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THERAPY

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FOREWORD

Combining mental tasks with physical exercise

Dear readers,

Proponents of "embodied cognition", a new approach in cognitive science, argue that we can better understand and influence human thinking when we take into account that it takes place both in and with a body. Accordingly, explanatory models that focus only on the abstractness of thinking and its neuronal foundations fall short. Mind, body and environment must be understood as parts of a dynamic system in which cognitive processes take place as complex interactions between the components.

Consequently, the embodied cognition approach implies that exercise programmes to improve cognition and motor skills not only need to be reimagined, but also remade. Research shows a clear link between physical activity and cognitive abilities. One resource for therapy resulting from this research is cognitive-motor training. This is a form of training in which participants are challenged to respond to mental tasks with physical actions, thereby improving basic life skills more than, for example, strength or coordination training alone.

The focus here is the application of specific training programmes to simultaneously improve physical and cognitive functioning in the context of neurology and geriatrics. Particularly with regard to gait stability and fall prevention, impressive results can be achieved through cognitive-motor training. The computer-based exercise programmes are also motivating and generate enthusiasm among the test subjects.

Enjoy reading!

Jakob Tiebel

Contact the editorial team: therapy@thera-trainer.com
(Tell us what you think!)

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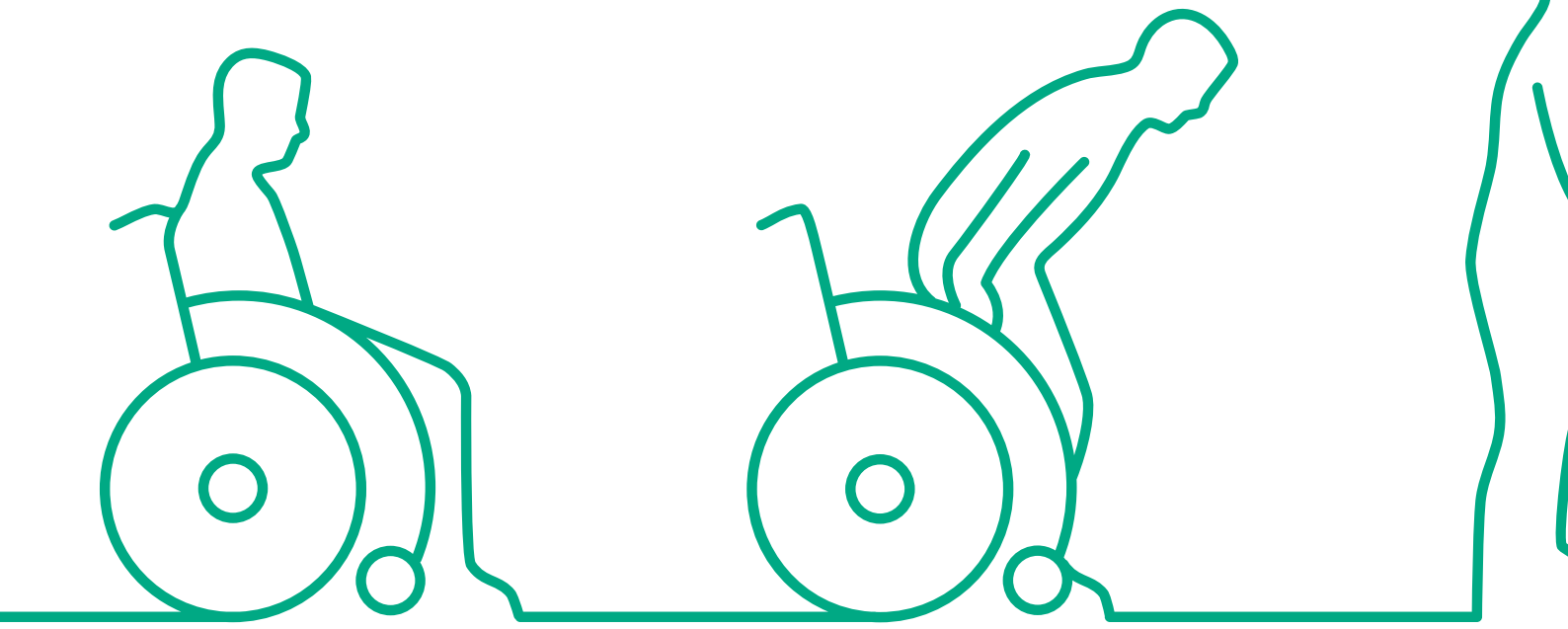
SCIENCE

Focus of treatment in the rehabilitation phase model

Effectiveness of rehabilitation exercise in improving physical function of stroke patients: A systematic review

Jakob Tiebel



Motor rehabilitation after stroke is a key element for the greatest possible functional recovery and a fundamental determinant for a return to an autonomous life.

Motor rehabilitation after stroke is a key element for the greatest possible functional recovery and a fundamental determinant for a return to an autonomous life for those affected. The number of intervention studies investigating the effectiveness of stroke rehabilitation treatment approaches has increased exponentially over the past two decades. Most of this work focuses on proving the effectiveness of individual interventions. In future, more combined treatment approaches for effective rehabilitation that are oriented towards the phase model of rehabilitation will be examined. Currently, we do not have enough of an overview to determine best practice.

In a review published in 2022, a Korean research group led by Kyung Eun Lee investigated the importance of multimodal rehabilitation exercise programmes for the recovery of physical function in stroke patients. The researchers selected relevant publications in the MEDLINE, PubMed and Google Scholar databases. 21 articles were selected for analysis. The quality of the studies was determined using the PEDro scale. The rehabilitation programmes were analysed according to intervention type and treatment focus in the acute, subacute and chronic phases.

According to the results, the early acute phase of rehabilitation mainly involves therapies with electrical and robotic support in combination with passive manual mobility exercises. The subacute phase consists mainly of aerobic exercise programmes to improve walking ability and arm function. The approaches are combined with cardiovascular training. It has been shown that the severity of the impairment and comorbidities have an influence on treatment planning. In the chronic phase, preference is given to everyday-oriented exercise programmes combined with telerehabilitation and the use of intelligent training systems. Regaining functional independence and autonomy is particularly important at this stage, and is accompanied by an increasing use of computerised warning systems and mobile safety devices.

The results of the systematic review show the established treatment priorities throughout the phase model of stroke rehabilitation. The researchers concluded that combination therapies must be further investigated in future in order to establish corresponding guideline recommendations for the phase model. In this way, evidence-based treatment pathways can improve care in the respective phases of stroke rehabilitation.

The researchers concluded that combination therapies must be further investigated in future in order to establish corresponding guideline recommendations for the phase model.

SOURCES:
Lee KE, Choi M, Jeoung B. Effectiveness of Rehabilitation Exercise in Improving Physical Function of Stroke Patients: A Systematic Review. Int J Environ Res Public Health. 2022 Oct 5;19(19):12739. doi: 10.3390/ijerph191912739. PMID: 36232038; PMCID: PMC9566624.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9566624/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9566624/

SCIENCE

Additional mobility training for heart attack patients

Effect of early robot-assisted physiotherapy on the assessment of functional independence in patients after myocardial infarction

Jakob Tiebel

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9140991/

As with other cardiovascular diseases, robotic training is also widely used as part of rehabilitation after heart attacks.

Coronary heart disease (CHD) is the leading cause of morbidity and mortality worldwide. The most common form of CHD is myocardial infarction (MI), commonly known as a heart attack.. The number of patients admitted to hospital after suffering a heart attack is steadily increasing. This indicates a great need for effective rehabilitation. In early hospital rehabilitation, the main goals are to prevent deconditioning and thromboembolic complications and to prepare patients for discharge, as well as to return to normal daily life as soon as possible. As with other cardiovascular diseases, robotic training is also widely used as part of rehabilitation after heart attacks. So far, however, there has been no significant clinical evidence for its use in cardiac patients of working age.

The aim of the study was to investigate the effectiveness of assistive robot-based mobility training in post-MI patients. The target group of the study were patients of working age (<64 years) who need an effective physiotherapeutic process to return to work and daily life as soon as possible.

A total of 92 (50 men, 42 women) hospitalised post-MI patients with an age of 60.9 ± 2.32 years participated in the study. An early intensive physiotherapy programme (7×/week, 2×/day) with an average duration of 45 minutes per session was performed for each patient. Patients were consecutively assigned to the experimental group (EG) and the control group (CG). 20 minutes of robot-assisted training with the THERA-Trainer tigo bed or seat bike were integrated into all EG physiotherapy sessions. The FIM score (Functional Independence Measures) at admission and after 14 days of rehabilitation was used for assessment. Subjective stress perception and stress intensity were assessed using the BORG scale.

The aim of the study was to investigate the effectiveness of assistive robot-based mobility training in post-MI patients.

When analysing the time-group effect using ANOVA with repeated measures, it was found that the EG showed better results in activities of daily living ($p < 0.001$) and motor indicators ($p = 0.001$). The effect of the therapy was higher in the EG where the additional robot-assisted movement training had been integrated into the physiotherapy programme. The patients in the EG improved especially in the areas of verticalisation, hygiene and mobility.

These results indicate an improvement in performing daily activities and in mobility. The researchers conclude that the early use of robotic physiotherapy offers additional treatment benefits in the rehabilitation of patients after a heart attack. As part of the experiment, the patients regularly exercised on the THERA-Trainer tigo, a cycling trainer for use while lying or sitting.

The need for effective and efficient rehabilitation measures will continue to increase in the coming years as more and more people suffer from the consequences of coronary heart disease. These research results show that robot-assisted therapy using assistive mobility therapy devices has a positive effect and offers additional treatment benefits to patients after a myocardial infarction. The FIM indicators of the experimental group improved in the areas of ADLs and mobility with a statistically significant difference compared to the group with only conventional physiotherapy. Based on the results, the use of mobility trainers in the early rehabilitation of heart attack patients can only be recommended. However, due to the lack of evidence so far, the positive effects of the intervention are still relatively unknown to the professional public. Further research is needed to validate the results and to implement them as comprehensively as possible in everyday care.

SOURCES:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9140991/

Bartík P, Vostrý M, Hudáková Z, Šagát P, Lesňáková A, Dukát A. The Effect of Early Applied Robot-Assisted Physiotherapy on Functional Independence Measure Score in Post-Myocardial Infarction Patients. Healthcare (Basel). 2022 May 18;10(5):937. doi: 10.3390/healthcare10050937. PMID: 35628074; PMCID: PMC9140991.

SCIENCE

VR-based balance training for Paralympic shot put and javelin throwers

Effect of a virtual reality programme to improve trunk stability in Paralympic shot-putters and javelin throwers: A case study.

Jakob Tiebel

The positive results of virtual reality-assisted trunk training for participants contribute to the knowledge on this topic and open up the possibility of incorporating this technology into training protocols for Paralympic athletes.

Paralympic sport emerged as part of the rehabilitation process for people with disabilities. In Paralympic disciplines, motor control in the trunk area and especially in the abdominal area is of great importance in preventing injuries and improving athletic performance. There are many aids used by sports coaches to improve muscle strength, and thus trunk stability, and to reduce risks on the field. However, there is limited research on the use of virtual reality in conjunction with stabilometry platforms when training Paralympic athletes with physical disabilities.

Objective of study

The aim of the study was to determine the effect of a virtual reality-assisted trunk training programme on high-performance Paralympic athletes, shot-putters and javelin throwers with physical disabilities competing in throwing disciplines.

Methodology

The research was designed as an intra-subjective quasi-experimental study. Five high-performance

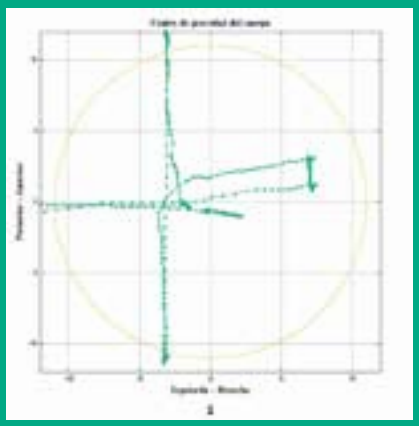
Paralympic athletes with physical disabilities were studied. A virtual reality software (THERA-soft), which contains playful content and patterns that can be adjusted in terms of time and intensity, and a dynamic standing and balance trainer (THERA-Trainer balo) were used as intervention equipment, which can be adapted to the patient and enable retraining of balance, proprioception, strengthening and achieving trunk control. The analysis variables were the level of anteroposterior and lateral displacement of the trunk and the changes in action volume. An initial evaluation, a six-week intervention and a final evaluation were conducted.

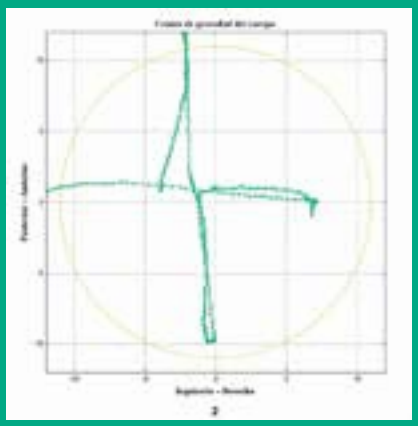
Results

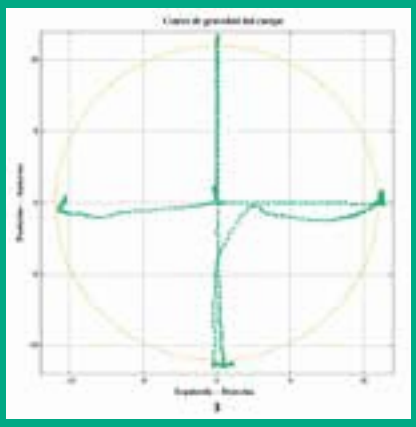
A tendency towards posterior displacement was noted in the initial assessment of all athletes. In the final assessment, the ranges of displacement increased for almost all subjects, except for subject 5, whose scores remained almost stable in both the initial and final assessments. The difference in displacement between the initial and final test was 6.26 degrees on average for the participants.

Conclusions

The positive results of virtual reality-assisted trunk training for participants contribute to the knowledge on this topic and open up the possibility of incorporating this technology into training protocols for Paralympic athletes.







l.ead.me/balance_training_paralympic

SOURCES:

Pérez-Trejos Luz Edith, Gómez Salazar Lessby, Ortiz-Muñoz Daniela, Arango-Hoyos Gloria-Patricia. Effect of a virtual reality program to improve trunk stability in Paralympic shot put and javelin throwers. A case study. Rev. Investig. Innov. Cienc. Salud [Internet]. 2022 Dec [cited 2023 Feb 07]; 4(2): 34-48.

SCIENCE

Updates on robotics-based vs. conventional gait training

A multi-centre controlled comparative clinical trial to investigate the effectiveness of interventions.

Jakob Tiebel

Although stroke survivors may benefit from robotic gait rehabilitation, inpatient robotic gait training needs further investigation. In this work, the researchers investigated the effectiveness of this approach (using an exoskeleton or an end-effector robot) compared to conventional gait training in subacute stroke survivors.

In a multi-centre, controlled clinical trial, 89 patients in the subacute stage after a stroke completed twenty sessions of robot-assisted (robot group) or conventional gait training (control group) in addition to standard daily therapy. Robotic training was performed with an exoskeleton (RobotEXO group) or an end effector (RobotEND group). Clinical outcomes were assessed before and after treatment. Walking speed during the 10-metre walk test (10 MWT) was the primary outcome in this study and secondary outcomes were the 6-minute walk test (6 MWT), the timed up and go test (TUG) and the modified Barthel index (mBI).

The characteristics studied in the robot and control groups did not differ at the start of the study. At the end of the study period, a significant advantage in the 10 MWT was observed in the robot group. A benefit was also observed in the following parameters: 6 MWT, TUG and mBI. In addition, the patients in the robot group outperformed those in the control group in walking speed, endurance, balance and ADL. Patients in the RobotEND group improved their walking speed more than those in the RobotEXO group.

The researchers conclude that inpatient robot-assisted training improves walking ability in subacute stroke survivors more than conventional training. These results suggest that people with subacute stroke may benefit from robotic training to improve walking speed and endurance. The results also suggest that end-effector robots are superior to exoskeleton robots in improving gait speed.

The results also suggest that end-effector robots are superior to exoskeleton robots in improving gait speed.

A well-structured new study from January 2023 supports previous findings from reviews. The suitably high number of cases underlines the quality and significance. In particular, the study highlights that end-effector robots seem to be more promising than exoskeletons in improving walking speed. Although it still cannot be ruled out that the results are distorted by different stages of the disease and degrees of functional impairment, it should be noted that people with subacute stroke who are unable to move around independently benefit considerably from inpatient robot-assisted gait training. Further large, controlled studies are needed to compare outcomes between the two device types in more homogeneous populations and to determine the optimal protocol design for maximum efficacy. The conditions that influence effectiveness still need to be better understood.

SOURCES:

Pournajaf S, Calabrò RS, Naro A, Goffredo M, Aprile I, Tamburella F, Filoni S, Waldner A, Mazzoleni S, Focacci A, Ferraro F, Bonaiuti D, Franceschini M, TreadStroke Group. Robotic versus Conventional Overground Gait Training in Subacute Stroke Survivors: A Multicenter Controlled Clinical Trial. J Clin Med. 2023 Jan 5;12(2):439. doi: 10.3390/jcm12020439. PMID: 36675371; PMCID: PMC9861649.

SCIENCE

Mobility training for children with cerebral palsy

New study on the effectiveness of the THERA-Trainer tigo in the rehabilitative treatment of children with cerebral palsy

Jakob Tiebel

Cerebral palsy is a common disorder worldwide and is considered the most common cause of motor disabilities in childhood. Technological innovations for rehabilitation play a fundamental role in the treatment of this disease, which can improve the quality of treatment and outcomes.

The aim of a research study by the Cuban working group, led by the scientist José Jesús Lucas Ramírez from the Centro de Referencia Nacional La Habana, was to determine the effectiveness of mobility training with the THERA-Trainer tigo for the treatment of spasticity of the dorsal thigh musculature in children with cerebral palsy.

The researchers conducted a quasi-experimental study on 30 children with spastic diparesis admitted to the paediatric rehabilitation service at the Julio Díaz Hospital from May 2018 to May 2019. The subjects were evaluated at the beginning, after 10 and after 20 sessions of treatment with the THERA-Trainer tigo using the Ashworth scale and the device parameters.
The children were between 6 and 12 years old (9.7 ± 3.7 years) and predominantly male (63%). The presence of orthopaedic deformities (86.7%) was predominant, including breech deformities (90%) and genus flexus (73%). Significant improvements were achieved qualitatively in the expression of spasticity ($p < 0.001$), quantitatively in the number of spasms occurring ($p < 0.001$), total motor activity ($p < 0.001$) with less assistive drive support from the motor of the THERA-Trainer tigo ($p < 0.001$). A satisfactory response to the training programme was observed in 93.3% of the children.

The researchers conclude from the results of the study that the use of the THERA-Trainer tigo in conjunction with the protocol of the paediatric rehabilitation service of the Julio Díaz Hospital is an effective intervention for the treatment of children with spastic diparesis.

SOURCES:

Lucas RJJ, Dunn GE, Coronados VY, et al. Efficacy of Thera Trainer Tigo 510 in the Rehabilitative treatment of children with cerebral palsy. Rev Cub de Med Fis y Rehab. 2021;13(1):1-16.

The researchers conclude from the results of the study that the use of the THERA-Trainer tigo in conjunction with the protocol of the paediatric rehabilitation service of the Julio Díaz Hospital is an effective intervention for the treatment of children with spastic diparesis.

l.ead.me/rehabilitative_treatment_of_children

SCIENCE

Robot-assisted gait training for Parkinson's disease

Robot-assisted gait training using the THERA-Trainer lyra with end-effector guided steps vs. treadmill training with visual step guidelines in patients with Parkinson's disease: A randomised controlled pilot study

Veronika Seidl

Parkinson's disease is one of the most common neurodegenerative diseases worldwide [1]. Some of the symptoms, such as balance and gait disturbances and risk of falls, respond poorly to pharmacotherapy [2]. Therefore, physiotherapy is an important component in the treatment of patients with Parkinson's disease [3]. With robotic gait training or treadmill training, it is possible for patients to increase walking distance and step repetitions during therapy [4]. This is important for motor learning and improving walking skills in everyday life.

The aim of this study was to investigate whether robotic gait training using the THERA-Trainer lyra with end-effector guided steps can improve stride length more than treadmill training with visually prescribed steps.

In this randomised controlled trial, 20 patients with Parkinson's disease (Hoehn & Yahr 1-4) were randomly assigned to 2 groups: a THERA-Trainer lyra group and a treadmill group. Each group received 30 minutes of gait training 3 days per week for 4 weeks. Patients were assessed by a physiotherapist before the procedure, after each treatment and at the end of the procedure. The primary outcome parameter was stride length, measured with the 10-metre walk test.

At the beginning of the study, there were no differences between the two groups. After four weeks, both groups had improved their stride length in the primary target value (THERA-Trainer lyra - Group A: mean value 11.50 cm ± 6.33; Treadmill - Group B: mean value 8.30 cm ± 7.45), but no significant differences were found between the two groups ($p = 0.58$).

The aim of this study was to investigate whether robotic gait training using the THERA-Trainer lyra with end-effector guided steps can improve stride length more than treadmill training with visually prescribed steps.

Secondary outcome measures were walking speed and postural stability during walking, which also improved in both groups without significant difference. The results show a trend towards improvement in gait abilities through training with the THERA-Trainer lyra, but larger studies are needed to further investigate the effectiveness of robotic gait training with the THERA-Trainer lyra in patients with Parkinson's disease.

Change in both groups	Lyra group, mean value ±SD	Treadmill group, mean value ±SD
10 MWT stride length (cm)	11.50 ± 6.33	8.30 ± 7.45
10 MWT walking speed (km/h)	1.16 ± 0.73	0.84 ± 0.49
FGA (points of max. 28)	5.50 ± 3.24	4.00 ± 5.73

Veronika Seidl Physiotherapy, Neurologisches Therapiezentrum Gmundnerberg, Altmünster, Austria

SOURCES:
[1] GBD 2016 Parkinson's Disease Collaborators, 2018
[2] Ceballos-Baumann & Ebersbach, 2018
[3] Keus et al., 2014

Ambient Assisted Living (AAL)

Digitalisation to promote social participation in old age

Jakob Tiebel

Digitalisation demands and promotes a societal transformation that has now encompassed all facets of our daily lives [3]. The revolution triggered by highly developed microelectronics and computer technology, which has led us into an increasingly digitalised world since the end of the 20th century, is comparable to the industrial revolution that transformed us into an industrial society about 200 years ago [4].

A major objective of this digital revolution is to bring about more prosperity and quality of life [1]. Digital innovations should do one thing above all: make our lives easier. For the vast majority of younger people, i.e. "digital natives" who have already grown up with modern technologies, this is undoubtedly true. For them, moving in the digital world and capitalising on its advantages comes naturally [2,5]. But what about the older people in our society, who are generally considered to be much less familiar with digital innovation compared to younger people?

Openness towards digitalisation despite older age

Digital change obviously also offers opportunities for the older generation. Fear of modern technologies is disappearing and older people are discovering the digital world more and more for themselves [6].

"Older people are open to digitalisation; they are curious and want to become active and capable players in digital society. Digitalisation must be designed to encourage this curiosity. It must produce sovereign digital actors who can competently use the variety of digital technologies to participate in social life in a self-determined way for as long as possible" [6].

This development process is stimulated by the increasingly emergent properties of digital systems, which can make life easier, especially in old age. Examples include digital support for everyday activities such as shopping, simplified

communication with grandchildren living far away, as well as telemedical approaches and digitally supported care and rehabilitation services [6].

When megatrends like digitalisation and demographic changes intertwine

The idea of using digitalisation explicitly to promote social participation in old age has given rise to an area of independent research and development called "Ambient Assisted Living" (AAL), promoted by national and European funding bodies, including for science and technology.

AAL brings the megatrends of digitalisation and demographic change together. AAL encompasses diverse methods, concepts, systems, products and services that are intended to support the lives of older people in a situational and unobtrusive manner. The assistance systems are specifically designed to make it easier for older people to live in their own homes for as long as possible and to participate in social life in a self-determined way.

AAL research is focused on adapting public services to a growing number of older people and their needs [6]. The field is interdisciplinary, practically oriented and includes behavioural and technical aspects. As physical activity in particular is an essential part of a self-determined life, AAL is an especially exciting field in this area. Numerous digital applications are specifically designed to preserve this important determinant of autonomy and independence in old age [6].

Healthcare-related research, development and evaluation

That is why THERA-Trainer has been a committed supplier of technology in this area for many years. The goal: to increase or maintain the quality of life of people with potential or existing assistance needs through the use of AAL technologies.

Numerous exciting and promising research and development projects have already been realised in recent years, including with the Felix Platter Hospital in Basel, Switzerland (cf. THERAPY 2018-1), the AAL Living Lab at Kempten University of Applied Sciences, Germany (cf. THERAPY 2019-1), Dividat, Switzerland (THERAPY 2023-1) and the Austrian medical technology cluster VR4 Mind&Motion (cf. THERAPY 2023-1).

In addition to the development of new technologies for geriatric medicine, the evaluation of user barriers, technical barriers, market barriers and network barriers in particular played a major role in these projects. Both from the perspective of the patients and their particular needs and local circumstances, as well as systemically, across organisations and borders.

Continuing the search for concepts to care for an ageing society

THERA-Trainer will continue to participate in this field of research and development in the future. Demographic change today is already demanding, with increasing severity, suitable concepts to care for the ageing society of tomorrow. Particular emphasis will be placed on the areas of strength, endurance and mobility as well as balance training and fall prevention. But new software technologies and the use of virtual reality will also become increasingly important. Research institutions around the world are invited to jointly develop and implement new digital innovations.

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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 Native.Health, a digital health marketing agency.

Fall prevention

Generation-specific healthcare against the backdrop of demographic change

Jakob Tiebel

The changes to age distribution in society are accompanied by an exponentially increasing demand for health services. The reason for this is the increased incidence of age-associated diseases, which are facilitated by advanced age, last for a long time and are difficult or impossible to cure. The shifts in the morbidity spectrum create new demands, especially in the specialist disciplines of rehabilitation and physical medicine [32].

Health policy faces the challenge of making appropriate use of increasingly scarce resources in order to be able to guarantee high-quality and at the same time affordable healthcare in the future [2,32,36].

In this context, preventive measures aimed at preventing severe health impairments and the need for long-term care in old age are becoming increasingly important [2,32,33]. In particular, this also includes measures to promote mobility and fall prevention, as with increasing loss of mobility, there is increased risk of falling and also of fall-related injuries [2,32,33,34].

Falling in old age and its consequences

In Germany alone, 4-5 million elderly people fall every year. About one third of seniors over the age of 65 living in a private home environment fall on average once a year. Among those over 80, the rate is higher than 50 percent [26,27,35]. People who have an increased risk of falling related to age usually experience repeated falls over time [24].

Up until they experience their first fall, seniors usually still live alone and largely independently in their familiar surroundings. However, they become increasingly unsteady on their feet. Basic everyday activities such as getting up from an armchair or moving from the hob to the fridge pose an unpredictable risk [2,29]. In about half of all cases, falls in the private home environment do not initially result in serious physical injuries. In 30-40 percent of cases, minor injuries such as bruises, abrasions and haematomas occur [2,27,35].

Falls are usually trivialised by those who experience them, as they generally wish to remain in their familiar environment and are afraid that an increasing loss of mobility means they will have to leave. The subjective assessment of the individual risk of falling usually differs greatly from the results of objective examinations. If a fall is minor, a doctor is rarely consulted because "nothing bad happened" [29]. Afterwards, however, those affected are greatly unsettled and increasingly isolate themselves. They no longer leave the house for fear of falling again. This decreased activity accelerates age-related muscle wasting [2,29].

When people lose confidence in their own motor skills, it is usually not only their physical activity that suffers, but also their diet. The nearest supermarket may be quite far away, which means that grocery shopping becomes less frequent [2,29]. Prolonged impaired nutrition leads to a critical reduction in muscle mass and function, which, in conjunction with the progressive physical ageing process and an increasing decline in mobility, results in a clinical presentation of sarcopenia [40].

Sarcopenia is characterised by a progressive and generalised loss of motor neurones, muscle mass and strength. In particular, fast type II muscle fibres atrophy, which are important for adequate support, protection and positioning reactions. Anabolic resistance also develops. This means that anabolic stimuli increase muscle protein synthesis only to a reduced extent and the muscles regenerate less effectively. The elderly tire quickly and often have reduced motivation due to increasing physical weakness [41].

The connection between sarcopenia and an increased risk of falling is confirmed in a review paper by Feuchter [12]. The results show that sarcopenia is associated with a significantly higher rate of falls as well as a significantly higher risk of falling. Both fear of falling and fall-related injuries such as fractures are significantly increased in people with sarcopenia [12]. Frailty is also closely linked with sarcopenia. Frailty describes a decrease in functional reserves and the resulting reduced resilience of elderly bodies to endogenous and exogenous disruptive factors [4,40].

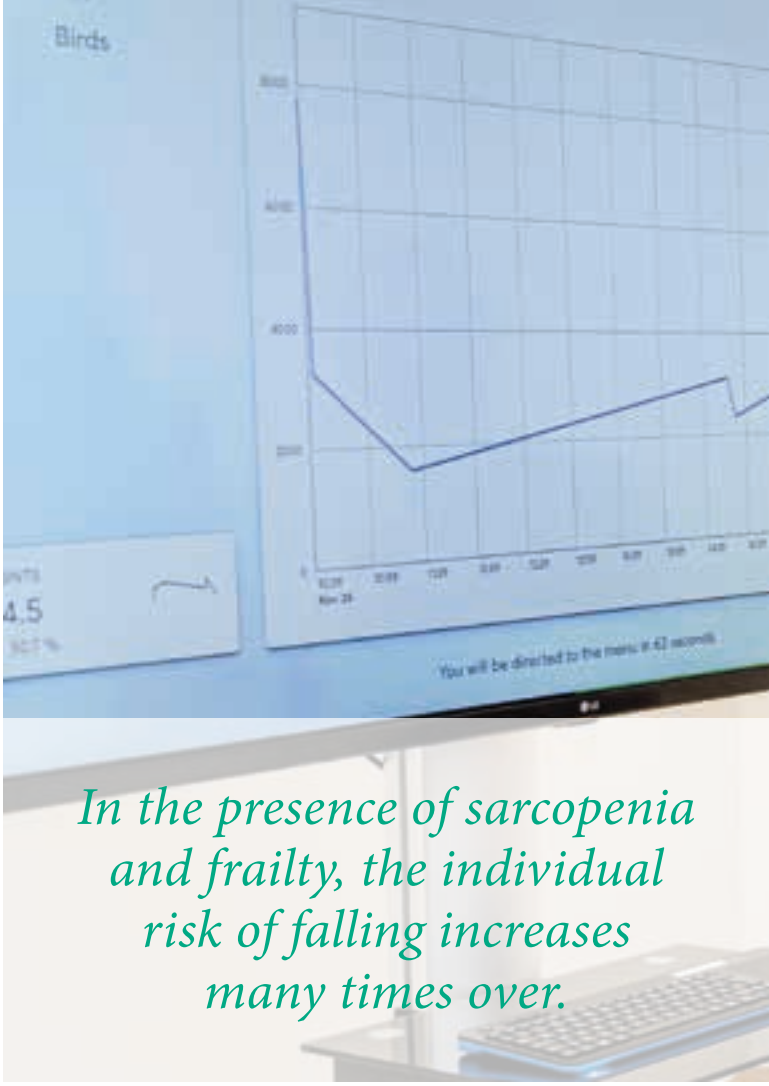
Frailty is determined by physical, psychological and sociological factors [40]. The definition of Fried et al. has become widely accepted, according to which frailty is characterised by physical weakness, rapid fatigue, slowed walking speed, reduced activity and unintentional weight loss [13]. The diagnosis is made when at least three of these five criteria are met. Sarcopenia and frailty are closely linked both pathophysiologically and clinically and are highly relevant to the functionality and mobility of older people [40].

In the presence of sarcopenia and frailty, the individual risk of falling increases many times over [6]. But those affected usually do not seek help because they are ashamed. Ultimately, it is only a matter of time before another fall occurs, resulting in more serious injuries [18,29,30].

Significance of falls and fall-related injuries in health economics

When considering the health economics perspective, a relevant example is the femoral neck fracture, which in 90% of cases in the very elderly results from low-energy trauma during a fall (in most cases from a standing position, sideways onto the hip or onto an extended or splayed leg), with pre-existing polymorbidity [3,22,23,28]. The fracture causes the affected person a lot of pain, and the leg can no longer be actively moved as a result. The treatment of choice is surgery, and in many cases falls result in a permanent dependency on care [33,37].

Half of those affected by a fall-related femoral neck fracture still suffer from a loss of mobility one year after the event. They can no longer climb stairs, use the toilet independently or walk outdoors [19]. A hip fracture thus represents a drastic change in the social and qualitative aspects of life [25]. This is because the fracture perpetuates a vicious cycle of immobilisation and lack of activation. Those affected hardly dare to get out of bed because they have completely lost confidence in their body and no longer consider themselves to be capable. An increased fear of falling leads to generally avoidant behaviour [37].



In the presence of sarcopenia and frailty, the individual risk of falling increases many times over.

For about a quarter of those affected, this means that, despite follow-up rehabilitation, they cannot initially return to their own homes and have to be cared for at least temporarily as inpatients [3]. In addition to the health problems, the economic and social significance of the disease becomes obvious here. In about 40% of all those affected, it can be assumed that a hip fracture will lead to a permanent dependency on care. This means that every fifth patient with a hip fracture has to move to a nursing home [5].

Treatment of hip fractures alone represents a considerable challenge for the healthcare system and the supportive community due to the need for care so often associated with them [22,42]. In Germany, the immediate treatment costs nationwide are in the billions, not including the long-term costs. Analyses by Weyler and Grandjour from [43] show that hip fractures cause direct costs of 2.77 billion euros annually from a societal perspective.

Against the backdrop of rising incidences due to increasing ageing in society, this is expected to increase to 3.85 billion by 2030 [43].

The importance of measures to promote mobility and prevent falls in ageing people from a health economics perspective results from the assumption that mobility losses, falls and fall-associated injuries and the associated financial burdens for the health care system are avoidable [2,33,34].

It is assumed that up to 30 percent of health-care costs could be saved if prevention and health promotion were pursued more consistently [42].

Prophylactic strategies to promote mobility and prevent falls

It seems obvious that the treatment of falls should no longer be considered only in terms of surgical and non-surgical care for fall-related injuries and fractures. In particular, it must be based on a systematic strategy to avoid falls, i.e. fall prevention [9,23]. Weyler & Grandjour [43] conclude that effective preventive measures need to be identified to avoid hip fractures in particular.

After decades of health policy being primarily focused on curative medicine, there are now increasing efforts to make more intensive use of the potential of prevention, which has now been clearly proven medically, and to systematically expand it [17,42].

"This development is to be welcomed, as the available evidence shows that a focus on curative care ("repair medicine") not only perpetuates inefficiencies, but also leads to treatment burdens for patients, premature illness and death. This can be avoided by an early and effective prevention and health promotion strategy" [17].

Prevention should be seen as an effective strategy to unlock the health potential of the population and to contribute to reducing health inequalities and demands on the healthcare system [17,42]. Thus, prevention contributes to improved well-being and quality of life on both the individual and societal levels [17].

In general, a distinction can be made between three forms of prevention: primary, secondary and tertiary prevention. Primary prevention pursues the goal of preventing the recurrence of a disease (promotion of mobility in old age). It serves to reduce the incidence of disease (avoiding falls) by minimising known risk factors (lack of exercise, balance disorders). Since a large proportion of falls in old age are caused by loss of mobility, primary measures should aim to increase physical activity. These can start long before a first fall occurs. Secondary prevention is geared towards early detection and containment of an emerging disease or disease risks in order to improve the chances of treatment (implementation of fall prevention screening programmes, wearing hip protectors). Tertiary prevention attempts to reduce the medical or psychosocial consequences of specific diseases and to prevent relapses (return home while ensuring independence, preventing new falls) [42].

Goals and possibilities of fall prevention programmes

Understandably, investing in preventive strategies requires choosing appropriate interventions based on the available evidence [42]. National and international guidelines recommend a wide range of options to promote mobility and prevent falls [2,7,11,8,20]. A range of informal and formal tests and measurement tools are used to assess the degree of mobility and the risk of falls [2,33]. The choice of appropriate preventive measures depends largely on individual limitations and risk factors, which is why a specific prevention programme is usually always preceded by a differentiated assessment of existing mobility limitations and fall risks [2,33,34]. The results of the diagnosis lead to a multimodal prevention programme consisting of a combination of

Multidisciplinary approaches that include cognitive training during physical activity are particularly appropriate for those at increased risk of falling.

appropriate individual interventions adapted to the identified risk factors [2,37].

Table 1 provides an overview of the most common fall risk factors from the American Geriatrics Society's guideline on fall prevention [1]. The risk factors were identified on the basis of selected evidence and prioritised in a quantitative analysis using the relative risk (RR, for prospective studies) or odds ratio (OR, for retrospective studies) [42].

Table 1. Identified fall risk factors based on selected evidence [42].

Risk factor	Significant/ Total	M RR/OR	95% CI
Muscular weakness	10/11	4.4	1.5-10.3
History of falls	12/13	3.0	1.7-7.0
Gait disturbance	10/12	2.9	1.3-5.6
Use of walking aids	8/8	2.6	1.2-4.6
Visual disturbances	6/12	2.5	1.6-3.5
Arthritis	3/7	2.4	1.9-2.9
ADL deficits	8/9	2.3	1.5-3.1
Depression	3/6	2.2	1.7-2.5
Cognitive impairment	4/11	1.8	1.0-2.3
Age >80 years	5/8	1.7	1.1-2.5

Figure 1 shows that interventions to prevent falls are as diverse as the risk factors that can cause them. A distinction is made between personal, environmental, behavioural and fracture prevention measures [42].

Figure 1. Spectrum of interventions for fall prevention [42] (own illustration).

- Personal interventions
  - Implementation of training programmes
  - Eyesight check
  - Medication review
- Environment-related interventions
  - Adaptation of the home environment
  - Removal of tripping hazards in the home
- Behaviour-related interventions (information & training)
  - Safe behaviour in the home
  - Sturdy non-slip footwear
- Fracture prevention measures
  - Hip protectors (to prevent hip fractures)
  - Measures geared towards pathophysiological causes (e.g. administration of medication)

A large number of the interventions described that have been proposed to reduce the frequency and risk of falls have now been investigated for their effectiveness. The first high-quality reviews of prevention programmes that aimed, among other things, to improve physical fitness, identify risks and make structural changes to the living environment are provided by the Cochrane reviews published in 1997 and 2003 [14,15]. At the beginning of the 21st century, almost all fall prevention programmes initially proved to be ineffective, so interest shifted over the years primarily to the application of fracture prevention measures [10,14,15]. The aim was not to prevent the falls themselves, but their consequences (e.g. through hip protectors, vitamin D supplementation) [42].

The importance of training programmes in the context of fall prevention

It remains the case that much of the available advice on promoting mobility and preventing falls is based on studies with limited scientific evidence. The low quality is mainly due to methodological weaknesses in the studies and lack of comparability of the results. In addition, there is a lack of research results on the effectiveness of individual measures specific to setting and target group.

However, subject to these limitations, current research suggests that training programmes to promote motor functions should be a core element of multimodal prevention programmes, as they are crucial in maintaining older people's mobility

and reducing the risk of falls. It should be noted, however, that positive effects can be expected especially in seniors who are still spry and possess a minimum of functional abilities [2].

For example, in the most recent version of its guideline on the prevention of falls in older adults, the US Preventive Services Task Force (USPSTF) points to the superiority of exercise programmes to promote motor functions (recommendation grade B) compared to other multimodal intervention programmes (recommendation grade C) and vitamin D supplementation (recommendation grade D). The authors conclude that older people can best protect themselves from falls and the fractures they cause by exercising regularly. The studies that investigated the effectiveness of exercise in the USPSTF guideline uniformly conclude that seniors are significantly less likely to fall (RR 0.89; 95% CI 0.81-0.97), and the incidence of injuries (incidence rate IRR 0.81; 95% CI 0.73-0.90) and falls (IRR 0.87; 95% CI 0.75-1.00) is reduced overall through regular physical activity and adequate exercise. Multidisciplinary approaches that include cognitive training during physical activity are particularly appropriate for those at increased risk of falling.

A review by Sharrington and colleagues published in early 2019 also examined the effectiveness of exercise in preventing falls in older people living independently [31]. The authors searched the literature for relevant reports of randomised controlled trials until May 2018 and were able to include a total of 108 of them (23,407 subjects) in a meta-analysis. The studies come from 25 countries. On average, the participants were 76 years old and 77 percent were female. The evidence regarding the effect of fall prevention exercises is highly reliable. The authors conclude that exercise programmes significantly reduce both the rate and number of falls among older people living at home. Exercises reduce the number of falls by about a quarter (23% reduction). This means that if 850 out of 1,000 seniors fall within a year, exercise programmes can prevent about 195 of these falls. It is interesting that the effects were the same regardless of whether the seniors already had an increased risk of falling or not. This speaks in favour of starting preventive measures as early as possible. In addition, exercise programmes reduced fall-related fractures by about a quarter (27% reduction). Further studies are needed to verify the results [31].

It remains the case that much of the available advice on promoting mobility and preventing falls is based on studies with limited scientific evidence.

The THERA-Trainer senso can be used for targeted cognitive-motor training in older people.

Step training improves reaction time, balance and reduces falls in older people

In a systematic review from 2017, Okubo et al. summarise the evidence for the effectiveness of step training programmes [21]. The results suggest that both reactive and volitional stepping exercises reduce the number of falls in older adults by about 50%. This clinically significant reduction is mainly due to improvements in reaction time, gait, balance and balance recovery.

Van het Reve & de Bruin [39] were also able to show that it is precisely the combination of strength-balance training with specific cognitive training that has a positive effect on walking, gait initiation and divided attention during motor tasks. The results are confirmed by numerous other studies, which have already shown that cognitive-motor training improves executive functions and effectively reduces falls.

The combination of strength-balance training with specific cognitive training has a positive effect on walking, gait initiation and divided attention during motor tasks.

The THERA-Trainer senso can be used for targeted cognitive-motor training in older people. A variety of scientifically validated training programmes and progressive algorithms ensure individual and continuous progress. The system also provides assessments for testing cognitive and motor functions, which have been reviewed in collaboration with ETH Zurich to ensure that they meet quality criteria. The performance metrics thus provide a reliable and meaningful overview of the physical and cognitive condition.

The THERA-Trainer senso includes special training software that guides and motivates users to achieve their goals. Each programme is designed to work towards a specific goal and is constantly adapting to the abilities of the participants. This not only strengthens cognitive-motor functions, but also sustainably promotes the joy of movement.

Prevention should be seen as an effective strategy to unlock the health potential of the population and to contribute to reducing health inequalities and demands on the healthcare system.

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Cognitive-motor training

Improving daily living functions and reducing the risk of falls in older adults

Ageing is associated with physical and cognitive decline and an increased risk of falls, which affects independence and quality of life among older people. Numerous studies have investigated the effects of interactive cognitive-motor training on mobility and fall risk in older adults. This training approach specifically combines physical activity (e.g. stepping movements) with cognitive challenges/stimuli, thus strengthening the cognitive-motor interaction that is fundamental to most activities of daily living.

Exergaming is a novel approach to encourage this interaction in a playful way. Exergames offer technology-based and motivating cognitive-motor training.

The latest THERA-Trainer Education webisode introduces the validated cognitive-motor training system THERA-Trainer senso – a system specifically designed to train balance and coordination as well as cognitive functions of older people through evidence-based exergaming on a stepping plate. In addition to a scientific backdrop and evidence on the effectiveness of the training, the learning session includes many practical tips and application examples.

Dr. Sc. Manuela Adcock is Head of Research at Dividat AG and has a PhD from ETH Zurich. Manuela Adcock is a neuropsychologist with many years of clinical experience at the Zurich University Hospital.

Watch the video here:

l.ead.me/cognitive_motor_training


senso

Body and brain – An inseparable team

Effectiveness of cognitive-motor training in neurology and geriatrics

Lars Timm

Getting up, shopping or going for a walk with friends: all of our everyday activities require the precise interaction of motor and sensory functions as well as the central nervous system. The brain, which is responsible for coordinating these subsystems, plays a central role. This interaction usually works perfectly in healthy, young people. In old age, after illnesses or accidents, people often find it difficult to interact optimally with their environment due to disturbances in the aforementioned subsystems or their coordination. This can lead to restrictions in everyday functioning and mobility and can even lead to falls and loss of independence.

Falls – Causes, consequences and prevention

In industrialised countries, one in three people over the age of 65 falls once a year on average. In the over-85 age group, the annual risk of falling increases to 50%. Falls among older people result in serious injuries in nearly 15% of those affected. These injuries lead to pain, a reduction in mobility and independence, and not infrequently an increased fear of falling. Furthermore, in addition to personal suffering, falls also lead to high costs for society and represent a socio-economic problem.

In medicine, a fall is defined as an accidental event resulting from loss of balance while standing or moving. The following degenerative changes are given in the literature as reasons for an increased risk of falling, which can be triggered by ageing processes, injuries or diseases:

- Changes in the motor system, e.g. reduced muscle mass/muscle strength
- Changes in the sensory system, e.g. impaired sensory perception
- Changes in the central nervous system, e.g. reduced signal conduction

Loss of muscle mass (sarcopenia) and muscle strength (dynapenia) are cited as the main causes of an increased risk of falling. Interestingly, dynapenia

progresses faster than sarcopenia, so there is no linear connection. This illustrates that one of the most important fall risk factors, muscular weakness, is due to deficits not only of the motor system but also of the nervous system [1].

For the complex process of walking, higher-order brain functions (cognitive processes) are required in addition to intact signal conduction and functional motor brain areas. Attentional and executive functions in particular are necessary for a safe gait pattern. Executive functions refer to cognitive abilities that enable goal-directed action (e.g. attention control). The executive functions are localised in the frontal lobe of the brain, which is subject to particularly strong degenerative changes during the ageing process. If age, illness or injury lead to an impairment of cognitive functions, this results in an increased risk of falls [2].

In "dual-task" paradigms in particular, it becomes obvious that walking requires cognitive resources. If a person is given a cognitive task such as arithmetic in addition to walking (dual-task condition), the gait pattern changes. The additional task requires resources that are no longer available to control walking. Dual-task interference, which can also be observed in healthy people, is intensified not only by ageing processes but also by neurological diseases [3].

Therefore, for successful fall prevention, training of cognitive functions must be considered in addition to improving muscle strength and balance.

Training the interaction between the body (motor and sensory system) and the brain is central here. Physical activity should therefore be combined with cognitive challenges. This type of training is increasingly known as cognitive-motor training [4].

Cognitive-motor training – Advantages and implementation

A new and particularly promising type of training focuses precisely on this combined concept. Interactive cognitive-motor training (also called dual-task training) couples movements with cognitive tasks. It simulates the demands of our daily lives and trains brain-body communication in a targeted way [4]. There is ample evidence in the research literature that cognitive-motor training is effective [5,6,7,8]. There are improvements in physical functions (e.g. balance, coordination, gait) but also in cognitive functions (e.g. attention or executive functions). It is also noted that cognitive-motor training can minimise the risk of falls in older people [9].

Researchers suggest that combined cognitive-motor training may lead to superior results compared to sequential training approaches. Findings from animal research confirm this assumption, which is caused by a synergistic effect [10]: Physical activity seems to trigger positive changes in the brain (neuroplastic effects) (e.g. the generation of new neurons), and cognitive challenge might be crucial to maintain these effects (e.g. integration of the new cells into the existing network).

Cognitive-motor training is suitable for anyone who wants to strengthen brain-body communication.

The senso was developed in cooperation with ETH Zurich, and enables such interactive cognitive-motor training in combination with exergames (exercise games). The user is presented with training games on a screen, each of which addresses specific brain functions. The games are controlled by means of body movements such as steps or shifts in balance. The movements are detected by a pressure-sensitive plate.

Fields of application and scientific evidence

Cognitive-motor training is suitable for anyone who wants to strengthen brain-body communication. It is used in prevention, as well as in therapy and rehabilitation. The senso is frequently used in the field of "active aging", fall prevention and geriatrics as well as in neurorehabilitation.

Studies with healthy seniors in the context of fall prevention have shown that training on the senso improved the most important gait parameters (e.g. walking speed or stride length) [11,12]. These parameters are in turn directly related to a reduced risk of falling.

Cognitive-motor training on the THERA-Trainer senso is also suitable for use with neurological diseases such as dementia, Parkinson's disease, stroke or multiple sclerosis. In a study with stroke patients, it was shown that both improvements in physiological parameters (e.g. gait pattern) and optimisation of brain functions (e.g. psychomotor speed) can be achieved through training with the THERA-Trainer senso [13]. In a study on patients with severe cognitive impairments in the context of dementia, positive effects of THERA-Trainer senso training were seen in walking speed and rapidity of step execution, in general cognitive status as well as psychological wellbeing [14].

In industrialised countries, one in three people over the age of 65 falls once a year on average. In the over-85 age group, the annual risk of falling increases to 50%.

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SCIENCE

Intradialytic exercise

Movement as medicine during haemodialysis

Jakob Tiebel

Long-term haemodialysis treatment has a catabolic effect on the muscles. This results in reduced quality of life and everyday independence, an increased risk of falls and a shortened life expectancy.

Background

About half a million Americans have chronic kidney disease and are regularly dependent on haemodialysis (HD). During HD, waste, salt and fluid are filtered from the blood of patients via an artificial kidney called a dialyser. The number of HD patients in America is identical to that of many European countries. Globally, a substantial increase in the number of people requiring dialysis is predicted by 2040, accompanied by a steady increase in the cost of care [8,23].

Most patients receive dialysis through direct access to the bloodstream. This can be via a central venous catheter, an arteriovenous fistula or a synthetic arteriovenous graft. Most patients opt for inpatient HD treatment, which usually takes place three times a week and lasts an average of 4 hours. Alongside this, patients must adhere to strict fluid and nutritional guidelines to protect their cardiovascular system, bones and muscle mass. In addition, HD patients have been shown to have problems with their physical performance, which is why it has become widely accepted over the last ten years that HD patients should get as much exercise as possible – not just before or after, but especially during HD treatment.

The typical HD patient

Long-term haemodialysis treatment has a catabolic effect on the muscles. This results in reduced quality of life and everyday independence, an increased risk of falls and a shortened life expectancy. Nutritional factors, hormonal changes, inflammation, metabolic acidosis, neuropathies, inactivity and complications from various comorbidities also contribute to accelerated muscle loss [11,27].

Due to the consequences and comorbidities, the risk of hospitalisation increases. A typical HD patient spends an average of 11 days per year in hospital. In addition, HD patients have a 37% higher risk of being readmitted to hospital within one month. Recurrent hospitalisations set a negative spiral in motion. They lead to further muscle atrophy, which, together with an estimated immobilisation of 4 to 6 weeks per year, contributes to an even greater decline in physical performance [4,23].

Increasing activity levels is therefore one of the most promising solutions to counteract muscle atrophy and associated reduced physical functions. The remedy of choice: Regular mobility training, which is either extradialytic (outside dialysis treatment) or intradialytic (during dialysis). Reports indicate that while extradialytic training can bring

Globally, a substantial increase in the number of people requiring dialysis is predicted by 2040, accompanied by a steady increase in the cost of care.

greater benefits in terms of physical performance and functional abilities, compliance is lower compared to intradialytic interventions.

Therefore, intradialytic training, usually performed during the first 2 hours of HD treatment, is a useful non-pharmacological "medicine" for HD patients. The best known example of intradialytic mobility training is the use of a cyclic movement exerciser, such as the THERA-Trainer bemo. The training device is positioned in front of the treatment chair or at the foot of a bed and allows cycling to be performed during HD in a lying position [7,13,18].

Benefits of intradialytic exercise

Research on intradialytic movement has been conducted for more than 30 years. Many of these studies have been summarised in systematic reviews [2,3,9,10,14,24,25,26,32].

The results suggest that dialysis adequacy improves especially when exercise is performed during HD. Intradialytic cycling can increase blood flow to the working leg muscles. This transports the trapped urea (and other toxins) from the muscle compartments into the bloodstream to be effectively filtered out during HD [12,22].

Research results also show improvements in fatigue, depression, quality of life, sleep, inflammation and hospitalisation [1,15,17,19,21,30]. Although the methods are very different and the significance is usually low with small groups of subjects, the general consensus in the literature leans towards intradialytic exercise being at least better than complete passivity during HD lasting several hours. However, a future shift towards larger, multi-centre studies with precise training intensities and durations still needs to increase the strength of evidence on intradialytic training [21].

A working group led by Stefan Degenhardt and Kirsten Anding-Rost from Germany is making an important contribution to the proof of efficacy of intradialytic exercise with its multi-centre DiaTT study [29]. The abbreviation DiaTT stands for Dialysis Training Therapy. In contrast to care in Germany and other countries in Europe and the world until now, the DiaTT study design consistently integrates an individualised physical training programme during each haemodialysis session.

The aim of the DiaTT study is to investigate the effects of a 12-month intradialytic exercise programme on physical functioning, frailty and health economics in a large cohort of HD patients in a real-world setting. DiaTT is a prospective, cluster-randomised (1:1), controlled, multi-centre, clinical intervention study in 28 dialysis units with the aim of recruiting >1100 HD patients. The DiaTT will thus be the largest randomised controlled trial to assess frailty, quality of life and mortality in the field of nephrology, as almost as many patients will be included as have previously been studied in total in smaller studies [29].

If the researchers' hypotheses are confirmed, the results will drastically support the previous assumption that physical activity during dialysis improves mobility, quality of life and medical parameters, and the measures simultaneously contribute to a reduction in outpatient and inpatient medical costs. The study was launched in 2018. In January 2020, patient inclusion was completed in all participating centres. In fact, about 1,350 patients could be included in this large-scale study. The results, which will be ground-breaking for the future of intradialytic exercise, are now eagerly awaited [29].

Barriers in relation to practical implementation

Despite the anticipated benefits and recommendations to increase exercise during HD, there are still few established intradialytic exercise programmes in standard care. The Dialysis Outcomes and Practice Patterns Study (DOPPS), which examined HD institutions in 12 countries, shows that Germany, Sweden, Australia, New Zealand and Canada already offer intradialytic training programmes. However, the number of facilities that regularly conduct intradialytic exercise is still less than 20 per cent, so there is still a great need. Possible obstacles to consistent implementation must be identified and removed in this context in order to consistently increase the amount of training offered [16,28].

Funding problems, staff workload and lack of equipment were cited as the main barriers to running intradialytic exercise programmes. Other concerns include nephrologists' perceptions of safety and insufficient knowledge about exercise [16,26,31]. Interestingly, in a survey of 198 nephrologists, Delgado and Johansen [5] found that 100% of respondents thought physical activity was important for their patients; however, 35% did not think their patients would be open to a conversation about physical activity. Ironically, in a study by the same authors two years later, only 4% of patients with renal failure said they were not interested in this topic. These patients strongly believed that exercise is important, and 93% said they would be likely to exercise more if their doctor or a healthcare professional guided them in taking this "medicine" [6].

Increasing activity levels is therefore one of the most promising solutions to counteract muscle atrophy and associated reduced physical functions.

More information on the DiATT study can be found at the following link: **https://www.diatt.de**

l.ead.me/intradialytischer_sport

The findings suggest that the challenges lie more in staff perceptions and not in patients' opinions about exercise. It is likely that many patients see intradialytic exercise as a welcome distraction that can improve their self-esteem and their ability to actively participate in their own healthcare.

Final thoughts

Based on current evidence and empirical findings, national and international associations recommend that patients with renal insufficiency exercise for more than 30 minutes at moderate intensity on most days of the week.

Currently, the recommendations are mainly geared towards extradialytic exercise. Although there is still no scientific consensus on intradialytic exercise, all results from research and practice so far point to its usefulness in promoting a greater presence of movement during HD.

The results of the DiaTT study will be groundbreaking for the future of intradialytic exercise and are therefore eagerly awaited.

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 Native.Health, a digital health marketing agency.

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Sports therapy during dialysis

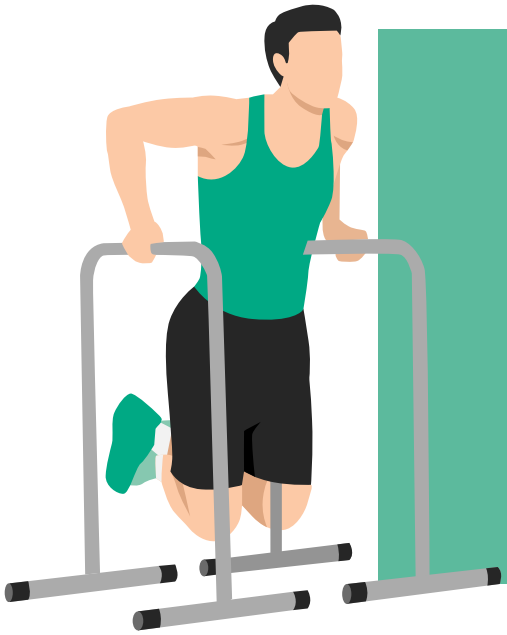
Increasing the physical performance of patients with end-stage renal disease during haemodialysis

Lars Timm

End-stage renal disease (ESRD) is almost always accompanied by a reduction in physical performance in affected patients, which inevitably leads to restrictions in everyday life. Anaemia, acidosis, glucose transport disorders, hyperkalaemia, polyneuropathy and osteopathy are mentioned in the literature as the most important performance-reducing factors [3]. In direct comparison with people of the same age without kidney disease, the activity level of haemodialysis patients (HDPs) is reduced by about 35% [7]. According to Gomes et al. 2015, not even 21% of HDPs reach the WHO-recommended minimum activity level of 10,000 steps per day. The reasons for this are varied and range from fatigue to a lack of exercise opportunities [5].

Worldwide scientific studies have already shown that physical training in HDPs has a significant positive effect on performance, quality of life and social life [6]. These effects can be observed in all performance classes, but the effect is even more significant in severely debilitated patients than in HDPs with good physical performance [1]. As HDPs are confined to the treatment chair or bed for up to 1,000 hours a year, physical training during dialysis is the optimal solution for improving performance in a time-efficient and effective way.

Nevertheless, a survey from 2017 shows that about 2/3 of dialysis facilities do not yet offer sports therapy training programmes during dialysis, even though 70% of the patients would gladly make use of such an offer. The reasons for the lack of such an offer range from a lack of space in the facilities and funding problems to scepticism among staff towards the training intervention [8]. However, a structured, professionally guided sports therapy intervention is safe even for severely affected patients and the benefits far outweigh the risks. But how can a training session like this be methodically structured and implemented?



Worldwide scientific studies have already shown that physical training in haemodialysis patients has a significant positive effect on performance, quality of life and social life.

Methodical structure of a sports therapy training session for HDPs

This kind of training intervention is always essentially divided into 3 phases. The shunt arm must never be under load during any of these phases.

Warm-up phase:
Any training intervention, whether for healthy or impaired individuals, should always start with a warm-up programme. Tasks to improve mobility are particularly suitable for this, in order to mobilise the joints and prepare the body for the physical strain ahead. Mobilisation must include all parts of the body, with special attention paid to spinal mobility. Correct instruction and execution are essential for the positive effect of these exercises. Jerky and bouncy movements should be avoided.

Main phase:
Mobilisation of the joints should be complemented by dynamic stretching of the fascial connective tissue structures. Coordination ability, which is often impaired, should also be promoted through targeted exercises. The focus of strength training should be on leg strength, but for a balanced development of the total body musculature, strengthening exercises for the trunk and upper extremities must also be considered. During the strengthening exercises, it is imperative to pay attention to physiological posture in order to prevent injuries. Bed ergometers should be used for vital endurance training. The passive function of these training devices enables even very weak patients to participate in the training programme.

Bed ergometers should be used for vital endurance training. The passive function of these training devices enables even very weak patients to participate in the training programme.

Cool-down phase:
The training session ends with relaxation and breathing exercises, which have a calming effect on the patient to prevent muscle tension. Through mindfulness exercises, the body can be consciously perceived, which leads to improvements in well-being [4].

When and how often should training take place?

To ensure a high effectiveness of training, it should be carried out regularly and over a longer period of time. Two to three training sessions per week are recommended for HDPs, each during the first 3 hours of dialysis treatment. In this early period of treatment, dehydration is not yet so far advanced, while potassium values have already normalised and hyperacidity is partially balanced. As a general rule, patients should train regularly at medium load rather than infrequently at high load.

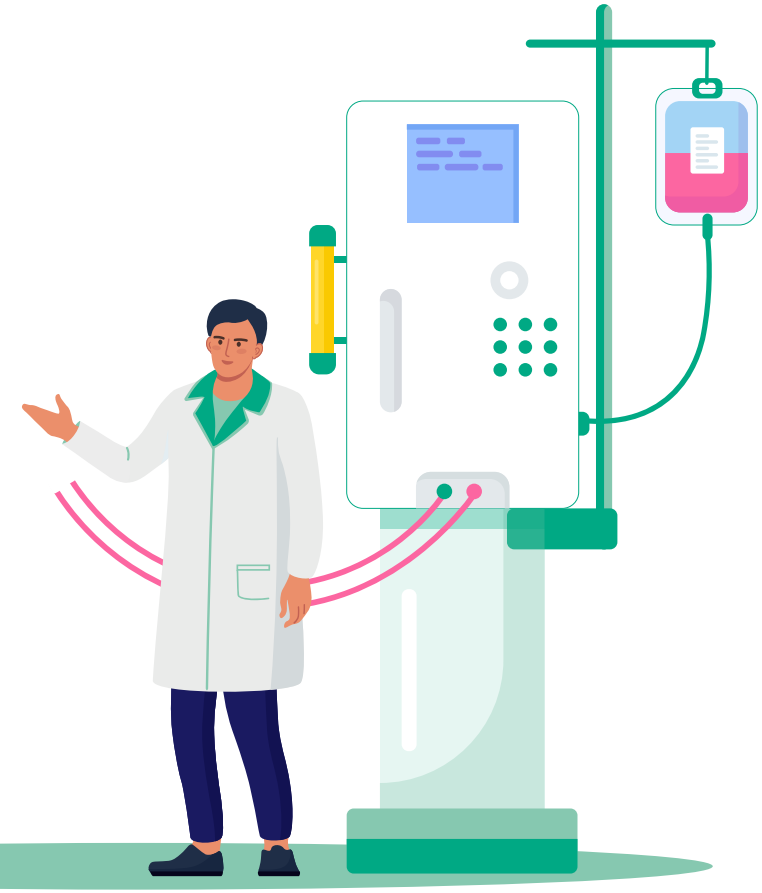
To ensure a high effectiveness of training, it should be carried out regularly and over a longer period of time.

Load control:

Optimal load control is essential, especially for HDPs, as both an overload and underload should be avoided at all costs. Both subjective and objective parameters can be used to control loads.

The RPE scale (also known as the Borg scale) is often used for subjective training control [2]. Here, the patient describes the subjectively perceived degree of exertion during the training. However, this self-perception can be impaired or flawed, especially in inexperienced patients. This potential source of error can be avoided by carefully introducing the patient to this control tool. The patient learns how to correctly assess the load through different exercises. During the main phase of the training session, exertion should be perceived as "somewhat strenuous", during the warm-up and cool-down phases the exertion should be in the "very light" range. Due to the susceptibility to error in self-assessment, care staff should also regularly check for possible signs of overload (compressed breathing, pallor around mouth and nose).

The load is controlled objectively mostly by measuring the heart rate. A stress test on the bicycle



ergometer can be used to make accurate predictions about exercise level and heart rate. If such a test is not possible for medical or logistical reasons, a stress test can also be performed with the bed ergometer, whereby the load is relativised using the Borg scale. The test should be stopped at a load of "Borg 15-16". The training pulse is then calculated using the Karvonen formula. Recommendations on training pulse rate based solely on formulas are not recommended due to the high level of heart rate variability and the associated susceptibility to error.

How can the training be increased?

At the beginning of training, significant increases in performance can be achieved even at low load. In order to be able to constantly guarantee the optimal load level, the training intensity must be constantly adjusted. Especially in patients with hypertension, high-intensity training should be avoided. The load should be increased very cautiously and initially adjusted by volume and not by higher exercise intensity. Sufficient recovery phases should also be ensured.

Endurance training:
- Increasing training time
- Increasing training frequency
- Increasing training intensity

Strength training:
- Increasing number of repetitions
- Increasing number of sets
- Increasing intensity

Contraindications:

Before any sports therapy intervention, a detailed discussion must take place with the attending physician in order to define the training goals and exclude possible contraindications. As part of this examination, a stress test can often also be carried out for load control. The most common contraindications are (Fuhrmann 2016):

- Resting blood pressure above 180/100 mmHg
- Severe heart failure
- Non-treatable cardiac arrhythmias
- Serum potassium <3.5 or >6.5 mmol/l
- Neg. base excess <5mmol/l
- Central venous temporary rigid dialysis catheters

Any training intervention, whether for healthy or impaired individuals, should always start with a warm-up programme.

Conclusion:

When it comes to professionally conducted sports therapy training during dialysis, the positive effects far outweigh the risks.

So the message to facilities is to get started!

With trained staff and the appropriate training equipment, patients can benefit significantly from the training sessions and their positive effects with a little extra effort.

Many ready-made training plans are already available for structured training and do not have to be devised from scratch.

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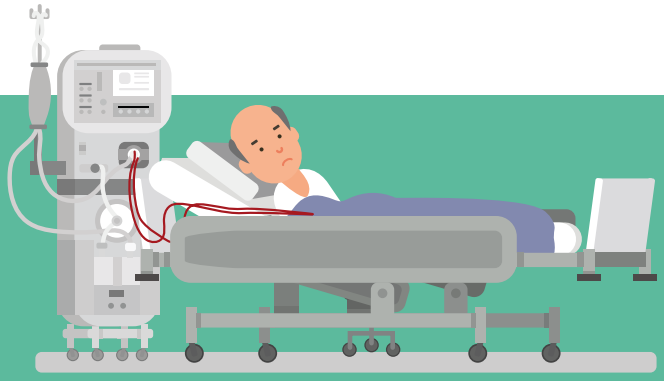
HEALTH & VITALITY

despite daily dialysis routine



THE PROBLEM
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Portrait: "Fortschritt" Physiotherapy Clinic

With each other. For each other. Stronger together.
Physiotherapist and clinic owner Özge Demirezen in conversation.

Interview: Christine Hohensteiner | Photos: "Fortschritt" Physiotherapy Clinic

In May 2016, Özge Demirezen opened the doors of the "Fortschritt" (Progress) physiotherapy clinic in Erlangen, Germany. Sometimes you need to take a detour, she says. Demirezen first successfully completed a three-year nursing training course and then went on to complete physiotherapy training. She has always had an interest in the field of neurology, and is still passionate about it today. Her goal was to establish a large, modern clinic with plenty of space and the best that modern therapy has to offer. That dream has come true. Today, she and her team of 13 treat the entire spectrum of neurological diseases in their 400 m² clinic. They all place an emphasis on active dialogue with patients, relatives, carers and colleagues from other disciplines. The clinic works with the latest therapy equipment to successfully close the gap between inpatient and outpatient aftercare. In our interview, Demirezen details how her clinic is structured and demonstrates, using the example of robotics-assisted gait therapy, that by setting the right goals, and with the right level of therapy and patient motivation, ambitious objectives can be achieved even in aftercare when the right amount of steps are taken.

Interviewer: Neurology is a kind of "hobbyhorse" for the "Fortschritt" physiotherapy clinic. What does the interactive process between neurological patients, the interdisciplinary team and caregivers look like in practice?

Özge Demirezen: We work closely together and discuss ideas in depth. Relatives play a very important role here, and we show them, among other things, what they can do at home to complement the therapy. Because there are 24 hours in a day and it is very important for neurological patients to use them as effectively as possible.

Interviewer: One of the slogans on your website translates to: "Stronger together in our 400 m² clinic". How is the clinic structured?

Özge Demirezen: Our clinic is fully digitalised

This may sound emotional, but I actually have a patient in mind who came here in a wheelchair some time ago and could neither stand nor walk at the beginning. Today he can walk up the stairs independently again.

and barrier-free. We have a special focus on equipment-assisted therapy.

Interviewer: Why did you choose the THERA-Trainer lyra for gait rehabilitation?

Özge Demirezen: For me, the quick set-up especially was an argument for choosing the THERA-Trainer lyra. We have a limited amount of time during therapy sessions and we want to use it as effectively as possible, which the quick set-up allows. We also achieve a significantly higher number of step repetitions with the gait trainer, which we would otherwise not be able to achieve in such a short time.

Interviewer: How is the patient experience during equipment-assisted gait training?

Özge Demirezen: The feedback from our patients is consistently positive. Walking in particular is of central importance for almost all neurological patients. With robot-assisted therapy, we can work effectively on these goals and usually achieve positive results in a short time. This may sound emotional, but I actually have a patient in mind who came here in a wheelchair some time ago and could neither stand nor walk at the beginning. Today he can walk up the stairs independently again.

Interviewer: What role do traditional treatment concepts play alongside modern evidence-based approaches in your clinic?

Özge Demirezen: I think the concepts work very well together. Not against each other, but really with each other. Of course, everyone is fairly convinced of their own treatment approach. But I think we are really succeeding in combining traditional treatment approaches with the possibilities available to us today, such as robotics. They not only co-exist but mesh together.

Interviewer: Care structures are often criticised

in terms of walking, a much higher frequency is usually required. To prove our effectiveness, we document every piece of progress in the clinic as a matter of course, so our name says it all (laughs). And we are naturally very efficient in what we do, given the scarcity of resources. With the THERA-Trainer lyra, for example, we achieve much more intensive therapy in the same amount of time compared to conventional gait training. It's one of the most hard-working therapists we have! It allows us to increase intensity and save on human resources at the same time.

To prove our effectiveness, we document every piece of progress in the clinic as a matter of course, so our name says it all.

for providing too little outpatient aftercare to neurological patients in terms of the frequency and intensity of therapy. What is your take on this? What benefits does the treatment concept at "Fortschritt" offer patients in aftercare?

Özge Demirezen: I certainly agree. First of all, doctors often don't know how much they are allowed to prescribe and are not even aware that they can also prescribe several therapies to patients to increase intensity. This means we spend a lot of time raising awareness in our day-to-day. There needs to be a constant dialogue between doctors, relatives and patients in order to set appropriate goals for therapy and to create a treatment plan based on this. A lack of interconnection and unclear objectives often lead to initial failure. It must of course also be made clear that it's not possible to work consistently on a goal with one physiotherapy appointment a week. Especially

Interviewer: What role does training at home play beyond this?

Özge Demirezen: So especially for the goals of standing and walking, there is a possibility that patients may receive a therapy device for home use. A THERA-Trainer tigo for movement training or a THERA-Trainer balo for balance training can be prescribed by the doctor. Our patients then use the devices at home during their therapy-free time. This allows them to continue working on their goals during and especially after intensive therapy in the clinic. This is a very important pillar in ensuring sustainable results from the therapy.

Interviewer: It is often claimed that regaining abilities, such as the ability to walk, is hardly possible after the subacute phase following stroke and the transition to outpatient aftercare. Is this view confirmed in practice?

Özge Demirezen: No, it's not. The keyword here is neuroplasticity. We manage to achieve a lot of repetitions in a very short time, for example in walking. And some of the outcomes are incredible. We have had a patient who suffered a stroke 12 years ago and is still breaking records. Motivation plays a decisive role here. And this is usually reinforced even further by the use of robotics. So I am really happy and grateful that we have such possibilities in physiotherapy today. We love and live for our profession at "Fortschritt" physiotherapy clinic. And we are happy that we can offer our patients so much thanks to these possibilities.

Interviewer: Thank you very much.

Özge Demirezen: My pleasure!

l.ead.me/praxis_physio-therapie_fortschritt_erlangen

Özge Demirezen
is a qualified nurse
and physiotherapist.

An expert in outpatient neurological aftercare, she has been running her own clinic since 2016: "Fortschritt" Physiotherapy Clinic in Erlangen.

Personal fulfilment in a profession you love and live for is one of the greatest gifts ever. My wonderful and capable team completes me and shares this philosophy. Stronger together for our patients.

Systematic gait training

For successful rehabilitation of walking ability, the intensity of therapy and a high level of repetition are decisive factors according to numerous findings of research in the field of motor learning. The Schmieder clinics use the lyra gait trainer for this purpose.

Johannes Danke

Since 2018, the Schmieder clinics have been relying on robotic gait training with the THERA-Trainer lyra. The gait trainer, which is based on the end-effector principle, enables patients to train intensively at their performance limit in every phase of rehabilitation by gradually adjusting individual parameters. This creates the best conditions to enable those affected to return to a self-determined everyday life and the best chances of regaining the ability to walk.

Features

By flexibly adjusting the training parameters, patients can be challenged optimally according to their individual motor requirements. The gait trainer reproduces the natural walking movement and the patient's muscle memory can be reactivated. With simple manoeuvres, the stride length, height of the handrails and weight relief can be adjusted to the needs of the patient. The direct

"The focus today is on providing very active therapy that is close to everyday life."

l.ead.me/kliniken_schmieder_lyra

"This means that exercise should not just be highly targeted, it should also be as intensive as possible. This is especially true of rehabilitation to restore patients' ability to walk."

ground-level access also allows the quick and easy transfer of patients with severe disabilities.

All training data and training protocols are transmitted directly to the therapist's tablet, who can thus access and adjust the training analysis at any time.

Objectives

Important therapy goals, such as regaining the ability to walk, increasing walking speed and improving endurance and gait pattern, can be achieved using the gait trainer. The flexible and gradual adjustment of the training parameters enables very effective and flexible training that is individually oriented to the abilities of the patients.

SOURCES/ORIGINAL WORK

Systematic gait training. Schmieder clinics:

https://www.kliniken-schmieder.de/unser-profil/leistungsspektrum/therapie/physiotherapie/gangtraining.html#/tab_einfuehrung

Johannes Danke is a physiotherapist and head of professional competence for the areas of physiotherapy, sports therapy and physical therapy at the Schmieder clinics. He studied motor neurorehabilitation at the University of Konstanz. In addition to working with patients, his main task is to ensure the quality of therapy and the implementation of scientific findings or technical developments in the daily therapy routine.

TECHNOLOGY & DEVELOPMENT

From virtual to reality

How digital transformation is influencing rehabilitation

Jakob Tiebel

What used to be science fiction is increasingly becoming reality. The application of digital health, teletherapy and virtual reality has gained momentum not least with the COVID-19 pandemic.

But how do these new treatments actually work? And how can they be meaningfully and usefully integrated into everyday practice?

Patients are increasingly informing themselves about diseases via the internet and looking for answers to health-related questions online.

Digitalisation is not only changing the way we communicate and interact with each other, but also how we keep ourselves healthy. Wearable sensors and apps are no longer just used for smart communication, but also to collect and analyse health data.

A distinction can be drawn between solutions for patients and experts. Whilst the former serve a medical purpose and support the treatment of acute or chronic disorders, the latter are used by health professionals to monitor patients as well as for treatment or practice management.

The actual influences and effects of digitalisation on patients, therapists and treatments - although many things are already in use in practice - are still difficult to assess. Research to date suggests that digital solutions can and should be used to support established treatment procedures. However, there are still many unanswered questions surrounding the topic of digitalisation. In particular, what impact the changes will have on our healthcare system and the way we treat patients in the future.

But one thing is clear from the developments so far. Digitalisation will have a lasting impact on healthcare, and therefore also on therapeutic work in rehabilitation. To what extent, will be further determined on the one hand by technological progress, and on the other hand by the way that we identify with the topic as therapists and make use of the "new digital" in practice.

For patients, too, digitalisation is bringing a cultural change that is characterised by fundamental changes in information and decision-making behaviour. More and more things and processes in our daily lives are already connected to each other. Patients are increasingly informing themselves about diseases via the internet and looking for answers to health-related questions online.

Parallel to the developments, the economic framework conditions in the healthcare system and thus also in the rehabilitation sector have been tightening for years.

In the future, the definition of therapeutic due diligence will regularly include the use of digital innovation.

In view of the numerous disruptive innovations permeating the health market, it is becoming increasingly difficult for healthcare professionals to maintain an overview. Both funders and healthcare providers therefore hope that digitalisation will simplify and speed up access to healthcare services, as well as make them more cost-effective, in order to mitigate the rising costs caused by increasing ageing and chronic disease.

Prospective market analyses forecast potential savings of billions of dollars through the progress of digitalisation. As of today, however, the predictions are several times ahead of reality. Critical voices actually predict that digitalisation will initially make everything even more expensive and complicated, which probably resonates with most users at grassroots level. For service providers, funders and

politicians, the challenge in the coming years will be to critically weigh up the costs, benefits, opportunities and risks and to transfer them into new care models.

Developments in the field of rehabilitation so far show that therapy concepts will no longer be concentrated on traditional treatment in clinics and practices alone, in the long term. The future will be determined by hybrid models of care that include various forms of digital therapies in addition to traditional treatments.

Teletherapeutic applications, as well as app-supported therapy monitoring, exercise trackers, electronic documentation of the disease and therapy process, and tools for increasing motivation and imparting knowledge will increasingly contribute to optimising the care situation in the context of rehabilitation.

On a systemic level, an interactive and continuous learning process is emerging at practice level, which includes the discussion of evidence, therapeutic consensus and objective feedback on the performance of digital health services. Against the background that therapeutic behaviour is influenced by a complex interplay of opportunities, skills and motivation, it is crucial that suitable framework conditions for dealing with digitalisation are in place, and that corresponding training and further education pathways are universal, so that practitioners can benefit from the opportunity to qualify accordingly in matters of the "new digital".

What initially sounds like extra work can, however, improve satisfaction and the individual experience of therapeutic competence in the long term. In addition to expanded competences, digital therapies also offer new possibilities for care and billing. In addition, the analysis of sensor data and therapy via video call can be carried out regardless of location, which means therapists will have more freedom and flexibility in shaping their work in the future.

What is the implication of all these changes for therapists in rehabilitation? In inpatient as well as outpatient rehabilitation, where access to affordable and appropriate therapy is often considerably more difficult for many patients due to their illness, the increasing shortage of specialists and the current standards of care, evidence-based practice will benefit greatly from the use of digital technologies in the future.

In the future, the definition of therapeutic due diligence will regularly include the use of digital innovation. However, from the perspective of ex-

Developments in the field of rehabilitation so far show that therapy concepts will no longer be concentrated on traditional treatment in clinics and practices alone, in the long term.

perts and practitioners as well as from the perspective of patients, there is still an increased need for understanding and safety with regard to the use of such systems.

In order to ensure quality and transparency in the long term, many digital health applications still need to be evaluated more precisely and their functionality and effects need to be made more comprehensible to users. Ignoring them for this reason, however, would be the wrong approach. The systems improve their features and accuracy primarily by being used in clinical settings under controlled conditions by experienced practitioners and by being continuously improved within the framework of clinical evaluations.

Jakob Tiebel studied Applied Psychology with a focus on Healthcare Managementand has gained clinical expertise through previous therapeutic work in neurorehabilitation. He researches and publishes on theory-practice transfer in neurorehabilitation and is the owner of Native.Health, a digital health marketing agency.

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