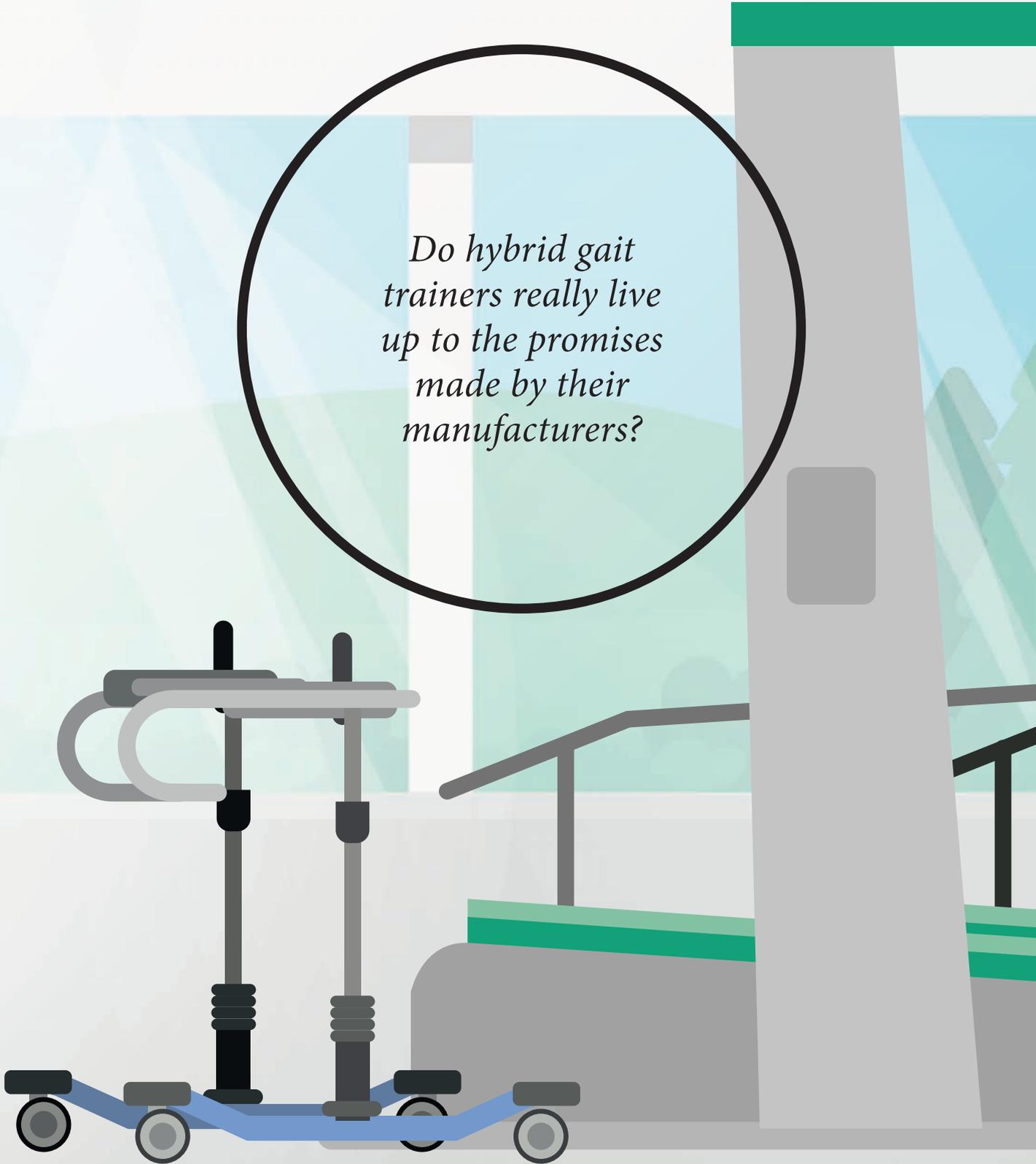


# Putting hybrid gait trainers to the test

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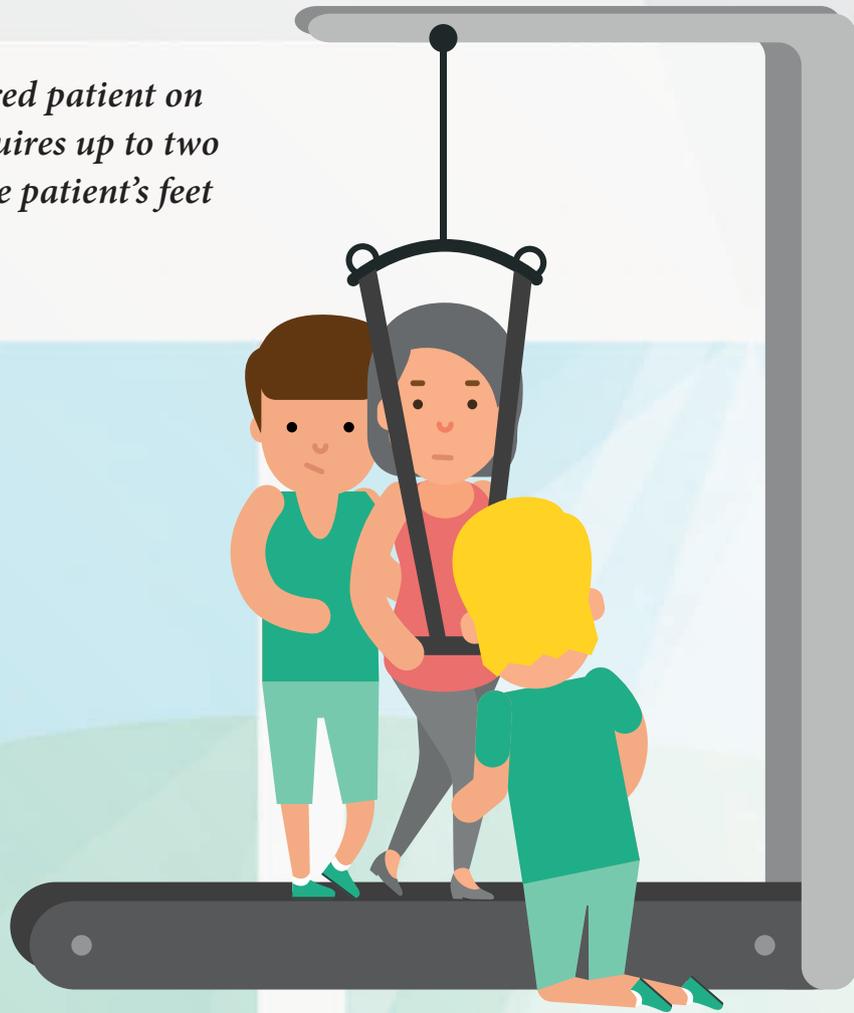
Based on current evidence, the recovery of walking ability is best practised by walking, and this includes training on the ground. However, training cannot be carried out using a robot-assisted gait trainer. Therefore, in order to enable patients to train walking under conditions that reflect everyday 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].

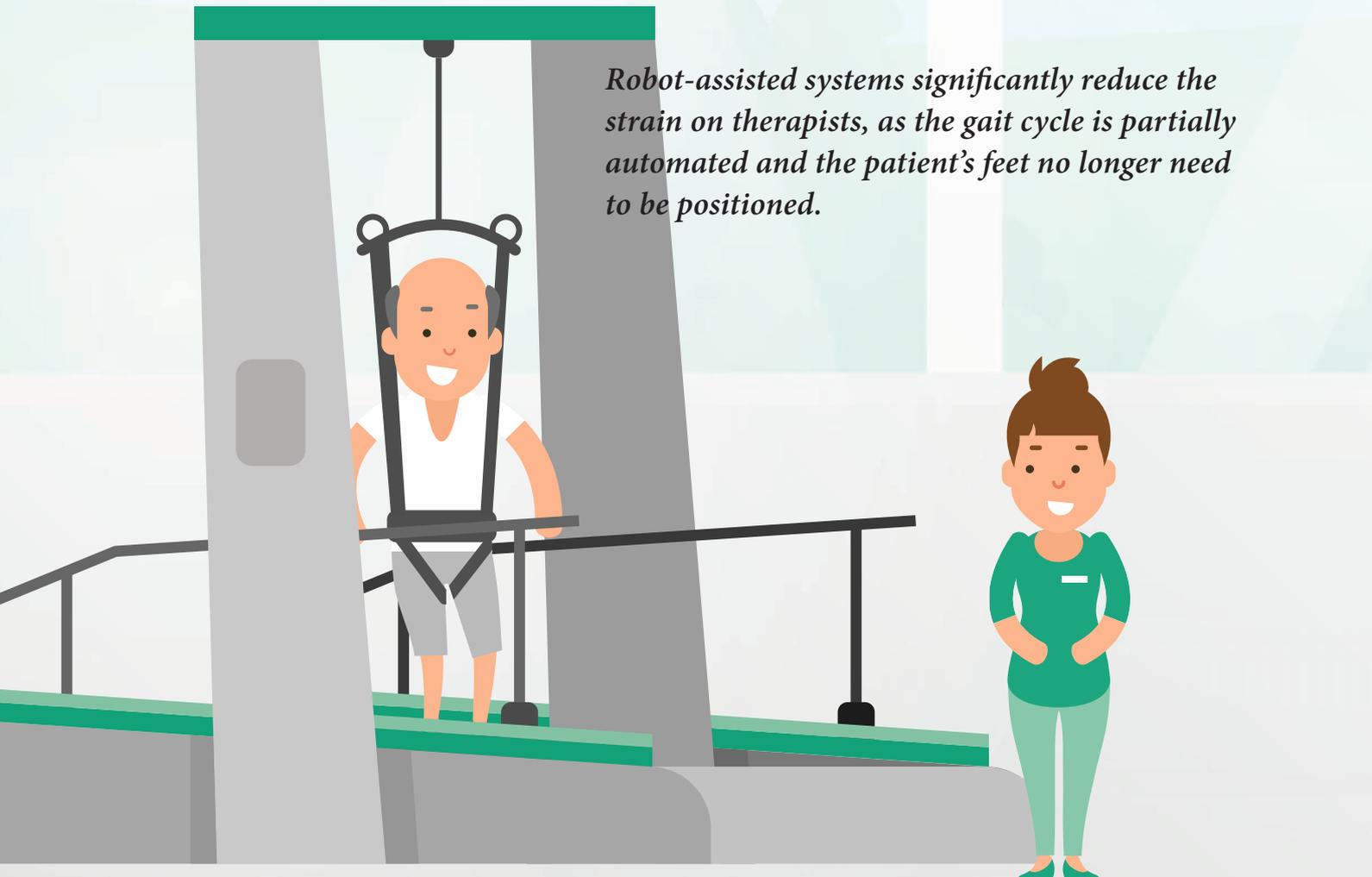
Since the introduction of robot-assisted therapy around ten years ago, electromechanical gait trainers have been used increasingly in the early phases of rehabilitation. To an extent, they have revolutionised locomotion therapy [4]. The precursor to such devices was the treadmill with partial body weight 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.*



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

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

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

*Mobile exoskeletons have been setting the trend for some years.*

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

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.

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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