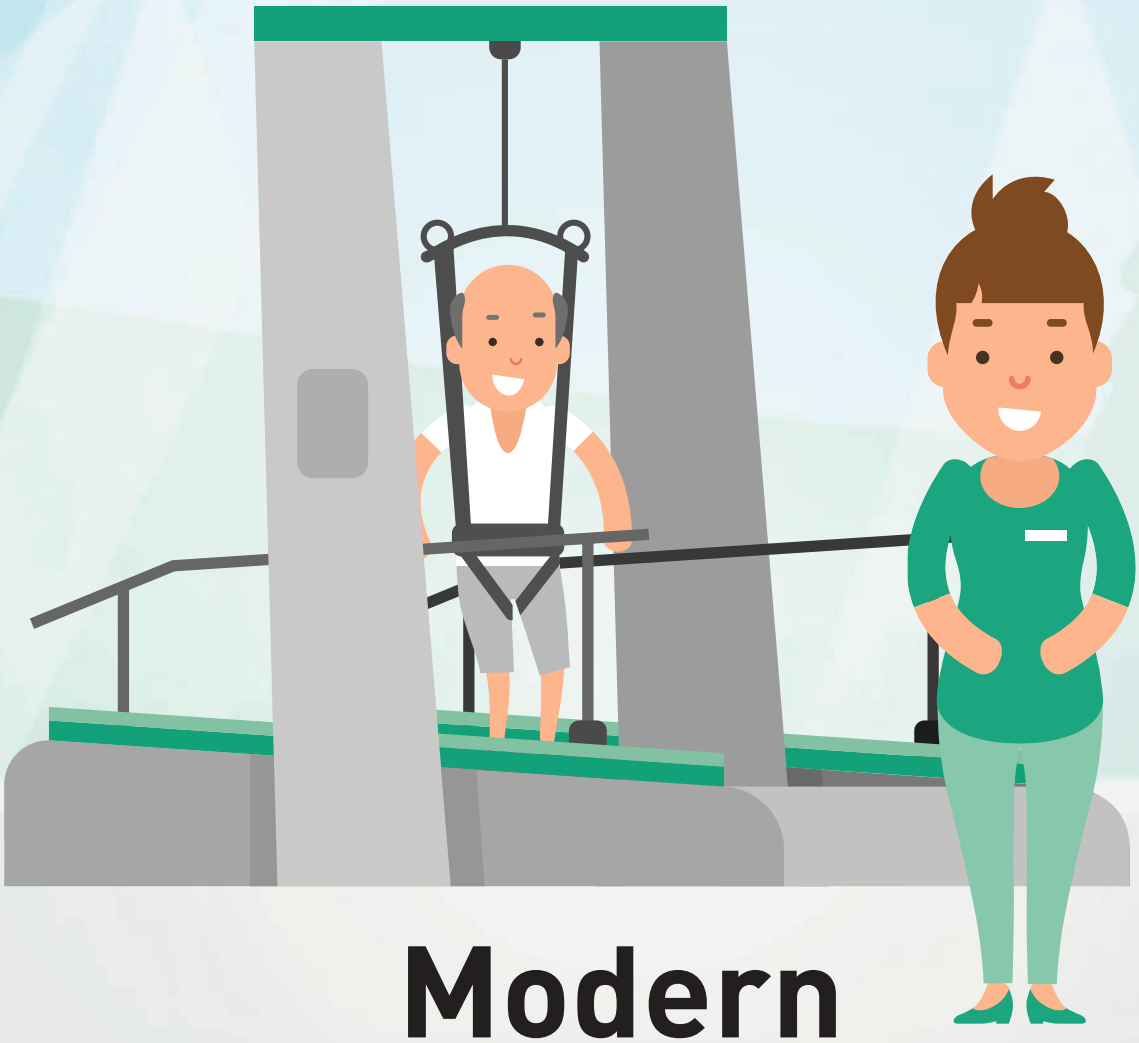
01 | 2018 SECOND VOLUME

THERAPY

THE SPECIALIST MAGAZINE FROM MEDICA MEDIZINTECHNIK GMBH



Modern gait rehabilitation

THERAPY & PRACTICE
A critical look at geriatric hospital rehabilitation

SCIENCE
The effectiveness of treadmill training

TECHNOLOGY
Training in virtual worlds

Free of charge

We are looking to strengthen our editorial team!

Would you like to write an article yourself?
This is your chance! Modern neurorehabilitation offers a wide range of interesting subject matters.

Don't hesitate! Send your proposal to the editorial team:
therapy@thera-trainer.de

We look forward to your contribution!

FOREWORD

Inspired to think ahead

Dear Readers,

First of all, I would like to thank all those who have let THERAPY inspire them to think ahead over the past 12 months, and to extend a warm welcome to everyone who is reading our science magazine for the first time starting with this issue.

At the beginning of a new year, we often reflect on the one gone by: What was good? What wasn't so good? What were the best moments?

We at the editorial team are looking back on two issues of THERAPY, the content of which was strongly shaped by findings in neuronal plasticity, the principles of motor learning and the search for best practice in neurorehabilitation.

You, the reader, accompanied us along the way. You provided feedback, commented, argued, and motivated us to present exciting new topics with every issue. And for this too, we would like to say a heartfelt thanks.

The question now arises: What will the new year bring?

We would like to reveal to you some interesting insights into modern gait therapy. In line with the motto "practise walking by walking", this issue of THERAPY highlights the various aspects of device-based gait training.

Martin Huber introduces the world of postural control, and explains what keeps us balanced. In addition, Sabine Lamprecht reports on motor therapy for multiple sclerosis.

We hope you enjoy reading this issue.

Best wishes on behalf of the editorial team,

Jakob Tiebel
Contact the editorial team at:
therapy@thera-trainer.de (and tell us what you think!)

One in every five to seven walking impairments can be prevented by using robot-assisted gait therapy in the early stages following a stroke.

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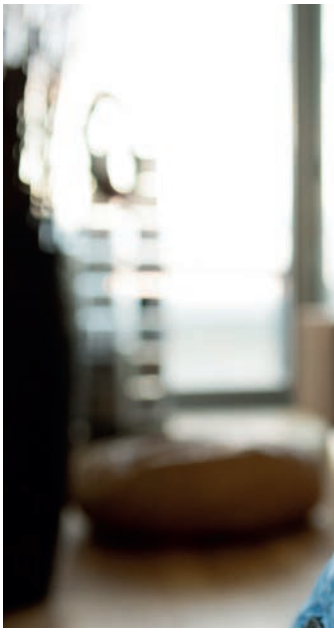
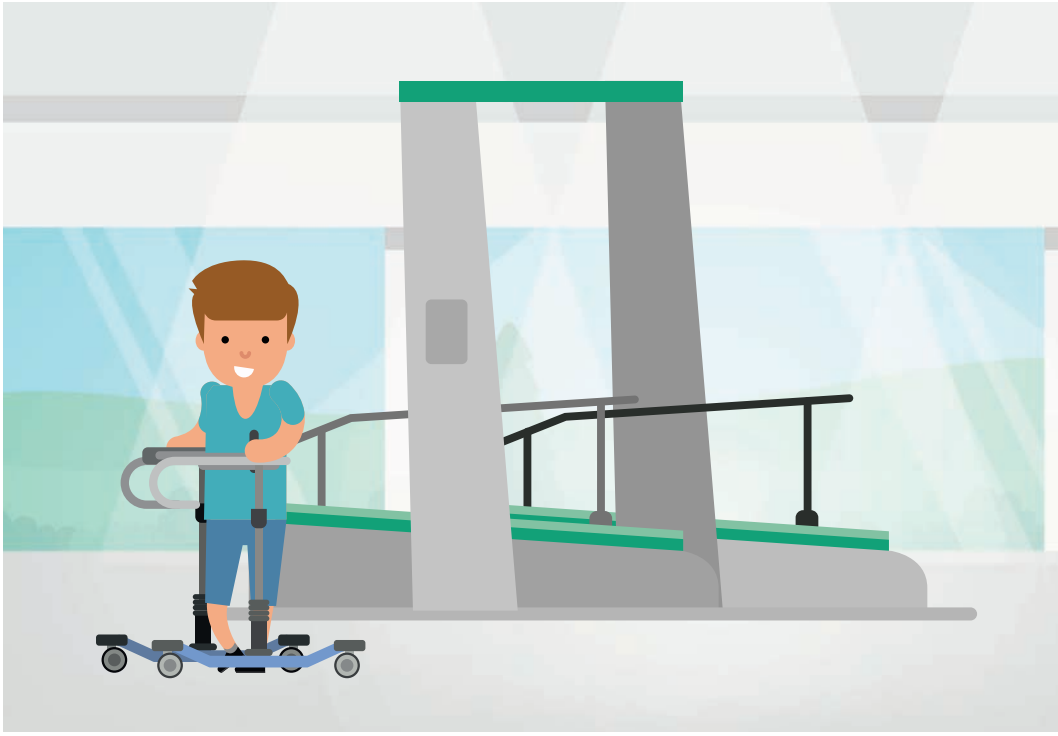
What keeps us balanced?





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University geriatric medicine at Felix Platter Hospital

Training in virtual worlds improves balance ability

Putting hybrid gait trainers to the test

Cover Story: Modern Gait Rehabilitation

Science

Therapy & Practice

Technology & Development

Sections

A critical look at geriatric hospital rehabilitation

According to recent studies, elderly patients with multiple conditions often do not receive optimal care in hospitals. The number of geriatric patients with multiple clinical patterns in hospitals rose from 1.1 million to 2 million between 2006 and 2015 in Germany alone. Increasing numbers of those affected receive special rehabilitation treatment in clinics, which, due to the complexity of care, seems to be considerably more expensive than normal rehabilitation, but not necessarily more effective.

By Jakob Tiebel

The consequences of demographic change are omnipresent. In Europe and other industrialised countries around the world, the number of patients aged 70 and over in hospitals is increasing rapidly.

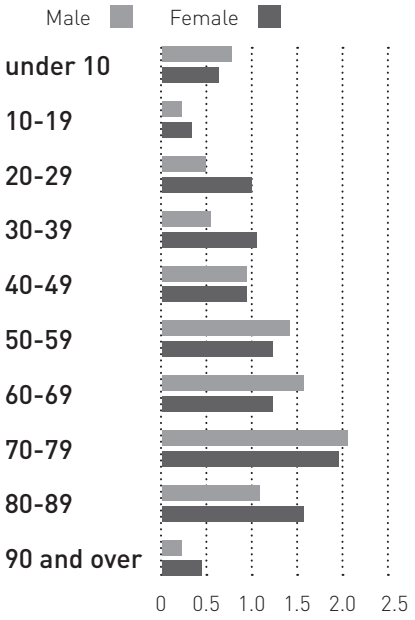
The number of patients aged 70 and over in hospitals is increasing rapidly.

Over the last ten years, the number of geriatric patients rose by around 80 percent. In Germany alone, there has been an increase of around one million treatment cases, according to a recent health insurance study. Forecasts predict that "generation 70 plus" will experience at least another 50 percent increase by 2050.

Geriatric medicine is a relatively new discipline dedicated specifically to elderly patients whose health and independence are often impaired by not just one, but several acute and chronic diseases.

Patients are cared for by multi-professional teams, including specialists in neurology, internal medicine and geriatrics, as well as staff trained in nursing, physiotherapy, occupational therapy, speech therapy, social and care counselling, nutrition counselling, psychology and pastoral

Hospitalisations by age group in 2015, in millions



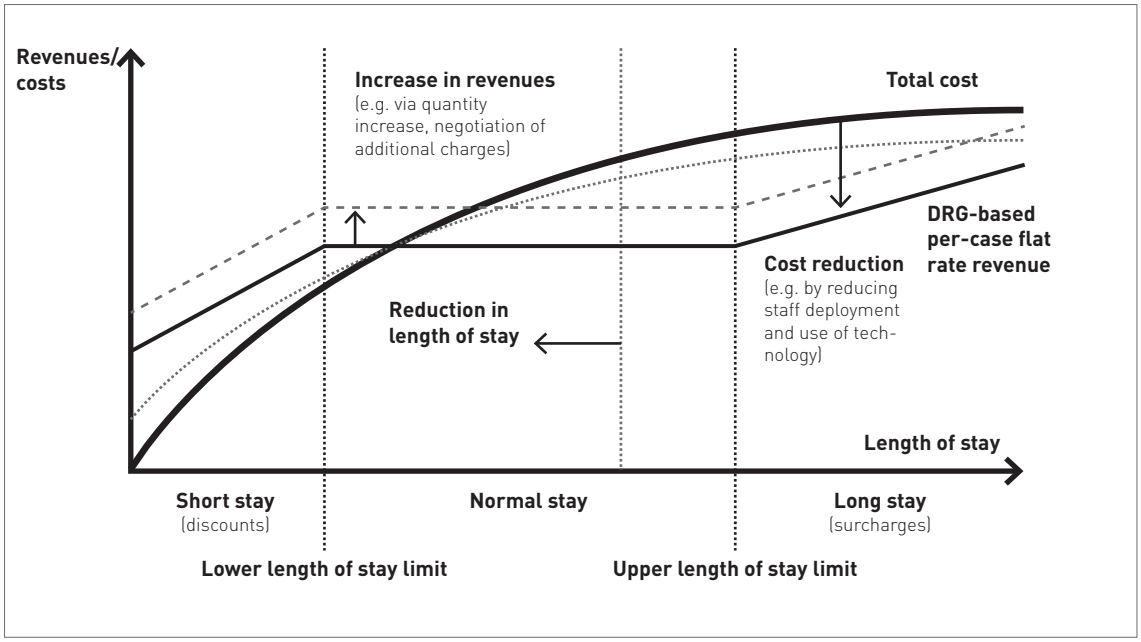
German Federal Statistics Office, Wiesbaden 2016

care. Together, caregivers work towards recognising functional disorders that impact everyday life, taking physical, psychological, social and spiritual aspects into account, and then treating these disorders in a targeted manner. Unfortunately, in reality, care is not always adjusted to the individual needs of patients. Hospitals today seem to focus primarily on one thing: money.

With the introduction of diagnosis-specific per-case flat rates and fixed daily treatment charges, the requirements for successful hospital management have increased considerably. After several decades of very little change in the healthcare system, change has now, in many ways, become the only remaining constant. The abolition of the cost-price principle and the introduction of per-case flat

Hospitals today seem to focus primarily on one thing: money.

rates have meant that economic management, and therefore well-planned occupancy management, have become key topics for many hospitals.



Many clinics have already been forced to close their doors in recent years due to a drastic increase in competition and price pressure. In terms of operating results, almost every other hospital is in deficit.

The total costs incurred are often higher than the revenues that can be obtained from per-case flat rates. Short-term revenue increases are created through volume expansions and the negotiation of additional fees. Cost reductions are achieved primarily through a reduction in staff deployment and use of technology, as well as by shortening hospitalisation periods.

However, these measures are not very promising in the long term. Instead, a restructuring of care processes and an optimisation of clinical treatment paths seems to be necessary in order to successfully combine "values and value" – values from an ethical and moral perspective, and value in the sense of goal-oriented economic activity. Unfortunately, such strategic approaches are rarely encountered in reality. Far too often, hospital management plays the role of the "fire brigade", instead of investing in effective long-term "fire prevention" measures.

This situation can be exemplified by the care procedure for one of the most common injuries

Multidisciplinary hospitals can ensure optimal care.

suffered by older people: femoral neck fracture. In most cases, the cause is a fall sideways onto the hip, or onto the leg when extended or spread. The hip fracture causes the affected person a lot of pain, and as a consequence, the leg can no longer be actively moved. The treatment of choice is surgery. Nevertheless, a drastic consequence in many cases is permanent dependency on care, since the fracture begins a vicious circle of immobilisation and lack of activation. Those affected barely dare to get out of bed because they feel they can no longer

rely on their bodies. They are very afraid of falling, and develop avoidance strategies. The resulting lack of exercise leads to a progressive decline in strength, endurance and mobility. This leads to more falls and complications such as thrombosis and pneumonia.

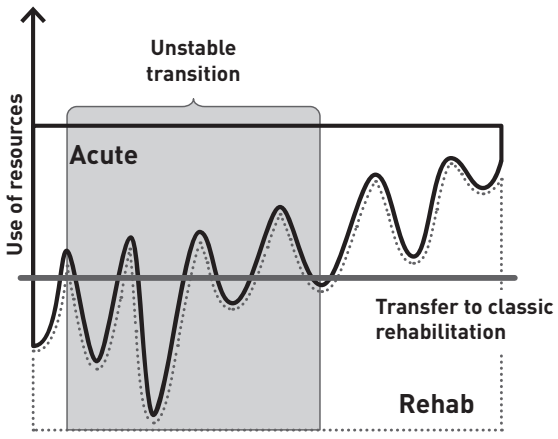
This can be prevented if the right therapy is provided after the operation. It is crucial that patients are made fit for everyday life again in as rapid and targeted a manner as possible. This usually happens as part of a subsequent rehabilitation measure. As geriatric patients are often not stable enough to be transferred to subsequent rehabilitation due to their pre-existing conditions, further treatment takes place in the hospital, as part of a geriatric early rehabilitation complex treatment programe (geriatische frührehabilitative Komplexbehandlung, GFKB) created specifically

for this purpose. The GFKB aims to compensate for the unstable transfer of geriatric patients from acute treatment to rehabilitation.

Increasing age-related multimorbidity is creating a need for these kinds of treatment procedures. The justification given for integrating this service into the per-case flat rate system is that the multimorbidity typical of geriatric patients becomes part of the case definition, and the provided services therefore explicitly correspond to it. This means that geriatric rehabilitation in hospital includes complex services that are intended to justify flat-rate care fees. And that is exactly how it works – clinics can charge correspondingly higher fees if they provide geriatric patients with inpatient GFKB treatment for at least two weeks following acute treatment. The service providers thus promise the cost bearers that they will optimally resolve the treatment backlog resulting from demographically induced multimorbidity, following the principle of economic efficiency. The GFKB certainly has potential, both in terms of social and benefit law, as an early rehabilitation programme in hospitals that is compatible with the per-case flat rate system and is secured as a complex treatment.

But a recent study reveals the programme's weaknesses. Around 47 percent of patients become dependent on care after hospital rehabilitation, while this number is significantly lower – only 40 percent – after traditional rehabilitation. Nevertheless, the number of complex treatments rose sharply in recent years. The proportion of patients who are discharged from the hospital after exactly 14 days is particularly high, which could be due to the financial reward. For example, complex treatment following a femoral neck fracture costs around €4,100 after 14 days of treatment. This is about €1,000 more than would be charged for classic rehabilitation. The question therefore arises as to whether the care is truly primarily focused on the individual needs of patients, or whether financial incentives play a larger role.

Geriatric rehabilitation between the conflicting priorities of hospitals and rehabilitation facilities



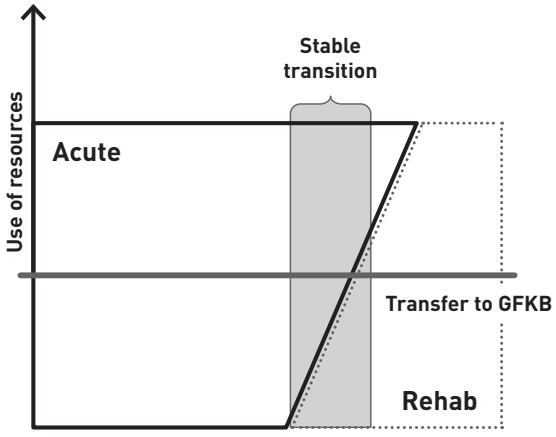
The possibilities offered by the GFKB should not be fundamentally called into question, however. It is clear that multidisciplinary hospitals with appropriate specialisation can indeed guarantee a good standard of care.

In addition, medical care today demands a high degree of adherence to ethical, moral and social values, and this must also remain financially viable through good business management.

Clinics that want to secure their future in the long term must start making plans now

In future, general conditions will lead to the establishment of further competitive elements in the healthcare market, and the fees charged per case will continue to decrease. Clinics that want to secure their future in the long term must start making plans now in order to remain competitive in the future. Economising alone is certainly not a sustainable formula. Instead, clinics will need to organise a fundamental change, and optimise processes relevant to value creation in such a way that they contribute equally to optimal patient care and to economic results. And last but not least, the motto "prevention is better than cure" applies to geriatrics just as much as any other field – it is important to focus on preventive measures such as avoiding falls.

More on page 14.



Source: Dr Friedemann Ernst, Geriatrics Competence Centre at MDK Nord 13/09/2012

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University geriatric medicine at Felix Platter Hospital

Everyday clinical practice and university research come together at Felix Platter Hospital in Basel, Switzerland, where the latest findings and advances in geriatric medicine are continuously being integrated into diagnostics and therapy. This makes the specialist hospital a showpiece for the structuring of modern geriatric medicine. In addition to rehabilitation, the specialists at the Mobility Center focus primarily on the prevention of age-related mobility restrictions.

By Jakob Tiebel

The medical offering at the Felix Platter Hospital is divided into the fields of university geriatric medicine and geriatric rehabilitation, and covers almost all aspects of geriatric care, from acute treatment to outpatient specialist consultations for elderly people with gait disorders and increased risk of falls.

At the Basel Mobility Center of the Felix Platter Hospital, doctors, scientists and therapists work closely together to identify and measure mobility problems that occur in old age. The institute also offers the opportunity for outpatient assessment of gait and dynamic balance disorders, and carries out measurements to determine functional deficits in everyday life.

The Basel Mobility Center is dedicated to both the clinical routine with patients and clinical research with study participants. These areas are not separate, but intertwined – the insights gained from research should flow directly into the work carried out with patients.

Particular emphasis is placed on the early detection of mobility problems. Early detection enables the use of preventive measures, with the aim of keeping the elderly patient mobile and functionally independent for as long as possible.

Mobility consultation

Walking difficulties are not an inevitable consequence of age. There are many systems and factors that influence a person's standing and gait pattern. Changes to these factors associated with age – e.g. vision problems, hearing loss, decreased muscle strength – are a challenge, given that they require attention to compensate for them and compromise stability and gait control. As a result, elderly people often experience an indefinable malaise, a feeling of unsteadiness when walking, concerns about activities that they used to be able to carry out automatically and with ease, or they may even feel dizzy.

These complaints are clarified thoroughly and in detail during the mobility consultation. The focus is on the ability to function in everyday life. In addition to medical history and relevant medical examinations, evaluations of static and dynamic balance, as well as functional ability in everyday activities, and possibly also a gait analysis, are carried out as required. The results can then be used to develop recommendations for therapy plans aimed at maintaining or improving individual functionality and mobility, as well as stability when walking, for the affected person.

The need is great, as mobility issues among elderly people are now among the main causes of falls. According to statistics, one in three people aged over 65 falls at least once a year. Broken bones are a frequent consequence, with femoral neck fractures being a particular source of concern.

The causes of falls are analysed in detail at Felix Platter Hospital

Patients are asked to walk across a ten-metre-long carpet for analysis

In many cases, these lead to a vicious circle of immobility and fear that can end in further falls, dependency on care, social isolation and death. At Felix Platter Hospital, staff work intensively with patients to break this negative spiral by precisely analysing the causes of falls, and remedying them with targeted therapeutic measures.

Gait analysis

Gait analysis is an important diagnostic element in this context. It helps to accurately identify fall risks while also serving as a modern fall prevention method. With the help of a "temporo-spatial" investigation, the gait pattern of persons at risk of falling can be analysed in detail even before a fall occurs, opening up the possibility of preventing a worse outcome thanks to individualised consultation and treatment.

An important tool in this case is electronic gait analysis (GAITRite®), which allows the spatial and temporal parameters of the dynamic gait to be quantified. The measurements can also detect very discrete gait disturbances that are often unrecognisable to the naked eye. A special feature of such gait analysis is the investigation of neuromotor control of walking by means of measurements under dual conditions ("dual task"). Patients must perform a second task at the same time as walking. This could be, for example, reciting animal names or counting backwards. Not infrequently, patients initially show no anomalies in gait analysis, but suddenly become unsteady and almost fall when a cognitive task is added. This is because certain changes in gait are associated with a risk of falling and/or with brain disorders. Gait analysis under "dual task" conditions is therefore also a suitable test procedure not just for identifying mobility disorders and an increased risk of falling in elderly people, but also for the early detection of brain disorders. This results in close interdisciplinary collaboration with the Memory Clinic at Felix Platter Hospital, where gait analysis is also an integral part in the diagnosis of dementia.

In practice, patients undergoing gait analysis

are asked to walk across a ten-metre-long carpet that is connected to a computer via a cable. The carpet contains around 30,000 sensors that precisely record the subjects' steps and tell the computer when, how and where the patients put their feet down. Parameters such as step length, cadence, stride width and other key values for the analysis and evaluation of the gait pattern are calculated with the associated software.

In order to be able to give patients direct recommendations for action, to help them improve their balance and steadiness when walking at home, Felix Platter Hospital has developed the "Better Balance" flyer – a self-training programme designed to improve strength, endurance, balance and coordination.

New research project launched with THERA-Trainer lyra

Felix Platter Hospital relies on state-of-the-art methods, not just in diagnostics but in therapy too. For almost two years, the lyra end-effector gait trainer has been used in the gait rehabilitation programe, allowing therapists and patients to benefit from the advantages of modern gait rehabilitation robotics.

The Mobility Center, under the direction of Dr Stephanie Bridenbaugh, launched a new research project with the gait trainer last year in collaboration with physiotherapists. At the Mobility Center, the medical director is currently supervising Master's student Sandro Caminada, a sports scientist from the Department of Sport, Exercise and Health of the University of Basel. As part of his Master's thesis, Sandro is examining the effects of training with the gait trainer on elderly people with restricted mobility in the context of a prospective intervention study.

The team sees great benefit in the work thanks

In order to determine how patients are coping after rehabilitation, a follow-up visit takes place three weeks after they are discharged

to the pragmatic approach and the high clinical relevance. The results of the study are planned not only to be published later in a peer-reviewed journal, but also to be fed back as directly as possible into everyday clinical practice. In this way, physiotherapists obtain immediate feedback on which patients benefit from lyra training, how their functional assessments correlate with objective measurements from gait analysis, and how the patients get on after leaving the hospital.

The post-inpatient outcome of the subjects is particularly interesting for the researchers. In order to determine how patients are coping at home after rehabilitation, a follow-up visit takes place three weeks after they are discharged from the clinic. "This follow-up is particularly fascinating, because the time after being discharged from inpatient rehabilitation until potentially being re-hospitalised is still a black box", Bridenbaugh says. "If we can prove that lyra training significantly improves the mobility of our rehabilitation patients, and that its effects continue after the patients are discharged, this therapy option will inevitably become more present among physiotherapists and will, most likely, be used more frequently and in a more targeted way."

The results of the study are set to become available by spring 2018 at the latest.

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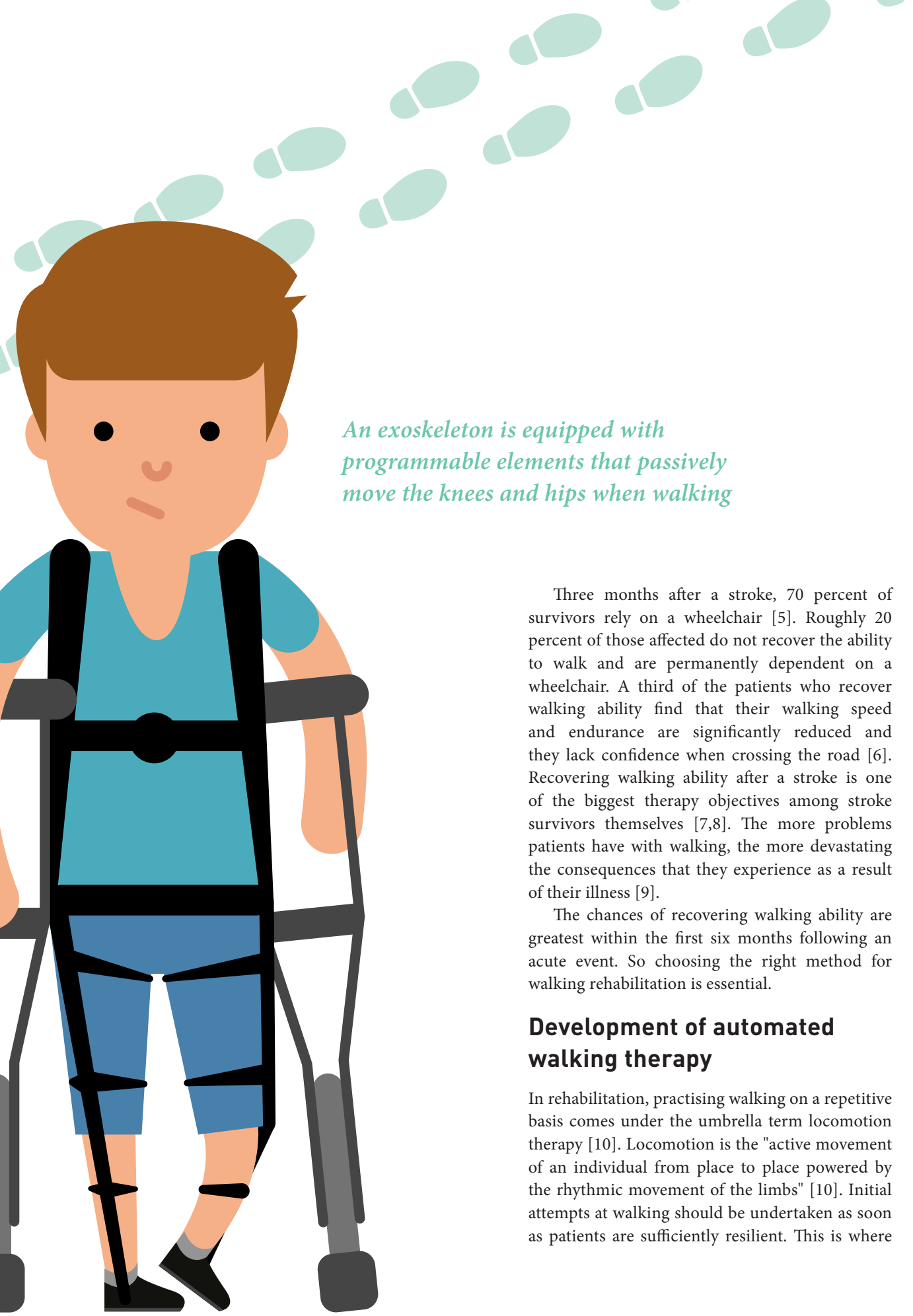
One in every five to seven walking impairments can be prevented by using robot-assisted gait therapy in the early stages following a stroke

MODERN GAIT REHABILITATION

Practise walking by walking!

There are 15 million strokes worldwide each year. Some 270,000 of them happen in Germany alone. These figures are expected to double by 2030 [1,2,3]. Restoring walking ability and associated activities as part of neurological rehabilitation is one of the main concerns in physiotherapy. An important objective is to enable patients to participate actively in society once more [4].

By Jakob Tiebel



An exoskeleton is equipped with programmable elements that passively move the knees and hips when walking

Three months after a stroke, 70 percent of survivors rely on a wheelchair [5]. Roughly 20 percent of those affected do not recover the ability to walk and are permanently dependent on a wheelchair. A third of the patients who recover walking ability find that their walking speed and endurance are significantly reduced and they lack confidence when crossing the road [6]. Recovering walking ability after a stroke is one of the biggest therapy objectives among stroke survivors themselves [7,8]. The more problems patients have with walking, the more devastating the consequences that they experience as a result of their illness [9].

The chances of recovering walking ability are greatest within the first six months following an acute event. So choosing the right method for walking rehabilitation is essential.

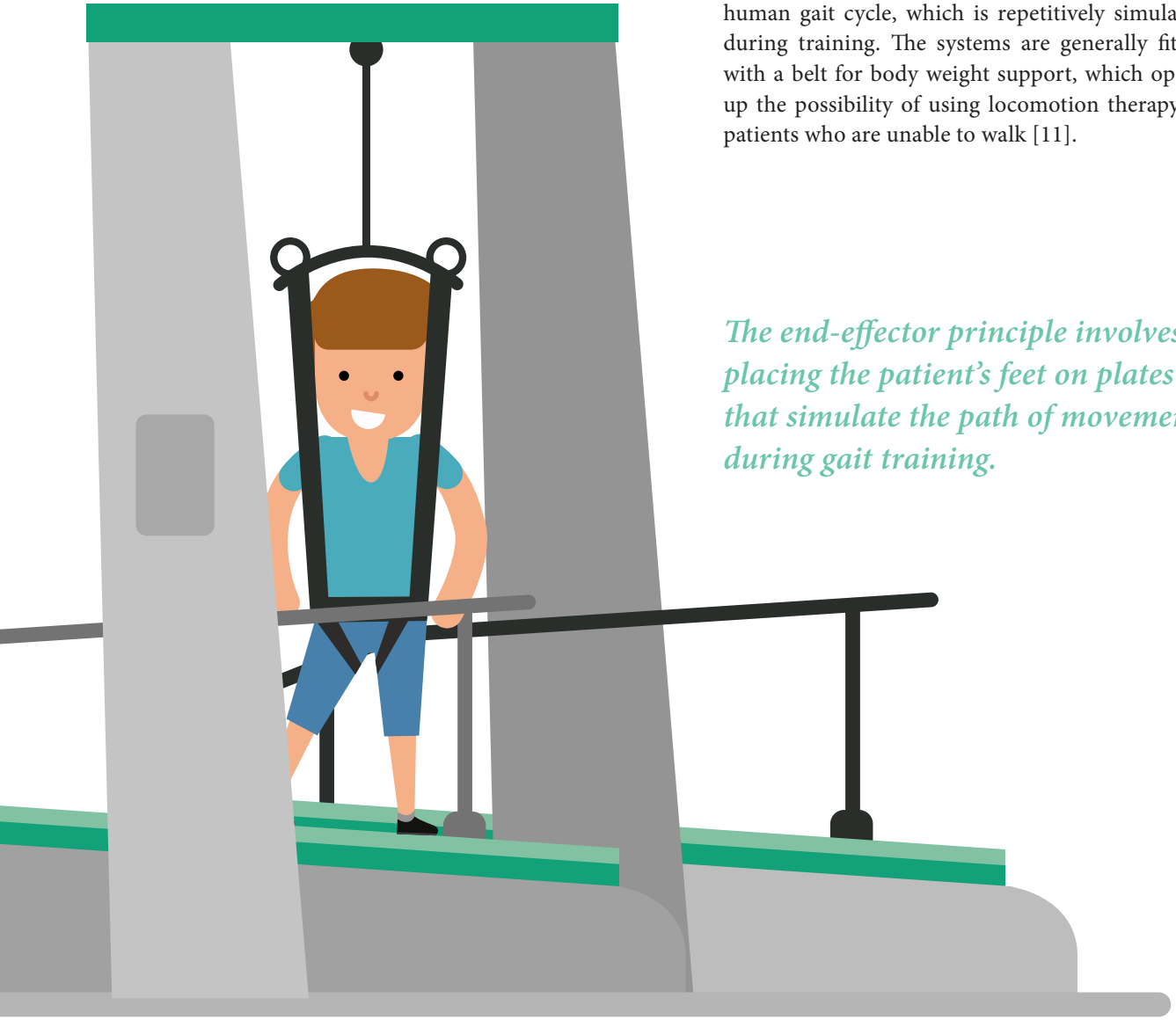
Development of automated walking therapy

In rehabilitation, practising walking on a repetitive basis comes under the umbrella term locomotion therapy [10]. Locomotion is the "active movement of an individual from place to place powered by the rhythmic movement of the limbs" [10]. Initial attempts at walking should be undertaken as soon as patients are sufficiently resilient. This is where

practising walking function is critical. Task-specific and repetitive training should be the preferred option. The manual treadmill with body weight support was a first step in this direction [11]. The development of modern robotic-supported systems has continuously broadened the range of options – so much so that locomotion therapy in the last 20 years has developed into an integral part of neurological rehabilitation and become an area of physiotherapy [10].

Use of robotics – technological progress is revolutionising gait therapy sustainably

In addition to treadmills with and without safety belts and partial body weight support, there are essentially two distinct stationary electromechanical devices: exoskeleton gait trainers and end-effector gait trainers. While the exoskeleton is constructed in such a way that the hip and knee joints are moved during the walking cycle with leg orthoses fitted with electric motors, the end-effector systems are characterised by having no proximal guidance at the hips and knees but instead at the distal tips of the limbs. The patient's feet are held in place on mobile foot plates. The trajectory of the foot plates corresponds to the human gait cycle, which is repetitively simulated during training. The systems are generally fitted with a belt for body weight support, which opens up the possibility of using locomotion therapy in patients who are unable to walk [11].



The end-effector principle involves placing the patient's feet on plates that simulate the path of movement during gait training.

Key definition – electromechanical-assisted gait training

(robot-assisted gait training, RAGT) is an alternative to both classic "overground" gait training and treadmill training with and without body weight support. A distinction is made between exoskeleton systems, where the patient is moved by means of motor-driven orthoses, and end-effector systems, where the step cycle is simulated via motor-driven foot plates. Electromechanical gait trainers are used in the context of rehabilitation to provide patients who are unable to walk with highly effective, task-oriented gait training with many repetitions which, according to current evidence, significantly increases the chance of regaining independent walking ability after a stroke. In the past, comparative studies have shown significantly higher success rates from the use of end-effector gait trainers, which is why these systems are considered to be correspondingly more effective. They also have the benefit of being much easier to handle and more intuitive to use.

Increased efficiency – better outcome with significantly lower strain

Clinical studies prove that treadmill training with partial body weight support improves walking ability in stroke patients [12]. Despite the generally positive effects attributed to locomotion therapy with robotic supported systems, no significant advantage has been conclusively proven compared to manual treadmill therapy [13]. However, training a severely impaired patient on a treadmill frequently requires up to two therapists who, mostly under intense physical exertion, position the patient's feet in order to reproduce repetitive gait cycles [14]. Using an electromechanical gait trainer therefore offers clear advantages, particularly in the acute and sub-acute stage of rehabilitation. Because the therapists are under significantly less strain, the patient can practise a higher number of repetitions of gait cycles in a unit, which is essential for restoring walking ability [15].

Studies favour end-effector gait trainers – DGNR has been recommending their use since December 2015

Numerous clinical studies over the last ten years have investigated the therapeutic effect of automated gait therapy in stroke patients. What these studies have revealed is that a combination of electromechanical gait training and physiotherapy is significantly more advantageous compared to purely conventional therapy [16,17,18]. The large-scale, multi-centre German gait trainer study (DEGAS study) showed in 2007 that, when compared to 45 minutes of conventional physiotherapy over 20 treatment units, the combination of a 20-minute gait training session on an end-effector trainer and 25 minutes of conventional physiotherapy increases the chance of being able to walk independently again by a factor of 2.5 [20]. Electromechanical gait therapy is highly effective for repetitively practising a physiological gait pattern. It also enables controlled cardiovascular training and functional strengthening of the muscle groups needed for walking [11]. This type of intervention is particularly beneficial to stroke patients who are unable to walk in the sub-acute stage (<3 months following a stroke) [19].

It is assumed that one in seven cases of inability to walk can be prevented with intensive gait training. The therapy chances also depend on the type of device used for therapy. The group of end-effector trainers performs significantly better compared to exoskeletons [19].

The S2e Guideline "Rehabilitation of Mobility after Stroke (Re-MoS)" published by the German Society of Neurorehabilitation (DGNR) in December 2015 classified the use of end-effector trainers for stroke patients who are unable to walk as a "Should" recommendation [21].

Broad range of application – not only stroke patients benefit

In addition to strokes, there are other neurological diseases: spinal cord injuries, multiple sclerosis, Parkinson's disease and traumatic brain injury. These diseases also frequently lead to impairments in walking ability. Various studies have demonstrated the potential in the use of automated gait therapy even for these disorders [22,23,24].

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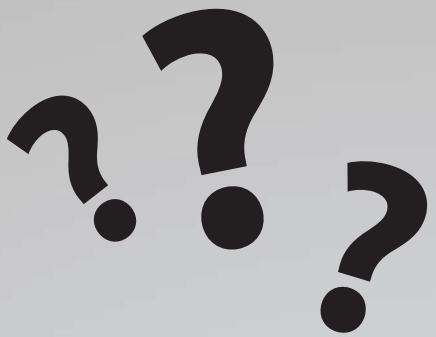


SCIENCE

What do therapists think of robot-assisted therapy after a stroke?

The effectiveness of robot-assisted therapies has undoubtedly been proven. But until now it has not been clear what therapists, as users, think of the modern treatment methods. Stephenson and Stephens explored this question in detail as part of their scientific studies. To this end, the researchers at a stroke centre in the UK conducted semi-structured interviews with therapists and asked for their opinions.

The evaluations show that, in principle, therapists have an open-minded and positive attitude towards robot-assisted therapies, and see them as a meaningful and effective supplement to conventional therapy. A particular challenge is the successful implementation of the measures in everyday clinical practice, for example with regard to existing resources and skills. The authors conclude that relevant guidelines should be created.

LITERATURE

Stephenson, Andrew and Stephens, John. "An exploration of physiotherapists' experiences of robotic therapy in upper limb rehabilitation within a stroke rehabilitation centre." Disability and Rehabilitation: Assistive Technology (2017): 1-8.

SCIENCE

Current Cochrane Review once again confirms

effectiveness of electromechanical gait training

In the update to the Cochrane Review, which was first published in 2007, the working group led by Jan Mehrholz confirms the effectiveness of electromechanical-assisted gait training in post-stroke rehabilitation based on comprehensive meta-analyses. Following stringent quality criteria in their literature research, the scientists were able to consider a total of 36 randomised controlled trials involving 1,472 patients that compared electromechanical gait training with conventional treatment methods.

The results show that electromechanical gait training has significant effects on the ability to walk. Stroke patients who receive electromechanical gait training in combination with physiotherapy have a greater chance of regaining the ability to walk independently than patients who only undergo conventional gait training as part of physiotherapy.

The strongest effects are seen in patients who begin the training process at a very early stage

According to the authors, one in every five to seven walking impairments could be avoided through the systematic use of electromechanical gait trainers.

The strongest effects are seen in patients who begin the training process at a very early stage, i.e. in the first three months after a stroke, and who are not able to walk at the beginning of the therapy.

There are still many questions regarding the amount, frequency and duration of training. The authors believe that further research is needed here.

The integration of these modern treatment methods into practice also poses a challenge for clinics. There are still only few who succeed in putting the recommendations of science, research and internationally recognised guidelines into practice.

LITERATURE

Mehrholz J, Thomas S, Werner C, Kugler J, Pohl M, Elsner B. Electromechanical-assisted training for walking after stroke. Cochrane Database Syst Rev. 2017;CD006185. doi: 10.1002/14651858.CD006185.

Gait robotics at Gmundnerberg therapy centre

The Neurological Therapy Center Gmundnerberg (NTG) has been using the THERA-Trainer lyra gait trainer since March 2017, helping to expand its treatment offering in the gait rehabilitation of neurological patients.

By Dr Hermann Moser and Maria Anna Kraxberger

Choosing the right gait rehabilitation is extremely important for restoring impaired walking ability, such as can occur in neurological disorders (e.g. stroke, spinal cord injury, MS, Parkinson's disease, cerebral palsy and TBI). The following factors are particularly crucial:

- Frequent repetition
- Task specificity
- Independent activity
- Motivation of the learner

Automated gait therapy, which reduces physical strain during the training and improves efficiency though increased repetitions, is at the cutting edge of technology in this field. The NTG therefore recently started using the state-of-the-art lyra gait trainer. "We are pleased to be one of the first institutions in Austria to offer therapy with lyra. The introduction of end-effector robotics is an important step in the overall care of our patients and enables state-of-the art gait rehabilitation", says Medical Director Dr Hermann Moser, M. Sc.

Faster therapy success

With the lyra gait trainer, severely affected patients can be gently guided back to daily life, step by step, using gradually adjusted training settings. The patented robotics generate a human gait pattern that specifically stimulates neuroplasticity processes. The combination of high repetition rates and a human gait pattern allows faster therapeutic success in regaining a natural and safe gait pattern. "The lyra trainer optimally supports the patients and therapists in achieving their common goal. With this acquisition, we can make the walking training process offered to our patients more targeted and more effective," says Therapy Manager Maria Anna Kraxberger, who is also enthusiastic about the development.

Faster therapy success thanks to high repetition rate

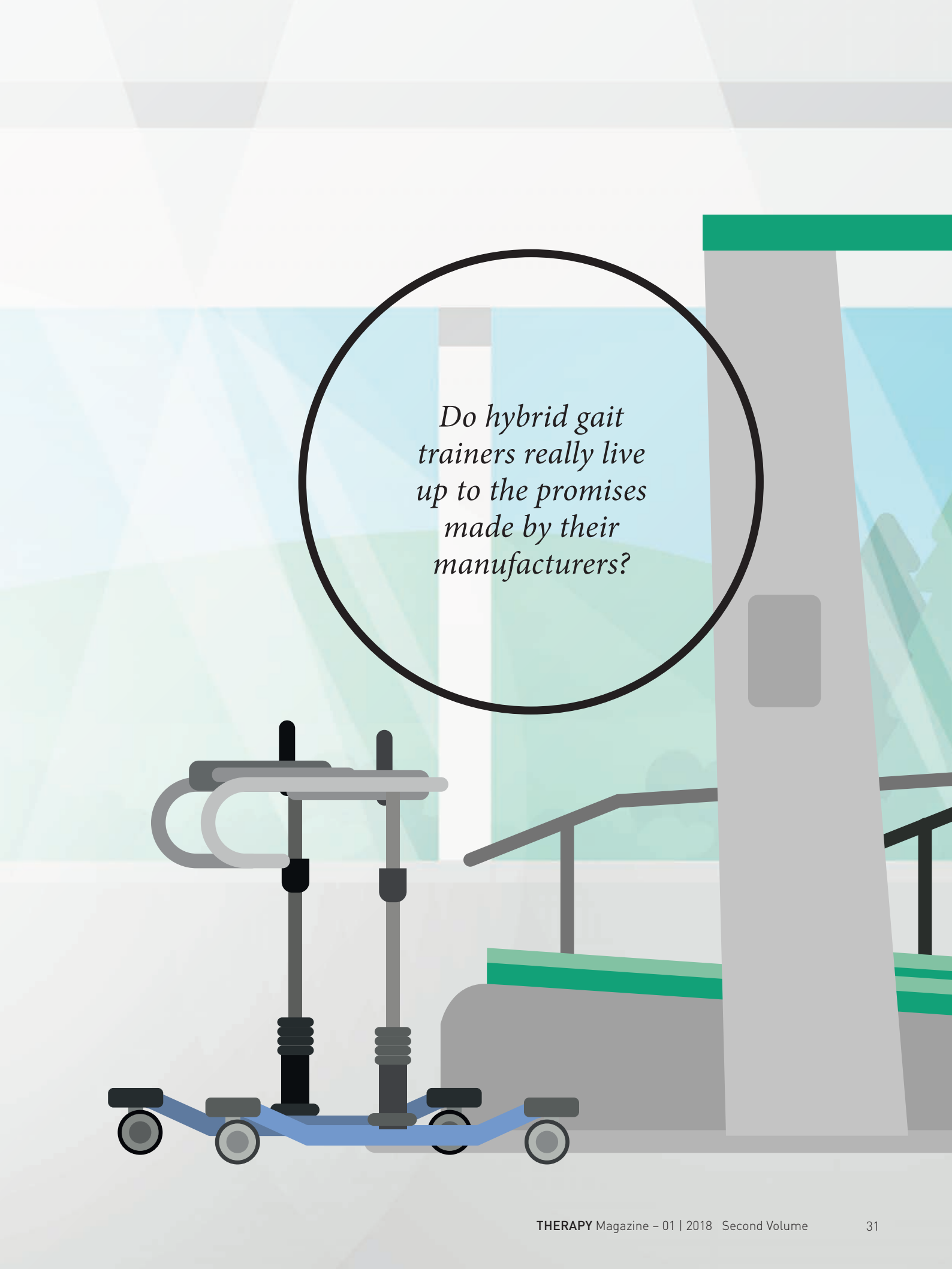
Dr Hermann Moser

Maria Anna Kraxberger

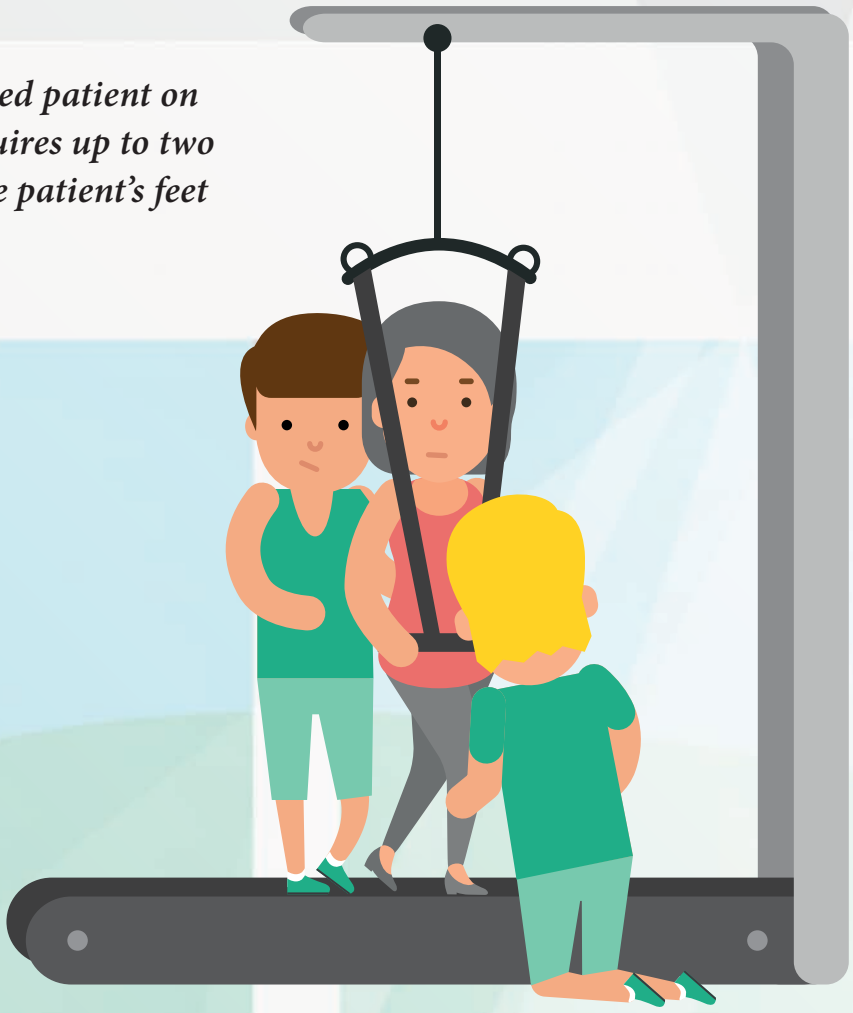
Putting hybrid gait trainers to the test

Based on current evidence, the recovery of walking ability is best practised by walking, and this includes training on the ground. However, training cannot be carried out using a robot-assisted gait trainer. Therefore, in order to enable patients to train walking under conditions that reflect everyday life at an early stage during inpatient rehabilitation, various hybrid systems are trying to establish themselves at the interface with stationary gait training robots. Their manufacturers promise to close the gap between stationary gait training and walking freely on the ground. But have they managed to achieve this?

By Jakob Tiebel


Do hybrid gait trainers really live up to the promises made by their manufacturers?

Training a severely impaired patient on a treadmill frequently requires up to two therapists who position the patient's feet with great physical effort.



"To be able to walk again!" – this is the most important goal for many people who have suffered from a loss of walking ability as a result of a stroke [1,2]. In recent decades, improved knowledge of our nervous system's powers of reorganisation have led to a change in thinking regarding therapy.

To an extent, gait trainers have revolutionised locomotion therapy

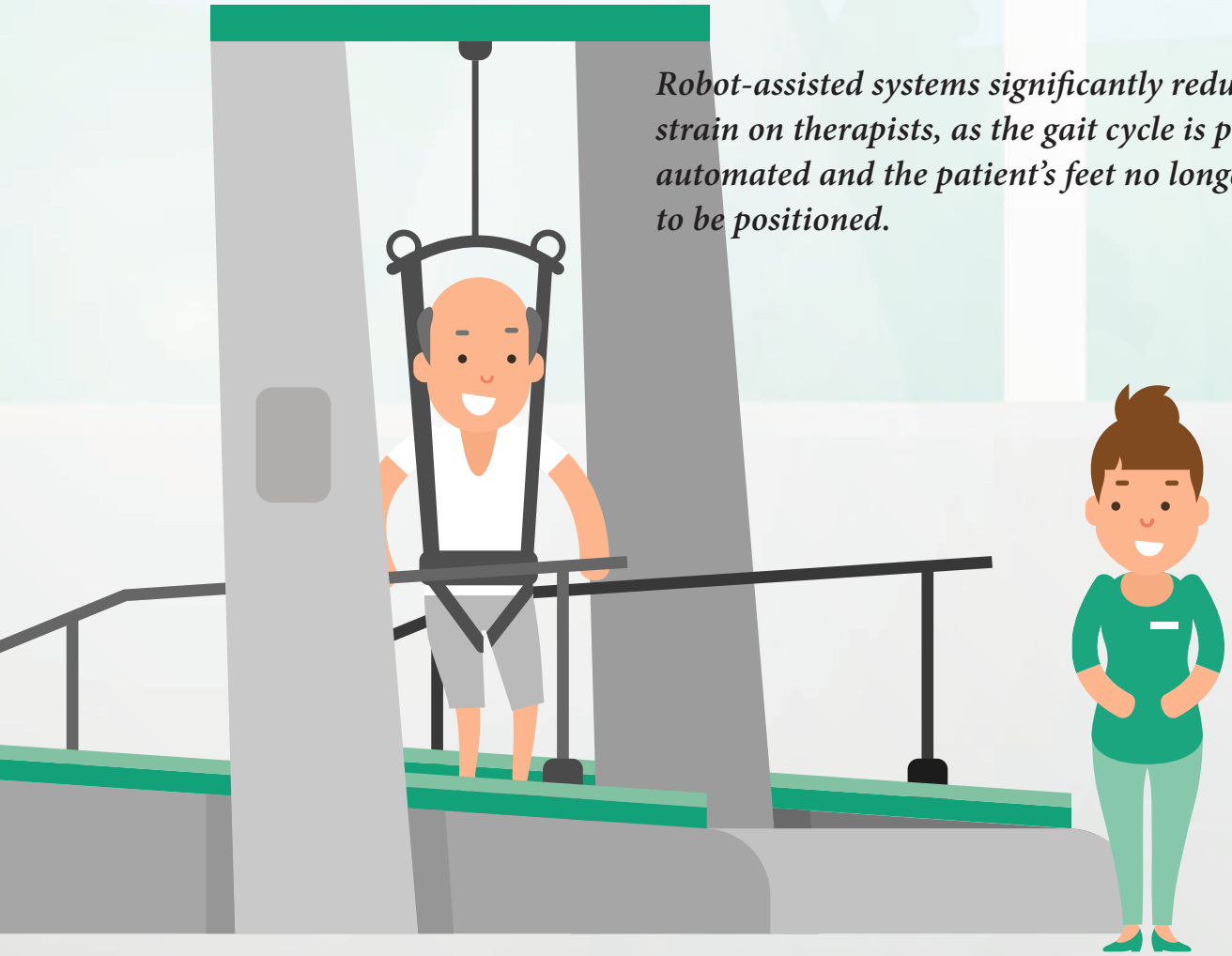
Increased emphasis is placed on functional therapies based on findings in the area of motor learning. First attempts to walk are made as soon as the patient is resilient enough [3].

Since the introduction of robot-assisted therapy around ten years ago, electromechanical gait trainers have been used increasingly in the early phases of rehabilitation. To an extent, they have revolutionised locomotion therapy [4]. The precursor to such devices was the treadmill with partial body weight support. This is not directly inferior to modern gait trainers [5,6], but when training a severely impaired patient, it frequently requires up to two therapists to position the patient's feet with great physical effort in order to reproduce the required number of repeated gait cycles [7,8]. With robot-assisted systems, however, this is not necessary. The gait cycle is partially automated, significantly reducing the strain on the therapists [3,7,8]. Based on current evidence, end-effector systems promise the greatest treatment success in comparison with exoskeletons [9]. These treatment

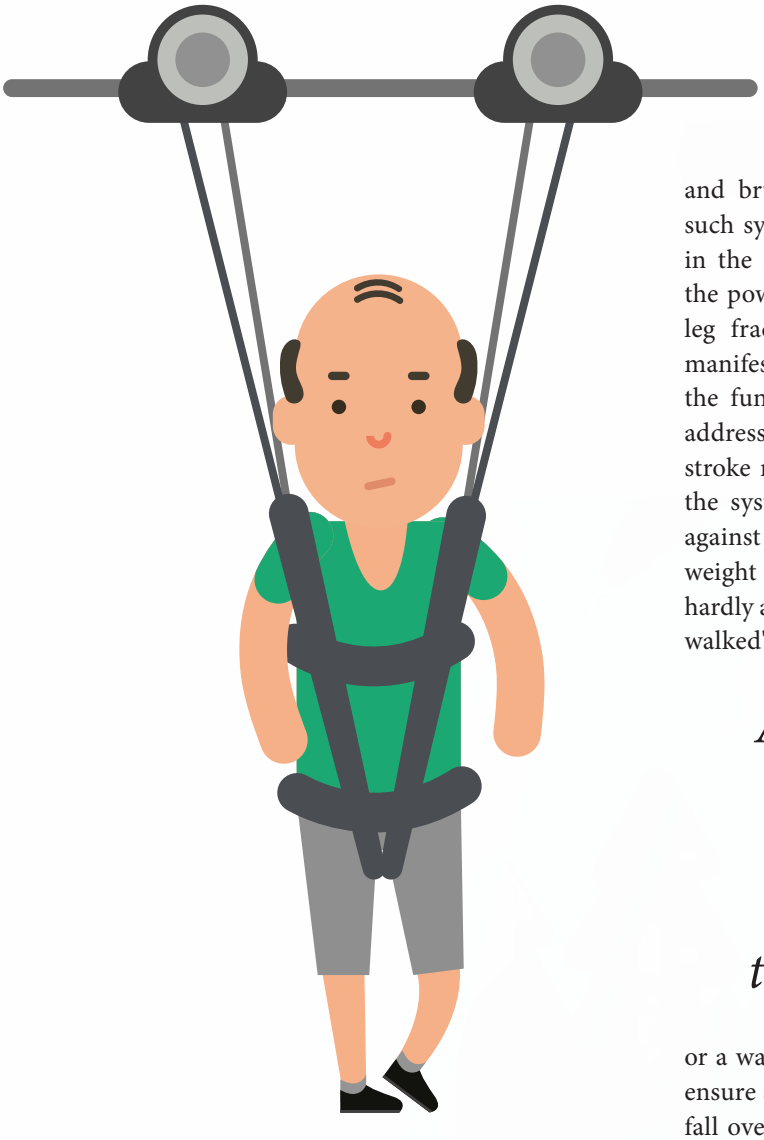
methods primarily benefit the patient, who is not yet able to walk, by facilitating the relearning of the movements required for walking, mainly by means of multiple repetition [10].

However, at the end of a rehabilitation programme, a patient should not only be able to walk in the context of therapy with the aid of an electromechanical gait trainer [11]. They also need to be able to move around safely at home and in unfamiliar environments without the support of a therapist [12]. Training walking under conditions that reflect everyday life is an essential prerequisite for this [3]. Specific parameters such as endurance and walking speed can also be effectively trained on a treadmill in this phase [13], but this does not replace function-oriented gait training on the ground. The reason for this is that the systems only partially enable the principles of motor learning to be implemented, since the focus here is on the repetition of movement, but not the movement task itself [14]. "Practise walking by walking" [15]. And we must not forget that this also includes walking in open spaces, on uneven ground, and overcoming obstacles, despite all the benefits that result from stationary locomotion training with end-effectors, treadmills, etc. Variations in speed, changing direction, carrying objects (e.g. shopping bags, glasses, bottles, trays) and walking with external interference (e.g. crowds) – it is the everyday challenges that make walking such a complex process. And this process needs to be practised! [3]

Functional gait training on the ground therefore focuses on the transition into everyday life, as well as improving movement, coordination, and weight transfer to the paretic side. Training must take place in a specific context, under conditions that are as realistic as possible [3,16]. The work of Carr and Shepherd (2003) [16] paved the way for training that reflects everyday functions. But this does not have to mean that the use of devices here is taboo. Quite the opposite – in order to meet the requirements of this training as early as possible in the course of inpatient rehabilitation, special



Robot-assisted systems significantly reduce the strain on therapists, as the gait cycle is partially automated and the patient's feet no longer need to be positioned.



hybrid systems have been developed over the last few years. Their manufacturers promise to close the gap between stationary gait training and walking freely on the ground. But have they managed to achieve this?

Mobile exoskeletons have been setting the trend for some years. These are gait training machines attached to the body and driven by servomotors, which support or strengthen the user's leg movements. The multi-jointed high-tech orthoses are strapped tightly to the patient's lower body and legs, which often leads to unpleasant side effects such as skin abrasions and bruises [14]. Nevertheless, the existence of such systems is justified to an extent, particularly in the rehabilitation of paraplegics, even though the power packs have been known to cause lower leg fractures in the occasional paraplegic with manifest osteoporosis [17]. Regardless of this, the fundamental question of usefulness must be addressed in the context of restorative therapy in stroke rehabilitation. Lack of evidence aside [18], the systems do not have any features to protect against falls. To make matters worse, the heavy weight of the apparatus means that patients are hardly able to keep their balance. They can only "be walked" with the help of other aids such as crutches or a walking frame. In addition, an assistant must ensure at all times that the patient does not simply fall over following a total loss of balance. We can therefore conclude that these masterpieces of engineering seem entirely unsuited to function-oriented gait training.

Mobile exoskeletons have been setting the trend for some years.

Among the modern hybrids, the classic overhead trolley represents a more traditional solution.

Among the modern hybrids, the classic overhead trolley represents a more traditional solution. It has been tried and tested for many years, and can certainly be used for secure gait training on flat ground. The patient is secured via a belt attached to a ceiling-mounted guide rail, without body weight support. Newer, more advanced models are based on the same principle, but allow the patient to be secured dynamically, with partial body weight support, via an electromechanical traction device that moves along with them in the rail system. Patients can move along the rail system independently, actively shifting the body's centre of gravity. However, the walking speed is limited by the patient's motor skills and is usually very slow [3]. Given that the guide rails are attached to the ceiling, they do not take up any storage space on the ground. However, the apparent advantage of space

saving is quickly put into perspective when one considers that at least one additional treadmill is required to enable patients to undergo accelerated speed-dependent training [13]. In addition, it must be remembered that the radius of action is always fixed by the rail system and is therefore limited. The patient is thus only partially able to decide freely where to move. In recent developments, this weakness has been compensated by the absence of a central overhead suspension. Instead, patients are secured via the belt to a dynamic four-point tension system, allowing large parts of the available space to be utilised.

Mobile overground systems are a modern alternative

Mobile overground systems represent an alternative to fixed ceiling installations. These

self-contained mobile systems are usually battery-powered and allow the patient to walk upright and hands-free in an open space. They convincingly close the gap between stationary gait training and walking freely on the ground. Here too, the patient is secured by a belt system, which prevents a fall in the event of a loss of balance. The devices can be used anywhere in a clinic where there is sufficient space. The THERA-Trainer e-go is one such mobile gait trainer equipped with an electric motor. It is based on a unique concept: the patient is secured to a support frame during therapy via a pelvic belt below the body's centre of gravity. The securing system does not influence the upper body at all. This is a key advantage over all other systems available on the market, where dynamic control over the body's centre of gravity is heavily influenced by the securing belt and suspension systems. Overhead belt suspensions may seem to give patients more safety and support, but at the same time they ensure that the upper body is excluded from the dynamic process of walking. Essential aspects of postural control, which are highly important to safe walking on the ground, can only be trained

The overground system can be used anywhere in a clinic

to a limited extent with such systems. Another advantage is that a speed adjusted to the patient's individual performance level can be selected via a stepless speed control system. It is also possible to force higher walking speeds and speed variations, just as on a treadmill. Patients can walk forwards and backwards, and can change direction while standing or moving. The system is controlled via an intuitive control and display unit in the form of a wired handheld remote control. In addition, the device has a two-stage adjustable balance unit, which allows the degrees of freedom during training to be adapted to the patient's balance ability. Since the frame is accessible from all sides thanks to its compact design, the therapist can accompany the patient closely and can, for example, bring them to the limits of stability in order to specifically train not just anticipatory balance, but also reactive balance while walking.

Even longer walking distances that exert patients to their limits are possible with the THERA-Trainer e-go without the risk of falling. The arms can swing reactively during walking [3]. Everyday activities such as carrying and transporting objects can also be practised under realistic conditions.

The arms can swing reactively during walking

Soft floor mats and suitable stepping areas allow different surfaces and obstacles to be simulated. This ensures that training is specific, task-oriented and relevant to everyday life. The independent activity of the patient is promoted as much as possible [3].

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Intensive continuous therapy for paraplegia

For some 23 years now, patients with spinal cord injuries have been treated at Centro Giusti, a private institute of physical medicine and rehabilitation in Florence (Italy). The institute follows the "Riabilitazione Intensa e Continuativa" (RIC) approach, a specially developed treatment concept. RIC is intensive continuous therapy. The continuous adaptation of the therapeutic setting and treatment intensity are essential core aspects of the concept. Depending on the performance level, the duration and dose of therapy are progressively increased to achieve continuous improvements. The therapy takes into account the principles of motor learning. Task-oriented training is particularly central in gait therapy.

Modern emergency medicine and numerous advances in technology have greatly improved the care of patients with spinal cord injuries over the last decade. Improvements that have long been considered unattainable can now be achieved with new therapeutic procedures and the use of specific treatment methods. Dr Wise Young, a neurologist at Piscataway University (NY), puts it in a nutshell. In one of his publications he writes: "Recovery after

a spinal cord injury is no longer the exception, it is the rule." For this to be true, functional improvement must be the goal of therapy and pursued with the necessary intensity.

This is where RIC comes in. It consists of several core components: task-oriented training (standing, walking), movement therapy for bones and joints (stretching, mobilisation) and physical therapy (massages, electrotherapy, vibration therapy).

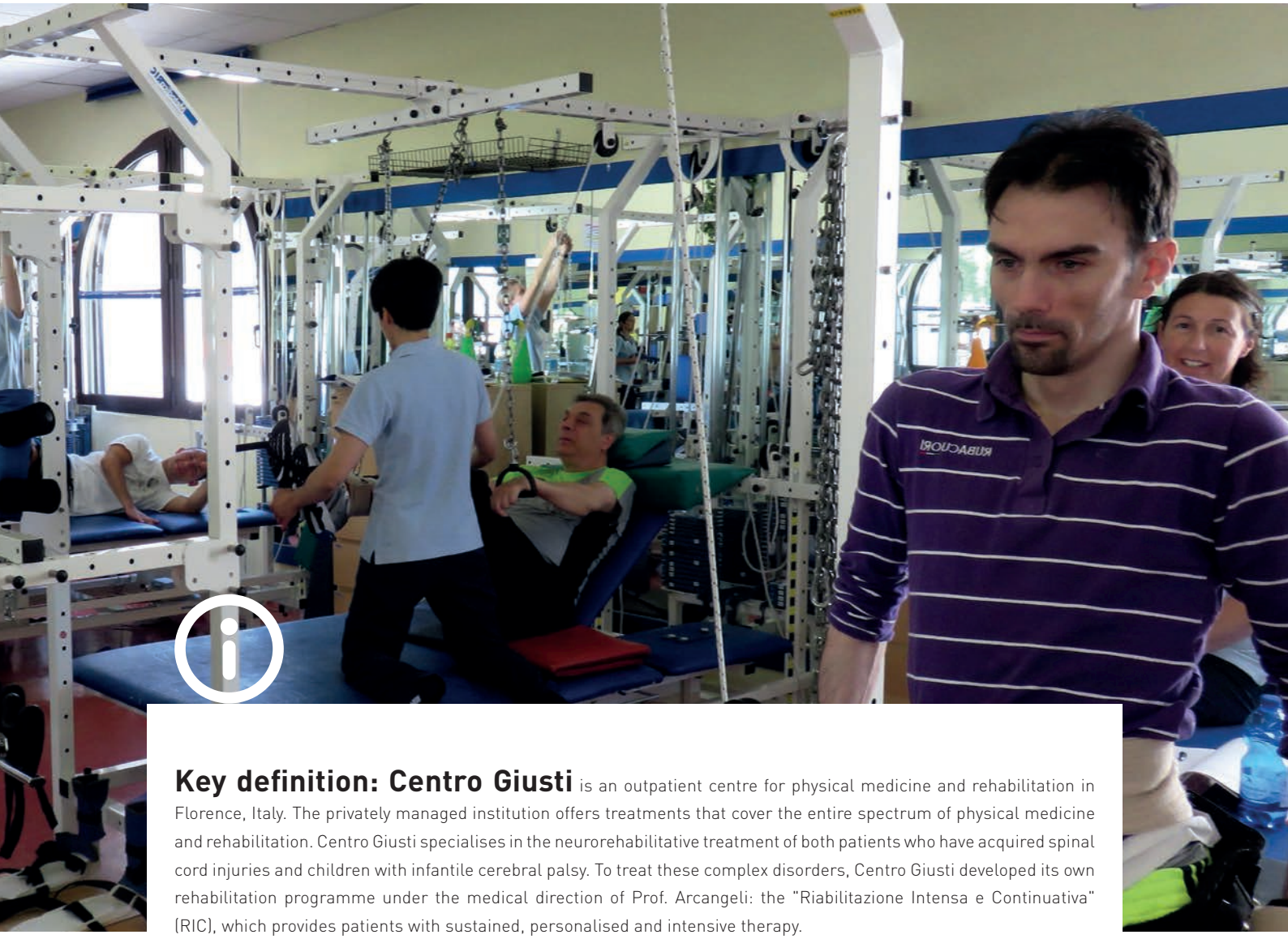
"As the medical director of the rehabilitation centre, I have three main goals with RIC," explains Prof. Arcangeli, who has developed the concept significantly. He is convinced that "therapy in patients with spinal cord injuries must be personalised, intensive and sustained."

Given that clinical images often vary widely, patients need to be given therapy tailored to their specific needs. And the right dose plays a decisive role. "Patients undergo an intensive treatment programme that runs on at least five consecutive days in the week, during which patients take part in functional activities for at least four to six hours a day," explains Arcangeli. "The desired healing process often only materialises after more than

a year of rehabilitation, so plenty of time must be given for treatment." In this respect, it is very important that the therapy is constant.

Walking has to feel natural.

The overall objective of all measures is to restore maximum autonomy and independence for the patient. Regaining the ability to walk is critical to this, which is why it is worked on as early as possible. Patients practise the action of walking in a basic physiological standing position with as little support as possible. "It has to feel natural," says Arcangeli. "This is the only way to give psychological stimuli, which are just as important as the necessary physiological stimuli." By practising walking by walking, patients feel they have some level of self-efficacy during gait therapy.



Key definition: Centro Giusti is an outpatient centre for physical medicine and rehabilitation in Florence, Italy. The privately managed institution offers treatments that cover the entire spectrum of physical medicine and rehabilitation. Centro Giusti specialises in the neurorehabilitative treatment of both patients who have acquired spinal cord injuries and children with infantile cerebral palsy. To treat these complex disorders, Centro Giusti developed its own rehabilitation programme under the medical direction of Prof. Arcangeli: the "Riabilitazione Intensa e Continuativa" (RIC), which provides patients with sustained, personalised and intensive therapy.

"This increases motivation and helps them to pursue, and ultimately achieve, their own goals energetically."

The training programme includes practising independent movement transitions (sitting to standing) in addition to tasks to improve balance and coordination.

RIC also envisages the targeted use of modern rehabilitation equipment such as the THERA-Trainer e-go. The mobile training device makes it possible to carry out safe gait training, during which patients can move freely around the clinic. "This allows patients to regain a sense of security and feel that training is helping them to regain their autonomy and independence," says Arcangeli.

"The aim of the RIC concept is to improve the motor skills of patients as much as possible. For this to happen, it is essential that the patient actively participates in the rehabilitation process. And it's also very important from a psychological point of view."

Back to everyday life, step by step

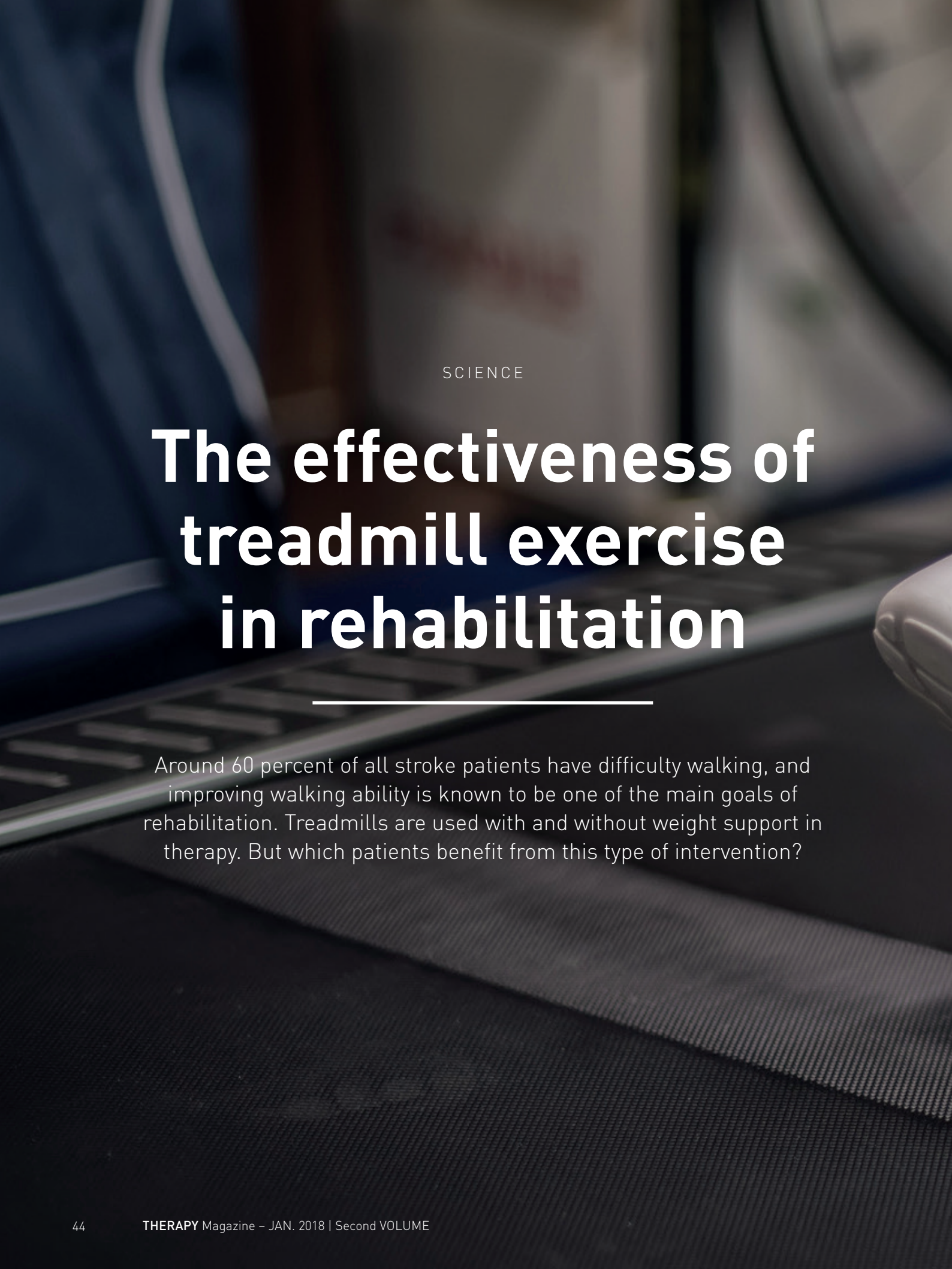
Since the end of 2015, the Bad Rodach Medical Park has offered its patients a new kind of gait rehabilitation. Now, together with the gait trainer THERA-Trainer e-go, patients at the Bad Rodach Medical Park are going "back to everyday life, step by step".

True to the motto of Prof. Stefan Hesse "If you want to learn how to walk, you have to practise walking," the THERA-Trainer e-go is consistently integrated into the existing gait rehabilitation concept of the German clinic.

With the THERA-Trainer e-go, sufferers practise free walking in the room, under real environmental conditions, yet in a safe setting without the danger of a serious fall. The clinic has been using the THERA-Trainer e-go for several months with patients who are able to stand on the floor in a safe environment, and who are keen to gain greater freedom of movement.

Above all, in the Bad Rodach Medical Park, patients should be able to decide themselves where to go – for example to the kiosk or to the clinic reception. After a while, they often start to feel secure and independent in everyday situations again. Step by step to more freedom: How can we make the road to recovery more attractive and effective?

The THERA-Trainer e-go is used extensively in the Bad Rodach Medical Park.



SCIENCE

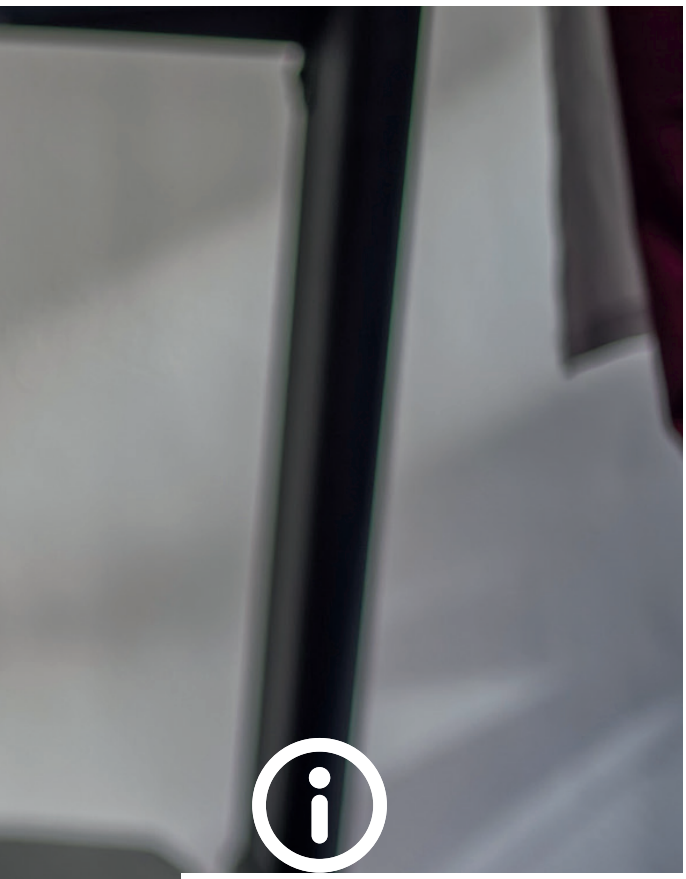
The effectiveness of treadmill exercise in rehabilitation

Around 60 percent of all stroke patients have difficulty walking, and improving walking ability is known to be one of the main goals of rehabilitation. Treadmills are used with and without weight support in therapy. But which patients benefit from this type of intervention?

The update to the review by Jan Mehrholz and colleagues published in August 2017 makes a significant contribution to clarifying this question. The researchers investigated whether and to what extent treadmill training can improve walking compared to other training methods. They reviewed 56 studies involving a total of 3,105 patients.

The scientists found moderate evidence that stroke patients who can already walk independently at the start of therapy benefit from the treatment. In particular, sustained improvements in walking speed and endurance were demonstrated. Conversely, patients who are not able to walk hardly benefit at all from treadmill training.

Treadmill training should be used primarily with mobile stroke patients to improve endurance and gait speed



An evaluation of the subgroups shows that statistically and clinically significant improvements can be achieved, especially within the first three months after a stroke. The effects on patients treated in the chronic phase (i.e. more than six months after the stroke) are usually more minor.

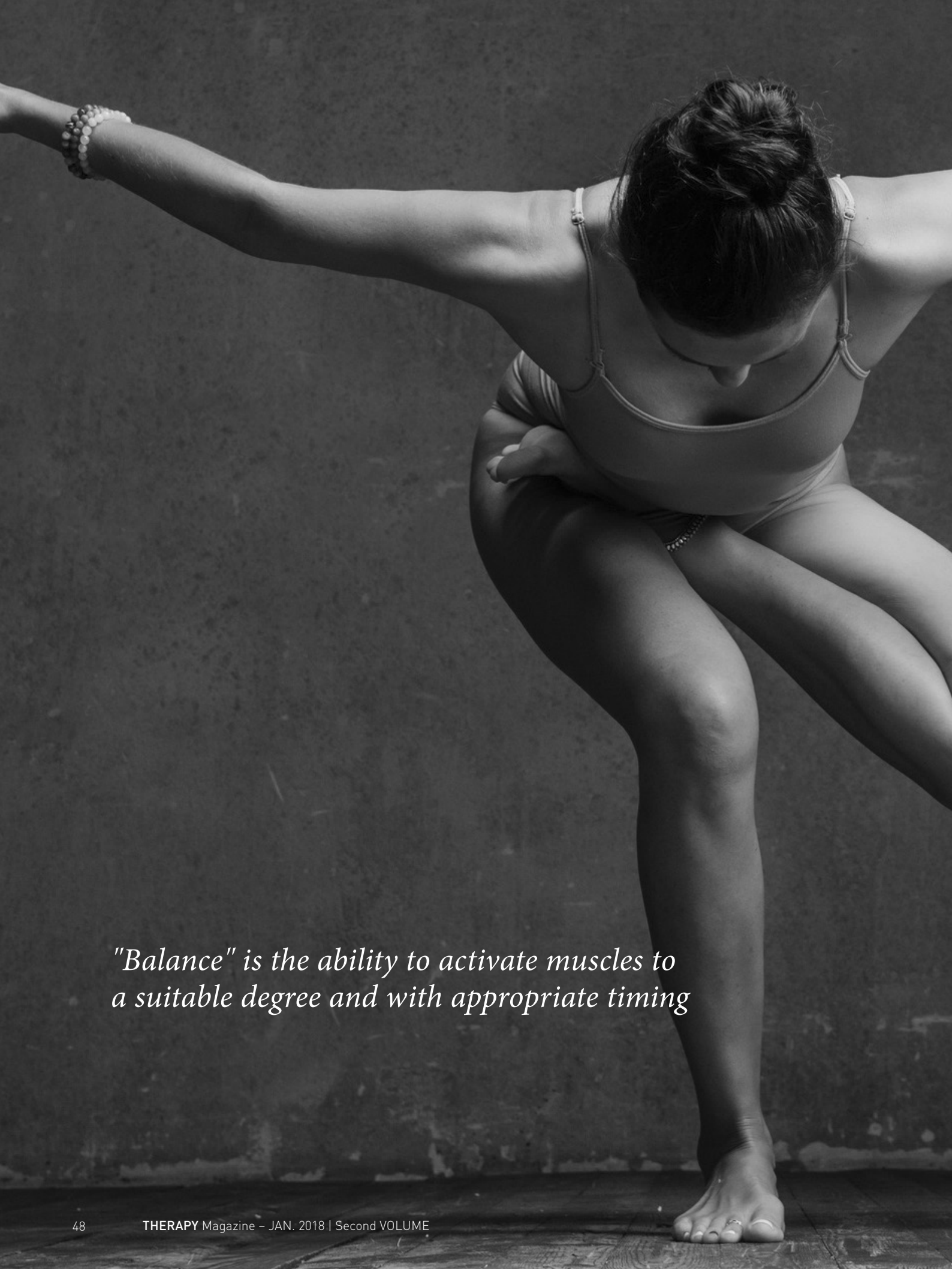
In practice, treadmill training should therefore be used especially with stroke patients who can walk on their own to specifically improve their walking speed and endurance as early as possible.

Future studies should particularly examine the effects of treadmill training with different frequencies, duration or intensity (in terms of speed increments and the gradient), and the use of handrails.

LITERATURE

Mehrholz J, Thomas S, Elsner B. Treadmill training and body weight support for walking after stroke. Cochrane Database of Systematic Reviews 2017, Issue 8. Art. no.: CD002840. DOI: 10.1002/14651858.CD002840.pub4

Key definition: Treadmill training with and without bodyweight support (BWSTT) is an intervention that is usually performed as part of physiotherapy in different settings. In neurological rehabilitation, treadmills are used for task-specific training to improve walking ability, and especially gait speed and endurance.
The patient is secured during training with a harness system, which can also support part of their body weight. As a rule, the patient is able to actively repeat the gait cycle. Occasionally, the patient is guided by the therapist, although it should be noted that, according to the latest scientific findings, patients who are unable to walk benefit more from training on an electromechanical gait trainer. With these devices, the legs are moved along a natural step curve on motorised footplates, which also removes a physical burden from the treating therapist.



"Balance" is the ability to activate muscles to a suitable degree and with appropriate timing

What keeps us balanced?

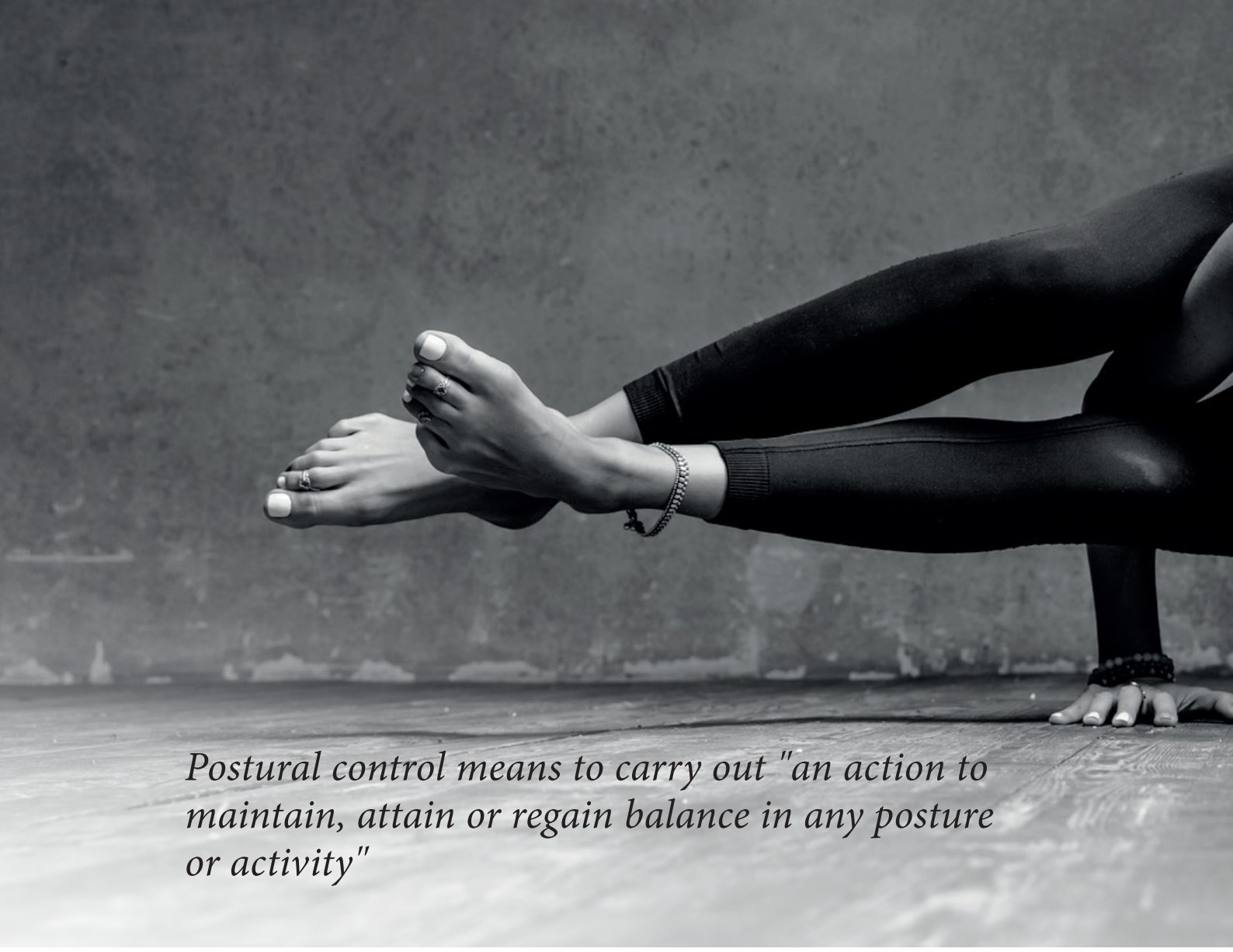
By Martin Huber

Control of balance is one of man's most fascinating abilities. The "balance system" is responsible for keeping the centre of gravity within the base of support (known as postural stability, see below) and maintaining the appropriate positioning of body parts in relation to the rest of the body and to the environment (postural orientation, see below) [4]. Some authors describe "balance" as the ability to activate muscles to a suitable degree and with appropriate timing so as to prevent a fall [19]. Almost all human movements involve these requirements to varying degrees [6]. Balance control is therefore an inherent part of most everyday activities.

When standing and walking, one of the greatest challenges is to shift and move the relatively high centre of gravity over the relatively small base of support (feet) in a controlled manner.

Limitations in our ability to balance have far-reaching consequences. Balance control correlates with independence, quality of life and self-efficacy [14,20].

Almost all neurological conditions have an impact on balance. That is why the training and improvement of balance are central goals in motor neurorehabilitation.



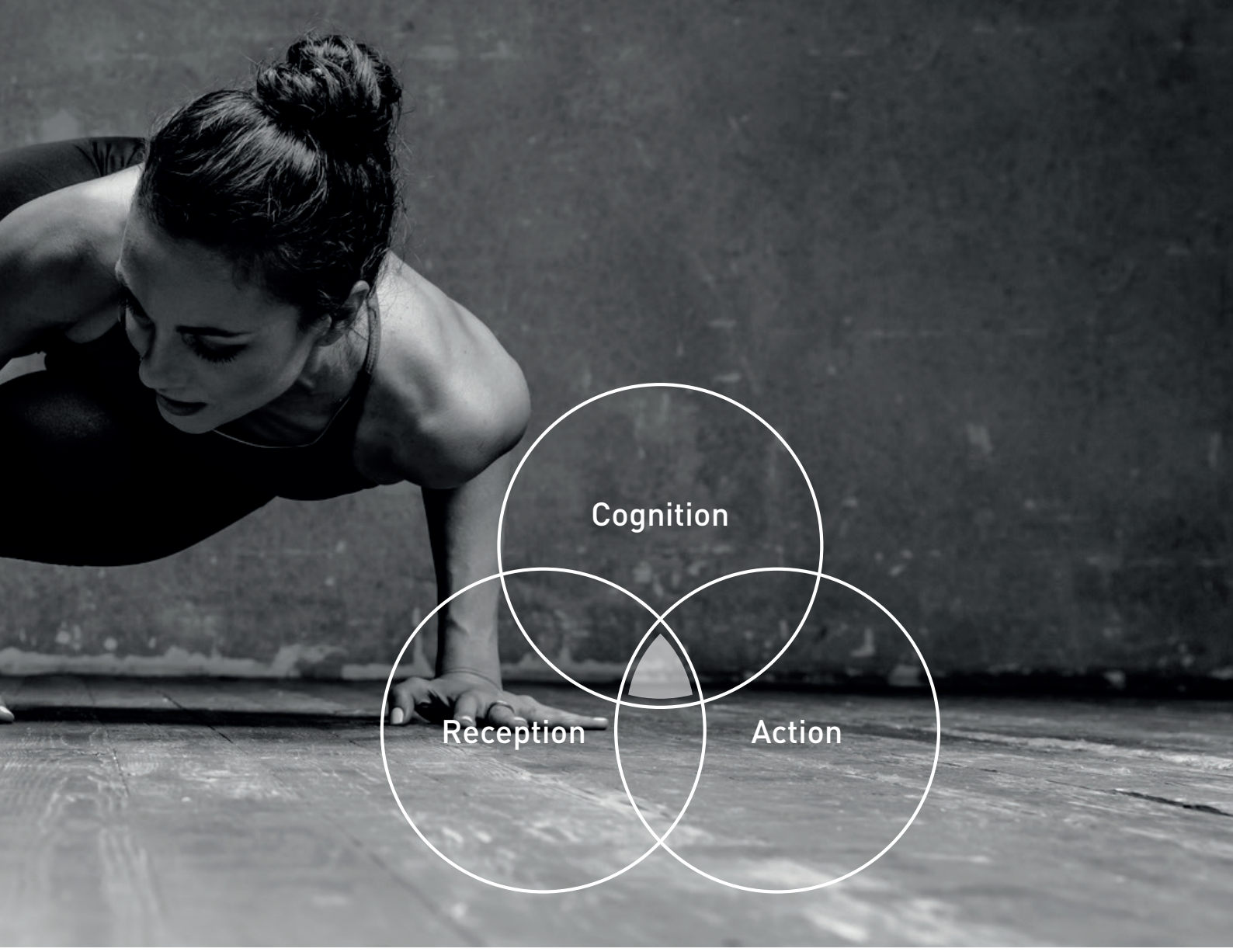
Postural control means to carry out "an action to maintain, attain or regain balance in any posture or activity"

Mixed messages? Balance, equilibrium or postural control?

Literature in the field usually uses the term "postural control" (PC). However, the terms "equilibrium" and "balance" are often used synonymously (and have been in this article as well). Balance is defined as the "ability of a person not to fall" [12]. Postural control goes far beyond this, meaning to carry out "an action to maintain, attain or regain balance in any posture or activity" [12]. According to Horak and Macpherson, two basic factors are key: postural stability (active stabilisation of the body's centre of gravity over the base of support by coordinating sensorimotor strategies) and postural orientation (often also referred to as postural alignment, i.e. actively maintaining the appropriate positioning of body parts in relation to the rest of the body and to the environment) [3,8].

Capturing complexity – Interaction between many parts

In order to be able to systematically map and analyse the complexity of postural control, many well-known researchers propose using a framework [4, 9, 15, 17, 18]. One of the most widely used framework models in the field is Shumway-Cook /



Woollacott [5]. This will be referred to below.

Interaction model – Different control mechanisms and task requirements

According to Shumway-Cook & Woollacott, postural control is the result of the interaction of the individual (person who is moving), the task (activity) being performed and the environment in which the activity takes place [17]. We will use the term "interaction model" below.

Three basic aspects are required from the

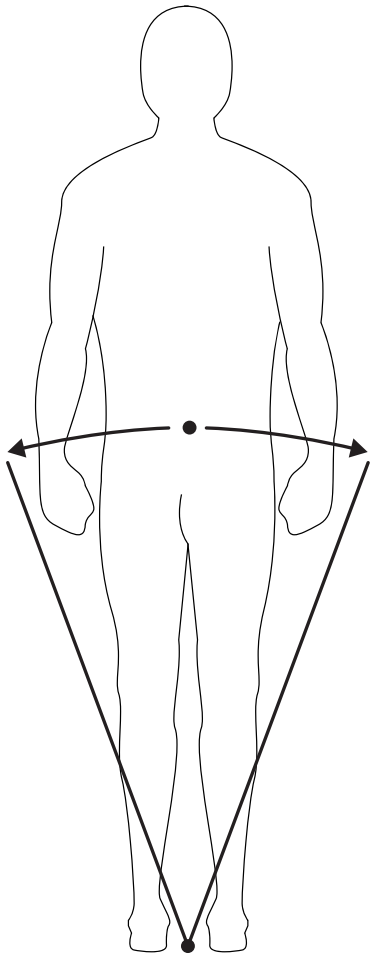
The **motor** aspects include the following parts [5]:

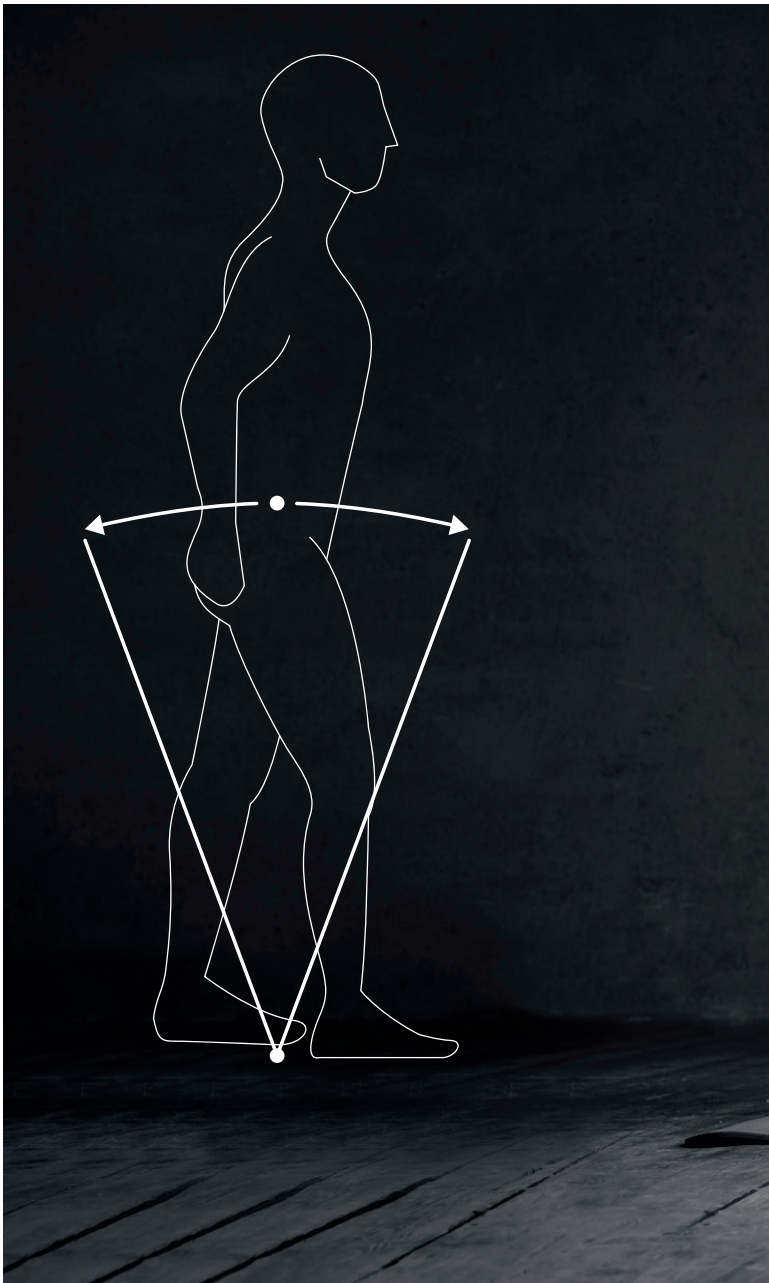
- Active upright standing against gravity
- Appropriate positioning of body parts in relation to the rest of the body and the environment
- Active control of the body's centre of gravity over the base of support by coordinating sensorimotor strategies (postural synergies) with internal and external influences

individual: motor skills (action), sensory function (perception) and cognition.

We will focus mainly on three types of postural synergies: the ankle and hip joint strategies and protective responses (walking or supporting). They are necessary both for anticipatory and reactive postural control [17]. The anticipatory adjustments are also referred to as "anticipatory postural adjustments" (APAs) [11]. They allow for postural adjustments before performing a focal movement, e.g. lifting an arm while standing (internal influence). The limb movement sets the centre of gravity in motion. This "disturbance" is calculated in advance and the appropriate muscles are activated to ensure postural control. A functioning ankle strategy is crucial for this to work. It defines the space in which the centre of gravity can be shifted while maintaining control with an upright posture (alignment). This potential movement space is called the "cone of stability" [16]. It defines the limits of stability when standing. All activities when standing (arm movements, weight transfers, etc.) take place in this movement space. The bigger it is, the better the balance.

The response to external, unpredictable influences is also important. In these situations, for example, the implementation of a fast protective step is very important (reactive postural control) [10].





Environmental and task-related influences

Since movements always take place in an environment, this aspect also significantly influences postural control. From a therapeutic point of view, the challenge is to assess which environmental factors are relevant and therefore to be given special consideration. For instance, the type of floor has a big impact on postural control. Different requirements arise when, for example, the floor is unstable or stable, flat or sloping, slippery or solid, etc. Distractions (other people), the use of aids (stick, walking frame) or lighting conditions can also have an impact.

The **sensory** aspects include the following parts [5]:

- Integration of sensory input from different information sources: Vision, balance organs and somatosensory (proprioception and surface sensitivity).
- Sensory weighting (depending on the situation, the CNS weights the sensory input differently. In a dark room, for example, the somatosensory input has to be given greater weighting than the visual input)
- Body schema (internal representation of the body)

The **cognitive** aspects include the following parts [5]:

- Dual or multiple task capability: In everyday life, we are required to adapt to a constantly changing environment [15]. To do so, we need to divide our attention. Part of our attention "stays" with the PC, another part is focused on the environment.
- Self-efficacy: Feeling capable of exercising control over actions makes us feel self-effective. The degree of self-efficacy we feel determines how we behave and how we assess situations and handle them [7].

The task can be structured in terms of postural control according to the following criteria: steady state (static), dynamic-anticipatory and dynamic-reactive [17]. These are known as "balance mechanisms". They can be used to indicate the very basic "nature" of the (balance) task. Other relevant aspects of the task include use of the upper limbs, change of position (turning while standing, standing up/sitting down), different types of walking including tasks that often lead to balance difficulties or even falls, such as the transition from sitting to standing, turning, walking [1,2,13].

Martin Huber is a physiotherapist, and in 2007 he gained his Master of Science in Neurorehabilitation. It was in 2012, in his article "Wissenschaft braucht Kutscher" ["Science needs people in the driving seat"] in the specialist magazine Physiopraxis, that he reported on the subject of "knowledge translation" in neurorehabilitation.

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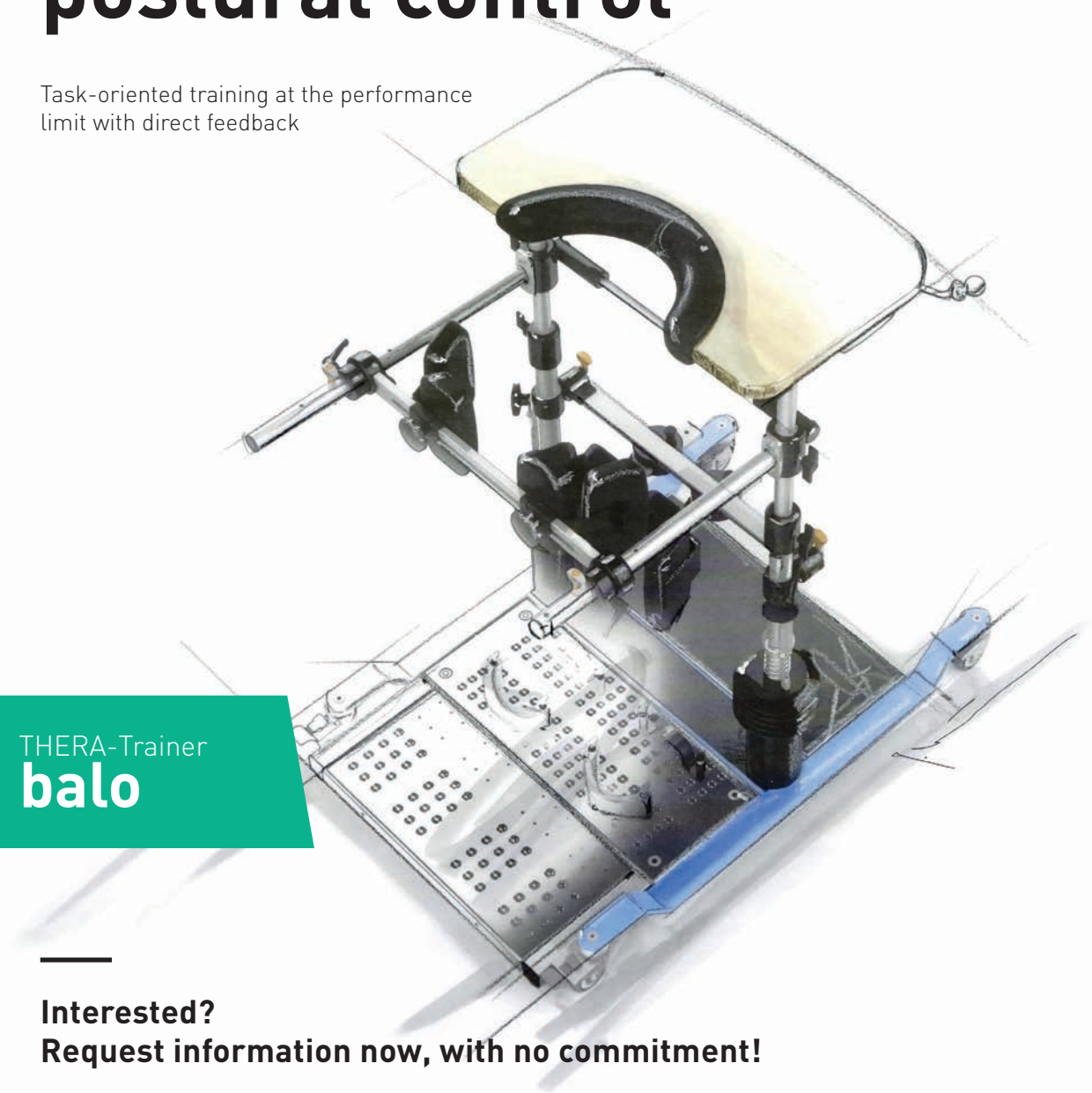

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TECHNOLOGY & DEVELOPMENT

Training in virtual worlds improves balance ability

The motor limitations caused by a stroke often lead to impaired balance and equilibrium. These postural control disorders reduce the quality of life of those affected and in many cases increase the risk of falling.

The results of some studies have already suggested in the past that using virtual reality can improve the ability to balance of those affected, and that the training effects lead to better results compared with conventional training methods.

An overview of the current research is provided by a review by Ling Chen and his research group from the Department of Rehabilitation Medicine at the Guangdong Engineering and Technology Research Centre for Rehabilitation Medicine and Translation.

Overall, the researchers included nine studies from 2006 to 2015, in which stroke patients, divided into control and intervention groups, sought to improve their static and dynamic balance with conventional therapies or modern training methods using virtual reality.

To measure the improvements, common assessments such as the Berg Balance Scale and the

Timed Up and Go-Test were used.

The results show that in eight of the nine studies patients in the intervention groups showed considerably greater improvements than those in the control groups. The authors talk about moderate evidence and describe virtual reality training as a useful addition to conventional rehabilitation programmes to improve the balance of patients after a stroke.VR can be described as a system of hardware and software that can be used to display a computer-generated environment in real time. Using interactive devices and three-dimensional displays, the viewer completely immerses themselves in a different (virtual) world, with which they can interact, for example, through hand or head movements. Virtual reality is thus a simulation that, in the best case, can no longer be distinguished from reality for the viewer.

It should be noted that virtual reality was used in the study as a very elastic term. In addition to professional VR solutions, the studies also used classic game consoles such as Nintendo Wii, Playstation, etc. which strictly speaking do not meet the definition criteria of virtual reality.

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Ling Chen, Wai Leung Ambrose Lo, Yu Rong Mao, et al., "Effect of virtual reality on postural and balance control in patients with stroke: A systematic literature review," BioMed Research International, vol. 2016, Article ID 7309272, 8 pages, 2016. doi:10.1155/2016/7309272

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Key definition: Virtual rehabilitation

refers to the use of virtual reality for the treatment of neurological and neurophysiological diseases and disorders, among other things. The therapy is partly or fully supported by the use of the technology.

The term "virtual rehabilitation" was coined in 2002 at the first workshop on the topic "Virtual Reality Rehabilitation (Mental Health, Neurological, Physical, Vocational) VRMHR 2002" in Lausanne, Switzerland. Since then, relevant research from the participating fields has been consolidated under this keyword. In 2008, the International Society for Virtual Rehabilitation was founded.

Virtual rehabilitation provides a number of benefits over traditional therapy:

- Increased motivation of patients to cooperate
- Automatic recording and evaluation of therapy data
- Opportunity to offer home-based therapy or teletherapy, in which part of the therapy takes place with patients and therapists being separated by geography and/or time - Potential to develop novel forms of therapy, which would be unthinkable without the use of technology.

However, the benefits of the technology for physiotherapy and occupational therapy have so far been documented mainly in the form of case studies. Its use also has disadvantages and involves certain risks. Immersion in VR, for example, can lead to temporary illnesses similar to seasickness, also referred to as VR sickness or simulator sickness. In addition, using it on patients with impaired perception should be deemed to be questionable.

Fitness and exergames as well as other computer-based training and therapy methods are frequently subsumed under the term of virtual rehabilitation in daily usage. However, this is not formally correct, so when using the term it is important to clarify which technologies and application scenarios are actually meant.

Part 1

Multiple sclerosis – a disease with 1,000 faces

Motor therapy for multiple sclerosis

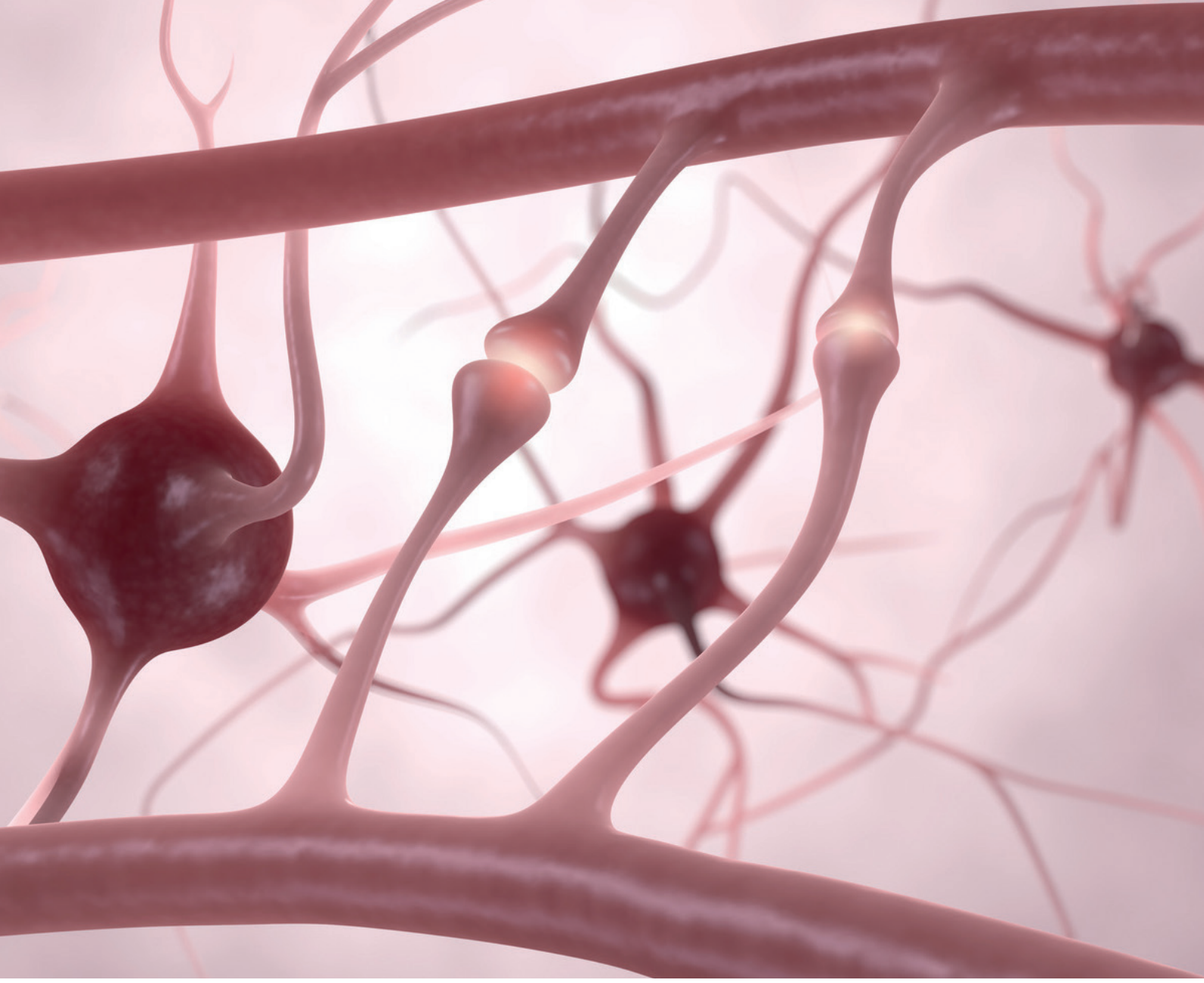
The first part of the expert report by physiotherapist and neurorehabilitation expert Sabine Lamprecht deals with the topic of "Paresis in Multiple Sclerosis".

By Sabine Lamprecht

Treating MS patients is a big challenge for any therapist. The various neurological symptoms and their individual severity and distribution give rise to a very complex clinical picture that cannot be equated with other neurological clinical pictures.

MS is the most common neurological disorder in young adults and the most common cause of disability for young people. The disease peak is just 25 years old. New insights into the clinical picture make physiotherapy and occupational therapy even more important than before. These days, improved diagnostics mean that the disease can be diagnosed very early on, often after the first neurological symptom. The diagnostic procedure consists of a clinical examination of the symptoms, an examination of the evoked potentials (i.e. measurement of the central nerve conduction velocity) and if necessary a CSF examination. The most important diagnostic tool for MS is MRI. Evidence of a dissemination of symptoms – in other words, very different points in the central nervous system (CNS) are affected – is a direct

MS is the most common neurological disorder in young adults



indication of MS.

In recent years, not only has diagnosis improved, but a lot has also been done in causal MS therapy in terms of medication. Nevertheless, the following still applies: The earlier the diagnosis is made and causal drug therapy is started, the better the success of therapies. The variety of therapies is very broad and targeted medical intervention is possible, especially with relapsing-remitting MS, while causal medication often struggles to counter the often creeping chronic deterioration.

Therapy is essential at every stage of MS. Time and again it is shown that with targeted physiotherapy, occupational therapy, and certainly speech therapy, great success can be achieved. The effectiveness of weight training [3], balance training [5,6], training on movement exercisers [1] and treadmill training [10, 12] is just as proven for MS patients as the effectiveness of group therapies [11].

Specific MS therapy

MS has its own pathophysiology, which differs from other neurological diseases. This requires a disease and symptom-specific approach to motor MS therapy. The very different progression of the disease, the wide range of symptoms and not least the necessary interdisciplinary approach make treating MS a major challenge.

Symptoms at the start of the disease				
	(1) %	**(2)** %	**(3)** %	**(4)** %
Somatosensory disorder	41.3	42	40	33
Vision disorders (reduction in vision + dysmotility)	36.9	33	34	30
Gait disturbances	31.8			18
Paresis	23.4	44	39	approx. 16
Dizziness	8.0		5	
Sphincter disturbances	5.5	9	5	
Fine motor skills disorders	3.9			
Fatigue	1.6			
Epileptic seizures	0.7			
Psychological disorders	0.6	4		

(1) Beer and Kesselring (1988), N= 688 **| (2)** Poser S (1986), N= 3248
(3) Matthews (1985) **| (4)** Paty and Poser (1984), N= 461

The disease often begins in episodes, with the patient affected by only one or a wide range of symptoms. Initial episodes often present themselves as visual and somatosensory disorders or muscle weaknesses.

After an initial episode, the symptoms can completely regress and sufferers can go years without any problems. [Kesselring 2010]. Irregular episodes usually pass into what is known as secondary progressive MS after years and develop into a gradual worsening of the symptoms. The main motor symptoms of MS are:

- Paresis/weaknesses
- Motor and cognitive fatigue
- Spasticity – usually combined with paresis
- Ataxia – often combined with cognitive symptoms

In addition, somatosensory disorders, bladder problems, cognitive deficits and mental health problems (especially depression) often occur. [7]

Findings and therapeutic approaches to paresis

According to one study, paresis is an early symptom of MS in up to 44 percent of patients. It is therefore more common than somatosensory disorders (about 42 percent) and the most disabling symptom in terms of function. As the disease progresses, paresis is usually associated with compensatory spasticity and thus often leads to therapists and doctors being more likely to focus on spasticity. Therapists are able to proceed effectively and specifically against weakness and achieve good functional improvements.

At the onset of the disease, the dorsal flexors are primarily affected, later hip flexors and abdominal muscles are impacted; weaknesses in the quadriceps muscle and the calf muscles are also frequently found and are especially noticeable when walking [9]. This functional chain leads to a common MS-specific problem while walking.

Functional connections when walking

MS patients often say they stumble when walking and their toes get stuck. Particularly weak muscles react in the short term with a significant deterioration in their strength and endurance performance. In contrast to stroke patients, MS patients usually demonstrate no circumduction, as the calf is less spastic and therefore the foot is not so heavily plantarflexed. Since a weakness in foot dorsiflexion cannot be compensated for by increased leg lift, many MS patients complain

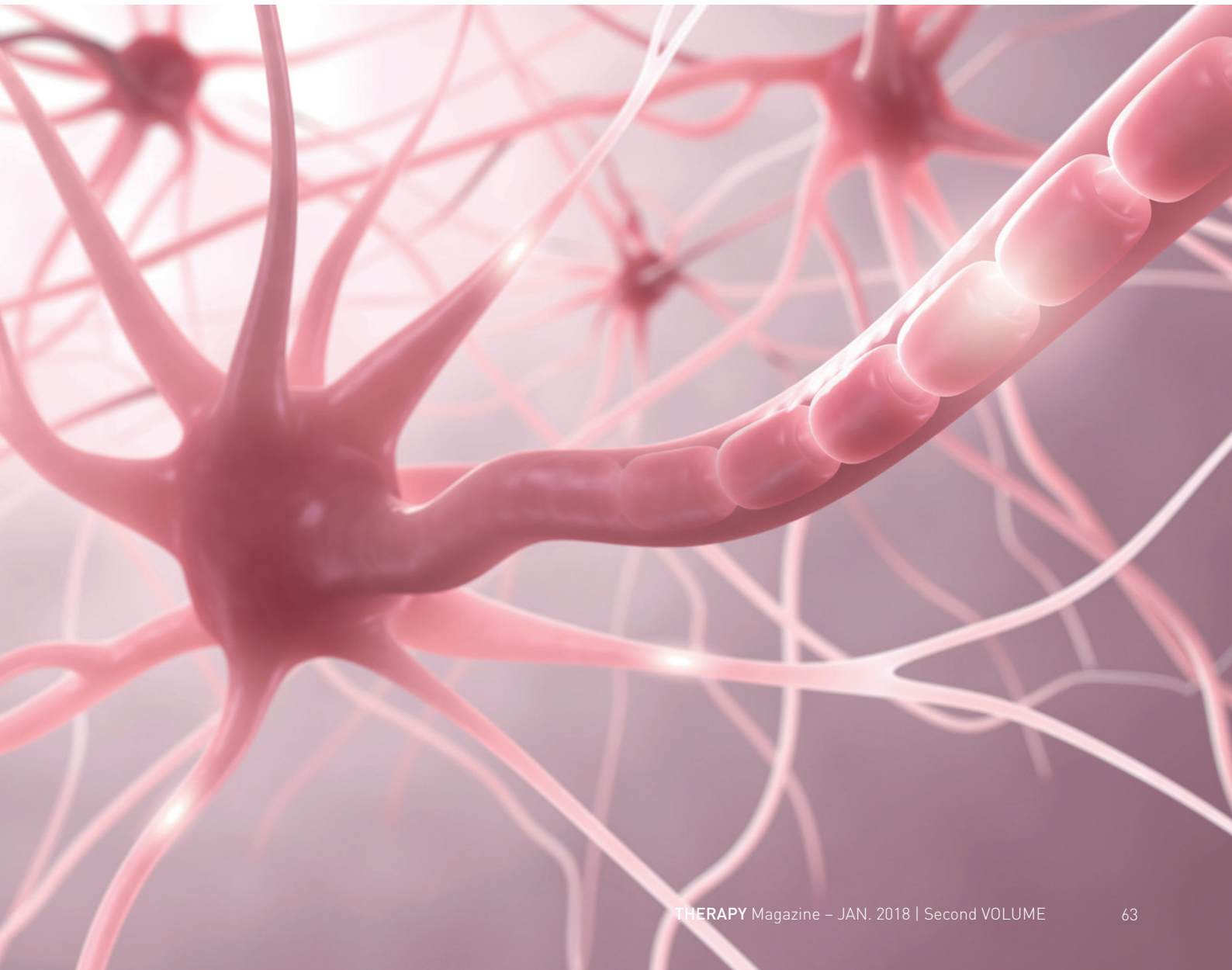
of difficulties in bringing the leg forward while walking; it "sticks" to the floor. This is illustrated in a gait analysis, where sufferers have difficulty with the non-supporting leg phase and use a stick on the weaker side to bring the affected leg forward.

Fatally, combined with an increase in reflex activity, this often leads doctors to conclude that the reason for the problems is too high a tone (= spasticity). Paresis is therefore not looked into and, in the worst case, antispasmodics are prescribed which make paresis worse.

The dorsal flexor

Dorsal flexors are not strength muscles, but must work constantly when walking. We therefore need to look at the power of the muscles in connection with their function. Because endurance is severely impaired by motor fatigue with MS, it is recommended to first tire out the dorsal flexors in addition to a standard muscle function test, and then test them again. In practice, this has involved knocking the forefoot on the ground with about twenty repetitions and then another strength test. We then see the typical weaknesses that would not be found with a single test. This strength endurance deficit causes patients to avoid longer stretches of walking at the beginning of the illness, which in turn further worsens endurance performance. This vicious cycle can be broken by consistently using interval training for walking distances and specifically strengthening the affected muscles in parallel.

The evidence of weight training for MS is well established in studies [2,3,4]. The dorsal flexor can be trained by repeatedly tapping the forefoot on the floor (effective therapy intensity from about



100 repetitions per day). Furthermore, the dorsal flexor is activated, especially when functionally walking uphill.

Aids for the dorsal flexor can and should also be used early on. A small increase in the heel with a sliding insole tip, a Redredyn orthosis and, in case

Each step activates and strengthens the muscle chains

of severe weakness combined with a spastic calf, also a toe-off orthosis have all been proven to help. The more frequently used dorsal flexor systems with functional electrostimulation are also certainly a very effective aid for MS. It is important that the device is light, so that the patient is not forced to carry extra weight with each step.

Every step – including walking with appropriate aids – functionally activates and strengthens the crucial muscle chains, including the torso.

The hip flexor

The slower a person walks, the more balance and strength they need. Because MS patients have a much slower pace compared to healthy individuals, they need more activity and strength in their hip flexors. However, these flexors often show early signs of weaknesses as well and therefore also need to be trained for endurance. Here too, targeted strength training of the hip flexor and the entire ventral chain helps, whether with traction devices, Thera bands or by walking uphill, climbing stairs, etc.

Other specific weaknesses

The quadriceps muscle must be able to hold our entire body weight on one leg while walking. A weakness in the quadriceps is often compensated for by hyperextension in the knee. Its functional activity should be tested, for example, with knee bends on one leg with a straight upper body,

and then it needs to be trained for strength with an effective training stimulus. The goal is for the patient to repeatedly support their body weight on one leg. If the leg axis cannot be maintained, it is advisable to repetitively train individual movement sections on the climbing wall. Here we mean pushing up the body weight and eccentric easing with one leg.

The calf muscles should also be strengthened, as the calf on each leg must bring the entire body weight forward as quickly as possible. Here, training needs to focus on strength and elasticity. The calf muscles can be tested by checking that the patient is capable of standing on tip toes on one leg. Again, both test and training must focus on frequent repetitions. The patient can work on their strength endurance and elasticity by jumping, skipping or standing on tip toes on one leg.

Upper limbs

The upper limbs are usually less affected in MS patients. In the advanced stages of the disease, however, arm/hand paresis can occur. The tone increase is very moderate in the upper limbs. Here, too, paresis is the most common functional problem besides somatosensory disorders. The small hand muscles in particular are often weak very early on, which is reflected in problems with fine motor skills. This can be counteracted with daily training involving repetitive endurance exercises and strength exercises, such as frequent training with heavy Baoding balls or clothes pegs. In addition, proximal muscle weaknesses and shoulder muscle weaknesses are possible, which often result from a weakness of the rotator cuff in MS patients, which leads to insufficient guidance of the humeral head. Therefore, it is important to train the shoulder muscles in closed chains, as is the case with all support activities and many training devices.

Specific training with an active-passive movement trainer for MS patients with paresis

Training with an active-passive movement exerciser such as the THERA-Trainer tigo specifically works the dorsal flexor, hip flexor and quadriceps with the active pedalling of both legs, and is therefore specific, meaningful training for people with MS in all stages of the disease, not only for contracture prophylaxis and reduced spasticity.

Appropriate resistances must be set in order to train weak muscles. To improve endurance, the patient must walk until they have muscular fatigue and then, after short breaks (often three to five minutes is enough) continue with the training process, as interval training. Here the emphasis is on strength endurance training.

Rest often means a steady decline in functions.

Regular training with the THERA-Trainer tigo is also available to train proximal strength endurance and thus also the shoulder muscles and the connection to the core muscles. One advantage of training with the THERA-Trainer tigo is that the training stimulus at home can be set sufficiently

high and frequently, since it makes perfect sense to train daily – or even better, three times a day. The lower the endurance per training session, the more often training should take place with lower training stimulus.

Gait rehabilitation

The most important qualities of walking are endurance and speed. While walking endurance is improved by targeted interval training, speed should be specifically targeted with speed training on treadmills, for example. If there is no treadmill, patients should repeatedly walk short distances as fast as possible. If a gait trainer like the THERA-Trainer e-go is available, they can also practise walking on the floor.

Summary

Paresis is functionally the most debilitating symptom for people with MS. In combination with exertional motor fatigue and the Uhthoff phenomenon, it is the cause of a widespread error in treatment: both MS sufferers and many therapists want to avoid exertion – and rest when action is urgently needed. However, this rest often means a steady decline in functions for those affected by MS. If they actively train at all, then usually it is with too little training stimulus and no long-term training development plan. However, training can restore lost functions and lead to amazing functional improvements in strength, endurance and balance. [8]

The implications for therapy are that MS patients should train specifically and permanently with an effective training stimulus and a high number of repetitions, and should not be afraid of overdoing it. Effort does not trigger episodes – a temporary worsening of symptoms is a sign of MS-specific pathophysiology and no reason to reduce regular training!

Since MS patients are often still young, the cardiovascular issue is less of a concern.

Preview of the next part

In the next part of our series you can read more about fatigue and the Uhthoff phenomenon. We will also be discussing tests and treatments for spasticity in multiple sclerosis.

Sabine Lambrecht passed her physiotherapy exam in Berlin in 1982. Since then she has completed various advanced training programmes. In 2006 she gained her Master of Science in Neurorehabilitation at Danube University Krems, Austria. From 1983 she worked as a senior physiotherapist at Christophsbad Neurological Clinic, where she helped to establish the Physiotherapeutic Department. In 1987 she opened her own practice with her husband. She was a lecturer at the University of Applied Sciences in Heidelberg and is now a lecturer at Dresden International University in Fellbach.

Next part in issue 2 | 2018

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A self-test for "those affected"

Scientific findings and research suggest that physiotherapeutic interventions in the context of neurorehabilitation should be evidence-based. Traditional treatment methods such as Bobath, Vojta, etc. are becoming more and more obsolete, as knowledge of the brain's ability to reorganise requires measures that follow the principles of motor learning. The future lies in task-oriented practice with as many repetitions as possible and training at the individual performance limit of a patient. This means change and calls for a break with old, to some extent cherished habits.

Take the test and find out where you stand! Are you already working based on the evidence? Or do you still prefer to use traditional treatment methods?

In treatment, I think it's important that...

1. ... my patients practise as intensively as possible the things they want to be able to do again.

☐ a) Yes, patients should intensively practise the things they should be able to do again!

☐ b) No, as a therapist, I know best what is good for my patient.

2. ... my patients take as many breaks as possible between exercises.

☐ a) Yes, because they still need strength for other treatments in the day.

☐ b) No, they should take a break after intensive therapy, when they are exhausted.

3. ... patients practise walking functionally after a stroke.

☐ a) Yes, walking is learnt by walking. Walking training is therefore paramount!

☐ b) No, walking is not just learnt by walking. Patients usually need very individual exercises on the therapy bench to optimally prepare them for walking.

4. ... exercises are performed with many repetitions.

☐ a) Yes, many repetitions are very important in neurorehabilitation!

☐ b) No, the quality of a movement, for example, is much more important than the number of repetitions!

5. ... patients are trained together in a group.

☐ a) Yes, group therapy is very effective and usually encourages patients and motivates them!

☐ b) No, group therapy is economical, but less effective than individual therapy!

6. ... patients regularly do the exercises themselves (self-training) to increase the therapy dose.

☐ a) Yes, the regular treatment time is usually not enough. Self-training is extremely important!

☐ b) No, the regular treatment times are sufficient. Self-training is not required!

7. ... I regularly check my treatment methods for efficacy.

☐ a) Yes, I mainly use standardised assessments to show progress to the patient as well.

☐ b) No, I know that what I do is effective. As an expert, I can recognise progress even without measuring instruments.

8. ... my patients follow my instructions exactly and do not develop their own solution strategies.

☐ a) Yes, this is very important because otherwise patients tend to do movements incorrectly!

☐ b) No, it is actually a real advantage if patients start to develop their own solution strategies!

Correct answers: 1 = a); 2 = b); 3 = a); 4 = a); 5 = a); 6 = a); 7 = a); 8 = b)

1-2 right = Engage more with evidence-based methods!

3-4 right = You are on the right path, stay with it!

5-6 right = Not bad, you're doing a lot right!

7-8 right = Great, you're a specialist in your field!

Giving up is not the answer

Marcus Kriegel is 42 years old. A snowboarding accident has left him paralysed and in a wheelchair. He has no control over his body from the fourth cervical vertebra down. His body is at the stage of an eight-month-old child.

Katarzyna Kosiedowska, physiotherapist at NRK Aachen Rehabilitation Centre, is optimistic: "Marcus is very motivated, he is fighting and has therefore made great progress in a short space of time." Marcus will be going to the Rehabilitation Centre for outpatient rehabilitation for a total of two months. There the training takes him to his physical limits: he cannot walk on his own, but is put in the end-effector gait trainer for therapy. This has a positive effect on his organism and Marcus is thrilled. "Circulation is stimulated, spasticity is reduced, the organs are once again where they belong."

"It's a very nice feeling"

Walking upright with the help of the THERA-Trainer lyra helps him on a psychological level, too. "It's nice to be at the right height again," he says happily. What is especially remarkable is the fact that Marcus has been an amateur DJ for a long time and has already DJed again at a festival since his accident. "It took me back to normality for a bit, to my life before the accident," he says. "It's great when you realise that people don't care whether you're standing or sitting in a wheelchair."

Rehabilitation days in the clinic are exhausting. Nevertheless, Marcus continues to fight because: "Giving up is not an option."

This may be the key to success – he can now sit unsupported for short periods of time.

The report on Marcus Kriegel and his rehab at NRK Aachen Rehabilitation Centre is available online in the WDR media library.

SOURCE

Report by WDR Fernsehen TV channel, programme "Lokalzeit aus Aachen – Zurück ins Leben" [Local news from Aachen – Back to life]. The video can be found at: www1.wdr.de/mediathek/video

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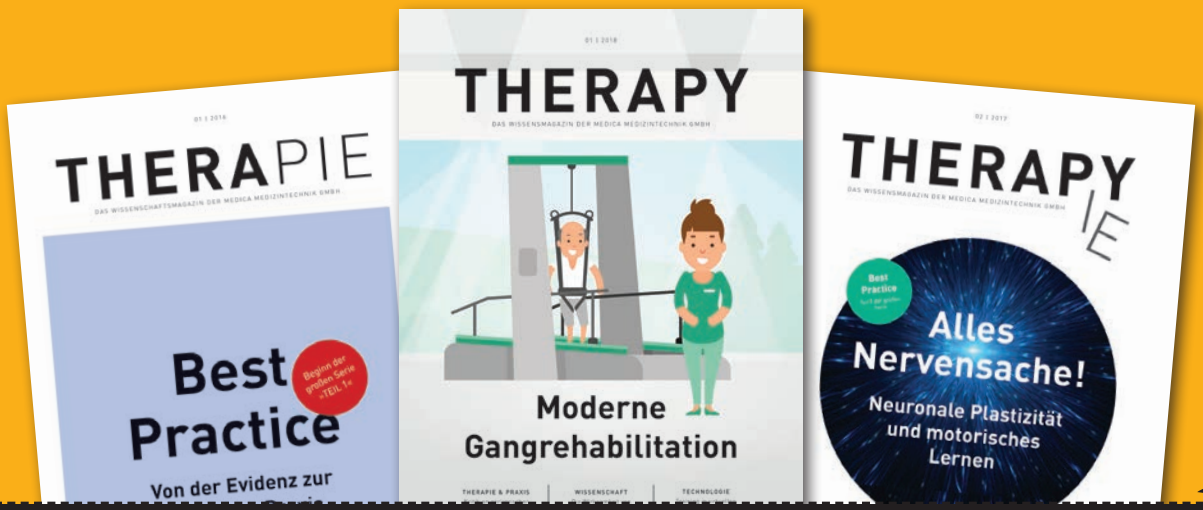

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