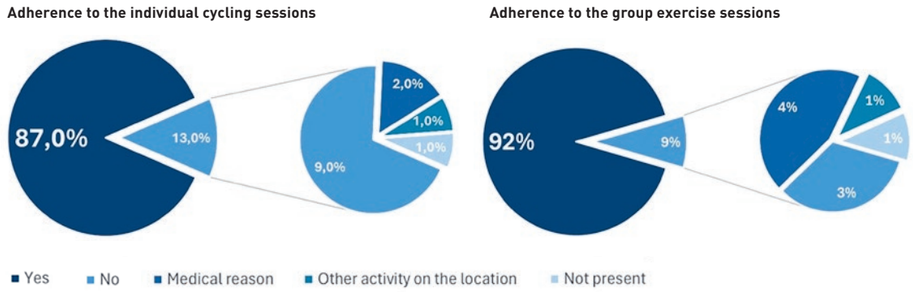


Figure 2 and 3



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THERAPY & PRACTICE

Fall prevention in geriatrics

Cognitive-motor training with the THERA-Trainer senso in geriatric rehabilitation – an insight into clinical practice

Vanessa Haug & Thomas C. Kosiolek

Falls are among the most common health risks in older age. Cognitive-motor training can simultaneously enhance balance, mobility and cognitive function. This article introduces the THERA-Trainer senso and, drawing on practical experience, illustrates its use in geriatric rehabilitation at the AGAPLESION BETHESDA KLINIK ULM.

Fall prevention as a key challenge of geriatrics

As the population continues to age, fall prevention is becoming increasingly important. Approximately one third of all people over the age of 65 fall at least once per year (Hagedoorn et al., 2025; Xu et al., 2022). The consequences range from injuries and fractures to long-term restrictions in mobility and independence. Furthermore, falls frequently lead to fear of falling and withdrawal from physical and social activities. This resulting inactivity, in turn, heightens the risk of subsequent falls (Xu et al., 2022).

As the maintenance of balance depends on the interplay of sensory, cognitive and motor processes, older adults with cognitive impairments in particular may struggle to respond appropriately to changing environmental demands. Consequently, the risk of falling is particularly high in this population group (Perreira & Kanashiro, 2022). The aim of geriatric rehabilitation is therefore to improve mobility and balance and to preserve them for as long as possible.

Cognitive-motor training through exergaming

With advancing age, muscle strength and cognitive function decline (Cruz-Jentoft et al., 2019; Popescu et al., 2024). As everyday movements demand both physical and cognitive performance, training approaches that simultaneously address both domains are gaining increasing importance (Hortobágyi et al., 2021).

“Studies show that training with the THERA-Trainer senso can improve balance and mobility and is well accepted by older people.”





“Patients are also able to train independently following an introductory session. This fosters self-efficacy and eases the burden on the therapeutic team.”

Exergaming is an established form of training. It combines movement tasks with digital gaming elements. In addition to balance, strength and coordination, exergaming also trains attention, reactivity and decision-making (Chen et al., 2021; Monteiro-Junior et al., 2016). Studies demonstrate positive effects on mobility, balance and fall risk, together with high training motivation attributable to the game-based design (Sadeghi et al., 2021; Doherty et al., 2024).

The article “Measuring, training, motivating” on the AS-Tra project (p. 30 in this issue) also demonstrates how digital assistance systems can be used to monitor physical activity, deliver targeted training support and enhance patient motivation throughout the therapy process.

The THERA-Trainer senso as a training system

The THERA-Trainer senso is an exergaming system designed specifically for older people. On a sensor-based platform, stepping movements and weight shifting are combined with cognitive tasks, allowing balance, reactivity and cognitive function to be trained simultaneously. The training demands can be individually adjusted. Studies show that training with the THERA-Trainer senso can improve balance and mobility and is well accepted by older people. The system therefore offers a practical means of incorporating cognitive-motor training into fall prevention protocols (Manser et al., 2023; Yang & Lee, 2026).

Integration into daily clinical practice

The senso has been firmly integrated into the training room at AGAPLESION BETHESDA KLINIK ULM. Access to the device is controlled via personalised RFID cards, which are also used for the strength training equipment. Bespoke training programmes can be configured and saved during initial setup. This ensures the senso is seamlessly integrated into existing training regimens, and patients are able to train independently following an introductory session. This fosters self-efficacy and eases the burden on the therapeutic team. In addition, short set-up times allow for more efficient use of therapy time, benefiting the patient.

Handrails on the device are available to ensure safe transfer and initial stabilisation. This facilitates entry, particularly for patients using a rollator or transferring from a wheelchair. The longer-term aim, however, is to progress towards training that is as unassisted and closely aligned with everyday activities as possible.

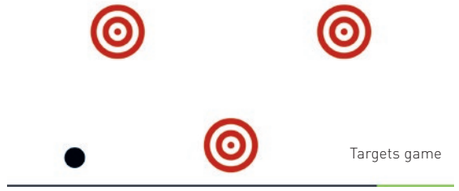
Training design and therapeutic benefits

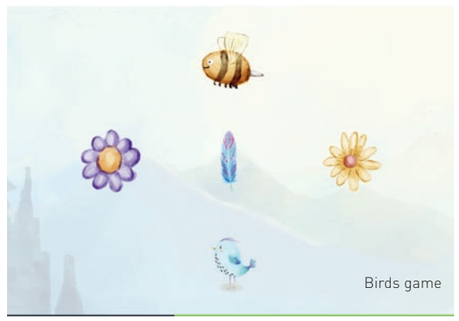
The senso is employed in both individual therapy sessions and Medical Training Therapy. Popular games include Simple, Targets and Birds. By combining stepping movements and weight shifting with cognitive tasks, balance, attention, reactivity and action planning are trained simultaneously. The automatic difficulty adjustment enables individualised load control.

A key advantage of the system is the clear, visual evaluation of training results. Progress is immediately visible and can be easily tracked by both patients and therapists. This direct feedback has a motivating effect and supports long-term training adherence. Further notable benefits include the ease with which the device can be cleaned, as well as the effective support it offers during patient transfer onto the training platform.



Evaluation of training outcomes using “Targets” as an example





To progress training, elastic resistance bands, balance cushions and functional supplementary tasks such as squats, obstacle negotiation, and throwing and catching exercises are employed. This creates varied training with high relevance to activities of daily living.

“Progress is immediately visible and can be easily tracked by both patients and therapists.”

Practical experiences and challenges

Challenges arise primarily for patients with pronounced cognitive or sensory impairments. The automatic game continuation feature supports independent use, as games proceed without requiring further input from the patient. Occasionally, internet connectivity issues can also impede the training process. The integrated assessments and training plans offer considerable potential for training control and progress documentation; however, this potential has not yet been fully utilised in our day-to-day clinical practice.



“Overall, it is clear that the senso can be integrated very effectively into everyday geriatric rehabilitation practice.”

Conclusion:

Overall, it is clear that the senso can be integrated very effectively into everyday geriatric rehabilitation practice and is positively accepted by both patients and therapists. The system facilitates motivating, individually tailored training of balance, mobility and cognitive function, thereby addressing key risk factors for falls. Experience to date demonstrates that exergame-based training modalities are also feasible for implementation with geriatric patients and represent a valuable adjunct to established therapeutic approaches.

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SCIENCE

Measuring, training, motivating

Assistive technology systems for promoting nutrition and mobility in older age: contextualising the AS-Tra project (THERAPY 2024-I) within current research

Jakob Tiebel

The review article by Förster, Happe and colleagues on the AS-Tra project, published in THERAPY 2024-I (Förster et al., 2024), outlines the development and iterative optimisation of a self-administered assessment and training system designed for elderly people aged 70 and above. This article situates the initiative within the now burgeoning field of digital health interventions for older adults at risk of sarcopenia and frailty. Between 2024 and 2026, several systematic reviews and meta-analyses have been published, reporting predominantly positive – albeit heterogeneous – effects of digital interventions on muscle function, balance and mobility (Dai et al., 2025; Chen et al., 2025; Makizako et al., 2025). Central components of the AS-Tra system – the instrumented timed up and go test, digital dynamometry and exergaming via force measurement platforms – have each been independently validated in parallel studies (Böttinger et al., 2024; Polo-Ferrero et al., 2026; Leung et al., 2026). The working group's own follow-up publications confirm the developmental rationale outlined in THERAPY 2024-I: By the third iteration, usability reached a "good" level (Förster et al., 2026a), and a four-week pilot study demonstrated feasibility under real-world conditions (Förster et al., 2026b). At the same time, it is becoming evident that two questions left unresolved in the original article – behaviour change based on the transtheoretical model, and effectiveness under real-world conditions – continue to be only partially supported by current international research findings (Fawole et al., 2025).

Starting point: the AS-Tra system

Förster et al. (2024) describe the AS-Tra project (Assistance System for Sustainable Improvement of Nutritional and Mobility Status of Older People Aged 70 Years and Older Under Consideration of the Transtheoretical Model of Health Behavior Change) as an assistive technology system comprising two central components: a tablet-based app and a measurement and training station (MuTS). The MuTS comprised pulse measurement, handgrip strength measurement, an automated TUG chair (aTUG-Chair) and the THERA-Trainer senso as an interactive training device. The target group comprises independently living elderly people aged 70 and above with early signs of malnutrition or mobility deficits (Happe et al., 2024). Requirements and preferences of the target group were systematically collected across five focus groups involving n = 21 participants (mean age 78.5 years) (Happe et al., 2024); THERAPY 2024-I reports an improvement in System Usability Scale (SUS) scores across the first two cycles of structured usability testing, increasing from 70.63 to 84.55 – progressing from "acceptable" to "good". The planned next steps comprised simulated independent use, a field pilot study and, finally, a two-arm RCT.

This roadmap, outlined in THERAPY 2024-I, can now be cross-referenced with the working group's follow-up publications from 2025/26, together with concurrent reviews from the international field.

New developments between 2024 and 2026

Meta-analytic evidence for digital health interventions in sarcopenia and frailty

The article in THERAPY 2024-I argues primarily at a conceptual level that assistive technology systems could enable early detection and prevention (Förster et al., 2024). This assumption can now be tested quantitatively. To date, the most comprehensive meta-analysis synthesises 16 RCTs involving older adults with frailty or sarcopenia, identifying significant effects of digital interventions on muscle mass (WMD 1.01; 95% CI 0.08–1.94), gait speed (WMD 0.09), timed up and go test (WMD –0.52 s), 30-second chair stand test (WMD 2.19), balance (SMD 0.61) and quality of life (Dai et al., 2025). Interestingly, hand grip strength – the key outcome measure in AS-Tra – shows no significant improvement following digital interventions in this analysis; by contrast, a parallel meta-analysis of 11 RCTs involving 757 patients with





a formal diagnosis of sarcopenia found a significant, albeit small, effect on hand grip strength (SMD 0.28) and a moderate effect on skeletal muscle mass (SMD 0.35) (Chen et al., 2025). Both reviews rate the certainty of evidence as low to moderate according to GRADE and note substantial heterogeneity (Dai et al., 2025; Chen et al., 2025).

For healthier, community-dwelling older adults without a formal sarcopenia diagnosis, a third meta-analysis (13 RCTs, n = 742) shows that digital interventions improve hand grip strength, usual gait speed and sit-to-stand performance, but not appendicular muscle mass (Makizako et al., 2025). A narrative review, together with a recent systematic review, consistently concludes that digital tools raise awareness of malnutrition and reduce screening burden for healthcare professionals, with co-designed, user-centred interfaces consistently enhancing acceptance (Amatrudo et al., 2026). A review focusing specifically on app-based interventions among community-dwelling older adults identified, across six studies involving 818 participants, a significant effect on step count (+799 steps/day), whereas the evidence relating to nutritional outcomes was described as "relatively unresearched", yielding mixed findings (French et al., 2024).

Training that motivates – and delivers measurable results

This evidence base supports the conceptual premise underlying the AS-Tra project, while simultaneously highlighting where expectations require recalibration: Effects on muscle mass and hand grip strength are, at best, small, and the nutritional impact of digital tools remains poorly substantiated (French et al., 2024). For a system explicitly designed to address both domains, this is a key consideration.

Exergaming and the THERA-Trainer senso in context

The original article selects the THERA-Trainer senso as the training component on the basis of focus-group preferences (Förster et al., 2024; Happe et al., 2024). The evidence base for exergame-based training in older adults has since grown stronger and supports this decision, albeit with certain limitations. A meta-analysis of 14 RCTs (n = 724) involving commercial exergames in residential care settings demonstrates consistent improvements in balance: a reduction in TUG time (SMD –0.87 s) and a mean increase of 2.88 points on the Berg Balance Scale, with higher training doses (≥ 9 weeks) associated with greater treatment effects (Leung et al., 2026).

In order to classify AS-Tra, it is essential to recognise exergaming as an effective form of balance and mobility training. Compared with conventional balance training, additional effects are not evident in all analyses; however, findings vary according to the technology used, training design and dosage. A meta-analysis by Cieślik et al. (2024), comprising 28 studies and 1,457 participants, demonstrates moderate to larger effects specifically for motion-capture systems (SMD 0.48–0.86). For force-plate-based systems – among which the THERA-Trainer senso, with its five measuring plates, is functionally classed – the evidence for improvements in functional mobility remains, to date, less pronounced, though fundamentally positive. Clinically relevant effects appear to be achievable primarily at a training duration exceeding 134 minutes per week.

Sturnieks et al. (2024) provide a particularly robust evidence base for efficacy in a randomised controlled trial involving 769 participants. A home-based step-exergaming programme significantly reduced fall rates over a twelve-month period (IRR 0.74; 95% CI 0.56–0.98), whereas passive cognitive training demonstrated no comparable effect. For an assistive system such as AS-Tra, this is an important external argument: Exergame-based training can make a relevant contribution to fall prevention, provided it is delivered at an adequate dosage, undertaken regularly, and designed to be cognitively and motorically challenging.

Older adults are able to carry out measurements and training independently.

The transtheoretical model in a digital context

The conceptual grounding of AS-Tra within the transtheoretical model (TTM) points to a field that remains, as yet, poorly substantiated by evidence (Förster et al., 2024). A systematic review published in 2025, examining TTM-based interventions to increase physical activity in older adults, identified only three studies (two RCTs, one non-RCT, n = 1,474). The review found low certainty of evidence, with no significant effects on physical activity or self-efficacy reported in the RCTs; where effects did occur, these were most likely to emerge during the maintenance phase (Fawole et al., 2025). A 2024 RCT employing nurse-led motivational interviewing based on the TTM (n = 117, 24 weeks), by contrast, reports marked transitions from the contemplation to the action phase (70.4 % vs. 9.3% in the control group) and higher step counts (Sönmez Sarı & Kitiş, 2024). The discrepancy shows that TTM-based interventions are effective when combined with personal interaction; in purely digital, self-directed usage scenarios without such interaction, efficacy remains, as yet, unclear.

The follow-up publications of the AS-Tra working group

The follow-up investigations of the AS-Tra system, announced in THERAPY 2024-I, are now available as two publications.

Iterative development for a use that is as independent as possible

Förster et al. (2026a) describe the complete three-stage usability process involving a total of 34 participants with a mean age of 78.60 ± 5.59 years;

70.93% were female. The System Usability Scale (SUS) score rose from 70.63 in the first cycle to 84.55 points in the second cycle, before reaching 78.18 points in the third cycle.

In the third cycle, more independent use was simulated: Participants remained alone in the laboratory without study personnel present, received audio instructions, and were monitored via webcams and eye-tracking glasses. Of a total of 607 tasks, 63.11% were completed without assistance. A further 14.92 % were achieved following repetition or rephrasing of the instruction, and 20.33 % following a direct solution cue. Only 1.15% remained unsolved.

The SUS score, although lower than in the second cycle, remains within the "good" rating score, demonstrating that outcomes obtained under close supervision cannot be fully extrapolated to unsupervised, independent use. The authors therefore stress the importance of suitable support functions and testing conditions that closely reflect real-world conditions.

Four-week feasibility pilot study

Förster et al. (2026b) subsequently investigated the AS-Tra system over a four-week period. Nine older adults took part, with one participant withdrawing from the study prematurely. The mean age was 80 ± 5 years, with women accounting for 50%.

Grip strength, timed up and go, and 5-time chair rise test were assessed at baseline, and after one, two and four weeks. In addition, participants used the nutrition app, wore an activity sensor for seven days, and completed regular training sessions at the measurement and training station.

Usability was rated as good, with an average SUS score of 79.3 ± 13.4 points. The overall system also received a predominantly positive assessment, with a mean Evaluation of Overall System (EOS) score of 2.01 ± 0.99 on a scale of 1 to 5. Technical issues affecting individual components of the measurement and training station occurred in no more than 17% of sessions in each case.

The tablet-based nutrition diary was associated with the most pronounced difficulties. Software crashes occurred in 17 of the 30 planned data entries; overall, problems or errors were recorded in 22 of the 28 sessions in which the software was actually used. By contrast, questionnaires, activity sensors and automated functional assessments generally proved to be practicable.

The pilot study therefore provides initial confirmation of the feasibility of data collection and the good acceptance of the overall system, but does not confirm its health-related efficacy. Before the planned randomised controlled trial can be conducted, the nutrition diary in particular must be further developed, both technically and in terms of user experience.

This observation is consistent with the findings of the narrative review by Amatrudo et al. (2026). Digital tools can facilitate the identification of malnutrition risk and support nutritional management. However, consistent involvement of the target group, co-design and age-appropriate user interfaces are essential to ensure acceptance and reliable use among older adults.



Where AS-Tra stands in the current field of research

Conceptual strengths. Few of the digital health interventions for older adults currently published in the literature combine inpatient-based, standardised assessments (grip strength, iTUG, chair rise test) with app components designed for home use. The "measurement station as an anchor point – app for everyday use" approach is rarely described in the literature, distinguishing AS-Tra from purely wearable and app-based interventions. The focus group work also confirmed requirements specific to the target group, revealing strong interest among older adults in self-monitoring, notably heart rate and grip strength (Happe et al., 2024).

Empirically robust core components. Between 2024 and 2026, the assessment methods selected in the original article underwent independent validation: digital dynamometers demonstrated excellent agreement with the Jamar reference standard (Polo-Ferrero et al., 2026), smartphone-based iTUG applications proved to be reliable self-assessment tools (Böttinger et al., 2024), and exergame-based training using force plates showed consistent balance effects across meta-analytic evidence (Leung et al., 2026).

Unresolved questions on efficacy. At the meta-analytic level, the effects of digital interventions on functional outcome measures (TUG, chair-stand test, gait speed, balance) are now consistently documented, whereas effects on muscle mass and grip strength remain small or inconsistent (Dai et al., 2025; Chen et al., 2025). For nutritional outcomes – the second core pillar of AS-Tra – the evidence base remains heterogeneous (French et al., 2024). The planned two-arm RCT by the working group would, for the first time, address the evidence of efficacy in both domains under conditions of independent use by individuals aged 70 and above with emerging deficits.

Methodological challenge. The decline in the SUS score between cycle 2 and the sole use scenario in cycle 3 illustrates a challenge that other reviews also raise: Usability, when measured in structured test settings, systematically overestimates everyday usability (Förster et al., 2026a). Ambient assisted living studies emphasise that the effects of digital systems often only stabilise over a period of several months and are heavily dependent on the home environment (Chaudhary et al., 2026).

Behaviour change theory. While the TTM is theoretically well-founded, empirical evidence supporting it remains limited. Fawole et al. (2025) found low certainty of evidence and no significant effects in RCTs; TTM approaches were effective primarily when combined with personal interaction. For a system explicitly designed to promote independent use, this gives rise to a specific research contribution: AS-Tra can demonstrate whether digital representations of TTM phases can offset the efficacy disadvantage of purely digital TTM applications.

Conclusion

The AS-Tra system described in THERAPY 2024-I remains conceptually robust even after three iterative development cycles. The roadmap published by Förster et al. (2024) has since been substantiated by the working group's 2025/26 follow-up



reports: usability reaches a good level even under conditions of sole use (Förster et al., 2026a), and the feasibility of combined data collection has been demonstrated (Foerster et al., 2026b). Over the same period, the international body of research has grown substantially more robust: meta-analyses consistently show moderate effects of digital interventions on functional mobility (Dai et al., 2025), smaller and heterogeneous effects on muscle parameters (Chen et al., 2025; Dai et al., 2025), and continued limited efficacy in the nutritional field (French et al., 2024).

The specific scientific contribution of AS-Tra – the combination of stationary, ambient-instrumented assessments with everyday app use in individuals aged 70 and above with emerging deficits – remains underrepresented in the international field and confirms continuation of the programme.

Comment:

AS-Tra is pursuing a conceptually convincing and equally engaging approach: standardised functional assessments, interactive training, activity tracking and digital support for nutrition and exercise are combined within a single system. The combination of a central measurement and training station with everyday app use sets the project apart from purely wearable or app-based solutions. Another positive aspect is the early involvement of older people in the development process.

The publications to date demonstrate good usability and fundamental technical feasibility. The principles employed – digital force measurement, automated mobility testing and exergame-based training – are also fully consistent with current scientific thinking.

Its greatest strength is also its main challenge: AS-Tra combines mobility, nutrition and behaviour change within a complex intervention. The health benefits will therefore depend substantially on whether these components function reliably, are utilised to a sufficient degree, and can be sustainably integrated into the daily routines of older adults. The problems encountered with the nutrition diary and the greater need for support during independent use demonstrate that technical stability and low-threshold guidance remain crucial in this regard.

Further clinically focused research will need to determine whether the good levels of acceptance and technical feasibility observed also translate into measurable improvements in mobility, nutritional status and activities of daily living. In contrast to current findings from aggregated evidence, the critical evaluation of suitable primary endpoints could be decisive for the quality and validity of future outcomes.

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From therapy device to care pathway

Review of the THERA-Trainer Rehabilitation Masterclass at the Mo.Ritz Therapy Centre, Moritz Klinik

Jakob Tiebel





The true value of therapy devices extends far beyond the setting in which they are used. What matters most is the clinical impact they deliver in patient care: more precise therapeutic decision-making, greater treatment intensity, clear treatment progression, and smoother transitions between inpatient rehabilitation, outpatient therapy and long-term aftercare.

The THERA-Trainer Rehabilitation Masterclass at the Mo.Ritz Therapy Centre at the Moritz Klinik Bad Klosterlausnitz clearly illustrated this connection. The focus was not on technology as an end in itself, but rather on a key question in modern neurorehabilitation: How can guidelines, clinical experience, standardised assessments, robotics and integrated care be combined in such a way that patients derive the greatest possible benefit in their everyday lives?

Rehabilitation is more than the sum of individual therapies

The event was opened by Dr Hans Ziegenthaler, Senior Consultant at the Moritz Klinik. His introduction gave participants an initial overview of the hospital and its specialist departments. What became clear was that the effectiveness of modern rehabilitation arises from the interplay of medical management, care, diagnostics, therapeutic treatment, provision of medical equipment, family engagement and aftercare. It does not begin with a therapy device – nor does it end when the patient leaves the treatment room. It should be understood as a coordinated, phased and clinically justified process. For this process to work, the individual elements must be properly coordinated.

When new technology also demands new structures

Jens Müller, physiotherapist and Head of the Therapy Department at the Moritz Klinik, went on to outline the evolution of the Mo.Ritz concept for delegates. His presentation demonstrated that establishing a device-assisted therapy environment reflects a vision, rather than merely an investment decision. The decision to implement new rehabilitation technologies in a structured way has an impact on the definition of workflows, responsibilities and therapeutic decision-making processes. Their introduction is therefore always accompanied by a process of organisational development.

As a result, Mo.Ritz became a change management project within the clinical setting, addressing not only spatial, technical and logistical issues. Crucially, it was the close collaboration with the therapeutic team in the design of new treatment pathways that made all the difference. After all, a device cannot make therapeutic treatment decisions. Clear indications, defined responsibilities, training concepts and clear criteria for the initiation, progression and conclusion of therapy are essential. Only by

Technology only enhances patient care when it is meaningfully integrated into clinical decision-making and treatment pathways.

translating technology into clinical practice does a technical possibility evolve into a clinically meaningful element of patient care.

From modern equipment to a well-conceived treatment space

During the subsequent guided tour, delegates were able to experience the Mo.Ritz Therapy Centre firsthand as a consistently well-conceived treatment environment. Standardised assessments, device-assisted interventions and therapeutic measures dovetail across phases and disciplines. Technological capabilities are systematically integrated into coordinated therapy concepts.

Which patients benefit from electromechanical gait training? Which patients benefit from robotic-assisted gait training, and when is treadmill training, overground walking or standing training more appropriate? And in which cases does a targeted combination of different approaches offer the greatest benefit?

Guidelines, assessments and clinical experience need to work hand in hand if progress is to make a genuine difference to patients' lives.

These questions shape the therapeutic decision-making process. Crucially, it is the well-grounded selection of interventions, their rational combination and integration into clear treatment pathways. In this way, the specific strengths of each available technology can be used to targeted effect in patient care.

TheMoS: a new approach to mobility therapy after stroke



The new TheMoS guideline on mobility therapy after stroke served as a central scientific point of reference for the Masterclass.

Alongside the tour of the hospital, Prof Susanne Saal and Anja Röck provided insights into the current evidence base for gait therapy. TheMoS is set to supersede the current ReMoS guideline, establishing itself as the new evidence- and recommendation-based framework for the management of mobility impairments after stroke. The guideline follows a clear internal structure, organised according to interventions and target criteria.

Prof Saal particularly emphasised the importance of practical implementation. Guidelines are designed to structure clinical decision-making, reduce uncertainty and be reliably integrated into everyday patient care.

In neurorehabilitation in particular, interventions must be planned on a patient-specific, phase-appropriate basis and coordinated across a range of care settings. To this end, TheMoS consolidates current evidence to provide evidence-based recommendations. As such, the guideline will provide valuable guidance for a complex care setting in which inpatient, day-patient and outpatient treatment phases must be closely coordinated.

How guidelines are put into practice

This is demonstrated by Anja Röck, BSc Physiotherapy, co-developer of the new guideline-based gait laboratory at the SRH health centres in the Northern Black Forest. As a member of the innovation team, she played a key role in the development of the guideline-based care concept.

Her presentation showed the concrete steps required to translate evidence-based gait rehabilitation into everyday clinical practice. This includes conceptual planning, decisions relating to spatial and technical infrastructure, practitioner qualification, and the integration of procedures into existing treatment pathways.

In this way, the abstract question of scientific evidence was transformed into a practical question of implementation, ensuring that evidence-based recommendations genuinely reach patients.

Assessments: measuring to make better decisions

In the afternoon, Janet Gewalt from the Moritz Klinik turned the spotlight onto the role of standardised assessments. In everyday clinical practice, assessments are sometimes regarded as an additional documentation task. When used correctly, however, they offer considerably more than that: they form the basis for therapeutic decision-making.

Instruments such as the Functional Ambulation Category for assessing ambulatory function, and the Berg Balance Scale or Mini-BESTest for evaluating balance and postural control, help to establish a detailed baseline assessment. They support the selection of appropriate interventions, make changes visible, and enable treatment progression to be evaluated objectively.

Assessments therefore create a shared language. They combine observation, clinical experience and measurable outcomes – making decisions more robust and easier to justify in interprofessional exchange.



High repetition numbers are not enough

The presentations and discussions also highlighted a key tension at the heart of modern neurorehabilitation. Device-assisted therapy can increase treatment intensity, enable a high number of targeted repetitions, and make treatment progression more objectively measurable.

However, these potential benefits do not materialise on their own. Points of intense discussion included inclusion and exclusion criteria for electromechanical gait training, the transition from robotic-assisted therapy to treadmill-based training, and the question of when patients should progress to overground walking.

The transfer into everyday life was of particular importance to participants. Improvements achieved within the protected therapeutic setting are clinically significant. However, they only achieve clinical effectiveness when patients become more independent, active and mobile in their daily lives – in other words, when successful transfer to the participation level is achieved. The key question was therefore not just: Can a patient walk better under therapeutic conditions? But also:

To what extent does the patient apply these newly acquired skills beyond the therapy room?

Exchange as part of the development of care provision

The first day of the event concluded with a joint evening reception near the hospital. The informal setting offered space for in-depth discussion, critical enquiry, and exchange between professionals from a range of clinical disciplines and care settings.

This is a particular strength of the annual Masterclass event. It brings together individuals who not only discuss modern gait rehabilitation in theory, but who are also responsible for its implementation in everyday clinical practice and who continue to develop it further under real-world conditions.

The discussions that emerge in this setting are far more than a supporting programme. They establish the foundations for exchanging clinical experience, critically appraising established routines, and integrating innovative treatment strategies into everyday practice.

The greatest gap often occurs at the interface

The second day of the event focused on the transition from inpatient rehabilitation to outpatient follow-up care. Peter Georgas-Frey from Fachkliniken Wangen presented the development of an outpatient centre affiliated with the hospital. This enables patients to transition directly from neurological rehabilitation into aftercare provided in close association with the hospital.

His presentation therefore addressed one of the greatest challenges within the healthcare system: Gaps in care frequently arise not during inpatient treatment itself, but at the interface with aftercare. If therapeutic goals are not consistently pursued, information is transferred incompletely, or appropriate follow-on services are not arranged in a timely manner, even high-quality inpatient rehabilitation can lose its long-term efficacy. A successful care pathway must therefore extend the beyond discharge date.

Modern neurorehabilitation requires not only better equipment, but above all more robust systems and reliable care transitions.

Rehabilitation during the chronic phase

Marko Schütze, who owns an interdisciplinary specialist practice treating neurological patients, complemented this perspective by drawing on his experience in outpatient care. His presentation demonstrated that device-assisted therapy can also play a significant role in the chronic phase – provided it is applied appropriately as part of a multimodal approach and with a patient-centred focus.

It is not solely about improving individual body functions. Mobility, communication, activity and social participation must be considered as a whole. By way of example, he demonstrated how standing and gait training can be combined with speech and language therapy interventions.

Such emancipatory approaches deliberately move away from rigid professional silos. As a consequence, the emphasis shifts away from determining which profession is responsible for a specific function, and towards the shared therapeutic goal for the patient, and how therapies dovetail across disciplines.

From knowledge to therapeutic practice

The follow-up practical workshop saw selected case studies presented to the therapy group for discussion. Treatment sequences – particularly on the Lyra gait trainer – were demonstrated. The format combined clinical case work with hands-on use of the technology. Participants had the opportunity not only to observe modern gait laboratory techniques, but also to trial them and reflect on their experience as a group.

Combining case studies, demonstrations and hands-on experience supports the transfer of knowledge into clinical practice. After all, implementing device-assisted therapy requires more than simply regurgitating study findings. Therapists must be able to assess movement quality, understand device settings, interpret patient responses and formulate appropriate progressions. Technological proficiency is therefore always a matter of clinical decision-making competence.



It is not the device that transforms care, but its implementation

The closing panel discussion drew together the key themes addressed across both days of the event. The message was clear: translating evidence into practice is not an afterthought. It is central to the development of modern care.

Guidelines, assessments and technologies remain ineffective unless they are integrated into clear processes, interprofessional decision-making and integrated care pathways. At the same time, health services research must in future investigate more intensively how new concepts can be introduced under real-world conditions, permanently embedded and carried forward across care interfaces.

There is significant potential particularly at the transition from inpatient rehabilitation to outpatient therapy. This is frequently the critical juncture at which gains made during therapy are either consolidated and transferred into daily life, or an otherwise successful rehabilitation pathway loses momentum due to insufficient continuity of care.

Modern neurorehabilitation needs better systems

The THERA-Trainer Rehabilitation Masterclass at the Moritz Klinik provided a clear illustration of what will be crucial to neurorehabilitation in the years ahead. Publication of a guideline alone does not change clinical practice. Nor does the acquisition of a new therapy device.

The clinical value of modern rehabilitation lies in its implementation: when evidence is translated into reliable routines, assessments underpin therapeutic decision-making, technologies are employed in a targeted manner, and treatment goals are upheld across sector boundaries.

Modern neurorehabilitation therefore does not simply require more technology. It needs better systems, within which technology can flourish.

The Masterclass continues into 2027

The THERA-Trainer Rehabilitation Masterclass will take place again next year. The venue has yet to be confirmed. Stay tuned – and be there when clinical expertise, hands-on experience and innovative rehabilitation technologies come together again in 2027.



Jakob Tiebel studied Applied Psychology with a focus on Healthcare Management and has clinical expertise through previous therapeutic work in neurorehabilitation. He researches and publishes on theory-practice transfer in neurorehabilitation and is the owner of hestrix, an agency for digitalisation and communication in the healthcare sector.

TECHNOLOGY & DEVELOPMENT

From robot to routine

Why neurorehabilitation technology only becomes effective through proper implementation

Jakob Tiebel

Robotics, sensor technology and digital therapy systems can make neurorehabilitation more intensive, more repetitive and more readily measurable. However, technological advancement alone does not determine whether this potential actually translates into benefits for patients. A recent publication in npj Digital Medicine highlights the factors that determine whether rehabilitation technologies become a lasting part of clinical routine – providing important insights for device-assisted neurorehabilitation.

The discussion surrounding rehabilitation technology is frequently dominated by one question: is the device effective? This question is undoubtedly central to robotic-assisted neurorehabilitation. In clinical care, however, this is followed by a second question that is at least equally important: Is an effective technology actually integrated into clinical practice in such a way that patients benefit from it on a regular basis, with sufficient intensity and with a justifiable use of resources?

This precise implementation gap was examined by Stockley and colleagues in a study published in 2026. Starting point: Rehabilitation technologies – including telerehabilitation, virtual reality, sensor technology, apps, robotics, exoskeletons and neuromodulation – hold the promise of improved access to rehabilitation, higher training intensities and additional opportunities for motivation and self-management. However, their use in routine clinical care remains inconsistent.

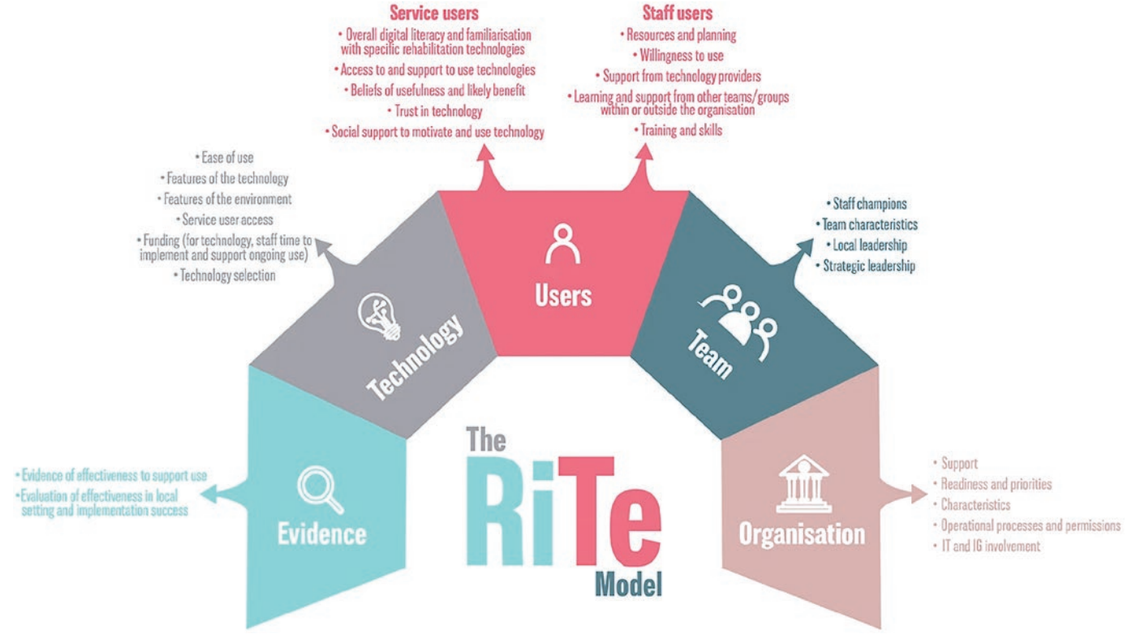
When evidence alone is not enough

For their investigation, the researchers conducted interviews with 48 stakeholders from ten NHS sites across England, Scotland and Wales. Participants included not only therapists but also patients and family members, IT managers, senior leadership, innovation managers, governance experts, as well as developers and stakeholders from the regulatory environment. In parallel, three literature reviews addressing implementation models, neurological rehabilitation and behavioural approaches were evaluated and integrated with the qualitative findings.

The result is the Rehabilitation Technology Implementation Model – RiTe. The model describes five closely interrelated domains that determine the successful implementation of a rehabilitation technology: Evidence, Technology, Users, Team and Organisation. The crucial point here is not the individual category itself, but rather the systemic perspective. A technology may be clinically effective and technically well-developed, yet still fail as a result of inadequate training, unfavourable workflows, insufficient support from leadership, or complicated procurement and IT processes.

This represents a significant shift in perspective for neurorehabilitation. The actual clinical performance of a robotic system cannot be inferred from motor power, degrees of freedom, sensor technology or software functions alone. What ultimately matters is the therapy carried out with it under real-world conditions.

Technology is only effective when it is applied in everyday clinical practice.



The Rehabilitation Technology (RiTe) Implementation Model.



Robotic-assisted technologies at MOTIONrehab, UK

Evidence: not only proving efficacy, but making the effect visible

The first RiTe domain concerns evidence. Before implementation, it should be established which clinical question a technology is intended to address and how robust the existing evidence is. After implementation, however, this task does not end. The authors explicitly call for continued monitoring of clinical outcomes, evaluation of costs and benefits, and observation of any adverse consequences arising from implementation.

This distinction is particularly relevant for robotic-assisted neurorehabilitation. The available evidence addresses whether a particular form of training can be effective under defined conditions. A healthcare facility must also establish whether these conditions can be achieved in everyday clinical practice: How many patients are actually being treated? How often? What is the recommended training duration and intensity? How much active participation is achieved? Which functional changes can be observed?

Classic evidence-based practice is therefore increasingly giving way to a combination of external evidence and local care data. For equipment manufacturers, this means: Training systems should not only facilitate therapy, but also ensure that its implementation is as transparent and assessable as possible.

Technology: the best function is the one that gets used

In the Technology domain, RiTe does not primarily focus on the degree of technical innovation. The key considerations are alignment with clinical need, ease of use, accessibility, funding and integration into existing treatment protocols and workflows. The environment – hospital, rehabilitation facility, outpatient care or the home setting – also alters the requirements placed on a system.

This has direct implications for rehabilitation robotics. Additional technical capabilities are only of clinical value if they enhance a therapeutic process. A highly complex system that requires lengthy setup times, can only be operated by a small number of specialists, or is rarely available during the daily routine may therefore, despite its impressive technical capabilities, deliver a low real-world therapy dose.

Conversely, seemingly mundane characteristics can suddenly become decisive performance features: rapid patient transfer, straightforward adjustment, intuitive operation, reliable safety functions and short turnaround times between patients. This influences how frequently a device can be deployed – and ultimately, therefore, how many repetitions and how much training time actually reach the patient.

The best rehabilitation robot is not the most complex – it is the one that enables more effective therapy.



Therapeutic gamification and rehabilitation technologies in use at MossRehab, USA

Users: technology must work for two user groups

A particular feature of rehabilitation technologies is that they always have at least two user groups: patients and healthcare staff.

Among patients, motor, cognitive and sensory impairments influence usage, as do technical competence, expectations and confidence. In the case staff, by contrast, key considerations include competence, the perceived therapeutic benefit and compatibility with their own professional way of working. Stockley et al. also demonstrate that ongoing support is particularly important at critical junctures – during initial setup, when technical issues arise, following updates and during the onboarding of new staff.

This finding is particularly relevant to neurorehabilitation. A robotic system changes not only the patient's movement, but also the therapist's role. Physically demanding manual assistance can, in part, be replaced by technical assistance. This, in turn, presents new tasks: selecting patients, configuring systems, determining levels of support, interpreting training data and integrating device-assisted therapy with functional activities.

Robotics does not, therefore, replace clinical reasoning. It shifts part of this to a different level.

Interestingly, Stockley and colleagues observed differing perceptions in this regard: Therapists generally viewed technology as an adjunct to therapy. Some patients, by contrast, interpreted the technology itself as the treatment. The authors also identify this as a potential risk: if technology comes to be regarded as a substitute for rehabilitation, this risks excluding patients who are unable to engage with a particular system.

Team: robotics needs champions

According to RiTe, technology implementation is not a one-off decision made by a purchaser or a dedicated therapist. Of particular importance are a shared understanding within the team, local leadership and staff champions – experienced members of staff who integrate the technology in everyday practice, support colleagues and act as points of contact when problems arise. The visible support of management is equally crucial.

This explains a well-known phenomenon in clinical practice: two hospitals may use the same robotic system and achieve completely different results. In one facility, the device forms part of a defined treatment pathway; the team is familiar with the indications and training parameters, and utilisation is high. In the other, the same technology may be physically present in the therapy area, yet is only used sporadically.

The difference does not lie in the device.

For successful robot-assisted neurorehabilitation, key questions need to be addressed prior to installation: Who decides on the indication? Who sets up the patient? Which professional groups can use the system? What are the therapeutic goals? How is training progression controlled? How are new members of staff trained? And which key metrics will be used after several months to determine whether the implementation is working?

The RiTe model significantly extends the traditional approach to product training. Instruction is essential – implementation goes considerably beyond this.

Organisation: the robot must fit into the care system

Ultimately, organisation plays a decisive role. Data protection, IT, hygiene, procurement, maintenance, financing, spatial requirements and strategic priorities can either facilitate or hinder the introduction of a technology. The interviews show that a lack of knowledge regarding such processes can significantly delay implementation projects, or even lead to their discontinuation.

Implementation determines both utilisation and clinical benefit.



Therapy room in neurological rehabilitation at MEDIAN Klinik NRZ Magdeburg

The RiTe model was developed largely on the basis of clinical experience within the NHS. In insurance-funded healthcare systems, additional factors may come into play – particularly requirements from health insurance providers and differing funding mechanisms.

This means that in terms of robotics, health economics also comes to the fore. The purchase price alone reveals little about a system's economic value. Key considerations include actual usage, staffing requirements, training time, patient throughput, maintenance demands and clinical benefit.

A simple example illustrates this clearly. If technology makes it possible to train a high number of quality-controlled gait cycles, this initially appears therapeutically attractive. This potential only becomes economically relevant, however, when patients can be transferred into the system swiftly, staffing resource requirements remain manageable, and the device is utilised with sufficient frequency.

From individual devices to a technology-supported treatment pathway

This is precisely where the RiTe model proves particularly relevant to the THERA-Trainer approach. The portfolio encompasses not just a single robotic system, but motor-assisted movement training, dynamic standing and balance training, robotic-assisted gait training and software solutions spanning various phases of rehabilitation. The THERA-Trainer lyra, for example, enables electromechanically assisted, repetitive gait training based on the end-effector principle; balo and coro address safe dynamic standing and postural control, while tigo and toro facilitate motor-assisted cycling.



The gait laboratory at DianaKlinik Bad Bevensen

Viewed through the lens of the RiTe model, however, the value of such a portfolio does not lie in assembling as many devices as possible in a therapy room. The technology becomes genuinely compelling when it gives rise to a clinically justifiable treatment pathway.

A severely affected patient may initially require motor-assisted activation and loading, followed by progressively increasing control of trunk and centre of gravity, dynamic standing and, ultimately, highly repetitive task-specific gait training. The technical intervention changes in line with the patient's functional status – but the therapeutic goal remains focused on activity and mobility. THERA-Trainer therefore describes a cross-device concept spanning cycling, standing and balancing, and gait training across the full continuum of rehabilitation phases — an approach increasingly adopted by clinics for group and circuit-based therapy sessions.

The next generation of rehabilitation robotics must be more than just technically superior

Perhaps the most important finding of the study by Stockley et al. is, indirectly, as follows: the future of rehabilitation technology will not be decided in development departments alone.

Naturally, enhanced sensors, adaptive assistance, more powerful actuators, intelligent algorithms and immersive training environments remain key considerations. However, to achieve genuine clinical impact, innovation must be pursued with equal rigour across usability, workflow integration, training, data availability, service and implementation models.

From this, five strategic implications can be drawn: evidence should be more closely linked to real-world usage and outcome data; devices must be consistently designed to minimise procedural barriers; clinical application and continuous training are integral to the product itself, not merely an after-sales service; individual technologies should be integrated into indication- and phase-specific treatment pathways; and the success of an installation should be measured not at commissioning, but in terms of utilisation, therapy dosage, clinical outcomes and sustainability.

Consequently, the criteria for what makes a good rehabilitation robot are changing too.

The system with the most features isn't necessarily the best. The crucial factor is whether the right patient can train the right task at a sufficient dose using the device – and whether a clinic has the organisational capacity to deliver this reliably, day in, day out.

The real innovation, therefore, does not begin with switching on the robot. It begins at the point where technology becomes an integral part of good rehabilitation practice.

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LIFE IN MOTION

SCIENCE

Walking is networking

Physiology of human gait and postural control: an overview

Jakob Tiebel



Human bipedal locomotion – walking, in short – is governed by a complex interplay between multiple levels of the nervous system. Central pattern generators located in the spinal cord produce fundamental rhythmic movement patterns. The brainstem and cerebellum regulate and stabilise this activity. The cortex intervenes to a greater extent when movements need to be planned or adapted to novel situations. At the same time, the visual system, vestibular apparatus and proprioceptive system continuously supply sensory information regarding the body's position and movement (Takakusaki 2013).

Ageing processes and neurological disorders can compromise this finely tuned interplay. Walking then frequently becomes slower, more irregular and less stable. This, in turn, increases the risk of falls (Montero-Odasso et al. 2012).

The following article describes how walking is modelled and controlled within the nervous system, what changes occur with ageing and disease, and the resulting implications for rehabilitation. It builds on the article "Physiology of walking and postural control", published in Neurologie & Rehabilitation 2024/02, supplementing its arguments with additional primary and review literature, together with a further translation into clinical practice.

Introduction

Walking appears effortless, yet it requires bones, joints and muscles to work in concert with peripheral sensory receptors and the entire neuraxis, from the spinal cord to the prefrontal cortex. For this reason, gait patterns provide a wealth of information regarding an individual's overall health and functional status. Gait speed is of particular relevance. Gait speed is regarded as an important marker of functional independence in older adults. Individuals who consistently walk at a speed of less than approximately 0.6 metres per second frequently require assistance. At speeds above 1.0 metres per second, on the other hand, functional independence is generally significantly greater. A decrease of just 0.1 metres per second is already associated with an increased risk of falls, disability and mortality (Kyrdalen et al. 2018; Davey et al. 2025).

Falls can be understood as a clinical manifestation of inadequate gait and balance control. They demonstrate particularly clearly what happens when the coordination between the functional systems involved is no longer reliable.

More than a third of community-dwelling adults aged over 65 experience at least one fall within a year. In residential care settings, the proportion is even higher (Verghese et al. 2009). Vertigo, balance and coordination disorders are among the leading causes, and their sequelae – fractures, immobilisation, fear of falling – account for a considerable proportion of healthcare expenditure in high-income countries.

Understanding the physiology of walking is therefore not merely a fundamental neuroscientific challenge, but also a public health priority, and one of considerable significance for prevention and rehabilitation.

Significance of central pattern generators

The rhythmic alternation between flexor and extensor musculature during walking is generated by spinal interneuronal networks, referred to as central pattern generators (CPGs) (Takakusaki 2013). A substantial component of gait is therefore already organised at spinal cord level.

Animal studies have shown that such networks can generate locomotion-like movement patterns even without direct control from the brain. Findings from spinal cord stimulation and neuromodulation studies in individuals with spinal cord injury suggest that the human spinal cord possesses comparable mechanisms (Minassian et al. 2017).

The CPGs can therefore be understood as a kind of basic motor driving locomotion. They provide the rhythm. This rhythm, however, does not operate independently of the environment. Sensory information from muscles, joints, skin and the sole of the foot continuously influences it. This allows the nervous system to detect, for example, when a foot makes contact with the ground or the degree of load-bearing through a given leg. Step timing is adjusted accordingly (Takakusaki 2013).

The coordination between the arms and legs is likewise linked to these mechanisms. The characteristic automatic arm swing when walking is thus part of a broader rhythmic coordination system (Minassian et al. 2017). By contrast, higher centres in the brain determine factors such as speed, direction and adaptation to the situation at hand.

Supraspinal control of locomotion

Above the level of the spinal cord, the brainstem and cerebellum perform key functions. One important region in this context is the mesencephalic locomotor region. It is involved in initiating gait and regulating its speed. Certain neurons promote locomotion, whilst others can inhibit or halt it (Ryczko 2022). The diencephalon and cerebellum contain further regions that work in conjunction with this system. Together, they ensure that locomotion can be initiated, sustained and adapted to the situation at hand (Jahn et al. 2008).

It is noteworthy that automated gait requires comparatively little cortical control. Studies using functional imaging and near-infrared spectroscopy show that certain sensory areas of the cortex are, in fact, less active during steady-state gait. This reduced activity is thought to protect the automated movement pattern from unnecessary interference (Jahn et al. 2008).

The cerebellum is also involved in walking. It performs several tasks at the same time. It stabilises the movement rhythm, processes information from the vestibular system and coordinates the movements of different joints. It also plays a key role in motor learning and in adapting gait to new demands (Morton & Bastian 2004; Schniepp et al. 2017; Ilg & Timmann 2013).

Damage to the cerebellum therefore frequently results in a characteristic ataxic gait. A wide standing and walking base, marked step-to-step variability and impaired coordination of joint movements are characteristic features (Serrao et al. 2018; Cabaraux et al. 2022).

Cortical modulation and the locomotor network

So, as long as we are walking on familiar terrain at a steady pace, a large proportion of the movements required occur automatically. As soon as the situation changes and becomes more complex, however, the demand for cortical control increases. This applies, for example, to gait initiation, stopping, turning, negotiating obstacles or walking on unfamiliar surfaces. Frontal and parietal brain regions become particularly active in these situations (Takakusaki 2013).

The supplementary motor area, for example, prepares postural adjustments. The premotor cortex plans movement sequences. Parietal and temporal regions process information about the position of the body in space. These adjustments are then integrated into the ongoing movement pattern via connections to the brainstem. The basal ganglia and cerebellum support this process.

This cortically distributed organisation explains why neurological disorders can impair walking in very different ways. In Parkinson's disease, Alzheimer's disease or cerebral microangiopathy, different structures and networks are affected in each case. However, these changes all share a fundamental adaptive mechanism. The less reliably the automated components of gait control operate, the more forcefully the nervous system attempts to shift control to higher cortical levels. As a result, walking becomes less automatic and increasingly requires conscious monitoring and control.





This additional cortical control can initially help to compensate for instability and maintain stability during walking. However, it does have its limitations. Attention and cognitive processing capacity are limited. The more walking depends on this, the more vulnerable it becomes to additional demands such as conversation, orientation, obstacles, or changes of direction. What largely occurs incidentally in a healthy individual increasingly becomes a conscious task. This shift from automated to more cortically controlled locomotion is a common feature of many neurological gait disorders (Montero-Odasso et al. 2012; Roytman et al. 2024).

Sensory integration for balance and gait

The increasing cortical control can, however, only function if the nervous system receives reliable information about body position, movement and the environment. **Gait control therefore always has a sensory component.** This is particularly evident when it comes to balance: the upright stance is biomechanically unstable. Even minor deviations can cause the body to move further out of the vertical under the influence of gravity. The nervous system must therefore continuously monitor the body's position in space and intervene with corrective action as required.

For this, it primarily draws on three sources of information: proprioception via muscles, joints and skin, the visual system, and the vestibular system in the inner ear. From these signals, the nervous system continuously generates as reliable a picture as possible of how the body is aligned and moving. On this basis, appropriate muscular responses are triggered to maintain posture and balance (Peterka 2018).

Crucially, the brain flexibly weights these three sources of sensory information. Where visual information becomes unreliable, the brain relies more heavily on proprioceptive or vestibular signals. Conversely, where proprioceptive input is impaired, visual and vestibular information becomes more significant. This continuous adjustment is referred to as sensory reweighting and is a central mechanism of balance control (Peterka 2018).

Somatosensory information is derived, among other sources, from the plantar surface of the foot, the ankle joints, muscle spindles and joint receptors. This information is available particularly rapidly and is therefore important for immediate reactions to perturbations This information may be diminished in the presence of peripheral neuropathy. As a result, affected individuals may respond too late to a slip or unexpected contact and fall more frequently (Richardson & Ashton-Miller 1996; Kohle et al. 2024).

The vestibular system provides information about the position of the head in relation to gravity and about head movements. It plays a key role in postural alignment and gaze stabilisation during movement. With bilateral loss, the visual surroundings may appear to blur or jump during walking. At the same time, standing and gait stability decrease markedly, particularly when visual orientation is also impaired (Schniepp et al. 2017).

Visual information helps in assessing how the body moves relative to its surrounding environment. One important cue in this context is the so-called optic flow. As we move forwards, the entire visual field changes in a characteristic manner. This information is slower than somatosensory signals but becomes particularly important when other sensory systems are unreliable (Peterka 2018).

In healthy people, the three systems can, to some extent, compensate for one another. Good proprioceptive awareness, for example, can compensate for impaired vision. Difficulties arise primarily when several systems are impaired simultaneously. And this becomes more common with increasing age (Roytman et al. 2024).

Gait speed, variability and falls

The extent to which these individual functional domains interact can, to a certain degree, be directly assessed through observation of the gait pattern. Two parameters are particularly significant in this respect: gait speed and gait variability. Gait speed describes how quickly a person moves. Gait variability, by contrast, reflects the extent to which individual steps differ from one another.

Gait speed reflects the interplay of many contributing factors. These include cardiovascular capacity, muscle strength, joint mobility and neuronal control. From age 60, it decreases on average by approximately one per cent per year. Reduced gait speed is associated with a higher risk of disability, falls and mortality, independent of comorbidities and frailty (Kyrdalen et al. 2018; Davey et al. 2025).

Effective neurorehabilitation trains not only muscles, but the entire sensorimotor network.

Gait variability adds a further important dimension to this picture. It describes, for instance, the extent to which step duration or step length fluctuate from one step to the next. High variability indicates that the underlying movement rhythm is less stable. In a prospective study, step-time variability in older adults who subsequently experienced falls was more than twice as high as in those who did not go on to fall. In this study, variability predicted future falls more accurately than gait speed alone (Hausdorff et al. 2001). Comparable associations have also been described in other cohorts (Verghese et al. 2009; Hausdorff et al. 1997).

Both parameters are nevertheless closely linked to the degree of automaticity of gait. Very slow walking requires more continuous sensory and cortical control and may therefore be more susceptible to perturbations than more highly automated walking at a faster pace (Schniepp et al. 2017). This is exactly where it becomes clear that gait stability is not a question of strength and balance alone. It also depends significantly on the extent of cognitive resources the nervous system must allocate to the control of gait.

Walking requires attention

The less automated walking becomes, the more consciously the brain must monitor and adjust the movement. This requires attention. This relationship becomes particularly evident when a secondary task must be performed simultaneously with walking. A classic example is walking whilst counting backwards. In healthy older adults, gait pattern typically changes only slightly under these conditions. In people with mild cognitive impairment or early neurodegeneration, however, walking can slow considerably more markedly.

These additional decrements are referred to as dual-task costs. In the Gait and Brain Cohort of 112 older adults with mild cognitive impairment, high dual-task cost during backward counting was associated with a significantly increased risk of developing dementia within the subsequent six years. By contrast, gait speed during single-task walking was not predictive (Montero-Odasso et al. 2017).

The link between movement and cognition is also evident at population level. In the Honolulu-Asia Aging Study, men with a very low daily walking distance developed dementia more frequently

than men who regularly covered greater distances (Montero-Odasso et al. 2012). Dual-task tests can therefore reveal the extent to which an individual relies on conscious control and how well walking and additional cognitive demands can be managed simultaneously. Such tests capture an aspect of gait control that may otherwise remain concealed during simple straight-line walking (Verghese & Holtzer 2010; Montero-Odasso et al. 2012).

Yet cognitive demands are not the only factor capable of challenging these limited resources. Emotional factors, too, alter the extent to which an individual consciously controls their gait. This is particularly evident in the fear of falling.

Fear also alters gait

Fear of falling affects walking not only psychologically but also directly via motor control mechanisms. Individuals who feel unsteady tend to monitor and control their own movement more closely. Walking consequently often becomes slower, more cautious and less automatic.

Fear of falling is common among older adults with gait disorders. It is associated with a slower and, in some cases, more variable gait pattern. This association persists even after statistically accounting for physical impairments (Vellas et al. 1997; Ayoubi et al. 2015).

A meta-analysis demonstrated moderately increased gait variability in older adults with fear of falling. However, other studies suggest that part of these differences arises because affected individuals consciously choose to walk more slowly. The slower pace is not necessarily indicative of an additional loss of control. It may also initially represent a sensible protective strategy, through which the nervous system seeks to gain greater control and security (Reelick et al. 2009).

This strategy becomes problematic when caution develops into persistent avoidance behaviour. A fear-driven reduction in walking results in diminished functional capacity, reduced movement experience and a loss of confidence in one's own mobility. This can further exacerbate the underlying instability. Multicomponent exercise programmes combined with cognitive-behavioural therapeutic approaches can help interrupt this cycle, at least temporarily.

What does this mean for rehabilitation?

This highlights a key point in rehabilitation. Safe gait does not arise from a single mechanism alone. Rhythm, strength, sensory processing, balance, attention and emotional security are in constant interplay. Training should therefore address more than just one of these domains.

Evidence-based gait rehabilitation must integrate the various levels of motor control. Repeating numerous steps forms an important foundation for this, but is not sufficient on its own. Rhythmic repetition specifically engages the automated and spinal components of locomotion. In everyday life, however, gait has to be continuously adapted. People need to start and stop, change direction, manage varying speeds, react to perturbations, and simultaneously perceive their environment or carry out other tasks.

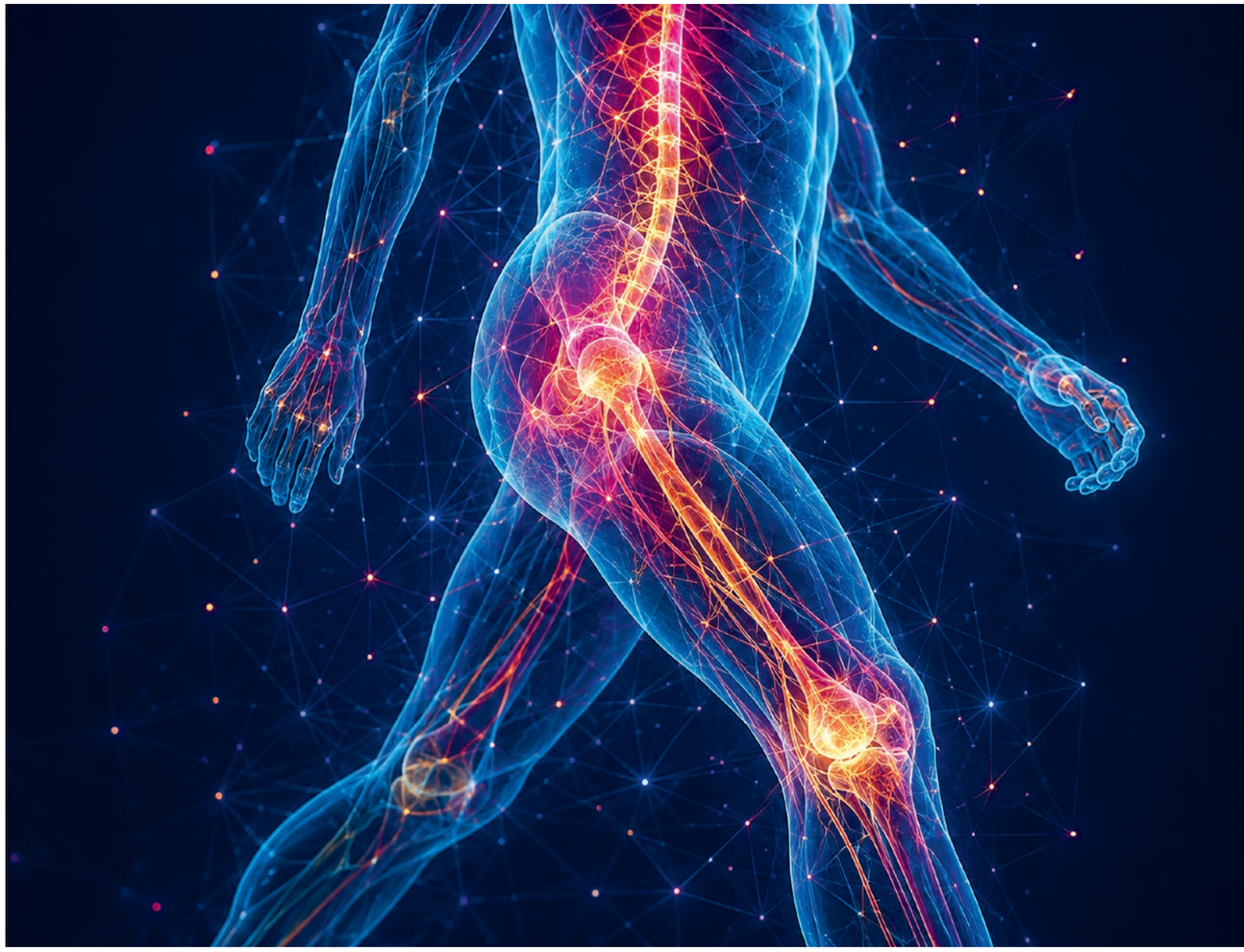
A comprehensive training regime should therefore systematically incorporate such demands. This includes changes in pace and direction, varying surfaces, perturbations and dual-task activities. Very slow gait can also be purposefully used, as sensory and postural deficits may become more clearly apparent than during more automated walking patterns (Montero-Odasso et al. 2012; Ilg & Timmann 2013; Schniepp et al. 2017).

The practical challenge lies in delivering these varied training stimuli safely, with sufficient intensity and as much frequency as possible. This is precisely where device-based methods can play an important role.

Opportunities in device-assisted gait rehabilitation

Device-assisted gait rehabilitation should therefore accomplish more than simply repeating a predefined movement pattern. Its potential lies in enabling targeted, precisely dosed training of the various components of locomotion. This includes movement rhythm, physical exercise tolerance, postural control, sensory information processing, task-specific gait training and adaptation to additional cognitive demands.

Simple step repetition, once the initial phase of gait rehabilitation has been completed, falls short if balance, attention and adaptability are not also



taken into account. Conversely, general strength or endurance training alone is insufficient to relearn gait. What matters most is combining these training methods in a way that addresses each patient's specific impairments and therapeutic goals.

The THERA-Trainer complete solution

The THERA-Trainer product ranges can be understood as a coordinated, yet non-linear, training continuum. Depending on the patient's mobility level, therapeutic goal, exercise tolerance and safety requirements, different forms of training can be employed individually or in combination. What matters here is not the device alone, but rather the training method and the physiological mechanism specifically targeted.

Cycling – getting active and building load tolerance

Depending on the system and functional level, THERA-Trainer cycling enables passive, motor-assisted or active movement training of the legs. The range extends from bed-bound training with the THERA-Trainer bemo to seated cycling using systems such as toro, tigo or mobi.

The cyclical movement enables a high number of rhythmic, reciprocal movement repetitions. This can support neuromuscular activation, maintain or increase joint mobility, and simultaneously place demands on the cardiovascular system and muscular endurance. Cycling therefore offers a low-threshold entry point into more intensive movement training, particularly for patients who are not yet able to walk or who fatigue quickly. Studies conducted in post-stroke populations demonstrate that supplementary cycling can also support improvements in motor function and balance (Katz-Leurer et al., 2006).

Therapeutic focus:
Activation, rhythmic movement, endurance, mobility and preparation for verticalisation and gait training.

Progression and transfer:
Passive movement → motor-assisted activity → active cycling → increased load and longer training duration → combination with more upright and task-specific forms of training.

Classification:
Cycling activates fundamental sensorimotor and rhythmic processes. It does not, however, replace the specific training of standing, balance and gait.

Cycling activates, standing stabilises, gait mobilises, dual task ensures everyday safety.

Standing & Balancing – controlling posture and responding flexibly

Safe walking requires the body to be stabilised against gravity, the ability to achieve weight acceptance and controlled displacement of the centre of gravity. Standing & Balancing therefore forms the link between fundamental motor activation and functional locomotion.

The THERA-Trainer verto initially supports safe verticalisation and weight acceptance. The THERA-Trainer balo extends training to include active, dynamic weight shifts within a fall-safe environment. With the THERA-Trainer coro, dynamic standing control, greater weight shifts and preparatory stepping activities can be trained in more advanced patients.

With increasing capability, the demands placed on the nervous system change accordingly. The primary focus is initially on pure stabilisation of the body. Later on, movements must be anticipated, perturbations compensated for and information from various sensory systems processed flexibly. This enables targeted training of both anticipatory and reactive balance responses, trunk control, weight acceptance and sensory reweighting.

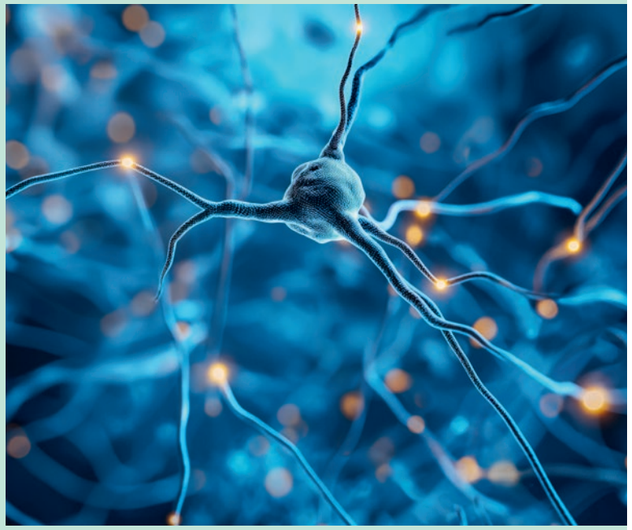
Cognitive-motor demands can already be integrated in a targeted manner at this stage. The THERA-Trainer senso combines weight shifts and stepping movements with visual, cognitive and reactive tasks. Patients are required, for example, to respond to stimuli, make decisions, or divide their attention between motor and cognitive tasks. This not only trains balance but also increasingly targets the motor-cognitive interaction that is essential for safe mobility in everyday life.

In individuals with multiple sclerosis, cognitive-motor dual-task training improved dynamic stability during both straight-line and curved walking in a randomised controlled trial (Tramontano et al., 2024). Positive data regarding feasibility and fall-related functional parameters are also available for senso-based training in patients with Parkinson's disease (Jäggi et al., 2023).

Therapeutic focus:
Verticalisation, weight acceptance, trunk and balance control, sensory integration, reactive stability and, increasingly, attention and motor-cognitive control.

Progression and transfer:
Stable verticalisation → active weight shifting → reaching movements → dynamic balance tasks → reactive perturbations → preparatory stepping → additional motor or cognitive tasks → complex dual-task situations.

Classification:
Standing & Balancing therefore not only establishes the biomechanical conditions for gait. As difficulty increases, the ability to control posture and movement under changing sensory and cognitive demands is also trained.



Gait – relearning to walk by walking

As soon as targeted locomotor training becomes feasible and indicated, the actual gait movement takes centre stage. A high number of task-specific step repetitions plays a pivotal role in the recovery of walking ability.

The THERA-Trainer lyra is a robotic end-effector gait trainer. The feet are guided through repeated step cycles via moving footplates. This enables intensive and reproducible gait training to be conducted even in individuals who are not yet able to walk independently.

The training combines rhythmic stepping movements with an upright body position, alternating leg movement and repeated weight acceptance. Particularly during the early phases of rehabilitation, robotic systems can significantly increase the number of steps that can actually be achieved. Systematic reviews demonstrate the benefits of electromechanically-assisted, repetitive gait training in regaining independent walking ability. End-effector-based systems in particular demonstrate favourable outcomes.

As walking ability improves, however, the task itself should also evolve. The focus shifts from the repetition of a stable movement pattern towards increasingly flexible gait control. This includes varying speeds, changes of direction, obstacles, start-stop tasks and, ultimately, cognitive-motor demands.

Therapeutic focus:
High step count, rhythmic gait organisation, weight acceptance, endurance and recovery of walking ability.

Progression and transfer:
Guided repetitive steps → increasing active participation → longer walking phases → overground walking → changes in speed and direction → obstacles and perturbations → dual-tasking and everyday mobility.

Classification:
Robotic gait training can enable high repetition numbers and early task-specific training. However, to ensure successful carryover to activities of daily living, gait must increasingly be practised in a variable, independent manner, and under changing environmental and attentional demands.



The less reliably the automated gait control mechanism functions, the more the nervous system attempts to safeguard stability through additional cortical control. As a result, gait becomes more consciously controlled, cognitively more demanding and more vulnerable to additional task demands.

Gait speed, gait variability and dual-task performance make different aspects of these changes visible. This gives rise to a principle for rehabilitation that is both simple and crucial: gait cannot be reduced to stepping movements alone. Successful training must integrate rhythmic activation, physical exercise tolerance, postural control, sensory integration, task-specific gait training and cognitive-motor adaptability.

The THERA-Trainer training continuum can address these varying requirements across different functional levels. Cycling generates movement and builds load tolerance. Standing & Balancing develops control against gravity and progressively integrates sensory and cognitive-motor demands. Gait translates these capabilities into a large number of specific steps and, ultimately, into variable, everyday walking. The therapeutic principle remains the decisive factor throughout: technology supports rehabilitation effectively when it enables the physiological demands of a specific task to be trained in a targeted way.

Conclusion

Gait is generated through the interplay of multiple levels of the nervous system. Spinal networks generate fundamental rhythmic movement patterns. The brainstem and cerebellum regulate and stabilise these patterns. The cortex intervenes to a greater extent when movements need to be planned, adapted or controlled under difficult conditions. At the same time, visual, vestibular and somatosensory information provides continuous feedback about the body and environment.

Age and neurological disorders can affect any of these levels. Despite differing underlying causes, a common pattern frequently emerges:



Jakob Tiebel studied Applied Psychology with a focus on Healthcare Management and has clinical expertise through previous therapeutic work in neurorehabilitation. He researches and publishes on theory-practice transfer in neurorehabilitation and is the owner of hestrix, an agency for digitalisation and communication in the healthcare sector.

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THERAPY & PRACTICE

Regaining confidence with games

At the geriatric day clinic of the Evangelisches Krankenhaus Essen-Steele, the THERA-Trainer senso is used to combine movement, balance and cognitive tasks. A case report published on Lokalkompass Wesel, a German local news site, shows how interactive training can support older patients in regaining confidence in their own mobility after falls.

Jakob Tiebel

Falls in older age often leave more than just physical consequences. In addition to fractures and diminished mobility, a marked fear of falling can lead patients to increasingly avoid physical activity – risking a downward spiral of insecurity, inactivity and further functional decline.

This is where the geriatric team in Essen-Steele comes in. On the THERA-Trainer senso, movement and cognitive tasks are combined: Stepping movements and weight shifting control the interactive games, simultaneously challenging strength, coordination, balance and attention. Progress is instantly visible, providing an additional source of motivation.

The case of an 82-year-old patient following surgical treatment for a femoral fracture demonstrates just how rapidly functional stability can be restored. Clinical Director Dr Hans-Christoph Heuer had first met the patient confined to bed, suffering from severe pain. Just four weeks later, she was already attending training without a rollator. For Heuer, this progress is the result of the therapeutic input provided by occupational therapy and physiotherapy – but also of the new training device.

The principle of prevention also remains a key consideration. Heuer's advice on healthy ageing is therefore clear: **"Keep moving – even when it's tough going!"**

This case report demonstrates how technology-assisted training can complement conventional geriatric therapy: not solely through movement-based exercise, but through the integration of motor function, cognition, motivation and real-time feedback.

Move. Think. Regain confidence.
The THERA-Trainer senso combines motor training with cognitive challenge – enabling patients to experience progress in real time.



"Keep moving – even when it's tough going!"

Nina Schwarz (therapist at the Evangelisches (Essen-Steele Hospital) training with her patient, Karin A. (82) on the THERA-Trainer senso, photo: Kliniken Essen-Mitte / Ines Walter

Original work

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THERAPY & PRACTICE

Robotics in Gait Rehabilitation: New Opportunities, New Workflows

Modern rehabilitation technologies enable intensive, highly repetitive training even for severely affected neurological patients. Using the example of the lyra, Dr Martin Schorl, Chief Physician of Neurology at Waldburg-Zeil Klinik Bad Wurzach Germany, explains how robotics not only supports gait therapy, but also fundamentally changes therapy workflows.

Miriam Keifert in an interview with Dr Martin Schorl, Chief Physician of Neurology, Waldburg-Zeil Klinik Bad Wurzach

Intensive therapy for severely affected neurological patients presents a particular challenge in everyday clinical practice. Modern rehabilitation technologies can help to transfer evidence-based findings on motor learning into practice and enable the necessary therapy frequencies.

In this interview, Dr Schorl explains the role of robot-assisted gait rehabilitation with the THERA-Trainer lyra in neurological rehabilitation, how it changes everyday therapy and what experience has been gained with severely affected patients.

Miriam Keifert: Why are modern rehabilitation technologies so important for neurological rehabilitation today?

Dr. Schorl: Modern rehabilitation technologies are essential for us in order to transfer evidence-based treatment approaches into everyday clinical practice. This applies in particular to current findings on motor learning. A decisive factor here is the frequency of therapy: patients need a high number of repetitions in order to regain or improve motor skills. Particularly in severely affected patients, achieving this intensity with conventional therapy methods often requires considerable staff resources. Modern technologies help us to treat these patients more frequently, more intensively and more systematically, thereby enabling the necessary therapy frequencies even in cases of severe impairment.

By bringing locomotion therapy together in one room, completely new workflows have emerged – both for patients and for therapists.



Miriam Keifert: How has the THERA-Trainer lyra changed your everyday therapy?

Dr. Schorl: The lyra has massively changed our everyday therapy. Its use enabled us to centralise locomotion therapy in one dedicated therapy room. Previously, therapy devices sometimes had to be taken to the wards, and severely affected patients were often treated there by two or even three therapists at the same time. This approach was very time- and staff-intensive.

With the establishment of a central locomotion studio, a completely new therapy setting has developed. Patients can be treated consecutively on different devices. This makes both traditional one-to-one therapy and group-based therapy workflows possible.

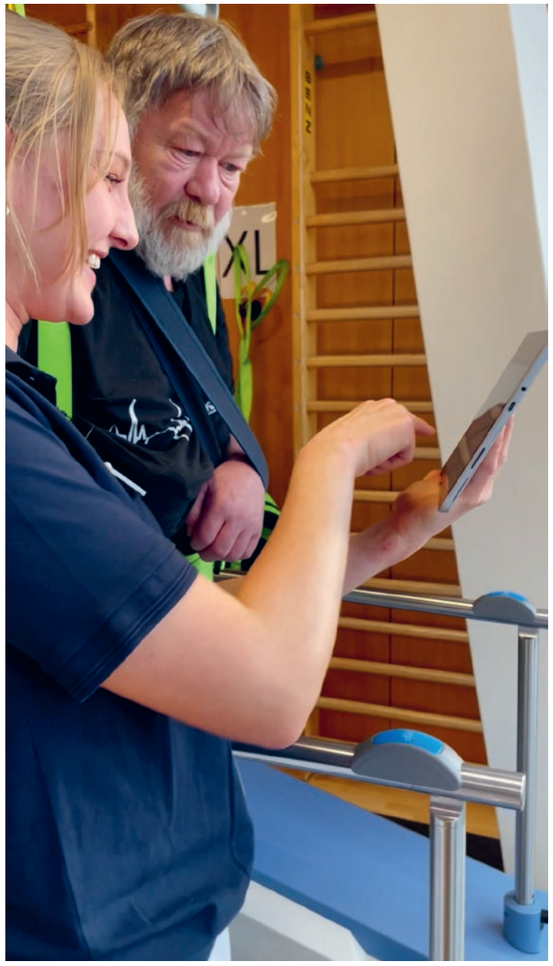
The changes can be seen in many areas: treatments are organised centrally, set-up times are shorter and easier to plan, and patients can train sequentially on different devices. At the same time, this opens new possibilities for group therapy, therapist scheduling can be organised more efficiently, patient journeys can be planned more effectively, and staff resources can be used more economically overall.

In the end, the lyra not only provided a new treatment option but also fundamentally changed our entire approach to locomotion therapy.

Miriam Keifert: Which patient groups do you primarily use the THERA-Trainer lyra for?

Dr. Schorl: In our neurological rehabilitation, we primarily use the THERA-Trainer lyra for patients in rehabilitation phases C and D. A large proportion of this patient group consists of people following a stroke.

For this patient group, the lyra has proven to be an effective therapy device, characterised by comparatively short preparation and adjustment times. It is particularly valuable for patients who are not yet able to walk, or are only able to walk to a very limited extent, at the beginning of rehabilitation. Especially during this phase, the technical support enables intensive and safe gait training – an important prerequisite for neurological rehabilitation.



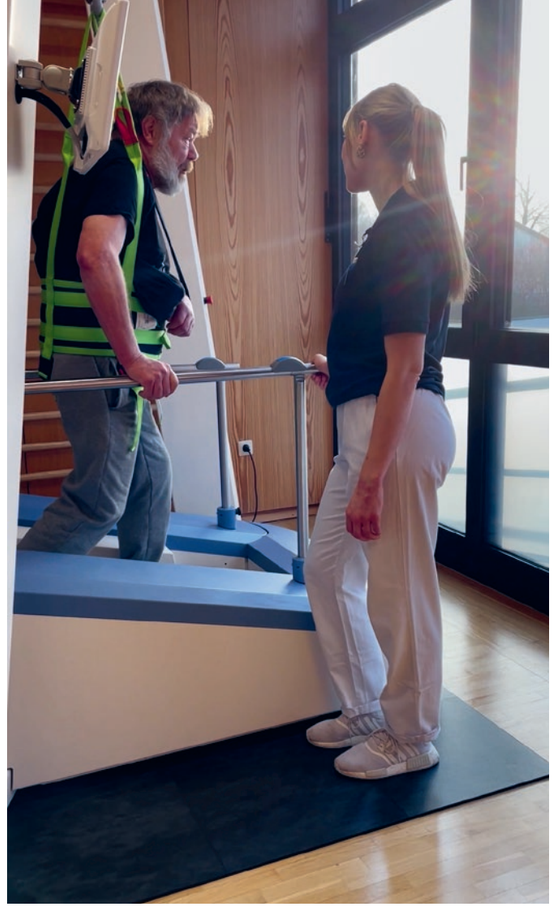
Miriam Keifert: What experience have you gained with the THERA-Trainer lyra in severely affected patients?

Dr. Schorl: Our experience with severely affected patients has been particularly impressive. Through more intensive gait rehabilitation with the THERA-Trainer lyra, we were able to restore walking ability in individual patients, even though they had previously been discharged from other facilities as no longer eligible for further rehabilitation or without a realistic prospect of regaining mobility.

For those affected, this means far more than clinical progress. Even partially regained walking ability can significantly change everyday life, independence and opportunities for social participation.

Based on our experience, intensive robot-assisted gait rehabilitation can also unlock additional rehabilitation potential in severely affected patients. It is important to emphasise that the success of therapy always depends on the individual starting situation and cannot be predicted in general terms.

We were able to achieve walking ability in patients who had previously been assessed as no longer eligible for further rehabilitation.



New technologies must fit into the existing therapy concept. They will only actually be used in everyday practice if they gain broad acceptance.

Miriam Keifert: What role does the THERA-Trainer lyra play within a holistic therapy concept?

Dr. Schorl: We do not consider the THERA-Trainer lyra as an isolated treatment option. Particularly for severely affected patients, gait rehabilitation is part of a multimodal treatment concept in which different therapeutic approaches are combined.

These include, in particular, botulinum toxin injections, corrective orthoses or comparable corrective aids, standing training and intensive gait rehabilitation with the lyra.

This combination is used, for example, in patients with pronounced leg or foot spasticity and resulting malpositions. In our assessment, the interaction of the different measures can help to restore the prerequisites for standing and walking.

The decisive factor is often not a single measure, but the coordinated combination of spasticity treatment, orthotic provision and intensive gait rehabilitation.

Miriam Keifert: How important is a practical testing phase before purchasing new rehabilitation technologies?

Dr. Schorl: A practical testing phase is a central prerequisite for us before we purchase a new technology and integrate it into everyday therapy. New devices are always initially tested in a clinical environment in order to assess their actual suitability for our workflows.

We ask ourselves various questions: How easy is the device to operate? How do the therapists get on with it? How do the patients respond to the therapy? Does the technology fit in with the existing forms of therapy? What spatial and organisational adjustments are required? How can its use be implemented economically? And above all: Will the device actually be used regularly in everyday practice?

When introducing the THERA-Trainer lyra, we initially carried out two test days. This enabled our team to familiarise themselves with the device and its possible applications even before installation.

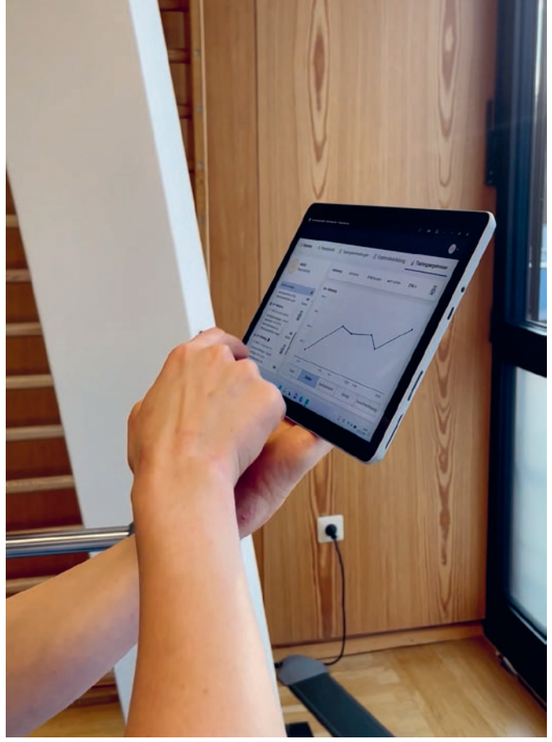
Our principle is therefore: no new technologies are introduced without a practical testing phase.

Miriam Keifert: How was the THERA-Trainer lyra integrated into the team's daily practice, and which factors are key to its long-term use?

Dr. Schorl: As our team had already had the opportunity to familiarise themselves with the THERA-Trainer lyra during the trial days, the subsequent training was completed very quickly. Following installation, a one-day training session was sufficient to enable the team to integrate the device independently into their daily therapy routine. As a result, the implementation process was largely smooth and without any significant disruption.

For the long-term use of a new technology, however, technical ease of operation is not the only decisive factor. Rather, it must be possible to integrate it into existing therapy workflows, and it must be accepted by both therapists and patients.

A technology can only be used successfully over the long term if it provides added value in everyday therapy and is accepted by everyone involved.



Miriam Keifert: How important is cooperation between the clinic and the manufacturer for the successful introduction and further development of a rehabilitation technology?

Dr. Schorl: From our perspective, successful cooperation between a clinic and a manufacturer begins even before the actual purchase. Several factors are crucial: the opportunity to trial the device, comprehensive training, close support during the implementation phase, and ongoing collaboration thereafter.

Especially for severely affected patients, combining different therapeutic approaches can open up new possibilities for standing and walking.

In addition, joint projects to assess effectiveness and usability, documentation of therapy outcomes and integration of the data into existing IT and reporting processes are important components of successful cooperation.

As a clinic, we were able to contribute our own experience and documentation requirements. Through the practice-oriented development of THERA-Trainer, solutions are created that provide real added value in everyday clinical practice, such as the new patient management software. This enabled us to switch to efficient, time-saving digital documentation.

Manufacturers and users should therefore not only work together during the installation of a system, but should jointly investigate how effective and practical a technology actually is in everyday clinical practice.

Miriam Keifert: What economic and structural challenges do you see in the introduction of modern rehabilitation technologies?

Dr. Schorl: From our perspective, the greatest challenge is the mismatch between the necessary investments and the existing reimbursement structures. Technologically sophisticated therapy devices involve high acquisition costs. At the same time, their use and clinical added value are often not adequately taken into account in current reimbursement systems.

Nevertheless, we decided to purchase the THERA-Trainer lyra because we particularly wanted to offer non-ambulatory patients a better chance of regaining their mobility. Robot-assisted gait rehabilitation has been the treatment of choice in guidelines for ten or fifteen years, with a very good "number needed to treat", and it is actually ethically unjustifiable to withhold such technology from patients.

The existing shortage of staff is another factor. Modern rehabilitation technologies can help to organise therapies more efficiently and reduce the staff required for certain treatment steps. We see considerable potential in this. At the same time, many facilities face the problem that they can only implement the necessary investments with difficulty due to the existing financing situation.

Robot-assisted gait rehabilitation has been the therapy of choice in clinical guidelines for the past ten to fifteen years, with a very favorable "number needed to treat". From an ethical perspective, it is therefore difficult to justify withholding such technology from patients.

Modern rehabilitation technologies are urgently needed in order to provide intensive, high-quality therapy even under conditions of staff shortages. At the same time, current reimbursement structures make it difficult for many facilities to gain access to precisely these technologies.

The experience of Waldburg-Zeil Klinik Bad Wurzach demonstrates the role that modern rehabilitation technologies can play in neurological rehabilitation. The THERA-Trainer lyra supports the implementation of intensive gait rehabilitation even for severely affected patients and meaningfully complements existing therapeutic approaches.

The technology itself is not the sole focus; rather, it is about targeted integration into a multimodal treatment concept. The combination of different therapeutic measures, structured organisation of workflows and a high therapy frequency can help to unlock additional rehabilitation potential.

We would like to thank Dr Martin Schorl for his valuable insights into his clinical experience and his practical perspectives on robot-assisted gait rehabilitation.



Miriam Keifert has a degree in sports science (M.Sc.) and works in product management of THERA-Trainer with a focus on "Clinical & Scientific".

TECHNOLOGY & DEVELOPMENT

Safe verticalisation, active training

Technology-assisted verticalisation and postural control are among the core components of modern rehabilitation after spinal cord injury. A recent article by Kuzmić and Ćurlin (2026) specifically places the THERA-Trainer balo within this therapeutic technology field.

Jakob Tiebel

For people with spinal cord injury, the upright body position is far more than an intermediate therapeutic goal. Verticalisation and postural stability rank among the most important functional priorities, regardless of lesion level or severity. Reduced muscle strength, altered sensory function and spasticity can, at the same time, significantly impair postural control – with direct consequences for transfers, self-care and other activities of daily living.

This is precisely where Kuzmić and Ćurlin see technology-assisted systems playing a crucial role. Alongside robotics, exoskeletons, sensor technology and neurostimulation, they describe devices specifically designed to support safe standing and active control of body position. As a concrete example, the authors cite the THERA-Trainer balo. Its stable frame enables secure training in an upright position. The integrated balance unit allows for both static and dynamic standing, thereby establishing the condition for controlled weight shifts and targeted training of postural control. The electric lift system further supports safe transfer from the wheelchair into the upright position.

The balo therefore combines two clinically relevant objectives in one system: safe patient verticalisation and active balance training. Rather than merely holding the patient in an upright position, the mechanical safety system can be utilised to permit movement within a protected setting, specifically challenging postural reactions.



The THERA-Trainer balo dynamic balance trainer enables individuals with impaired trunk control to train trunk stability and active weight shifting.

This article therefore underscores a key developmental trend in neurorehabilitation: technology should not merely compensate but enable safe, individualised and, wherever possible, active training. Particularly in patients who are not yet able to stand independently, this principle allows the upright position to be combined with therapeutically relevant tasks at an early stage of rehabilitation.

The THERA-Trainer balo combines verticalisation with targeted postural training.

Info:

The THERA-Trainer balo is cited in the current literature as an example of a technology-assisted solution for safe verticalisation, dynamic standing and targeted postural control training after spinal cord injury.

Original work

Kuzmić, A., & Ćurlin, M. (2026). Technological innovations in verticalization and postural control following spinal cord injury. Health Bulletin, 12(1), 117–128.

SCIENCE

Every revolution counts

Efficacy of therapy with the THERA-Trainer tigo compared with conventional rehabilitation after ischaemic stroke – a prospective comparative study at the University Clinical Center Niš (2025, n = 40)

Jakob Tiebel



Summary

A prospective comparative study conducted in 2025 at the Clinic for Physical Medicine and Rehabilitation, University Clinical Center Niš, investigated whether supplementary robot-assisted therapy with the THERA-Trainer tigo improves motor recovery after ischaemic stroke compared with conventional rehabilitation alone. The study included 40 patients with a first-time ischaemic stroke, confirmed by CT or MRI, presenting with mild to moderate symptoms and hemiparesis. The supplementary use of the tigo led to a statistically highly significant greater improvement in motor function in both the upper and lower extremities – with an identical overall duration of rehabilitation.

Background

Ischaemic stroke accounts for 75–80% of all strokes and is regarded as one of the leading causes of permanent disability in adulthood. Worldwide, 100–300 new cases per 100,000 inhabitants are recorded annually; specific mortality doubles with each decade of life beyond the age of 55. Even after optimal acute management – comprising thrombolysis, mechanical thrombectomy where appropriate, and secondary preventive antiplatelet therapy – a significant proportion of patients are left with a permanent motor deficit.

Functional recovery relies on neuroplasticity – the capacity of the nervous system to reorganise its structures and connections after injury. The national guidelines recommend early initiation of rehabilitation, identifying this as an essential component of successful treatment. Traditionally, rehabilitation has relied on kinesiotherapy and occupational therapy; however, in cases of severe paresis, these approaches are practically limited by the repetition number and the precision of manual movement guidance. Motor-assisted rehabilitation devices were developed specifically to close this gap: They enable early mobilisation even in cases of markedly impaired voluntary motor function, by providing controlled support to the movement.

The THERA-Trainer tigo is a movement exerciser offering motor-assisted cyclical movement patterns for the upper and lower extremities. It enables passive, assistive and active movement, thereby targeting different disease phases and degrees of impairment, and can improve muscle strength, range of motion, peripheral circulation and neuromuscular activation. Because each rotation is standardised, repeatable and measurable, the intensity, frequency and duration of the therapy can be precisely dosed.

Question

The aim of the study was to investigate the efficacy of therapy with the THERA-Trainer tigo compared with a purely conventional rehabilitation approach in terms of the restoration of motor function after ischaemic stroke.

Methodology

Study design: Prospective comparative study with a historical control group at the Clinic for Physical Medicine and Rehabilitation, University Clinical Centre Niš, conducted from January to December 2025.

Cohort. Originally 44 patients; following application of exclusion criteria, 40 patients remained (32 men, 8 women; mean age 66.82 ± 9.09 years). Patients included were those presenting with a first-ever, CT- or MRI-confirmed ischaemic stroke of mild to moderate clinical severity, right- or left-sided hemiparesis, and sufficient cognitive capacity to comprehend therapeutic instructions. Patients with a prior stroke, marked spasticity, behavioural or cognitive disorders, nosocomial infections or incomplete study completion were excluded.

Groups. Division into two equally sized groups (n = 20 each) according to rehabilitation period:

Control group: Retrospectively evaluated case notes of patients undergoing three weeks of conventional rehabilitation (kinesiotherapy and occupational therapy under physiotherapeutic guidance).

Experimental group: In addition to conventional rehabilitation, device-assisted therapy using the THERA-Trainer tigo, delivered over three weeks, five sessions per week, 30 minutes per session, involving controlled, repeatable and measurable active, assisted or passive crank/pedal rotation.

Both groups received an individually dosed programme corresponding to the severity and degree of mobility limitation; rehabilitation commenced approximately one month post-stroke in each case.

Outcome measures and assessment: Motor function was assessed using the Fugl-Meyer Assessment (FMA) for the upper and lower extremities – at admission (approximately one month post-stroke) and at discharge. Assessments were performed by the same assessor under standardised conditions on each occasion.

Statistics: Descriptive parameters (arithmetic mean, standard deviation, structural index), Student's t-test for small dependent or independent samples, and Fisher's exact test.

Results

Group comparability: No statistically significant difference between the control group and the experimental group with regard to age (68.05 ± 9.63 vs. 65.6 ± 8.29 years; $t = 0.27$; $p > 0.01$) or gender distribution (Fisher's exact test, $p = 0.695$). The total duration of rehabilitation also did not differ significantly (16.15 ± 4.3 days; $t = 0.82$; $p > 0.01$).

Motor function – upper extremity (Fugl-Meyer Assessment): At admission, both groups were comparable (control 40 ± 14.74; experimental 38.7 ± 11.27); at discharge, both groups demonstrated significant improvement (44.35 ± 13.78 and 50.05 ± 12.14 respectively; in each case $p < 0.01$). The mean improvement was 4.35 ± 1.93 points in the control group versus 11.35 ± 4.05 points in the experimental group – a highly significant difference in favour of the robot-assisted approach ($t = 6.97$; $p < 0.01$).

Motor function – lower extremity (Fugl-Meyer Assessment): There was also a significant improvement in both groups (control group 23.75 ± 5.91 → 26.3 ± 5.16; experimental group 20.9 ± 4.85 → 27.9 ± 4.24; $p <$ n 0.01 in each case). The mean improvement was markedly lower in the control group (2.55 ± 1.28 points) than in the experimental group (6.8 ± 2.04 points), $t = 7.87$, $p < 0.01$.

Key finding: The additional use of the THERA-Trainer tigo led to an approximately 2.5-fold greater improvement in motor function in both the upper and lower extremities compared with conventional rehabilitation alone – within an identical treatment duration.

Discussion and therapeutic context

The results demonstrate a statistically significant additional benefit of electromechanical movement therapy over conventional rehabilitation alone after ischaemic stroke. These findings are consistent with the international literature, in which electromechanical rehabilitation techniques are described as at least equivalent to, and frequently superior to, conventional approaches.

Mechanism of action: The observed effect can be explained by the interplay of three factors, consistent with the concept of neuroplasticity: (1) highly repetitive, task-specific movement delivered with a consistency that cannot be achieved manually; (2) active patient participation in assisted mode, whereby the patient's own movement intention is supplemented by motor-driven assistance; (3) peripheral and musculoskeletal secondary effects – contracture prophylaxis, improved circulation, preservation of joint integrity – which take effect even in passive mode.

Context of use: The practical benefit of the THERA-Trainer tigo unfolds across multiple dimensions:

It enables movement training for patients whose voluntary motor function is initially insufficient for active training.

It standardises repetition number, duration and intensity, enabling precise dosing and full documentation of therapy.

It relieves therapeutic staff of physically demanding manual guidance work and allows them to focus on more complex, individualised interventions – with potential implications for rehabilitation costs.

Interactive training parameters foster motivation and active patient participation – a key factor in therapy adherence.



Neuroplasticity requires repetition. The tigo delivers it – safely and at an individually adjustable training dose.

Limitations: The authors explicitly cite the limited sample size, a single-centre design and the application of the therapy as an adjunct to conventional rehabilitation as limitations of the study, meaning that the contribution of the conventional component to recovery cannot be fully isolated. For a more precise assessment of efficacy, larger, multicentre studies with longer follow-up are required.

Study highlights:

Adjunctive therapy using the THERA-Trainer tigo improves motor recovery after ischaemic stroke in the upper and lower extremities by a factor of approximately 2.5 compared with conventional rehabilitation alone – for the same duration of treatment. The mean increase in the Fugl-Meyer motor score was approximately 2.6 times higher in the experimental group than in the control group.

Design: Prospective comparative study with historical control group; measurements taken at admission (~1 month post-stroke) and at discharge | 1 centre (University Clinical Center Niš, 2025) | 40 patients.

Population: 40 adults (32 male / 8 female, mean age 66.82 ± 9.09 years) after a first-ever, CT-/MRI-confirmed ischaemic stroke with mild to moderate clinical severity and hemiparesis.

Intervention: THERA-Trainer tigo (motor-assisted movement exerciser, cyclical movement pattern passive / assistive / active, upper and lower extremity) in addition to conventional rehabilitation (kinesiotherapy and occupational therapy); comparison with conventional rehabilitation alone.

Intensity: 3 weeks, 5× per week, 30 minutes per session.

Outcome: Motor function, assessed using the Fugl-Meyer Assessment for the upper and lower extremity.

Upper extremity: Improvement +4.35 ± 1.93 (control) vs. +11.35 ± 4.05 (tigo); $t = 6.97$; $p < 0.01$

Lower extremity: Improvement +2.55 ± 1.28 (control) vs. +6.8 ± 2.04 (tigo); $t = 7.87$; $p < 0.01$

Duration of rehabilitation: No significant difference between groups (16.15 ± 4.3 days; $p > 0.01$)

Conclusion

This prospective comparative study demonstrates that the adjunctive use of the THERA-Trainer tigo constitutes a significant additional component in rehabilitation after ischaemic stroke. Given the same duration of rehabilitation, movement therapy achieves a significantly greater improvement in motor function of the upper and lower extremities than conventional rehabilitation alone. For clinical practice, this represents an evidence-based, titratable and resource-efficient component of modern neurorehabilitation – with direct benefit to patients in the form of measurable motor recovery and functional restitution.

Upper and lower limbs benefit equally – with high statistical significance ($p < 0.01$).

Comments

The Niš study confirms what has been emerging in international literature for years: device-assisted movement therapy can effectively complement conventional rehabilitation after ischaemic stroke and support motor recovery.

The THERA-Trainer tigo can create particularly advantageous training opportunities for patients with pronounced paresis, in cases where active and sufficiently intensive practice would otherwise only be possible to a limited extent. In this sense, it acts as a therapeutic multiplier, enabling repetitive movement even in cases of limited voluntary activity and supplementing existing staffing resources in a targeted way.

Original work

Radovanović, V., et al. (2025). The Significance of Robot-Assisted Therapy on the Recovery of Motor Function in Patients After Ischemic Stroke. [Manuscript accepted for publication]. Acta Medica Medianae. Clinic for Physical Medicine and Rehabilitation, University Clinical Center Niš.

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LIFE IN MOTION

TECHNOLOGY & DEVELOPMENT

The original dynamic standing frame

More than 25 years of development, clinical evaluation and therapeutic maturity

Otto Höbel, Dr. Jonathan Kopf, Jakob Tiebel

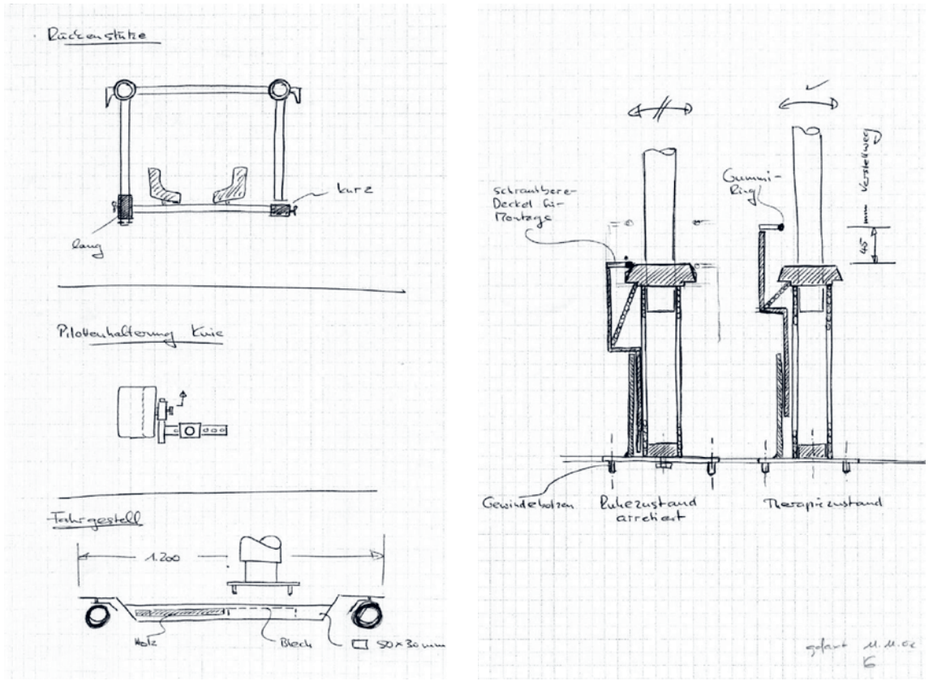
Classical standing frames were originally developed primarily for verticalisation. They bring people with limited mobility into an upright position and stabilise the body. However, static standing alone is not sufficient for relearning functional mobility and improving postural control. Postural control only develops when the centre of gravity is actively moved over the base of support, controlled and stabilised again following unexpected deviations.

At this point, in the late 1990s, the development of today's THERA-Trainer balo began. The aim was to develop a device that would create safety not through static verticalisation, but through controlled freedom of movement in a secured upright position. In other words, the person training should be able to move as actively as possible while standing, without being exposed to an uncontrolled risk of falling.

2000: The scientific origins

In 2000, Zlatko Matjačić, Inger Lange Johannesen and Thomas Sinkjar published the first scientific description of the so-called Multi-purpose Rehabilitation Frame. The system featured two mechanical degrees of freedom and enabled controlled movements of the legs and pelvis in the sagittal and frontal planes. At the same time, the degree of mechanical support could be varied in a targeted manner (Matjačić et al., 2000).

The authors had already formulated a principle that continues to characterise dynamic standing training to this day: as much stability as necessary, as much active movement as possible. Mechanical support was not used solely for safety, but could be deliberately reduced in order to gradually adapt the demands on postural control to the individual's

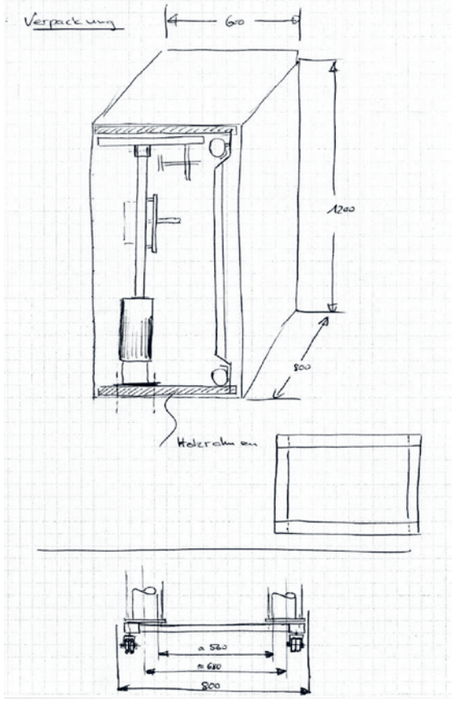


Early construction sketches show the basic principle of today's THERA-Trainer balo

performance level. The design therefore combined fall-safe standing with active weight shifting and transformed a conventional standing and positioning device into an active training platform. The conceptual separation of external safety and independent postural activity continues to form the scientific and technical basis of the THERA-Trainer balo.

2003: From the prototype to the BalanceReTrainer

Three years later, Matjačić, Hesse and Sinkjar described the further-developed system for the first time as the BalanceReTrainer. In addition to the technical design, they presented training methods for people with neurological impairments. One patient with chronic hemiparesis and spatial neglect completed ten days of training. The biomechanical analysis subsequently showed a clear functional improvement in controlled weight shifting (Matjačić et al., 2003).



The key advance of this work was the combination of training and objective movement analysis. Weight shifting was not merely observed qualitatively, but recorded biomechanically. This created a basis for reproducible training tasks: direction of movement, range of movement and degree of support could be specifically prescribed and adjusted over the course of training.

This was particularly relevant for people with severe impairments. In a free-standing situation, at least one therapist must always take over a large part of the stabilisation. In the BalanceReTrainer, this safety function was provided mechanically. This allowed the therapist's attention to be focused more strongly on movement initiation, symmetry, trunk control and task quality.

2003: Functional effects in people with amputation

Also in 2003, Matjačić and Burger investigated the system in 14 people with transtibial amputation. The participants trained for approximately 20 minutes on five consecutive days in the fall-safe BalanceReTrainer. Single-leg standing on the prosthesis, the Timed Up and Go test and the 10-metre walk test were recorded (Matjačić & Burger, 2003).

After training, the average standing time on the prosthetic limb increased from 2.98 to 4.30 seconds. The time in the Timed Up and Go test decreased from 6.15 to 5.40 seconds, and the time required to walk ten metres decreased from 5.51 to 4.50 seconds. Despite the short training duration, both a specific balance performance measure and functional mobility parameters therefore improved.



The BalanceReTrainer as an early precursor of today's THERA-Trainer balo – developed for dynamic balance training in a secured standing position.

The findings broadened the range of applications beyond neurological rehabilitation. Dynamic postural control is also central following amputation because body weight must be safely transferred onto the prosthesis and subsequently shifted again. The BalanceReTrainer enabled precisely these loading and control processes to be trained with a high number of repetitions.

2005: From standing to preparation for walking

In 2005, Matjačić and colleagues expanded the training concept to include targeted stepping activities. The publication described a method for dynamic balance training during standing and stepping in the Original BalanceTrainer, which was already commercially available at the time from medica Medizintechnik GmbH, manufacturer of THERA-Trainer. In a two-week case study, a person with chronic hemiparesis trained for 30 minutes twice daily (Matjačić et al., 2005).

The study addressed a central relationship: walking requires not only rhythmic leg movements, but also continuous control of the trunk and centre of gravity. Before each step, weight must be shifted onto the stance leg, stabilised there and the other leg unloaded. Deficits in this preparation often limit step initiation and gait quality.

The BalanceTrainer was thus positioned as part of a functional continuum ranging from trunk stabilisation through targeted weight shifting and loading of the stance leg to unloading of the swing leg and, ultimately, initiation of a step. This principle continues to characterise the THERA-Trainer balo: it is not intended solely for safe standing, but creates a training environment for key postural prerequisites for walking. Depending on the individual's performance level, small shifts of the centre of gravity can initially be trained, followed by larger movement amplitudes and, building on these, targeted stepping and even reaching tasks.

2006: Intensive training in sensorimotor neuropathy

In a randomised study in 2006, Matjačić and Zupan investigated 16 people with hereditary sensorimotor neuropathy. Both groups completed a programme of stretching, strengthening, as well as dynamic balance and mobility training. In the intervention group, training was performed in the BalanceTrainer; in the control group, comparable tasks were carried out with manual support from a physiotherapist (Matjačić & Zupan, 2006).

In the device group, the Berg Balance Scale, the Timed Up and Go test and the 10-metre walk test improved significantly. The study also demonstrated an organisationally relevant aspect: dynamic standing and stepping activities could be performed without permanent physical stabilisation by a therapist or carer.

This revealed a key potential of the system. The structural fall-safety mechanism enables a higher number of repetitions, longer periods of active training and more precise dosing. The therapist remains responsible for indication, set-up, progression and movement analysis, but does not need to manually stabilise the person training during every weight shift.

2009: Postural control becomes measurable by direction

In 2009, Cikajlo and Matjačić also investigated the BalanceTrainer as an experimental platform for the instrumental assessment of postural responses. In a study involving ten people after stroke and seven neurologically healthy comparison participants, unexpected movement impulses were applied from eight different directions and the resulting response and loading patterns were analysed (Cikajlo & Matjačić, 2009).

The study demonstrated that balance control can be considered in a direction-specific manner: while movements in one direction may be well controlled, lateral or diagonal demands can produce markedly different response patterns. The approach

therefore provided an illustrative example of the potential of the BalanceTrainer as a research instrument for differentiated analysis of postural control.

However, this instrumental assessment function remained an experimental research approach and was not continued as a standard function of the THERA-Trainer balo. Instead, further product development focused on the underlying therapeutic principle: creating a safe training environment in which direction of movement, degree of support and task demands can be adapted to individual abilities and active postural control can be specifically promoted.

2010: Clinical evaluation in subacute stroke rehabilitation

In 2010, Goljar and colleagues investigated the training in a randomised controlled study involving people in the subacute phase after stroke. Of the 50 people enrolled, 39 completed the study. Conventional balance training was compared with device-assisted training in the BalanceTrainer. Both interventions improved balance and functional mobility (Goljar et al., 2010).

The significance of this study rests on the clinical validation of the training principle under controlled conditions. By this point, the BalanceTrainer had long ceased to be an experimental one-off design and had become a standardisable training environment that could be integrated into a regular neurological rehabilitation process.

Standardisation is particularly relevant in subacute rehabilitation. Performance levels can change within a short period of time. The degree of support, range of movement and task complexity must therefore be adjusted regularly. The mechanical design allows such progression without abandoning the fundamental fall-safety mechanism, even for patients who are unable to walk.

2012: Integration of virtual feedback

With the integration of virtual tasks in 2012, the mechanical training platform was enhanced with visual real-time feedback. In a pilot study involving six stroke patients, training was carried out over three weeks: two weeks in the clinic and one week in the home environment. Training took place five times per week for up to 20 minutes per session (Cikajlo et al., 2012).

The virtual task translated the real weight shift into a visible response on the screen. This provided the person training with immediate information about direction of movement, dosing and achievement of the target. At the same time, the task created an external focus of attention: rather than the isolated movement of the body being the focus, the aim was to achieve a visible action goal.

The study documented improvements including in the Berg Balance Scale, the Timed Up and Go test, the 10-metre walk test and single-leg standing. It also showed that the dynamic training principle can be combined with digital and telerehabilitation approaches.

From the BalanceReTrainer to the THERA-Trainer balo

The names and technical designs were continuously developed over the years. The scientific and technological origins can be traced clearly: the Multipurpose Rehabilitation Frame evolved into the BalanceReTrainer and from there into the THERA-Trainer Standing & Balancing product line, represented today by the THERA-Trainer balo.

The current balo combines fall-safe upright positioning with a patented dynamic balance unit. This allows weight shifts in all directions and therefore targeted movement of the centre of gravity over the base of support. The feet, knees and pelvis can be individually secured according to the functional requirements. This also means that people who are not yet able to stand independently can be included in active training at an early stage.

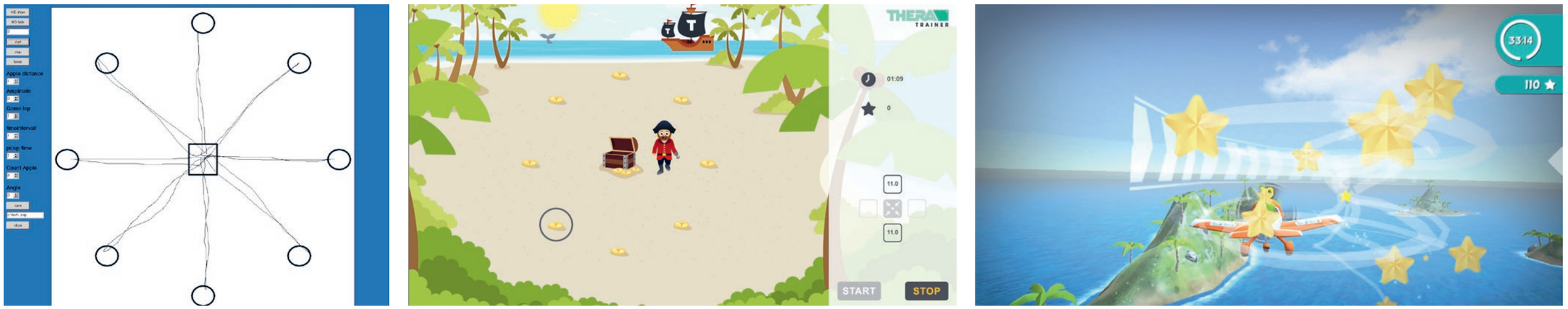
What is crucial is the continuity of the underlying principle. The balo does not merely support the achievement of a vertical position, but enables a graded progression of:

- trunk stability and axial control,
- active weight bearing,
- multidirectional shifting of the centre of gravity,
- anticipatory and reactive balance responses,
- reaching and grasping tasks and preparatory stepping activities.

This means that the same device can be used in different phases of rehabilitation: from supported verticalisation through dynamic standing to the immediate preparation of functional mobility.

Why the balo is the Original

The claim to be the Original of dynamic standing training is based not solely on product tradition. It can be traced through a research and development history spanning more than 25 years. The first paper in 2000 already described the essential design principles: controlled multidirectional movement and adjustable mechanical support. In the following years, the system was investigated in stroke, neglect, amputation and sensorimotor neuropathy. The research included technical development work, biomechanical analyses, clinical case studies, pilot studies and randomised controlled trials.



The development of the software over time: from simple direction-based feedback tasks to interactive virtual training applications.

This breadth is exceptional for a rehabilitation medicine training device. Research has addressed not only whether people can stand in the device, but also which motor demands can be trained in it, how training affects functional performance, how postural responses can be objectively assessed and how digital feedback systems can be integrated.

From a scientific perspective, it is not possible to derive a general superiority over other forms of therapy for every indication. What can be stated with confidence, however, is that the THERA-Trainer balo is among the longest-standing, most systematically and most clinically diversely investigated dynamic standing trainers.

More than a standing device

The particular quality of the balo lies in combining apparent opposites: safety and freedom of movement. Support and independent activity. Verticalisation and functional training. Mechanical reliability and digital feedback.

This means that training can begin early and develop alongside functional progress. A person does not need to be able to stand safely already in order to work on postural control. At the same time, the device remains sufficiently challenging to train more complex weight shifts, grasping tasks and stepping activities later on.



This particular combination has made the THERA-Trainer balo a benchmark in dynamic standing training for more than 25 years: not because of a short-lived technological trend, but because of a consistently developed, scientifically investigated and clinically proven training principle.

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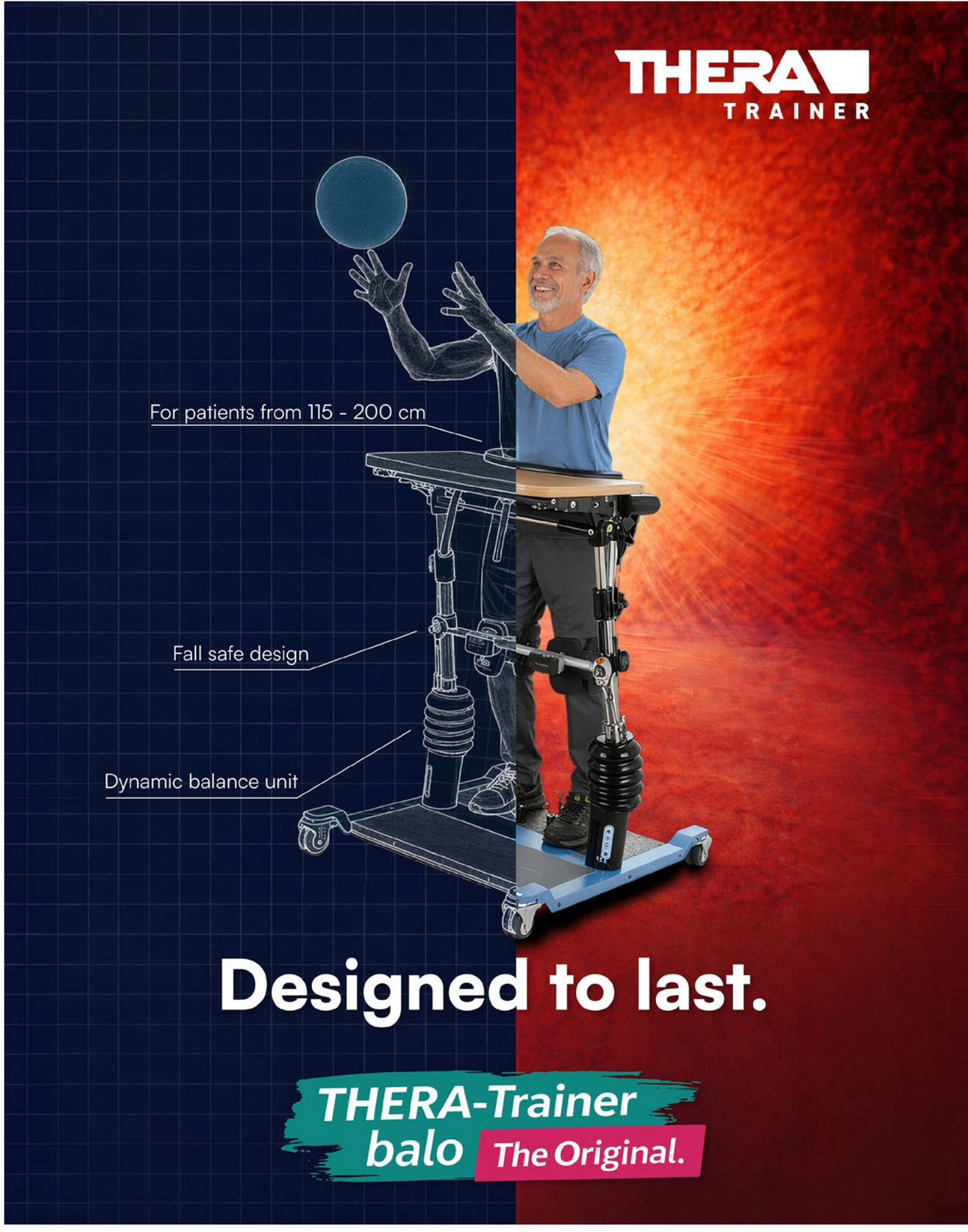
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The THERA-Trainer balo was not the result of a single idea, but of years of practical experience, close collaboration and continuous development.



Even at the age of 75, nerve recovery is still possible.

When movement becomes possible again

Therapeutic case vignette on the conservative management of a fall-related axillary nerve injury using the THERA-Trainer in a 75-year-old female patient over a rehabilitation period of one year.

Jakob Tiebel

A 75-year-old female patient presented following a fall, with pronounced functional impairment of the right shoulder. Over the following weeks, active mobility had progressively declined. Clinical examination revealed marked atrophy of the deltoid muscle, a prominent shoulder contour, and an almost complete inability to actively raise the arm. The findings were consistent with an axillary nerve injury, which primarily innervates the deltoid and teres minor muscles and is thus plays a key role in shoulder abduction and stabilisation.

Isolated lesions of the axillary nerve are comparatively rare and represent a particular therapeutic challenge in older patients. Age-associated sarcopenia, reduced neuromuscular reserve, and a potentially slowed reinnervation can complicate functional recovery.

In the present case, however, a consistently conservative treatment approach was pursued. Over a period of twelve months, a marked restoration of shoulder function was achieved.

Early rehabilitation: maintaining mobility and promoting neuromuscular activity

At the start of treatment, manual muscle testing showed deltoid muscle strength of 1/5: a muscle contraction was discernible; however, active movement of the arm was not yet possible. Accordingly, early rehabilitation initially focused on maintaining passive mobility, preventing secondary shoulder stiffness, and targeted neuromuscular stimulation.

The treatment programme included passive and assisted mobilisation of the shoulder joint, together with biphasic electrical stimulation of the affected musculature, each administered for approximately 15 minutes. In addition, upper body training using the THERA-Trainer tigo was incorporated into the treatment programme.

Upper body training was employed to maintain mobility of the shoulder girdle, facilitate repetitive movement patterns, and support neuromotor re-education. At the same time, the training provided an opportunity to maintain physical activity and cardiovascular loading despite the significant impairment of the upper extremity.

For the patient, the guided and continuously repeatable movement was of particular importance. While independent lifting of the arm was not initially possible, the affected extremity could nonetheless be integrated into a cyclical movement pattern. This allowed the shoulder to be moved regularly through a controlled range of motion, without requiring sufficient strength for free active arm movements at this stage.

The training formed part of a multimodal, comprehensive physiotherapeutic concept and was combined with passive mobilisation, electrical stimulation, transcutaneous electrical nerve stimulation (TENS), pain management, and, later, an increasing proportion of active exercises. As reinnervation progressed, the focus gradually shifted from securing mobility towards active movement control and muscle strengthening.

After approximately five months, pain had markedly diminished and mobility of the shoulder joint had been largely preserved. A clinically relevant shoulder stiffness was successfully avoided. This established favourable conditions for the more active rehabilitation phase that followed.

Functional development over twelve months

Over the subsequent course of treatment, voluntary muscle activity increased steadily, resulting in a marked functional improvement of the affected shoulder over the twelve-month rehabilitation period. The active shoulder flexion improved from an initial 0° to approximately 90°, whilst active abduction increased from 0° to around 60°. In parallel, manual muscle testing showed an improvement in deltoid muscle strength from an initial 1/5 to 2+/5–3/5. This enabled increasingly active movements, up to and including movements against gravity.

The clearly visible atrophy of the deltoid muscle observed at baseline also showed a discernible regression during treatment. At the same time, neuromuscular control of the shoulder girdle improved, enabling the arm to be increasingly employed in a targeted and functional manner. This progress was ultimately reflected in everyday activities. The patient regained the ability to perform basic activities independently using the affected limb, such as combing her own hair. Notably, no pronounced secondary complications, such as clinically relevant shoulder stiffness or persistent severe pain, occurred during treatment. Overall,

The patient was able once again to comb her own hair and perform routine tasks.

progressive neuromuscular recovery was therefore reflected not only in measurable improvements in range of motion and muscle strength, but also in a tangible restoration of independence in activities of daily living.

Clinical classification

This case demonstrates that even in cases of pronounced axillary nerve palsy in older age, relevant functional recovery may be achievable over an extended rehabilitation period. Crucially, it was not any single therapeutic intervention, but rather the sustained combination of joint preservation, neuromuscular stimulation, repetitive movement and subsequent active strengthening.

Upper body training using the THERA-Trainer tigo integrated seamlessly into this concept, particularly during the early and intermediate phases of rehabilitation. It enabled repetitive, controlled movement cycles at a time when free active arm movements were still barely achievable, thereby supporting the transition from passive mobilisation towards increasingly independent motor activity.

This case vignette therefore illustrates an important principle of conservative rehabilitation for peripheral nerve injuries. Neurological regeneration takes time – throughout this period, mobility, muscular status and functional activity must be preserved as consistently as possible and progressively rebuilt. In this context, device-assisted, adaptable movement training can constitute a valuable component of a long-term physiotherapy treatment plan.



The THERA-Trainer tigo as a cornerstone of early rehabilitation – positively impacting joint preservation, movement and muscle strengthening.

Original work

Ayub, S., Sheerani, M., Mirza, S., Thourani, N., & Dodani, P. (2026). Axillary nerve injury (C5–C6) with deltoid and teres minor weakness in a 75-year-old female managed by physiotherapy. The Healer Journal of Physiotherapy and Rehabilitation Sciences, 6(1), 6–10. https://doi.org/10.55735/j9skcw87

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THERA TRAINER

SCIENCE

Steps to greater mobility

A recent prospective study demonstrates that older stroke patients with atrial fibrillation or diabetes mellitus can also achieve significant functional gains during early rehabilitation. Of particular interest are the objectively recorded changes observed during training with the THERA-vital motor-assisted movement exerciser (editor's note: predecessor model of the THERA-Trainer tigo) used as part of the rehabilitation programme.

Jakob Tiebel

Stroke patients with atrial fibrillation or diabetes also demonstrated marked functional progress under early rehabilitation.



Atrial fibrillation and diabetes mellitus are among the most common comorbidities after stroke and are associated with a less favourable prognosis. Romanova et al. (2025) therefore investigated whether these cardiometabolic comorbidities influence functional recovery during early inpatient rehabilitation.

The prospective study enrolled 46 post-stroke patients with a mean age of approximately 70 years. Over a period of 3.5 weeks, they received 120 minutes of rehabilitation daily, five days a week. Alongside individual therapeutic exercises, various training devices were introduced from the third to fifth day onwards – including the THERA-vital.

After completion of rehabilitation, approximately 80% of participants demonstrated a functional improvement. Notably, patients with atrial fibrillation or diabetes mellitus did not differ significantly from patients without these comorbidities. Even after matching for age and sex, this finding remained consistent. Age, by contrast, proved to be significantly more relevant to rehabilitation outcome.

The progress metrics recorded during training are particularly insightful. Practically all patients were able to increase their training duration – on average from approximately 9–10 minutes at the outset to around 18–20 minutes by the end of rehabilitation. In 98% of patients, load distribution between the lower extremities also improved, approaching a more balanced engagement of both sides.

The results therefore provide two important insights from everyday clinical practice. First, atrial fibrillation and diabetes mellitus do not appear to significantly influence early functional recovery after stroke. Second, the training data collected using the cycling trainer show how load tolerance and bilateral limb contribution can change objectively within a few weeks.

The study demonstrates the additional value that device-based training parameters can offer for the objective documentation of rehabilitation progress – particularly in older and medically complex patients. The presence of individual cardiometabolic comorbidities is less crucial than whether patients can be enrolled in active rehabilitation at an early stage, following a structured pathway tailored to their functional performance level.

Conclusion

Early rehabilitation after stroke resulted in functional improvements in the majority of patients – irrespective of the presence of atrial fibrillation or diabetes mellitus. Approximately 80% of the total sample demonstrated improvements. Age was the only factor that differed significantly between patients with and without improvement. These findings underscore the importance of early-initiated rehabilitation and demonstrate that atrial fibrillation and diabetes mellitus did not significantly influence early functional recovery in this study. The rehabilitation programme comprised individual therapeutic exercises alongside training with various devices, including the THERA-vital (editor's note: predecessor model of the THERA-Trainer tigo).

Original work

Romanova, E., et al. (2025). Functional Recovery in Patients with Atrial Fibrillation and Diabetes Mellitus Following Early Post-Stroke Rehabilitation. SN Comprehensive Clinical Medicine, 7, 431.

TECHNOLOGY & DEVELOPMENT

Arm ergometry: a window into cardiac function

In a prospective, ESC-compliant (European Society of Cardiology) screening study in pacemaker patients, the portable ergometer THERA-Trainer mobi enables diastolic stress echocardiography – gentle, finely graduated and safe enough for a multimorbid target population in whom conventional exercise testing reaches its limits.

Jakob Tiebel

Heart failure with preserved ejection fraction (HFpEF) accounts for around half of all heart failure cases and is associated with reduced quality of life, frequent hospitalisations and increased mortality. The diagnosis is particularly challenging in older patients with a pacemaker. Here, multimorbidity and the haemodynamic consequences of long-term right ventricular pacing converge. At the same time, pacing artefacts and mechanical dyssynchrony on resting echocardiography can affect precisely those Doppler parameters on which HFpEF diagnosis largely relies. As a result, without exercise stress testing, the condition frequently goes undetected in this patient group – potentially delaying guideline-directed therapy.

In the Portuguese PM-HFpEF study, the THERA-Trainer mobi is used to provide standardised exercise loading as part of diastolic stress echocardiography. The procedure offers practical advantages for this patient group.

Gentle for very elderly pacemaker cohorts

Conventional exercise testing is generally performed using the legs – on a cycle ergometer or treadmill. For elderly and frail cardiac patients, however, this can already represent a considerable obstacle. In the PM-HFpEF study, arm ergometry was therefore purposefully chosen. It is often more readily performed in older, multimorbid adults – and thus in the typical profile of many pacemaker patients – whilst also enabling a rapid return to the supine position for the ultrasound imaging that immediately follows. Studies on arm ergometry demonstrate that it can generate sufficient cardiovascular loading, even in patients with limited exercise capacity, to reveal exertion-dependent changes in cardiac filling pressures.

Info

HFpEF stands for Heart Failure with preserved Ejection Fraction. It refers to a form of heart failure in which the heart pumps normally (ejection fraction ≥ 50 %), but the heart muscle exhibits increased stiffness. As a result, the ventricle is unable to fill properly with blood during the filling phase (diastole).

Flexible and space-saving in the examination room

During the examination, the mobi is positioned on a height-adjustable table directly in front of the patient, who sits upright at the edge of the examination couch. The device integrates seamlessly into the diagnostic workflow, rather than requiring adaptation of the entire assessment setup. Following completion of the exercise phase, the table can be swiftly withdrawn, allowing the echocardiographic examination to continue without the need for time-consuming repositioning.

Finely graduated and precision-controlled

Another advantage of the THERA-Trainer mobi is the precisely titratable exercise load. The study protocol employs short, standardised stages of 30 seconds' exercise loading each, with defined resistance increments. Following an adaptation phase at 0.4 kg (approximately 2 N m), resistance is increased in up to six increments to a maximum of 3.0 kg (15 N m). The aim is a submaximal heart rate of 100 to 110 beats per minute. This fine gradation allows even individuals with significantly limited exercise tolerance to be guided in a controlled, stepwise manner up to a diagnostically meaningful exercise intensity.

Safety as part of the study protocol

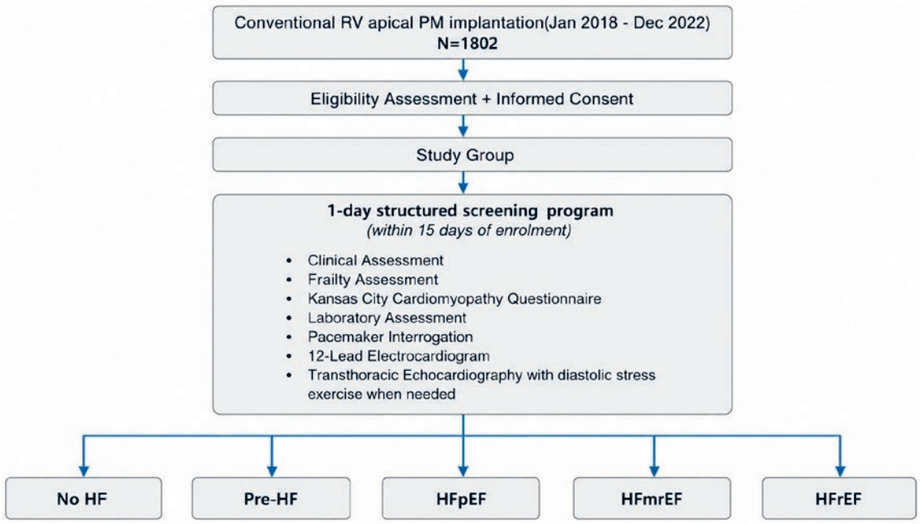
Exercise load is conducted under continuous ECG monitoring by trained staff, with pacemaker wearers additionally monitored via intracardiac electrogram. The test is terminated immediately upon reaching the target heart rate or the onset of limiting symptoms. The seated position, controlled increase in exercise load and straightforward handling of the mobi support a well-controlled examination procedure, even in vulnerable patient groups.

Note

Training on the mobi is also safe for patients fitted with a pacemaker. It must simply be ensured that no direct bodily contact with the device occurs in the area of the pacemaker, by maintaining a minimum safety distance of 5 cm.

Diastolic stress echocardiography using an upper-body ergometer





Overview of the screening programme and diagnostic pathway of the PM-HFpEF study.

The key benefit: detecting HFpEF during exercise

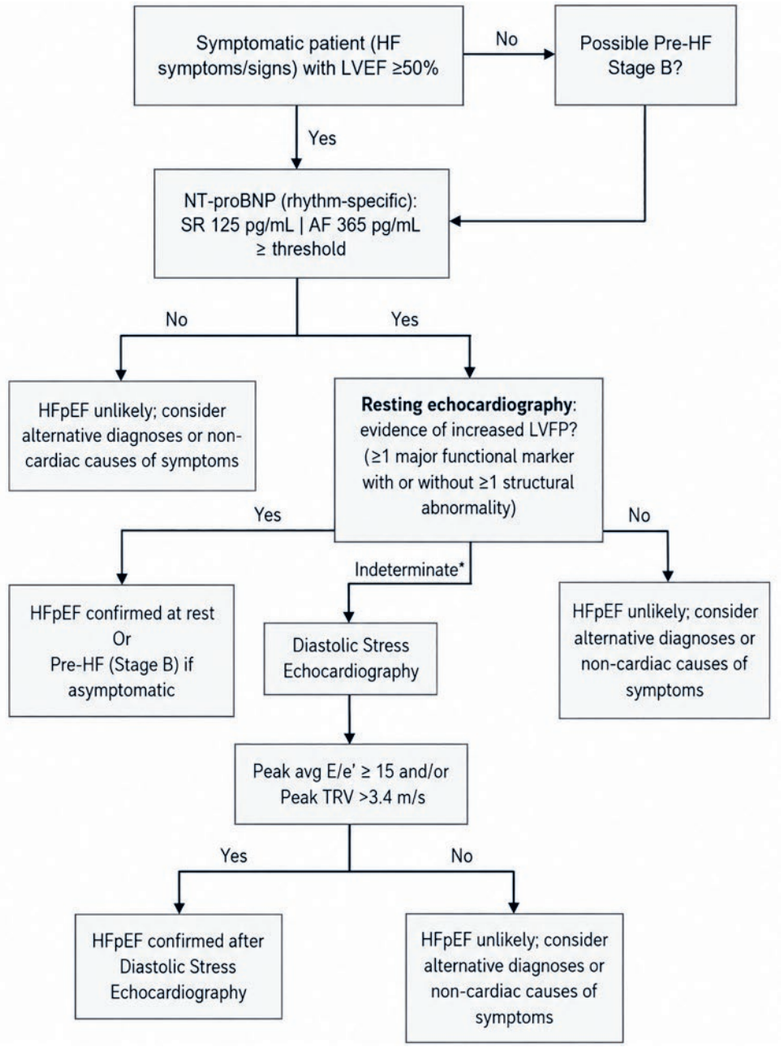
For pacemaker patients in particular, exercise-dependent diagnostics can prove crucial. In HFpEF, changes in cardiac filling pressures often only become apparent during physical exertion. If the examination remains confined to resting conditions, there is therefore a risk that the condition may go undetected in this growing patient group. In the study setup, the THERA-Trainer mobi provides the practical basis for applying standardised exercise stress to even older, multimorbid patients, with echocardiographic examination performed immediately afterwards.

The THERA-Trainer mobi enables safe, exercise-dependent diagnosis in a seated position.

HFpEF only becomes apparent under exercise stress and is frequently overlooked in pacemaker patients.

Conclusion

In this context, the THERA-Trainer mobi fulfils a function that goes beyond that of a conventional training device. It provides a controlled, titratable exercise load with flexible spatial integration, ideally suited to diastolic stress echocardiography. This enables diagnostic assessment even in patients for whom conventional exercise stress testing is of limited suitability – helping to unmask potentially latent HFpEF during exertion.



Diagnostic assessment process: assessment at rest, referral for diastolic stress echocardiography and post-exercise assessment.

With controlled 30-second exercise intervals to the submaximal target heart rate.

Original work

Santos, E., Teixeira, R., Almeida, J., Fonseca, P., Oliveira, M., Gonçalves, H., Primo, J., Diaz, S., Barros, A., Vilela, E., Sampaio, F., Saraiva, F., Oliveira, M., & Fontes de Carvalho, R. (2026). Screening for HFpEF in pacemaker patients: Study design and protocol of the PM-HFpEF study. PLOS ONE, 21(6), e0349667. https://doi.org/10.1371/journal.pone.0349667

TECHNOLOGY & DEVELOPMENT

More than just watts

How the THERA-Trainer tigo makes joint loads visible during cyclical movement training

Jakob Tiebel

Training duration, cadence and power output are among the key parameters of cyclical movement training. However, they only offer limited insight into the actual mechanical loading occurring at the hip, knee and ankle joints. A study published in the Journal of Biomechanics therefore investigated how joint contact forces during seated movement training can be estimated using a model-based approach. In the experimental setup, the THERA-Trainer tigo served as a controllable, robotically driven movement therapy device.

The internal mechanical dose

Joint contact forces describe the resultant load within a joint. They are determined not solely by the force transmitted to the crank, but also by muscle activation, co-contraction, joint position, force effect, anatomical lever ratios and movement coordination.

This means that two individuals can generate markedly different internal loads despite identical power output and cadence. In particular, radial crank forces and muscle forces can place strain on the joints without this being directly reflected in the displayed wattage.

Since joint contact forces can only be measured directly using invasive procedures, the researchers combined experimental measurement data with an individualised neuromusculoskeletal computer model.

The experimental setup with the THERA-Trainer tigo

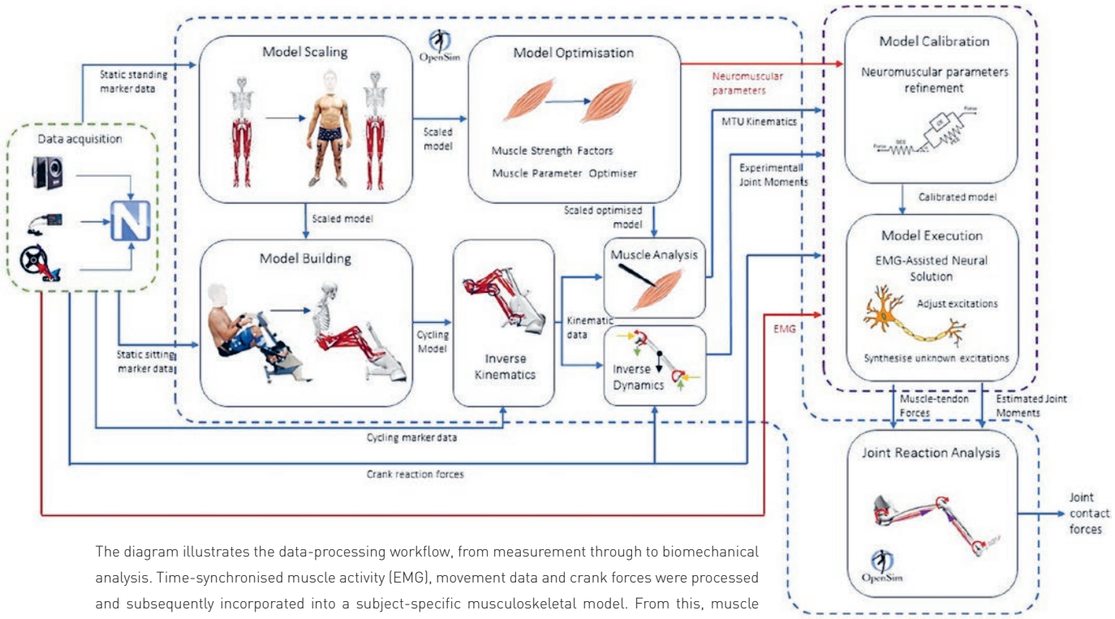
Eleven healthy adults took part in the investigation. Participants trained on a THERA-Trainer tigo under six controlled conditions:

- 40 or 60 revolutions per minute
- 15, 30 or 45 watts each

Position, seat spacing and movement execution were standardised. Specialised cranks recorded tangential and radial forces as well as crank angle. In addition, movements were recorded using a three-dimensional camera system, and the activity of 15 muscles was captured using surface EMG.

The measurement data were incorporated into a computer model adapted to individual body height and body mass. On this basis, muscle forces as well as the contact forces at the hip, knee and ankle joints were estimated.

The THERA-Trainer tigo did not itself measure the joint forces during this process. It provided the reproducible movement task and standardised human–machine interface necessary for biomechanical analysis.



The diagram illustrates the data-processing workflow, from measurement through to biomechanical analysis. Time-synchronised muscle activity (EMG), movement data and crank forces were processed and subsequently incorporated into a subject-specific musculoskeletal model. From this, muscle forces and the resulting joint contact forces at the hip, knee and ankle joints were calculated using the modelling approach.

Same power output, different joint loading

The key finding: at identical power output, peak contact forces at group level were higher at 40 rpm than at 60 rpm. This effect was observed at the hip, knee and ankle joints.

The difference was most pronounced at the knee. At the knee, mean peak contact forces at the lower cadence were approximately 0.33 to 0.46 body weights higher, depending on the power level.

This is biomechanically plausible: if the same power output is to be achieved at a lower cadence, a higher torque per revolution is required. The resulting joint loading, however, also depends on which muscles are activated, the extent to which antagonistic muscle groups co-contract, and the timing and direction of the force applied to the crank.

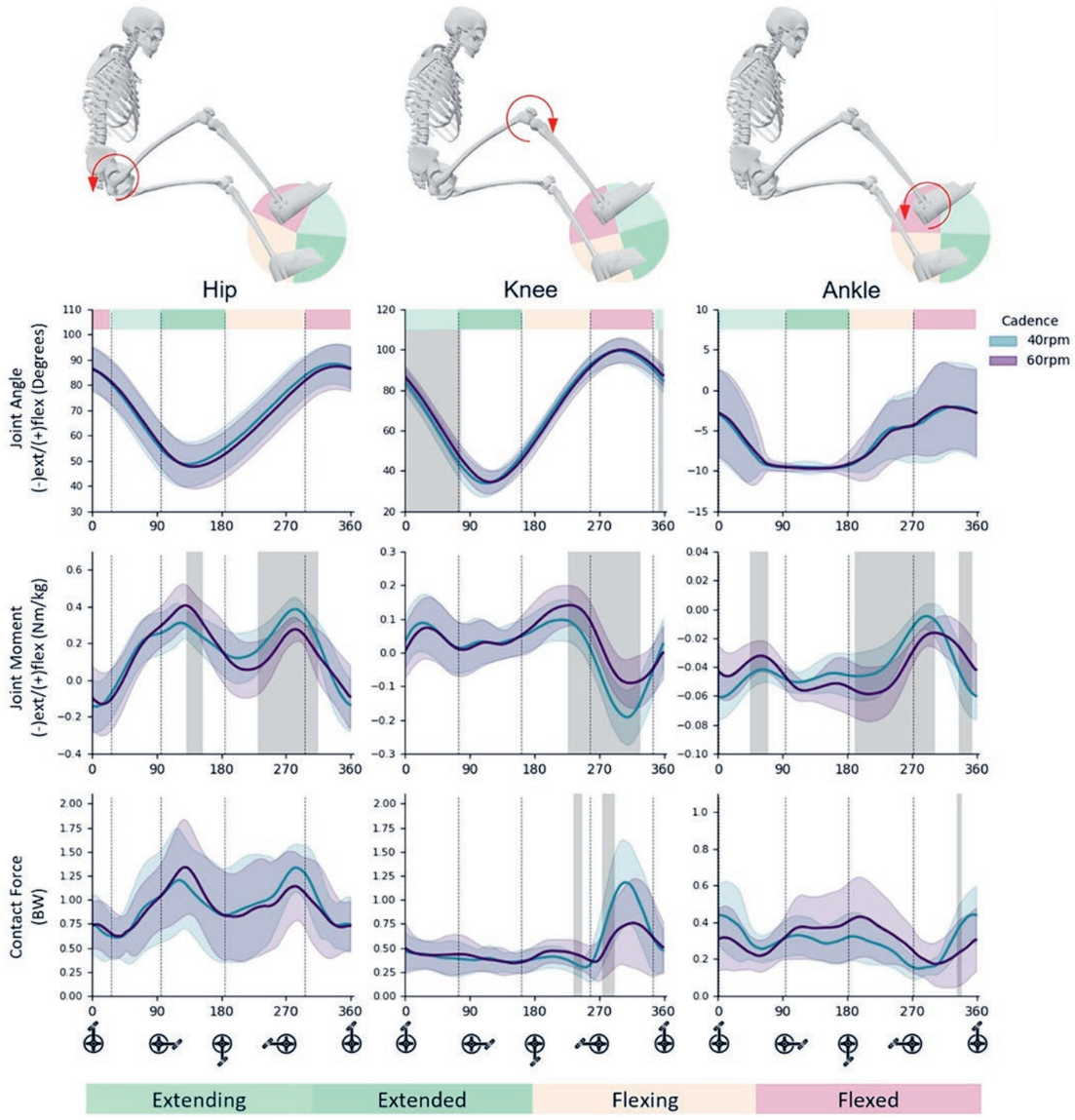
Accordingly, mean crank power output showed only a weak association with peak joint contact forces. The correlation values ranged between 0.063 and 0.211. A reliable estimation of internal joint loading based on power output (watts) alone was therefore not possible.

Individual mobility strategies remain crucial

The group means did not hold true for every individual. In some participants, higher loads at the knee or ankle joint occurred at 60 rpm. The timing of peak joint loading within the crank cycle also varied.

This variability points to individual neuromuscular strategies. Individuals can accomplish the same external movement task through differing muscle recruitment, force distribution, stabilisation and co-contraction.

Consequently, no generalised dosage rule can be derived from these findings. A higher cadence is



The diagram illustrates movement trajectories (top), joint moments (middle) and joint contact forces (bottom) at the hip, knee and ankle joints during cycling at 40 and 60 rpm, at comparable power output (~15 W). The values are shown over one complete crank revolution. Grey-shaded areas indicate significant differences between the two cadences ($p < 0.05$).

not inherently safer, nor is a lower cadence inherently more strenuous The individual biomechanical response to the specific training condition is what matters.

Prospects for research and training management

The study broadens the perspective on training dosage. Common parameters such as duration, resistance, cadence, power output and movement cycles remain important, but do not fully capture internal mechanical loading.

In conjunction with additional sensors and patient-specific models, it may become possible in future to estimate joint loading during training. For FES-assisted applications, it is also conceivable that stimulation patterns could, in the longer term, be tailored to the desired mechanical loading.

This is a promising direction for research and development Real-time estimation of joint forces or automated model-based control of functional electrical stimulation was neither clinically validated nor investigated as a standard feature of the THERA-Trainer tigo within the study.

Significance of the THERA-Trainer tigo for biomechanical research

The scientific contribution of the study lies primarily in the measurement and modelling architecture developed. The THERA-Trainer tigo enabled a controlled, reproducible movement task closely aligned with real-world rehabilitation. Through the integration of specialised cranks with motion analysis, EMG and musculoskeletal modelling, the movement therapy device has become a platform for biomechanical research and evaluation.

This investigation therefore demonstrates two things: Power output and cadence are not sufficient to describe individual joint loading with any precision. At the same time, a standardisable, robotically controlled movement therapy device provides the foundation for systematically linking external training parameters with internal muscle and joint loading.

The long-term goal is a training control system that not only records the volume of movement generated, but also estimates the mechanical dose actually delivered to the body.

Original work

Crossley CB, Diamond LE, Saxby DJ et al. Joint contact forces during semi-recumbent seated cycling. Journal of Biomechanics. 2024;168:112094. DOI: 10.1016/j.jbiomech.2024.112094.



Training of the lower extremities with the THERA-Trainer tigo

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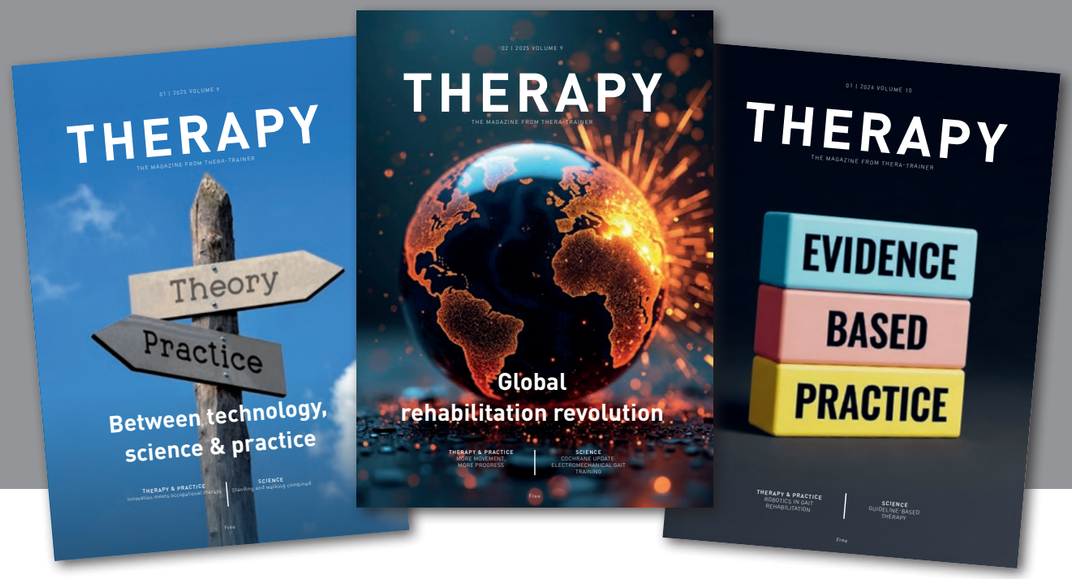
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