Royal Dutch Society for Physical Therapy

KNGF Guideline

Stroke

In the context of international collaboration in guideline development, the Royal Dutch Society for Physical Therapy (Koninklijk Nederlands Genootschap voor Fysiotherapie, KNGF) has decided to translate its Clinical Practice Guidelines into English, to make the guidelines accessible to an international audience. International accessibility of clinical practice guidelines in physical therapy makes it possible for therapists to use such guidelines as a reference when treating their patients. In addition, it stimulates international collaboration in the process of developing and updating guidelines. At a national level, countries could endorse guidelines and adjust them to their local situation if necessary.

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KNGF's objective is to create the right conditions to ensure that high-quality physical therapy is accessible to the whole of the Dutch population, and to promote recognition of the professional expertise of physical therapists. KNGF represents the professional, social and economic interests of over 20,000 members.

The guideline is summarized on a flowchart; the Practice Guidelines as well as the flowchart can be downloaded from www.fysionet.nl.

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A Introduction

A.1 Definition of KNGF Guidelines

KNGF Guidelines are national professional recommendations, based on scientific evidence, intended to optimize patient* care. Guidelines are intended to serve as an instrument to support physical therapists in making clinical decisions. Guidelines aim to provide guidance for everyday practice and at the same time to be flexible enough to enable therapists to deviate from them to meet individual needs, depending on the situation and the patient, provided this deviation is based on sound arguments.
This revised *KNGF Guideline Stroke* offers recommendations for appropriate care. The individual recommendations have been provided with indicators to assess the quality of physical therapy care. In the opinion of KNGF, checking the implementation of the guidelines is the responsibility of the physical therapists, in consultation with and supported by KNGF.

** Wherever the word 'patient' is used, it can also be read as 'client'.*

A.2 Goal

The objective of the *KNGF Guideline Stroke* is to improve the quality, transparency, and uniformity of the physical therapy provided to patients whose main diagnosis is a stroke (cerebrovascular accident), throughout the chain of integrated care, by explicitly describing the physical therapist's management of these patients on the basis of scientific research, adjusted where necessary on the basis of consensus among physical therapy experts in primary, secondary and tertiary care, as well as associated professions in the field. This also serves to define and clarify the professionals' tasks and responsibilities.
A synonym of 'stroke' is cerebrovascular accident (CVA). This Guideline uses the term stroke. Strokes can be subdivided into non-hemorrhagic stroke (brain infarction) and hemorrhagic stroke (cerebral hemorrhage).

Definition of stroke
According to the World Health Organization, a stroke or CVA is defined as 'rapidly developing clinical signs of focal (or global) disturbance of cerebral function lasting 24 hours or longer or leading to death, with no apparent cause other than of vascular origin'. Patients with a transient ischemic attack (TIA) and subarachnoid hemorrhage (SAH) are beyond the scope of this Guideline.

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A.3 Target group
This guideline is primarily intended for physical therapists treating patients with a stroke. It may also be consulted by physicians, nurses or other allied health care staff involved in the care for patients with a stroke, relatives or informal caregivers of patients, and researchers in the field of neurorehabilitation/stroke. An information leaflet is available for patients, their relatives and informal caregivers.

A.4 The need for a revised edition
Since the publication of the 2004 edition of the *KNGF Guideline Stroke*, many new research findings have been published regarding rehabilitation after a stroke, and regarding physical therapy in particular. As a result, many of the recommendations in the 2004 Guideline are no longer in line with the currently available evidence and insights.

A.5 Changes with respect to the first edition.
Changes in this second edition of the *KNGF Guideline Stroke* relative to the first edition concern a number of issues:

- The findings of controlled effect studies have been updated to July 2011, and the intervention chapter (Chapter F) now only presents recommendations based on the two highest levels of evidence.
- The treatment guideline is structured along the lines of the natural course after a stroke and the corresponding functional prognosis. The evidence for using a particular intervention is linked to the moment when a stroke occurs (phases after stroke) and is therefore presented for each phase.
- As regards prognostics, the Guideline discusses not only the early prediction of functional outcomes, in terms of walking ability, dexterity, and ADL six months after the stroke, but also offers information on identifying patients who will show functional changes, whether improvement or deterioration, in the longer term (i.e. more than six months after the stroke).
- New interventions have been incorporated, including group training using workstations ('circuit class training'), exercises done together with an informal caregiver ('family-mediated exercises'), robot-assisted gait training and robot-assisted training of the paretic arm and hand.
- The measurement instruments to be used have been critically revised; redundant instruments have been removed and a disorder-specific instrument for quality of life has been added; other instruments that have been added objectively assess neurological functions, cognitive functioning, fatigue, depression, and the burden of care experienced by informal caregivers.
- The role of informal caregivers and others close to the patient has been given a more prominent place.
- Some interventions are still at an experimental stage, such as 'transcranial Direct Current Stimulation' (tDCS), 'repetitive Transcranial Magnetic Stimulation' (rTMS) and 'mental practice'. Since the value added by these innovative techniques in terms of activities remains unclear, these are only mentioned here in the Guideline, and have as yet not been elaborated into recommendations.

A.6 Scope and position
This KNGF Guideline concerns the physical therapy management of patients with a stroke within the continuum of care. This involves the organizational context of care, diagnostics and prognostics, treatment options during the various stages after a stroke, evaluation and monitoring of the patient's physical functioning, and the conclusion of therapy.
The present Guideline complements the 'Richtlijn diagnostiek, behandeling en zorg voor patiënten met een beroerte' (guideline for the diagnostics, treatment and care of patients with a stroke' [in Dutch]) by the Dutch Institute for Healthcare Improvement (CBO) / Netherlands Society of Neurology (NVN), as well as the 'Zorgstandaard CVA/TIA' (CVA/TIA care guidelines [in Dutch]) by the Kennisnetwerk CVA Nederland (Stroke Knowledge Network Netherlands), and other monodisciplinary medical and allied health care guidelines.

The incidence of stroke increases with advancing age, and is estimated to be 45,000 a year in the Netherlands. The prevalence has also risen in recent years and was estimated at 226,600 in 2007. In view of the current increase in life expectancy and the aging of the population in the Netherlands, the prevalence is expected to rise further in the coming years. The absolute number of hospitalizations for stroke rose by about 50% between 1980 and 2009, and was 39,614 in 2009 (excluding day care admissions). Women were, on average, 72 years old at the time of their stroke, and men 69. The majority of hospitalizations (29,590) concerned patients with a cerebral infarction. The duration of hospital stays fell sharply between 1980 and 2009, from 25 to just 9 days for men and from 32 to just 10 days for women.
After cancer, cerebrovascular disorders are the main cause of death, not only in the Netherlands but also worldwide. On the other hand, mortality due to stroke has fallen in recent years, to 9069 persons in the Netherlands in 2009. Of the hospitalized patients, 41.3% were discharged home, 3% were discharged to a home for the elderly, 33% to a nursing home, 8.4% to a rehabilitation center and 2.7% to a different hospital, whereas the discharge destination was unknown for 1.6%, and 9.9% died at the hospital.
The costs of care for patients with a stroke are high, amounting to 2.2% of the total health care costs in the Netherlands. The consequences of a stroke are not limited to the patient's own physical, psychological, communicative, and social problems. A stroke also has major effects on those close to the patient (partner, children and relatives), which may lead to additional costs.
In addition to more advanced age and male sex, risk factors for suffering a first or recurrent stroke include: a previous TIA or stroke, the presence of hypertension, diabetes mellitus, smoking, coronary heart disease, excessive alcohol use and lack of physical activity.

A.7 Context and use of this Guideline
New controlled studies on the rehabilitation of patients with a stroke are being published every month. Hence, it is virtually impossible for an individual physical therapist to keep up with all publications reporting on such controlled studies. Updates based on meta-analyses, including Cochrane Reviews, often appear with such long delays that they are no longer up to date at the time of publication.

The *KNGF Guideline Stroke* aims to reflect as fully as possible the results of effect studies into the value added by physical therapy to the rehabilitation of patients with a stroke, as published in the scientific literature. The recommendations it presents are intended to offer guidance, based on scientific evidence, for clinical decisions regarding the treatment of patients with a stroke. As such, the Guideline reflects the current state of the evidence for physical therapy interventions for this patient group. The Guideline does not offer a survey of all interventions carried out by physical therapists in routine practice. Nor are the recommendations in the Guideline intended as a universal solution for the treatment of any patient with a stroke.
The 2004 edition of this Guideline was based on 123 randomized controlled trials (RCTs). The current Guideline is based on 344 RCTs and reflects the state of scientific research up to July 2011. In view of the exponential increase in the number of published effect studies, the project team and the external advisory group expect that the current Guideline will need to be updated by 2015, and that a more or less continuous updating process will be required in the future.

A.8 Conceptual framework of the Guideline

The framework used in constructing the Guideline was based on:

- the 'International Classification of Functioning, Disability and Health' (ICF) by the World Health Organization (WHO);
- the time course of recovery after a stroke: the acute/hyperacute (rehabilitation) phase, the early rehabilitation phase, the late rehabilitation phase and the chronic phase;
- the process of physical therapy treatment: diagnostics and prognostics, intervention, evaluation and monitoring, and concluding the treatment.

A.8.1 WHO ICF

The WHO's OCF has served as the structuring principle for the present Guideline. The physical therapy process aims to optimize the patient's condition in terms of impairments of body functions, limitations of activities, and restrictions of participation, while also addressing the context of the patient's health problem. The latter includes interactions between a patient and their environment, such as the organizational structure of the health care system, social factors like informal caregiving, and the physical environment. In addition, the ICF can help physical therapists in structuring and presenting the stroke patient's functional performance from a wider perspective.

A.8.2 Time course

Recovery after a stroke is not linear, but follows a curve, with most of the recovery taking place during the first days to months.
The recovery process can be said to include four phases, which merge into each other and are not sharply demarcated:

- **The hyperacute/acute (rehabilitation) phase – (H)AR,** lasting 0 to 24 hours. This phase is characterized by medical diagnostics and the prevention of progressive damage to the brain and secondary complications. The aim is to start mobilization and rehabilitation at an early moment.
- **Early rehabilitation phase – ER,** lasting from 24 hours to 3 months. This phase is characterized by rehabilitation aimed at restoring functions and, if that is impossible, learning compensatory strategies, in order to avoid or reduce limitations of activities and restrictions of participation. If necessary, adaptations to the patient's physical environment are implemented and home care is arranged.
- **Late rehabilitation phase – LR,** lasting 3 to 6 months. This phase is a continuation of the ER phase, emphasizing the prevention and reduction of limitations of activities and restrictions of participation. If necessary, adaptations to the patient's physical environment are implemented and home care is arranged.
- **Rehabilitation in the chronic phase – RC,** lasting longer than 6 months. This phase is characterized by support and counseling for the patient (i.e. preservation and prevention), with the aim of assisting the process of adapting, optimizing social functioning and learning to cope with limitations, preserving physical fitness and monitoring quality of life. If a patient shows functional improvements, the therapist concentrates on (temporarily) continuing the therapy; if the patient shows deterioration, they concentrate on regaining the functional level achieved by the initial therapy.
  Note: The treatment is limited in time. It is concluded when the treatment goals have been achieved or when the physical therapist is of the opinion that further physical therapy offers no added value, or estimates that the patient will be able to achieve their goals independently, without supervision from a physical therapist.

Figure 1 illustrates the distinctions between the various phases.

A.8.3 Physical therapy approach

The methodical approach to physical therapy consists of eight steps. The present Guideline groups these steps into 'diagnostics and prognostics' (steps 1 – 4), 'intervention' (steps 5 and 6) and 'evaluation and monitoring' (steps 7 and 8). Table 1 lists the chapters where each of these steps is discussed.

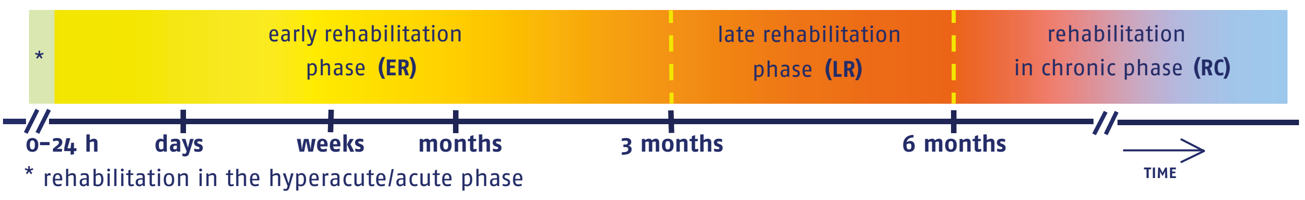

Figure 1. Timeline (non-linear) showing the various phases after a stroke.

Tabel 1. Steps in the methodical approach and the chapters in which they are described.

Step in the methodical approach	Chapter
1 presentation, defining the patient's presenting problem, screening and informing the patient 2 history-taking 3 physical therapy examination 4 establishing a physical therapy diagnosis and indication	diagnostic process: Chapters C and D
5 treatment plan 6 implementation of treatment	therapeutic process: Chapters B, E, F and G
7 evaluation 8 conclusion	evaluation, monitoring, record-keeping and conclusion: Chapters C and H

A.9 Methodology development

A.9.1 Working procedure

The process of revising the Guideline made use of the AGREE II instrument and the document entitled 'Richtlijn voor Richtlijnen' (guideline on guidelines). The process of revising the *KNGF Guideline Stroke* took place between December 2010 and June 2013, funded by a KNGF grant to the VU University Medical Center (VUmc). The project team, consisting of Prof. G. Kwakkel (project leader) and Ms. J.M. Veerbeek MSc (physical therapist), was assisted by the external advisory group, which included: Dr. R.P.S. van Peppen (programme manager Masters of Physiotherapy, University of Applied Sciences Utrecht, physical therapist), Dr. Ph.J. van der Wees (senior researcher at Radboud University Medical Center, Dept. IQ healthcare, Nijmegen), Ms. Karin Heijblom, (senior policy advisor Quality at KNGF), Dr. H.J.M. Hendriks (epidemiologist, physical therapist, Fysiotherapie Maasstaete, Druten), Dr. E.E.H. van Wegen (senior researcher at VU University Medical Center), and Mr. M.B. Rietberg (allied health professionals manager, Dept of Rehabilitation Medicine, VU University Medical Center).

At the start of the project, the project team and the external advisory group asked themselves the following questions for each of the subject areas.

Organizational structure of care

- What is the efficacy of stroke units in terms of survival and recovery rates of patients with a stroke?
- What is the position (or domain) of a physical therapist within the care continuum for patients with a stroke?
- What competencies must a physical therapist have to provide the best possible care to patients with a stroke?

Diagnostics and prognostics

- What determinants, as measured during the hyperacute/acute (rehabilitation) phase and at the start of the early rehabilitation phase, are decisive for the recovery of skills of patients with a stroke during the first six months after the stroke?
- What determinants are decisive for functional changes six months after the stroke and thereafter?

Intervention

- What interventions belong to the domain of physical therapy?
- What evidence is available for these physical therapy interventions for patients with a stroke?
- What gaps are there in the scientific research into stroke for the physical therapy domain?

Evaluation and Monitoring

- What measurement instruments are reliable, valid, responsive, and clinically useful during the treatment of patients with a stroke?
- How and at what moments should the functional status of a patient with a stroke be monitored and evaluated during the process of physical therapy?

In order to answer the clinical questions and achieve consensus about the wording of the recommendations, a monodisciplinary guideline development team was established, consisting of subject experts from primary, secondary, and tertiary health care: Mr. A.A.G. Goos, Mr. W.O. Hanssen, Ms. B.C. Harmeling-van der Wel, Mr. L.D. de Jong MSc, Ms. J.F. Kamphuis MSc, Ms. M.M. Noom, Mr. R. van der Schaft, Ms. C.J. Smeets, Mr. T.P.M.M. Vluggen MSc, Mr. D.R.B. Vijsma, and Ms. C.M. Vollmar. These experts were asked to review draft versions of the Guideline, and have met several times to discuss contentious issues and achieve consensus.

After consensus had been achieved in the expert group, the Guideline was presented to representatives of the various professional organizations that are also involved in the interdisciplinary treatment of patients with a stroke, as well as to the stroke patients' society. These representatives were asked to evaluate whether the recommendations ran counter to views in their own disciplines or to the patients' perspective. This group included representatives of: Hart&Vaatgroep (Dutch Heart and Vascular Group); Ergo-therapie Nederland (Dutch Association of Occupational Therapists); Kennisnetwerk CVA Nederland (Stroke Knowledge Network Netherlands); Nederlandse CVA-vereniging 'Samen Verder' (Dutch Stroke Association); Nederlandse Vereniging voor Klinische Geriatrie (Dutch Geriatrics Society); Nederlandse Vereniging voor Logopedie en Foniatrie (Dutch Association of Speech Therapy and Phoniatrics); Nederlandse Vereniging voor Neurologie (Netherlands Society of Neurology); Nederlandse Vereniging voor Neuropsychologie (Netherlands Society for Neuropsychology); Nederlandse Vereniging van Revalidatieartsen (Netherlands Society of Physical and Rehabilitation Medicine); Nederlands Instituut van Psychologen, sectie Revalidatie (Dutch Association of Psychologists, rehabilitation division); Nederlands Huisartsen Genootschap (Dutch College of General Practitioners); Nederlands-Vlaamse Beroepsvereniging voor Neuropsychologen (Dutch-Flemish Professional Association for Neuropsychologists); Verenso - Dutch Association of Elderly Care Physicians and Social geriatricians; Verpleegkundigen & Verzorgenden Nederland, afdeling Neuro & Revalidatie (Dutch Nurses' Association, Neuro & Rehabilitation division); Werkgroep CVA Nederlands (Dutch Stroke Working Group).

A.9.2 Literature search

The literature search undertaken for the purpose of revising the *KNGF Guideline Stroke* was limited to systematic reviews and randomized controlled trials (RCTs) which included only patients with a stroke or in which data from patients with a stroke were analyzed separately. Systematic reviews were only used as a means of identifying the primary studies. Search terms were used to systematically search the electronic databases PubMed, EBSCO*host*/Excerpta Medica Databank (EMBASE), EBSCO*host*/Cumulative Index of Nursing and Allied Health Literature (CINAHL), Wiley/Cochrane Library Central Register of Controlled Trials (CENTRAL), Cochrane Database of Systematic Reviews (CDSR), Physiotherapy Evidence Database (PEDro) and SPORTDiscus™. Further literature was searched for by consulting relevant existing Dutch and international guidelines, statements and algorithms:

- 'Richtlijn Diagnostiek, behandeling en zorg voor patiënten met een beroerte' (guideline on the diagnostics, treatment and care for patients with a stroke) (2008) published by CBO/NVN;
- 'Zorgstandaard CVA/TIA' (care guidelines on CVA/TIA) (2012) published by Kennisnetwerk CVA Nederland (Stroke Knowledge Network Netherlands);
- 'National Clinical Guideline for Stroke' (2012) published by the Royal College of Physicians UK;
- 'Management of patients with stroke or TIA: assessment, investigation, immediate management and secondary prevention - a national clinical guideline' (2008) published by the Scottish Intercollegiate Guidelines Network;
- 'Guidelines for management of ischaemic stroke and transient ischaemic attack' (2008) published by the European Stroke Organisation (ESO) Executive Committee;
- 'Comprehensive overview of nursing and interdisciplinary rehabilitation care of the stroke patient: a scientific statement from the American Heart Association' (2010) published by the American Heart Association;
- 'Canadian Stroke Strategy, Canadian best practice recommendations for stroke care, update 2010', published by the Canadian Stroke Network and the Heart & Stroke Foundation of Canada;
- 'Evidence-based review of stroke rehabilitation' by Teasell et al. (2012);
- 'Clinical Guidelines for Stroke Management 2010' published by the Australian National Stroke Foundation;
- 'Clinical Guidelines for Stroke Management 2010' published by the Stroke Foundation of New Zealand and the New Zealand Guidelines Group;
- 'Helsingborg Declaration 2006 on European Stroke Strategies';
- relevant reviews from the Cochrane Collaboration;
- the algorithm for the paretic arm currently being developed by the World Network Upper Limb Stroke Rehabilitation.

The literature search included publications in English, Dutch, French, German, Spanish, and Portuguese.

A.9.3 Data synthesis

Recommendations for interventions

The recommendations for interventions were formulated on the basis of meta-analyses. The results of individual RCTs were pooled if two or more RCTs of sufficient methodological quality were available which had studied the same type of intervention and reported outcome measures from the same domain. The description of interventions in the scientific literature is unfortunately often rather incomplete, so the nature of the therapy offered is not always very clear. In some cases this makes it impossible to translate the findings into guidelines for specific physical therapy interventions for patients with a stroke.
Recommendations for cognitive rehabilitation were formulated using existing Dutch and international guidelines and recent systematic reviews.

Weighting the evidence

In accordance with the 'Richtlijn Diagnostiek, behandeling en zorg voor patiënten met een beroerte' (guidelines for the diagnostics, treatment, and care of patients with a stroke' [in Dutch]) by CBO/NVN, the treatment guidelines were formulated by weighting the available evidence on the basis of the nature of the study design,

Tabel 2. Categorization of research findings according to level of evidence for interventional studies.

A1	Systematic reviews based on at least a few RCTs of A2 level, with consistent findings across individual studies.
A2	RCTs of sound methodological quality and sufficient size and consistency (PEDRO scores of 4 points or more).
B	RCTs of lower methodological quality and quasi-experimental studies (PEDRO scores of 3 points or less).
C	Non-comparative studies; pre-experimental studies.
D	Not supported by research studies. Expert opinion.

*Tabel 3. Phrases used in the practice recommendations.**

1	When it is supported by at least 1 systematic review including at least two RCTs of A2 level, the recommendation is worded as follows:	
	SES: significant power of meta-analysis: high	'It has been demonstrated that ... leads to (improved) ...'
	SES: significant power of meta-analysis: low	'It has been demonstrated that ... leads to (improved) ...'
	SES: non-significant power of meta-analysis: high	'It has been demonstrated that ... has no added value ...'
	SES: non-significant power of meta-analysis: low	'It remains unclear whether ...'
2	When it is supported by 1 RCT of sound methodological quality (level A2), the recommendation is worded as follows: 'It is plausible that ...'	
3	When it is not supported by research at A level, the recommendation is worded as follows: 'There are indications that ...'	
4	When it is based on expert opinion, the recommendation is worded as follows: 'In the opinion of the guideline development team, ...'	

** The Guideline includes only recommendations for interventions based on Level 1 and level 2 evidence.*

the number of studies available, and their quality. For instance, results from meta-analyses and RCTs were given greater weight than results from non-comparative studies. The conventional evidence levels are shown in Table 2.

In view of the large number of published RCTs on stroke rehabilitation in the physical therapy domain, the recommendations in this revised edition of the Guideline are based exclusively on RCTs with a PEDRO (Physiotherapy Evidence Database) score of 4 or higher (i.e. studies of A2 level) where it concerns interventions for walking ability, dexterity and basic activities of daily living (basic ADLs). This implies that only recommendations based on Level 1 and Level 2 evidence are presented.
If evidence for a particular intervention was available from at least two high-quality RCTs, and the results could be pooled, a Level 1 recommendation was formulated. For interventions to which this applied, only Level 1 recommendations have been formulated, and no Level 2 recommendations. Level 2 recommendations were only formulated if only one RCT of high methodological quality was available for a particular intervention. Recommendations for the remaining interventions also include Level 3 and Level 4 recommendations, in view of the lack of RCTs into these interventions, which were nevertheless considered highly relevant to physical therapy.
The wording used for the recommendations with Level 1 evidence is based on: (1) the direction of the effect ('summary effect size' [SES] in favor of the experimental or control treatment), (2) the corresponding p-value, and (3) the statistical power of the meta-analysis). See *Table 3*.

A.9.4 Results
Based on the results of the literature search, 467 RCTs were included in the Guideline. These RCTs were used to formulate 70 recommendations with Level 1 evidence, 40 recommendations with Level 2 evidence, 9 recommendations with Level 3 evidence and 19 recommendations with Level 4 evidence.
Based on the meta-analyses, 22 interventions for 'walking and mobility-related abilities' were included with Level 1 evidence, and 10 interventions with Level 2 evidence. Fourteen interventions for 'dexterity' with Level 1 evidence were included, and 4 interventions with Level 2 evidence. Three interventions for ADL activities with Level 1 evidence were included, and 4 interventions with Level 2 evidence.

A.10 Structure of the intervention chapter

The intervention chapter (Chapter F) first defines the interventions for which Level 1 evidence was available, and then describes them in detail.
No detailed background information is presented for those interventions for which only Level 2 evidence was available, as none of these interventions have been studied in more than one RCT. A description of all RCTs is included in Appendix 1 of the *Verantwoording en Toelichting* (Review of the evidence) document (in Dutch).
A recommendation is a concise summary of the efficacy of an intervention. Symbols are used to indicate for which post-stroke phase the intervention in question has been studied, its efficacy, and the ICF level to which this efficacy applies (according to ICF; see Section A.8.1).

The following symbols are used:
- ◖◗ outcome measure(s) at the body function level and at the activities and participation levels of the ICF;
- ◖ outcome measure(s) at the body function level of the ICF;
- ◗ outcome measure(s) at the activities and participation levels of the ICF;
- ✓ phase for which the intervention was studied (with favorable effect);
- × phase for which the intervention was studied (with adverse effect);
- = phase for which the intervention was studied (no added value / added value unclear).

A.11 Limitations of the *KNGF Guideline Stroke* and recommendations for future research

The 467 RCTs relating to the physical therapy domain that we found (N = 25,373) show that an ever increasing proportion of the physical therapy management routinely applied to patients with a stroke is now evidence-based. Nevertheless, many interventions have still not been tested to determine their added value. For instance, there have been no controlled studies to assess the evidence for motor learning strategies in physical therapy, and no RCTs have been conducted in this professional domain to assess the added value provided by, e.g.:

- physical therapy interventions during the pre-mobilization phase, such as pulmonary care;
- getting up from the ground;
- learning skills like stair walking and cycling;
- training patients' traffic awareness;
- falls prevention programs;
- aerobic training to improve cognitive functioning;
- the use of walking aids like canes, four-legged walking sticks or rollators;
- the use of cryotherapy for hand edema;
- interventions for patients with perception impairments for verticality, including the pusher syndrome.

The value added by training one function rather than another and the way in which exercises are offered have hardly been tested in the physical therapy domain. Other interventions have only been examined in one low-quality RCT, such as visual biofeedback tracking training of the knee and repeated passive extension of the paretic wrist using a specially designed device. The lack of evidence for an intervention does not prove that it does not work. In some cases, the functional value added by a therapy is plausible on biological grounds. The fact that the value added by some interventions remains unclear, even though there have been randomized studies, may be due to insufficient statistical power to detect a differential effect, since the chances of proving the efficacy of the therapy under study are not only determined by the effect size but also by the number of patients involved in the RCTs, as well as by the prognostic comparability of the patients at the time of randomization. Most scientific studies in physical therapy are phase I and phase II trials, with small numbers of patients included and large prognostic differences between them. So far, only a few phase III/IV trials have been conducted. The type of treatment received by the control group can also influence the chances of detecting differential effects, as medical ethics prohibit withholding care from the control group.

In addition, there have been very few studies (phase I/II trials) of innovative intervention such as 'repetitive Transcranial Magnetic Stimulation' (rTMS) or 'transcranial Direct Current Stimulation' (tDCS) in combination with exercise therapy; in view of the experimental nature of these interventions, they have not been included in the present Guideline. The same goes for the use of mental practice for patients with a stroke.

The literature search for the intervention part of this Guideline was limited to identifying systematic reviews and RCTs, ignoring studies of 'lower' quality, such as pre-experimental studies, including single-case designs (n=1 studies). The Guideline has been brought up to date to July 2011. It seems likely that some controlled studies were missed due to the language restrictions in the literature search. Also, the description of interventions in the scientific literature is unfortunately often rather incomplete, so the nature of the therapy offered is not always very clear, which in some cases makes it impossible to translate them into a recommendation for specific interventions.

Since the outcomes of systematic reviews (and hence of meta-analyses) are affected by insufficient methodological quality of the RCTs included in them, the guideline development team decided to use a cut-off value for quality of 4 points on the PEDRO scale. This value is, however, arbitrary. The RCTs included in this Guideline show that the quality of RCTs in physical therapy has clearly improved in recent years. The objective of high-quality controlled studies should remain a major focal point for practitioners in attempts to provide scientific evidence on physical therapy for patients with a stroke. The design of RCTs should focus particularly on preventing bias by: (1) using a correct (i.e. independent) randomization procedure; (2) blinding of the researchers; and (3) an 'intention-to-treat' analysis, which includes dropouts in the statistical analysis.

In addition, there may have been an influence of publication bias, as RCTs resulting in positive findings get published but not those finding no or negative effects.

A general observation was that many publications fail to report follow-up data, and if they do, the timing of follow-up assessments varies widely. This means that the long-term added value of nearly all interventions is unknown. Systematic use and reporting of follow-up assessments over time would allow conclusions to be drawn about long-term effects.

There is also much room for improvement in the establishment of a functional prognosis and in determining the clinimetric properties of measurement instruments. For instance, little is known so far about identifying patients who are incorrectly classified on the basis of prognostic models as patients who will be unable to regain activities. In addition, there is a lack of valid predictors for patients who will still show further functional progress six months after their stroke, or are at risk for functional deterioration. The 95% confidence intervals for the measurement error are unknown for many measurement instruments, which means that it is unknown by how many points a score should change to indicate a real change.

A.12 Legal status of this Guideline

Once a guideline has been formally established, it serves as to guide the physical therapy community. A guideline is not a legally binding regulation, but describes the most up-to-date and evidence-based approach for a particular disorder. The recommendations are usually based on the 'average' patient. Care providers can deviate from it if the deviation is based on sound arguments. If a physical therapist deviates from the guideline, it is important that they offer arguments for doing so and record them in the patient file.

A.13 Implementation of the Guideline

The Guideline is disseminated through electronic channels and announced to relevant parties by means of e-mails and at national conferences and training courses, and is publicly accessible at www.fysionet-evidencebased.nl.

A.14 Guideline revisions

The methodological recommendations for developing and implementing guidelines state that any guideline should be revised within 3 to 5 years after the original publication. This implies that KNGF, together with the guideline development team, will decide in 2020 at the latest whether this guideline is still up to date. If necessary, a new guideline Development team will be assembled to revise the guideline.
New developments may necessitate an earlier start of the revision process.

A.15 Conflicts of interest

The project team, the external advisory group and the 11 members of the guideline development team declare no conflicting interests regarding the process of revising the *KNGF Guideline Stroke*.

A.16 Acknowledgments

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The inclusion of the above persons as consultants does not imply that each of them agrees with every detail of the Guideline.

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B General treatment principles and rationale of physical therapy

B.1 Organizational structure of rehabilitation within a stroke service

B 1.1 Stroke services

Systematic literature reviews have shown that patients benefit from very rapid admission to a hospital stroke unit, which specializes in the treatment of patients with a stroke. Treatment at a hospital stroke unit considerably reduces the risk of death and of ADL-dependence compared to treatment at non-specialized treatment centers. Admission to a hospital stroke unit reduces the mortality risk by an average of 18%, reduces hospital stays by an average of 8% and offers patients a 20% greater chance of being able to return to independent life at home.
The stroke unit should preferably be embedded in a specialized integrated stroke care system, sometimes referred to as 'stroke service'. A stroke service can be defined as a 'regional integrated care system of collaborating care providers.'
Care providers that can be regarded as part of a stroke service include:

- hospital stroke units;
- rehabilitation centers (rehabilitation stroke units);
- nursing homes, whether or not offering special rehabilitation facilities (nursing home stroke units) and 'long stay' wards;
- family physician services, physical therapy practices and agencies for community nursing and supportive care in primary health care.

The value added by treatment in stroke units is independent of the patient's sex and age and the severity of their stroke. This implies that any patient with a stroke should in principle be eligible for admission to a hospital stroke unit and that any institution admitting stroke patients should be embedded in a stroke service providing integrated care.

There are indications that it is the combination of the quality of coordinated interdisciplinary collaboration (also known as multidisciplinary collaboration) and the practice of establishing shared functional goals for treatment (goal setting) which determines the outcome in terms of ADL-independence and the mortality risk among patients admitted to a stroke unit.

In addition, it has been demonstrated that the following rehabilitation-related factors contribute to the higher quality of care by a stroke service:

- systematic screening of body functions from the moment of admission (intake);
- the use of a shared (interdisciplinary) treatment plan;
- frequent interdisciplinary consultations;
- an intensive rehabilitation approach tailored to the patient's wishes (presenting problem) and physical condition;
- a management approach based on preventing complications;
- frequent and systematic assessment of functional changes over time (monitoring);
- timely and structured education for patients and their partners and/or informal caregivers (e.g. relatives or children);
- preparing patients for discharge well in advance;
- frequent refresher courses for the professionals involved.

It remains unclear what specific influence each of these individual elements has on the quality of care, although several controlled studies have shown that the degree to which interdisciplinary stroke teams comply with evidence-based guidelines for treatment is positively associated with the degree of improvement obtained in terms of ADL-independence.
Major physical therapy-related aspects include: (1) early mobilization of patients, within 24 hours after the stroke; (2) establishing a goal shared by the entire team (goal setting); (3) frequent refresher courses for team members; and (4) systematic screening of patients and systematic monitoring of changes. It is precisely because physical therapists are involved throughout the stroke service that it is one of the core disciplines determining the continuity of rehabilitation in a stroke service. Each stroke unit has a specific size and a permanent stroke team. Ideally, a treatment team consists of a physician (neurologist, rehabilitation physician, elderly care physician or family physician), a nurse, a physical therapist, an occupational therapist, a speech therapist, a neuropsychologist, a social worker, an exercise therapist, an activities supervisor, a dietician and a pharmacist. The number of disciplines involved in the care for a particular patient can of course vary considerably, and is determined by the complexity of the patient's symptoms and the stage of the care program the patient is in.
The interdisciplinary collaboration within the stroke service must be coordinated. The actual content of the care provided to patients is coordinated by a team coordinator in the stroke team, while an 'integration coordinator' focuses on aspects of the process of care provision, such as transferring patients to different components of the stroke service and motivating the various stroke teams within the integrated service to collaborate. There must also be one central care provider, to whom the patient can turn at any time. This role can be played by various disciplines, such as a family physician, a stroke nurse or home care nurse.

Stroke team *1*

It has been demonstrated that having patients with CVA treated by a specialised interdisciplinary stroke team, who are working together at one common site (stroke unit), has a favorable effect on survival rates, length of stay, and ADL-independence, compared to regular care at a non-specialized ward. (Level 1)

Evidence-based guidelines *2, 3*

There are indications that treatment based on evidence-based treatment guidelines by an interdisciplinary stroke team has a favorable effect on survival rates, recovery of ADL-independence, patient satisfaction and healthcare-related costs for patients admitted to hospital in the hyperacute/acute and early rehabilitation phases. (Level 3)

In the opinion of the guideline development team, patients hospitalized with a stroke should also be treated by a physical therapist during the weekend. (Level 4)

B.1.2 Physical therapy at the stroke service

The role of the physical therapist in the interdisciplinary team
The central place occupied by the physical therapist within the team of experts implies that he or she must confer with the other disciplines involved at scheduled times about the intended patient management (the physical therapy treatment plan). The physical therapist's tasks include:

- recording data on the care provided, including the intended functional goals, and reporting these to the stroke team or the referring physician;
- keeping track of the rehabilitation management approach agreed by the interdisciplinary team;
- regularly objectively assessing the patient's functioning and changes therein, and recording the numerical assessment outcomes in the patient's file.

About 50% of patients are discharged home from the hospital. A considerable proportion of this group require further physical therapy. The primary care system also includes a stroke team, usually consisting of a family physician, a physical therapist, a (community) nurse and people in the patient's social environment. In view of the current trend of 'early supported discharge', the services of such stroke teams will be increasingly called upon. The smooth functioning of such a team is not a foregone conclusion, and all care providers involved will have to take initiatives and participate in making their contributions. The jointly established care plan will focus on self-management, secondary prevention, ability to move about in and around the house, ADL and falls prevention, and must include regular feedback among the various disciplines on interventions undertaken and progress made, as well as frequent consultations between the disciplines involved.
In view of the physical therapist's frequent contact with the patient, he or she will often be the one to identify problems or care needs which require assistance by the family physician (e.g. for problems of a sexual nature) or the home care service. The impor-

tance of effective and coordinated collaboration in primary care is also evident in the situation of a patient in the chronic phase living at home.

The physical therapist's working procedure within the stroke service
Physical therapy primarily aims to examine and treat the often visible, physical consequences of a stroke, while also taking other aspects, like neuropsychological consequences, into account. In view of the complexity of the potential disorders and the great heterogeneity of this category of patients, effective treatment requires the physical therapist to have highly specialized skills.
In accordance with the definition of 'evidence-based practice', the physical therapy approach focuses on the following aspects:

- the patient's preferences, wishes, needs, and expectations as regards the treatment (presenting problem) and those of the patient's partner;
- the problem definition and treatment goal, or the focus of treatment, within the goal(s) jointly established by the interdisciplinary team;
- the estimated chances of functional improvements (functional prognosis/therapeutic feasibility);
- potential impediments that determine the manner and level of the patient's functioning;
- the way in which the patient is screened, monitored and treated, choices that have to be based on the available evidence, as presented in the document entitled *Verantwoording en Toelichting* (review of the evidence; in Dutch), while taking into account the patient's clinical condition and situation.

This usually means that the physical therapy management is determined by problem definitions that are relevant to the patient. The problem definition usually necessitates further diagnostics to elucidate the underlying cause of, e.g., a painful hemiplegic shoulder or balance problems. After the prognosis has been estimated and the interventions have been decided upon, measurement instruments and assessment moments will have to be selected in order to monitor the patient's progress. All of these elements, problem definition, diagnosis, prognosis, intervention, and evaluation, have to be recorded in the patient's file and have to be included in the transfer documents, so that the physical therapy management can be continued if the patient's own physical therapist is unavailable, or if the patient is discharged home or referred to another department or institution.

Coordinating the care within the interdisciplinary team
Physical therapy interfaces with occupational therapy, (neuro) psychology, and nursing (including specialized neurological nursing) in terms of examination methods and interventions aimed at ADL activities and cognitive rehabilitation, such as the treatment of (hemi-)inattention and/or dyspraxia. Such examination methods and interventions are situated at the interface between the disciplines and can therefore not be simply allocated to one particular discipline. The division of tasks within the treatment team as regards these interfaces will be determined by the specific expertise of the care providers and will be decided by mutual agreement.

Neither the current physical therapy curriculum at Dutch universities of applied science (HBOs) nor the available post-graduate programs can guarantee that physical therapists have sufficient expertise regarding cognitive rehabilitation. The guideline development team therefore recommends that, before initiating treatment, the physical therapist should consult an expert (usually an occupational therapist or a (neuro)psychologist) about the way the treatment should take account of the patient's functional neuropsychological problems. In some cases the physical therapist may have to transfer the treatment to a practitioner from another care discipline, who is more competent in this respect. This implies that physical therapy does not claim these subject areas for itself, but collaborates with those in the treatment team who possess the specific expertise required.
Nevertheless, the approach at stroke units is increasingly becoming transdisciplinary, with any discipline that happens to be treating a patient at a particular moment also knowing about the treatment protocols used by other disciplines within the team. This means that any member of the team looks at the patient's overall situation, regardless of their professional background. In the case of physical therapy, this means that the therapist does not focus purely on the musculoskeletal system, but also looks at complications not directly related to their own discipline. Examples include the presence of swallowing problems, de development of deep vein thrombosis and pressure sores, and the presence of involuntary twitches due to epilepsy. The coordination and collaboration with the speech therapist relates to the treatment goal of 'being able to sit up', in order to prevent swallowing problems, while the coordination and collaboration with the nursing staff relates to the treatment goals of getting the patient out of bed and getting them to be active outside the bed.

Training, refresher courses and maintaining skills
In view of the complexity of the potential disorders and the great heterogeneity of this category of patients, effective treatment requires a physical therapist to have highly specialized skills. A physical therapist is expected to possess knowledge and skills regarding the diagnostic process, the functional prognostics, the available evidence for physical therapy interventions and the selection of recommended measurement instruments. In addition, a physical therapist must be able to draw up a feasible and realistic treatment plan and to evaluate it. This requires knowledge of basic subjects like anatomy and neuroanatomy, pathophysiology and neuropathophysiology, movement coordination and various forms of motor learning. This knowledge is provided by postgraduate training programs. Since the basic physical therapy curriculum does not include sufficient practical training to enable therapists to effectively treat patients with a stroke, they also need training in neurorehabilitation, and specifically in stroke rehabilitation.
The training program must always include supervised implementation of these components of the physical therapy process. Physical therapists must also keep up with new developments in training programs and relevant research in neurorehabilitation.
In any case, it is the individual physical therapist who remains ultimately responsible for maintaining their expertise in treating patients with a stroke. An essential precondition for this is regularly treating several patients. In the opinion of the professional association, the external advisory group and the experts consulted for the development of this Guideline, a physical therapist should treat at least five stroke patients a year in order to be sufficiently qualified.

The physical therapist's expertise *4*

In the opinion of the guideline development team, effective physical therapy for patients with a stroke requires knowledge and experience. A necessary condition for sufficient expertise is that physical therapists treating patients with a stroke should receive sufficient additional training and treat stroke patients on a regular basis. (Level 4)

Context and interpretation

The guideline development team recommends postgraduate training courses in neurorehabilitation, focusing on stroke and including the teaching and supervised practice of basic subjects like (neuro)anatomy, (neuro)physiology, movement control and motor learning, and evidence regarding all parts of the physical therapy process. A physical therapist should treat at least five stroke patients a year in order to be regarded as sufficiently qualified.

In addition, the guideline development team recommends that each physical therapist should be a member of a regional stroke network in which expertise is exchanged and responsibilities are coordinated, in order to ensure quality and continuity of care.

The criteria for postgraduate training courses and the minimum annual number of patients to be treated will probably be further tightened in the coming years.

B.2 Intensity of exercise therapy

In the context of this Guideline, intensity of exercise therapy means 'the number of hours spent on exercise therapy'. The advantage of this definition is that treatment time is easy to measure. The disadvantage is that the actual number of repetitions and the amount of energy spent remain unclear. Intensification thus means an increase in the number of hours spent on exercising relative to the regular number of hours. There is evidence of undertreatment in practice.

The intensity at which patients exercise, expressed as duration and frequency of training, is positively associated with the rate at which, and possible with the degree to which, the patient recovers their motor functions and ADL skills. This concerns exercises without the use of special equipment or complex devices. A higher treatment intensity appears to have a favorable effect on the functional outcomes. This effect has been found for walking and walking-related abilities and dexterity, in all phases of rehabilitation, but is more pronounced within the first two months after the stroke occurs.

The exercise therapy dosage does not show any ceiling effects. In practice, this means that, depending on the patient's physical condition and ability to learn, stroke patients should preferably be treated several times a day during the rehabilitation process, including weekends. The treatment sessions should be led by a physical therapist with the necessary expertise, or be delegated by a therapist with the required expertise in neurorehabilitation and stroke. In addition, patients should be given every opportunity to exercise outside of the scheduled treatment sessions, whether or not with the help of an informal caregiver. Just like patients in the early post-stroke phases, those in the chronic phase should also be treated with sufficient intensity.

Intensity of exercise training *5*

◐ It has been demonstrated that increasing the intensity of therapy (in terms of more hours of exercise) for patients with a stroke, compared to less intensive exercising, results in more rapid recovery of *selective movements*, *comfortable walking speed*, *maximum walking speed*, *walking distance*, *muscle tone*, *sitting and standing balance*, performance of *basic activities of daily living*, and *severity of depression and anxiety*. (Level 1)
Studied for ER (✓), LR (✓), RC (✓).

Context and interpretation

The effects that have been found relate mostly to exercise therapy aimed at walking ability and walking-related functions and activities. It is as yet unclear whether the effects of intensifying exercise therapy persist in the longer term.

The guideline development team recommends that patients with limitations of basic ADL activities (<19 points on the Barthel Index) should be enabled during their admission to exercise for at least 45 minutes a day, whether or not supervised by a physical therapist and/or occupational therapist. The treatment sessions should be led by a physical therapist who has the necessary expertise to treat stroke patients, or be delegated to another therapist by a supervising physical therapist with the required expertise. In addition, patients should preferably be enabled to exercise outside the scheduled therapy hours, for instance integrated in nursing care, if the patient's situation and the available facilities allow this. Just like patients in the early post-stroke phases, those in the chronic phase should also be treated with sufficient intensity if physical therapy is indicated.

The duration and intensity of rehabilitation will have to be established for each individual patient in consultation with the patient and the care providers involved (including the patient's neurologist and rehabilitation physician).

B.3 Task and context specificity of training effects

The training effort for stroke patients should as much as possible be aimed at learning or re-learning skills that are important for the patient's everyday life. The principle of the specificity of treatment effects in patients with a stroke relates not only to the actual movements made while exercising, but also to the environment (context) in which they are practiced. The training program for many patients will, however, initially have to be at the level of body functions, in order to enable them to perform activities.

Skills should preferably be trained at the patient's own domestic or work environment. Research has shown that early supported discharge with the aim of continuing the treatment at the patients' home does not reduce the quality of life of patients or their informal caregivers. This usually concerns patients with moderate or mild impairments with a Barthel Index of 10 points or higher.

From an economic point of view, there are indications that early supported discharge with the necessary care provided at the patient's home (informal care, physical therapy, and occupational therapy), assisted where possible by e-health facilities, is cheaper than regular inpatient of outpatient care.

Task specificity of training effects *6*

It has been demonstrated that training specific skills, such as exercising balance while standing and reaching to grasp objects, has a favorable effect on the specific skill being trained by stroke patients, in all phases of rehabilitation. Transfer to other skills, which were not specifically trained during the therapy, has however hardly been demonstrated. (Level 1)

Context specificity of training effects *7*

It has been demonstrated that training stroke patients in a functional context has a favorable effect on learning specific movements or skills, regardless of the patient's rehabilitation phase. If possible, patients with a stroke should preferably be rehabilitated in their own domestic and community environment. (Level 1)

B.4 Neurological exercise methods or treatment concepts

Recent decades have seen the development of various neurological treatment methods, each with its own theoretical background, from which the developers tried to understand and guide movements. These methods are often contradictory in terms of theoretical and practical development.
This is because the various methods involve different interpretations of the coordination impairments and the patterns underlying movement behavior, as the required basic knowledge is lacking.
At the time of publication of the present Guideline, nine different neurological exercise concepts for the treatment of patients with a stroke are commonly applied in physical therapy worldwide, namely:

- 'Neuro Developmental Treatment' (NDT), also known as the Bobath concept;
- Proprioceptive Neuromuscular Facilitation (PNF);
- Brünnstrom's concept;
- Rood's concept;
- Ayres' concept;
- Johnstone therapy;
- 'Motor Re-learning Program' (MRP);
- Perfetti's method;
- Affolter's method.

Around 2002, over 80% of physical therapists in the Netherlands were assumed to be working according to the principles of the Bobath concept in treating patients with a stroke. No information is available on the percentage prevailing at the time of publication of the present Guideline. There is, however, no evidence for preferring any particular method, including the Bobath concept, over the others. Most studies have even shown that interventions based on the Bobath concept are less effective than the control interventions. Nor have controlled kinematic studies shown that the quality of the movement control is demonstrably influenced by following a particular concept. For the time being, the assumption is that none of the treatment concepts is preferable to the others in terms of functional recovery. There are, however, indications that patients with a stroke remain longer at a stroke unit if they are treated strictly in accordance with the Bobath concept.

There is a lack of scientific evidence especially as regards aspects that are regarded as preconditions in some exercise concepts, such as: (1) the presence of associated movement patterns; (2) control of muscle tone for posture and movement; and (3) symmetry of movement. As no added value has been proven for any of these neurological exercise methods, the guideline development team recommends using an eclectic treatment approach, focusing on direct learning of the actual intended functional skill.

Neurological exercise methods or treatment concepts (NDT/Bobath) *8*

◐ It has been demonstrated that neurological exercise methods or treatment concepts (NDT/Bobath) are no more effective for patients with a stroke at the body functions and activities levels than other treatment methods. (Level 1)
Studied for ER (=), LR (=), RC (=).

Context and interpretation

Direct comparisons of the effect of exercise therapy according to the Bobath concept with the effect of other interventions have often found these other interventions to be superior. These other interventions include mCIMT, bilateral arm training, bilateral arm training with rhythmic auditory cueing (BATRAC), robotics for the paretic arm, task-specific training, robot-assisted gait training, multisensory training, muscle strength training, training sitting balance with visual feedback, walking with rhythmic auditory stimulation, therapy based on the principles of the motor re-learning program or problem-willing oriented movement.
The guideline development team recommends using an eclectic treatment approach, by selecting a suitable evidence-based intervention for each individual patient, based on their clinical and other characteristics. In most cases, the emphasis will be on the actual learning of functional skills.

B.5 Motor learning principles

There are various schools of thought in physical therapy regarding the development of motor learning. The main theoretical models include: reflex theory, the hierarchical or phylogenetic model, motor programming theory, (dynamic) system theory, dynamic action theory, ecological theory and process-oriented models.
Interestingly, many neurological exercise methods, like the Bobath concept, the Brunnstrom method and the Johnstone method, have based their theory on the concepts prevailing at the time, such as the reflex theory and the hierarchical theory of motor learning, whereas the concepts developed later, such as dynamic system theory and ecological theory, have only been sparingly integrated in physical therapy. Furthermore, the skills to which the more recent theories are applied are often limited by the fact that it is necessary to define in advance the order and control parameters, like walking speed or frequency, when guiding a repetitive movement like walking.
Unfortunately, none of the above approaches offers a sufficient explanation of the motor problems encountered by patients with a stroke. Nor do these models offer a universal solution that physical therapists can use to effectively determine the structure of the therapy for each motor problem.
Ten different PhD projects from the three framework research

programs initiated by the Netherlands Organization for Scientific Research (ZonMW) over the past 15 years have shown that the recovery of functionalities like sitting, standing, walking and dexterity can only be explained from patients learning to cope with existing functional losses (adaptation strategies), while functional recovery within the first 12 weeks can be explained by spontaneous neurological recovery. The results of animal experiments are consistent with the possibility that early functional exercising during the first weeks and up to three months after a stroke can result in better neurological recovery. So far, however, no evidence for this assumption is available from human studies.
There have not yet been any controlled effect studies to find out which theoretical model is the most effective for which skill, for which stroke patients, and in which phase. What has been shown is that the suitability of a particular motor learning model is greatly affected by the characteristics of the task to be learned. For example, the dynamic system (or action) theory has been found to offer a good concept for a better understanding of the deviant hemiplegic gait in cyclic or repetitive movements like walking. A good example of this is the use of external visual, somatosensory and auditory rhythms. Stability and flexibility of movement patterns and the use of control parameters like speed and/or rhythm, which determine the frequency coupling between arm and leg swing (order parameter), can be utilized in physical therapy, for instance to improve the symmetry of the hemiplegic gait. On the other hand, dynamic system theory is less easily applied to single or discrete actions, like getting dressed or throwing a ball. The motor programming theory would be much more suitable for these actions. And the ecological theory, which relates to the interaction between task and environment, is more suitable for attempts to manipulate the patient´s environment to facilitate certain movements, for instance adjusting the height of a chair for a patient who has trouble standing up.
All this shows that knowledge of motor learning theories in physical therapy, provided it is correctly interpreted, could guide the physical therapy strategy for patients with a stroke. The real value added by these models for learning skills has, however, hardly been investigated.

Despite the lack of applied research into the significance of choosing a particular concept, what can be said is that a number of elements determine the efficacy of motor learning:

- The *exercises* need to be tailored to the individual patient, which means they should neither be too easy nor too difficult.
- The exercises should involve sufficient *repetition*, which should however not affect the natural variation of movements (the 'repetition-without-repetition' principle).
- There should be frequent and sufficiently long *periods of rest* between the sessions and repetitions.
- The therapist should give *feedback* (both verbal and non-verbal) on the performance of the movement that is being learned ('knowledge of performance'), with decreasing frequency.
- The patient's *motivation* to learn should be stimulated by offering them information about the goal, the coaching and the provision of (positive) feedback.
- The exercises must be carried out in a *meaningful* environment.
- Complex multiple movements, like getting dressed, which involve more declarative learning, should be addressed by *segmenting the motor action into its constituent components*, whereas automatic movements (such as walking) should preferably not be presented in fragmented form. Procedural learning of movements that are normally performed automatically should focus on the results of the action, while declarative learning should focus on the performance of the movement.

Motor learning *9, 10*

It is plausible that improvements in functional skills like sitting, standing, walking, and dexterity are brought about by learning adaptation strategies. (Level 2)

It is plausible that functional exercise therapy in an environment that is as relevant as possible to the patient (context-specific tasks) has a favorable effect on the specific skill to be learned. A combination of variation and sufficient repetition (repetition-without-repetition) has proved to be an important element of effective learning processes. (Level 2)

Context and interpretation

The guideline development team recommends taking account of all known elements of effective motor learning in the rehabilitation of patients with a stroke.
The task to be learned also has to be relevant and meaningful to the patient, and the exercises have to be offered at a level of difficulty that is just manageable for them (i.e. at the limits of their ability). Finally, the exercises have to include enough repetition, while retaining sufficient variety and allowing enough periods of rest. Patients must be given frequent feedback on their performance and the results of their movements. This feedback can be provided in verbal or non-verbal form.

B.6 Teleconsultation/telerehabilitation

A recent technological development in health care is that of teleconsultation, which involves keeping in contact with patients through telecommunication, e.g. by phone or video link.
This allows patients to be counseled from a distance.
Telerehabilitation involves patients taking control of their own treatment to a larger extent than usual, as they have to perform exercises on their own or with the help of an informal caregiver, and have to regularly evaluate their progress and performance with the physical therapist. Patients can also take the initiative in contacting the therapist.
Teleconsultation can also be used for patient education, contacts with fellow patients and counseling informal caregivers.

Telerehabilitation/teleconsultation *11*

It is plausible that telerehabilitation/teleconsultation results in improved dexterity for patients with a stroke. (Level 2)

Context and interpretation

Telerehabilitation for patients with a stroke appears to be a promising method, as this form of rehabilitation addresses aspects like self-management, independent exercising, and empowerment of patients (and their partners) in their own domestic and community environment. There are also indications that telerehabilitation may be cost-effective, in that patients can be discharged sooner and physical therapists and other care providers do not incur traveling costs. It is as yet unclear which form of telecommunication is most effective for which subgroups of patients.

B.7 Self-management

Self-management involves enabling patients to cope with the physical, psychological, communicative, social, and lifestyle consequences of their disorder. This also includes the ability to monitor these consequences and coping with the medical or allied care treatments. Self-management is arranged jointly by the patient and their care providers. This may mean that the treatment is largely controlled by the care providers in the period shortly after the stroke, and control is gradually taken over by the patient and/or their informal caregiver(s) later.

Self-management by patients is also a crucial element of physical therapy treatment. The patients, and if applicable their informal caregiver, are regarded as much as possible as autonomous partners in the process. Self-management is one of the focal points not only in physical therapy, but also within the interdisciplinary care for chronic disorders.

Self-management can be regarded as effective if the patient is able to 'monitor their own health status and to show the cognitive, behavioral and emotional reactions that contribute to a satisfactory quality of life.' Many patients with a stroke, however, have cognitive and/or behavioral impairments which may preclude the most effective self-management.

Numerous self-management programs are available, which differ both in the form of presentation (individual or in groups) and in terms of content. Nearly all programs, however, involve information, goal-setting, problem solving and promoting self-efficacy. Self-efficacy is the expectation or conviction someone has regarding their ability to influence something or to achieve a particular goal. Self-management programs often include exercise therapy to promote the patient's self-efficacy, which is associated with aspects like 'ADL-independence', 'physical activity', 'depressive complaints' and 'quality of life'.

The Dutch Stroke Association (Nederlandse CVA-Vereniging *'Samen Verder'* - www.cva-vereniging.nl) facilitates self-management by offering education and organizing training days for patients and their partners and/or informal caregivers. The society´s general goal is to support patients as effectively as possible in their attempts to cope with the consequences of their stroke. Extensive information on self-management is also offered by the *'Zorgstandaard Cardiovasculair Risicomanagement'* (care guidelines for cardiovascular risk management) (www.vitalevaten.nl) and the *'Zorgstandaard CVA/TIA'* (care guidelines for CVA/TIA) (www.kennisnetwerkcva.nl).

Self-management *12*

It is plausible that self-management programs are effective in improving the self-efficacy, participation, and quality of life of patients with a stroke. (Level 2)

Context and interpretation

Interdisciplinary collaboration is important when offering self-management programs. Major elements of these programs include providing information, goal-setting, problem-solving, and promoting self-efficacy. The ideal content of such programs, as well as the moment after the stroke at which they should be offered and the way they should be presented, remain unclear.

Patients' initiative and control over their treatment can be facilitated in the context of physical therapy by actively engaging the patient in goal-setting and by using methods like telerehabilitation. Exercise therapy can also increase the patient's self-efficacy.

B.8 Secondary prevention: lifestyle programs involving physical training

Patients who have previously suffered a TIA or a mild stroke are at increased risk for recurrence or other cardiovascular disorders. The risk of recurrence is largely determined by the risk factors that are present. Many pharmacological interventions are available that can help reduce the risk of stroke among this group of patients, but risk factors like smoking and physical inactivity can also be reduced by non-pharmacological interventions such as lifestyle programs. Physical inactivity is not only a risk factor for recurrent stroke or other cardiovascular disorders, but also has an adverse effect on other – often also lifestyle-related – risk factors such as hypertension, insulin resistance and glucose intolerance.

Lifestyle programs are currently attracting increasing interest. These programs may involve various combinations of interventions, usually including lifestyle advice regarding diet, giving up smoking, losing weight and physical activity. In addition, they may include physical exercise interventions. Exercise and fitness programs have a favorable effect on hypertension, type 2 diabetes mellitus, elevated cholesterol levels ('low-density lipoprotein cholesterol' [LDL]), and overweight/obesity.

Lifestyle advice and active participation in exercise interventions are not yet routine recommendations for patients who have suffered a TIA or a stroke with no or only mild paresis ('minor stroke'). Nevertheless, these patients will benefit from supervised and structured aerobic exercise, just like patients with cardiovascular problems such as status after cardiac infarction of heart failure. Further information on secondary prevention is available in the *'Zorgstandaard Cardiovasculair Risicomanagement'* (care guidelines for cardiovascular risk management) (www.vitalevaten.nl) and the *'Zorgstandaard CVA/TIA'* (Care guidelines for CVA/TIA) (www.kennisnetwerkcva.nl).

Secondary prevention: lifestyle programs involving physical training *13*

It is plausible that the risk factors for stroke in patients with a history of TIA or 'minor stroke' are favorably influenced by lifestyle programs involving aerobic exercising. (Level 2)

Context and interpretation

Physical therapists play an important role in lifestyle programs to support secondary prevention for patients who have suffered a TIA or 'minor stroke', as regards screening patients and supervising the program. In view of the wide-ranging character of lifestyle interventions, interdisciplinary collaboration is preferable.

Elements of such programs include participating in aerobic exercising and advice regarding matters like smoking, alcohol

use, physical activity, and dietary patterns. The ideal content of lifestyle programs, as well as the moment after the stroke at which they should be offered and the way they should be presented, remain unclear.
Section F.1.17, 'Training aerobic endurance', discusses the selection of patients for aerobic training as well as the content of aerobic training programs.

B.9 Falls prevention

A fall can be defined as 'an unintentional change in body position resulting in a person coming to rest on the floor or another lower level surface'. Falls are frequent among patients with a stroke and may have bodily consequences, such as minor wounds but also hip fractures or head trauma. Patients may also develop a fear of falling, which may reduce their independence, physical activity level, and social participation. The frequency of falls among the stroke population is higher than that among healthy people of the same age: 15-40% of these patients fall during their stay at inpatient settings, and up to 70% of them fall during the first 6 months after the stroke, while falls also occur frequently during the chronic phase.
Risk factors for falls include severe hemiparesis, previous falls, balance problems, walking, and ADL limitations, depression and/or cognitive impairments.
Muscle power and balance training exercises have a favorable effect on the risk of falling among older adults living at home, and the same is true for multifactorial interventions (a combination of balance training, vitamin-D suppletion, adjustment of medication, adaptations to the home environment, special footwear or the use of walking aids and/or hip protectors). The efficacy of these training exercises and interventions for patients with a stroke has not yet been tested.

Falls prevention *14*

In the opinion of the guideline development team, all patients with a stroke need to be screened for elevated risk of falling, after which, if necessary, a preferably interdisciplinary, multifactorial treatment strategy can be designed. (Level 4)

Context and interpretation

Interventions relevant to physical therapists include advice on footwear and the use of walking aids, offering strength and balance training in the context of a falls prevention program, and increasing the patient's self-efficacy. The physical therapist should also take account of environmental factors and visual impairments. The ideal content of a multifactorial program remains unclear. The physical therapist's tasks also include detecting risk factors for falls that are beyond the physical therapy domain, such as orthostatic hypotension, and reporting such factors to the referring physician.

C Diagnostic process

The diagnostic process starts with the referral by a physician and the patient presenting to a physical therapist, followed by history-taking and physical examination, after which the process concludes with an analysis of the findings. A number of measurement instruments with their corresponding scoring forms are recommended for the objective assessment of aspects like neurological symptoms and the functional consequences of a stroke.
An intake form for diagnostic purposes has been developed (Appendix 2 in this Practice Guideline), which is also available online at www.fysionet-evidencebased.nl).
This form and the selected measurement instruments can be used by physical therapists working in primary, secondary and tertiary settings. A copy of the information obtained during the diagnostic process should be included in any physical therapy transfer file, to ensure the continuity of the recording of physical therapy data within a regional stroke service.
Clinical reasoning, that is, the ability to interpret measurement results of validated instruments and to take clinical decisions based on sound arguments, is not a foregone conclusion; it requires experience and expertise.

C.1 Referral, presentation, and history-taking

The following information needs to be recorded in the physical therapy file upon referral and presentation and from the findings of the subsequent history-taking: patient details, including name, date of birth, sex, national identification number (known as *burgerservicenummer* or BSN in the Netherlands) if applicable, address and medical diagnosis; details of stroke; type of stroke; location of stroke; hospital to which the patient was admitted; date of admission; patient´s educational level and occupation; information on the patient´s domestic situation; hobbies or daily activities; preferred hand; comorbidity; pre-existing motor and cognitive functioning; relevant history of medical and or psychiatric events; relevant medication and, where applicable, information about the patient´s partner and children. A survey of details to be recorded is available in the KNGF guideline on record keeping in physical therapy (*KNGF-richtlijn Fysiotherapeutische Verslaglegging*).
At the start of therapy, the physical therapist needs to know about the patient´s premorbid and current functioning, the presence of impairments and limitations/restrictions, the available social support and the patient´s presenting problem and expectations. Where possible, these data can be derived from the medical file, the nursing file and/or electronic patient file. If no information is available or the files are not accessible, the physical therapist should interview the patient in order to ascertain and evaluate the level of functional impairments such as paresis, range of motion, coordination, somatosensation, as well as limitations of activities like transfers, walking ability, dexterity, and ADL. If the patient is unable to provide the necessary information themselves, the therapist may ask their partner or informal caregiver.

C.2 Diagnostic assessment using measurement instruments

After the history-taking, the therapist draws preliminary conclusions and formulates hypotheses, which then form the basis for diagnostic procedures. The guideline development team recommends the use of a number of selected measurement instruments in order to objectively assess impairments of body functions, limitations of activities and restrictions of participation, as well as facilitating and impeding environmental factors. These instruments enable the therapist to assess treatment domains relevant for the patient at the levels of activities and participation, such as dexterity, walking and related abilities, basic and instrumental ADLs and

perceived quality of life. At the body functions level these may involve neurological functions, physical condition, psychological and neuropsychological functions, and fatigue.
Measurement instruments can be classified on the basis of their function, for instance instruments that mostly have a diagnostic, classifying, screening, and/or evaluating function. This Guideline subdivides the measurement instruments into basic instruments and recommended instruments. The basic instruments are a set of preferred instruments that record major impairments of body functions and limitations of activities, while the recommended instruments are optional. Some of the recommended instruments are intended to collect information within a domain that has already been objectively assessed by means of one of the basic instruments, and in that sense supplements the basic instruments. Most of the recommended instruments, however, cover other (but relevant) domains than those covered by the basic measurement instruments.
The physical therapist does not always have to conduct all the required assessments him/herself. Physical therapists can contact the other disciplines in the treatment team to try and arrive at a balanced division of tasks and hence of the time investment involved in assessments.
One of the preconditions for the use of nearly all of these instruments is that the patient should have sufficient cognitive abilities to understand the questions and follow instructions. If this is not the case, the therapist will have to rely exclusively on clinical observation (i.e. description) to record the impairments of body functions, limitations of activities, and restrictions of participation. Table 4 presents an overview of all measurement instruments. All instruments and the forms showing their clinimetric properties regarding patients with a stroke are available at www.meetinstrumentenzorg.nl.

C.2.1 Basic measurement instruments

The seven basic measurement instruments selected by the guideline development team serve to quantify: muscle strength on the hemiplegic side, trunk activity, balance, walking ability, dexterity, and basic ADL activities: (1) the 'Motricity Index' (MI), (2) the 'Trunk Control Test' (TCT), (3) the 'Berg Balance Scale' (BBS), (4) the 'Functional Ambulation Categories' (FAC), (5) the 10 meter walk test (10MWT) at comfortable walking speed, (6) the 'Frenchay Arm Test' (FAT) and (7) the 'Barthel Index' (BI). These instruments can be used for both diagnostic and evaluative purposes. They have been selected on the basis of their reliability, responsiveness, predictive and construct validity, and finally their practical feasibility. Not all measurements have to be taken during the same session; they can also be administered in stages, depending on the patient's physical condition and the severity of the stroke.

C.2.2 Recommended measurement instruments

In addition to the above basic instruments, this Guideline includes 21 recommended measurement instruments, which can be used in relevant situations. A physical therapist will select one or more of these instruments based on the patient's presenting problem and the corresponding treatment goals, and/or use them at their own discretion. Each measurement instrument has its own (limited) applications, and can be used for diagnostic, screening, and/or evaluation purposes, depending on the severity of certain symptoms, the time since the stroke and the place where the patient is being treated.
Recommended measurement instruments are: (1) the 'Fugl-Meyer Assessment' (FMA), (2) the 10-meter walk test (10MWT) at maximum walking speed, (3) the 6-minute walk test (6MWT), whether or not combined with the 'Borg Rating of Perceived Exertion' (Borg RPE), (4) the Trunk Impairment Scale (TIS), (5) the 'Timed Up and Go test' (TUG), (6) the 'Action Research Arm Test' (ARAT), (7) the 'Nine Hole Peg Test' (NHPT), (8) the 'Nottingham Extended ADL index' (NEADL), (9) the 'Stroke-Specific Quality of Life scale' (SSQoL), (10) the neutral-zero method (NZM) (goniometer), (11) the 'Modified Ashworth Scale' (MAS), (12) the Erasmus MC modification of the (revised) 'Nottingham Sensory Assessment' (EmNSA), (13) the 'National Institutes of Health Stroke Scale' (NIHSS), (14) the 'Numeric Pain Rating Scale' (NPRS), (15) the 'Falls-Efficacy Scale' (FES), and (16) the 'Fatigue Severity Scale' (FSS).
The Guideline also includes five recommended measurement instruments that are particularly used to detect and report impairments of body functions or environmental factors that do not primarily belong to the physical therapist's domain but may affect the physical therapy treatment, viz.: (17) the 'Hospital Anxiety and Depression Scale' (HADS), (18) the 'Montreal Cognitive Assessment' (MoCA), (19) the 'O-Letter Cancellation Test' (O-LCT), and (20) the 'Caregiver Strain Index' (CSI). Administering these screening instruments may be useful particularly if the therapist suspects an impairment within one of these domains, whereas no care provider with professional expertise in these particular domains is as yet involved in the treatment. The outcomes of these assessments can, provided they are implemented in an interdisciplinary approach, be used to ensure unambiguous and transparent communication between the team members, but also to detect and report as yet unnoticed problems that do not primarily fall within the physical therapy domain.
Finally there is (21) the 'Cumulative Illness Rating Scale' (CIRS) which classifies the degree and severity of multimorbidity.

Table 4. Domains and measurement instruments relevant to physical therapy, divided into basic instruments and recommended instruments.

Domain ICF level		**(H)AR**	**VR**	**LR**	**RC**
Walking and walking-related functions and activities					
Functions:					
MI for lower extremity	muscle strength	●	●	●	●
10MWT comfortable (FAC ≥ 3)	walking speed	●	●	●	●
FMA for lower extremity	selective movements	●	●	●	●
10MWT maximum (FAC ≥ 3)	walking speed	●	●	●	●
6MWT (whether or not combined with Borg RPE) (FAC ≥ 3)	walking distance, functional endurance	●	●	●	●
Activities:					
TCT	trunk activity	●	●	●	●
BBS	sitting and standing balance	●	●	●	●
FAC	walking ability	●	●	●	●
TIS	sitting balance	●	●	●	●
TUG (FAC ≥ 3)	walking ability	●	●	●	●
Dexterity and related functions and activities					
Functions:					
MI for upper extremity	muscle strength	●	●	●	●
FMA for upper extremity	selective movements	●	●	●	●
Activities:					
FAT*	dexterity	●	●	●	●
ARAT*	dexterity	●	●	●	●
NHPT*	dexterity	●	●	●	●
Basic ADLs					
Activities:					
BI**	basic ADLs	●[a]	●	●	●
Extended ADLs					
Activities:					
NEADL	extended ADLs	●[a]	●	●	●
Perceived quality of life:					
Participation:					
SSQOL	quality of life				●

Table 4. Domains and measurement instruments relevant to physical therapy, divided into basic instruments and recommended instruments. (contd.)

Domain ICF level		**(H)AR**	**VR**	**LR**	**RC**
Other:					
Functions:					
NZM	range of motion	●	●	●	●
MAS	resistance to passive movements	●	●	●	●
EmNSA	somatosensory impairments	●	●	●	●
NIHSS***	neurological impairments	●	●		
CIRS	multimorbidities	●	●	●	●
NPRS	pain experienced	●	●	●	●
FES	self-efficacy in maintaining balance	●	●	●	●
FSS[b]	fatigue			●	●
HADS[b,c]	anxiety and depression		●	●	●
MoCA[b]	cognitive functions	●	●	●	●
O-LCT[b]	neglect	●	●	●	●
Activities:					
MRS	functional status	●	●	●	●
Environmental factors:					
CSI[d]	caregiver strain		●	●	●

(H)AR = hyperacute or acute (rehabilitation) phase; VR = early rehabilitation phase; LR = late rehabilitation phase; RC = rehabilitation during chronic phase.
● *Phase in which the basic / recommended measurement instrument is administered.*

10MLT = Ten-meter walk test; 6MWT = Six-minute walk test; ARAT = Action Research Arm Test; BI = Barthel Index; BBS = Berg Balance Scale; Borg RPE = Borg Rating of Perceived Exertion; CIRS = Cumulative Illness Rating Scale; CSI = Caregiver Strain Index; EmNSA = Erasmus MC modification of the (revised) Nottingham Sensory Assessment; FAC = Functional Ambulation Categories; FAT = Frenchay Arm Test; FES = Falls-Efficacy Scale; FMA = Fugl-Meyer Assessment; FSS = Fatigue Severity Scale; HADS = Hospital Anxiety and Depression Scale; MAS = Modified Ashworth Scale; MI = Motricity Index; MoCA = Montreal Cognitive Assessment; mRS = Modified Rankin Scale; NEADL = Nottingham Extended ADL index; NIHSS = National Institutes of Health Stroke Scale; NHPT = Nine Hole Peg Test; NZM = Goniometer using the Neutral-Zero method; NPRS = Numeric Pain Rating Scale; O-LCT = O-Letter Cancellation Test; SSQoL = Stroke-Specific Quality of Life scale; TCT = Trunk Control Test; TIS = Trunk Impairment Scale; TUG = Timed Up and Go test.

a To assess the premorbid situation. b Intended to detect and report; treatment not primarily within the physical therapy domain.
c To be administered from 7 days after the stroke. d After patient is discharged home or after trial stay at home, provided an informal caregiver is present.
** Possibly to be derived from occupational therapy file. ** Possibly to be derived from nursing file. ** Possibly to be derived from medical file.*

C.2.3 Systematic measurements

The KNGF guidelines regard 'systematic measurements' as an integral part of evidence-based practice. Scheduled assessment points, starting at the first contact for treatment, provide clear information on the course of the illness and the rehabilitation process. Table 5 lists the recommended assessment points. The assessment points for the purpose of establishing a functional prognosis are discussed in Chapter D.

Table 5. Overview of recommended assessment points for the basic and recommended measurement instruments.

	(H)AR	VR	LR	RC
Basic measurement instruments				
Always to be administered:				
• during the diagnostic process	●	●	●	
• at conclusion of treatment period and when transferring a patient to another physical therapist	●	●	●	
• at the end of the first week, and 3 and 6 months after the stroke		●	●	
To be administered depending on context:				
• just before any interdisciplinary consultation (functional [rehabilitation] outcomes)	●	●	●	●
• timing of administration depends on patient's presenting problem and corresponding treatment goals, and/or at the physical therapist's discretion				●
Recommended measurement instruments				
To be administered depending on context:				
• timing of administration depends on patient's presenting problem and corresponding treatment goals, and/or at the physical therapist's discretion	●	●	●	●

(H)AR = hyperacute or acute (rehabilitation) phase; VR = early rehabilitation phase; LR = late rehabilitation phase; RC = rehabilitation during chronic phase.
● *Phase in which the basic or recommended measurement instrument is to be administered.*

The use of measurement instruments as part of clinical reasoning is important not only in that it enables the patient's current status to be objectively assessed, but is also important for the correct establishment and adjustment of functional goals (goal-setting). This is only possible by means of frequent administration of reliable and valid measurement instruments, which are sufficiently sensitive to objectively assess changes. This means that the assessment points should not be limited to the diagnostic process, but continue during the therapeutic process.

During the first 6 months after the stroke: hyperacute/acute phase, early and late rehabilitation phase
In the first 6 months, the basic measurement instruments are administered during: (1) the diagnostic process; (2) at the end of the first week; (3) after 3 months; and (4) after 6 months. They also have to be administered (5) at the end of the treatment period (including when the patient is transferred to another physical therapist). The guideline development team recommends that these instruments should also be used just before any interdisciplinary consultation, at moments linked to the patient's presenting problem and the corresponding treatment goals, and/or at the physical therapist's discretion.
Which of the recommended measurement instruments are relevant is determined by the patient's presenting problem and the corresponding treatment goals, and/or at the physical therapist's discretion.

Six months after the stroke: rehabilitation during the chronic phase
The timing and frequency of assessments during the chronic phase are largely determined by the changes expected or observed during the treatment. Both the basic and the recommended measurement instruments can be administered at the start of the physical therapy process and subsequently at moments determined by the treatment goals. The basic assumption is that functional changes (whether progress or deterioration) during the chronic phase could be a reason to continue, adjust, resume or terminate the treatment. The functional monitoring during the chronic phase is discussed in Chapter D.

Systematic measurements (monitoring) *15*

There are indications that systematic measurements (monitoring) using reliable and valid measurement instruments enhance the process of clinical argumentation and the continuity of care for patients with a stroke. (Level 3)

Context and interpretation
Any patient with a stroke should be systematically assessed in terms of body functions, activities, and participation prior to the start of the physical therapy process, preferably using reliable, valid, and responsive measurement instruments. These measurements should be administered at predefined moments during the physical therapy process, in order to objectively monitor the patient's clinical course.

D Functional prognosis

Prognosis as used in this Guideline refers to predicting the stroke patient's future functioning. These predictions are based on a combination of (preferably clinical) factors, also known as predictors or determinants, and can be used to inform patients and those near to them, as well as to support the clinical decision-making process. In addition, knowledge of the determinants can be used in selecting patients for care innovation projects and scientific research.

The functional recovery after a stroke follows a curve, with 80% of the recovery taking place in the first 3 months. In the context of prognostics, a rough distinction can be made between two phases in the disease course: the first phase covers the first 6 months after the stroke, while the second covers the subsequent period.

The first 6 months are generally characterized by functional recovery, with initial impairments of body functions and limitations of activities decreasing or even disappearing completely. In this phase, it is particularly the recovery potential which is important. It must be said that not all patients show equal recovery for all outcome measures (walking ability, dexterity and basic ADLs). A majority of patients will have a stable functional status during the chronic phase (after the first 6 months). Some patients, however, do show further progress or deterioration during this period. Hence, the emphasis during the chronic phase is on identifying patients who are likely to show further functional recovery, as well as those at risk for deterioration. Since the highest rate of recovery is seen in the first few weeks after the stroke, the predictors of functional prognosis regarding walking ability, dexterity and basic ADLs for the period following the first 6 months after the stroke will be different from those in the first 6 months after the stroke.

Table 6 lists the moments at which a functional prognosis can be established with the help of reliable and valid measurement instruments. The first functional prognosis for walking and dexterity should be established as soon as possible, but preferably on day 2 after the stroke, based on the determinants. A prognosis for basic ADLs should be established on day 5. If this initial prognosis is unfavorable, the determinants should be objectively assessed every week during the first month and monthly thereafter, up to 6 months after the stroke, as long as the prognosis remains unfavorable. Research into the determinants of functional changes after the first 6 months has been very limited. The predictors of walking ability and basic ADLs largely correspond. There are indications that a more advanced age, higher cortical function impairments, depression, fatigue and/or physical inactivity predict functional deterioration regarding walking ability and basic ADLs. Deterioration of dexterity is often seen among patients with incomplete recovery of dexterity, somatosensory function impairments and/or neglect. It is unclear what aspects can be used to predict further improvements during the chronic phase. The determinants and the corresponding recommended measurement instruments with predictive value for functioning 6 months after the stroke are listed in Table 7.

D.1 Prognostic determinants of functional recovery during the first 6 months

In view of the ever shorter stays at hospital stroke units, it is important to be able to accurately predict a patient's functioning as soon as possible, in order to provide correct advice for triage. In addition, it is important to reliably estimate the functional outcome during the first few days after the stroke, and to inform the patients and their relatives of this prediction, so they can implement timely home adaptations if necessary.

Longitudinal research has shown that 80% of the functional recovery takes place in the first 3 months after the stroke. On average, only 10-15% of patients still show clinically relevant improvements at the activities level.

If a patient shows functional deterioration within the first 6 months after the stroke, within the 95% confidence interval of the error of measurement, the team will have to investigate the underlying causes, which may include the development of secondary complications or comorbidities.

D.1.1 Walking ability

About 70-80% of patients with a stroke eventually regain the ability to walk independently. This implies that the prognosis for the recovery of walking ability is basically favorable. By far the greater proportion of recovery of walking ability takes place within 3 months after the stroke. There are indications that recovery of walking ability can to a large extent be predicted during the first 1-2 weeks after the stroke. For patients who are initially unable to walk independently, a favorable recovery of independent walking ability can even be accurately predicted during the first few days after the stroke, based on sitting balance (a score of 25 points on the sitting balance item of the Trunk Control test) and mild paresis of the leg (Motricity Index ≥25 points or a score of ≥19 on the motor part of the Fugl-Meyer Assessment for the lower extremity).

Clinical determinants for patients who do not meet these criteria

Table 6. Overview of assessment points for establishing a functional prognosis

Assessment points	(H)AR	VR	LR	RC
Measurement instruments always to be administered: • < 48 hours	●	●		
Measurement instruments to be administered if prognosis <48 hours is unfavorable: • weekly during the first month, monthly thereafter up to the 6th month after a stroke		●	●	
Monitoring changes (if recovery after 6 months incomplete): • biannually				●

(H)AR = hyperacute or acute (rehabilitation) phase; VR = early rehabilitation phase; LR = late rehabilitation phase; RC = rehabilitation during chronic phase.

● *Phase to which the assessment point applies.*

Table 7. Determinants and recommended measurement instruments to help establish a prognosis for the patient's functional status after the stroke.

Domain	**Determinants**	**Measurement instruments**	
		Administer at least:	Consider:
walking ability	sitting balance	TCT – sitting balance	
	motor function of leg	MI – lower extremity	FMA – lower extremity
	initial ADL skills		BI
	age		
	homonymous hemianopia		NIHSS – visual fields
	urinary incontinence		BI – bladder
	premorbid walking ability		FAC
	premorbid ADL skills		BI
dexterity	motor function of arm	FMA – finger extension MO – shoulder abduction	
	initial dexterity		FAT, ARAT
	neurophysiological outcome measures (MEO, SEP)		
basic ADLs	ADL at end of first week	BI (day 5)	
	initial neurological status, e.g. motor function of arm		NIHSS, MI – upper extremity
	age		
	initial walking ability		FAC
	premorbid ADL skills		BI
	premorbid participation		mRS
	recurrent stroke		

ARAT = Action Research Arm Test; BI = Barthel Index; FAC = Functional Ambulation Categories; FAT = Frenchay Arm Test; MEP = Motor-evoked potentials; FMA = Fugl-Meyer Assessment; MI = Motricity Index; mRS = modified Rankin Scale; NIHSS = National Institutes of Health Stroke Scale; SEP = Somatosensory-evoked potentials; TCT = Trunk Control Test.

will have to be assessed again in the course of the second week, as research has shown that predictions during the first few days after the stroke often result in too pessimistic a view for these patients. The chances of regaining independent walking ability are also determined by: initially reasonable ADL skills, younger age, absence of homonymous hemianopia, urinary continence and the absence of premorbid limitations of walking ability and ADLs.
Systematic literature reviews have shown that the above determinants of walking ability largely correspond to those for ADL-independence after a stroke.

Prognosis for walking ability 6 months after the stroke *16, 17*

It has been demonstrated that establishing an estimated prognosis for the patient's walking ability 6 months after the stroke requires their sitting balance (assessed with the sitting balance item of the Trunk Control Test) and the motor function of the leg (assessed with the Motricity Index) to be recorded as soon as possible, but preferably on day 2 after the stroke. (Level 1)

In the opinion of the guideline development team, patients who initially have an unfavorable prognosis for walking ability should be monitored weekly during the first 4 weeks and then monthly for 6 months after the stroke for recurrence of the above determinants, using reliable and valid measurement instruments. This remains necessary as long as a patient remains unable to walk independently. (Level 4)

D.1.2 Dexterity

About 40% of the patients with a stroke who have an initial paresis of the arm show some degree of recovery of dexterity 6 months after the stroke; 11–34% of this group have completely regained the use of the arm after these 6 months. The recovery of the paretic arm follows a more or less fixed pattern. Recovery of motor function is found to develop in a proximal-to-distal direction in most patients with a hemispheric stroke in the anterior circulation, although there are exceptions, for instance in patients with a stroke in the thalamus or in the anterior cerebral artery and in patients with a lacunar stroke. Characteristic features of this natural recovery include the early use of the trunk when grasping and lifting objects as well as proximal control from the shoulder. Patients use movement synergies that enable them to perform functional movements. This implies that the development of such synergies can be regarded as a favorable adaptive process, and that they should not be automatically regarded as pathological. A further development of decreasing dependence on synergies and the ability to make isolated/selective movements reflect the spontaneous neurological recovery.
If recovery of the paretic hand takes place, the gross grasp function is the first to return, followed by the extension grip and gross pinch. It is only in the final stages that fine pinch recovers. By far the greatest proportion of functional recovery is found to take place in the first few months after the stroke. Dexterity usually improves less prominently than walking ability, and the recovery of the arm is slower than that of the leg. Nevertheless, there are indications that the long-term dexterity outcome of the paretic arm is largely determined during the first 2 weeks after the stroke.
Functional recovery is highly associated with:

- the severity of the paresis, particularly as regards the finger extensors (Fugl-Meyer Assessment ≥1 point) and the shoulder abductors (Motricity Index ≥9 points), also known as the ‘SAFE’ model (Shoulder Abduction – Finger Extension);
- initial dexterity;
- neurophysiological measures like ‘motor-evoked potentials’ (MEP) and ‘somatosensory-evoked potentials’ (SEP).

Research has shown that over 90% of patients who show no voluntary grip function or extension function of the wrist and fingers after a critical period of 2 weeks will not show recovery of the dexterity at 6 months and 1 year after the stroke. However, an unfavorable prognosis cannot be established as accurately as a favorable prognosis.

Prognosis for dexterity 6 months after the stroke *18, 19*

It has been demonstrated that establishing an estimated prognosis for the patient’s dexterity 6 months after the stroke requires their capacity for finger extension (assessed with the Fugl-Meyer Assessment) and shoulder abduction (assessed with the Motricity Index) to be recorded as soon as possible, but preferably on day 2 after the stroke. (Level 1)

In the opinion of the guideline development team, patients who initially have an unfavorable prognosis for dexterity should be monitored weekly during the first 4 weeks and then monthly for 6 months after the stroke for recurrence of the above determinants, using reliable and valid measurement instruments. This remains necessary as long as a patient lacks dexterity. (Level 4)

D.1.3 Basic ADL activities

Depending on the definition used for independence in activities of daily living, an estimated 25–74% of patients with a stroke will continue to need some degree of assistance with ADLs in the long term. An analysis of the results of prognostic studies can be used to establish a trend that predicts the functional recovery of ADL-independence after a stroke. By far the most important predictor is:

- the level of ADL-independence at the end of the first week (as assessed by, e.g., the Barthel Index on day 5).

Other important independent determinants that can be assessed at an early stage include:

- initial neurological status (as assessed by the National Institutes of Health Stroke Scale; NIHSS), including paresis of the arm;
- age;
- initial walking ability;
- premorbid independence for activities;
- recurrent stroke.

Neither the patient’s sex, nor the presence of risk factors such as atrial fibrillation turn out to have predictive value in this respect. The same goes for the type of stroke (ischemic or hemorrhagic), the topographical subtypes (Oxford Community Stroke Project Classification: lacunar syndrome [LACS], partial anterior circulation syndrome [PACS], total anterior circulation syndrome [TACS], posterior circulation syndrome [POCS]), radiological variables, consciousness, dysarthria and premorbid level of participation. It is unclear whether there is an (independent) relation between recovery and impairments like homonymous hemianopia, visuo-spatial (hemi-) inattention and conjugate deviation of the eyes.

Prognosis for basic ADL activities 6 months after the stroke *20, 21*

It has been demonstrated that the ideal moment to estimate a patient’s chances of performing basic ADL activities 6 months after the stroke is to determine their Barthel Index at the end of the first week after the stroke, but preferably on day 5. The Barthel Index records what a patients actually does at the time of the assessment, not what they could potentially do. (Level 1)

In the opinion of the guideline development team, patients who initially have an unfavorable prognosis for basic ADL activities should be monitored weekly (4 times) during the first month and then monthly for 6 months after the stroke for recurrence of the above determinants, using reliable and valid measurement instruments. This remains necessary as long the patient is still dependent for basic ADL. (Level 4)

D.2 Prognostic determinants of changes during the chronic phase

A large percentage of patients experience long-term limitations of activities. Although the majority of patients show no further recovery during the period following the first 6 months after the stroke, some 10-40% of patients, depending on the outcome measure chosen, are found to show further improvements or gradual deterioration, beyond the 95% confidence interval of the measurement error. Significant deterioration or continued improvement justifies the continuation or resumption of physical therapy during the chronic phase.

D.2.1 Walking ability

About 20-30% of patients show improvement of walking ability beyond the 95% confidence interval of the measurement error during the chronic phase, while 10-20% show deterioration. Unlike the early determinants of the recovery of walking ability during the first 6 months after the stroke, predictors of changes in walking ability during the chronic phase have been the subject of only a few cohort studies. After a stroke, patients are always at risk for deterioration of walking ability, both after the first few months of inpatient rehabilitation and after they have been in the chronic phase for some time. More advanced age, higher cortical function impairments, depression, fatigue, and/or physical inactivity appear to predict functional deterioration regarding walking ability and basic ADLs. The cohort studies that yielded these findings, however, were of moderate methodological quality, so the results have to be interpreted with caution.
As yet, no predictors of improvement in the period following the first 6 months after the stroke are known.

Prognosis for functional changes in walking ability in the period following the first 6 months after the stroke *22-24*

In the opinion of the guideline development team, an indication of possible further changes in walking ability for patients during the chronic phase who have a Functional Ambulation Categories (FAC) score of 3 or more at 6 months after the stroke can be obtained by having them do the 10-meter walk test at comfortable speed every 6 months. A meaningful change can be defined as a change in the walking speed of at least 0.16 m/s relative to the speed attained 6 months after the stroke. (Level 4)

In the opinion of the guideline development team, patients in the chronic phase who still have a limited walking ability in the period following the first 6 months after the stroke should be monitored for their functional performance regularly (every 6 months). (Level 4)

In the opinion of the guideline development team, the fact that a patient in the chronic phase shows significant functional changes at the level of activities justifies continuation or resumption of physical therapy. (Level 4)

D.2.2 Dexterity

About 10-15% of stroke patients show improvement of dexterity beyond the 95% confidence interval of the measurement error during the chronic phase. Patients who have some dexterity at 6 months after their stroke but have not fully recovered (i.e. show incomplete recovery of the upper extremity), and patients with somatosensory impairments and visuospatial neglect of the paretic body side prove to be at risk for 'learned non-use'. They tend to use the paretic arm and hand less when performing activities of daily living than might be expected from their motor performance. In the long term, 10% of this group show deterioration of dexterity.

Prognosis for functional changes in dexterity in the period following the first 6 months after the stroke *25-27*

In the opinion of the guideline development team, an indication of possible changes in dexterity for patients during the chronic phase with a Frenchay Arm Test score of 1-4 points 6 months after the stroke, and with somatosensory functional impairments and/or hemispatial neglect, can be obtained by evaluating their dexterity every 6 months (preferably by means of the Action Research Arm Test [ARAT]), as these patients are at risk for 'learned non-use'. A meaningful change can be defined as a change in the ARAT score of at least 6 points relative to the score obtained 6 months after the stroke. (Level 4)

In the opinion of the guideline development team, patients in the chronic phase who still have a limited dexterity in the period following the first 6 months after the stroke should be monitored in terms of functioning regularly (every 6 months). (Level 4)

In the opinion of the guideline development team, the fact that a patient in the chronic phase shows significant functional changes at the level of activities justifies continuation or resumption of physical therapy. (Level 4)

D.2.3 Basic ADL activities

About 10-15% of patients show significant improvement in basic ADLs during the chronic phase, while about 5-40% deteriorate in this respect.
Two large prospective cohort studies found that ADL-independence decreases during the chronic phase, with the greatest deterioration taking place about 2 to 3 years after the stroke. This is also true for patients who did have basic ADL skills at 6 months after their stroke. There have, however, been few studies to identify determinants of deterioration of these ADL skills in the long term. There are indications that more advanced age, higher cortical function impairments, depression, fatigue, visual impairments and/or physical inactivity are functional predictors of deterioration of basic ADL skills. The cohort studies that yielded these determinants were, however, of moderate methodological quality, so that the results have to be interpreted with some caution.

Prognosis for functional changes in ADL erformance in the period following the first 6 months after the stroke *28–30*

In the opinion of the guideline development team, an indication of possible changes in the performance of ADL activities during the chronic phase can be obtained by determining the Barthel Index (BI) every 6 months. A meaningful change can be defined as a change in the BI score of at least 2 points relative to the score obtained 6 months after the stroke. (Level 4)

In the opinion of the guideline development team, patients in the chronic phase who still have ADL limitations in the period following the first 6 months after the stroke should be monitored in terms of functioning regularly (every 6 months). (Level 4)

In the opinion of the guideline development team, the fact that a patient in the chronic phase shows significant functional changes at the level of activities justifies continuation or resumption of physical therapy. (Level 4)

E Pre-mobilization phase

E.1 Definition of pre-mobilization

The pre-mobilization phase is defined as 'the phase in which the medical strategy is to keep the patient in bed.' Interdisciplinary collaboration with the nursing team and others is very important during this phase; in addition, it is important to keep the pre-mobilization phase as short as possible.
The physical therapy interventions described in this chapter also apply to patients who are already mobilizing, but who are inactive during the greater part of the day.

E.2 Prognosis and natural course during the pre-mobilization phase

All patients should be admitted to a hospital stroke unit for further diagnostics as soon as possible, but not later than 4.5 hours after the stroke, so that intravenous thrombolysis (with recombinant Tissue Plasminogen Activator or rTPA) can be considered if the patient has a cerebral infarction. The physical therapy care during the hyperacute/acute phase may be different for each patient. The aim is always to keep the bed-bound phase as short as possible, and to start mobilizing each patient within 24 hours after the stroke, in order to prevent secondary complications.

E.3 Diagnostics and care in case of complications during the pre-mobilization phase

Secondary complications include: (1) fever, (2) airways and urinary tract infections, (3) pressure sores, (4) pain, (5) deep vein thrombosis (DVT), (6) cardiac complications such as arrhythmias and myocardial infarction, (7) gastro-intestinal complications, and (8) depression. These complications are especially associated with a reduced level of consciousness, advanced age, urinary incontinence, pre-existing impairments and massive hemispheric strokes due to ischemia (total anterior circulation or TACT) or hemorrhages.

E.4 Duration of pre-mobilization phase

Although the aim is early mobilization, rapid mobilization of patients with a reduced level of consciousness or certain complications may not always be desirable. Nor is rapid reactivation the preferred strategy in: (1) intracerebral hemorrhage, in view of the risk of exacerbation of the hemorrhage due to elevated blood pressure, and (2) subarachnoid hemorrhage, in view of the risk of recurrence.

Duration of premobilization phase and early start of rehabilitation *31, 32*

There are indications that the duration of the premobilization phase may vary from a few hours to many weeks, and depends on aspects like the presence of fever, cardiac instability and general malaise, and a reduced level of consciousness. (Level 3)

It is plausible that starting rehabilitation as early as possible (preferably within 24 hours after the stroke occurred) accelerates and enhances functional recovery. (Level 2)

E.5 Physical therapy during the pre-mobilization phase

The role of physical therapists in the interdisciplinary team during the pre-mobilization phase consists of advising, monitoring and where necessary treating. This may involve:

- recommending the ideal body position in the bed, which should also be perceived as comfortable by the patient;
- offering advice about establishing and monitoring an effective program of changes in body position, e.g. in order to prevent pressure ulcers, edema of the hand and shoulder pain, taking account of the optimum position of the paretic shoulder and the preferred drainage positions, and where necessary encouraging the nurses to fully implement this program;
- monitoring any functional impairments such as paresis, somatosensory impairments, resistance to passive movements and range of motion;
- ensuring and maintaining optimized pulmonary ventilation and sputum clearance.

There is no consensus as to the ideal body position in bed. For the time being, the aim is to ensure a position that the patient finds comfortable and that reduces the risk of unilateral (point) pressure. Daily or otherwise frequent contacts with the patient enable the physical therapist to recognize common complications, such as deep vein thrombosis (DVT), involuntary twitches (epileptic activity) and pneumonia, at an early stage.
The physical therapist has an important function in detecting and reporting problems. Finally, the physical therapist needs to monitor the patients, recording the level of physical and cognitive progress or deterioration and where necessary reporting this to the rest of the team.

Body position in bed *33*

In the opinion of the guideline development team, the stroke patient's body position in bed should be such that it is perceived as comfortable. (Level 4)

Edema of the hand *34*

It is plausible that intensive intermittent pneumatic compression (IPC) of the paretic lower arm in the early rehabilitation phase is not more effective in relieving edema of the hand than other interventions for patients with a stroke. (Level 2)

Preventing pressure ulcers *35*

There are indications that the risk of pressure ulcers for stroke patients in the premobilization phase is reduced by frequently changing their body position in the bed. The risk of pressure ulcers can also be reduced by checking skin areas exposed to point pressure (heel and coccyx) on a daily basis. (Level 3)

Preventing bronchopneumonia *36*

There are indications that regularly changing a stroke patient's body position in the bed during the premobilization phase reduces the risk of bronchopneumonia. (Level 3)

Pulmonary ventilation *37*

It remains unclear whether breathing exercises and manual chest compression are more effective in optimizing the pulmonary function and sputum clearance of patients with a stroke than other interventions. (Level 3)

Training inspiratory muscle strength *38*

It remains unclear whether training the inspiratory muscle strength of patients with a stroke is more effective than other interventions. (Level 1)

(Supervised) active exercises *39*

There are indications that exercising (reactivation) during the premobilization phase is an effective intervention for patients with a stroke. (Level 3)

Detecting deep vein thrombosis *40*

In the opinion of the guideline development team, stroke patients in the premobilization phase should be checked daily for symptoms of edema, painful calf, local redness and heat, and fever, as these could indicate deep vein thrombosis (DVT). The risk of DVT can be reduced by mobilizing the patient (i.e. making them stand up and/or walk) immediately after the stroke, if possible, under the supervision of a physical therapist. (Level 4)

Early involvement of informal caregiver(s) *41*

There are indications that the rehabilitation process can be optimized by informing the stroke patient's informal caregiver at the earliest possible occasion about what the patient can and cannot do. (Level 3)

F Mobilization phase

An important goal of rehabilitation after a stroke is to enable patients to be discharged home, or if this proves impossible, to another place of their own preference, such as a nursing home, a home for the elderly, sheltered accommodation or an apartment with facilities for special care services. This implies that patients will have to be as independent as possible in their activities of daily living, both indoors and outside.
This chapter discusses the interventions that can be implemented during the mobilization phase. Based on the ICF classification, this phase can be subdivided into the domains that physical therapy is concerned with: (1) walking ability and other mobility-related abilities, (2) dexterity and (3) ADLs.
Physical therapy during the mobilization phase concentrates on optimizing the patient's activities, such as (1) maintaining and changing body positions, (2) independent walking, including walking outdoors, crossing streets, using stairs etc. (3) using some means of transportation, (4) using the paretic arm, (5) self-care and housekeeping, and (6) leisure time pursuits and sports. This does not imply that only exercises at the activity level are used. Sometimes it may be necessary to train functions that are preconditional to activities.
The physical therapist should select interventions not only on the basis of their efficacy, but also on the basis of the determinants that predict recovery. Hence the therapist should, in the first 6 months after the stroke, assess the determinants predicting the recovery of the patient's walking ability during these 6 months. For the same reason, the physical therapist should also monitor, if applicable, the patient's functioning during the chronic phase. The factors predicting the patient's functioning are described in Chapter D.
The interventions during the mobilization phase relate to walking ability and all other mobility-related abilities, as well as the aids used for these abilities, dexterity and the recovery of ADLs. Aids serve to enhance safety and independence when the patient changes their body position, remains in a standing position or moves from one location to another. Cognitive rehabilitation is also started during the mobilization phase, but since the physi-

cal therapist participates in a team that provides the cognitive rehabilitation, this type of rehabilitation is discussed in a separate chapter (Chapter G, 'Cognitive Rehabilitation').
Within each of the sections below, the interventions are grouped according to the level of evidence. The interventions for which Level 1 evidence is available are discussed in detail, while for the interventions for which Level 2 evidence exists, only the recommendation concerning the intervention is given, along with a description of the context and interpretation of the recommendation. The RCTs on which the recommendations are based are discussed in Appendix 1 of the document called *'Verantwoording en Toelichting'* (review of the evidence; in Dutch).
The first sections below discuss the interventions aimed at walking ability and other mobility-related abilities for which Level 1 evidence (F.1) or Level 2 evidence (F.2) is available, while Section F.3 discusses the interventions relating to aids that can be used during the mobilization phase. Sections F.4 and F.5 then discuss the interventions aimed at recovery of dexterity for which Level 1 and Level 2 evidence, respectively, is available. Finally, Section F.6 discusses the interventions aimed at recovering ADLs.

F.1 Interventions aimed at walking ability and other mobility-related functions and abilities during the mobilization phase (Level 1)

F.1.1 Early mobilization from the bed

Early mobilization has been defined as 'mobilizing a patient from the bed within 24 hours after the stroke, and encouraging them to practice outside the bed.'
The goal of early mobilization is to reduce the time that elapses between the stroke and the first time the patient leaves the bed, and to increase the amount of physical activity that the patient engages in outside the bed. There is no consensus about the precise meaning of very early mobilization or about who should be responsible for the decision to implement it. In the context of this Guideline, very early mobilization means getting the patient out of bed within 24 hours and having them engage in active practice while out of bed.
Many patients remain inactive outside of therapy hours during the first 2 weeks after a stroke, and are often in a one-bed room, especially when admitted to a general ward at a hospital. Admission to a stroke unit would probably improve the prognosis regarding survival, ADL-independence and living independently after the rehabilitation period. The efficacy of stroke units is attributed to the more systematic diagnostics applied there, as well as the strategy of early activation and interdisciplinary rehabilitation. Early mobilization and rehabilitation are assumed to be particularly important components.

Early mobilization from the bed *42*

◐ It remains unclear whether early mobilization from the bed, i.e. within 24 hours after the stroke occurred, is more effective than later mobilization as regards *complications*, *neurological deterioration*, *fatigue*, *basic ADL activities* and *discharge home.* (Level 1)
Studied for (H)AR (=).

Context and interpretation

It remains unclear whether early mobilization is more effective than mobilization at a later stage, due to insufficient statistical power of the studies that have examined this.
As there are currently no indications that early mobilization from the bed has any *adverse* consequences for patients, regardless of the type and localization of their stroke, the guideline development team recommends mobilizing stroke patients from the bed within 24 hours after the stroke occurred, provided the patient's neurological and cardiovascular status has been judged by a neurologist to be sufficiently stable.
It remains unclear to what extent early mobilization reduces complication rates and improves basic ADL performance.

F.1.2 Exercising sitting balance

Sitting balance can be defined as 'achieving, maintaining or restoring stability during a seated position or activity.'
In rehabilitation, a satisfactory sitting balance is considered an important prerequisite for functional daily activities, such as getting dressed, reaching and eating. In addition to maintaining sitting balance, whether or not while reaching and grasping, reducing the asymmetric distribution of body weight while sitting is regarded as an important part of the treatment.

Exercising sitting balance *43, 44*

◐ It has been demonstrated that exercising sitting balance by means of reaching exercises with the non-paretic arm improves the *sitting balance and speed of reaching from a seated position* of patients with a stroke. (Level 1)
Studied for ER (=) and RC (=).

◖ It has been demonstrated that training sitting balance using reaching exercises for the non-paretic arm in a seated position does not improve the *symmetry of the ground reaction forces* of stroke patients. (Level 1)
Studied for ER (=) and RC (=).

Context and interpretation

The guideline development team recommends exercising sitting balance by means of reaching exercises for the non-paretic arm, teaching the patient to reach beyond the supporting surface (i.e. beyond arm's length) and to become aware of their own body posture.
It remains unclear to what extent sitting balance exercises improve the patient's ability to stand up from a seated position and/or their walking ability.
There is no reason to assume that the effects, or lack of effects, of exercising sitting balance will not also occur in the late rehabilitation phase.

F.1.3 Exercising standing up and sitting down

Standing up and sitting down can be defined as 'moving the body centre of gravity (BCoG) from sitting to standing position and vice versa without loss of balance.'
Being able to rise from a chair by oneself is an essential part of many ADL activities, such as getting dressed, going to the toilet and walking. Aspects that might influence standing up can be divided

into factors that relate to the chair (e.g. the height of the seat), the patient (e.g. muscle strength of the legs, balance) or strategy (e.g. speed, placing of the feet or attention).

Exercising standing up and sitting down *45*

◐ It remains unclear whether exercising standing up and sitting down is more effective as regards the *symmetric distribution of body weight* and the *ability to stand up and sit down* than other interventions for patients with a stroke. (Level 1)
Studied for ER (=) and RC (=).

Context and interpretation

It remains unclear whether exercising standing up and sitting down is more effective than the control intervention with which it was compared, due to insufficient statistical power of the studies that examined this.
Although it seems likely that repeatedly standing up and sitting down will increase the muscle strength of both the paretic and non-paretic legs, it remains unclear to what extent exercising standing up and sitting down improves the symmetry (left-right distribution) of the patient's body weight during these posture changes.
The effect on maintaining balance during activities is also unknown.

F.1.4 Exercising standing balance without visual feedback from a force platform

Standing balance can be defined as 'achieving, maintaining, or restoring stability during a standing position or activity.'
Balance problems may be caused by impairments of the organ of balance, and/or motor, somatosensory, visual, or cognitive impairments. They may involve reduced load bearing by the paretic leg, delayed or absent balancing reactions, and reduced postural anticipation of perturbations.
Standing exercises are often applied as part of the rehabilitation program after a stroke, as balance problems impede functional ADL-independence. The therapist can manipulate the circumstances during these exercises by varying the patient's dependence on visual information or varying the surface on which the patient stands. Standing frames are sometimes used as well.

Exercising standing balance without visual feedback from a force platform *46*

◐ It remains unclear whether exercising standing balance without visual feedback from a force platform is more effective as regards *standing balance*, *standing up and sitting down*, and *walking ability* than other interventions for patients with a stroke. (Level 1)
Studied for ER (=) and RC (=).

Context and interpretation

It remains unclear whether exercising standing balance without visual feedback from a force platform is more effective than the control intervention with which it was compared, due to insufficient statistical power of the studies which examined this.

F.1.5 Exercising postural control with visual feedback while standing on a force platform

A force platform allows patients to be given visual information on the distribution of their body weight over their two legs in the frontal plane and the position of the body's center of gravity while standing.
This information is obtained from pressure sensors that record the weight under each foot and the position of the body. The force platform consists of two separate force plates and offers a global representation of the vertical projection of the body's center of gravity (BCoG) on the supporting surface. During bilateral stance, this projection falls between the two feet, at the level of the os naviculare. The platform is connected to a computer screen visualizing the projection of the BCoG. The patient is standing with each foot on a force plate and is instructed not to move their feet while exercising.
Postural control is exercised by asking the patient to distribute their body weight symmetrically over the two legs (i.e. static balance) or to shift their body weight within the sagittal or frontal plane (i.e. dynamic balance). Exercising the body weight distribution helps the patient achieve symmetry while standing and/or improves postural control.

Exercising postural control with visual feedback while standing on a force platform *47*

◖ It has been demonstrated that exercising postural control with visual feedback while standing on a force platform improves the *postural sway* in stance of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

Context and interpretation

The guideline development team recommends that exercising postural control while standing on a force platform with visual feedback should not be done in isolation, but be integrated in regular therapy.
It remains unclear to what extent exercising postural control with visual feedback while standing on a force platform improves the better walking ability and reduces the risk of falling.
There is no reason to assume that the effects found for exercising postural control with visual feedback while standing on a force platform will not also occur during the late rehabilitation phase.

F.1.6 Exercising balance during various activities

Balance is defined as 'achieving, maintaining or restoring stability in various positions or during various activities.' Balance is a frequently used term which is often related to the terms stability and posture/stance control. Balance problems may be caused by impairments of the organ of balance and/or motor, somatosensory, visual, or cognitive impairments. They may involve reduced load bearing by the paretic leg, delayed or absent balancing reactions, and reduced postural anticipation of perturbations.
A satisfactory sitting balance is considered an important prerequisite for functional daily activities, such as getting dressed, reaching and eating, and the same is true for a good standing balance.

Exercising balance during various activities *48*

◗ It has been demonstrated that exercising balance during various activities results in improved *sitting and standing balance* and improved performance of *basic activities of daily living* by stroke patients. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

Context and interpretation
GThe guideline development team recommends having patients exercise balance while they are performing various activities, in various conditions regarding visual dependence, type of surface, width of the supporting surface, shifting the body's center of gravity and level of distraction during task performance (i.e. combined tasks). Standing balance can also be exercised using a standing frame.

F.1.7 Body-weight supported treadmill training

Body-weight supported treadmill training (BWSTT) is defined as treadmill training in which the body weight is partially borne by a parachute harness. The harness is attached to an elastic system that absorbs the vertical body movements during the entire walking cycle. This type of gait training is also known as Partial Body Weight Support (PBWS). Patients who are not able to support their own body weight are more or less forced by BWSTT to functionally load the paretic leg.
The extent of body weight support can usually be continuously adjusted (0-100%). BWSTT for stroke patients usually requires the presence of two physical therapists. Sitting beside the treadmill on the hemiplegic side, one therapist uses guided active movement to move the paretic leg during the swing phase, and if necessary this therapist also stabilizes the paretic knee during the support phase. A second therapist instructs the patient and checks the balance, standing behind the patient. BWSTT also has certain disadvantages. The number of staff involved in the BWSTT, and the fact that the physical therapists often have to work close to the floor, make BWSTT a very labor-intensive therapy. The equipment requires considerable financial investments, and cannot be transported. Weight support of 45-50% seems to have a negative effect on the gait of stroke patients (partly by inducing toe gait). An advantage of BWSTT is that it increases the intensity of task-specific training as the patient takes more steps on a treadmill. Compared to normal walking, the gait during BWSTT is also more symmetrical, and is characterized by a longer monopedalic phase of the paretic leg and a greater hip extension.
BWSTT is preferably administered in the form of 5 minutes of walking followed by a period of rest, with an effective exercise time of 20-30 minutes in each session. Although the ideal equipment settings for these training sessions cannot be exactly specified, an initial support of 30-40% of the body weight at a low walking speed of 0.1-0.3 m/sec are often used at the start of the training. Over the treatment period, the goal is to increase the walking speed, the walking distance and duration, and to decrease the body weight support to 0%.

Body-weight supported treadmill training *49, 50*

◖ It has been demonstrated that body-weight supported treadmill training improves the *comfortable walking speed* and *walking distance* of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

◗ It has been demonstrated that body-weight supported treadmill training is not more effective than the control intervention with which it was compared as regards the *sitting and standing balance* of patients with a stroke. (Level 1)
Studied for ER (=) and RC (=).

Context and interpretation
The guideline development team recommends applying body-weight supported treadmill training for patients who are as yet unable to walk (FAC ≤3), or are physically too weak or obese for 'hands-on' mobilization. At the start of rehabilitation, the maximum level of support should be 40%, and this level should be gradually reduced, while walking speed and the duration of exercising sessions should be systematically increased depending on the patient's abilities.
There is no reason to assume that the effect, or lack of effect, found for body-weight supported treadmill training should not also occur in the late rehabilitation phase.

F.1.8 Robot-assisted gait training

Robot-assisted gait training is a form of walking exercise in which the walking cycle is guided by electromechanically controlled footplates ('end-effectors') and/or an orthosis (i.e. an exoskeleton) which control the legs in a preprogrammed walking cycle, or parts of the walking cycle. The patient's body weight is partially supported by a harness. This enables patients to engage in high-intensity exercising.
Robotics systems that offer support only when it is required ('assist as needed', based on the power contributed by the patient or on the patient's position) also induce patients to actively participate. The aim of robot-assisted gait training is to improve the walking ability of patients who are initially unable to walk independently, or to improve their gait.
Robot-assisted gait training can be combined with functional electrostimulation of the paretic leg (quadriceps muscle, common peroneal nerve).
There is no need for the physical therapist to provide physical support as patients shift their feet, which means that this form of gait training is less labor-intensive for the therapist than conventional walking exercises or treadmill training, whether or not with body-weight support. Examples of robot-assisted training devices include the Lokomat® (Hocoma AG, Switzerland), the Gait Trainer® (Reha-Stim, Germany), the AutoAmbulator® (Health South, USA) and the Lopes® (Twente University, Laborator Biomechanical Engineering, the Netherlands). A disadvantage is the high investment costs.

Robot-assisted gait training *51, 52*

◐ It has been demonstrated that robot-assisted gait training for stroke patients who are unable to walk independently improves their *comfortable walking speed*, *maximum walking speed*, *walking distance*, *heart rate*, *sitting and standing balance*, *walking ability* and performance of *basic activities of daily living*, compared to conventional therapy (including overground walking). (Level 1)

Comfortable walking speed studied for ER (✓), maximum walking speed for ER (✓) and RC (✓), walking distance for ER (✓) and RC (✓), heart rate for ER (✓), sitting and standing balance for ER (✓), walking ability for ER (✓), basic activities of daily living for ER (✓) and RC (✓).

◐ It has been demonstrated that combining robot-assisted gait training with *functional electrostimulation* of the paretic leg improves the *sitting and standing balance* and *walking ability* of patients with a stroke, compared to conventional therapy (including overground walking). (Level 1)
Sitting and standing balance studied for ER (✓) and RC (✓), walking ability for ER (✓).

Context and interpretation

The guideline development team recommends considering robot-assisted gait training, whether or not in combination with functional electrostimulation of the quadriceps muscle and common peroneal nerve, for patients with an FAC of 3 or less.
It remains unclear whether the effects are influenced by the type of robot used. The assumption is that the efficacy of robot-assisted gait training is largely determined by the number of repetitions, i.e. the intensity.
There is no reason to assume that the effects found for robot-assisted gait training should not also occur in the late rehabilitation phase.

F.1.9 Treadmill training without body-weight support

In treadmill training without body-weight support, patients walk on a treadmill with or without supporting the non-paretic arm on the horizontal bar. The physical therapist stands beside the treadmill on the hemiplegic side and assists, if necessary, by facilitating hip flexion or placing the foot of the paretic leg. The physical therapist can also stand on the treadmill behind the patient to check the patient's balance.
The important advantage of gait training on a treadmill is that (1) it allows better control of walking speed; (2) the therapist is better able to observe the gait and (3) can, if necessary, easily intervene manually. The walking speed is gradually increased, with the rate of increase determined by, e.g., the maximum heart rate reserve (HRR), the patient's comfort, or a predefined protocol. The number of minutes that a patient walks without stopping is usually divided over the sessions, although the therapist may also decide to have the patient walk at maximum speed for short intervals (30 seconds), alternating with periods of rest (2 minutes).
Walking on a treadmill has the important disadvantage that the body is more or less standing still relative to the environment. This means that no normal optic flow is induced, as is the case when walking on solid ground. Another important aspect is that a person's walking speed and stride length on a treadmill are systematically lower, whereas the cadence is higher than while walking on a floor. From a biomechanical point of view there is no difference between the push-off forces while walking on solid ground or walking on a treadmill.

Treadmill training without body-weight support *53*

◖ It has been demonstrated that treadmill training without body-weight support is more effective in increasing *maximum walking speed* and *width of gait* than conventional gait training for patients with a stroke. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

Context and interpretation

The guideline development team recommends using treadmill training without body-weight support, with progressive increase in walking speed and/or slope, walking distance, and exercise duration, for stroke patients with an FAC of 3 or more.

F.1.10 Overground gait training

This type of gait training involves walking and walking-related activities on a solid surface.
The physical therapist observes the patient's gait – usually on a level surface – and has the patient do exercises to influence their gait. The physical therapist usually gives direct feedback on the patient's gait. This form of gait training also includes safety while walking and/or preparatory exercises like stepping onto a step box, or putting weight on the paretic leg to improve its strength. Overground gait training is a frequently applied form of training, and can be used in almost any setting or location without requiring a great deal of high-tech equipment.

Overground gait training *54, 55*

◖ It has been demonstrated that overground gait training by stroke patients who are able to walk without physical support is more effective in increasing *walking distance* and reducing *anxiety* than walking on a treadmill. (Level 1)
Studied for RC (✓).

◖ It has been demonstrated that overground gait training for patients with a stroke who are unable to walk independently at the start of therapy has an adverse effect on their *aerobic endurance* compared to body-weight supported walking exercises. (Level 1)
Studied for ER (×).

Context and interpretation

The guideline development team recommends overground gait training, not only for patients who are able to walk independently, with or without a walking aid, but also for patients who require physical support.
It remains unclear whether overground gait training is more effective in terms of outcome measures like walking ability and gait parameters than other interventions.

If the goal is to improve the aerobic endurance of patients who are unable to walk independently at the start of the therapy, it is better to choose a different type of training.

F.1.11 Gait training with external auditory rhythms

Gait training with external auditory rhythms is a form of therapy in which a rhythmic auditory signal is presented, with the aim of improving the patient's gait.
Rhythmic auditory stimulation (RAS) is described as a treatment method in which cyclic movement patterns, such as walking, are influenced by presenting auditory rhythms. The same principles underlie the use of music (Musical Motor Feedback or MMF) or position. The present Guideline uses the term external auditory rhythms (EAR). The auditory stimuli are presented at a rhythmic frequency that is synchronized with the patient's gait cadence, usually with the help of a metronome or music with a known number of beats per second. The patient is usually instructed to adjust the pace frequency of their paretic leg to the external rhythm while walking.
The goal is to influence gait parameters such as pace frequency, stride length and hence walking speed and symmetry.

Gait training with external auditory rhythms *56*

◖ It has been demonstrated that gait training with external auditory rhythms (EAR) is not more effective for patients with a stroke than conventional gait training, in terms of *gait parameters*. (Level 1)
Studied for ER (=) and RC (=).

Context and interpretation

The use of EAR during gait training can be considered in order to improve the patient's gait. The rhythm is adapted to the individual patient and is progressively accelerated in steps of 5-10%. The use of EAR should be alternated with exercising without rhythms during each session.
There is no reason to assume that the effects found for gait training with EAR should not also occur in the late rehabilitation phase.

F.1.12 Gait training in public spaces

Walking in public spaces is a form of training that is done in the patient's everyday environment, such as their immediate residential area, a shopping center or a park. Attention is paid to aspects like crossing a street, avoiding obstacles and oncoming pedestrians, walking on various types of surface and doing two tasks at the same time, preferably in a variety of weather conditions. 'Community ambulation' (i.e. walking in public spaces safely and independently) is the ability to integrate walking with other activities in a complex environment. The aim is to enhance the patient's ability to safely and independently walk in public spaces. Regaining the ability to safely and independently walk in public spaces is important in order to optimize participation. However, outdoor walking is a complex activity: the patient will have to start and stop and change direction frequently – and unexpectedly – and will also have to adjust their walking speed and avoid obstacles, and all this on a variety of surfaces. In normal everyday life, people also do other things besides walking, such as conversing, looking around them or carrying objects. In addition, it involves aspects like walking speed, the ability to cover a particular distance and the extent to which one is able to divide one's attention.

Gait training in public spaces *57*

◖ It remains unclear whether gait training in public spaces is more effective than other interventions for patients with a stroke in terms of *maximum walking speed*. (Level 1)
Studied for ER (=) and RC (=).

Context and interpretation

It remains unclear whether gait training in public spaces is more effective than the control treatment with which it was compared, due to insufficient statistical power of the studies that examined this.
The guideline development team recommends exercising walking ability in a functional context, in typical public spaces like parks or streets, and in a variety of conditions. Conditions can be varied as regards the degree of distraction while walking, maneuvering, combined tasks and the type of surface. The patient should preferably also exercise in different weather conditions.

F.1.13 Mobility training in virtual reality

Virtual reality mobility training involves the use of computer technology which enables the patient to move about in a virtual environment and receive feedback on their performance. This type of training aims to improve the patient's skills after a stroke. It has been suggested that the use of a virtual environment produces cortical reorganization.
The three-dimensional virtual environment can be created by 'immersive' or 'non-immersive' methods. Immersive methods involve the patient wearing a special pair of glasses showing a virtual environment, creating the illusion that the patient is actually in that environment. Non-immersive methods involve showing the virtual environment on a computer monitor or projection screen. The virtual environment may consist of a typical public space, like a street or a park in which the patient has to avoid obstacles, but also a kind of game setting to train the range of motion of a particular joint. The patient is given visual and sometimes also auditory feedback on their performance ('knowledge of performance') and the results ('knowledge of results'). The exercising is usually done on a treadmill, and can be done with or without supervision. Important elements of the training method are repetition, task-specificity, motivation, and challenge.

Mobility training in virtual reality *58*

◖ It remains unclear whether virtual reality mobility training is more effective than other interventions for patients with a stroke in terms of *comfortable and maximum walking speed*, *spatiotemporal gait parameters* and *walking ability*. (Level 1)
Studied for RC (=).

Context and interpretation

It remains unclear whether exercising standing up and sitting down in virtual reality is more effective than the control intervention with which it was compared, due to insufficient statistical power of the studies that examined this.

Important elements of virtual reality training appear to be the number of repetitions, the context-specificity and the patient's enjoyment of the exercises.

F.1.14 Circuit class training for walking and other mobility-related functions and activities

Supervised circuit class training (CCT) for walking and other mobility-related activities involves two or more patients exercising at the same time, using workstations that may be arranged in a circuit. The exercises are progressive, in terms of the number of repetitions or complexity, and are tailored to the patient's individual needs. The workstations can have different goals. For instance, one workstation may focus on activities, such as standing up and sitting down, stepping up and down a step box, maintaining balance while standing, walking and avoiding obstacles, walking on an uneven surface, and walking up and down stairs. Another workstation may focus on body functions, such as increasing muscle strength by means of power training equipment and endurance by means of a bicycle ergometer. Each station is often used for 5 minutes. There is usually one supervisor for every 3 participants, with a maximum of 12 participants.
Circuit class training represents an efficient use of the physical therapist's time. This means that more patients can be exercising for longer within the same available time slot, which may save costs. CCT also leads to interactions between patients and to peer contacts, which may encourage patients to skip fewer training sessions.

Circuit class training for walking and other mobility-related functions and activities *59*

◐ It has been demonstrated that circuit class training (CCT) for walking and other mobility-related functions and activities improves walking *distance/speed*, *sitting and standing balance* and *walking ability*, and *reduces inactivity* in patients with a stroke. (Level 1)
Walking distance/speed studied for ER (✓), LR (✓) and RC (✓), sitting and standing balance for ER (✓), LR (✓) and RC (✓), walking ability for ER (✓), LR (✓), and RC (✓), and inactivity for LR (✓) and RC (✓).

Context and interpretation

The guideline development team recommends using supervised CCT with 6-10 workstations for patients who are able to walk at least 10 m independently (under supervision if necessary) (FAC ≥ 3). This means that CCT is especially suitable for patients treated in an outpatient clinic or other setting outside of a hospital or nursing home. There are indications, however, that CCT with workstations is also effective for non-ambulatory patients.
The exercises may involve activities like standing up and sitting down, stepping up and down a step box, maintaining standing balance, walking while avoiding obstacles, walking on an uneven surface and walking up and down stairs. Workstations may also focus on body functions, such as increasing muscle strength by means of power training equipment and endurance by means of a bicycle ergometer or treadmill.
Depending on the group size, CCT with workstations is 2-3 times as efficient as individual therapy.

F.1.15 Walking and other mobility-related functions and activities exercised under the supervision of an informal caregiver

The regular allied health care treatment can be supplemented with walking and walking-related exercises under the supervision of an informal caregiver, such as the patient's partner, a relative, friend, or volunteer.
Intensive exercise therapy leads to better outcomes in terms of walking ability and independence for basic ADL. In practice, patients often fail to exercise with sufficient intensity, due to a lack of health care resources. In addition, patients are often physically inactive outside of therapy hours. The current problems caused by the rapidly rising costs of health care have led to a search for innovative ways to enable patients with a stroke to exercise more without incurring higher costs. One of the options is to enable patients to exercise independently under the supervision of an informal caregiver, outside regular therapy. This not only means that the patient spends more time exercising, producing health gains, but other advantages of exercising with an informal caregiver have also been reported. It might improve the communication between therapists and informal caregivers and might involve the caregiver more closely in the rehabilitation program, thus reducing the burden of care, also as regards the patient being discharged home.

Walking and other mobility-related functions and activities exercised under the supervision of an informal caregiver *60*

◖ It has been demonstrated that exercising walking and other mobility-related functions and activities under the supervision of an informal caregiver improves the performance of *basic activities of daily living* for the patient with a stroke, and reduces the *perceived burden of care for the informal caregiver*. (Level 1)
Studied for ER (✓).

Context and interpretation

The guideline development team recommends exercising walking and other mobility-related functions and activities together with an informal caregiver under the auspices of a physical therapist, as an add-on to regular exercise therapy. The informal caregiver should be chosen by the patient and should be screened beforehand for their mental and physical resilience (Hospital Anxiety and Depression Scale (HADS) score ≤7 and Caregiver Strain Index (CSI) score <7).
There is no reason to assume that the effects found for exercising under the supervision of an informal caregiver should not also occur in the late rehabilitation and chronic phases.

F.1.16 Training muscle strength in the paretic leg

Muscle strength training for the paretic leg involves progressive active resistance exercises, using strength training equipment, hand-held weights, elastic devices, or gravity. The muscle contractions are isometric or dynamic (concentric, eccentric, isokinetic, or isotonic). Muscle strength relates to the maximum force a specific muscle or muscle group can generate. The ability to perform repeated muscle contractions is also referred to as 'muscular endurance'.
Many patients with a stroke already had reduced muscle strength prior to the stroke. This may be caused by age-related changes,

the presence of comorbidities, or an inactive (sedentary) lifestyle. A stroke often further reduces muscle strength, due to peripheral physiological changes in the muscles, such as: (1) muscle atrophy as a result of 'disuse', (2) insulin resistance, (3) elevated serum levels of inflammation markers, resulting in increased vascular resistance, i.e. hypertension, (4) reduced peripheral blood flow, and (5) a shift in muscle fiber phenotype from 'slow twitch' (type I) fibers to 'fast twitch' (type II) fibers. Type II muscle fibers are more vulnerable to fatigue, as they use anaerobic metabolic pathways. As a consequence, movements require a higher level of metabolic activity, which affects the ability to perform activities. This reduced physical activity level can reduce not only muscle strength but also aerobic endurance.

Improving or maintaining muscle strength and muscular endurance is usually achieved by means of repeated muscle contractions against a progressively increasing resistance. The exercises can be offered in either a functional or non-functional way, using the patient's own body weight, elastic devices, weights, or special training equipment. The exercises may be done individually but also in a group or as circuit class training.

It is plausible that strength training with the help of fitness equipment or more functional forms of training does not lead to increased spasticity.

Strength training involves each exercise being performed in 1-3 sets of 10-15 repeats, at a frequency of 2-3 times a week.

Training muscle strength in the paretic leg *61*

◖ It has been demonstrated that training the muscle strength of the paretic leg or both legs of stroke patients increases their *muscle strength* and *resistance to passive movement*, and improves the patient's *gait* in terms of *cadence*, *symmetry*, and *stride length*. (Level 1)
Studied for ER (✓) and RC (✓).

Context and interpretation

The guideline development team recommends having stroke patients train the muscle strength of the major muscle groups using fitness equipment, functional training or weights, at a minimum frequency of 2-3 times a week, involving 1-3 sets of 10-15 repetitions for 8-10 muscle groups.

The assumption that muscle strength training increases spasticity in the extremity being trained appears to be unfounded.

There is no reason to assume that the effects that have been found for muscle strength training of the paretic leg should not also occur in the late rehabilitation phase.

F.1.17 Training aerobic endurance

Aerobic endurance is trained with the help of interventions to maintain or improve aerobic endurance and is implemented by training the major muscle groups. The major muscle groups are used in walking, on a treadmill or otherwise, or during workout on a bicycle ergometer, an arm-leg ergometer, or an exercise stepper. Aerobic endurance relates to an individual's ability to perform physical activities over a longer period. It contributes to the central capacity of the circulatory and respiratory systems to provide the body with oxygen, as well as the peripheral capacity of skeletal muscles to use this oxygen.

Many patients with a stroke already had reduced physical fitness even prior to the stroke. This may be caused by age-related changes, the presence of comorbidities or an inactive (sedentary) lifestyle. For some time after the stroke, the maximum oxygen consumption is lower than in healthy people of the same age, whereas the energy consumption for activities of daily living is actually increased. When the body's aerobic metabolism fails to meet the energy requirements for ADL activities, it switches to the anaerobic metabolism. As a result, the patients tire more easily, thus further reducing their physical activity level. Physical deconditioning can also result from problems like apraxia, orientation problems, or visual impairments. All of these problems can limit the patient's ability to perform activities, leading to further deconditioning, and their physical condition goes into a downward spiral.

The primary objective of aerobic endurance training is to improve the aerobic component of physical fitness. This is usually done by exercising for longer periods on some type of equipment (e.g. bicycle, treadmill, or rowing ergometer) or by walking or stair walking exercises, which are not, however, aimed at improving walking ability as such. Aerobic endurance training is not only important in the context of ADLs; cardiovascular fitness is also a major aim in view of its association with morbidity and mortality from cardiovascular diseases. Aerobic endurance training is safe if the patient meets the criteria of the American College of Sports Medicine (ACSM).

Aerobic endurance training is done in 20-60 minute sessions, or a larger number of 10-minute sessions, for 3-7 days a week, at an intensity of 40-70% of maximum oxygen consumption (VO_{2max}), 40-70% of the heart rate reserve (HRR), 50-80% of the maximum heart rate (HR_{max}) and a Borg RPE score of 11-14, and can also be given as circuit class training.

Training aerobic endurance *62*

◑ It has been demonstrated that training aerobic endurance increases the *maximum oxygen consumption*, *respiratory functions in terms of* FEV_1 *and expiratory flow per minute and workload* of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

Context and interpretation

The guideline development team recommends having patients with a stroke train their aerobic endurance, using the major muscle groups. This may involve walking (possibly on a treadmill), cycling on an ergometer or performing stepping exercise with the help of a step box.

The minimum frequency is three times a week, 20-60 minutes per session (or several 10-minute sessions). Intensity: VO_{2max} 40-70%, HRR 40-70%, HR_{max} 50-80% or a Borg RPE score of 11-14 (on a scale of 6-20). This also applies to patients with a transient ischemic attack (TIA) or 'minor stroke'. There are indications that these patients benefit from fitness training, just like healthy people of the same age, in terms of reducing risk factors like high blood pressure.

Aerobic endurance training is safe if the patient meets the criteria of the American College of Sports Medicine (ACSM). These criteria indicate that the risk of exertion-related adverse events like acute cardiac arrest or myocardial infarction can be reduced by systematic and effective screening

of patients, designing a suitable therapy program, designing a suitable therapy setting and carefully monitoring and instructing patients.
Screening should involve risk stratification based on the patient's medical history, the presence of potential neurological complications and other medical conditions for which physical training is contra-indicated (such as an insufficiently controlled heart disorder).
There is no reason to assume that the effects that have been found for aerobic endurance training should not also occur in the late rehabilitation phase.

F.1.18 Aerobic endurance training combined with strength training

This option involves interventions to maintain or improve both muscle strength and aerobic endurance, using training equipment, weights, isometric exercises or circuit class training. For further details see Sections F.1.16 'Training muscle strength in the paretic leg', F.1.17 'Training aerobic endurance', and F.4.12 'Training muscle strength in the paretic arm and hand'.

Aerobic endurance training combined with strength training *63*

◐ It has been demonstrated that a combination of aerobic endurance training and strength training improves *selective movements*, *muscle strength of the paretic leg*, *comfortable and maximum walking speed*, *walking distance*, *maximum oxygen consumption*, *heart rate in exertion*, *balance*, *level of physical activity in everyday life*, and *quality of life* for patients with a stroke. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

Context and interpretation

The guideline development team recommends having patients with a stroke participate in physical training programs to improve aerobic endurance and muscle strength.
Aerobic endurance is trained using fitness equipment, at a minimum frequency of three times a week, for 20-60 minutes per session (or several 10-minute sessions). Intensity: VO_{2max} 40-70%, HRR 40-70%, HR_{max} 50-80% or a Borg RPE score of 11-14 (on a scale of 6-20).
Muscle strength is trained using fitness equipment or functional training, at a minimum frequency of 2-3 times a week, involving 1-3 sets of 10-15 repetitions for 8-10 muscle groups.

F.1.19 Hydrotherapy

Hydrotherapy is a form of exercise therapy that uses the mechanical and thermal characteristics of water during partial immersion for therapeutic purposes, such as improving balance, muscle strength, aerobic endurance, and/or agility. It sometimes involves the use of 'hands-on' techniques, such as joint mobilization, stretching techniques, or relaxation. The therapy can be given individually or in groups. The supervised therapy ideally takes place in a specially designed exercise pool.
Hydrotherapy applies various concepts, such as: (1) the Halliwick method (balance and stability exercises), (2 the Bad Ragaz Ring Method (muscle strength exercises based on principles of proprioceptive neuromuscular facilitation or PNF), (3) deep-water running or aquajogging, (4) the Watsu method (for relaxation), and (5) the Ai Chi method (a combination of deeper breathing and exercises for the extremities carried out in broad, slow movements).

Hydrotherapy *64*

◐ It has been demonstrated that hydrotherapy increases the *muscle strength of the paretic leg* of patients with a stroke. (Level 1)
Studied for RC (✓).

Context and interpretation

The guideline development team recommends considering hydrotherapy to increase muscle strength. This may involve aerobic training, functional gait training, or exercises using the Halliwick and Ai Chi methods.

F.1.20 Interventions to improve the somatosensory functions of the paretic leg

Impairments of somatosensory functions frequently occur after a stroke. They are caused by impairments of the vital sensibility (sense of touch, pain, and temperature) and gnostic sensibility (sense of posture, movement, and vibration) and can be a major impediment in learning motor skills and applying them in everyday activities. Interventions to improve sensory functions may focus on distinguishing and perceiving different water temperatures when the paretic leg is being washed, or on recognizing the structure of the surface the patient is sitting or standing on. Another opportunity for training somatosensory functions is to ask the patient to locate external stimuli.
Impairments of somatosensory functions can be reduced or eliminated by means of passive techniques such as electrostimulation or active techniques involving exposure to various stimuli, e.g. texture, form, temperature, or sense of position.
Proprioception can be exercised while in supine, sitting, or standing position. In this type of training, the physical therapist asks the patient to position both the paretic and the non-paretic extremity in various angles of the joints. Sensory function can also be influenced by electrostimulation.

Interventions to improve the somatosensory functions of the paretic leg *65*

◐ It has been demonstrated that interventions to improve the somatosensory functions of the paretic leg of patients with a stroke are not more effective in terms of *selective movements*, *walking speed*, or *sitting and standing balance* than other interventions. (Level 1)
Studied for ER (=) and RC (=).

Context and interpretation

The guideline development team recommends not treating somatosensory functions in isolation.

F.1.21 Electrostimulation of the paretic leg

Electrostimulation of peripheral nerves and muscles is a form of therapy using surface electrodes. Three forms of electrostimulation are distinguished:

- neuromuscular electrostimulation (NMS): electrostimulation of a muscle group leading to visible muscle contractions; this form of electrostimulation can be integrated in functional activities;
- electromyography-triggered neuromuscular electrostimulation (EMG-EMS): electrostimulation of a muscle group triggered by EMG activity generated by the patients themselves; this form of electrostimulation can also be integrated in functional activities;
- 'transcutaneous electrical nerve stimulation' (TENS): low-frequency electrostimulation of a muscle or muscle group, usually without visible muscle contractions.

Electrostimulation involves stimulating muscle groups in the paretic extremity. The two most commonly used forms of electrostimulation are NMS and EMG-NMS, but TENS can also be used. This Guideline includes only those RCTs that used external electrodes, as the placement of intramuscular electrodes is beyond the physical therapy domain.
NMS involves activating the paretic muscles by means of electrical stimulation in a precisely defined sequence. The goal of both NMS and EMG-NMS is to increase the maximum range of motion and the muscle strength in patients with hemiparesis of the leg. The stimulation in EMG-NMS is only activated when the patient actively attains an individualized, pre-set threshold value of muscle activity. The device produces an auditory or visual cue, upon which the patient must actively contract the muscle to attain the pre-set threshold value. If the patient manages to attain this value, the device stimulates the movement, resulting in a maximum range of motion.
If electrostimulation is applied while the patient is performing an activity, this is referred to as functional electrostimulation (FES). FES is defined as 'activating paretic muscles by means of electrical stimulation in a precisely defined sequence in order to assist activities of daily living.' FES for the lower leg involves using surface electrode activation of the peroneal nerve, or stimulation of the dorsal flexors of the foot itself, in order to increase the dorsal flexion of the ankle during the swing phase of the hemiplegic leg while walking. Placing the electrodes on the triceps surae muscles results in stimulation of the 'push-off'. Electrode placement elsewhere on the hemiplegic leg, such as the quadriceps muscles and the hamstrings, has also been described as 'multichannel functional electrical stimulation' (MFES). MFES can also be integrated in walking in an electromechanical walking device.
TENS differs from EMG-NMS and NMS in that TENS does not involve visible muscle contractions.

Electrostimulation of the paretic leg using surface electrodes *66-68*

◖ It has been demonstrated that neuromuscular stimulation (NMS) of the paretic leg improves *selective movements*, *muscle strength*, and *resistance to passive movements* for patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

◐ It remains unclear whether EMG-triggered neuromuscular electrostimulation (EMG-NMS) of the paretic leg is more effective than other interventions for patients with a stroke. (Level 1)
Studied for ER (=) and RC (=).

◐ It has been demonstrated that transcutaneous electrical nerve stimulation (TENS) of the paretic leg improves *muscle strength* and *walking ability and related activities* for patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

Context and interpretation

It remains unclear whether EMG-NMS of the paretic leg is more effective than the control intervention with which it was compared, due to insufficient statistical power of the studies which examined this.
The guideline development team recommends using electrostimulation of the paretic leg (e.g. the anterior tibial muscles, the peroneal nerve, and the gastrocnemius, soleus and quadriceps muscles) during training sessions for patients who are able to stand or walk (whether or not with support) (i.e. FAC ≥ 2) and have some voluntary control of the paretic leg.
The best settings for the stimulator and the ideal frequency and intensity of this intervention remain unclear.
There is no reason to assume that the effects that have been found for electrostimulation of the paretic leg should not also occur in the late rehabilitation phase.

F.1.22 Electromyographic biofeedback (EMG-BF) for the paretic leg

Electromyographic biofeedback (EMG-BF) was a popular method especially in the 1970s and 80s. EMG-BF is a form of therapy in which electrical motor unit action potentials (muscle activity) are recorded by surface electrodes applied to the skin covering the muscles. A biofeedback device then converts the recorded muscular activity into visual and/or auditory information for patient and therapist. In feedback therapy, the patient is asked to increase or reduce the activity of the relevant muscles while performing the intended movement.
EMG-BF for the lower extremities uses auditory or visual feedback to try and improve walking speed, symmetric distribution of body weight while standing, gait quality and range of motion of the ankle or knee. The EMG signal is recorded by external electrodes placed over the anterior tibial muscle / gastrocnemius muscle and/or the quadriceps / hamstring muscles.

EMG-BF for the paretic leg *69*

◖ It remains unclear whether electromyographic biofeedback (EMG-BF) is more effective for patients with a stroke in terms of *range of motion*, *walking speed*, *spatiotemporal gait parameters*, and *EMG activity* of the paretic leg than other interventions. (Level 1)
Studied for ER (=), LR (=), and RC (=).

Context and interpretation

It remains unclear whether EMG-BF for the paretic leg is more effective than the control intervention with which it was

compared, due to insufficient statistical power of the studies which examined this.
The guideline development team does not recommend using EMG-BF for the paretic leg for patients with a stroke.

F.2 Interventions aimed at walking ability and other mobility-related functions and abilities during the mobilization phase (Level 2)

F.2.1 Bilateral leg training with rhythmic auditory cueing

Bilateral leg training with rhythmic auditory cueing *70*

◖ It is plausible that bilateral leg training with rhythmic auditory cueing (BLETRAC) is not more effective for patients with a stroke in terms of *selective movements*, *walking speed* and *stride length* than other interventions. (Level 2)
Studied for RC (=).

Context and interpretation
BLETRAC involves patients making various bilateral flexion and extension movements of the leg while sitting. The rhythm is indicated by a metronome. The pattern consists of bilateral movements in or out of phase, which involve the legs moving simultaneously or sequentially. BLETRAC requires a special frame that allows the legs to be moved independently.
For the time being, the guideline development team does not recommend BLETRAC.

F.2.2 Mirror therapy for the paretic leg

Mirror therapy for the paretic leg *71, 72*

◖◗ It is plausible that mirror therapy for the paretic leg improves *selective movements* and the performance of *basic ADL activities* by patients with a stroke. (Level 2)
Studied for RC (✓).

◖◗ It is plausible that mirror therapy for the paretic leg is not more effective for patients with a stroke in terms of *resistance to passive movements* and *walking ability* than other interventions. (Level 2)
Studied for RC (=).

Context and interpretation
The guideline development team recommends considering mirror therapy for the paretic leg (especially ankle dorsiflexion) as an add-on to the regular treatment of patients with a stroke. In this therapy, the patient is positioned on the bed in a semi-seated position and looks into a mirror placed between their legs in the sagittal plane, with the mirroring surface facing the non-paretic leg.

F.2.3 Limb overloading with external weights on the paretic side

Limb overloading with external weights on the paretic side *73*

◖◗ It is plausible that limb overloading by carrying external weights on the paretic side during activities performed by patients with a stroke while standing and walking is not more effective in terms of *balance* and (comfortable) *walking speed* than other interventions. (Level 2)
Studied for RC (=).

Context and interpretation
The guideline development team ford not recommend patients with a stroke being made to carry external weights on the paretic side to improve balance and walking speed.

F.2.4 Systematic feedback on walking speed

Systematic feedback on walking speed *74, 75*

◖◗ It is plausible that providing systematic feedback on walking speed improves the *walking speed* of patients with a stroke. (Level 2)
Studied for ER (✓).

◖◗ It is plausible that providing systematic feedback on walking speed is not more effective in terms of the *duration of hospitalization*, *walking distance*, and *walking ability* of patients with a stroke than other interventions. (Level 2)
Studied for ER (=).

Context and interpretation
The guideline development team recommends informing the patient about their walking performance, in terms of maximum walking speed, as measured by the 10-meter walk test. This feedback should be repeated at each treatment session, in order to inform the patient of their progress.

F.2.5 Maintaining ankle dorsiflexion by means of a standing frame or night splint

Maintaining ankle dorsiflexion by means of a standing frame or night splint *76*

◖◗ It is plausible that the use of a standing frame is just as effective for patients with a stroke in terms of maintaining *passive range of motion in ankle dorsiflexion* and *getting up from a chair* as wearing a night splint. (Level 2)
Studied for ER (=).

Context and interpretation
It makes no difference in terms of maintaining or increasing ankle range of motion whether a patient uses a standing frame or a night splint.

F.2.6 Manual passive mobilization of the ankle

Manual passive mobilization of the ankle *77-79*

◖ It is plausible that manual passive mobilization of the ankle has a transient favorable effect on the *active and passive dorsiflexion of the ankle* of patients with a stroke. (Level 2)
Studied for RC (✓).

◗ It is plausible that manual passive mobilization of the ankle of patients with a stroke has an adverse effect on the *speed with which they stand up and sit down*. (Level 2)
Studied for RC (×).

◖◗ It is plausible that manual passive mobilization of the ankle is not more effective for patients with a stroke in terms of *symmetry while standing and walking* than other interventions. (Level 2)
Studied for RC (=).

Context and interpretation
The guideline development team does not recommend systematic use of manual passive mobilization of the ankle.

F.2.7 Range of motion exercises for the ankle with specially designed equipment

Range of motion exercises for the ankle with specially designed equipment *80*

◖◗ It is plausible that the use of a device* to influence the range of motion of the ankle is not more effective for patients with a stroke in terms of *active and passive range of motion*, *resistance to passive movements*, *muscle strength*, *walking distance*, *walking speed*, *balance*, *walking ability*, *activities of daily living* and *quality of life* than other interventions. (Level 2)
Studied for RC (=).

* Here: the 'Stimulo'. The Stimulo is a portable device which enables patients to perform passive or active dorsiflexion and plantarflexion of the ankle. The device automatically switches from dorsiflexion to plantarflexion and vice versa when the maximum range of motion is achieved.
The initial body position is supine.

Context and interpretation
The guideline development team does not recommend using the Stimulo device for patients with a stroke.

F.2.8 Ultrasound for the paretic leg

Ultrasound for the paretic leg *81, 82*

◖◗ It is plausible that applying ultrasound to the gastrocnemius and soleus muscles is more effective in terms of the *H_{max}/M_{max} ratio* of patients with a stroke than other interventions alone. (Level 2)
Studied for RC (✓).

◖◗ It is plausible that applying ultrasound to the gastrocnemius and soleus muscles is not effective in terms of the *resistance to passive movements* and *active or passive range of motion of the ankle* of patients with a stroke who show increased resistance to passive movements of the ankle in dorsiflexion and no passive range of motion impairment of the ankle. (Level 2)
Studied for RC (=).

Context and interpretation
Since applying ultrasound to the paretic leg has not been found to produce clinically relevant effects, the guideline development team does not recommend this use for patients with a stroke.

F.2.9 Segmental muscle vibration for drop foot

Segmental muscle vibration for drop foot *83, 84*

◖ It is plausible that the use of segmental muscle vibrations of the dorsiflexors as an add-on therapy is more effective for patients with a stroke and drop foot in terms of *kinematic outcome measures* and *electromyographic muscle functions* than other interventions. (Level 2)
Studied for RC (✓).

◖ It is plausible that the use of segmental muscle vibrations is not more effective for patients with a stroke and drop foot in terms of *gait parameters*, including *walking speed*, *stride length*, and *cadence* than other interventions. (Level 2)
Studied for RC (=).

Context and interpretation
The guideline development team does not recommend using segmental muscle vibration in the treatment of drop foot.

F.2.10 Whole body vibration

Whole body vibration *85*

◖◗ It is plausible that whole body vibration is not more effective for patients with a stroke in terms of *muscle strength*, *somatosensory functions*, *sitting and standing balance*, *walking ability*, *other mobility-related abilities*, and *basic activities of daily living* than other interventions. (Level 2)
Studied for ER (=).

Context and interpretation
The guideline development team does not recommend the use of whole body vibration for patients with a stroke.

F.3 Aids to improve ambulation during the mobilization phase

F.3.1 Walking aids to improve walking ability

Walking aids, such as canes (including the 'Canadian cane'), elbow crutch, walking frame, rollator or tripod or quadripod, are intended to help patients stand and/or walk safely and independently.

Walking aids to improve walking ability *86*

In the opinion of the guideline development team, the use of walking aids is beneficial to patients with a stroke in terms of safety, independence, and efficiency of walking, as well as confidence. (Level 4)

F.3.2 Leg orthoses to improve walking ability

A leg orthosis is an external, removable support that can be used to improve functional ambulation, reduce spasticity or pain, prevent hyperextension, and treat contractures and edema.

Leg orthoses to improve walking ability *87–90*

◖ It has been demonstrated that gait training with the help of a leg orthosis along a bar, supported by a physical therapist, is just as effective for patients with a stroke in terms of *walking speed* and *walking distance* as body-weight supported treadmill training. (Level 1)
Studied for ER (=).

◖ It is plausible that walking with a leg orthosis results in greater improvements to the *walking speed* and e*nergy consumption* of patients with a stroke than walking without such a leg orthosis. (Level 2)
Studied for RC (✓).

◗ It is plausible that the use of a leg orthosis by patients with a stroke does not improve their performance of *transfers*. (Level 2)
Studied for RC (=).

◖ It has been demonstrated that gait training with the help of a leg orthosis along a bar, supported by a physical therapist, is not more effective for patients with a stroke in terms of *walking distance* than body-weight supported treadmill training. (Level 2)
Studied for ER (=).

Context and interpretation

The guideline development team recommends trying out a leg orthosis for patients whose safe and/or efficient walking ability is impeded by drop foot during the swing phase of walking. The decision to prescribe a leg orthosis should preferably be made by the interdisciplinary team and in consultation with the rehabilitation physician.
In addition, prescribing a custom-made orthosis should be done in consultation with an orthoses expert.
The role of the physical therapist is that of identifying and monitoring functionality, safety, walking speed, walking ability, gait, and the comfort of the orthosis.
The guideline development team recommends evaluating the fit of orthoses in a specially equipped gait laboratory.

F.3.3 Exercising self-propulsion in a hand-propelled wheelchair

Patients with a stroke who are unable to walk safely usually have a wheelchair prescribed to them.

Exercising self-propulsion in a wheelchair *91, 92*

◖◗ It is plausible that using the non-paretic hand and foot to propel a hand-propelled wheelchair has no adverse effect on the *resistance to passive movements* and the performance of *activities of daily living* by patients with a stroke who are unable to walk independently, but can sit unaided. (Level 2)
Studied for ER (✓).

In the opinion of the guideline development team, the use of a wheelchair improves the safety, independence and radius of action of non-ambulatory patients with a stroke. (Level 4)

Context and interpretation

A wheelchair enables a patient to cover larger distances, and/or makes it easier for care providers and informal caregivers to move the patient around. Wheelchairs used by patients should be regularly checked for tire pressure, seat fit and sitting posture. Adaptations to the wheelchair must be made in consultation with the occupational therapist and rehabilitation physician.
The choice of options provided by the wheelchair should initially be based on the way the patient would like to propel the chair, after which one can evaluate in practice which form of propulsion is the most efficient for the patient.

F.4 Interventions to improve dexterity during the mobilization phase (Level 1)

F.4.1 Therapeutic positioning of the paretic arm

The goal of therapeutic positioning of the arm is to maintain range of motion. It is a common component of therapy at a time when the patient is still inactive most of the time. Therapists often position patients with a stroke in a specific body posture while they are lying or sitting, to prevent contractures, strains on muscles and joints, or point pressure, improve pulmonary ventilation and/or facilitate sputum clearance. There is however no consensus among professionals about the proper positioning of the body and/or extremities. The proper positioning of the body is often dictated by the prevailing assumptions of underlying neurological treatment concepts regarding muscle tone normalization and the prevention of contractures.

Therapeutic positioning of the paretic arm *93*

◖ It has been demonstrated that therapeutic positioning of the paretic arm results in preservation of the *passive exorotation of the shoulder* of patients with a stroke. (Level 1)
Studied for ER (✓).

Context and interpretation

The guideline development team does not recommend therapeutic positioning of the paretic arm for patients with a stroke, since the average effect is only 7 degrees of exorotation of the shoulder, which is not clinically relevant, whereas positioning requires major time investment. The guideline development team does recommend ensuring that the paretic arm is in a comfortable and stable position when the

patient is sitting or lying in bed, to prevent impingement and pain.
It remains unclear to what extent correct positioning affects the development of edema in the paretic arm of patients with a stroke.

F.4.2 Reflex-inhibiting positions and immobilization techniques for the paretic wrist and hand

The use of reflex-inhibiting positions or local immobilization by means of splints or plaster is intended to prevent or reduce increased resistance to passive movements (i.e. passive resistance), or to maintain or increase the active or passive range of motion of the wrist and/or finger extension.
The intervention involves slowly stretching the spastic muscles (so-called slow stretch techniques) to normalize the muscle tone for posture and movement. The goal is to influence the active and passive range of motion of joints in patients with spastic paresis. Examples include reflex-inhibiting patterns and postures, as applied in various neurological exercise methods, or local immobilization by means of splints ('reflex inhibitory splinting') or plaster ('inhibitory casts').

Reflex-inhibiting positions and immobilization techniques for the paretic wrist and hand *94*

◖ It remains unclear whether reflex-inhibiting positions and immobilization techniques for the paretic wrist and hand of patients with a stroke are more effective in terms of *resistance to passive movements*, *pain*, and *passive range of motion* than other interventions. (Level 1)
Studied for ER (=), LR (=), and RC (=).

Context and interpretation

It remains unclear whether reflex-inhibiting positions and immobilization techniques for the paretic wrist and hand of patients with a stroke are more effective than the control intervention with which they were compared, due to insufficient statistical power of the studies which examined this.
The guideline development team does not recommend the routine use of immobilization techniques like splints and positioning for the paretic wrist and hand.

F.4.3 Use of air-splints around the paretic arm and hand

Applying external pressure around a paretic extremity by means of air-splints (or wrapping) is a technique that is primarily used to reduce spasticity in the extremity and/or hand edema. The idea behind these treatment techniques is that the steady light pressure on the skin and muscles inhibits the myotatic reflex arc. The air-splint, an inflatable flexible cylinder which exerts external pressure around one or more joints, is sometimes regarded as an effective way to reduce spasticity in a limb, for instance in the neurological treatment method developed by Johnstone. In the case of wrapping, the pressure is applied by a compress.

Use of air-splints around the paretic arm and hand *95*

◐ It remains unclear whether the use of air-splints around the paretic arm and hand of patients with a stroke is more effective in terms of *selective movements*, *resistance to passive movements*, *somatosensory functions*, *pain*, and *dexterity* than other interventions. (Level 1)
Studied for ER (=) and LR (=).

Context and interpretation

It remains unclear whether the use of air-splints around the paretic arm and hand is more effective than the control intervention with which it was compared, due to insufficient statistical power of the studies which examined this.
The guideline development team does not recommend the routine use of air-splints around the paretic arm and hand of patients with a stroke.

F.4.4 Supportive techniques and devices for the prevention or treatment of glenohumeral subluxation and/or hemiplegic shoulder pain

Supportive techniques and devices for the prevention or treatment of glenohumeral subluxation and/or hemiplegic shoulder pain involve the use of slings, arm orthoses, or strapping techniques. Glenohumeral subluxation is assumed to be mainly caused by a reduced activity of the supraspinatus muscle and the deltoid muscle (dorsal parts). Slings or strapping techniques provide mechanical support that has a preventive effect and assists in the treatment of glenohumeral subluxation. Strapping involves applying tape around the paretic shoulder muscles in order to: (1) correct the limited lateral rotation of the scapula, (2) support the humeral head in the glenoid fossa and (3) relieve the supraspinatus muscle. Strapping has the theoretical advantage over a sling of reducing glenohumeral subluxation while preserving the range of motion of the shoulder joint.
The relation between glenohumeral subluxation and hemiplegic shoulder pain is unclear, as shoulder pain is assumed to be caused by multiple factors. Hemiplegic shoulder pain has been associated with glenohumeral subluxation, development of adhesive capsulitis, neuritis of the suprascapularis nerve, subdeltoid bursitis, tendovaginitis of the biceps tendon, neuropathy of the brachial plexus, arthritis, thalamic pain and spasticity. In addition, hemiplegic shoulder pain may be caused by repeated traumatization of the shoulder by the patient, their caregiver or relatives. Pain in the hemiplegic shoulder can also be caused by the shoulder-hand syndrome or sympathetic reflex dystrophy.

Supportive techniques and devices for the prevention or treatment of glenohumeral subluxation and/or hemiplegic shoulder pain *96*

◖ It remains unclear whether the use of slings, strapping, or arm orthoses for patients with a stroke is more effective in terms of preventing *hemiplegic shoulder pain* and for *selective movements* than other interventions. (Level 1)
Studied for ER (=).

Context and interpretation

It remains unclear whether the use of supportive techniques and devices to prevent or treat glenohumeral subluxation and/or hemiplegic shoulder pain is more effective than the control intervention with which it was compared, due to insufficient statistical power of the studies that examined this.

In patients with a combination of glenohumeral subluxation and hemiplegic shoulder pain, strapping might reduce the degree of diastasis during standing and walking.
The effect of a sling or arm orthosis has not been examined in controlled studies. The guideline development team recommends supporting the paretic arm of patients with glenohumeral subluxation and hemiplegic shoulder pain with the help of an arm rest or worktop on their chair or wheelchair. The patient and their informal caregiver should also be instructed on the best way to handle the positioning and support for the paretic arm.

F.4.5 Bilateral arm training

Bilateral arm training (BAT) is a form of therapy in which cyclic movement patterns or motor activities are actively performed by both arms simultaneously but independently. It may also involve alternating movements. An important component of this method is repetitive movements.
BAT can be used in the context of functional activities or using applications like robotics, EMG-triggered electrostimulation or bilateral arm training with rhythmic auditory cueing (BATRAC), which uses an external auditory rhythm to train flexion/extension of the elbow in a variety of movement patterns. In this intervention, the patient sits at a table with an apparatus with two handles that move independently. The handles have to be moved backwards and forwards by the patient with both hands. Patients with severe impairments of the hand function have the paretic hand strapped to the handle. The movements can be synchronized (0 degrees in phase) or alternated (180 degrees out of phase). The rhythm is adjusted to the patient's preferred rate, which is determined by having the patient perform the cyclic movements at comfortable speed for 5 minutes. A metronome can be used to indicate the rhythm and to promote synchronization of the movements of the two arms. There are also modified forms of BATRAC which involve, for instance, flexion/extension movements of the wrist and/or fingers.
In EMG-triggered electrostimulation, both arms simultaneously perform the same movement, for instance wrist and finger extension, with the paretic arm being stimulated as soon as a predefined EMG threshold value is attained. A similar principle underlies the bilateral use of robotics, with both arms simultaneously performing the same movement, such as reaching or making circular arm movements.
Animal experiments have provided indications that the repetitive element of stereotypical movement patterns plays an important role in learning a movement. Simultaneous activation of the paretic and non-paretic arms (bilateral exercising) is assumed to create an overflow of activation to the paretic arm. It has also been suggested that the simultaneous exercising reduces the intracortical inhibition of the paretic hemisphere. After a stroke, the inhibition through the corpus callosum is reduced, causing an asymmetric pattern: the ipsilateral primary motor cortex (M1) becomes less active, reducing the suppression of the contralateral M1. This may lead to greater excitability of the contralateral M1 cortex, which then in turn increases the suppression of the ipsilateral M1. Bilateral arm training is thought to work by re-balancing corticomotor excitation and transcallosal inhibition, thus promoting the recovery of the paretic arm.

Bilateral arm training *97*

◐ It remains unclear whether bilateral arm training is more effective than unilateral arm training for patients with a stroke in terms of *selective movements*, *muscle strength*, *dexterity*, *perceived use of the paretic arm in everyday life* and performance of *basic activities of daily living*. (Level 1)
Studied for LR (=) and RC (=).

Context and interpretation

It remains unclear whether bilateral arm training is more effective than unilateral arm training, due to lack of statistical power of the studies which examined this.
The guideline development team recommends considering bilateral arm training for patients with a stroke.
It remains unclear whether functional bilateral arm training should be preferred to bilateral arm training using devices.

F.4.6 (Modified) Constraint-Induced Movement Therapy and immobilization

(Modified) Constraint-Induced Movement Therapy or (m)CIMT is a form of therapy consisting of immobilization of the non-paretic arm, usually in combination with task-specific training of the paretic arm using a large number of repeats ('forced use').
CIMT was developed in the 1970s for patients in the chronic phase of a stroke. There is no uniform definition of CIMT, but it is a complex rehabilitation intervention with an interdisciplinary origin. Major components include the immobilization of the non-paretic arm and repetitive task-specific training of the paretic arm. The patient is trained intensively for several weeks to use the paretic arm in ADL activities. Patients with a hemiparesis tend to integrate the paretic arm less and less in ADL, even if the motor function of the arm would allow such integration. This is mostly due to the fact that the non-paretic arm can perform the intended tasks more quickly and easily and that the functional use of the non-paretic arm requires a relatively large effort and is less efficient and accurate. According to this theory, the patient, as it were, 'learns' not to use the paretic arm for various functional activities ('learned non-use'). By greatly restricting the use of the non-paretic arm, CIMT tries to overcome this learned non-use and to achieve functional ADL gains. This is also thought to strengthen use-dependent cortical reorganization.
Several modified forms of CIMT (mCIMT) have been described, which involve lower intensities than the original CIMT. The shared characteristic of these modified protocols is that the non-paretic arm is immobilized for a shorter time each day, as in the original CIMT, with a lower duration and frequency of the therapy sessions, but with a longer total period of treatment. Immobilization means that only the non-paretic arm is immobilized.
The present Guideline distinguishes between original CIMT, high-intensity CIMT, low-intensity CIMT and mere immobilization of the non-paretic arm.

- Original CIMT consists of:
  - constraining the non-paretic arm with a padded mitt* for 90% of the patient's waking hours;
  - task-oriented repetitive training of the paretic arm for 6 hours a day; and
  - behavioral strategies to improve both compliance and transfer of the activities practiced in the clinical setting to the patient's home environment, for 2-3 weeks.
- High-intensity mCIMT consists of:
  - immobilization of the non-paretic arm with a padded mitt for 90% of the patient's waking hours; and
  - three or more hours of training a day.
- Low-intensity mCIMT consists of:
  - immobilization of the non-paretic arm with a padded mitt for 90% of the patient's waking hours; and
  - 30 minutes to 3 hours of training a day.
- Mere immobilization of the non-paretic arm with a padded mitt, without specific training focused on the paretic arm.

(modified) Constraint-Induced Movement Therapy (CIMT) *98-101*

'Original' Constraint-Induced Movement Therapy (CIMT)
◗ It has been demonstrated that original CIMT improves the *dexterity*, *perceived use of arm and hand*, *quality of arm and hand movements*, and *quality of life* of patients with a stroke. (Level 1)
Studied for LR (✓).

High-intensity modified Constraint-Induced Movement Therapy (mCIMT)
◗ It has been demonstrated that high-intensity CIMT improves the *dexterity*, *perceived use of arm and hand*, and *quality of arm and hand movements* of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

Low-intensity modified Constraint-Induced Movement Therapy (mCIMT)
◖◗ It has been demonstrated that low-intensity mCIMT improves the *selective movements*, *dexterity*, *perceived use of arm and hand*, *quality of arm and hand movements*, and performance of *basic activities of daily living* of patients with a stroke. (Level 1)
Selective movements studied for ER (✓) and RC (✓), dexterity for ER (✓), LR ✓), and RC (✓) and perceived use and quality of movements for ER (✓), LR (✓), and RC (✓).

* *A padded mitt is a cotton-wool lined glove that the patient wears on the non-paretic side while performing activities; it allows elbow extension at moments of disturbed balance.*

Immobilization of the non-paretic arm without specific training focused on the paretic arm
◖◗ It remains unclear whether immobilizing the non-paretic arm without task-specific training of the paretic arm is more effective than other interventions for patients with a stroke. (Level 1)
Studied for ER (=) and LR (=).

Context and interpretation
Low-intensity and high-intensity mCIMT also appear to offer added value during the late rehabilitation phase.
The guideline development team only recommends original CIMT for highly motivated patients with some degree of voluntary extension of the paretic wrist and one or more fingers, who are in the late rehabilitation phase or chronic phase. This should preferably be used in consultation with the informal caregiver and where applicable with the nurse.
The use of mCIMT is also recommended only for those stroke patients with some degree of voluntary extension of the paretic wrist and/or one or more fingers. This is relevant for highly motivated patients in the early or late rehabilitation phase or the chronic phase. The guideline development team recommends starting with low-intensity mCIMT soon after the stroke and gradually increasing the intensity. Immobilization of the non-paretic arm should be combined with daily functional dexterity training of the paretic arm ('shaping') for at least 2 weeks.
The team does not recommend the use of a sling instead of a padded mitt, in view of risks to safety during walking and related activities.

F.4.7 Robot-assisted training of the paretic arm

Robot-assisted training, also known as electromechanically assisted training, is a form of therapy using robotics. These new and efficient strategies were explored in the late 1990s. The robot usually consists of an electromechanical device controlled by a computer and special software. Its aim is to promote recovery of the patient's dexterity by means of high-intensity repetitive interactive training.
This type of training makes efficient use of the opportunities for larger numbers of repetitions and longer therapy time that are provided by the fact that the patient can exercise semi-autonomously. In addition, the robotics allows objective and reliable monitoring of the development of arm and hand function in time, as the device can electronically record data on the movements and the number of repetitions. The exercises are often integrated in a computer game.
Various types of robot are available, with different degrees of freedom. Most focus on the proximal arm function (shoulder and elbow), but some also enable the patient to train the distal part of the arm or the entire upper extremity. Available robotics systems offer various training modes. Most offer a passive mode (where the robot moves the patient's arm) and an assisted active mode (in which the robot partially supports the movement, with the patient initiating the movement, after which the robot supports it over a predefined trajectory). Some robots also offer a mode in which the robot offers resistance when the patient moves voluntarily and selectively (active resistance mode). Although most robots are intended for unilateral training, some also offer the option of

bilateral training. This involves active movements of the non-paretic arm being passively performed mirrorwise by the robot on the paretic arm.
Examples of robot-assisted training units include the MIT-MANUS (Massachusetts Institute of Technology), the ARM Guide (Assisted Rehabilitation and Measurement Guide), the MIME (Mirror-Image Motion Enabler) and the InMotion Shoulder-Elbow Robot, Bi-Manu-Track, NeReBo (Neurorehabilitation Robot).
A disadvantage is the high investment costs of these devices.

Robot-assisted training of the paretic arm *102-104*

◖ It has been demonstrated that **unilateral** robot-assisted training of the paretic **shoulder and elbow** of patients with a stroke improves the *selective movements* and *muscle strength of the paretic arm* and reduces *atypical pain* in the paretic arm. (Level 1)
Selective movements and muscle strength studied for ER (✓), LR (✓) and RC (✓), atypical pain for ER (✓) and LR (✓).

◖ It has been demonstrated that **bilateral** robot-assisted training of the **elbow and wrist** improves the *selective movements* and *muscle strength of the arm* of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

◖ It remains unclear whether robot-assisted training in which the **arm and hand** are trained simultaneously is more effective for patients with a stroke in terms of *selective movements* and *muscle strength* than other interventions. (Level 1)
Studied for ER (=) and RC (=).

Context and interpretation
It remains unclear whether robot-assisted simultaneous training of the arm and hand is more effective than the control intervention with which it was compared, due to insufficient statistical power of the studies that examined this.
The guideline development team recommends using shoulder-elbow and/or elbow-wrist robotics for patients with a stroke as an add-on to exercise therapy if one or more goals at the body function level have been defined. There are no indications that the type of robot influences the above effects. It remains unclear whether the use of shoulder-elbow robotics is more effective than other interventions in terms of improving dexterity.
Robot-assisted training is just as effective as other forms of exercise therapy with the same duration and frequency. There is no reason to assume that the effects, or lack of effects, of robot-assisted training of the paretic arm will not also occur in the late rehabilitation phase.

F.4.8 Mirror therapy for the paretic arm and hand

Mirror therapy is a form of therapy in which a mirror is placed alongside the non-paretic hand in such a way as to create the impression that the mirror image is showing the paretic arm and hand. The therapy is based on the theory that visual information on the movements of the non-paretic limb, which the patient receives via a mirror, can work as a substitute for the reduced or absent proprioceptive input from the paretic limb.
The physical therapist instructs the patient to move their hand(s) in synchronized fashion, whether or not towards a point or object on the table. The paretic arm may or may not be moved passively or by assisted active effort.
During the mirror therapy, the patient is seated at a table that is placed as close to the patient as possible. The patient leans against the back of the chair with their arms lying on the table on both sides of the mirror, which stands on the table perpendicular to the surface (in the sagittal plane). The mirror has a width of 45 cm and a height of 60 cm, and the reflecting surface faces the patient's non-paretic side. The height of the table is such that the top edge of the mirror is at least at the level of the patient's eyes. The patient sees the reflection of the non-paretic arm and perceives this as a visual representation of the paretic arm. The patient is then instructed to move their hand(s) towards a point or object on the table. The following variations can be used: (1) the patient tries to move both arms, with the paretic arm joining in to the best of its ability; (2) the movements are only performed with the non-paretic arm; or (3) the movements are performed by the non-paretic arm, while the therapist guides the paretic arm. The visual information gives the patient the illusion that the paretic arm is also moving and that both hands reach the target.
The mechanisms underlying mirror therapy mostly relate to the presence of so-called 'mirror neurons', which are associated with observing and imitating movements. These are located in the premotor cortex, which is involved in preparing for movements, and in the somatosensory cortex, which is involved in the sense of touch. Other mechanisms that have been proposed to explain the effect include increased alertness and spatial attention.

Mirror therapy for the paretic arm and hand *105*

◖ It remains unclear whether mirror therapy for the paretic arm and hand of patients with a stroke is more effective in terms of *selective movements*, *resistance to passive movements*, *pain*, and *dexterity* than other interventions. (Level 1)
Studied for LR (=) and RC (=).

Context and interpretation
It remains unclear whether mirror therapy for the paretic arm and hand is more effective than the control intervention with which it was compared, due to insufficient statistical power of the studies which examined this.
The guideline development team does not recommend the routine use of mirror therapy for the paretic arm of patients with a stroke.

F.4.9 Virtual reality training of the paretic arm and hand

For a definition and description of virtual reality training, see Section F.1.13 'Mobility training in virtual reality'.
The activities in the virtual environment are controlled by sensors placed on the paretic arm, a controller held in the hand or a keyboard and computer mouse. This technique can be used to train gross motor functions of the arm as well as grasping and manipulating objects. The patient is given visual and sometimes also auditory feedback on the correctness of their movements ('knowledge of performance') and the results ('knowledge of results'). The exercises can be done with or without supervision.

Virtual reality training of the paretic arm and hand *106, 107*

◗ It has been demonstrated that virtual reality training of the paretic arm and hand as an add-on to regular exercise therapy for patients with a stroke improves the performance of *basic activities of daily living*. (Level 1)
Studied for ER (✓) and RC (✓).

◖ It has been demonstrated that virtual reality training of the paretic arm and hand as an add-on to regular exercise therapy for patients with a stroke has an adverse effect on *resistance against passive movements*. (Level 1)
Studied for ER (×) and RC (×).

Context and interpretation

The guideline development team recommends the use of virtual reality training of the arm and hand as an add-on to exercise therapy for patients with a stroke. Important elements in this intervention include repetition, task specificity, motivation, and challenge. Training should last about 30 minutes per session, and should preferably be given on 5 days a week, for a period of a few weeks.
Since this form of training can lead to increased muscle tone, this aspect should be monitored.
There is no reason to assume that the favorable and adverse effects of virtual reality training of the paretic arm and hand should not also occur during the late rehabilitation phase.

F.4.10 Electrostimulation of the paretic arm and hand

For a definition and description of electrostimulation, see Section F.1.21, 'Electrostimulation of the paretic leg.' Orthoses with integrated electrodes have been developed for the electrostimulation of the paretic arm and hand, e.g. the *Handmaster*.

Electrostimulation of the paretic arm using surface electrodes *108-113*

NMS of the paretic wrist and finger extensors
◖ It has been demonstrated that neuromuscular electrostimulation (NMS) of the paretic wrist and finger extensors of patients with a stroke is not more effective in terms of *selective movements*, *muscle strength*, *active range of motion for wrist and finger extension*, and *dexterity* than other interventions. (Level 1)
Studied for ER (=) and RC (=).

NMS of the paretic wrist and finger flexors and extensors
◖ It has been demonstrated that neuromuscular stimulation (NMS) of the paretic wrist and finger flexors and extensors of patients with a stroke improves *selective movements and muscle strength*. (Level 1)
Studied for ER (✓).

NMS of the paretic shoulder muscles
◖ It has been demonstrated that neuromuscular electrostimulation (NMS) of the paretic shoulder muscles of patients with a stroke reduces *glenohumeral subluxation*. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

EMG-NMS of the paretic wrist and finger extensors
◖◗ It has been demonstrated that EMG-triggered neuromuscular electrostimulation (EMG-NMS) of the paretic wrist and finger extensors of patients with a stroke improves *selective movements*, *active range of motion*, and *dexterity*. (Level 1)
Studied for ER (✓) and RC (✓).

EMG-NMS of the paretic wrist and finger flexors and extensors
◖◗ It remains unclear whether EMG-triggered neuromuscular electrostimulation (EMG-NMS) of the paretic wrist and finger flexors and extensors of patients with a stroke is more effective in terms of selective movements and dexterity than other interventions. (Level 1)
Studied for ER (✓) and RC (✓).

TENS for the paretic arm
◖◗ It has been demonstrated that transcutaneous electrical nerve stimulation (TENS) is not more effective in terms of resistance against passive movements and the performance of basic activities of daily living by patients with a stroke than other interventions. (Level 1)
Studied for ER (=) and RC (=).

Context and interpretation

The guideline development team recommends the use of both EMG-NMS and NMS as an add-on to regular exercise therapy for patients with some degree of voluntary extension of the paretic wrist and/or fingers, including EMG-NMS for the extensors of the paretic wrist and fingers (extensor carpi radialis, extensor carpi ulnaris and extensor digitorum communis muscles) and NMS not only for the extensors, but also the flexors of the paretic wrist and fingers. The therapist may consider using the Handmaster device, which was developed especially for this purpose, or another type of orthosis with integrated electrodes.
The guideline development team recommends the use of NMS of the paretic shoulder muscles (posterior part of the deltoid and supraspinatus muscles) for stroke patients in the early rehabilitation phase who suffer from glenohumeral subluxation and hemiplegic shoulder pain.
The best settings for the stimulator and the ideal frequency and intensity of this intervention remain unclear. The effects of EMG-NMS and NMS can be partly explained by a difference in therapy time.
There is no reason to assume that the effects, or lack of effects, of EMG-NMS and NMS will not also occur in the late rehabilitation phase.
The guideline development team does not recommend the *routine* use of TENS for the paretic arm, nor of NMS for the paretic wrist and finger extensors.

F.4.11 Electromyographic biofeedback (EMG-BF) for the paretic arm and hand

For a definition and description of EMG-BF see Section F.1.22, 'Electromyopgraphic biofeedback (EMG-BF) for the paretic leg.'

EMG-BF for the paretic arm and hand *114*

◐ It remains unclear whether EMG biofeedback (EMG-BF) for the paretic arm is more effective for patients with a stroke in terms of *selective movements*, *active range of motion*, and *dexterity* than other interventions. (Level 1)
Studied for LR (=) and RC (=).

Context and interpretation
It remains unclear whether EMG-BF for the paretic arm is more effective than the control intervention with which it was compared, due to insufficient statistical power of the studies which examined this.
The guideline development team does not recommend using EMG-BF for the paretic arm for patients with a stroke.

F.4.12 Training muscle strength in the paretic arm and hand
For a definition and description of strength training see Section F.1.16, 'Training muscle strength in the paretic leg.'

Training muscle strength in the paretic arm and hand *115*

◐ It remains unclear whether muscle strength training for the paretic arm and hand of patients with a stroke is more effective in terms of *selective movements*, *muscle strength*, *range of motion*, *pain*, and *dexterity* than other interventions. (Level 1)
Studied for ER (=) and RC (=).

Context and interpretation
It remains unclear whether muscle strength training of the paretic arm and hand is more effective than the control intervention with which it was compared, due to insufficient statistical power of the studies which examined this.
The guideline development team recommends having stroke patients train the muscle strength of the major muscle groups using fitness equipment or functional training, at a minimum frequency of 2-3 times a week, involving 1-3 sets of 10-15 repetitions for 8-10 muscle groups. This may involve circuit class training with (functional) workstations, weight-lifting devices, hand-held weights, or isometric exercises.
The assumption that muscle strength training increases spasticity in the extremity being trained appears to be unfounded.
In view of the possible risk of shoulder complaints, muscle strength exercises involving over 900 of shoulder abduction or anteflexion should be used cautiously, especially for patients with evident paresis of the shoulder muscles.

F.4.13 Trunk restraint while training the paretic arm and hand
The patient's trunk can be externally fastened to the back of the chair while they exercise reaching and grasping, thus preventing them from using their trunk. Patients with moderate paresis often compensate for the reduced arm function in task-oriented arm training by means of excessive forward movements of the trunk. External restraint of the trunk in such forms of arm training limits these compensatory movements, and is assumed to promote the use of active elbow extension, anteflexion of the shoulder and coordination among the various arm joints. The external restraint can be achieved by shoulder straps or an electromagnet fixing the patient to the back of the chair, or by a board applied at trunk level to prevent the trunk from moving forward. This is an effective strategy to achieve functional use of the arm in the short term, although it has been suggested to be ineffective in the longer term. The addition of trunk restraint during arm training is a relatively new concept, and has so far only been assessed in small-scale studies among patients in the chronic phase.

Trunk restraint while training the paretic arm and hand *116*

◐ It has been demonstrated that trunk restraint while training the paretic arm and hand of patients with a stroke has an adverse effect on the *perceived use of the arm and hand* compared to training forms not using this type of restraint. (Level 1)
Studied for RC (×).

Context and interpretation
The guideline development team does not recommend the routine use of trunk restraint while training the paretic arm and hand of patients with a stroke.

F.4.14 Interventions to improve the somatosensory functions of the paretic arm and hand
For a definition and description of somatosensory impairments, see Section F.1.20, 'Interventions to improve the somatosensory functions of the paretic leg.'
The interventions can involve distinguishing the form, weight, or structure of objects using the paretic hand, identifying numbers or letters drawn on the patient's paretic hand or arm by the therapist, washing the hand with water of different temperatures, or distinguishing the form, weight or structure of objects placed in the patient's hand by the therapist.
The exercises can be performed with the patient in supine, sitting or standing position. The physical therapist asks the patient to position both the paretic and the non-paretic extremities at various angles of the joints.

Interventions to improve the somatosensory functions of the paretic arm and hand *117*

◖ It has been demonstrated that interventions to improve the somatosensory functions of the paretic arm and hand of patients with a stroke improve the *somatosensory functions* and reduce the *resistance to passive movements*. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

Context and interpretation
The guideline development team recommends that somatosensory functions of patients with a stroke should not be treated in isolation, but should where possible be integrated in existing exercise programs to improve dexterity.

F.5 Interventions to improve dexterity during the mobilization phase (Level 2)

F.5.1 'Continuous passive motion' for the shoulder

Continuous passive motion (CPM) for the shoulder *118*

◐ It is plausible that the use of a continuous passive motion (CPM) device by patients with a stroke is not more effective in terms of *the stability of the shoulder joint*, *muscle strength*, *selective movements*, *resistance to passive movements*, *pain*, and performance of *basic activities of daily living* than other interventions. (Level 2)
Studied for ER (=).

Context and interpretation
The guideline development team does not recommend the use of a CPM device for the shoulder of patients with a stroke.

F.5.2 Subsensory threshold electrical and vibration stimulation of the paretic arm

Subsensory threshold electrical and vibration stimulation of the paretic arm *119*

◐ It is plausible that subsensory threshold electrical and vibration stimulation of the paretic arm of patients with a stroke is not more effective in terms of *somatosensory functions*, *selective movements*, *dexterity*, and *quality of life* than other interventions. (Level 2)
Studied for RC (=).

Context and interpretation
The guideline development team does not recommend using subsensory threshold electrical and vibration stimulation of the paretic arm of patients with a stroke.

F.5.3 Circuit class training for the paretic arm

Circuit class training for the paretic arm *120*

◐ It is plausible that circuit class training with workstations for the paretic arm improves *selective movements* and *dexterity* of patients with a stroke. (Level 2)
Studied for RC (✓).

Context and interpretation
The guideline development team recommends using circuit class training with workstations intended to train the paretic arm of patients who show incomplete recovery of dexterity. The workstations may offer muscle strength training for the shoulder muscles, exercises to improve the range of motion of the joints, load bearing by the paretic arm, functional activities requiring functions like fine motor control of the hand or reaching, electrostimulation of the wrist and fingers, or robotics.
Each session should last 60 minutes. Circuit class training should be done on 3 days a week, and should be continued for several weeks.

F.5.4 Passive bilateral arm training

Passive bilateral arm training *121, 122*

◖ It is plausible that passive bilateral arm training is not more effective for patients with a stroke in terms of *selective movements*, *maximum contraction strength of the hand*, and *neurological functions* than other interventions. (Level 2)
Studied for RC (=).

◖ It is plausible that passive bilateral arm training improves *neurophysiological outcome measures* like excitation of the ipsilateral motor cortex of patients with a stroke. (Level 2)
Studied for RC (=).

Context and interpretation
The guideline development team does not recommend the use of passive bilateral arm training for patients with a stroke.

F.5.5 Mechanical arm trainer

Mechanical arm trainer *123, 124*

◐ It is plausible that the use of a mechanical arm trainer by patients with a stroke is not more effective in terms of *selective movements*, *muscle strength*, *resistance to passive movements*, and performance of *basic activities of daily living* than other interventions. (Level 2)
Studied for ER (=).

◗ It is plausible that the use of a mechanical arm trainer improves the dexterity of patients with a stroke. (Level 2)
Studied for ER (✓).

Context and interpretation
The guideline development team does not recommend the routine use of a mechanical arm trainer for patients with a stroke.

F.6 Interventions for ADL activities during the mobilization phase

F.6.1 Skills for daily living (ADL)

Skills in activities of daily living can be subdivided into basic ADLs and extended ADLs. The former include activities like self-care, eating and drinking, urinary and fecal continence, transfers and moving about indoors. Extended ADLs involve more interaction with the environment and are therefore more complex than the basic ADLs. Examples include organizing and performing housekeeping tasks and hobbies, using the telephone, managing one's finances, visiting people and transportation outside the home.

F.6.2 Training for dyspraxia to improve ADL-independence

Stroke patients with dyspraxia or apraxia have problems performing learned and/or goal-oriented tasks. The limitations, which can occur with varying degrees of severity, cannot be primarily attributed to motor, coordination, or sensory impairments. Nor are there impairments of vision, hearing, language comprehension, atten-

tion, arousal, motivation, spatial perception, intellect, consciousness, or memory that can fully explain the limitations. Apraxia is more common among patients with a stroke in the left hemisphere than the right. Regardless of laterality, apraxia is assumed to affect ADL-independence. It is usually the occupational therapist who diagnoses the apraxia.
The functional problems arising from these often permanent ideational and ideomotor apraxia impairments can be treated by integrating strategy training or gestural training in regular therapy. Strategy training focuses on skills that are useful to the patient and should preferably be presented in a structured approach, if possible on a daily basis, and possibly supported by aids (photo albums, writing pads). In view of the occupational therapist's specific expertise in this area, it is often this discipline which coordinates the strategy training for patients with dyspraxia or apraxia. Gestural training involves exercises relating to: (1) the use of objects, (2) symbolic gestures, and (3) body postures.
This requires collaboration between the physical and occupational therapists, in view of the latter's specific expertise. This collaboration should be embedded in an interdisciplinary treatment plan, which also involves nurses.

Training for dyspraxia to improve ADL-independence *125-128*

◐ It remains unclear whether the treatment of dyspraxia using gestural training for patients with a left hemisphere stroke has a favorable effect on the severity of *ideational and ideomotor apraxia* compared to other interventions. (Level 1)
Studied for RC (✓).

◐ It is plausible that the treatment of dyspraxia using gestural training has a favorable effect on the *basic activities of daily living* of patients with a left hemisphere stroke. The effects persist in the longer term. (Level 2)
Studied for RC (✓).

◐ It is plausible that strategy training for the treatment of dyspraxia has a favorable effect on the *basic activities of daily living* of patients with a left hemisphere stroke, and the effects also *extend to non-trained tasks*. The effects plateau in the long term. (Level 2)
Studied for LR (✓).

◐ It is plausible that strategy training for patients with a stroke of the left hemisphere is not more effective in terms of the severity of *ideational and ideomotor apraxia*, *muscle strength*, and *dexterity* than other interventions. (Level 2)
Studied for LR (=).

Context and interpretation

The guideline development team recommends that patients with a stroke who have problems independently performing functional activities due to dyspraxia or apraxia should be trained to improve ADL-independence. The strategy or gestural training can be integrated in the regular therapy, even from the early rehabilitation phase on.
This requires collaboration between the physical and occupational therapists, incorporated in an interdisciplinary treatment plan, in view of the specific expertise of the two disciplines. In view of occupational therapists' specific expertise on dyspraxia, it is often this discipline which coordinates the training for patients with dyspraxia.
So far, interventions for the treatment of dyspraxia or apraxia and the consequences of dyspraxia or apraxia for everyday life have only been examined in small-scale studies.

F.6.3 Interventions aimed at learning/re-learning and resuming leisure or social activities in the home setting

Leisure or social activities include activities that are performed at home or in the community, like gardening or painting. Stroke patients are often unable to find meaningful ways of spending their leisure time, and indicate that they are frequently bored during the day. The lack of meaningful leisure activities regularly leads to unnecessary tensions in the family. This is why teaching them to engage in activities in the home situation is considered to be an important part of the rehabilitation of stroke patients.

Interventions aimed at learning/re-learning and resuming leisure or social activities in the home setting *129-131*

◗ It has been demonstrated that therapy to learn/re-learn leisure or social activities at home, such as gardening or painting, have a favorable effect on the *participation in leisure time activities* of patients with a stroke. (Level 1)
Studied for ER (✓).

◐ It has been demonstrated that therapy aimed at leisure or social activities at home by patients with a stroke is not more effective in terms of *quality of life*, *mood*, and *depression* than other interventions. (Level 1)
Studied for ER (=) and RC (=).

◐ It is plausible that therapy aimed at leisure and social activities at home is not more effective in terms of improving *motor functions*, *basic activities of daily living*, *extended activities of daily living*, and *participation* by patients with a stroke, nor in terms of reducing the *perceived stress of the patient's partner*, than other interventions. (Level 2)
Motor functions studied for ER (=), basic activities of daily living for ER (=), extended activities of daily living for LR (=), participation for LR (=), and perceived stress of the partner for LR (=).

Context and interpretation

The guideline development team recommends considering therapy in the patient's home setting aimed at learning and resuming leisure activities, especially when the patient asks for it. It is possible that younger patients with a stroke benefit more from therapy at home than older patients.
In view of the overlap with occupational therapy, the therapy must be coordinated with the occupational therapist.

G Cognitive rehabilitation

The main sources on which this Section is based are three guidelines for cognitive rehabilitation for non-congenital brain injury, which were developed by: (1) the Cognitive Rehabilitation Task Force, Brain Injury - Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine, (2) the European Federation of Neurological Societies and (3) the Dutch Consortium Cognitieve Revalidatie.

A commonly accepted definition of cognitive rehabilitation is 'any intervention strategy or technique which enables patients and their families to live with, manage, by-pass, reduce or come to terms with cognitive deficits precipitated by injury of the brain'. Regardless of the type of intervention or the cognitive function(s) that are intervened on, the goal is to achieve changes that are relevant to patients' everyday lives. The rehabilitation can focus on various cognitive functions, such as attention, concentration, perception, memory, understanding, communication, argumentation, problem-solving skills, judgment, initiative, planning, self-monitoring, and consciousness (awareness). Cognitive rehabilitation may include psycho-education to improve cognitive functions and increase the patient's understanding of their own cognitive performance, educating the patient and their social environment, explaining the use of aids and strategies, and cognitive training. Cognitive training is that part of cognitive rehabilitation that aims at reducing and learning to cope with cognitive impairments, rather than on eliminating the impairment itself. It sometimes involves 'skills training', but more often it concerns the use of compensatory strategies, using cognitive compensation mechanisms as well as external mechanisms like structuring the environment and providing support. Patterns of specificity of treatment effects and treatment intensity (in terms of numbers of repetitions) also prove to be important principles of cognitive rehabilitation, which partly determine its efficacy.

Effective treatment of patients with a stroke requires a physical therapist to possess knowledge of the underlying functional cognitive impairments, and the best way to deal with these impairments. Cognitive rehabilitation is an interdisciplinary approach and must be implemented in consultation with a neuropsychologist. If the team does not include a neuropsychologist, the team will have to contact a local expert. The administration and interpretation of tests will be left to an expert (neuropsychologist or specialized occupational therapist). In some institutions or teams, the physical therapists may have already familiarized themselves with a number of simple tests (often due to the insufficient availability of other experts). These particularly include tests to screen patients for hemispatial neglect. If a physical therapist has demonstrable expertise, based on training and clinical experience, the treatment and monitoring of these cognitive impairments may also be included in their tasks.

This section discusses cognitive rehabilitation for attention deficits, memory problems, and neglect, as impairments of these functions can have a major impact on the physical therapy process. Dyspraxia has been discussed in Section F.6.2, 'Training for dyspraxia to improve ADL-independence'.

G.1 Cognitive rehabilitation aimed at attention deficits

About 40% of patients with a stroke have some impairments of attentional functions, with various degrees of severity. Attention can be subdivided into: (1) activation or arousal level, (2) focused attention, (3) divided attention, and (4) persistent attention. The speed with which information is processed plays an important role in attentional functions. About 70% of patients find it difficult to perform well under pressure of time. A delay in processing information has a negative influence on attentional functions, memory, and the organization and planning of behavior. Slow information processing manifests itself for example in patients taking considerable time before responding to a question or instruction. The attention deficits themselves may constitute a target for treatment. Computer-controlled therapy of attention deficits involves presenting multiple stimuli that the patient must try to remember during a pause in the program, or the patient may be asked to memorize the order in which the stimuli were presented. The structure of the therapy should preferably be progressive.

A reduced ability to concentrate may have consequences for the design of the therapy. A 30-minute therapy session may be too long, and environmental factors like noisy activity in the exercise room may affect the patient's ability to concentrate on the therapy.

Cognitive rehabilitation aimed at attention deficits *132, 133*

◖ It remains unclear whether training to improve attention *during the first 6 weeks after the stroke* is more effective than other interventions. (Level 1)
Studied for ER (=).

◖ It has been demonstrated that attention training using compensation strategies has a favorable effect on the *attention span* of patients *whose stroke occurred 6 weeks ago*. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

Context and interpretation

The treatment of attention deficits consists of attention training and metacognitive training. Metacognitive training focuses on complex functional tasks, and involves the therapist giving feedback and teaching compensation strategies to enable patients to improve their performance of these tasks. In addition, the therapist may consider supervised use of special computer programs.

The training of time pressure management involves the therapist teaching the patient cognitive strategies to avoid or cope with pressure of time.

Attention process training involves tasks being hierarchically stepped up in terms of the level of attention required for them.

It is important to take a patient's reduced attention span into account when planning their daily program, defining the duration of therapy sessions, or engaging the patient in conversations. The usual 30-minute duration of therapy sessions may be too long for these patients, and two 15-minute sessions spread over two parts of the day may be preferable. Similarly, the (cognitive) rehabilitation program should include periods of rest, defined in consultation with the patient, to ensure that the latter does not become overtired and hence unable to absorb information. Finally, the therapist must take the patient's reduced attention span into account when conducting a conversation involving several people and when offering physical therapy in a room where several other patients are being treated, or where there are other distracting environmental factors, such as music.

G.2 Cognitive rehabilitation aimed at memory deficits

Memory deficits form a barrier to rehabilitation as regards learning or re-learning skills. Memory is the ability to commit information to memory (imprinting), retain it (remembering) and use it later, which means reproducing (recall) as well as recognizing (recognition).
A commonly used subdivision of 'memory' is that into short-term memory and long-term memory, and the long-term memory can be further subdivided into declarative memory and procedural memory. The short-term memory (also referred to as working memory) involves retaining information in memory for a short time (a few minutes at most). Working memory also plays a role in planning complex tasks, which by definition require much executive control. Information from the short-term memory is stored in the long-term memory if the information is repeated. The declarative (or conscious or explicit) memory relates to knowledge derived from previous experiences and events. This type of memory plays an important role in re-learning or learning activities that involve conscious organization and planning, such as self-care. Procedural memory relates to skills that are learned and retained in memory, especially learning or practicing motor skills.
Memory training can use compensatory strategies, which may involve external strategies, such as a written step-by-step plan, or internal strategies like visualization. Composing, keeping and training the use of a memory book and/or diary requires one of the treatment team to be assigned the function of permanent coordinator.
The emphasis should be on the patient learning to independently solve memory problems with the help of the memory book and/or diary, and this strategy should be offered by the entire team, in a systematic and coordinated approach.
Another type of training strategy is that of 'errorless learning'. This involves training the declarative memory by asking patients to remember information presented for increasing intervals.

Cognitive rehabilitation aimed at memory deficits *134, 135*

◗ It has been demonstrated that memory strategies using internal and external strategies have a favorable effect on patients with a stroke in terms of *learning to compensate for mild memory deficits.* (Level 1)
Studied for LR (✓) and RC (✓).

◗ It is plausible that memory strategy training in functional situations, using external strategies, has a favorable effect on patients with a stroke who have moderate to severe memory deficits, in terms of *learning functional skills in these situations.* (Level 1)
Studied for LR (✓) and RC (✓).

Context and interpretation

Memory training does not appear to improve the ability to retain information in memory. Memory training is most effective when patients are able to function more or less independently in everyday life, are aware of their memory problems, and are able and motivated to actively use memory strategies continuously and independently.
The guideline development team recommends using strategy training for patients with memory deficits in a functional context, by teaching them internal strategies (visualization) and external compensation strategies. This requires collaboration with a (neuro)psychologist, as other cognitive impairments may hamper the effective use of strategies.
Another option may be 'errorless learning'.
The guideline development team recommends that strategy and memory training should always be applied in consultation with a (neuro)psychologist and an occupational therapist.

G.3 Cognitive rehabilitation for hemispatial neglect

Hemispatial neglect or hemineglect (also known as hemispatial inattention) is defined as 'the inability of the patient to respond to new or important stimuli which are provided on the contralateral side of the affected hemisphere'. The goal of neglect therapy is to influence the patient's attention for the neglected side. Examples of neglect therapy include: (1) visual scanning training, which requires the patient to make saccades (rapid jerks of the eyes from one fixation point to another, in small movements) applying a systematic scanning pattern, (2) wearing hemispatal sunglasses, (3) wearing prism glasses, (4) activating the extremities on the neglected side, (5) transcutaneous electrical nerve stimulation (TENS) of the neck muscles, and (6) feedback using video images.

Cognitive rehabilitation for hemispatial neglect *136, 137*

◖ It has been demonstrated that visual scanning training has a favorable effect on the *attention for the neglected side* of patients with a stroke in the right hemisphere. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

◖ There are indications that the following neglect-oriented training forms have a favorable effect in terms of the *attention for the neglected side* of patients with a stroke in the right hemisphere: combined training for visual scanning, reading, copying, and describing figures, activation of the extremities on the neglected side, stimulating the neck muscles, wearing hemispatial sunglasses, wearing prism glasses, and video feedback. (Level 3)
Studied for ER (✓), LR (✓) and RC (✓).

Context and interpretation

Although the above interventions have been proven to be effective at the body function level, as assessed for instance with the 'Line Bisection Test' and the 'Letter Cancellation Test', they do not improve ADLs. Stimulating the neck muscles has a very transient effect.
Scanning training for neglect in patients with a right hemisphere stroke needs to be intense, that is, 30-60 minutes a day, over a number of weeks. The therapy can also be applied several times a day by care providers from various disciplines and possibly by the patient's informal caregiver.

G.4 Cognition and aerobic exercising

Aerobic exercise not only has a favorable effect on physical outcome measures like maximum oxygen consumption, but also improves cognitive performance. This favorable effect has been attributed to neurophysiological and neurochemical changes in parts of the brain involved in cognition, including proliferation of neurons, an increase in the volume of structures like the hippocampus, improved cerebral perfusion, and changes in functional activation patterns.
Supervised aerobic exercising by healthy older adults, such as brisk walking or jogging during a minimum period of 6 weeks, has been found to improve attention and speed of information processing, executive functioning, and memory compared to older adults not engaging in aerobic exercising. Older adults with cognitive impairments and dementia have also been found to benefit from physical training programs. There appears to be a dose-response relationship between the level of physical activity and memory improvements.
Effects on cognitive outcomes have also been found among patients with a stroke. Although this has only been examined in small-scale studies, there are no reasons to assume that the above affects of physical training on older adults with and without cognitive impairments could not be generalized to patients with a history of stroke.

Cognition and aerobic exercising *138*

◖ It is plausible that aerobic training has a favorable effect on *conditional learning* and *implicit learning* by patients with a stroke. (Level 2)
Studied for RC (✓).

Context and interpretation

Whether patients with a stroke have cognitive impairments or not, it is important that they become physically active after their illness, for instance by participating in aerobic training with fitness equipment or through brisk walking or jogging, at least 3 times a week, for 20-60 minutes at a time (or multiple 10-minute sessions). Intensity: VO_{2max} 40-70%, HRR 40-70%, HR_{max} 50-80% or a Borg RPE score of 11-14 (on a scale of 6-20).

H Reporting, record-keeping and concluding the treatment

The physical therapist is a permanent member of the interdisciplinary team in the entire stroke service. Prior to the start of the physical therapy process, this interdisciplinary team should be informed, orally and/or in writing, about the physical therapist's working diagnosis and treatment plan. During the course of the physical therapy process, the team must be kept informed of the therapeutic process, including the goal(s) of the therapy, the choice(s) of therapy, the course of the therapy including (interim) treatment outcomes, the findings of monitoring, and the recommendations.

The therapy is concluded if the treatment goals have been achieved or if the physical therapist is of the opinion that further physical therapy offers no added value, or estimates that the patient will be able to achieve their goals independently, without guidance from a physical therapist.
If the physical therapist wants to conclude the therapy for the above reasons, in consultation with the patient, he/she will have to:

- discuss with the patient and their informal caregiver, if present, why the therapy is to be terminated;
- offer recommendations, if necessary, for the maintenance or improvement of the patient's functioning;
- make appointments for 6-monthly sessions to monitor functional performance if functional recovery is still incomplete 6 months after the stroke, and/or there are any risk factors for functional deterioration;
- inform the patient and their informal caregiver, if present, about reasons for contacting the physical therapist for a re-evaluation of the patient's functional performance at an earlier time than 6 months, and about the changes that indicate the need for re-evaluation;
- if necessary, give the informal caregiver advice about ensuring the patient's safety and when to offer assistance or refrain from offering assistance.

The physical therapist should also inform the referring physician about aspects like the patient's individual treatment goals, the therapy process, treatment outcomes, and advice given (aftercare), after consulting him or her about their need for information. This information may be provided during the process, but in any case must be given at the time of conclusion of the therapy. The referring physical will in most cases be a neurologist, rehabilitation physician, elderly care physician or family physician. If the family physician is not the referring doctor, he or she should nevertheless always receive a copy of the report.
More information about feedback to family physicians is provided in the NHG/KNGF Guideline on '*Gestructureerde informatie-uitwisseling tussen huisarts en fysiotherapeut*' (systematic exchange of information between family and physical therapist; in Dutch).
Record-keeping should be done according to the KNGF guideline on record-keeping in physical therapy (*KNGF-richtlijn Fysiotherapeutische Verslaglegging*; in Dutch). In accordance with this guideline, the final report should preferably contain the following information, in addition to the minimum required data:

- whether the patient was treated in accordance with the present KNGF Guideline, in what respects (if any) the therapy deviated from the Guideline and why;
- whether any appointments have been made for monitoring the patient's functioning.

Recording and reporting patient information is important not only within the treatment team, but also in the wider chain of integrated care. An electronic patient file can facilitate the reporting process within the interdisciplinary team and between the components of the integrated care system, as well as the process of reporting and therapy conclusion.

Supplements

Supplement 1 Recommendations

◖◗ outcome measure(s) at the ICF levels of body functions, activities, and participation
◖ outcome measure(s) at the ICF level of body functions
◗ outcome measure(s) at the ICF levels of activities and participation
✓ phase for which the intervention was studied (favorable effect)
× phase for which the intervention was studied (adverse effect)
= phase for which the intervention was studied (no added value / added value unclear)

General treatment principles and rationale of physical therapy

Stroke team
1 It has been demonstrated that having patients with CVA treated by a specialised interdisciplinary stroke team, who are working together at one common site (stroke unit), has a favorable effect on survival rates, length of stay, and ADL-independence, compared to regular care at a non-specialized ward. (Level 1)

Evidence-based guidelines
2 There are indications that treatment based on evidence-based treatment guidelines by an interdisciplinary stroke team has a favorable effect on survival rates, recovery of ADL-independence, patient satisfaction and healthcare-related costs for patients admitted to hospital in the hyperacute/acute and early rehabilitation phases. (Level 3)

3 In the opinion of the guideline development team, patients hospitalized with a stroke should also be treated by a physical therapist during the weekend. (Level 4)

The physical therapist's expertise
4 In the opinion of the guideline development team, effective physical therapy for patients with a stroke requires knowledge and experience. A necessary condition for sufficient expertise is that physical therapists treating patients with a stroke should receive sufficient additional training and treat stroke patients on a regular basis. (Level 4)

Intensity of exercise training
5 ◖◗ It has been demonstrated that increasing the intensity of therapy (in terms of more hours of exercise) for patients with a stroke, compared to less intensive exercising, results in more rapid recovery of selective movements, comfortable walking speed, maximum walking speed, walking distance, muscle tone, sitting and standing balance, performance of basic activities of daily living, and severity of depression and anxiety. (Level 1)
Studied for ER (✓), LR (✓), RC (✓).

Task specificity of training effects
6 It has been demonstrated that training specific skills, such as exercising balance while standing and reaching to grasp objects, has a favorable effect on the specific skill being trained by stroke patients, in all phases of rehabilitation. Transfer to other skills, which were not specifically trained during the therapy, has however hardly been demonstrated. (Level 1)

Context specificity of training effects
7 It has been demonstrated that training stroke patients in a functional context has a favorable effect on learning specific movements or skills, regardless of the patient's rehabilitation phase. If possible, patients with a stroke should preferably be rehabilitated in their own domestic and community environment. (Level 1)

Neurological exercise methods or treatment concepts (NDT/Bobath)
8 ◖◗ It has been demonstrated that neurological exercise methods or treatment concepts (NDT/Bobath) are no more effective for patients with a stroke at the body functions and activities levels than other treatment methods. (Level 1)
Studied for ER (=), LR (=), RC (=).

Motor learning
9 It is plausible that improvements in functional skills like sitting, standing, walking, and dexterity are brought about by learning adaptation strategies. (Level 2)

10 It is plausible that functional exercise therapy in an environment that is as relevant as possible to the patient (context-specific tasks) has a favorable effect on the specific skill to be learned. A combination of variation and sufficient repetition (repetition-without-repetition) has proved to be an important element of effective learning processes. (Level 2)

Telerehabilitation/teleconsultation
11 It is plausible that telerehabilitation/teleconsultation results in improved dexterity for patients with a stroke. (Level 2)

Self-management
12 It is plausible that self-management programs are effective in improving the self-efficacy, participation, and quality of life of patients with a stroke. (Level 2)

Secondary prevention: lifestyle programs involving physical training
13 It is plausible that the risk factors for stroke in patients with a history of TIA or 'minor stroke' are favorably influenced by lifestyle programs involving aerobic exercising. (Level 2)

Falls prevention
14 In the opinion of the guideline development team, all patients with a stroke need to be screened for elevated risk of falling, after which, if necessary, a preferably interdisciplinary, multifactorial treatment strategy can be designed. (Level 4)

Diagnostic process
Systematic measurements (monitoring)
15 There are indications that systematic measurements (monitoring) using reliable and valid measurement instruments enhance the process of clinical argumentation and the continuity of care for patients with a stroke. (Level 3)

Functional prognosis
Prognosis for walking ability 6 months after the stroke
16 It has been demonstrated that establishing an estimated prognosis for the patient's walking ability 6 months after the stroke requires their sitting balance (assessed with the sitting balance item of the Trunk Control Test) and the motor function of the leg (assessed with the Motricity Index) to be recorded as soon as possible, but preferably on day 2 after the stroke. (Level 1)

17 In the opinion of the guideline development team, patients who initially have an unfavorable prognosis for walking ability should be monitored weekly during the first 4 weeks and then monthly for 6 months after the stroke for recurrence of the above determinants, using reliable and valid measurement instruments. This remains necessary as long as a patient remains unable to walk independently. (Level 4)

Prognosis for dexterity 6 months after the stroke
18 It has been demonstrated that establishing an estimated prognosis for the patient's dexterity 6 months after the stroke requires their capacity for finger extension (assessed with the Fugl-Meyer Assessment) and shoulder abduction (assessed with the Motricity Index) to be recorded as soon as possible, but preferably on day 2 after the stroke. (Level 1)

19 In the opinion of the guideline development team, patients who initially have an unfavorable prognosis for dexterity should be monitored weekly during the first 4 weeks and then monthly for 6 months after the stroke for recurrence of the above determinants, using reliable and valid measurement instruments. This remains necessary as long as a patient lacks dexterity. (Level 4)

Prognosis for basic ADL activities 6 months after the stroke
20 It has been demonstrated that the ideal moment to estimate a patient's chances of performing basic ADL activities 6 months after the stroke is to determine their Barthel Index at the end of the first week after the stroke, but preferably on day 5. The Barthel Index records what a patients actually does at the time of the assessment, not what they could potentially do. (Level 1)

21 In the opinion of the guideline development team, patients who initially have an unfavorable prognosis for basic ADL activities should be monitored weekly (4 times) during the first month and then monthly for 6 months after the stroke for recurrence of the above determinants, using reliable and valid measurement instruments. This remains necessary as long the patient is still dependent for basic ADL. (Level 4)

Prognosis for functional changes in walking ability in the period following the first 6 months after the stroke
22 In the opinion of the guideline development team, an indication of possible further changes in walking ability for patients during the chronic phase who have a Functional Ambulation Categories (FAC) score of 3 or more at 6 months after the stroke can be obtained by having them do the 10-meter walk test at comfortable speed every 6 months. A meaningful change can be defined as a change in the walking speed of at least 0.16 m/s relative to the speed attained 6 months after the stroke. (Level 4)

23 In the opinion of the guideline development team, patients in the chronic phase who still have a limited walking ability in the period following the first 6 months after the stroke should be monitored for their functional performance regularly (every 6 months). (Level 4)

24 In the opinion of the guideline development team, the fact that a patient in the chronic phase shows significant functional changes at the level of activities justifies continuation or resumption of physical therapy. (Level 4)

Prognosis for functional changes in dexterity in the period following the first 6 months after the stroke
25 In the opinion of the guideline development team, an indication of possible changes in dexterity for patients during the chronic phase with a Frenchay Arm Test score of 1–4 points 6 months after the stroke, and with somatosensory functional impairments and/or hemispatial neglect, can be obtained by evaluating their dexterity every 6 months (preferably by means of the Action Research Arm Test [ARAT]), as these patients are at risk for 'learned non-use'. A meaningful change can be defined as a change in the ARAT score of at least 6 points relative to the score obtained 6 months after the stroke. (Level 4)

26 In the opinion of the guideline development team, patients in the chronic phase who still have a limited dexterity in the period following the first 6 months after the stroke should be monitored in terms of functioning regularly (every 6 months). (Level 4)

27 In the opinion of the guideline development team, the fact that a patient in the chronic phase shows significant functional changes at the level of activities justifies continuation or resumption of physical therapy. (Level 4)

Prognosis for functional changes in ADL performance in the period following the first 6 months after the stroke
28 In the opinion of the guideline development team, an indication of possible changes in the performance of ADL activities during the chronic phase can be obtained by determining the Barthel Index (BI) every 6 months. A meaningful change can be defined as a change in the BI score of at least 2 points relative to the score obtained 6 months after the stroke. (Level 4)

29 In the opinion of the guideline development team, patients in the chronic phase who still have ADL limitations in the period following the first 6 months after the stroke should be monitored in terms of functioning regularly (every 6 months). (Level 4)

30 In the opinion of the guideline development team, the fact that a patient in the chronic phase shows significant functional changes at the level of activities justifies continuation or resumption of physical therapy. (Level 4)

Premobilization phase
Duration of premobilization phase and early start of rehabilitation
31 There are indications that the duration of the premobilization phase may vary from a few hours to many weeks, and depends on aspects like the presence of fever, cardiac instability and general malaise, and a reduced level of consciousness. (Level 3)

32 It is plausible that starting rehabilitation as early as possible (preferably within 24 hours after the stroke occurred) accelerates and enhances functional recovery. (Level 2)

Body position in bed
33 In the opinion of the guideline development team, the stroke patient's body position in bed should be such that it is perceived as comfortable. (Level 4)

Edema of the hand
34 It is plausible that intensive intermittent pneumatic compression (IPC) of the paretic lower arm in the early rehabilitation phase is not more effective in relieving edema of the hand than other interventions for patients with a stroke. (Level 2)

Preventing pressure ulcers
35 There are indications that the risk of pressure ulcers for stroke patients in the premobilization phase is reduced by frequently changing their body position in the bed. The risk of pressure ulcers can also be reduced by checking skin areas exposed to point pressure (heel and coccyx) on a daily basis. (Level 3)

Preventing bronchopneumonia

36 There are indications that regularly changing a stroke patient's body position in the bed during the premobilization phase reduces the risk of bronchopneumonia. (Level 3)

Pulmonary ventilation

37 It remains unclear whether breathing exercises and manual chest compression are more effective in optimizing the pulmonary function and sputum clearance of patients with a stroke than other interventions. (Level 3)

Training inspiratory muscle strength

38 It remains unclear whether training the inspiratory muscle strength of patients with a stroke is more effective than other interventions. (Level 1)

(Supervised) active exercises

39 There are indications that exercising (reactivation) during the premobilization phase is an effective intervention for patients with a stroke. (Level 3)

Detecting deep vein thrombosis

40 In the opinion of the guideline development team, stroke patients in the premobilization phase should be checked daily for symptoms of edema, painful calf, local redness and heat, and fever, as these could indicate deep vein thrombosis (DVT). The risk of DVT can be reduced by mobilizing the patient (i.e. making them stand up and/or walk) immediately after the stroke, if possible, under the supervision of a physical therapist. (Level 4)

Early involvement of informal caregiver(s)

41 There are indications that the rehabilitation process can be optimized by informing the stroke patient's informal caregiver at the earliest possible occasion about what the patient can and cannot do. (Level 3)

Mobilization phase

Walking ability and other mobility-related functions and abilities during the mobilization phase

Early mobilization from the bed

42 ◖◗ It remains unclear whether early mobilization from the bed, i.e. within 24 hours after the stroke occurred, is more effective than later mobilization as regards complications, neurological deterioration, fatigue, basic ADL activities and discharge home. (Level 1)
Studied for (H)AR (=).

Exercising sitting balance

43 ◖◗ It has been demonstrated that exercising sitting balance by means of reaching exercises with the non-paretic arm improves the sitting balance and speed of reaching from a seated position of patients with a stroke. (Level 1)
Studied for ER (=) and RC (=).

44 ◖ It has been demonstrated that training sitting balance using reaching exercises for the non-paretic arm in a seated position does not improve the symmetry of the ground reaction forces of stroke patients. (Level 1)
Studied for ER (=) and RC (=).

Exercising standing up and sitting down

45 ◖◗ It remains unclear whether exercising standing up and sitting down is more effective as regards the symmetric distribution of body weight and the ability to stand up and sit down than other interventions for patients with a stroke. (Level 1)
Studied for ER (=) and RC (=).

Exercising standing balance without visual feedback from a force platform

46 ◖◗ It remains unclear whether exercising standing balance without visual feedback from a force platform is more effective as regards standing balance, standing up and sitting down, and walking ability than other interventions for patients with a stroke. (Level 1)
Studied for ER (=) and RC (=).

Exercising postural control with visual feedback while standing on a force platform
47 ◖ It has been demonstrated that exercising postural control with visual feedback while standing on a force platform improves the postural sway in stance of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

Exercising balance during various activities
48 ◖ It has been demonstrated that exercising balance during various activities results in improved sitting and standing balance and improved performance of basic activities of daily living by stroke patients. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

Body-weight supported treadmill training
49 ◖ It has been demonstrated that body-weight supported treadmill training improves the comfortable walking speed and walking distance of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

50 ◗ It has been demonstrated that body-weight supported treadmill training is not more effective than the control intervention with which it was compared as regards the sitting and standing balance of patients with a stroke. (Level 1)
Studied for ER (=) and RC (=).

Robot-assisted gait training
51 ◖◗ It has been demonstrated that robot-assisted gait training for stroke patients who are unable to walk independently improves their comfortable walking speed, maximum walking speed, walking distance, heart rate, sitting and standing balance, walking ability and performance of basic activities of daily living, compared to conventional therapy (including overground walking). (Level 1)
Comfortable walking speed studied for ER (✓), maximum walking speed for ER (✓) and RC (✓), walking distance for ER (✓) and RC (✓), heart rate for ER (✓), sitting and standing balance for ER (✓), walking ability for ER (✓), basic activities of daily living for ER (✓) and RC (✓).

52 ◖◗ It has been demonstrated that combining robot-assisted gait training with functional electrostimulation of the paretic leg improves the sitting and standing balance and walking ability of patients with a stroke, compared to conventional therapy (including overground walking). (Level 1)
Sitting and standing balance studied for ER (✓) and RC (✓), walking ability for ER (✓).

Treadmill training without body-weight support
53 ◖ It has been demonstrated that treadmill training without body-weight support is more effective in increasing maximum walking speed and width of gait than conventional gait training for patients with a stroke. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

Overground gait training
54 ◖ It has been demonstrated that overground gait training by stroke patients who are able to walk without physical support is more effective in increasing walking distance and reducing anxiety than walking on a treadmill. (Level 1)
Studied for RC (✓).

55 ◖ It has been demonstrated that overground gait training for patients with a stroke who are unable to walk independently at the start of therapy has an adverse effect on their aerobic endurance compared to body-weight supported walking exercises. (Level 1)
Studied for ER (×).

Gait training with external auditory rhythms
56 ◖ It has been demonstrated that gait training with external auditory rhythms (EAR) is not more effective for patients with a stroke than conventional gait training, in terms of gait parameters. (Level 1)
Studied for ER (=) and RC (=).

Gait training in public spaces
57 ◖ It remains unclear whether gait training in public spaces is more effective than other interventions for patients with a stroke in terms of maximum walking speed. (Level 1)
Studied for ER (=) and RC (=).

Mobility training in virtual reality

58 ◖ It remains unclear whether virtual reality mobility training is more effective than other interventions for patients with a stroke in terms of comfortable and maximum walking speed, spatiotemporal gait parameters and walking ability. (Level 1)
Studied for RC (=).

Circuit class training for walking and other mobility-related functions and activities

59 ◖◗ It has been demonstrated that circuit class training (CCT) for walking and other mobility-related functions and activities improves walking distance/speed, sitting and standing balance and walking ability, and reduces inactivity in patients with a stroke. (Level 1)
Walking distance/speed studied for ER (✓), LR (✓) and RC (✓), sitting and standing balance for ER (✓), LR (✓) and RC (✓), walking ability for ER (✓), LR (✓), and RC (✓), and inactivity for LR (✓) and RC (✓).

Walking and other mobility-related functions and activities exercised under the supervision of an informal caregiver

60 ◖ It has been demonstrated that exercising walking and other mobility-related functions and activities under the supervision of an informal caregiver improves the performance of basic activities of daily living for the patient with a stroke, and reduces the perceived burden of care for the informal caregiver. (Level 1)
Studied for ER (✓).

Training muscle strength in the paretic leg

61 ◖ It has been demonstrated that training the muscle strength of the paretic leg or both legs of stroke patients increases their muscle strength and resistance to passive movement, and improves the patient's gait in terms of cadence, symmetry, and stride length. (Level 1)
Studied for ER (✓) and RC (✓).

Training aerobic endurance

62 ◖◗ It has been demonstrated that training aerobic endurance increases the maximum oxygen consumption, respiratory functions in terms of FEV1 and expiratory flow per minute and workload of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

Aerobic endurance training combined with strength training

63 ◖◗ It has been demonstrated that a combination of aerobic endurance training and strength training improves selective movements, muscle strength of the paretic leg, comfortable and maximum walking speed, walking distance, maximum oxygen consumption, heart rate in exertion, balance, level of physical activity in everyday life, and quality of life for patients with a stroke. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

Hydrotherapy

64 ◖◗ It has been demonstrated that hydrotherapy increases the muscle strength of the paretic leg of patients with a stroke. (Level 1)
Studied for RC (✓).

Interventions to improve the somatosensory functions of the paretic leg

65 ◖◗ It has been demonstrated that interventions to improve the somatosensory functions of the paretic leg of patients with a stroke are not more effective in terms of selective movements, walking speed, or sitting and standing balance than other interventions. (Level 1)
Studied for ER (=) and RC (=).

Electrostimulation of the paretic leg using surface electrodes

66 ◖ It has been demonstrated that neuromuscular stimulation (NMS) of the paretic leg improves selective movements, muscle strength, and resistance to passive movements for patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

67 ◖◗ It remains unclear whether EMG-triggered neuromuscular electrostimulation (EMG-NMS) of the paretic leg is more effective than other interventions for patients with a stroke. (Level 1)
Studied for ER (=) and RC (=).

68 ◖◗ It has been demonstrated that transcutaneous electrical nerve stimulation (TENS) of the paretic leg improves muscle strength and walking ability and related activities for patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

EMG-BF for the paretic leg
69 ◖ It remains unclear whether electromyographic biofeedback (EMG-BF) is more effective for patients with a stroke in terms of range of motion, walking speed, spatiotemporal gait parameters, and EMG activity of the paretic leg than other interventions. (Level 1)
Studied for ER (=), LR (=), and RC (=).

Bilateral leg training with rhythmic auditory cueing
70 ◖ It is plausible that bilateral leg training with rhythmic auditory cueing (BLETRAC) is not more effective for patients with a stroke in terms of selective movements, walking speed and stride length than other interventions. (Level 2)
Studied for RC (=).

Mirror therapy for the paretic leg
71 ◖◗ It is plausible that mirror therapy for the paretic leg improves selective movements and the performance of basic ADL activities by patients with a stroke. (Level 2)
Studied for RC (✓).

72 ◖◗ It is plausible that mirror therapy for the paretic leg is not more effective for patients with a stroke in terms of resistance to passive movements and walking ability than other interventions. (Level 2)
Studied for RC (=).

Limb overloading with external weights on the paretic side
73 ◖◗ It is plausible that limb overloading by carrying external weights on the paretic side during activities performed by patients with a stroke while standing and walking is not more effective in terms of balance and (comfortable) walking speed than other interventions. (Level 2)
Studied for RC (=).

Systematic feedback on walking speed
74 ◖◗ It is plausible that providing systematic feedback on walking speed improves the walking speed of patients with a stroke. (Level 2)
Studied for ER (✓).

75 ◖◗ It is plausible that providing systematic feedback on walking speed is not more effective in terms of the duration of hospitalization, walking distance, and walking ability of patients with a stroke than other interventions. (Level 2)
Studied for ER (=).

Maintaining ankle dorsiflexion by means of a standing frame or night splint
76 ◖◗ It is plausible that the use of a standing frame is just as effective for patients with a stroke in terms of maintaining passive range of motion in ankle dorsiflexion and getting up from a chair as wearing a night splint. (Level 2)
Studied for ER (=).

Manual passive mobilization of the ankle
77 ◖ It is plausible that manual passive mobilization of the ankle has a transient favorable effect on the active and passive dorsiflexion of the ankle of patients with a stroke. (Level 2)
Studied for RC (✓).

78 ◗ It is plausible that manual passive mobilization of the ankle of patients with a stroke has an adverse effect on the speed with which they stand up and sit down. (Level 2)
Studied for RC (×).

79 ◖◗ It is plausible that manual passive mobilization of the ankle is not more effective for patients with a stroke in terms of symmetry while standing and walking than other interventions. (Level 2)
Studied for RC (=).

Range of motion exercises for the ankle with specially designed equipment

80 ◐ It is plausible that the use of a device* to influence the range of motion of the ankle is not more effective for patients with a stroke in terms of active and passive range of motion, resistance to passive movements, muscle strength, walking distance, walking speed, balance, walking ability, activities of daily living and quality of life than other interventions. (Level 2)
Studied for RC (=).

* Here: the 'Stimulo'. The Stimulo is a portable device which enables patients to perform passive or active dorsiflexion and plantarflexion of the ankle. The device automatically switches from dorsiflexion to plantarflexion and vice versa when the maximum range of motion is achieved. The initial body position is supine.

Ultrasound for the paretic leg

81 ◐ It is plausible that applying ultrasound to the gastrocnemius and soleus muscles is more effective in terms of the H_{max}/M_{max} ratio of patients with a stroke than other interventions alone. (Level 2)
Studied for RC (✓).

82 It is plausible that applying ultrasound to the gastrocnemius and soleus muscles is not effective in terms of the resistance to passive movements and active or passive range of motion of the ankle of patients with a stroke who show increased resistance to passive movements of the ankle in dorsiflexion and no passive range of motion impairment of the ankle. (Level 2)
Studied for RC (=).

Segmental muscle vibration for drop foot

83 ◖ It is plausible that the use of segmental muscle vibrations of the dorsiflexors as an add-on therapy is more effective for patients with a stroke and drop foot in terms of kinematic outcome measures and electromyographic muscle functions than other interventions. (Level 2)
Studied for RC (✓).

84 ◖ It is plausible that the use of segmental muscle vibrations is not more effective for patients with a stroke and drop foot in terms of gait parameters, including walking speed, stride length, and cadence than other interventions. (Level 2)
Studied for RC (=).

Whole body vibration

85 ◐ It is plausible that whole body vibration is not more effective for patients with a stroke in terms of muscle strength, somatosensory functions, sitting and standing balance, walking ability, other mobility-related abilities, and basic activities of daily living than other interventions. (Level 2)
Studied for ER (=).

Aids to improve ambulation during the mobilization phase

Walking aids to improve walking ability

86 In the opinion of the guideline development team, the use of walking aids is beneficial to patients with a stroke in terms of safety, independence, and efficiency of walking, as well as confidence. (Level 4)

Leg orthoses to improve walking ability

87 ◖ It has been demonstrated that gait training with the help of a leg orthosis along a bar, supported by a physical therapist, is just as effective for patients with a stroke in terms of walking speed and walking distance as body-weight supported treadmill training. (Level 1)
Studied for ER (=).

88 ◖ It is plausible that walking with a leg orthosis results in greater improvements to the walking speed and energy consumption of patients with a stroke than walking without such a leg orthosis. (Level 2)
Studied for RC (✓).

89 ◗ It is plausible that the use of a leg orthosis by patients with a stroke does not improve their performance of transfers. (Level 2)
Studied for RC (=).

90 ◖ It has been demonstrated that gait training with the help of a leg orthosis along a bar, supported by a physical therapist, is not more effective for patients with a stroke in terms of walking distance than body-weight supported treadmill training. (Level 2)
Studied for ER (=).

Exercising self-propulsion in a wheelchair
91 ◐ It is plausible that using the non-paretic hand and foot to propel a hand-propelled wheelchair has no adverse effect on the resistance to passive movements and the performance of activities of daily living by patients with a stroke who are unable to walk independently, but can sit unaided. (Level 2)
Studied for ER (✓).

92 In the opinion of the guideline development team, the use of a wheelchair improves the safety, independence and radius of action of non-ambulatory patients with a stroke. (Level 4)

Dexterity in the mobilization phase
Therapeutic positioning of the paretic arm
93 ◖ It has been demonstrated that therapeutic positioning of the paretic arm results in preservation of the passive exorotation of the shoulder of patients with a stroke. (Level 1)
Studied for ER (✓).

Reflex-inhibiting positions and immobilization techniques for the paretic wrist and hand
94 ◖ It remains unclear whether reflex-inhibiting positions and immobilization techniques for the paretic wrist and hand of patients with a stroke are more effective in terms of resistance to passive movements, pain, and passive range of motion than other interventions. (Level 1)
Studied for ER (=), LR (=), and RC (=).

Use of air-splints around the paretic arm and hand
95 ◐ It remains unclear whether the use of air-splints around the paretic arm and hand of patients with a stroke is more effective in terms of selective movements, resistance to passive movements, somatosensory functions, pain, and dexterity than other interventions. (Level 1)
Studied for ER (=) and LR (=).

Supportive techniques and devices for the prevention or treatment of glenohumeral subluxation and/or hemiplegic shoulder pain
96 ◖ It remains unclear whether the use of slings, strapping, or arm orthoses for patients with a stroke is more effective in terms of preventing hemiplegic shoulder pain and for selective movements than other interventions. (Level 1)
Studied for ER (=).

Bilateral arm training
97 ◐ It remains unclear whether bilateral arm training is more effective than unilateral arm training for patients with a stroke in terms of selective movements, muscle strength, dexterity, perceived use of the paretic arm in everyday life and performance of basic activities of daily living. (Level 1)
Studied for LR (=) and RC (=).

'Original' Constraint-Induced Movement Therapy (CIMT)
98 ◗ It has been demonstrated that original CIMT improves the dexterity, perceived use of arm and hand, quality of arm and hand movements, and quality of life of patients with a stroke. (Level 1)
Studied for LR (✓).

High-intensity modified Constraint-Induced Movement Therapy (mCIMT)
99 ◗ It has been demonstrated that high-intensity CIMT improves the dexterity, perceived use of arm and hand, and quality of arm and hand movements of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

Low-intensity modified Constraint-Induced Movement Therapy (mCIMT)
100 ◐ It has been demonstrated that low-intensity mCIMT improves the selective movements, dexterity, perceived use of arm and hand, quality of arm and hand movements, and performance of basic activities of daily living of patients with a stroke. (Level 1)
Selective movements studied for ER (✓) and RC (✓), dexterity for ER (✓), LR (✓), and RC (✓) and perceived use and quality of movements for ER (✓), LR (✓), and RC (✓).

Immobilization of the non-paretic arm without specific training focused on the paretic arm
101 ◐ It remains unclear whether immobilizing the non-paretic arm without task-specific training of the paretic arm is more effective than other interventions for patients with a stroke. (Level 1)
Studied for ER (=) and LR (=).

Robot-assisted training of the paretic arm
102 ◖ It has been demonstrated that unilateral robot-assisted training of the paretic shoulder and elbow of patients with a stroke improves the selective movements and muscle strength of the paretic arm and reduces atypical pain in the paretic arm. (Level 1)
Selective movements and muscle strength of the arm studied for ER (✓), LR (✓), and RC (✓), atypical pain for ER (•) and LR (✓).

103 ◖ It has been demonstrated that bilateral robot-assisted training of the elbow and wrist improves the selective movements and muscle strength of the arm of patients with a stroke. (Level 1)
Studied for ER (✓) and RC (✓).

104 ◖ It remains unclear whether robot-assisted training in which the arm and hand are trained simultaneously is more effective for patients with a stroke in terms of selective movements and muscle strength than other interventions. (Level 1)
Studied for ER (=) and RC (=).

Mirror therapy for the paretic arm and hand
105 ◖ It remains unclear whether mirror therapy for the paretic arm and hand of patients with a stroke is more effective in terms of selective movements, resistance to passive movements, pain, and dexterity than other interventions. (Level 1)
Studied for LR (=) and RC (=).

Virtual reality training of the paretic arm and hand
106 ◗ It has been demonstrated that virtual reality training of the paretic arm and hand as an add-on to regular exercise therapy for patients with a stroke improves the performance of basic activities of daily living. (Level 1)
Studied for ER (✓) and RC (✓).

107 ◖ It has been demonstrated that virtual reality training of the paretic arm and hand as an add-on to regular exercise therapy for patients with a stroke has an adverse effect on resistance against passive movements. (Level 1)
Studied for ER (×) and RC (×).

Electrostimulation of the paretic arm using surface electrodes
NMS of the paretic wrist and finger extensors
108 ◖ It has been demonstrated that neuromuscular electrostimulation (NMS) of the paretic wrist and finger extensors of patients with a stroke is not more effective in terms of selective movements, muscle strength, active range of motion for wrist and finger extension, and dexterity than other interventions. (Level 1)
Studied for ER (=) and RC (=).

NMS of the paretic wrist and finger flexors and extensors
109 ◖ It has been demonstrated that neuromuscular stimulation (NMS) of the paretic wrist and finger flexors and extensors of patients with a stroke improves selective movements and muscle strength. (Level 1)
Studied for ER (✓).

NMS of the paretic shoulder muscles
110 ◖ It has been demonstrated that neuromuscular electrostimulation (NMS) of the paretic shoulder muscles of patients with a stroke reduces glenohumeral subluxation. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

EMG-NMS of the paretic wrist and finger extensors
111 ◐ It has been demonstrated that EMG-triggered neuromuscular electrostimulation (EMG-NMS) of the paretic wrist and finger extensors of patients with a stroke improves selective movements, active range of motion, and dexterity. (Level 1)
Studied for ER (✓) and RC (✓).

EMG-NMS of the paretic wrist and finger flexors and extensors
112 It remains unclear whether EMG-triggered neuromuscular electrostimulation (EMG-NMS) of the paretic wrist and finger flexors and extensors of patients with a stroke is more effective in terms of selective movements and dexterity than other interventions. (Level 1)
Studied for ER (✓) and RC (✓).

TENS for the paretic arm
113 It has been demonstrated that transcutaneous electrical nerve stimulation (TENS) is not more effective in terms of resistance against passive movements and the performance of basic activities of daily living by patients with a stroke than other interventions. (Level 1)
Studied for ER (=) and RC (=).

EMG-BF for the paretic arm and hand
114 It remains unclear whether EMG biofeedback (EMG-BF) for the paretic arm is more effective for patients with a stroke in terms of selective movements, active range of motion, and dexterity than other interventions. (Level 1)
Studied for LR (=) and RC (=).

Training muscle strength in the paretic arm and hand
115 It remains unclear whether muscle strength training for the paretic arm and hand of patients with a stroke is more effective in terms of selective movements, muscle strength, range of motion, pain, and dexterity than other interventions. (Level 1)
Studied for ER (=) and RC (=).

Trunk restraint while training the paretic arm and hand
116 It has been demonstrated that trunk restraint while training the paretic arm and hand of patients with a stroke has an adverse effect on the perceived use of the arm and hand compared to training forms not using this type of restraint. (Level 1)
Studied for RC (×).

Interventions to improve the somatosensory functions of the paretic arm and hand
117 It has been demonstrated that interventions to improve the somatosensory functions of the paretic arm and hand of patients with a stroke improve the somatosensory functions and reduce the resistance to passive movements. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

Continuous passive motion (CPM) for the shoulder
118 It is plausible that the use of a continuous passive motion (CPM) device by patients with a stroke is not more effective in terms of the stability of the shoulder joint, muscle strength, selective movements, resistance to passive movements, pain, and performance of basic activities of daily living than other interventions. (Level 2)
Studied for ER (=).

Subsensory threshold electrical and vibration stimulation of the paretic arm
119 It is plausible that subsensory threshold electrical and vibration stimulation of the paretic arm of patients with a stroke is not more effective in terms of somatosensory functions, selective movements, dexterity, and quality of life than other interventions. (Level 2)
Studied for RC (=).

Circuit class training for the paretic arm
120 It is plausible that circuit class training with workstations for the paretic arm improves selective movements and dexterity of patients with a stroke. (Level 2)
Studied for RC (✓).

Passive bilateral arm training
121 It is plausible that passive bilateral arm training is not more effective for patients with a stroke in terms of selective movements, maximum contraction strength of the hand, and neurological functions than other interventions. (Level 2)
Studied for RC (=).

122 It is plausible that passive bilateral arm training improves neurophysiological outcome measures like excitation of the ipsilateral motor cortex of patients with a stroke. (Level 2)
Studied for RC (=).

Mechanical arm trainer
123 ◐ It is plausible that the use of a mechanical arm trainer by patients with a stroke is not more effective in terms of selective movements, muscle strength, resistance to passive movements, and performance of basic activities of daily living than other interventions. (Level 2)
Studied for ER (=).

124 ◗ It is plausible that the use of a mechanical arm trainer improves the dexterity of patients with a stroke. (Level 2)
Studied for ER (✓).

ADL activities during the mobilization phase
Training for dyspraxia to improve ADL-independence
125 ◐ It remains unclear whether the treatment of dyspraxia using gestural training for patients with a left hemisphere stroke has a favorable effect on the severity of ideational and ideomotor apraxia compared to other interventions. (Level 1)
Studied for RC (✓).

126 ◐ It is plausible that the treatment of dyspraxia using gestural training has a favorable effect on the basic activities of daily living of patients with a left hemisphere stroke. The effects persist in the longer term. (Level 2)
Studied for RC (✓).

127 ◐ It is plausible that strategy training for the treatment of dyspraxia has a favorable effect on the basic activities of daily living of patients with a left hemisphere stroke, and the effects also extend to non-trained tasks. The effects plateau in the long term. (Level 2)
Studied for LR (✓).

128 ◐ It is plausible that strategy training for patients with a stroke of the left hemisphere is not more effective in terms of the severity of ideational and ideomotor apraxia, muscle strength, and dexterity than other interventions. (Level 2)
Studied for LR (=).

Interventions aimed at learning/re-learning and resuming leisure or social activities in the home setting
129 ◗ It has been demonstrated that therapy to learn/re-learn leisure or social activities at home, such as gardening or painting, have a favorable effect on the participation in leisure time activities of patients with a stroke. (Level 1)
Studied for ER (✓).

130 ◐ It has been demonstrated that therapy aimed at leisure or social activities at home by patients with a stroke is not more effective in terms of quality of life, mood, and depression than other interventions. (Level 1)
Studied for ER (=) and RC (=).

131 ◐ It is plausible that therapy aimed at leisure and social activities at home is not more effective in terms of improving motor functions, basic activities of daily living, extended activities of daily living, and participation by patients with a stroke, nor in terms of reducing the perceived stress of the patient's partner, than other interventions. (Level 2)
Motor functions studied for ER (=), basic activities of daily living for ER (=), extended activities of daily living for LR (=), participation for LR (=), and perceived stress of the partner for LR (=).

Cognitive rehabilitation
Cognitive rehabilitation aimed at attention deficits
132 ◖ It remains unclear whether training to improve attention during the first 6 weeks after the stroke is more effective than other interventions. (Level 1)
Studied for ER (=).

133 ◖ It has been demonstrated that attention training using compensation strategies has a favorable effect on the attention span of patients whose stroke occurred 6 weeks ago. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

Cognitive rehabilitation aimed at memory deficits
134 ◗ It has been demonstrated that memory strategies using internal and external strategies have a favorable effect on patients with a stroke in terms of learning to compensate for mild memory deficits. (Level 1)
Studied for LR (✓) and RC (✓).

135 ◗ It is plausible that memory strategy training in functional situations, using external strategies, has a favorable effect on patients with a stroke who have moderate to severe memory deficits, in terms of learning functional skills in these situations. (Level 1)
Studied for LR (✓) and RC (✓).

Cognitive rehabilitation for hemispatial neglect
136 ◖ It has been demonstrated that visual scanning training has a favorable effect on the attention for the neglected side of patients with a stroke in the right hemisphere. (Level 1)
Studied for ER (✓), LR (✓) and RC (✓).

137 ◖ There are indications that the following neglect-oriented training forms have a favorable effect in terms of the attention for the neglected side of patients with a stroke in the right hemisphere: combined training for visual scanning, reading, copying, and describing figures, activation of the extremities on the neglected side, stimulating the neck muscles, wearing hemispatial sunglasses, wearing prism glasses, and video feedback. (Level 3)
Studied for ER (✓), LR (✓) and RC (✓).

Cognition and aerobic exercising
138 ◖ It is plausible that aerobic training has a favorable effect on conditional learning and implicit learning by patients with a stroke. (Level 2)
Studied for RC (✓).

Supplement 2 Intake Form

Name of physical therapist:.. *(Patient card)*

Date of completion: ....

Location of admission:
❍ hospital (stroke unit)
❍ rehabilitation center (stroke unit)
❍ nursing home (stroke unit)
❍ primary care
❍ other ....

Patient number: ....
(only if no patient card is present)

Given name: ....

Family name: ....

Sex:
❍ female
❍ male

Date of birth*: ...... / ...... /.................

Address
street: .... (optional)

postal code / town: .... (optional)

Date of stroke*: ...... / .... /................

Laterality (with comments if applicable):
❍ right hemisphere: ....
❍ left hemisphere: ....
❍ brainstem: ....
❍ cerebellum: ....
❍ other: ....

Type of stroke (with comments if applicable):
❍ cerebral hemorrhage: ....
❍ cerebral infarction: ....
❍ other: ....

Date of admission:* ...... / ...... / ....

Date of discharge:* ...... / ...... / ....

Referring physician: ....

Name of family physician: ....

Insurance details: ....

Highest completed level of education: .... (optional)

*month/day/year

Occupation:	❍ present:		
	❍ previous, plus reason for discontinuation: .... (e.g. retired, disability)		
	❍ clerical work		
	❍ other:		
	❍ fulltime ....❍ part-time: ....%		
	Physically demanding work	❍ heavy	
		❍ moderate	
		❍ light	
Leisure activities:	❍ sports, namely:		
	frequency: .... per		
	❍ hobbies:		
Preferred hand:	❍ left	❍ right (relating to writing hand)	
Domestic situation before stroke:			
Living independently:	❍ yes	❍ no	❍ other: ....
If so,	❍ living alone	❍ living together	
House:	❍ ground floor only	❍ multiple floors	
Are there stairs or an elevator?	❍ yes	❍ no	
handrail of stairs (going upstairs)	❍ left	❍ right	❍ none
elevator	❍ yes	❍ no	❍ n.a.

Apart from the stairs, if present, are there other obstacles in the house, such as doorsteps, carpets/rugs, door springs?

....

....

Transportation before the stroke:

Was the patient able to move about unaided?

	❍ yes	❍ no	

What type of transportation did the patient use?

❍ public transport			
❍ car			
❍ bicycle	❍ specially adapted: .... (e.g. tricycle, tandem bike)		
❍ walking	❍ walking aid: ....(e.g. rollator, cane)		
	outside	❍ yes	❍ no
	inside	❍ yes	❍ no

❍ other: ....

Details of patient's partner:

Does the patient have a partner?	❍ yes	❍ no
Is the partner in good health?	❍ yes	❍ no

If not: ....

Does the partner have a job? ❍ yes ❍ no
occupation / former occupation: ....
❍ fulltime ❍ part-time: .... %

Is the partner in need of care? ❍ yes ❍ no

Are there any children who can provide care? ❍ yes ❍ no

Care already being provided:
❍ informal caregiver(s) (e.g. neighbors, relatives)
❍ domestic help
❍ home care
❍ district nurse
❍ meals delivery service
❍ other: ....

Has the patient suffered a stroke previously?
❍ yes
❍ left hemisphere number ..... date........./........./...............
❍ right hemisphere number ..... date........./........./...............
❍ other: ....
number ..... date......... / ..../ ....
❍ no
❍ unknown

Hereditary disorders in family (first and second degree: parents, siblings)? ❍ yes ❍ no
If so, which? ....

Pre-existing impairments: ❍ no
❍ yes → consider Modified Rankin Scale (MRS)
→ consider Nottingham Extended ADL index (NEADL)

Relevant medical history
Did the patient have one or more disorders/pathologies before their stroke?
Record them if they could present an impediment to physical therapy:

Circulatory system: ❍ yes ❍ no ❍ unknown
If so, which? ....
(e.g. angina pectoris, intermittent claudication)
Date of diagnosis:* ..../........../...................
Details: ....

Respiratory system: ❍ yes ❍ no ❍ unknown
If so, which? ....
Date of diagnosis:* ..../......... / ....
Details: ....

*month/day/year

Musculoskeletal system: ❍ yes ❍ no ❍ unknown
If so, which? ....
Date of diagnosis:* ..../......... / ....
Details: ....

Digestive system: ❍ yes ❍ no ❍ unknown
If so, which? ....
Date of diagnosis:* ..../......... / ....
Details: ....

Genitourinary system: ❍ yes ❍ no ❍ unknown
If so, which? ....
Date of diagnosis:* ..../......... / ....
Details: ....

Relevant psychiatric history:
❍ no
❍ yes, namely: ....
❍ unknown

Risk factors: ❍ no ❍ yes, namely: .... (e.g. smoking, alcohol use)

Medication:
Does the patient use any medication that could affect their treatment?
❍ yes ❍ no ❍ unknown
If so, which? ....

Neurological examination:
CT scan: ❍ yes ❍ no
Date: .... /........./ ....
Result: ....

MRI scan: ❍ yes ❍ no
Date: .... /........./ ....
Result: ....

Details of supplementary medical/neurological examinations (e.g. Doppler ultrasound, EEG)
Results: ....
....

*month/day/year

Disciplines consulted:

Stroke team
❍ neurologist
❍ rehabilitation physician
❍ speech therapist
❍ physical therapist
❍ occupational therapist
❍ psychologist
❍ social worker
❍ rehabilitation nurse
❍ transfer nurse

Other disciplines
❍ cardiologist
❍ neurosurgeon
❍ vascular surgeon
❍ pulmonologist
❍ urologist
❍ dermatologist
❍ general internal medicine
❍ ophthalmologist
❍ ENT physician
❍ exercise therapist
❍ dietician
❍ activity supervisor
❍ other: ....

Conclusion of intake:

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