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REVIEW ARTICLE

Gait rehabilitation after stroke: review of the evidence of predictors, clinical outcomes and timing for interventions

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Abstract
The recovery of walking capacity is one of the main aims in stroke rehabilitation. Being able to predict if and when a patient is going to walk after stroke is of major interest in terms of management of the patients and their family's expectations and in terms of discharge destination and timing previsions. This article reviews the recent literature regarding the predictive factors for gait recovery and the best recommendations in terms of gait rehabilitation in stroke patients. Trunk control and lower limb motor control (e.g. hip extensor muscle force) seem to be the best predictors of gait recovery as shown by the TWIST algorithm, which is a simple tool that can be applied in clinical practice at 1 week post-stroke. In terms of walking performance, the 6-min walking test is the best predictor of community ambulation. Various techniques are available for gait rehabilitation, including treadmill training with or without body weight support, robotic-assisted therapy, virtual reality, circuit class training and self-rehabilitation programmes. These techniques should be applied at specific timing during post-stroke rehabilitation, according to patient's functional status.

Keywords Stroke · Gait rehabilitation · Prognosis · Recovery of function

Introduction

In Europe, stroke affects 600 thousand people each year, with an overall prevalence of 3.7 million people [1]. Initially, one of two stroke victims will be unable to walk [2]. Although 80% of them will recover independent walking at the chronic stage, 50% (of the overall prevalence), will do so with some level of impairment [2]. Only 30–50% of stroke victims are capable of community ambulation, an important indicator of the activities and participation domains of the International Classification of Functioning, Disability and Health (ICF) [3, 4].

Independent walking is an important indicator of overall autonomy and quality of life and one of the main goals in stroke rehabilitation [5, 6]. Not only does it determine the level of independence in daily living, but it also influences overall health. Motor capacity is defined as what a person can do in a standardised, controlled environment and motor performance as what a person actually does in his/her daily environment [7]. The ICF model has distinguished the qualifiers 'capacity' and 'performance' for every activity and participation domain [7]. Walking capacity can be assessed by measures, like the Functional Ambulation Category (FAC) that evaluates how much human support is needed by a patient, regardless of the need of assistive devices. It is an ordinal scale, scoring from 0 to 5, and relates to the activities domain of the ICF. Walking performance relates to the activities and participation domains and environmental factors of the ICF model and has been largely studied [4, 8]. Various factors influence walking performance, such as gait speed and gait distance.

Being able to predict whether and when a patient will be able to walk, is of great interest when it comes to managing patient and families expectations. It is also important when planning an inpatient rehabilitation programme and its duration. Thus, gait recovery prediction can influence decisions regarding rehabilitation stay and discharge destination [9].

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The aim of this narrative review was to synthesise the evidence for the best predictive factors of walking recovery after stroke and for the best rehabilitation techniques to date at each post-stroke rehabilitation phase in order to present a state-of-the-art summary to clinicians in the neurorehabilitation field.

Methods

The most recent clinical guidelines on stroke rehabilitation were first searched and examined. Subsequently, a search of the databases PubMED, Embase and Cochrane was performed, using the following key words: 'stroke', 'gait rehabilitation', 'walking rehabilitation' and 'prognosis'. Only articles published between the latest guideline's publication dates and now were examined. Lastly, only systematic reviews and randomised controlled trials were considered. For the second objective of this review, the focus was put on rehabilitation techniques; thus, pharmacological and neuromodulatory techniques were not included. Kinematic and energy consumption variables, as obtained by quantified gait analysis, were not addressed in this article.

Results

The results were based on the two most relevant guidelines, which are the ones published by the Royal Dutch Society for Physical Therapy (KNGF) and the American Heart Association (AHA), published in 2014 and 2016, respectively [6, 10]. This has been acknowledged by numerous authors, and is summarised in an article by Platz et al. published in 2019 [11]. These guidelines provide a framework for stroke rehabilitation and we updated their recommendations with the most relevant recent literature.

Four phases are currently described in post-stroke rehabilitation: the hyper-acute phase, regarding the first 48 h; the early rehabilitation phase, from 48 h to 3 months; the late rehabilitation phase, from 3 to 6 months; and the chronic phase, after 6 months [6]. Recommendations in rehabilitation vary according to each phase [6, 10].

Predictive factors of gait

Independent gait recovery (walking capacity)

Numerous authors have identified factors that when present within the first 2 weeks post-stroke, predict better walking outcomes, such as younger age, less lower limb motor impairment, less sensory loss, absence of hemianopia, better sitting balance and trunk control [12, 13]. They suggest that a multimodal approach should be prioritized, including clinical assessment scales, neurophysiological assessments and neuroimaging techniques [14].

According to the KNGF guidelines, the chances of regaining independent walking ability at 6 months post-stroke can be predicted by evaluating sitting balance and leg function within 1–2 weeks post stroke. Indeed, a score of 25 points on the sitting balance item of the trunk control test (TCT) and a motricity index ≥ 25 points or a score of ≥ 19 on the motor part of the Fugl-Meyer (FM) assessment for the lower extremity are required in order to regain independent walking (Level 1) [6]. Other determinants are initially reasonable ADL skills, younger age, absence of homonymous hemianopia, urinary continence and absence of premorbid limitations of walking ability and ADLs [6].

A recent study (2017) by Smith et al. evaluated the influence of clinical assessment, transcranial magnetic stimulation (TMS) and magnetic resonance imaging (MRI) as potential predictive factors of gait recovery. They included 41 patients in their prospective cohort study and concluded that the only predictive factors of gait recovery were trunk control and hip extension strength [9]. They developed the TWIST algorithm to predict independent walking at 3 months post-stroke (Fig. 1). The latter includes TCT results and hip extensor muscle strength one week after stroke and is able to predict independent walking at 6 and 12 weeks post-stroke, as measured by the FAC scale. FAC scores of 1–3 indicate the need of some level of assistance

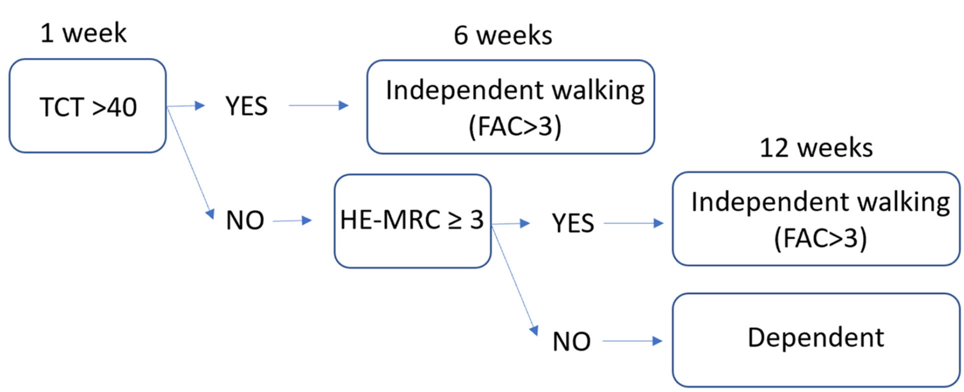

Fig. 1 The TWIST algorithm, by Smith et al. [9], *TCT* trunk control test, *FAC* functional ambulation category, *HE-MRC* hip-extension-Medical Research Council

by at least one person in order to walk. A score of 4 indicates the ability to walk indoors without assistance or supervision and a score of 5 indicates total independence in gait. The authors considered independent gait for FAC scores 4 and 5. The TCT evaluates four axial movements: rolling both sides, sitting up and sitting on the edge of the table with feet off the ground for 30 s. A score of 0 indicates that the patient is unable to perform the task without assistance; a score of 12, that task is performed in an abnormal way; and a score of 25, correct performance. The total score is obtained by the addition of these 4 sub-scores (0–100) [15]: Patients who score > 40 at the TCT at 1 week post-stroke should recover independent gait by 6 weeks post-stroke (sensitivity = 100% and specificity = 91%). Patients who score < 40 at the TCT and present a hip extension MRC grade ≥ 3 should recover independent walking by 12 weeks post-stroke (sensitivity = 80% and specificity = 100%). Those who present a hip extension MRC grade < 3 will probably be dependent in walking (sensitivity = 93% and specificity = 100%) [9].

The TWIST algorithm is, to our knowledge, the only published predicting algorithm for gait recovery after stroke. Although promising, its validation warrants further studies on a greater number of subjects.

In previous studies, TMS and MRI techniques were found to be strong predictors of upper limb recovery post-stroke; however, in this study, they were not found to be good predictors for walking recovery [9, 14]. The authors nuance these results explaining that lower limb's motor control is characterised by bilateral and alternative descending pathways, which contribute to motor redundancy. Other pathways may need investigating, given the finding that trunk control plays such an important role in lower limb motor recovery, such as the reticulospinal and vestibulospinal tracts.

Walking performance

In a recent study (2017), Fulk et al. [16] performed a cross-sectional analysis of data of two other stroke rehabilitation trials (LEAPS and FASTEST) [17, 18] in order to extract secondary analysis of real-life walking activities and determine the variables that best influence walking categories a year after stroke.

Walking categories were determined by the combined methods of Tudor-Locke and Bassett Jr [19] and Perry et al. [8], to distinguish three different categories depending on the number of steps performed every day: home (100–2499 steps/day), limited community (2500–7499 steps/day) and unlimited community (≥ 7500 steps/day). They used bootstrapping methods to select the most stable predictive model and receiver-operating characteristic to identify cut-off values. They found that the best predictive model was the association of the results of the 6-min walking test (6mWT), the Berg balance scale (BBS) and the FM assessment. However, they realised, according to area under the curve in ROC analysis, that using only the 6mWT did not affect the prediction outcome. The latter had a cut-off of 205 m to distinguish between home and community ambulation (sensitivity 71% and specificity 79%) and a cut-off of 288 m between limited community and unlimited community ambulation (sensitivity 68% and specificity 77%).

Comfortable walking speed has been used as a determinant of walking performance by some authors [20–22]; however, Fulk et al. did not find it to be a significant determinant of community ambulation [16]. Nevertheless, they presented the cut-off values for comfortable gait speed between each category: to distinguish between home and community ambulation: 1.76 km/h (sensitivity 87% and specificity 61%) and between limited community and unlimited community: 3.35 km/h (sensitivity 60% and specificity 80%).

Rehabilitation techniques

We chose to present the recommendations for gait rehabilitation presenting Levels 1 or A for at least one of the two aforementioned guidelines [the Royal Dutch Society for Physical Therapy (KNGF) and the AHA, published in 2014 and 2016, respectively]. The AHA guidelines refer to a Classification of Recommendations and Level of Evidence framework and the KNGF guidelines to a Level of Evidence framework. Both of these approaches are summarised in Table 1.

General principles

According to both the guidelines, rehabilitation should start in the hyper-acute phase, with mobilisation and supervised active exercises in bed. The aim of early mobilisation is to reduce immobility-related complications and to stimulate motor control recovery [23]. According to the KNGF guidelines, rehabilitation should start within 24 h of stroke (if no other medical condition prevents it) (Level 2) [6]. However, they state that it remains unclear whether mobilisation from bed in the first 24 h of stroke is more effective than later mobilisation (Level 1) [6]. The AHA guidelines recommend against intensive out of bed early mobilisation < 24 h (Class III, Level C) [10]. They point out the results of the second AVERT trial (2015) that randomised 2014 adults into 2 groups, one receiving early intensive mobilisation (within 24 h post-stroke, focused on sitting, standing and walking activities, 3 times a day) and one receiving usual care (less intensive—in frequency and dosage—in and out of bed mobilisation within 24–48 h of stroke). They found that the early intensive intervention was associated with significantly lower odds of a favourable outcome (modified Rankin Scale of 0–2) and no evidence of accelerated walking recovery at

Table 1 Levels of evidence (KNGF and AHA)

KNGF	AHA				
Levels of evidence	Classification of recommendation and levels of evidence				
Level	Level	Class I	Class IIa	Class IIb	Class III
1	A	Recommendation that procedure is useful/effective	Recommendation in favour of procedure being useful/effective	Recommendation's usefulness/efficacy less well established	Recommendation that procedure is not useful/effective and may be harmful
2					
3	B				
4	C				

Level 1, *A* data from systematic reviews and/or RCTs, consistent findings across studies; *Levels 2*, *A* RCTs of sound methodological quality, sufficient size and consistency (PEDRO ≥ 4); *Levels 3*, *B* RCTs of lower methodological quality, experimental studies (PEDRO ≥ 3); and *Levels 4*, *C* expert's opinion. *Class I* benefit >> risk, intervention should be recommended; *Class II* benefit > risk, *Class IIa* intervention should be reasonably recommended, *Class IIb* intervention may be considered; and *Class III* no evidence, evidence of harm [6, 10]

3 months [24]. In conclusion, there are strong recommendations against intensive, out of bed mobilisation, within 24 h of stroke. There are strong recommendations in favour of starting rehabilitation at 48 h of stroke, which should take place 2–3 times a day, less than 3 h a day, focusing in out of bed activities, including sitting, standing and walking activities [6, 10]. There is low evidence in favour of starting short sessions of out of bed mobilisation between 24 and 48 h of stroke, in patients with mild and moderate strokes, but the optimal timing remains unclear [6, 10, 25].

The Australian Clinical Guidelines for Stroke management, updated in 2017, support these recommendations [23–25].

In the early and late rehabilitation phases (up to 6 months), both guidelines agree that gait rehabilitation should be intensive, repetitive, task oriented and context specific in terms of exercise training (Class I, Level A-AHA, Level 1-KNGF). For each patient, the difficulty level must be adapted, exercises must be varied to keep them interested and motivated and feedback should be provided.

Specific techniques

The different techniques as well as the most appropriate timing in rehabilitation when they should be applied are summarised in Table 2.

Treadmill training, with or without body-weight support, is widely used. Treadmills can provide unlimited walking distance and a large variety of speeds in a stable surface and a confined space. They can provide lateral arm and body weight support, which can be interesting in the early rehabilitation phase, limiting the number of people needed (therapists or carers) to assist the patient. The technique is considered safe, as adverse events are not more frequent or more serious than with overground training. Lastly, most treadmills provide feed-back, in terms of speed, distance, heart rate, etc., thus answering to the recommendations aforementioned regarding rehabilitation. According to the KNGF guidelines, treadmill training without body weight support has shown to be better than conventional training in terms of increase of maximum walking speed and stride (Level 1). Treadmill training with body weight support improves comfortable walking speed and walking distance (Level 1) [6]. According to the AHA guidelines, treadmill training with or without body weight support may be reasonable for the recovery of gait (Class IIb, Level A) [10]. A 2017 Cochrane review concluded that treadmill training, with or without body weight support, improves speed (0.22 km/h, 95% CI 0.11 to 0.32) and walking distance (14.19 m, 95% CI 2.92 to 25.46), as measured in the 6mWT, but not the chances of walking independently [26]. However, the minimal detectable change (95% MDC), which corresponds to the minimal change that exceeds the measurement error in score, for

Table 2 Summary of the rehabilitation phases and the specific techniques that have proven their efficacy in each phase

Gait rehabilitation after stroke			
Hyper-acute phase (0–48 h)	Early rehabilitation phase (48 h to 3 months)	Late rehabilitation phase (3–6 months)	Chronic phase (> 6 months)
In and out of bed mobilisation. Sitting, standing and walking 2–3 times a day KNFG: Level 2 AHA: Level C AVERT trial, 2015 Australian guidelines for stroke management, 2017	Treadmill training with or without support, 20–60 min, 3–5 times a week Patients able to walk (FAC > 1, most effective for patients FAC ≥ 3) Improves walking speed (0.22 km/h, 95% CI 0.03 to 0.09) and distance (14.19 m, 95% CI 2.92 to 25.46, 6mWT) KNFG: Level 1 AHA: Level A Cochrane review 2017 (Mehrholz et al.)	–	–
	RAT, 30–60 min, 3–5 times a week during 4–8 weeks Patients highly impaired at walking (FAC ≤ 3) Improves walking capacity NNT: 7 KNFG: Level 1 AHA: Level A Cochrane review 2017 (Mehrholz et al.)	–	–
	VR in addition to other forms of gait training Improves walking speed (SMD 1.03, 95% CI 0.38 to 1.69) and balance (SMD for TUGT 1.35, 95% CI 1.02 to 1.67; for BBS 2.18, 95% CI 1.52 to 2.85) Systematic review and meta-analysis 2016 (Rooij et al.)		
	CCT, 30–90 min, 3–5 times a week (FAC > 3) CCT improves walking speed (0.54 km/h, 95% CI 0.10 to 0.19) and distance (60.9 m, 95% CI 44.55 to 77.17, 6mWT), walking capacity, physical activity and fitness level KNFG: Level 1 AHA: Level A Cochrane review 2017 (English et al.)		
	Self-rehabilitation programmes KNFG: Level 1		

KNFG and AHA guidelines levels of recommendation are indicated when appropriate

RAT robotic-assisted therapy, *VR* virtual reality, *CCT* circuit class training, *FAC* functional ambulation category (score 0–5), *6mWT* 6-min walking test, *CI* confidence interval, *SMD* standard mean difference, *TUGT* timed up and go test, *BBS* Berg balance scale

walking speed has been calculated at 0.54–0.9 km/h, and for walking endurance at 34.4 m for people with stroke at a chronic stage and 61 m for people early after stroke, thus making the author's findings probably not clinically significant [26–29]. Patients who are already independent in walking at the early rehabilitation phase (< 3 months) will benefit the most from all forms of treadmill training. For patients in the late and chronic phases (> 3 months), treadmill training did not show a statistically significant outcome (in terms of walking speed and distance) compared to conventional physiotherapy gait training.

Robotic-assisted therapy (RAT) is increasingly used in the rehabilitation field. There are various robots that assist walking including exoskeletons and/or end-effector robots. They are interesting in rehabilitation as they can provide intensive and repetitive task training, provide assistance when needed as well as deliver feedback, thus answering to the aforementioned recommendations regarding rehabilitation. However, they are still nowadays very expensive. According to the KNGF guidelines, RAT used in stroke patients who are unable to walk independently has shown to increase comfortable walking speed, walking distance, sitting and standing balance, walking ability and performance in basic activities of daily living, as well as lowering mean heart rate (Level 1) [6]. According to the AHA, RAT in association with conventional therapy may be considered (Class IIb, Level A) [10]. A recent Cochrane review, published in 2017, concluded that RAT in addition to physiotherapy improved walking capacity after stroke but did not have an effect in walking speed and walking distance [30]. Patients who are dependent for walking and in the early rehabilitation phase (< 3 months) will benefit the most from RAT. The number needed to treat for an additional beneficial outcome (NNT) found by the authors was of 7 (95% CI 6 to 8), meaning that 7 patients need to receive RAT in addition to physiotherapy in gait training after stroke, in order for one patient to recover independent walking. This can be considered as a low number, making the intervention efficient. Lastly, RAT was considered safe, as adverse events were not more frequent or more serious in the intervention groups.

Virtual reality (VR) is also being frequently included in rehabilitation programmes. It can provide highly repetitive training, with great variability, which participates at keeping the patient motivated, limits their perception of exertion and improves their adaptability capacity. It also allows for individualised training, adapting it to the patient's specific needs (home-like scenarios), and allows the use of constraint induced movement therapy. Lastly, it provides patients with feedback [31]. These aspects are in accordance with the aforementioned recommendations regarding rehabilitation. Its utility is being demonstrated in the cognitive rehabilitation domain; however, its interest remains unclear according to the KNGF guidelines (Level 1) [6]. A systematic review and meta-analysis, published in December 2016 by de Rooij et al., was more optimistic [31]. They concluded that VR was better than conventional therapy in improving walking speed and balance, with a standardised mean difference (SMD) for gait speed of 1.03 (95% CI 0.38 to 1.69; $P < 0.002$), an SMD for the timed up and go test (TUGT) of 1.35 (95% CI 1.02 to 1.67; $P < 0.001$) and an SMD for the BBS of 2.18 (95% CI 1.52 to 2.85; $P < 0.001$) [6, 31]. An SMD is considered large when > 0.8, according to Cohen [32]. An SMD can be correlated with the NNT. An SMD of 1 corresponds to a NNT of 7 [33]. They also concluded that the benefit of VR could be seen regardless of the rehabilitation phase, as they did not observe significant differences between patients in the early or late phase [31]. These results bear the limitation of the lack of definition of VR at the time. The authors do not provide a clear definition of VR, as it could both mean video gaming and immersive VR. Lastly, VR was considered safe, as adverse events were not more frequent or more serious in the intervention groups.

Supervised circuit class training (CCT) is a valuable rehabilitation method, as it allows for intensive, repetitive and task-specific training. Various aspects of gait rehabilitation can be addressed in one session, such as strengthening, balance and steady-state training. This type of training has the advantage of allowing social interaction between patients. It also allows the therapist to include various patients at the same time, thus proving energy and cost efficient. The KNGF guidelines recommend this type of training as it has shown to improve walking distance and speed, walking ability, sitting and standing balance and fitness levels (Level 1) [6]. According to the AHA, CCT is a reasonable approach to gait rehabilitation (Class IIa, Level A) [10]. A recent Cochrane Review, published in 2017 by English et al., concluded that CCT improves walking distance and speed, walking capacity, physical activity and fitness level, not only in the early and late rehabilitation phases, but also in the chronic phase [34]. For walking distance, they found an improvement on the 6mWT of 60.9 m (95% CI 44.6 to 77.2), which is greater than an MDC improvement on the 6mWT (34.4 m for people with stroke at a chronic stage, and 61 m for people early after stroke) [28, 29]. This is of great interest, as walking distance, as measured by the 6mWT, is more correlated with community ambulation than walking speed, as aforementioned [16]. For gait speed, they found an improvement of 0.54 km/h (95% CI 0.36 to 0.68), which is greater than an MDC (0.22 km/h) and greater than 0.5 km/h, which was found to represent a substantial meaningful change, or a change above the minimal clinically important difference (MCID) for people after stroke [28]. They also found a significant improvement in balance (timed up and go test: −3.62 s, 95% CI −6.09 to −1.16; and activities of balance confidence scale: 7.76, 95% CI 0.66 to 14.87). Lastly, they found a significant improvement for independent mobility (stroke impact scale-mobility and physical items, FAC and the Rivermead Mobility Index) in CCT interventions compared with others [34]. This intervention can be safely proposed to stroke patients who are able to walk independently (FAC ≥ 3).

At a time where financial aspects cannot be overlooked and where rehabilitation hours with a specialist are counted, self-rehabilitation programmes have their place. However interesting, these programmes are hard to implement, as motivation may be hard to maintain, making this one of the challenges of rehabilitation professionals. According to the KNGF guidelines, self-rehabilitation programmes including walking activities have shown to improve performance in activities of daily living and to decrease the perceived burden of care for informal caregivers (Level 1) [6]. This should be implemented both in the early and late rehabilitation phases [6].

Discussion and conclusion

This narrative review aims to synthesise the best available predictive factors for the recovery of gait after stroke and the best rehabilitation techniques in order to achieve this. Several guidelines exist, and the two most pertinent ones have not been updated since 2014 and 2016, respectively [6, 10, 11]. Other relevant guidelines, such as the Australian Clinical Guidelines for Stroke management, were updated in 2017 [25]. Regarding the first objective of this review, the best-known predictive factors for the recovery of gait after stroke are trunk control and hip extension capacities, both included in the TWIST algorithm [9]. Regarding walking performance, walking distance indicators, such as the 6mWT, seem to be the best predictors, and not walking speed, as previously considered by some authors [16, 20–22, 35]. The TWIST algorithm is an easy tool to apply in the first week after stroke in the rehabilitation unit and should facilitate rehabilitation planning, as well as the discussion about prognosis with the patient and their family. If and when the patient recovers gait, evaluating walking distance by means of the 6mWT during the early and late rehabilitation phases is relevant, as it will inform carers about what is to be expected in terms of walking performance. This information will help making the decision regarding discharge timing and destination. Further research is needed in order to validate the TWIST algorithm as well as the predictive value of walking distance (measured by the 6mWT) regarding walking performance.

The second aim of this study was to summarise the best rehabilitation techniques for gait rehabilitation and is based on published clinical guidelines. Gait rehabilitation should start as early as possible, it should be intensive, repetitive, task specific and adapted to the patient's functional status, providing feedback in order to maintain motivation [6, 10]. Out of bed mobilisation should start at 48 h post-stroke, including sitting, standing and walking, 2–3 times a day [23, 36]. Uncertainty remains regarding the benefit of out of bed mobilisation at 24 h post-stroke as well as in the intensity of the rehabilitation, as was highlighted by the second AVERT trial [24]. The Australian Guidelines report that in some cases, mainly of moderate stroke, mobilisation at 24 h could be beneficial [25]. Some studies suggest that the severity of stroke could affect whether a patient will benefit from intensive early mobilisation or not [23]. This aspect could explain the lack of consensus and should be addressed in future research. Further studies should focus on less intensive early mobilisation in patients with more homogenous stroke severity (for instance according to their NIHSS score).

New technologies, such as RAT and VR have all their place in gait rehabilitation. However, studies regarding both techniques are sometimes hard to compare, as what is enclosed in both definitions can vary greatly. Regarding RAT, various robots exist, and although it is nowadays quite clear that they represent a significant benefit in gait rehabilitation, it still remains unclear which robot to use, at which rehabilitation phase, with what intensity and for which severity of stoke (for instance in terms of FAC) [30]. For VR, the current status is quite similar, with older studies mainly performed with non-inmersive VR and more recent ones with inmersive VR, thus contributing to probable bias in the current literature. There is an increased interest in research regarding this technique, and several studies are being performed and will help to better answer these uncertainties [37].

Self-rehabilitation and CCT should also be included in the rehabilitation programme from the moment patients attain a FAC score of ≥ 3. Treadmill training with and progressively without support, as well as RAT, should be used in the early rehabilitation phases (up to 3 months) and may be associated to VR. CCT can be introduced as soon as the patient is able to walk without help from another person (FAC > 3), and it should be maintained in the chronic phase (> 6 months post-stroke). VR should also be applied in the chronic rehabilitation phase. Self-rehabilitation should be introduced to the patient in the early phase, in order to prepare him for discharge, and it should be supervised at a distance by a therapist. This aspect of rehabilitation is also developing fast, as new technologies are being developed, which allow us to easily (and more frequently) communicate with patients and monitor their progress.

The advantage of performing a narrative review is to be able to cover a large range of issues regarding a clinical question and thus present a state of the arts on the subject in a synthesised and easy to read manner [38, 39]. The main limitation of this type of review is the lack of in-depth development of each aspect it covers and the lack of a strict methodology in the research of the evidence, as can be obtained by a systematic review. However, a systematic review is designed to answer a narrow and more-specific question, to which a stronger statistical significance can be added by performing a meta-analysis.

In terms of perspective for research, we can conclude that future studies are needed to enlighten some aspects in gait rehabilitation which remain unclear, and as usually in rehabilitation research, studies should aim to standardise protocols (in terms of intensity and frequency of interventions), in order to increase the strength of recommendations. A systematic review could be performed regarding the predictive factors of gait recovery after stroke. We did not identify any harmful interventions, with the exception of very early and intensive mobilisation (< 24 h, > 3 times a day, > 3 h a day).

Compliance with ethical standards

Conflict of interest The authors have no conflict of interest to declare.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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