

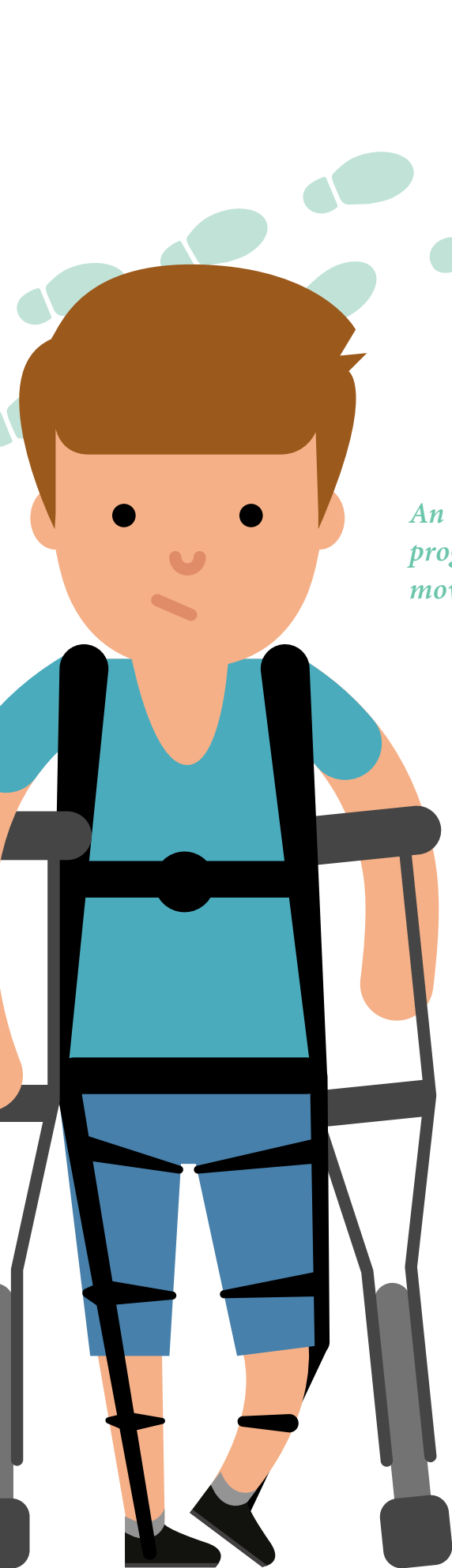
One in every five to seven walking impairments can be prevented by using robot-assisted gait therapy in the early stages following a stroke

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

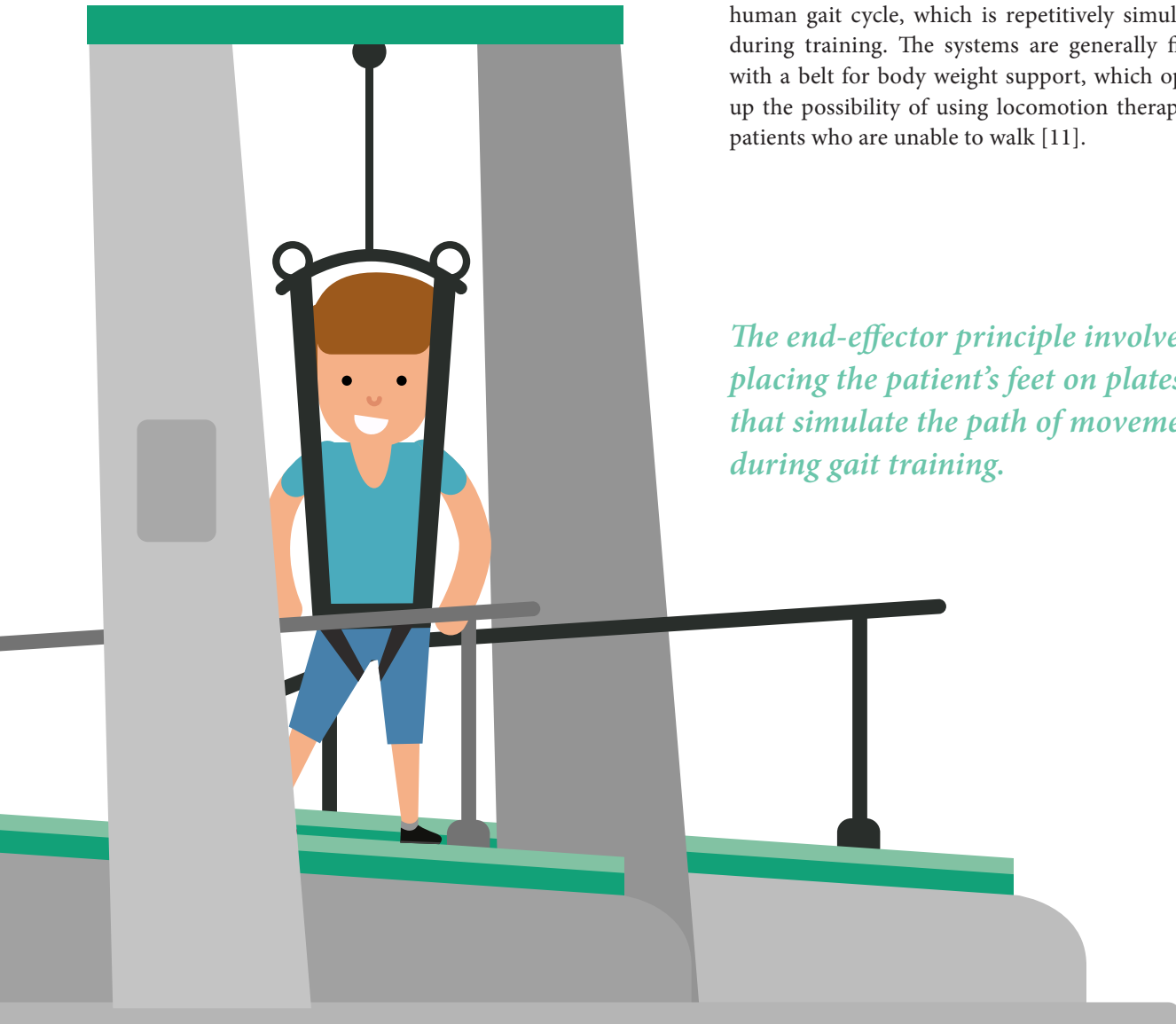
In rehabilitation, practising walking on a repetitive basis comes under the umbrella term locomotion therapy [10]. Locomotion is the "active movement of an individual from place to place powered by the rhythmic movement of the limbs" [10]. Initial attempts at walking should be undertaken as soon as patients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