On Self-Efficacy and Balance after Stroke

BY

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Dissertation for the Doctor of Philosophy (Faculty of Medicine) in Rehabilitation medicine presented at Uppsala University in 2002

ABSTRACT


The general aim of this work was to evaluate the outcome of specialised stroke rehabilitation and to examine the relation between both subjectively perceived and objectively assessed balance and impairments and some activity limitations. A further, integrated aim was to establish some psychometric properties and the usability of a newly developed Falls-Efficacy Scale, Swedish version (FES(S)) in stroke rehabilitation.

Seventy-three patients younger than 70 years of age with a first stroke and reduced walking ability were randomised into an intervention group (walking on a treadmill with body weight support) and a control group (walking on the ground). Time points of assessment were: on admission for rehabilitation, at discharge and 10 months after stroke. Walking training on a treadmill with body weight support and walking training on the ground were found to be equally effective in the early rehabilitation. The patients in both groups improved their walking velocity, motor function, balance, self-efficacy and ADL performance.

In a geriatric sample of 37 stroke patients examined at similar time points, significant improvements in self-efficacy, motor function, balance, ambulation and ADL occurred from admission to discharge independently of age. In comparison with observer-based balance measures, FES(S) at discharge was the most powerful predictor of ADL performance 10 months after onset of stroke.

In 30 patients with stable stroke, the overall test-retest reliability of FES(S) was found to be adequate. The internal consistency confirmed that FES(S) has an adequate homogeneity.

In a subsample of 62 patients from the original sample and in the geriatric sample, FES(S) correlated significantly with Berg’s balance scale, the Fugl-Meyer balance scale, with motor function and with gait performance. In the relatively younger group ADL (measured by the Functional Independence Measurement) correlated significantly with FES(S) on admission and at 10 months follow-up, while at discharge none of the FES(S) measures correlated significantly with ADL. In this subsample effect size statistics for detecting changes in FES(S) demonstrated very acceptable responsiveness of this scale during the early treatment period and during the total observation period.

In the light of these findings assessment and treatment of self-efficacy seems relevant in stroke rehabilitation.

Key words: Cerebrovascular disorders, rehabilitation, physiotherapy, balance, self-efficacy, treadmill walking, activities of daily living.

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ISSN 0282-7476
ISBN 91-554-5206-X

Printed in Sweden by Uppsala University, Tryck & Medier, Uppsala 2001
ORIGINAL PUBLICATIONS

This thesis is based in the following original papers, which will be referred to by their Roman numerals:


ABBREVIATIONS

BBS = Berg’s Balance Scale
BWS = Body Weight Support
FAC = Functional Ambulation Classification
FES = Falls-Efficacy Scale
FES(S) = Falls-Efficacy Scale Swedish Version
FIM = Functional Independence Measure
FMB/FMIB = Fugl-Meyer Balance Scale
F-MSAI/FMI = Fugl-Meyer Stroke Assessment Instrument
ICF = International Classification of Functioning, Disability and Health
KES = Kazis Effect Size
MRP = Motor Relearning Programme
NIH = National of Health Stroke Scale
RR = Responsiveness Ratio
SRM = Standard Response Mean
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INTRODUCTION

Estimating and understanding impairments and activity limitations following stroke should a matter be of high priority in health care, as stroke is the leading cause of activity limitations in adults (96), and not least for the reason that survival after stroke has increased during recent decades despite a growing elderly population (143, 157). One of the most pronounced and disabling effects of neural injury is the impairment of balance regulation (80). It has been postulated in physiotherapy research that balance cannot be separated from the action of which it is an integral component, or from the environment in which it is performed (26). Balance therefore forms the “foundation for all voluntary motor skills” (123).

International Classification of Functioning, Disability and Health

As a conceptual framework The World Health Organisation (WHO) model of Functioning, Disability and Health (ICF) (Fig 1) is used here (199). This classification has been identified as one way to approach stroke-outcome research (62). New factors in the ICF include a dimension of participation and a list of environmental factors that are important for understanding the complexity of disability. The model includes both positive and negative aspects of the three dimensions impairments, disability and participation. The positive aspects (functioning) are described as dimensions of body structures and functions, activity and participation (Fig 1). The negative aspects (disability) of these dimensions are described as impairment, activity limitation and participation restriction, respectively (199).

Body structures and functions. Significant deviations or loss in body structures and functions are described as impairments.

Activities. Activities are defined as the performance of person-level tasks or activities. Activities are the observable and reportable performance of the actions of individuals in the context of their culture. Activity limitation is the extent to which the individual has difficulty in performing the activity. An important consideration in activity performance classification is the question of whether the individual uses a device or personal assistance in performing the action.

Participation. Participation is defined as “an individual’s involvement in life situations in relation to health conditions, body structures and functions, activities and contextual factors” (199). The restriction of participation or involvement in life activities by external factors (social rules) is referred to as participation limitation/restriction.
Contextual factors: environmental and personal. Environmental factors include the physical, social, and attitudinal environments that influence individual functioning. Personal factors are described as “gender, age, health conditions, fitness, lifestyle, habits, upbringing, coping styles, social background, education, profession, past and current experience, overall behavior pattern and character style, individual psychological assets, and other characteristics, all or any of which may play a role in disability at any level” (199). The terminology of the ICF classification is used in this introduction, although the terminology suggested by Fugl–Meyer et al (57) is generally used in the articles.

### Disease or Disorders

<table>
<thead>
<tr>
<th>Body structures and functions</th>
<th>Activities</th>
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<td>Impairment</td>
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Environmental Factors  Personal Factors

Figure 1. Interactions between the dimensions of the International Classification of Functioning, Disability and Health (ICF).

### Stroke

**Definition and epidemiology.** The WHO defines stroke as an “acute neurologic dysfunction of vascular origin with sudden or at least rapid occurrence of symptoms and signs corresponding to involvement of focal areas in the brain”; further, the symptoms should last 24 hours or longer (173). This definition includes cerebral infarction and spontaneous cerebral haemorrhage, but excludes transient ischaemic attack (TIA) and stroke caused by tumour, trauma or subdural haemorrhage.

Large differences have been found in both the incidence of and mortality from stroke in multinational populations (178, 167). Within the WHO-MONICA project, detailed data on stroke have been recorded in 11 countries in people aged 35 to 74 years during recent decades. In Sweden, with an intermediate incidence in both genders, a shift towards higher ages has been reported in the occurrence of first-ever stroke in men, while the incidence in
different ages has remained unchanged in women (166). In both sexes, the rates increase dramatically with age (12, 157, 166). A decrease in stroke mortality has been reported in Sweden, as in western Europe, North America, and eastern Asia, whereas an increase has been seen in several eastern European countries (157). During the last decade and especially during the most recent years a slowdown of the declining trend in stroke mortality has been observed in Sweden (157). Among survivors in Sweden, the proportion of patients with extensive motor deficits has been reported to have decreased (166). Taking all findings together, stroke has become less lethal and impairing, though no less common, with an unchanged incidence which has shifted towards older age (12), and still causing activity limitations and participation restrictions.

Impairments after stroke

Some common impairments after stroke are impaired motor function, sensory deficits and perceptual deficits, impaired balance, cognitive limitations, aphasia and depression. At the impairment level, a wealth of studies have focused mainly on the recovery of motor function (22, 58, 100, 111). It was found in population-based studies that between 73 % (100) and 88 % (22) of all patients with stroke initially had hemiparesis, while the proportions with persistent motor deficits at 6 months and 12 months post stroke were 62 % and 37 % respectively, and the majority of these deficits were mild. In a Swedish study hemiparesis was present in 39 % of the patients within 2 weeks from stroke (19).

It is generally believed that the recovery of arm movement is less rapid and complete than that of leg movement (39). However, Duncan et al (43), in agreement with Fugl-Meyer et al (58), found that the severity of motor function impairment and the pattern of motor recovery were similar in the upper and lower extremities.

The recovery of motor function, sensation, perception and speech are representative of neurological recovery. It is well established that the major part of the neurological recovery takes place within the first 1 to 3 months following stroke, while only minor changes are seen between 3 months and 1 year post stroke (41, 189, 193). Recent studies on effects of intensive movement therapy have shown, however, that motor improvements are possible even a long time (1 to 17 years) after a stroke (40, 101, 129, 175). These findings are reflected by the anecdotal self-description of Smits (165), who stated that recovery may continue for as long as exercises are performed and that it does not level off as long as the person continues to do daily exercises.
Activity limitations after stroke

Activities of daily living (ADL). Many studies have addressed ADL in stroke survivors in many different samples (39, 86, 192, 194). Exact estimates of activity limitation following stroke are difficult to obtain, because of differences in population selection, outcome measures and time points for assessments. Findings in epidemiological studies, most of them conducted prospectively, are consistent in showing that the incidence of dependence in ADL is highest immediately after a stroke (40-75 %) (39, 86, 192, 194), and that the prevalence thereafter decreases to 57 % at discharge (39), 30 % 1 year post onset (86), 9 % 6 months post onset (192) and 0 % 3 months post onset (194). Concerning activity, the general consensus is that the ADL improvements in most patients are maximal within 6 months, and in fact most of the recovery occurs within the first 6-12 weeks. In a prospective, consecutive and community-based study, Jörgensen et al (90) found that the time course of both neurological and ADL recovery was closely related to the initial stroke impairment. Neurological recovery was achieved more rapidly than ADL recovery, on average 2 weeks earlier. The best ADL ability was reached within 9 weeks in patients with mild stroke, within 13 weeks in patients with moderate stroke, within 17 weeks in patients with severe stroke, and within 20 weeks in patients with very severe stroke.

Decreased walking ability is regarded here as an activity limitation. Although inability to walk is one of the most common problems immediately after stroke, most survivors later achieve some form of independence in ambulation, although few attain a level of normal walking speed (73). Wade et al. (193) reported from a population-based study that only 27 % of the patients had quite good walking capacity within one week of stroke, but that at 6 months 85 % were independent, although only 25 % had regained a normal speed of ambulation. In a study by Jörgensen et al. (91) it was found that initially after stroke 51 % had no walking function, 12 % were able to walk with assistance, and 37 % could walk independently; at the end of rehabilitation, 64 % of the survivors walked independently, 14 % were dependent on assistance, and 22 % had not gained any walking ability. From data on 27 000 stroke patients, Hamilton and Granger (67) reported that the lowest level of activity was seen in locomotion on admission and that this was still so at discharge, although the largest gain was seen in locomotion. The recovery of walking ability is generally said to occur during the first 6 months after a stroke (55, 136, 191). Jörgensen et al. (94) found that this recovery mainly occurred within the first 11 weeks after a stroke. They also stated that a valid prognosis of walking function in patients with mild/moderate leg paresis on admission can be
made in 3 weeks, and that further recovery should not be expected after 9 weeks. Recovery in patients with severe leg paresis or paralysis on admission is slower. A valid prognosis of walking function in this group of patients can be made in 6 weeks, and further improvement of walking function should not be expected later than 11 weeks after a stroke.

**Participation restrictions after stroke**

Few studies have addressed participation restrictions in stroke survivors using the ICF framework. Most studies dealing with the social impact of stroke have focused on the quality of life (QOL) of survivors, and have shown that restrictions in participation (94, 107, 151) and depression (97, 201) following stroke are detrimental for life quality, while social support (97) can enhance this quality. A marked decline in active leisure participation is often experienced after stroke, regardless of motor function (48, 131) and can affect leisure satisfaction (163, 186). The items lack of a job, impaired sex life, and inability to travel on vacation and pursue leisure-time activities gave low rankings for QOL in the study by Robinson-Smith et al (151), whereas items relating to family, home and emotional support had higher rankings. In a Finnish study the most affected domain 12 months after stroke was role limitations due to physical problems, both in men and women and across all ages (94). The importance of sexual life has been documented in many studies and has been identified as a dimension which should be considered in determining the quality of life of people after stroke (77, 89, 163). In a study by Clarke et al (28), among the few studies that have specifically addressed participation restrictions after stroke, it was found that marital status was associated with perceived participation restrictions 1 year after stroke, but that the effects varied in men and women. Men who were married reported fewer restrictions than unmarried men, while married women reported greater restrictions than unmarried women. Cognitive disability and a history of previous stroke were also found to contribute to participation restrictions in the later stages of recovery.

**Prediction of recovery after stroke**

The prognosis for neurological and functional recovery after stroke is influenced by a number of factors, which means that stroke recovery is markedly heterogeneous (50, 63, 88). The literature on predictors of outcome after stroke is enormous. Some factors that have been identified as valid predictors of recovery after stroke are: admission ADL score (within 2 weeks after onset) (171, 176, 192); urinary continence (11, 171, 176, 192); degree of motor
paresis or paralysis (11, 61, 171, 176); age (61, 69, 171, 192); loss of consciousness within the first 48 hours post-stroke (61, 176, 191); disorientation in time and place (10, 61, 191); sitting balance (192); status following recurrent stroke (192); level of perceived social support (59) and metabolic rate of glucose outside the infarction area in hypertensive patients (69). Many studies on predictors fail to cover the full period during which functional recovery can be expected, as the final observation often coincides with discharge (103).

**Balance**

The recovery of independence following stroke is a complex process requiring the reacquisition of many skills. Since controlling the body’s position in space is an essential part of functional skills, restoration of balance is a critical part of the recovery of ability after a stroke (160).

Despite the widespread use of the term balance, there is no universally accepted definition of human balance, as pointed out by Berg (14). Balance is an operational construct most often referring to the ability of a person not to fall (16, 197).

In ICF balance is not coded either as a function or as an activity in ICF. It is coded both under impairments of sensory (vestibular) functions and under neuromuscular and movement function. Postural reactions are coded as non-voluntary reflexes.

**Mechanical definitions.** The term balance (or equilibrium) as used in mechanics is defined as the state of an object when the resultant load (forces or movements) acting upon it is zero (Newton’s First Law) (13). The ability of an object to balance in a static situation is related to the position of the centre of mass, or COM (also referred as the centre of gravity or COG), and the area of the base of support (BOS) of that object (196). If the line of gravity of an object falls within the BOS of that object, then the object will be balanced. The object becomes unbalanced if the line of gravity is displaced out of the base of support (13).

**Human balance.** During upright stance, the human body has a relatively high COM and a relatively small BOS, a fact which places higher demands on the maintenance of stability (118, 197). When the line of gravity falls out of the BOS, the body has the inherent ability to sense the threat to stability (122). Muscular activity is used to counteract the forces of gravity and acceleration (196). This is what is commonly termed postural control.
Balance and postural control

Postural control can be defined as the act of achieving, maintaining, or restoring a state of balance during any posture or activity (146). Effective postural control involves both controlling the body’s position in space for stability (defined as controlling the centre of body mass within the base of support), and orientation (defined as the ability to maintain appropriate relationships between the body segments and also between the body and the environment for a task) (159). Adequate balance requires control of both gravitational forces to maintain posture, and acceleration forces to maintain equilibrium (123). Together, the postural and equilibrial components of balance control ensure stability of the body during widely differing activities. The exact demands on the balance control system are determined both by the task itself and by the environment in which it is performed, and different tasks and environments alter the biomechanical and information processing required for balance control (85).

Postural control systems. In order to meet the biomechanical challenges of task and environment, the balance mechanism requires adequate sensory input, efficient central processing and a strong effector system of muscles and joints (84). An abundance of sensory information (visual, somatosensory and vestibular) is normally available. An appropriate motor response must then be selected and implemented (85). The CNS activates synergistic muscles at mechanically related joints that are effective in controlling the centre of mass relative to the base of support and to ensure that forces generated at one joint for balance control do not produce instability elsewhere in the body. The view of muscle synergies has evolved towards a concept of “flexible” synergies, defined as a centrally organised pattern of muscle activity, that is responsive to initial conditions, perturbation characteristics, learning and intention (82).

Postural control strategies may either be proactive, reactive (compensatory) or predictive (anticipatory), or a mixture of these. The proactive balance mechanism is based on the visual system (142). The reactive postural control strategies rely on feedback control, where sensory information is used continuously by the CNS to update the corrections. Predictive postural control strategies use feed-forward control, and pre-programmed stabilising reactions are released, either predictively (anticipatory postural adjustments) or in reaction to sensory information pertaining to the state of instability (triggered postural reactions) (119). A predictive postural control strategy can involve a voluntary movement, or an increase in muscle activity, in anticipation of a predicted disturbance (146).
In the last decade the focus on balance research has been placed on motor and sensory strategies in static balance control (159). Balance control during dynamic activities such as locomotion and stair climbing has been less studied. However, during dynamic activities the body mass is repeatedly displaced outside the support of base, indicating the likelihood of other strategies being involved in the control of dynamic balance.

The postural responses are considered to rely on assessment and control from a number of different levels in the CNS, such as the brainstem, the vestibular nuclei and the cerebellum (82). Strategies for postural control therefore vary depending on an individual’s goal and environmental context. This view of postural control implies that balance control can be considered to be a fundamental motor skill learned by the CNS (85). Thus, like all other motor skills, postural control strategies can become more efficient and effective with training and practice.

**Balance after stroke**

Falls are common in patients with stroke in rehabilitation settings (135), in nursing homes (134) and at home (53). Despite the high risk of falling in stroke patients, serious injuries are uncommon (53).

The main cause of balance disturbances after stroke is the CNS lesion, which affects information processing and integration of sensory input as well as the effector pathways. Obviously many impairments may have a negative influence on balance after stroke. These include muscular weakness (4), abnormal muscle tone with stiffening of the joints (54), shortening of muscles with loss of range of motion (127), distorted proprioception (132) and impairment of the vestibular mechanism (35). It has been demonstrated that stroke patients have abnormal and delayed postural responses in the lower extremity muscles in standing displacements (37,108). Other postural control problems after stroke are loss of anticipatory activation during voluntary movements (81), an increase in sway during quiet standing (34), a decreased area of stability in stance (33), an uneven weight distribution in stance with less weight placed on the weaker leg (155), and an inability to execute effective stepping reactions (119). Furthermore, there may be difficulties in modifying and adapting postural movements to changing task demands (82).
Measures of balance

Trends in balance assessment have shifted in emphasis from complex laboratory testing to task-oriented evaluation in the clinical setting (144). Over the last 20 years new technology has been used to quantify the surface forces (112, 137, 152), muscle activations (4, 81, 76), movement patterns (83, 119) and joint torques (82, 102) that characterise postural responses to mechanical perturbations (36). These responses do not, however, provide information on the postural responses needed to control balance during different dynamic tasks (82). Traditional laboratory testing has also involved spontaneous sway during quiet stance, based on the assumption that sway is a good indicator of balance control (159). However, it has been demonstrated both that several types of patients with severe neurological disorders may have normal sway in quiet stance (159), and that sway is poorly related to dynamic activities such as walking and ADL (30, 112). The view of balance as a motor skill has led to the development of assessment tools that focus on measurement of the balance performance of the patient. Clinical balance tests have involved measuring the duration of the ability to maintain various positions (108), measurement of walking speed (145), mobility tasks (179) and measurement of self-generated perturbations (45). While each of these clinical tests is a valid assessment of a patient’s balance, each test only concerns one particular aspect of postural control. Hence, these tests may be criticized for not being able to predict how well people will perform outside the physiotherapy department. According to Huxham et al. (85), few clinical balance tests assess the vital proactive balance mechanism which the individual uses to avoid an obstacle, either because of self-generated perturbations or because of the static environment in which the tests are performed, requiring little or no use of the visual component of proactive balance control.

Self-efficacy

In clinical practice it is well known that stroke patients often have feelings of unsteadiness, insecurity and fear during task performance, which may be due to a subjectively perceived impairment of balance. A complement to objective balance assessment is the application of an individual’s own perception of balance, i.e. subjective balance. The Falls Efficacy Scale (FES) (180) is an instrument which measures fear of falling in individuals, based on the operational definition of this fear as “low perceived self-efficacy in avoiding falls during essential, non-hazardous activities of daily living” (180) and should reflect subjective balance. Few studies today have addressed the relation between subjective and objective balance.
Self-efficacy is regarded in the present studies as a personal factor in the ICF (199), a factor that has importance as an intervening variable in the development and maintenance of disability (188).

Self-efficacy, a cognitive construct referring to one’s self-perception about one’s performance ability, was initially proposed by Albert Bandura (5). Derived from the Social Cognitive Theory, the cognitive notion of personal self-efficacy implicated three separate conceptual domains: (a) having tacit task knowledge and skills; (b) having an explicit sense of confidence in one’s ability to mobilise the motivation and cognitive resources required to perform a specific task or skill; and (c) having confidence in one’s ability to successfully execute a specific task or skill in a given context. All three elements, plus the magnitude of the value placed on the anticipated outcome by the individual, have been deemed by Bandura to be potent mediators underpinning an individual’s willingness and desire to implement a task or activity in any specific context (6). Thus self-efficacy is a situation-specific form of self-confidence. Such beliefs are situational rather than static and can change over time as the individual changes (6). Individuals are characterised not simply according to their degree of general efficacy, but according to their efficacy within a specific activity. Individuals with high self-efficacy tend to tackle more challenging tasks, put forth more effort, and persist longer with a particular task in the face of aversive stimuli. In contrast, individuals with low self-efficacy tend to give up, attribute failure internally, and experience greater anxiety or depression (7). Reliable, valid assessments have been developed to measure efficacy in a range of activities in different populations and diagnosis groups (2, 148, 121). Among persons with arthritis, self-efficacy has been found to be a significant predictor of psychological well-being, adherence to prescribed treatments, and pain-coping (121). In community-residing elderly persons, significant cross-sectional relationships between self-efficacy and participation have been observed (181). Relative to health behaviour and ageing, self-efficacy has been found to be predictive of adherence to exercise regimens in asymptomatic (125) and different clinical (93) samples, of recovery from cardiovascular disease (24) and of survival rates among individuals with chronic disease (93). Additionally, a low level of self-efficacy has been associated with slower gait velocity (153, 180). However, few studies have addressed the impact of self-efficacy in stroke patients and to my knowledge no study hitherto has dealt with the relation between self-efficacy in balance and activity limitations solely in patients with stroke.
Falls-related self-efficacy

A Falls Efficacy Scale has been modelled, using Bandura’s theory of self-efficacy (180). Falls efficacy is defined as the degree of confidence of a person in performing common daily activities without falling (181). From the perspective of the self-efficacy theory, behaviours most relevant to the domain of activity limitations would consist primarily of self-care tasks, including personal activities of daily living (PADLs) and instrumental activities of daily living (IADLs). Falls-related self-efficacy has been found to be strongly associated with both PADL-IADL and social activity (181). The link between fear of falling and the level of confidence in performing certain self-care tasks without falling has been investigated to some extent. Fear of falling is defined as a lasting concern about falling that leads an individual to avoid activities that he/she remains capable of performing. Previous studies suggest that as judged by the answers to one dichotomous question, fear of falling is common among elderly persons, both those who have and those who have not experienced a fall (117, 182), and females have been reported to be more fearful than males (126, 185). In a cohort study a large proportion of community-living persons reported fear of falling, while at the same time they had high ADL-related self-efficacy (181). It seems contradictory to report fear of falling and at the same time feel confident in one’s ability to perform activities without falling. This paradox can be explained by the fact that a dichotomous question about fear of falling is general and may be considered by some subjects to reflect a more general state of anxiety (117). Tinetti concluded that fear of falling is a common cause of dependence and decline in participation among elderly persons (181,182), as almost 50% of those who had experienced a fall reported having a fear of falling and 28% of them avoided certain activities because of this fear (181). The self-imposed limitation is not necessarily a cause of impairments (181). It is possible that experience of deteriorating balance can cause this fear, and that fear can lead indirectly to a deterioration in balance as a result of self-imposed restriction on physical activity. Fear of falling may thus lead to a debilitating spiral, marked by loss of confidence and reduced activity, resulting ultimately in loss of independence (182). Franzoni et al (56) have found in a study of nursing home patients followed up for two years that fear of falling remained as the only significant predictor of decline in activities of daily living, as measured by the Barthel Index.
**Falls-Efficacy Scale, Swedish version (FES(S))**

FES(S) is a modified version of the Falls-Efficacy Scale (FES) (180) comprising 10 activities (nos. 4-13) of the original FES with three additional activities (1-3) (70). These three items are: getting in and out of bed, grooming and toileting. The rationale for the use of the additional items is that many stroke patients have considerable limitations in these activities in the early stage after stroke. The FES(S) focuses on relatively basic activities of ADL. The intention is to make the scale suitable even for subjects with moderate to severe disabilities (e.g. patients newly affected by stroke). It seems important to assess self-efficacy, and to do this the reliability, validity and responsiveness of the FES(S) must be established.

**Physiotherapy in stroke rehabilitation**

In physiotherapy a variety of movement therapy approaches are available for retraining motor skills in adult hemiplegic patients. Some methods (Proprioceptive Neuromuscular Facilitation, Rood, Brunnström, Bobath) rely on reflex and hierarchical theories of motor control, while others (Motor Relearning Programme (MRP) and Systems Theory Approach) derive clinical implications from more recent theories of motor control and motor learning as well as from principles of neural plasticity. Although physiotherapy is generally recognised as beneficial in patients with stroke, convincing evidence of its efficacy is lacking (46). It is not clear what type of physiotherapy promotes the fastest and best possible functional recovery.

In Sweden the MRP, developed by the physiotherapists Carr and Shepherd (25), is frequently used, as well as more eclectic approaches. A comparative study of the Bobath and MRP approaches indicated that MRP gave better results (106).

One of the major principles of the MRP is that an individual with movement dysfunction needs to be regarded essentially as one who has to re-learn how to perform the motor tasks required for daily life. In this therapy, emphasis is placed on the patient as an active learner and problem-solver rather than as a passive recipient of therapy (25). In MRP it is argued that the integration of the hemiparetic side in daily tasks will only be worth the effort if certain prerequisites are met. An important condition for success is an early start of rehabilitation in order to prevent non-use of the affected side, muscle weakness, loss of endurance and mental and perceptual deterioration, and to stimulate the patient’s learning abilities in both motor and cognitive functions (25). A second and even more important prerequisite is a consistent approach by all people involved, as rehabilitation should be regarded as 24-hour management.
A third requirement for the best result is a structured material environment; this implies that the environment should be structured in such a way that the patient is encouraged to use the hemiparetic side in daily activities (26). In practice, MRP assumes that training of stroke patients should be both task- and context-specific (26).

The systems theory approach described by Shumway-Cook and Woollacott (161) is based on the assumption that movement arises from the interaction of multiple processes within the individual, including perceptual, cognitive and motor processes and interactions between the individual, the task and the environment (162). This approach stresses the importance of therapeutic interventions that are specific to the task being trained.

**Balance training.** The goals of a task-oriented approach towards retraining of postural control include resolution or prevention of impairments, development of effective task-specific strategies, and adoption of task-specific strategies, so that functional tasks can be performed in changing environmental contexts (161). Correction of improvable impairments and prevention of secondary impairments are interventions on the impairment level. Interventions on the strategy level aim to help the patient to recover or to develop sensory and motor strategies that are effective in meeting the postural demands of different tasks. Intervention on the activity level focuses on having the patient practice successfully the performance of a wide variety of functional tasks in many contexts.

Since balance retraining often is only one component of a comprehensive physical rehabilitation programme, it is difficult to determine its contribution to overall recovery of functions and activities.

**Walking training.** Today, walking training in patients with stroke can be described as exercises designed to strengthen the affected lower limb in a way that is relevant to task performance. According to MRP the major emphasis in training for independent walking is placed on methods of training support and propulsion of the lower limbs, balance of the body mass over one or both feet, and control of the foot and knee paths through swing. The use of the hands for support should be discouraged, so as to enable dynamic balance and the ability to support the body through the lower limbs to be regained (26). The systems theory approach stresses the need for an equilibrium between therapeutic strategies focused on resolving impairments, and for retraining movement strategies for gait, and the importance of having the patient practice walking under various task and environmental conditions (162).
Locomotor training using a treadmill with body weight support (BWS) has been shown to optimise residual sensimotor integration for walking after stroke and spinal cord injury (8, 9), as well as in other neurological diseases with impaired lower limb and truncal function.

The BWS equipment provides the support needed to assume an upright position and allows the limb to move forward in stepping motion. The three essential components of walking – weight bearing, stepping and balance – are retrained simultaneously while the person is walking on a treadmill with BWS. Immediately after the injury, patients with stroke often do not have the balance and the strength in the lower extremities required to assume an upright position and to bear full weight on the lower limbs. A supporting harness to provide partial BWS may compensate for these deficits (52, 133). As gait improves, the BWS is decreased and the patient has to control an increasing percentage of his body weight (9, 51, 133).

In chronic, non-ambulatory hemiparetic subjects, a multiple baseline study and a single-case design study showed that treadmill training with partial BWS was more effective than regular physiotherapy in restoring gait ability and walking velocity (71, 72). In a pilot study on four hemiparetic patients, Hassid et al (68) found better gait symmetry on a treadmill than with ground-level walking, and Macko et al (115) found that treadmill training in 23 chronic stroke patients improved the physiological fitness. A randomised clinical trial on the use of a treadmill with BWS in patients with stroke showed that the BWS group had significantly better walking abilities than the group training while bearing full weight (187). Kosak and Reading (99) found in a randomised controlled study of 54 patients with stroke, that treadmill training with BWS and comprehensive brace-assisted walking were equally effective walking training techniques.

In stroke rehabilitation, the use of a treadmill with BWS is increasingly mentioned as an alternative method of walking training. This method has been tested mainly, however, in small clinical trials which are not conclusive enough to support recommending BWS in clinical practice at all stages.

In conclusion: Knowledge of the time course and extent of recovery of impairments and activity limitations post stroke is essential for treatment planning and prognosis, but these factors are only partly understood. Several investigators have studied the outcome and/or time of recovery after stroke, but have either failed to study the entire time course of recovery or have not assessed the full spectrum of relevant impairments. Today there is some knowledge about recovery from disability secondary to stroke, but as stated by Patel et al (141) the
recovery from specific impairments, e.g. balance, should be analysed in longitudinal studies. Also, the relationship between impairment, activity limitation and contextual factors (personal and environmental) in stroke patients needs to be examined. The concept of self-efficacy (personal factor) seems to be of importance in stroke rehabilitation, as performance of everyday actions becomes more challenging and requires more effort and perseverance after an acute event such as stroke, but few studies have addressed the impact of self-efficacy in stroke patients. Any instrument intended for assessment of self-efficacy must be tested for its validity and reliability in each particular disorder.

**Aims of the studies**

The overall aim of the work described in this thesis was to investigate the outcome of specialised stroke rehabilitation and to examine the impact of both subjectively perceived and objectively assessed balance on impairments and some activity limitations. A further aim was to examine the usefulness of the Falls-Efficacy Scale, Swedish version, in stroke rehabilitation.

The specific objectives of the studies were as follows:

- to compare the effects of walking training on a treadmill with body weight support and training on the ground with respect to ADL, walking ability, motor function and balance, the latter both objectively measured and subjectively perceived, at an early stage of rehabilitation in patients with stroke (I and Introduction);
- to examine the test-retest reliability of the FES(S) and its internal consistency (II and III);
- to examine the relationship between perceived self-confidence in task performance and two observer-assessed measures of balance and to determine whether there is a correlation between these three measures and motor function, ambulation and ADL on three different occasions after a first stroke (III and V);
- to evaluate the ability of the FES(S) to reflect clinically meaningful changes over time (IV);
- in elderly stroke patients admitted for subacute rehabilitation, to determine the extent to which observer-assessed balance and self-efficacy as expressed by perceived confidence in task performance change over time (V);
- to examine the utility of FES(S) in predicting the level of ADL 10 months after the onset of stroke (V).
SUBJECTS AND METHODS

The investigation comprised three different samples of stroke patients. The samples differed according to age and length of time since the onset of the stroke. Figure 2 shows the gender and mean age of the patients included in each study and the length of time post stroke at the first assessment. The studies were approved either by the Ethics Committees of the Faculties of Medicine at the University of Göteborg, Lund and Uppsala or by the Committee of the Medical Faculty of Uppsala University.

<table>
<thead>
<tr>
<th>Study I</th>
<th>Study II</th>
<th>Study V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Included patients: 73</td>
<td>Included patients: 30</td>
<td>Included patients: 37</td>
</tr>
<tr>
<td>Women/Men: 33/40</td>
<td>Women/Men: 10/20</td>
<td>Women/Men: 15/22</td>
</tr>
<tr>
<td>Mean age: 55</td>
<td>Mean age: 65</td>
<td>Mean age: 78</td>
</tr>
<tr>
<td>Mean time to first assessment (days): 22</td>
<td>Mean time to first assessment (months): 14</td>
<td>Mean time to first assessment (days): 22</td>
</tr>
</tbody>
</table>

Study III and IV
Included patients: 62
Women/Men: 27/35
Mean age: 54
Mean time to first assessment (days): 23

I

This study had a tri-centre design with participation of the Department of Rehabilitation Medicine, Sahlgrenska University Hospital, Göteborg, the Department of Rehabilitation Medicine, Uppsala University Hospital and the Department of Rehabilitation, Lund University Hospital.

During the years 1995 to 1999, 73 patients with a first-ever stroke with residual hemiparesis were recruited consecutively and randomised to a treatment group (n=36) and a control group (n=37). The inclusion criteria were a first-ever stroke, age less than 70 years at the time of the stroke, and a markedly reduced walking ability (inability to walk 10 metres in less than 14 seconds). The latter inclusion criterion was based on a gait velocity \( \geq 48 \text{ m/min} \), which is the speed necessary to cross an average intersection controlled by traffic lights (73).
The exclusion criteria were admission to the rehabilitation department later than eight weeks after the onset of the stroke, heart disease such as angina pectoris or cardiac insufficiency, psychiatric illness and inability to co-operate. Patients with concomitant impairments or disabilities caused by other conditions (e.g. rheumatoid arthritis) that could have hindered their treatment, and patients who were participating in other clinical studies, which could have compromised the effect of walking training, were also excluded.

All patients were assessed within one to two days after admission to the rehabilitation clinic, within one week prior to discharge from the clinic, and finally 10 months after the onset of stroke. They were assessed by one of three experienced physiotherapists (except when the National Institute of Health Stroke Scale and Functional Independence Measure were used) who were not involved in the treatment of the patients and who had previously established a common understanding of the assessments by testing two patients together. The patients received identical instructions and the tests were performed in the same sequence. Demographic data are presented in Figure 2.

The equipment for walking with body weight support consisted of a standard treadmill attached to a weight-supporting apparatus (TR Spacetrainer™). The treadmill measured 0.5 x 1.6 m and had a speed of 0 to 2 m/s. BWS varied between 100 % and 0 % of the user’s weight. An adjustable crossbar for hand support was mounted in front of the patients. The speed and distance were monitored on a display.

Treatment. The intervention group received 30 minutes of walking training 5 days a week on a treadmill with BWS. The physiotherapist assisted if the patient could not actively lift the paretic leg. In a few cases, at the beginning of the BWS training, two physiotherapists were needed to assist the patient’s movement of the leg and trunk. The patients wore comfortable shoes and were allowed to support themselves for balance on the crossbar. In some cases an ankle-foot orthosis was used. No verbal instructions were given, so that automatic walking should be encouraged. The BWS was gradually reduced as fast as possible, as the goal was to attain walking on the treadmill with full weight bearing. The BWS level and walking velocity were individually chosen and were adjusted to the improvement in the patient’s walking ability.

The control group received individual walking training by a physiotherapist for 30 minutes 5 days a week. The physiotherapy approach used followed the principles of the MRP (28). The training consisted of walking on the ground and did not include training on a treadmill. In the patients who were unable to walk, exercises were used to allow weight bearing on the
hemiparetic leg and to maintain segmental alignment for balance. Walking aids were used when appropriate.

Besides an equal amount of time on walking training each patient received additional 30 minutes physical therapy training 5 days a week. Thus, in each group the total duration of physiotherapy was 60 minutes per day. The aim of this training was to improve motor control and to strengthen functionally weak muscles, through techniques to improve the motor function of the paretic side and the range of motion, as well as transfers. The patients also practised on their own or in a group under supervision. The two groups received the same amount of treatment from the other members of the rehabilitation team in accordance with regular praxis at each department.

II

This study had a test-retest reliability design with a one-group convenience sample. The inclusion criteria were stroke in a stable phase and cognitive ability to participate. Physiotherapeutic assessments were used to select persons who were cognitively able to participate fully in the test procedure. Thirty patients with stable stroke (stroke onset between 5 and 84 months prior to the investigation) admitted to day-care units either at one rehabilitation unit or at one geriatric rehabilitation unit were included in the study (Fig. 2). The classification of impairments (motor function, sensory deficits, perceptual deficits, cognitive deficits) in the patients were made by their physiotherapists. Informed consent was obtained from the patients before inclusion. Falls-related self-efficacy was rated on a 10-point visual analogue scale on two occasions 5-22 (mean 10, median 7) days apart.

III and IV

Sixty-two patients from study I participated in studies III and IV. Patients were included if they met the following additional criteria: younger than 66 years at the time of stroke and cognitively able to communicate and co-operate validly. The 62 subjects (27 women, 35 men) had a mean age of 52 (+9.6) years (median 54 years, range 24-65 years). Thirty-three patients (53 %) had a right and 29 (47 %) a left hemiparesis. The mean interval between onset of stroke and admission to a rehabilitation clinic was 23 (+9.5) days (median 20.5 days, range 10-56 days). Thirty-one of the patients had been randomised to the treadmill group and 31 to the control group. There was no significant difference between the treadmill and the control group in any variable on admission. At the 10-month follow-up, 55 patients
remained in the investigation, 1 had died and 6 patients did not return for the follow-up assessment. Some demographic data for these studies are given in Figure 2. In study III the interactions between balance, perceived confidence in task performance, and motor function were investigated. Study IV focused on changes in outcome both from admission to discharge and from discharge to follow-up and on the responsiveness both objectively assessed balance measures and FES(S) to changes.

**STUDY V**

This study was conducted at a geriatric rehabilitation department between December 1, 1998 and January 31, 2001 and comprised patients with confirmed stroke admitted consecutively for physiotherapy. Inclusion criteria were age ≥ 66 years, first-ever stroke, an interval between stroke and admission of less than 8 weeks, ability to communicate and understand instructions, no other severe disabilities that might hinder their training, and living less than 50 kilometres from the participating hospital. Sixty patients fulfilled the inclusion criteria and among these, 12 declined participation in the investigation and 7 were not asked to participate. Among the 41 patients initially examined, 2 patients died during the follow-up period, one patient developed severe dementia and one declined further participation, giving a final sample of 37 subjects.

Assessments were made on entry into the study, at discharge and 10 months after stroke.

*Physiotherapy.* All patients were assessed and treated with a problem-solving approach (161, 162). The patients were evaluated in terms of total function within a changing environment and the goal of intervention was to optimise functions and abilities (26). The treatment included training of motor control, interventions to increase muscle strength and fitness, and promotion of skill acquisition, all with the aims of improving balance, transfers and walking. Exercises aimed to improve the stability of the trunk and hip, weight bearing on the hemiparetic leg, symmetry in body awareness and arm-hand function were commonly used. A plaster splint was used in some cases to facilitate weight bearing when patients had difficulties in loading the hemiparetic leg. Training of transfers were often made in daily-life situations such as getting out of bed and going to and from the toilet.


**Assessment methods**

Table 1. Overview of the measurements reported in the papers.

<table>
<thead>
<tr>
<th>Measure</th>
<th>STUDIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Institute of Health Stroke Scale (23)</td>
<td>X</td>
</tr>
<tr>
<td>Fugl-Meyer Stroke Assessment Instrument (58)</td>
<td>X</td>
</tr>
<tr>
<td>Berg’s Balance Scale (16)</td>
<td>X</td>
</tr>
<tr>
<td>Falls Efficacy Scale, Swedish Version (70)</td>
<td>X</td>
</tr>
<tr>
<td>Functional Ambulation Classification (79)</td>
<td>X</td>
</tr>
<tr>
<td>Walking 10 metres (192)</td>
<td>X</td>
</tr>
<tr>
<td>Functional Independence Measure (66)</td>
<td>X</td>
</tr>
</tbody>
</table>

*The National Institute of Health Stroke Scale* (NIH Stroke Scale) was used by physicians at the different departments as a descriptive measure of the neurological deficits on admission (23, 60) (Study I). The NIH Stroke Scale is a well validated instrument, with substantial results (130), that is used to assess the level of impairment in 15 neurological functions frequently affected by stroke.

*The Fugl-Meyer Stroke Assessment Instrument* (FMI), designed to assess the recovery pattern of motor function, balance and sensation after stroke, was used to evaluate post-stroke impairments. The range of joint motion and pain are further domains that are tested. There are separate subsections for assessment of motor function of the upper and lower extremity. Sensation, evaluated by light touch, is examined on four different locations of the arms and legs. Position sense, range of motion and pain are tested in eight joints. The scoring involves direct observation of performance. Each function is rated on an ordinal 3-point scale (0 = the item cannot be performed, 1 = the item can be performed in part, 2 = the item can be performed in full). The maximum score for the domains of motor function is 100 points, for sensation 24 points, for range of motion 44 points, and for pain 44 points. The inter- and intra-rater reliability coefficients for both upper and lower extremity subsections and for the total score have ranged from substantial to high (42, 156). Acceptable validity has been demonstrated by Dettman et al (33) and Fugl-Meyer et al (58). Furthermore, the scale has been reported to be responsive to fairly small changes in the patient’s status (120).
section of arm function has been shown to be responsive in the early phase after stroke, but less so at the chronic (i.e. > 1 year) stage (186).

The balance subscale of the Fugl-Meyer Stroke Assessment Instrument (FMIB) examines balance in both the sitting and standing position. The scale consists of 7 items, each of which is rated on an ordinal scale (the same scoring as in the motor function subscale), giving a maximum score of 14. The validity of the balance subscale has been reported by Malouin et al (120). Inter-rater and intra-rater reliability coefficients of > 0.85 have been reported for both the domain subscale and the entire scale (42), although Malouin et al (120) found poor internal validity for items concerning sitting balance.

Berg’s Balance Scale (BBS). This instrument consists of 14 items common in everyday life (16). The items evaluate the ability to maintain positions of increasing difficulty by decreasing the base of support, from sitting to standing, to close standing, to tandem standing and finally to standing on one leg. Other items evaluate the ability to perform specific tasks, such as transfer between positions, reaching forward, turning round and picking up an object from the floor. Scoring is based on the ability to perform the items independently and to meet certain time or distance requirements. Each item is scored along a scale from 0-4, giving a possible total score of 56. The scale has been shown in both an elderly population and in stroke patients to possess very good inter-rater intra-class correlation coefficient (ICC = 0.98) and intra-rater (ICC = 0.97) reliabilities (16, 17), as well as internal consistency (Cronbach’s alpha) of 0.85 – 0.98 (17). Acceptable validity estimates of BBS have also been reported (15, 169), as well as high responsiveness of BBS (198).

The Falls Efficacy Scale, Swedish Version is a self-reporting instrument for perceived confidence in task performance. It consists of a 13-activity questionnaire including both PADL (items 1-6) and IADL (items 8-13). Item 7, i.e. walking up and down stairs, is between PADL and IADL. The confidence in completing each activity was rated in full numbers along a visual analogue scale ranging from 0, not at all confident, to 10, completely confident, giving a possible total score of 130, and a maximal score for the subsections of 60.

Functional Ambulation Classification (FAC). The patients are rated at their most independent level of ambulation with regard to the amount of supervision or physical assistance needed.
from another person (78, 79). FAC has one item and a six-graded scale ranging from 0, non-functional ambulation, to 5, independent ambulation. The scale is simple to use and sensitive to changes during the transition from non-ambulatory to walking. The scale has only been tested for inter-rater reliability (Kappa of 0.72) (78).

*Walking test.* The test required that the patients walked 10 metres in a corridor (192). They wore their preferred shoes and assistive devices were used if necessary. They were asked to use a self-selected, comfortable walking speed. The time taken was measured with a stopwatch and the number of steps was counted (192). The test has been found to have high test-retest reliability in stroke patients (47, 168).

*Functional Independent Measures* (FIM™). This instrument was developed to measure ADL and to rate the requirement of care and outcome of medical rehabilitation. In this investigation it was used during the rehabilitation of in-patients as a team assessment by observation. Post-discharge follow-up scores were obtained by face-to-face interviews in the usual way (31). The instrument assesses self-care, sphincter control, mobility, locomotion, communication and social-cognition, all on a seven-point scale. There are 13 motor and 5 social-cognitive items. The FIM™ system employs 7-category ordinal scores to describe functional independence from 1, total assistance, to 7, independent. FIM™ measures performance, i.e. what an individual does in real situations. FIM™ has been found to have good validity and reliability (29), as well as good internal consistency (170).

**Statistical methods**

In all analyses a p level of ≤ 0.05 was considered statistically significant.  
*Paper I* Conventional formulae were used for calculation of means, medians and standard deviations. Fisher’s non-parametric permutation test was used for comparisons between groups, and Fisher’s permutation test for paired observations to test changes over time.  
*Paper II* The distributions of the results for the total FES(S) scale, its subscales and individual items are given as means (± SD), medians and ranges. Test-retest reliability was determined using the ICC. The relative Mann-Whitney U-test and Fisher’s exact probability test were used to identify group differences.  
*Paper III* The strength of correlations was calculated using Spearman’s rho coefficients.
**Paper IV** Distribution of scores are given as means (± SD), and median values. Scores on admission, at discharge and at follow-up were compared using Wilcoxon’s matched pairs signed rank tests. For calculating the strength of correlations between changes in different measures, Spearman’s rho correlations were used.

Three different methods were used to calculate the responsiveness of the instruments:

**Kazis Effect Size (KES)**
Kazis et al (95):

\[
\text{Mean change of rehabilitation group} \quad \text{Standard deviation of first score in same group}
\]

**Standard Response Means (SRMs)**
Liang et al. (109):

\[
\text{Mean change of rehabilitation group} \quad \text{Standard deviation of change scores in same group}
\]

**Responsiveness Ratio (RR)**
Guyatt et al, (64):

\[
\text{Mean change of rehabilitation group} \quad \text{Standard deviation of mean differences from baseline in a stable group}
\]

**Paper V** Group differences for ratio variables were assessed by Student’s t test and for ordinal scales by the Mann-Whitney U test. Balance scores on admission, at discharge and at follow-up were compared by Wilcoxon’s matched pairs signed rank tests. The strength of correlations was calculated using Spearman’s rho coefficients. Discriminant analyses were performed to determine the predictive effects of balance variables and the FES(S) measured at discharge on disability at follow-up. Patients were assigned a posteriori into two groups based on their FES(S) scores at discharge. Patients who scored above the group FES(S) median were considered to have high self-efficacy, while those at the group median or below were assigned to the low self-efficacy group.
RESULTS

Effects of walking training on a treadmill and on the ground (I)

Before treatment there were no significant differences in the assessment parameters between the treatment and the control group. The median value for motor function score was 31 in the intervention group and 28 in the control group. The median balance score was 24 for BBS and 11 for FMIB in the treatment group, and these figures were 25 and 12 respectively in the control group. When walking 10 metres, both groups (18 patients in the intervention group and 19 in the control group could walk on admission) showed a median velocity of 0.37 m/s on admission. The median FIM score was 54 for the motor items and 26 for cognitive items in the intervention group and in the control group these scores were 57 and 28 respectively. The motor function and balance were considered poor and the velocity very slow in those who were able to walk. Neither did the two training groups differ significantly in any measurement scores at discharge and at the 10-month follow-up. In the within-group comparisons, both the intervention group and the control group showed significant improvement between admission and discharge in motor function, balance, ambulation, walking speed and ADL. Only the control group improved significantly in balance from discharge to follow-up.

Effects of walking training on self-efficacy

The FES(S) was also used in study I, but is not included in paper I. The results of the assessments at the three time points are given in Table 2. There were no significant differences in FES(S) between the two groups on any of the three occasions. The 24 patients in the intervention group with complete FES(S) total ratings showed a median score of 54, while the corresponding 20 patients in the control group had a median score of 62. Both groups showed a significant improvement in FES(S) total, PADL and IADL from admission to discharge at the p< 0.0001, level whereas between discharge and follow-up the only significant improvement was in FES(S) PADL in the control group at the level of p< 0.05.

Reliability estimates of FES(S) (II and III)

The intraclass correlation coefficients for test-retest reliability for the whole FES(S) test and its subscales PADL and IADL were 0.97, 0.93 and 0.97 respectively. The correlation coefficients for the individual items ranged from 0.76 to 0.97. In addition there was a high degree of internal consistency, with a Cronbach’s alpha of 0.95 for the whole scale, and of 0.95 and 0.92 for the PADL and IADL subscales respectively.
Table 2. Self-efficacy scores on admission, at discharge and 10 months after the onset of stroke.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Intervention group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Admission Score</td>
<td>Discharge Score</td>
</tr>
<tr>
<td></td>
<td>Median (range)</td>
<td>Median (range)</td>
</tr>
<tr>
<td>FES(S) Total [130]</td>
<td>54 (0-128) (24)</td>
<td>124 (48-130) (29)</td>
</tr>
<tr>
<td></td>
<td>(included n)</td>
<td></td>
</tr>
<tr>
<td>FES(S) PADL [60]</td>
<td>34 (0-60) (28)</td>
<td>60 (27-60) (30)</td>
</tr>
<tr>
<td></td>
<td>(included n)</td>
<td></td>
</tr>
<tr>
<td>FES(S) IADL [60]</td>
<td>21 (0-60) (24)</td>
<td>57 (17-60) (29)</td>
</tr>
<tr>
<td></td>
<td>(included n)</td>
<td></td>
</tr>
</tbody>
</table>

[ ] Maximal possible score.
Relationship of self-efficacy to balance, motor function, ambulation and ADL as a part of validity estimations of FES(S) (III, IV and V)

Concurrent validity

In the younger stroke population (mean 52 years) FES(S) total correlated significantly though moderately with the Berg’s Balance Scale and FMIB both on admission (rho 0.46 to 0.68, p<0.001) and at discharge (rho 0.38 to 0.51, p<0.001). At follow-up, all correlations between BBS and the FES(S) total scores were significant (rho between 0.49 and 0.42, p<0.001), but only FES(S) total and FES(S) subsection IADL showed significant correlations with FMIB. On admission and at discharge motor function was significantly associated with FES(S) measures, while the associations at follow-up were weaker, though significant with one exception (FES(S) PADL vs motor function at follow-up).

The extent to which the different balance scores were associated with gait performance, measured with FAC, in the younger population is shown in Table 3 (not included in papers III and IV). FAC covaried more closely both on admission and at discharge with the observer-assessed balance measures than with the FES(S) measures, while all associations at follow-up were of almost the same magnitude.

Table 3. Spearman’s correlation (rho) coefficients between measures of balance and Functional Ambulation Classification (FAC) at three different time points after stroke.

<table>
<thead>
<tr>
<th>Balance</th>
<th>FAC</th>
<th>Admission p&lt; (n)</th>
<th>Discharge p&lt; (n)</th>
<th>Follow-up p&lt; (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FES(S) total</td>
<td>.60 .001 (44)</td>
<td>.52 .001 (60)</td>
<td>.55 .001 (55)</td>
<td></td>
</tr>
<tr>
<td>FES(S) PADL</td>
<td>.50 .001 (57)</td>
<td>.42 .001 (61)</td>
<td>.49 .001 (55)</td>
<td></td>
</tr>
<tr>
<td>FES(S) IADL</td>
<td>.51 .001 (45)</td>
<td>.51 .001 (60)</td>
<td>.55 .001 (55)</td>
<td></td>
</tr>
<tr>
<td>Observer-assessed:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BBS</td>
<td>.72 .001 (62)</td>
<td>.66 .001 (62)</td>
<td>.58 .001 (55)</td>
<td></td>
</tr>
<tr>
<td>FMB</td>
<td>.65 .001 (62)</td>
<td>.61 .001 (62)</td>
<td>.44 .001 (55)</td>
<td></td>
</tr>
</tbody>
</table>

Tables 4 and 5 show the correlations between balance, self-efficacy and ADL, measured by FIM, in the younger population (results not included in papers III and IV). Both balance and self-efficacy measures were significantly associated with both FIM total and FIM mobility on admission. This was particularly true for the observer-assessed balance scores. At discharge none of the FES(S) measures were significantly correlated with the FIM scores, whereas at
that time close correlations still persisted between the observer-assessed balance scores and FIM. However, significant associations between FES(S) measures and FIM recurred at follow-up (Table 5).

Table 4. Spearman’s correlation (rho) coefficients between measures of balance and ADL on admission and at discharge.

<table>
<thead>
<tr>
<th>Balance</th>
<th>FIM total</th>
<th>ADL</th>
<th>FIM mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Admission p&lt; (n)</td>
<td>Discharge p&lt; (n)</td>
<td></td>
</tr>
<tr>
<td>Perceived:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FES(S) total</td>
<td>.46</td>
<td>.01 (43)</td>
<td>.18 ns (57)</td>
</tr>
<tr>
<td>FES(S) PADL</td>
<td>.39</td>
<td>.01 (56)</td>
<td>.15 ns (58)</td>
</tr>
<tr>
<td>FES(S) IADL</td>
<td>.32</td>
<td>.05 (44)</td>
<td>.16 ns (57)</td>
</tr>
<tr>
<td>Observer-assessed:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BBS</td>
<td>.82</td>
<td>.001 (60)</td>
<td>.59 .0001 (58)</td>
</tr>
<tr>
<td>FMIB</td>
<td>.72</td>
<td>.001 (60)</td>
<td>.54 .0001 (58)</td>
</tr>
</tbody>
</table>

Table 5. Spearman’s correlation (rho) coefficients between measures of balance and ADL 10 months after stroke.

<table>
<thead>
<tr>
<th>Balance</th>
<th>FIM total</th>
<th>ADL</th>
<th>FIM mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 months p&lt; (n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FES(S) total</td>
<td>.43</td>
<td>.001 (54)</td>
<td>.40</td>
</tr>
<tr>
<td>FES(S) PADL</td>
<td>.43</td>
<td>.001 (54)</td>
<td>.41</td>
</tr>
<tr>
<td>FES(S) IADL</td>
<td>.39</td>
<td>.01 (54)</td>
<td>.36</td>
</tr>
<tr>
<td>Observer-assessed:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BBS</td>
<td>.44</td>
<td>.001 (54)</td>
<td>.54</td>
</tr>
<tr>
<td>FMIB</td>
<td>.56</td>
<td>.0001 (54)</td>
<td>.55</td>
</tr>
</tbody>
</table>

In the elderly population the Spearman’s rho coefficients between FES(S) and measures of balance, ambulation and ADL were significant (rho between 0.56 to 0.87) at all three time points of measurement. Both on admission and at discharge FES(S) total was relatively more closely correlated with BBS (0.82 respectively 0.79) and FAC (0.82 respectively 0.82) than
with FMIB and FIM, while at follow-up FES(S) also showed close correlations with FIM scores (rho between 0.76 and 0.87).

**Predictive validity (V)**

Univariate analyses of prospective (or predictive) correlations between FES(S) measurements and the other measures demonstrated that all initial FES(S) scores were significantly correlated with discharge balance, ambulation and ADL scores (rho between 0.56 and 0.81). FES(S) scores on discharge also correlated significantly with follow-up scores (rho between 0.49 and 0.82).

Discriminant analyses with the discharge scores of the two observer-assessed balance variables (BBS, FMB) and FES(S) were performed in order to assess the extent to which they could predict ADL performance, measured with FIM, at follow-up. The result showed that 86% of the patients were correctly classified regarding level of FIM total (dichotomized into two groups according to median score) at follow-up. The major classifier was FES(S) (Standardized Discriminant Coefficient: 0.70), followed by BBS (0.50), while FMIB was not a significant classifier in this respect. FIM mobility showed the same pattern, with 89% of the patients classified correctly regarding this parameter.

**Discriminative validity (V)**

Low and high FES(S) scores, operationally dividing the FES(S) by the median score at discharge, appeared to discriminate between patients’ improvements over time. Both the high and low self-efficacy groups made significant improvements, although starting from different baseline scores. The FES(S) detected functional gains in both groups, but the patients in the high-efficacy group improved more than those in the group with low-efficacy.

**Outcome of stroke rehabilitation from admission to discharge (IV and V)**

In the total sample of the relatively younger patients there were significant improvements in self-efficacy, balance and motor function from admission to discharge (Table 7). Among 62 patients, 95% had made improvement in balance according to BBS. Eighty-two per cent of 62 patients improved according to FMIB and 2 patients deteriorated. Concerning self-efficacy according to FES(S), a total of 42 of the 44 patients with available measures had improved. Four patients deteriorated in both FES(S) PADL and FES(S) IADL.
Additionally (not reported in IV), on admission the women had significantly lower (in all analyses \( p < 0.05 \)) scores than the men in FAC, BBS, FMIB, FES(S) total, FES(S) PADL, FIM total and FIM mobility. At discharge no significant differences between men and women were found either in any of the above-mentioned variables or concerning length of stay.

Table 6. Changes in functions and activities of the younger stroke subjects from admission to discharge.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Admission</th>
<th>Discharge</th>
<th>( p &lt; )</th>
<th>Number of patients improved/unchanged/deteriorated</th>
</tr>
</thead>
<tbody>
<tr>
<td>FES(S) total</td>
<td>57 (0-128)</td>
<td>124 (19-130)</td>
<td>.0001</td>
<td>42/1/1</td>
</tr>
<tr>
<td>(n=44)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FES(S) PADL</td>
<td>35 (0-60)</td>
<td>58 (19-60)</td>
<td>.0001</td>
<td>50/3/4</td>
</tr>
<tr>
<td>(n=57)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FES(S) IADL</td>
<td>23 (0-60)</td>
<td>54 (0-60)</td>
<td>.0001</td>
<td>39/2/4</td>
</tr>
<tr>
<td>(n=45)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BBS</td>
<td>25 (0-45)</td>
<td>51 (5-56)</td>
<td>.0001</td>
<td>59/3/0</td>
</tr>
<tr>
<td>(n=62)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FMIB</td>
<td>8 (0-12)</td>
<td>11 (6-14)</td>
<td>.0001</td>
<td>51/9/2</td>
</tr>
<tr>
<td>(n=62)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor function</td>
<td>29 (2-97)</td>
<td>53 (21-100)</td>
<td>.0001</td>
<td>60/0/2</td>
</tr>
<tr>
<td>(n=62)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAC</td>
<td>0 (0-5)</td>
<td>4 (0-5)</td>
<td>.0001</td>
<td>57/5/0</td>
</tr>
<tr>
<td>(n=62)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIM total</td>
<td>57 (17-86)</td>
<td>80 (56-91)</td>
<td>.0001</td>
<td>56/0/0</td>
</tr>
<tr>
<td>(n=56)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIM mobility</td>
<td>18 (5-30)</td>
<td>30 (18-35)</td>
<td>.0001</td>
<td>55/1/0</td>
</tr>
<tr>
<td>(n=56)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Only subjects who could perform the test both on admission and at discharge are included.

In the geriatric sample (table 7), significant improvements were made from admission to discharge, in self-efficacy, motor function, balance, ambulation and ADL. In balance measured with BBS, 28 of the 37 patients showed improvement, while 5 had decreased their scores. The FMIB score improved in only 15 patients, 16 patients made no improvements and 6 patients deteriorated. The FES(S) total score increased in 31 of the patients while only 24 patients increased their FES(S) PADL scores. Eight patients perceived deterioration in FES(S) PADL and 5 patients in FES(S) IADL.

Analyses of the impact of age showed that the 13 patients \( \geq 80 \) years of age improved their scores significantly in all measures used in the study, with the exception of FMIB, and that
there were no significant differences in these measures at discharge between the group of patients < 80 and the group ≥ 80 years.

Table 7. Changes in the functions and activities of the geriatric stroke subjects from admission to discharge; n = 37

<table>
<thead>
<tr>
<th>Variables</th>
<th>Admission</th>
<th>Discharge</th>
<th>p&lt;</th>
<th>Number of patients improved/unchanged/deteriorated</th>
</tr>
</thead>
<tbody>
<tr>
<td>FES(S) total</td>
<td>47 (2-130)</td>
<td>79 (19-130)</td>
<td>.0001</td>
<td>31/1/5</td>
</tr>
<tr>
<td>FES(S) PADL</td>
<td>32 (2-60)</td>
<td>45 (0-60)</td>
<td>.001</td>
<td>24/5/8</td>
</tr>
<tr>
<td>FES(S) IADL</td>
<td>15 (0-60)</td>
<td>27 (0-60)</td>
<td>.0001</td>
<td>31/8/5</td>
</tr>
<tr>
<td>BBS</td>
<td>36 (0-45)</td>
<td>40 (5-56)</td>
<td>.0001</td>
<td>28/4/5</td>
</tr>
<tr>
<td>FMIB</td>
<td>10 (4-14)</td>
<td>10 (4-14)</td>
<td>.01</td>
<td>15/16/6</td>
</tr>
<tr>
<td>Motor function</td>
<td>91 (16-100)</td>
<td>96 (9-100)</td>
<td>.0001</td>
<td>30/3/4</td>
</tr>
<tr>
<td>FAC</td>
<td>3 (0-5)</td>
<td>4 (0-5)</td>
<td>.0001</td>
<td>23/13/1</td>
</tr>
<tr>
<td>FIM total</td>
<td>58 (13-91)</td>
<td>85 (25-91)</td>
<td>.0001</td>
<td>32/2/3</td>
</tr>
<tr>
<td>FIM mobility</td>
<td>18 (5-35)</td>
<td>32 (6-35)</td>
<td>.0001</td>
<td>31/1/5</td>
</tr>
</tbody>
</table>

Changes between discharge and follow-up (IV and V)

In the younger stroke subjects, from discharge to follow-up 10 months after the onset of stroke, minor, though significant, further improvements in BBS, FMIB, motor function scores and task-related self-efficacy were found (Table 8). According to BBS and FMIB, 82 % and 84 %, respectively, of the 55 remaining younger patients increased or maintained the level of balance that they had achieved during their in-patient rehabilitation. The remaining 18 % and 16 % experienced a decline as reflected by BBS and FMIB, respectively.

Task-related self-efficacy was maintained or increased in 80 % of the patients, and the remaining 20 % decreased their score in FES(S) total. Eighty-two per cent and 78 % of the patients maintained their FES(S) PADL and IADL levels, respectively from discharge, while 20 and 15 patients, respectively, showed no change in scores, and in the remaining 10 and 12, respectively, there was a decline in these scores.
Table 8. Changes in the functions and activities of the younger stroke subjects from discharge to follow-up; n = 55

<table>
<thead>
<tr>
<th>Variables</th>
<th>Median score (range)</th>
<th>p&lt;</th>
<th>Number of patients improved/unchanged/deteriorated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discharge</td>
<td>Follow-up</td>
<td></td>
</tr>
<tr>
<td>FES(S) total</td>
<td>107 (19-130)</td>
<td>129 (16-130)</td>
<td>.01</td>
</tr>
<tr>
<td>FES(S) PADL</td>
<td>58 (19-60)</td>
<td>60 (6-60)</td>
<td>.05</td>
</tr>
<tr>
<td>FES(S) IADL</td>
<td>54 (0-60)</td>
<td>59 (7-60)</td>
<td>ns</td>
</tr>
<tr>
<td>BBS</td>
<td>51 (5-56)</td>
<td>53 (12-56)</td>
<td>.001</td>
</tr>
<tr>
<td>FMIB</td>
<td>11 (6-14)</td>
<td>12 (5-14)</td>
<td>.01</td>
</tr>
<tr>
<td>Motor function</td>
<td>53 (21-100)</td>
<td>70 (26-100)</td>
<td>.0001</td>
</tr>
<tr>
<td>FIM total (n = 50)</td>
<td>4 (0-5)</td>
<td>5 (0-5)</td>
<td>.0001</td>
</tr>
<tr>
<td>FAC</td>
<td>80 (57-91)</td>
<td>87 (57-91)</td>
<td>.0001</td>
</tr>
<tr>
<td>FIM mobility (n = 50)</td>
<td>30 (20-35)</td>
<td>33 (20-35)</td>
<td>.0001</td>
</tr>
</tbody>
</table>

In the geriatric group of stroke patients, (Table 9), further significant improvements from discharge to follow-up were observed in FES(S) total, FES(S) IADL, BBS, FAC, FIM total and FIM mobility, while no significant changes occurred in FES(S) PADL, motor function or balance according to FMIB. In FES(S) total, 26 of 37 patients maintained or increased their level of self-efficacy achieved at discharge, while 11 patients decreased their score. According to BBS, 27 patients increased or maintained their balance level, while 9 patients experienced deterioration in balance.

The analyses of age-groups showed that in the 13 patients ≥ 80 years there were no significant changes from discharge to follow-up in any of the measures used in the study.
Table 9. Changes in the function and activities of the geriatric stroke subjects from discharge to follow-up; n = 37

<table>
<thead>
<tr>
<th>Variables</th>
<th>Discharge</th>
<th>Follow-up</th>
<th>p&lt;</th>
<th>Number of patients improved/unchanged/deteriorated</th>
</tr>
</thead>
<tbody>
<tr>
<td>FES(S) total</td>
<td>79 (19-130)</td>
<td>100 (5-130)</td>
<td>.05</td>
<td>22/4/11</td>
</tr>
<tr>
<td>FES(S) PADL</td>
<td>45 (0-60)</td>
<td>52 (5-60)</td>
<td>ns</td>
<td>21/7/9</td>
</tr>
<tr>
<td>FES(S) IADL</td>
<td>27 (0-60)</td>
<td>37 (0-60)</td>
<td>.01</td>
<td>23/6/8</td>
</tr>
<tr>
<td>BBS</td>
<td>40 (5-56)</td>
<td>45 (3-56)</td>
<td>.01</td>
<td>24/3/9</td>
</tr>
<tr>
<td>FMIB</td>
<td>10 (4-14)</td>
<td>10 (4-14)</td>
<td>ns</td>
<td>14/13/10</td>
</tr>
<tr>
<td>Motor function</td>
<td>96 (9-100)</td>
<td>95 (3-100)</td>
<td>ns</td>
<td>19/6/12</td>
</tr>
<tr>
<td>FAC</td>
<td>4 (0-5)</td>
<td>5 (0-5)</td>
<td>.001</td>
<td>14/22/1</td>
</tr>
<tr>
<td>FIM total</td>
<td>85 (25-91)</td>
<td>89 (38-91)</td>
<td>.001</td>
<td>24/6/6</td>
</tr>
<tr>
<td>FIM mobility</td>
<td>32 (6-35)</td>
<td>34 (8-35)</td>
<td>.001</td>
<td>23/8/5</td>
</tr>
</tbody>
</table>

**Responsiveness (Paper V)**

The results of the three alternative effect-size calculations (Table 10) demonstrated that FES(S), BBS and FMIB had very acceptable responsiveness during the early rehabilitation period (admission to discharge) and during the total observation time (admission to 10-month follow-up). In the early rehabilitation period the best responsiveness values obtained with both the SRM and KES methods were noted for BBS and FES(S) total. Viewed over the whole period, the SRM value was highest for the BBS, followed by FMIB and FES(S) total, while the KES value was highest for BBS and FES(S) total.

The responsiveness ratio for FES(S) was quite high, ranging from 1.97 to 4.04 across the early and overall rehabilitation period.
Table 10. Effect sizes of the Falls-Efficacy Scale, Swedish version (FES(S)), with PADL and IADL subscales, the Berg Balance Scale (BBS) and the Fugl-Meyer Balance Subscale (FMIB) in patients with stroke.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Early response*</th>
<th>Overall response*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FES(S) total (n=38)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRM</td>
<td>1.31</td>
<td>1.29</td>
</tr>
<tr>
<td>KES</td>
<td>1.25</td>
<td>1.41</td>
</tr>
<tr>
<td>RR</td>
<td>3.57</td>
<td>3.86</td>
</tr>
<tr>
<td><strong>FES(S) PADL (n=51)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRM</td>
<td>1.15</td>
<td>1.09</td>
</tr>
<tr>
<td>KES</td>
<td>1.16</td>
<td>1.21</td>
</tr>
<tr>
<td>RR</td>
<td>1.97</td>
<td>1.97</td>
</tr>
<tr>
<td><strong>FES(S) IADL (n=39)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRM</td>
<td>1.26</td>
<td>1.24</td>
</tr>
<tr>
<td>KES</td>
<td>1.19</td>
<td>1.36</td>
</tr>
<tr>
<td>RR</td>
<td>3.52</td>
<td>4.04</td>
</tr>
<tr>
<td><strong>BBS (n=55)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRM</td>
<td>1.52</td>
<td>1.62</td>
</tr>
<tr>
<td>KES</td>
<td>1.32</td>
<td>1.44</td>
</tr>
<tr>
<td><strong>FMIB (n=55)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRM</td>
<td>1.15</td>
<td>1.38</td>
</tr>
<tr>
<td>KES</td>
<td>1.14</td>
<td>1.36</td>
</tr>
</tbody>
</table>

SRM = Standard Response Mean, KES = Kazis Effect Size, RR = Responsiveness Ratio
* Early response = admission to discharge, Overall response = admission to 10 months from onset of stroke
DISCUSSION

**Outcome considerations**

**Effect of walking training**

The ability of a patient to walk after stroke is often hindered by marked muscle weakness and poor balance control. Treadmill training with partial weight support may be beneficial for these patients, as it provides an opportunity for extensive practice of the whole task of walking in the presence of muscle weakness and poor balance control. The overhead harness prevents falling, reduces the muscle force requirements and decreases postural demands and anxiety (149).

Treadmill training with body weight support has been found to be useful for improving walking in individuals with stroke in a chronic stage (68, 72). Hesse et al (72) have shown that walking training with body weight support in the relatively later stages is superior to the Bobath method, according to which ambulation is not advocated until the patient is able to stand with minimal assistance for postural stability and alignment.

In the present studies, however, no significant difference in the effect of training was found between the treadmill group and the control group with walking training on the ground. The walking training in the control group was given in a structured way. The major differences between treadmill walking and on-the-ground walking lie in the different visual and kinaesthetic information received by the walker (158). Training on the ground incorporates walking in more natural environments and for different goals. To act effectively, patients need to be able, for example, to walk while carrying objects, which implies different balance demands.

We interpret our results as indicating that early physical therapy, including controlled walking training, either with a treadmill or with structured training on the floor, is beneficial in younger stroke patients irrespective of how it is delivered.

Current knowledge supports training approaches that emphasise task-related strengthening and co-ordinated exercises to promote endurance in various contextual and motivational environments (106). To improve walking, task-related training involves strategies to increase strength, coordination and the weight-bearing capacity of the affected limb, and provide an opportunity for intensive practice to develop skill in walking (26). Ideally, the strengthening exercises should resemble the task or components of the task being trained as closely as possible.
Changes in balance control

Irrespective of the level of impairment and of age, significant improvements in balance occurred from admission to discharge. This implies that even severely impaired and old patients with stroke have a good potential for improvement in balance. This finding is in conformity with other reports in the last decade of significant improvements in balance control in stroke patients over the course of rehabilitation (18, 21, 73, 198).

Although the main focus in study I was on walking training, the exercises used are also likely to train balance, since the movements basically present a threat to stability. Current knowledge suggests that in most stroke patients, difficulties with balance can be addressed by training the types of actions required in everyday life, such as standing up and sitting down, walking and stair climbing, as postural adjustments are task- and context-specific (85). These actions are self-initiated and train postural adjustments, anticipatory and ongoing, as part of the actions themselves. As mentioned previously, after an acute cerebral vascular accident it is unlikely that effective static balance control will be regained in a particular position until the individual can assume that position or is helped to obtain it and can practise there. Similarly, postural adjustments are unlikely to develop as part of a specific action until the type of action is practised (26). Winstein (195) documented that balance skills that are developed through training involving standing tasks have limited effects on balance control during walking in patients with stroke.

An individual who cannot assume the upright position of standing may, initially, need to practise with some type of external constraint, for example a harness, that controls some components of segmental alignment to allow the person to experience instability without falling (75). Thus treadmill training with a harness might hypothetically be beneficial for recovery of balance. However, this hypothesis was not supported in the present studies. The older group of stroke patients and the control group practised without access to body weight support. This implies that balance can be equally successfully trained without a harness. Carr and Shepherd (26) stated that a lack of understanding of the importance of lower limb muscle strength for balance (102) decreases the likelihood that rehabilitation will be effective in increasing balance and preventing falls, particularly in elderly individuals. Giving the patient an opportunity to practise tasks that are near their limits of stability (i.e. that present a threat to stability) is a critical component in improving balance control (31). In the present studies, the training was conducted by experienced physiotherapists who were able to plan individually tailored balance training.
Self-efficacy in task performance at an early stage after stroke

Whereas it is well known that improvement at an early stage after stroke is common even in elderly stroke patients (98, 113), self-efficacy after stroke has been only marginally studied. In the present studies the treadmill and control group showed equal increases in self-efficacy, as expressed by degree of confidence in task performance without falling, from admission to discharge. In the oldest patients, a significant improvement in self-efficacy, also was reached at discharge.

No specific training aimed at increasing perceived confidence in task performance had been given in any of the study groups and it is of particular interest that patients with low self-efficacy at discharge had significantly lower scores for functions and activities on admission. These differences were still evident and had even increased at discharge, implying that the patients’ perceived self-efficacy may be an important determinant of the outcome - a suggestion consistent with the self-efficacy theory, which postulates that an individual’s beliefs will affect his behaviour (6) and may lead to activity limitation. Efficacy expectations are often the products of a previous successful history of task performance. Such expectations may, in turn, influence future behaviour. The efficacy expectations are both determinants and consequences of behaviour. That is, they are reciprocally determining.

There is a high prevalence of depression among patients after stroke (1, 150, 201). Depression may have an impact on both individual QoL domains and global QoL (1, 20), which may lead to participation restrictions. Specifically, physical health, leisure participation, cognitive and social functioning, and life satisfaction have been shown to be deleteriously affected by depression (3, 94). Anxiety frequently coexists with depression and in such cases is often unrecognised on account of the overlapping nature of the two sets of symptoms (164). Considerable data have shown that various forms of anxiety are related to self-efficacy and that when statistical adjustments are made for self-efficacy, the relation between anxiety/fear and behaviour is often diminished (6). Anxiety and self-efficacy may be two sides of the same coin and may to a great extent, as may depression, reflect the level of coping. In a recent study by Robinson-Smith et al, (151), self-care self-efficacy was closely related to QoL and depression after stroke. Emphasis on psychosocial factors, such as self-efficacy, in rehabilitation strategies may improve the patients’ coping abilities and perceived satisfaction with life.
Outcome 10 months after stroke

As previously stated, there is a considerable difference of opinion concerning late recovery of functions and reduction of activity limitations after stroke. Paolucci et al (140) found improvement in mobility in 20% of their patients at 1-year follow-up in relation to that at hospital discharge. The present findings regarding motor function, balance, self-efficacy, ambulation and ADL ability showed that the majority of the stroke patients further improved their functions and abilities from discharge to follow-up, confirming that improvement in functional outcome may continue to occur even after the first few months (87, 139). However, age had an impact on the outcome at follow-up, as both the proportion of patients whose balance had improved and the levels of improvement were higher in the relatively younger group of patients, and in fact in the patients over 80 years of age no significant improvements at all occurred between discharge and follow-up. In general, the patients exhibiting deterioration at follow-up were those with perceptual deficits and neglect, findings in conformity with reported indications that performance on admission and functional outcome at discharge and follow-up are related to the severity of such perceptual deficits (19, 27, 138).

It is generally believed that the functional outcome after stroke is independent of gender. However, in agreement with Wade et al (191), who reported more severe deficits in arm function after stroke in women below the age of 66, as compared to older women as well as to men, we found that men in the younger group achieved a significantly better score on all measures at admission. Wyller et al (200) similarly found that women seemed to be functionally more impaired by stroke than men, and that the differences were less pronounced but still evident for ADL and motor function one year post stroke. However, the younger women in our investigation improved more rapidly than the men and thus reached a final function that was comparable to that of the men at discharge and follow-up.

Although approximately equal numbers of patients in the younger group showed deterioration in observer-assessed balance and in self-efficacy, the magnitude of the deterioration was considerably greater when assessed by the FES(S) instrument than when judged by the objective balance measures. One possible interpretation of this finding is that even slight or modest deterioration in externally observable balance may be perceived by the individual as a relatively greater level of uncertainty. A further explanation may be that decreased self-efficacy leads to decreased balance. From a social cognitive perspective it would seem that under challenging circumstances individuals have to possess not only the relevant skills and capabilities to carry out a task but also the beliefs in their ability to do so.
Indeed, Bandura (7) has suggested that the extent to which one has confidence in one’s capabilities to carry out these tasks is of greater importance.

The lower mean FES(S) scores in the elderly group may reflect the fact that elderly persons with stroke who return home from the hospital following in-patient treatment may run a risk of falling that is almost three times higher than the risk in persons without neurological deficits living in the community (53). The mean score per item in the elderly group was lower (6.1), while the mean score of 8.2 in the younger group was similar to mean scores reported previously from other studies on fall-related self-efficacy. Hill et al (74), for example, reported an average score of 8.3 for patients admitted to a “Fall and Balance clinic”, and Powell and Meyers (147) found a mean value of 8.1 for persons over 65 years of age living in the community.

Spontaneous or treatment-induced improvements

As none of the studies I, III, IV and V had a control group receiving no treatment, it is unclear to what extent the sub-acute improvements were spontaneous or treatment-induced. Critics of reports on effects of rehabilitation (38, 110) have argued that the reduction of impairments caused by spontaneous natural recovery of neurological function is the primary (if not the only) factor contributing to the reduction in disabilities that occurs during rehabilitation. Clinical observations and scientific investigations (49, 154), however, have suggested that even patients who do not experience reductions in their impairments achieve reduced activity limitations during rehabilitation. These improvements may be largely due to the learning and practice effects of rehabilitation. The present observations supported previous evidence that stroke patients improved their functions during the subacute period (114, 154). Moreover, Kvakkel et al found that intensive lower and upper extremity training during the first 20 weeks after stroke significantly improved the recovery of activities in terms of walking ability and ADL compared to a control condition in which the upper and lower extremities were immobilised by means of an inflatable pressure splint (104). The same study also provided support for the claim that exercise therapy primarily induces treatment effects on those parameters that are specifically trained. In the present investigations all patients underwent training with a high demand on balance function.
Relationship of self-efficacy to functions and activities

Moderate though significant correlations between FES(S) measures and observer-assessed balance were found in the younger group, while there were close correlations in the elderly group. The covariance between self-efficacy and balance in the elderly group was of the same level as that reported by Piotrowski and Cole (144) from a study comprising senior citizens (mean age 78 years, SD ± 6.88). These findings indicate either that self-efficacy in task performance is more closely related to balance in elderly stroke patients, or that elderly patients appear to have better perception of their own balance than younger patients. Thus, both of these measures may be needed for a complete assessment and training of balance, especially in the younger group, as different aspects of balance seem to be captured by these tests in the younger patients.

The same pattern of correlations was observed between FES(S), FAC and FIM in the two age groups, implying that the level of confidence (self-efficacy) may have a greater impact on activities in elderly stroke patients. According to the Social Cognitive theory, self-efficacy is a cognitive control system that influences the likelihood of performing behaviours particularly in two situations: when new behaviours are being learned, and when established behaviours are challenged. If, on the other hand, the performance of behaviours is more or less routine, then self-efficacy is thought to be less important (7, 125). The older stroke patients may have found the simple ADLs more challenging than did the younger patients, a possibility which might also explain the somewhat surprising non-significant correlation between FES(S) and FIM measured at discharge in the younger group. Another explanation could be a ceiling effect, as 23 %, 30 % and 39 % of the patients in the younger group reached a maximum score at discharge in FES(S) total, PADL and IADL, respectively, while no such ceiling effect occurred in the elderly group. A third tentative explanation might be that the relatively younger patients have more feelings of uncertainty and anxiety before discharge because they do not know how well they will be able to cope with the home environment and fear possible participation restriction. It is evident that observer assessment of balance is necessary in physical therapy to contribute to planning, implementation and evaluation of subacute treatment. From the latter point of view it again seems relevant to assess the self-confidence of stroke patients, as self-efficacy has been shown to have a sizeable impact on former patients regarding their abilities to be independent in mobility and ADL in their home environment (56, 105). This leads to the conclusion that in clinical practice in rehabilitation,
self-efficacy training may be beneficial when attempting simultaneously to improve both self-efficacy and physical skills (181).

**Statistical considerations**

**Reliability**
The measurements theory clearly indicates that tests that possess low reliability cannot have high validity (32). To investigate the test-retest reliability was the first step aimed to assess the validity and reliability of FES(S).

The fairly high level of relative reliability demonstrated, supports the usability of the FES(S) in research and in clinical practice. Stringent demands on reliability are especially desirable when instruments are used to evaluate the effectiveness of intervention and to monitor the status of patients over time, as minor deviations might be clinically meaningful differences. In research, any excess measuring errors will adversely influence the required sample size, the cost of the study and the power to detect true treatment effects. The reliability coefficients of 0.93 to 0.97 are quite near those recommended by Mahoney and Barthel, (116) for use in clinical practice (reliability coefficients ≥ 0.94) when results of repeated tests are to be used to make decisions about individuals. The reasonable test-retest reliability observed justified the further studies required for proper test development. Moreover, the acceptable internal consistency of the FES(S) and its subdivisions FES(S) PADL and IADL supports its index-construction properties.

**Concurrent validity**

In the younger group of patients (I, III, IV), FES(S) assessment was significantly associated with the two observer-assessed balance measures both on admission and at discharge, but at follow-up these co-variations were generally weaker. In the elderly group of patients on the other hand, the associations between FES(S) and balance were high at all points of assessment. From the concurrent validity point of view these results indicate that perceived confidence in task performance in terms of FES(S) is a valid expression of balance in both young and, perhaps especially, in elderly stroke patients who are able to communicate and understand instructions. However, the weaker correlation between the FES(S) and the two balance instruments at the 10-month follow-up in the younger group can be taken as evidence that the FES(S) is multifactorially determined and does not solely reflect impaired balance, at least in the younger group. The importance of other factors for the FES(S) is to some extent
confirmed by Lachman et al (105), who suggest that support from families and friends is an important prerequisite for continuing to remain active even in the face of fear of falling.

**Predictive validity**

The ability to make a prediction of the outcome after discharge, in terms of level of participation, is of value for clinical purposes, as it enables caregivers to identify patients that may be in need of specific strategies to maintain or increase functions and activities achieved under rehabilitation.

In comparison with the two observer-based balance measures, FES(S) at discharge proved to be the most powerful predictor of ADL performance 10 months after the onset of stroke. Studies addressing self-efficacy as a predictor of physical performance have been carried out in groups of community-living elderly people and in patients with other diagnoses (e.g. whiplash-related disorders) (128, 174). Mendes de Leon showed a significant interaction between self-efficacy and change in physical performance, suggesting that low self-efficacy is particularly predictive of functional decline leading to activity limitation among older individuals (128).

In most studies on predictors of ADL improvement, early predictors are identified in the acute stage. In a cross-validation study Löfgren et al (113) failed to identify a sufficiently accurate model for predicting chances of late ADL improvement in stroke patients. Feys et al (50) found that very early predictive accuracy diminished as predictions were made to a later stage in the recovery process, while assessment of the variables at two and six months increased the percentage of explained variance at 12 months. Thus, accuracy in predicting ADL performance at follow-up can be improved substantially by predictors obtained from discharge.

It has been suggested that self-efficacy may play an important role as a predictor for activity/participation, as self-efficacy expectations concern the individual’s beliefs relative to his or her capabilities of executing necessary courses of action to satisfy situational demands (6, 7). In many patients after stroke, performance of everyday activities becomes more challenging and requires greater effort. A robust sense of self-efficacy would thus appear to be of particular importance to patients after stroke.

**Responsiveness**

The responsiveness of an instrument cannot be evaluated separately from its reliability (64). If an instrument shows a considerable change in the mean score of a patient after an intervention, this can only be considered as an indication of the instrument’s responsiveness if
it has been shown to be reliable at test-retest in a stable population (172). Many different approaches have been described to quantify responsiveness (172). Using effect sizes for this purpose, with slight differences both observer-assessed balance and subjectively perceived task performance were sufficiently responsive to characterise changes during the subacute rehabilitation. The BBS proved to be the most responsive of the three instruments, followed by the FES(S), with the exception of the result of the Standard Response Mean (SRM) for the overall rehabilitation period. For patients with acute stroke, the BBS is a good criterion measure of responsiveness. The scale is widely used and has recently been tested for its responsiveness (203). Both the Kazis effect size and the SRMs of the Berg Balance Scale in this study (IV) were higher than those reported by Wood-Dauphinée et al (197). The good responsiveness of FMIB has not been documented previously.

In comparison with other stroke studies, the Responsiveness Ratios of the FES(S) during the early (3.57) and overall rehabilitation periods (3.86) were relatively high. Van Bennekom et al (183) found that the RRs of the Rehabilitation Activities Profile and the Barthel Index were 1.96 and 1.83 respectively at best, and for the Action research test van der Lee et al (189) reported an RR of 2.03. The relatively low effect size of FES(S) PADL (1.97) may be due to a ceiling effect, i.e. there may have been little or no more room for improvement in the PADL subscale.

There is no general consensus on the most appropriate strategy for quantifying responsiveness. SRM has been recommended by Stratford et al (172) for the reason that it is not influenced by sample size and that it incorporates the post-score variance. Although the patterns of SRMs and the effect size of Kazis et al (98) appear similar, they cannot be compared directly. The effect size of Kazis uses the standard deviation of the first scores as the denominator. It therefore fails to incorporate the post-score variance and hence may under- or over-estimate the effect size. Alternatively, SRMs, by using the standard deviation of the change scores as the denominator, incorporate the response variance and thus are mathematically closer to the answer obtained from a comparison in a clinical trial.

**Methodological comments**

There are several limitations to be considered in interpreting these findings. First, ADL-related self-efficacy was defined as the degree of confidence in performing ADLs without falling. Although there are no doubt reasons for a lack of confidence in performing ADLs other than fear of falling, this fear can be highly prevalent among patients with stroke, and is
therefore likely to have a major impact on activity/participation. Secondly, there is always the possibility of an artificial overlap between measures of self-efficacy and actual behaviour, due to the respondents’ failure to understand the distinction between the level of confidence to perform specific tasks (self-efficacy) and the actual performance of these tasks. However, such potential overlap was minimised by specific probes during the assessment, pointing out to the respondents the differences between efficacy and actual performance.

Another problem to be considered is the occurrence of ceiling and floor effects. BBS had a tendency to show a ceiling effect in comparison with FMIB in the younger group, as 9 (15 %) and 4 patients (6 %), respectively, reached the maximum possible score. On the other hand, FMIB did not seem to be sensitive enough to measure progress or deterioration in balance in the elderly group of patients. FES(S) displayed a ceiling effect in the younger group of patients at discharge, and therefore in about 23-39% of the patients no improvement could be recorded at follow-up. Anyhow, the common problem after discharge is a decay of self-efficacy (124, 174) and the FES(S) is sensitive to any decreases in this parameter.

When designing a reliability study, it is advisable to include subjects representing the range of ability of the target population so as to improve the generalisability of the results. However, it is possible to have high relative reliability across a wide range of scores and still demonstrate some discrepancies that warrant clinical concern. It is therefore important to examine the descriptive information on mean scores and absolute differences in addition to summary statistics. To date, the absolute reliability of FES(S) has not been published.

In spite of all efforts, the sample of elderly stroke patients is small and selected and cannot be regarded as representative. Moreover, the sample is selected concerning cognitive impairments.

The modest sample sizes, the selected samples and the cultural differences within and between countries must reasonably place limits on the ability to generalise the current findings to other impairment groups and perhaps even to the stroke population at large.

Conclusions

- Walking training on a treadmill with body weight support and walking training on the ground were equally effective in the early rehabilitation of younger patients after stroke, as the patients in both groups improved their motor function, balance, self-efficacy, walking velocity and ADL performance similarly.
- The relative reliability of the FES(S) instrument as determined by intraclass correlation
coefficients appears reasonably good. The adequacy of the FES(S) and its subdivisions FES(S) PADL and IADL as coherent instruments is supported by an acceptable internal consistency.

• Self-efficacy in task performance was more closely related to motor function, balance, ambulation and ADL in the elderly stroke patients than in younger stroke patients, indicating that ADL-related self-efficacy may be a particularly important cognitive control system in older stroke patients.

• The FES(S) scale is a responsive instrument, as this scale was just as responsive as BBS and FMIB in detecting changes during the early observation period (admission to discharge) and during the total observation time (admission to 10-month follow-up).

• In a geriatric sample of stroke patients irrespective of age, significant improvements were made from admission to discharge in self-efficacy, motor function, balance, ambulation and ADL.

• In comparison with observer-based balance measures, FES(S) at discharge was the most powerful predictor of ADL performance 10 months after the onset of stroke.

Implications and future directions

• The two different methods of physiotherapy used in the younger stroke patients of this study, partly including well controlled walking training, appear to be equally beneficial. Moreover, balance improves regardless of age.

• Assessment and treatment of self-efficacy seem relevant in stroke rehabilitation, as self-efficacy appears to be an important predictor of level of activity/participation after discharge.

• FES(S) is a statistically acceptable instrument which is easy to use in clinical practice and only marginally time-consuming, but it requires a communicable patient.

Further research is needed to determine whether implementation of strategies designed to influence perceptions of personal efficacy in stroke rehabilitation enhances the patients’ activities and participation.
ACKNOWLEDGEMENTS

This thesis has been made possible through the inspiring support and shared knowledge of many people in different clinical and teaching settings. To everyone who in any way has contributed to this work, I would like to express my sincere appreciation. In particular, I would like to express may gratitude to the following persons:

First, I would like to express my sincere gratitude to all patients and their relatives, without whose participation, interest and patience this study would not have been accomplished.

Professor Axel R Fugl-Meyer, my co-author and main scientific supervisor, for believing in me from the beginning, for generously guiding and accompanying me on this journey of multitudinous experiences and for his unfailing confidence in my ability, his knowledge, creative criticism, enthusiasm, and patience.

Associate Professor Birgitta Lindmark, my co-author and second tutor, for generously sharing her scientific knowledge, and for offering support and advice from the very beginning, for always having time for quick consultations, for stimulating discussions and for her great interest in my work.

Professor Gunnar Grimby and Associate Professor Jane Carlsson, for providing me with the opportunity to participate in the multicentre study and for constructive comments on manuscripts.

Lena Nilsson, my co-author, for fruitful and inspiring discussions.

Anna Hedin, my former tutor and room-mate, for her enthusiasm in the very beginning when I first discussed my research ideas, and for valuable help, encouragement and friendship.

Birgit Wahlberg my co-author, Mia Andersson, Bosse Kälvestrand, Ylva Åkerblom my colleagues at the geriatric rehabilitation department, for their valuable assistance and collaboration in the recruiting of patients to the geriatric rehabilitation study.
Eva Stafring, Åsa Liljenäs, Margareta Bouvin, physiotherapist at the Department of Rehabilitation Medicine, Academic Hospital, Uppsala for being responsible for the treatment of the patients, and for their willingness to share their experiences of the BWS in stroke rehabilitation.

Maud Marsden, for excellent linguistic revisions.

Kerstin Fugl-Meyer, Lena Jemtå, Björn Johansson, Katarina Laurell, Roland Melin, Inger Sjöberg, Rickard Stensman, Leif Stjernberg and Katarina Öberg at the Department of Neuroscience, Rehabilitation Medicine, for their interest, valuable discussions and cheerful support throughout the years.

All co-workers at the Department of Neuroscience, Section of Physiotherapy: Helena Ekbrink, Margareta Emtner, Pia Fredlund, Theodora Fredriksson, Anna Hartman, Marianne Hennig, Mats Hjortberg, Sören Jonasson, Birgit Kruse, Christel Lagerström, Signe Lind, Ingvar Ljungqvist, Cathrin Martin, Mia Pless, Maria Sandborgh, Eva Sjöberg, Carin Tegenfeldt, Gerd Tegler, Lena Zetterberg and Pernilla Åsenlöf-Fors, for positive support.

My family - my husband Lars and my sons Pontus, Johan and Fredrik - for just being there, for love and support and for being at hand to help me with their computer expertise.
My sisters and their families for their encouragement and enjoyable, relaxing friendship.
My mother Margit, for always being a strong female model.

This work was supported by grants from the Vårdal Foundation, The Swedish Stroke Association, The National Swedish Board of Health and Welfare, The Greta and Einar Asker Foundation, The Swedish Association of Neurologically Disabled (NHR), Rune and Ulla Almlöv’s Foundation, Rune Eander’s Foundation and the Swedish Association of Registered Physiotherapist (section of neurology)
REFERENCES

32. Currier DP. Elements of research in physical therapy. 3rd ed. Baltimore: Williams & Wilkins; 1990.


Maki BE, McIlroy WE. The role of limb movements in maintaining upright stance: the ‘change in support’ strategy. Phys Ther 1997; 77: 488-507.


Errata

There are several wrong numbers assigned to references in the text and in the list of references:

Introduction p. 23: The physiotherapy approached used followed the principles of the MRP 26 (not 28)
Introduction p. 43: However, in agreement with Wade et al 189 (not 191).
Introduction p. 48: The scale is widely used and has recently been tested for… 198 (neither 203 nor 197).
Introduction p. 48: …, and for the the Action research test van der Lee et al 184 (not 189).


Paper III p. 58, second column should be: For evaluation two types of scores were used in the motor part of the F-MSAI/FMI (not FMIB).

Paper III p. 60: FES(S) total median score at admission should be 57 (not 60).
  FES(S) total median score at discharge should be 120 (not 107).
  Motor function median score at admission should be 29 (not 20).

Paper IV Table 1: FES(S) total median score at admission should be 57 (not 61).
  FES(S) total median score at discharge should be 120 (not 107).
  Motor function median score at discharge should be 52 (not 53).

Table 5: Mean baseline score change for FES(S) IADL should be 0.8 (not 1.4).