DETERMINANTS OF OUTCOME IN GERIATRIC REHABILITATION: THE GRAMPS STUDY

MONICA VAN EIJK

'Man op het water'

Gedreven door de tijd
loop ik op het water
en loop ik steeds op water
op weg naar de eeuwigheid

MIX
Papier van verantwoorde herkomst
FSC® C004472

The research presented in this thesis was performed by a researcher of the department of Primary and Community Care, Centre for Family Medicine, Geriatric Care, and Public Health, Radboud University Nijmegen, Medical Centre, the Netherlands, in collaboration with the department of Rehabilitation, Nijmegen Centre for Evidence Based Practice, Radboud University Nijmegen, Medical Centre, the Netherlands.

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DETERMINANTS OF OUTCOME IN GERIATRIC REHABILITATION

THE GRAMPS STUDY

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Promotoren	Prof. dr. RTCM Koopmans Prof. dr. ACH Geurts
Copromotoren	Dr. SU Zuidema (UMC Groningen) Dr. H van der Linde
Manuscriptcommissie	Prof. dr. GP Westert Dr. HF de Leeuw Prof. dr. WP Achterberg (LUMC)

Voor mijn ouders,
Voor Sem,

Volo et Valeo

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GENERAL INTRODUCTION

GENERAL INTRODUCTION

Geriatric patients are characterized by the fact that they often suffer from multiple diseases that tend to increase in number with increasing age. [1] Due to the growing number of elderly in the Western world, combined with the rising of age and better treatment of acute and chronic illness, the number of elderly with multi-morbidity will rise as well. Multimorbidity, in turn, has great impact on a patient's physical as well as cognitive and social functioning, which is related to disabling impairments. [2-4] Sometimes these impairments will lead to temporary or permanent frailty. Frailty is a distinct, but partially overlapping concept with multimorbidity; multimorbidity predisposes to frailty, while frailty itself is predictive of disability. [5, 6] In the Netherlands, e.g. after stroke or major lower limb amputation, elderly with a low level of physical endurance due to multimorbidity and related disability are usually not admitted to high-intensity rehabilitation programs provided in rehabilitation centers. These patients are more often indicated for low-intensity rehabilitation programs in so-called skilled nursing facilities (SNFs) of nursing homes.

Geriatric rehabilition

Geriatric rehabilitation is a relatively new area of interest in the care for elderly people. The most commonly used definition is 'A multidisciplinary set of evaluative, diagnostic, and therapeutic interventions whose purpose is to restore functional ability or enhance residual functional capability in elderly people with disabling impairments'. [7] This definition underlines the importance of disability, besides age. Although we do not know much of recovery patterns, we know that age alone is not a good parameter for outcome. Geriatric patients are different from younger patients that need rehabilitation in many respects. Besides having multimorbidity, their disabilities are usually multi-causal. Pre-existent physical limitations are not only caused by medical reasons, but also by physiological ones, such as sarcopenia. [8] Geriatric patients often have associated cognitive problems that compromise the ability to learn new skills. [2] An interdisciplinary comprehensive geriatric assessment is necessary to completely map a geriatric patient's disabilities and treatment options. On the other hand, geriatric patients do not differ from younger individuals in their recovery potential during rehabilitation. [9]

Geriatric rehabilitation in the Netherlands

In the Netherlands, the field of geriatric rehabilitation has emerged within nursing homes. [10] In the nineties, literature on Dutch geriatric rehabilitation is mostly descriptive. Thirty-three percent of all patients admitted to a nursing home in 1991 were discharged to a less-intensive care facility or home, with 63% of them being (almost) independent in activities of daily living (ADL). [11] The median length of stay at an undifferentiated ward (patients admitted for rehabilitation care and residential care in the same ward) in a single nursing home was

15 weeks, with a discharge percentage of 47. [10] Of the patients that were discharged from the nursing home, 64% were able to walk with or without a walking aid. The remainder was mainly dependent on a wheelchair for their mobility.

With the differentiation of rehabilitation wards within nursing homes, and the importance of concentration of knowledge and care, nursing homes became an important part of integrated stroke services in the Netherlands. In these stroke services, different organizations are involved in the provision of appropriate care for patients in each phase after stroke. Patients that were indicated for low-intensity stroke rehabilitation provided in SNFs were usually older than 65 years, had multiple morbidities affecting exercise tolerance and requiring medical care, and were expected to be discharged within weeks or months. [12] The organized care delivered in stroke services resulted in improved quality of care [13] and a high probability of discharge to the home situation (82% within 6 months after admission). [12]

After the development of SNFs for stroke rehabilitation, the focus expanded to elderly with other diagnoses. For instance, collaboration between the orthopedic departments of (general and academic) hospitals and nursing homes led to the development of guidelines for different orthopedic conditions in geriatric patients, such as for hip fracture [14], elective orthopedic joint surgery, and amputation. [15] Some SNF's specifically devoted themselves to these orthopedic diagnose categories.

Currently, geriatric rehabilitation in the Netherlands is divided into five categories (total number of patients in the year 2007 admitted for rehabilitation in Dutch SNFs): [16] trauma (n=7.089), elective joint replacement of knee or hip (n=5.302), stroke (n=6.494), amputation (n=390), and other reasons for rehabilitation such as prolonged hospital stay after major surgery or recurrent hospitalization because of pulmonary diseases (n=8.193). In all cases, an elderly care physician is involved as the coordinator of the rehabilitation process. Furthermore, the elderly care physician takes care of the concomitant chronic diseases and prevents and treats complications. In 99% of the cases, a physiotherapist is involved to enhance mobility and to increase the physical condition of patients. Other professionals that are involved when needed (especially for stroke rehabilitation) are an occupational therapist 67%, a social worker 39%, a psychologist 38%, and a speech-language therapist 25%. [16] Almost all Dutch SNFs have consulting physiatrists who regularly visit patients during their rehabilitation.

A recent development stresses the need of scientific evaluation of the characteristics and outcome of geriatric rehabilitation. Nursing homes receive funding through individual care budgets (Zorg Zwaarte pakketten) that are divided into 10 budgets, all paid from the exceptional medical expenses act (AWBZ). Because geriatric rehabilitation is of relatively short duration compared to the residential care in nursing homes, a distinct reimbursement system is of great importance to smoothly transfer patients from hospital via SNFs to their homes. For this reason, the Dutch government has decided to re-allocate the reimbursement of geriatric rehabilitation in SNFs from the exceptional medical expenses act (AWBZ) to the health insurance act. With this change in the system, a challenge emerges, because there is not much literature about 'best care practices' in geriatric rehabilitation. As a consequence, it is difficult to substantiate the costs and benefits of geriatric rehabilitation provided in SNFs.

Predictors of outcome of geriatric rehabilitation

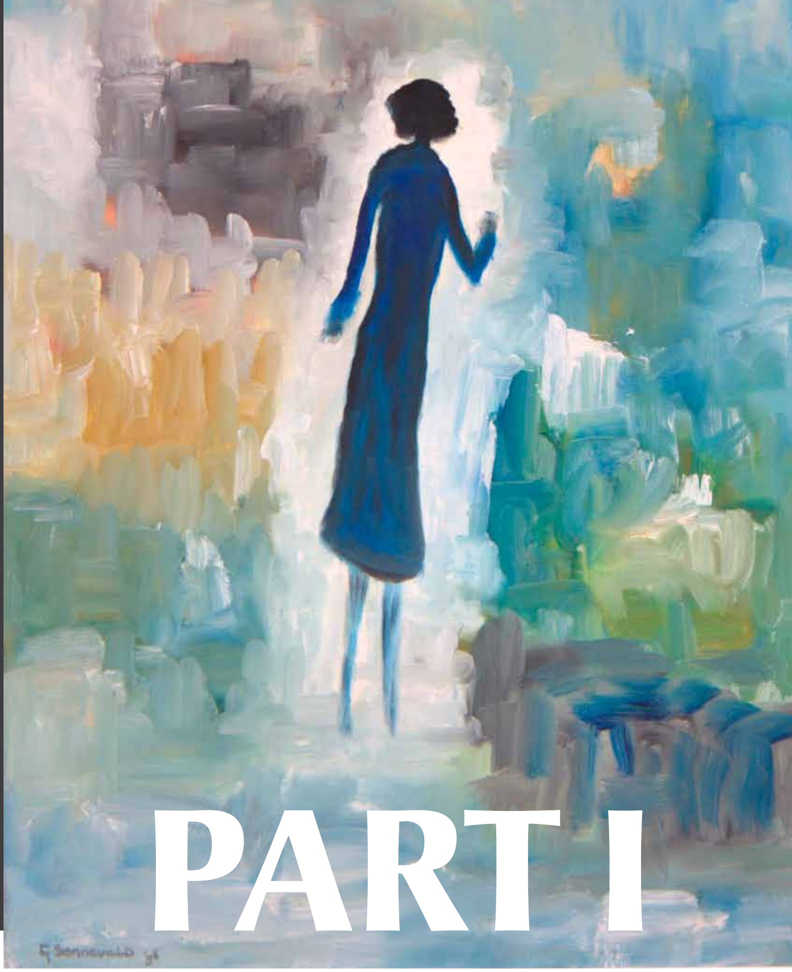
For adequate patient selection, it is important to understand more about expected outcomes of geriatric rehabilitation and factors associated with successful outcome. Preferably, the prognosis for functional recovery and rehabilitation outcome should be made at the start of the rehabilitation process. Age and initial functional abilities [17-20] as well as cognitive performance [20-24] are important predictors of rehabilitation outcome. The specific determinants associated with outcome of geriatric rehabilitation are currently not known. Studies in the literature predicting stroke rehabilitation outcome or outcome after rehabilitation for major lower limb amputation usually involve younger, more vital, patients in rehabilitation centers. These results may not apply to the geriatric patients that usually have low physical endurance. In this thesis, patients with stroke and patients with major lower limb amputation are the two target groups to study geriatric rehabilitation. Although the functional consequences of these disorders are very different, they have been investigated most often in the literature on geriatric rehabilitation and they constitute two of the five most important categories of geriatric rehabilitation in the Netherlands. In addition, both types of disorder share a common (vascular) etiology in elderly people.

Aim and outline of the thesis

A multicenter study was conducted in the Southern part of the Netherlands with the aim of investigating (the determinants of) the rehabilitation outcome in geriatric patients who had been admitted to one of 15 participating SNFs after stroke or major lower limb amputation: the Nijmegen GRAMPS study (Geriatric Rehabilitation in AMPutation and Stroke). The main research questions in this thesis are:

- What is the functional outcome of geriatric patients who are admitted to SNFs for rehabilitation after stroke or major lower limb amputation in the Netherlands?
- What determinants are independently associated with rehabilitation outcome in terms of discharge to an independent living situation and functional independence at discharge?
- What, in particular, is the influence of multi-morbidity on rehabilitation outcome?

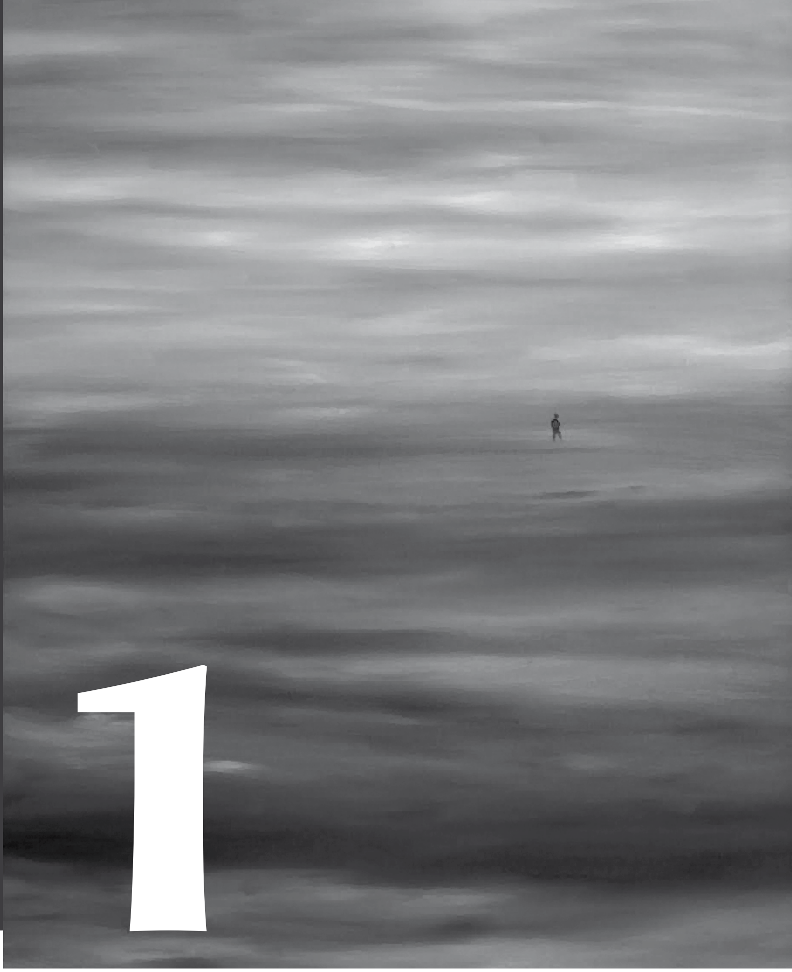
This thesis is divided into two parts; part I (chapters 1-3) covers geriatric rehabilitation after stroke and part II (chapters 4-6) focuses on geriatric rehabilitation after major lower limb amputation. In chapter 1 the design of the stroke study is outlined. This chapter also refers to the influence of neuropsychiatric symptoms on rehabilitation outcome, the social factors involved in the rehabilitation, and the quality of life of patients who are successfully discharged after rehabilitation. However, these latter issues are addressed in a companion thesis by Bianca Buijck. Chapter 2 describes the determinants of rehabilitation outcome in geriatric patients with stroke. Both predictors of successful discharge as well as predictors of functional status at discharge are determined and discussed. In chapter 3 the determinants of postural control on admission in the SNF are analyzed. Part II starts with an unpublished outline of the study design for investigating rehabilitation after major lower limb amputation. Chapters 5 and 6 cover the determinants of successful discharge and functional outcome at discharge in this group, including the determinants of prosthetic use. Finally, these findings are reviewed in the general discussion.



PART I

GERIATRIC REHABILITATION AFTER STROKE

'Vrouw naar het Licht'



1

GERIATRIC REHABILITATION OF STROKE PATIENTS IN NURSING HOMES: A STUDY PROTOCOL

Monica Spruit- van Eijk, Bianca I Buijck, Sytse U Zuidema, Frans LM Voncken, Alexander CH Geurts, Raymond TCM Koopmans.

BMC Geriatrics. 2010 Mar 27; 10:15.

ABSTRACT

Geriatric patients are typically underrepresented in studies on the functional outcome of rehabilitation after stroke. Moreover, most geriatric stroke patients do probably not participate in intensive rehabilitation programs as offered by rehabilitation centers. As a result, very few studies have described the successfulness of geriatric stroke rehabilitation in nursing home patients, although it appears that the majority of these patients are being discharged back to the community, rather than being transferred to residential care. Nevertheless, factors associated with the successfulness of stroke rehabilitation in nursing homes or skilled nursing facilities are largely unknown. The primary goal of this study is, therefore, to assess the factors that uniquely contribute to the successfulness of rehabilitation in geriatric stroke patients that undergo rehabilitation in nursing homes. A secondary goal is to investigate whether these factors are similar to those associated with the outcome of stroke rehabilitation in the literature.

Methods This study is part of the Geriatric Rehabilitation in AMPutation and Stroke (GRAMPS) study in the Netherlands. It is a longitudinal, observational, multicenter study in 15 nursing homes in the Southern part of the Netherlands that aims to include at least 200 patients. All participating nursing homes are selected based on the existence of a specialized rehabilitation unit and the provision of dedicated multidisciplinary care. Patient characteristics, disease characteristics, functional status, cognition, behavior, and caregiver information, are collected within two weeks after admission to the nursing home. The first follow-up is at discharge from the nursing home or one year after inclusion, and focuses on functional status and behavior. Successful rehabilitation is defined as discharge from the nursing home to an independent living situation within one year after admission. The second follow-up is three months after discharge in patients who rehabilitated successfully, and assesses functional status, behavior, and quality of life. All instruments used in this study have shown to be valid and reliable in rehabilitation research or are recommended by the Netherlands Heart Foundation guidelines for stroke rehabilitation.

Data will be analyzed using SPSS 16.0. Besides descriptive analyses, both univariate and multivariate analyses will be performed with the purpose of identifying associated factors as well as their unique contribution to determining successful rehabilitation.

Discussion This study will provide more information about geriatric stroke rehabilitation in Dutch nursing homes. To our knowledge, this is the first large study that focuses on the determinants of success of geriatric stroke rehabilitation in nursing home patients.

BACKGROUND

According to the World Health Organization, 15 million people worldwide suffered a stroke in 2004. [25] It has been reported that the mean stroke incidence rate in Western countries is 94 per 100.000 person years. [26] Although men are more often affected than women due to a younger age of onset, this gender difference becomes smaller with increasing age. [27] Stroke incidence typically increases with age and, due to the ageing of the population, stroke incidence rates are expected to rise. High age and low level of physical endurance, due to significant co-morbidity, are characteristic of the geriatric stroke population. Although rehabilitation after stroke is an important activity in many rehabilitation centers worldwide, most geriatric stroke patients are probably not admitted to these centers and, thus, do not participate in intensive rehabilitation programs. [28] These patients may be referred to nursing homes or skilled nursing facilities (SNF) that provide adapted rehabilitation programs combined with residential care, whereas others may not receive any formal type of multidisciplinary rehabilitation at all. As a result, geriatric stroke patients are greatly underrepresented in outcome studies and factors associated with the successfulness of their rehabilitation are largely unknown.

Few studies have dealt with the influence of comorbidity and age on the outcome of stroke rehabilitation. Atalay and Turhan [29] found that elderly stroke patients (older than 65 years of age) were less likely to be successfully rehabilitated despite similar Functional Independence Measure (FIM) scores on admission, compared to patients younger than 65 years. Yet, comorbidity and age were not associated with prolonged length of stay in the rehabilitation center. In the same vein, Fischer et al. [30] found that comorbidity and age did not uniquely contribute to predicting length of hospital stay. On the other hand, there is evidence that comorbidity and age are important factors in determining functional outcome after stroke. [31] Several additional studies have emphasized the importance of age for functional outcome after stroke, but estimates of the true impact of age seem to vary greatly. Whereas some studies reported a relatively small influence of age, [32, 33] other studies found that very old age, defined as 85 years and older, was a consistently strong predictor of poor outcome. [34]

Interestingly, Teasell et al. [28] have reported that rehabilitation in 'lower band' patients recovering from severe stroke, who were considered inappropriate for conventional inpatient rehabilitation programs, may still be quite successful in terms of gain in independency of self-care and ambulation. However, although the patients were on average 72 years of age, this study did not specifically focus on geriatric rehabilitation and did not examine the influence of comorbidity or age on rehabilitation outcome. Several other studies have shown that a substantial number of stroke patients that receive rehabilitation in SNFs or nursing homes can be successfully discharged to the community. [12, 35, 36] The probability of discharge greatly depends on individual rehabilitation potential, which is related to stroke severity and physical capacities. Besides, it appears that admission to SNFs increases the likelihood of successful rehabilitation in terms of discharge to the community. [35, 36]

In general, many studies have investigated the clinical, biological and demographic factors associated with the outcome after stroke. [17, 28-34, 37-47] A large number of such factors has been associated with the outcome after stroke rehabilitation (Table 1), but probably many of these factors are interrelated. This implicates that the unique contribution of these factors to stroke outcome, corrected for association with other factors, still has to be determined in order to be of value for clinical prediction in daily practice. In short, initial disability and age seem to be the most promising predictors of long-term activities of daily living (ADL) and discharge destination after rehabilitation.

Against this background, the primary goal of this study is to assess the factors that uniquely contribute to the successfulness of rehabilitation in geriatric stroke patients that undergo rehabilitation in nursing homes. Functional outcome is primarily assessed by discharge to an independent living situation and, secondarily, by various functional scales. A secondary goal is to investigate whether the factors that are uniquely associated with successfulness of rehabilitation in this geriatric population are similar to those associated with the outcome of stroke rehabilitation in the literature. To this end, we have set up a multicenter study in 15 nursing homes in the Southern part of the Netherlands. All participating nursing homes are selected based on the existence of a specialized stroke rehabilitation unit and the provision of dedicated multidisciplinary care. To our knowledge, this is the first study that focuses on the determinants of success of geriatric rehabilitation in nursing home patients.

Table 1: Factors associated with stroke outcome disability and discharge destination in the literature

Outcome	Factors associated with outcome
ADL scores	
FIM	- Initial FIM, age [32, 33]
BI	- Initial BI [37] - Initial NIHSS, age, premorbid disability, DM, infarct volume [38] - Trunk Impairment Scale, static sitting balance [39]
Discharge destination	- Age, incontinence [41] - initial FIM, age [40] - premorbid social support, FIM bowel, age, CMSA leg, type of premorbid accommodation [42] - initial MMSE, premorbid living with relatives [32] - discharge BI, LOS, age [43] - Initial FIM, age, male gender [28] - swallowing disorder [44]

FIM functional independence measure, BI barthel index, NIHSS national institute of health stroke scale, DM diabetes mellitus, CMSA Chedoke-McMaster stroke assessment, LOS length of stay

METHODS

Study design

This prospective study is part of the Nijmegen Geriatric Rehabilitation in AMPutation and Stroke (GRAMPS) study and comprises three measurements. Baseline data (T0) are collected within two weeks after admission to the nursing home. Patients and disease characteristics, functional status, cognition, behavior and caregiver information are registered (Table 2). The first follow-up (T1) is at discharge from the nursing home, and focuses on functional status and behavior. Successful rehabilitation is defined as discharge from the nursing home to an independent living situation within one year after admission. The second follow-up (T2) is at three months after discharge in patients who rehabilitated successfully and focuses on functional status, behavior and quality of life.

Data collection has started in January 2008, and will end in July 2010.

Table 2: research instruments

	Instrument	T0	T1	T2
Patient	Patient characteristics	X		
	Co-morbidity: Charlson Index	X		
	Medication list	X	X	
Functional status	Motricity index Arm and Leg*	X		
	Trunk control test*	X		
	Trunk impairment scale	X		
	Barthel index*	X	X	X
	Social activity: Frenchay activities index*	X		X
	One leg standing balance	X	X	X
	Frenchay arm test*	X	X	X
	Berg Balance scale*	X	X	X
	Functional Ambulation Categories*	X	X	X
	10m walking speed*	X	X	X
	Water swallowing test*	X		
Cognition	Mini Mental State Examination	X		
	Star cancellation test	X		
	Hetero anamnestic cognition test	X		
	Apraxia test	X		
	Communication: SAN score*	X		
Behavior	Neuropsychiatric inventory	X	X	X
	Neuropsychiatric inventory Nursing Home	X	X	
	Global depression scale 8	X	X	X
Quality of life	RAND 36 version 2			X
Caregivers	Social situation	X	X	X
	COOP WONCA	X		
	Caregiver strain index*			X

* test recommended by the Netherlands Heart Foundation SAN stichting afasie Nederland (Dutch Aphasia Foundation), COOP WONCA The Dartmouth COOP Functional Health Assessment Charts / WONCA

Patients

All patients who are consecutively admitted to one of the specialized rehabilitation wards of the 15 participating nursing homes are eligible to participate in this study. No other inclusion criteria were applied. Inability to give informed consent is an exclusion criterion. All participating nursing homes collaborate in the Nijmegen University Nursing Home Network of the Radboud University Nijmegen Medical Center. After admission patients are provided with oral information from the treating physician or nurse. In addition, all patients and their caregivers receive written information about the study. The patients indicate themselves whether they are interested to participate. The attending physician judges the legal capacity of his/her patients. In the case of doubts he/she consults the caregivers. In addition, the GRAMPS website (www.gramps.nl) provides extra information for interested patients and their caregivers.

Ethical approval

This research protocol was presented to the medical ethics committee of the district Nijmegen- Arnhem, the Netherlands. Ethics approval was not deemed necessary, because the design is observational and because legally incapable patients are excluded.

Assessment instruments

Data are collected by the multidisciplinary teams working in the participating nursing homes. Each discipline has the obligation to perform specific assessments. The selected outcome measures have been selected based on previously established reliability and validity or based on recommendations by the Netherlands Heart Foundation guidelines for stroke rehabilitation (table 2). [48]

Patient characteristics

General patient characteristics as well as disease characteristics, medication lists, and information about comorbidity, using the Charlson Index (CI), are registered. The CI comprises 19 categories of diagnoses from the International Classification of Diseases, (9th revision Clinical Modification ICD-9CM) and is based on a set of risk factors for one-year mortality risk. [49] The CI contains a weighted index for each disease at which the score is a significant predictor of one-year survival. One-year mortality rate for the different scores are: "0" 12%, "1-2" 26%, "3-4" 52% and ">5" 85%.

Functional status

The Barthel Index (BI), modified by Collin et al. in 1988, [50] measures dependency in activities of daily living (ADL). The BI is a valid and reliable instrument in stroke research. [50-53] The total score ranges from 0-20, with 20 representing complete functional independence. The Frenchay Activities Index (FAI) is used for assessment of extended ADL. The FAI [54] scores the actual activities undertaken by patients and can be divided in three domains: domestic housework, indoor activities and outdoor activities. The 15-item questionnaire is a reliable and valid instrument for measuring functional outcome in stroke patients. [55, 56] Even proxies give reliable information about FAI items. [57, 58]

The Frenchay Arm Test (FAT) is used to evaluate arm function after stroke. The patient is asked to perform five activities with his affected arm, for which he receives one point if successfully complete. The FAT is a valid and reliable instrument for use in stroke research. [59]

The Motricity Index [60] is used to evaluate motor impairment of the limbs. Six movements, divided in arm and leg movements, are observed. Three scores can be measured: arm score, leg score and side score. Both arm and leg scores have good criterion validity and are reliable if used by different observers. [61-63]

Item three of the Trunk Control Test (TCT) is used to assess static sitting balance: sitting in a balanced position on the edge of the bed for at least 30 seconds, with the feet above the ground. The Trunk Impairment Scale (TIS), developed by Verheyden and colleagues, [64] evaluates motor impairment of the trunk after stroke. TIS takes movement and coordination as well as static sitting balance into account. The TCT and TIS both show good validity and reliability. [62, 64]

The Berg Balance Scale (BBS)is an ordinal 14 item scale (0-56 points) developed by Berg et al. [65] to measure balance in stroke patients. Validity and reliability of the BBS is good, [66-69] however the scale is not suitable for patients with very severe impairments, who cannot maintain a balanced sitting position. [66] Ceiling effects have also been described by Mao [66] at 90-180 days post stroke. The one- leg- standing balance test, first used by Schoppen et al. is used to assess standing balance on the unaffected leg. [70] The Functional Ambulation Categories (FAC) [71] is a measure of the (in)dependency of gait. The FAC is an ordinal six-point scale with 0 indicating total dependency for walking and 5 indicating independent walking. The use of a walking device is allowed. Berg et al. found high correlations between the BBS and FAC scores. [65]

The Ten-Meter-Walking-Speed test (TMWS-test) times the walking speed along a distance of ten meters and can be performed at a comfortable or maximum walking speed. [72] Because the comfortable walking speed seems to be more responsive to functional recovery after stroke [73] and because the maximum walking speed can be estimated by multiplying comfortable walking speed by 1.32 [74], the TMWS- test is performed at comfortable walking speed, only by patients with a FAC score of 3 or higher.

The water swallowing test [48] is a simple bed-side test and resembles the water swallowing test proposed by Smithard and coworkers. [44] After drinking three spoons of water safely, half a glass of water is given to the patient. The patient fails in case of signs of choking. The speech therapist assesses food consistency after the patient safely drinks the water.

Cognition

The Mini- Mental- State- Examination (MMSE), developed by Folstein and McHugh, [75] is a screening instrument for cognitive impairment, and has a fair reliability and construct validity, with a high sensitivity for moderately-severe cognitive impairment and a lower sensitivity for mild cognitive impairment. [76] It comprises items testing orientation, attention, memory, language and constructive abilities. Bottom and ceiling effects have been described. [77] An important bias in using the MMSE in stroke research is the extensive use of language, which leads to unreliable results in aphasic patients. For this reason, we will not use the MMSE in patients with severe aphasia. The Hetero-Anamnestic- Cognition list (HAC list), derived from the MMSE by Meijer in his AMDAS study, [78] is used to explore the presence of premorbid cognitive disabilities. The proxy, preferably a partner if present, is asked a few simple 'yes' or 'no' questions concerning orientation, attention and calculation, language, memory, and executive skills. Severity is judged on the basis of need of assistance or professional therapy required.

The Star Cancellation Test (SCT), an item of the Behavioral Inattention Test (BIT), [79] is a screening instrument for detecting unilateral visuospatial neglect. The SCT consists of 52 large stars, 13 characters, 10 words, and 56 small stars. All small stars are to be eliminated. The researcher gives a demonstration by crossing out the two small stars in the middle. The cut-off point is 52. [79] Rough scores can be used to interpret the outcome of the SCT, rather than the visual lateralization scores. [80] There is sufficient evidence for good validity of the SCT. [81-83]

Van Heugten et al. developed a diagnostic tool for apraxia in stroke, based on an existing instrument. [84] This Apraxia test, differentiating between apraxia and non-apraxia, involves demonstration of object use and imitations of gestures. It has good validity and reliability. [84, 85]

The SAN (Stichting Afasie Nederland = Dutch Aphasia Foundation) score is used to quantify communicative impairment in stroke patients and is part of the Aachen Aphasia Test (AAT). [86] The SAN score is an ordinal 7-point scale with '1' indicating no communication possible and '7' indicating normal language skills. [87]

Behavior

The NeuroPsychiatric Inventory (NPI), originally developed for dementia patients, gives a global impression of behavioral problems and is applicable in other patient groups as well. [88] The NPI comprises 12 categories of problem behaviors: delusions, hallucinations, agitation/aggression, depression, anxiety, euphoria, disinhibition, irritability/lability, apathy, aberrant motor activity, sleeping disorder and eating disorder. If the interviewed person, either a nurse in the NPI-Nursing Home (NPI-NH) version or a partner or close relative in the NPI, positively answers the screening question, both frequency and severity (only in the NPI-NH version) are determined. The NPI closes each category with enquiring about emotional burden. The NPI is a valid and reliable instrument, [88] has been translated into Dutch, and has previously been used in stroke research. [89, 90]

The eight item version of the Geriatric Depression Scale (GDS-8) is a shortened patient-friendly test derived from the GDS-15 version, and has been developed specifically for the nursing home population. [91] It indicates the presence of depression at a cut-off of 3 out of 8.

Quality of life

The RAND- 36, developed to measure health related quality of life in chronically ill patients, comprises eight dimensions: physical functioning, role limitations due to physical health problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems, and general mental health. It also contains an additional item about perceived health change. [92] The item scores of all dimensions need to be recoded according to the RAND health sciences program standards. [93] The RAND-36 has been translated into Dutch by van der Zee et al., and was found to be a valid, reliable, and sensitive measurement of general health. [94]

Caregivers

The Dartmouth COOP Functional Health Assessment Charts / WONCA (COOP/WONCA) subscales [95-97] physical fitness, daily activities, feelings and overall health are used to measure proxy's functional status. Each subscale consists of a short title and an illustrated five-point response scale: scores 16 and up are indicative of high strain. [78]

The Caregiver Strain Index (CSI) is only used after discharge from the nursing home, when participation level of the patient plays a key role. [98] Optimal reintegration reduces the experienced strain of the caregivers. The CSI consists of 13 'yes' and 'no' questions, is an easy used instrument to identify strain, and shows validity. [99] A score of 7 or more positive responses indicates a high level of strain. [100] The CSI has been used in research on various diseases. [101-103]

Data analysis

All data is processed using the Statistical Package for Social Science 16.0 (SPSS 16.0). Different techniques will be used to analyze the data, depending on the research question.

- Descriptive analysis will be used for general patient characteristics, disease characteristics, treatment, successfulness of rehabilitation, and functional outcomes.
- Univariate analyses, parametric as well as non-parametric, will be performed for identifying the demographic and clinical factors that are associated with successful rehabilitation ($p<0.1$).
- Associated factors will then be tested in a multivariate logistic regression analysis to determine their unique contribution and overall explained variance of successfulness of rehabilitation.

Power

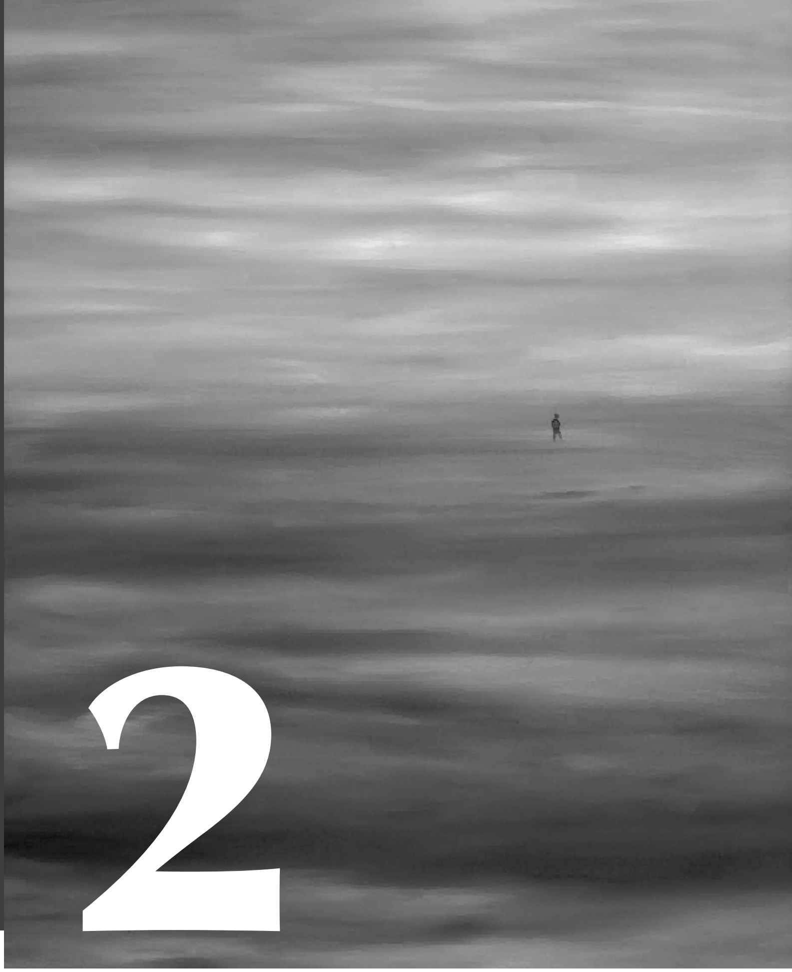
The required sample size was estimated using the rule of thumb according to Peduzzi et al.: [104] At least 10 patients per factor in the smallest group, in the case of a dichotomous outcome. Based on our experience, approximately 35% of the stroke patients, admitted to nursing homes for rehabilitation, cannot be discharged to an independent living situation. When testing a maximum of seven factors in the multivariate model, 70 patients need to be included in the smallest group (35%). Consequently, a total of 200 stroke patients will be included.

DISCUSSION

To our knowledge, this is the first large study that focuses on the determinants of success of geriatric stroke patients admitted to nursing homes. It will provide more detailed information about the factors that are uniquely associated to the successfulness of geriatric stroke rehabilitation and that can, thus, be used in building a clinical prediction model of discharge destination from nursing homes.

All selected outcome measures have proven to be reliable and valid, or are recommended by the Netherlands Heart Foundation.

Because legally incapable patients are excluded from this study, its external validity may be slightly affected. Therefore, general patient characteristics of the excluded patients are registered and compared to those of the included patients. Besides age, length of stay in the nursing home, and discharge destination are recorded to compare both groups. This multicenter research uses multidisciplinary teams to collect the data over a period of two-and-a-half years and, thus, may suffer from some measurement inaccuracies. To minimize such inaccuracies, over 90 people working in 15 Dutch nursing homes received the same instructions about performing the outcome measures during collective meetings before the start of the study. To ensure the quality of data collection during the study, each nursing home has 2 to 3 specially assigned professionals who maintain contact with the main researchers. In addition, a newsletter is provided every 6-8 weeks to keep everybody involved, informed, and motivated with regard to the progress of the study.



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DETERMINANTS OF REHABILITATION OUTCOME IN GERIATRIC PATIENTS ADMITTED TO SKILLED NURSING FACILITIES AFTER STROKE:A DUTCH MULTICENTER COHORT STUDY

Monica Spruit- van Eijk, Sytse U Zuidema, Bianca I Buijck, Raymond TCM Koopmans, Alexander CH Geurts.

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ABSTRACT

Objective To identify important demographic, clinical and functional determinants of successful discharge of geriatric patients from skilled nursing facilities (SNFs), particularly the role of multi-morbidity.

Design Prospective cohort study with data collection at baseline and at discharge.

Setting Fifteen SNFs in the Netherlands.

Participants Of 378 eligible patients, 186 were included.

Methods Multi-disciplinary teams recorded demographic and disease characteristics, as well as functional status, cognitive functioning, and multi-morbidity on admission. The study outcomes were discharge to an independent living situation within 1 year of admission, and functional status at discharge (Barthel Index).

Results Of the included 186 patients, 175 were followed up. Of these patients, 123 (70%) were successfully discharged. High Berg Balance Scale (BBS) and Star Cancellation Test (SCT) scores independently contributed to 48% of the variance of functional status at discharge, while low age, high BBS and SCT scores were independently related to successful discharge, explaining 33% of the variance. Multimorbidity was not an independent determinant of rehabilitation outcome.

Conclusions Geriatric patients admitted for 'low intensity' rehabilitation in SNFs after stroke appeared to have a fair prognosis for being successfully discharged. Postural control was an important determinant of both outcome measures.

BACKGROUND

In stroke patients, it has been shown that age and disability on admission are the most important determinants of rehabilitation outcome [32, 40, 42, 105]. However, most studies have been conducted in rehabilitation centres and included relatively young (mean age 68-72 years) stroke survivors with good exercise tolerance. As a consequence, the results of these studies may not apply to elderly patients with multi-morbidity that are typically admitted to skilled nursing facilities (SNFs) of nursing homes.

Only few studies have assessed the influence of multi-morbidity on rehabilitation outcome after stroke [31, 106-112]. Although several authors have reported such a relationship [31, 106-110, 112], a truly independent contribution of multi-morbidity to functional outcome was not always found [31, 106, 107, 109, 112]. Furthermore, many studies included relatively young stroke patients (≤70 years on average) [31, 106, 107, 109, 112]. The only study [113] that assessed multi-morbidity in patients older than 70 years (mean age 78 years) had a fixed follow-up of 6 months, irrespective of whether patients had ended their rehabilitation, and found that multi-morbidity was not independently associated with rehabilitation outcome. Because in the latter study only patients with a first-ever stroke were enrolled that were non-disabled before their stroke, the results cannot be generalised to all elderly patients with stroke.

Because the determinants of rehabilitation outcome after stroke are still largely unknown in geriatric patients, this study aimed to identify the most important demographic, clinical and functional characteristics that are independently associated with successful discharge to an independent living situation and functional status at discharge in geriatric patients admitted to SNFs after stroke. It was hypothesised that, besides age and initial disability, multi-morbidity would be an important determinant of rehabilitation outcome.

METHODS

This study is part of the Dutch Geriatric Rehabilitation in AMPutation and Stroke (GRAMPS) study. The design of this study has previously been described in detail [114]. Briefly, all patients who were consecutively admitted from the hospital stroke unit to one of the 15 participating stroke-specific SNFs in the Netherlands were eligible to participate in this study. Dutch SNFs are distinct units of nursing homes that provide dedicated multi-disciplinary care to patients in need of low-intensity rehabilitation, with a maximum amount of therapy of approximately 4 h per week. Patients admitted to an SNF are usually older than 75 years, have poor physical endurance or suffer from disabling comorbidity. The indication for admission in an SNF must be approved by an independent committee. The team in an SNF consists of an elderly-care physician, a physiotherapist, an occupational therapist, a language therapist, and a psychologist, supported by nursing staff. Often, a consultant physiatrist is available.

They make a treatment plan and have regular meetings in order to evaluate rehabilitation goals. In addition, when treatment goals have been attained or when there is no progression of a patient's capacities, the team will decide on the cessation of rehabilitation and establish a proper follow-up setting. In the Netherlands, SNFs are dedicated to geriatric rehabilitation after stroke, specific orthopedic conditions and major surgery (e.g. total hip arthroplasty), trauma, and conditions such as chronic obstructive pulmonary disease and heart failure. Patients who were unable or unwilling to give informed consent, those who were expected to be admitted less than 2 weeks, and critically ill patients were excluded from participation.

Multi-disciplinary teams were all instructed to perform the assessments as soon as possible, but no longer than 2 weeks after admission. At discharge or (at the latest) 1 year after admission, outcome measures were collected in the same participants. The research methods were approved by the regional medical ethics committee.

Outcome measures

Successful discharge was defined as discharge within 1 year after admission. Unsuccessful discharge was defined as still being admitted after 1 year or death within 1 year of admission. Functional status at discharge assessed with the Barthel Index (BI) was registered as a secondary outcome measure.

Independent variables

The characteristics that were recorded on admission were age, sex, the presence of a partner, and length of stay in the hospital, while age and sex were registered for the excluded patients as well. The clinical characteristics that were recorded on admission were the number (first-ever versus recurrent), type (hemorrhagic versus ischaemic), and location (left hemisphere, right hemisphere and other) of stroke. In addition, the adjusted Charlson Index [115] (adjCI) was registered, that is more suited for measuring multi-morbidity in stroke patients than the original version. AdjCI scores ≥2 were considered to reflect multi-morbidity [115].

For the assessment of functional status on admission, various instruments were used. The Frenchay Arm Test (FAT) [59] was used to evaluate arm function after stroke. The Motricity Index was used to evaluate motor impairment of the limbs. Postural control was tested with the Berg Balance Scale (BBS) [65]. The Functional Ambulation Categories (FAC) [71] were selected as a measure of the (in)dependency of gait. The BI was recorded as a measure of basic ADL. In addition, the premorbid BI was estimated on the basis of the history. For the assessment of extended ADL, the Frenchay Activities Index (FAI) was registered [54].The water-swallowing test was used to assess the safety of swallowing [44].

As for the assessment of global cognitive functioning, the Mini-Mental-State Examination (MMSE) was used. The Star Cancellation Test (SCT) of the Behavioural Inattention Test [79] was used to assess the degree of visuospatial hemineglect. The SAN score of the Aachen Aphasia Test [86] was recorded to quantify language impairments. The SAN score is calculated on an ordinal 7-point scale, with '1' indicating no communication possible and '7' indicating normal language skills. [87] The apraxia test was performed to assess apraxia. [84] Finally, patients' mood was assessed with the eight-item version of the Global Depression Scale (GDS8). [91]

Statistical analyses

First, statistical differences between patients showing successful and those showing unsuccessful discharge were tested for each independent variable using Student's t or Mann-Whitney U tests for continuous variables and chi-square tests for categorical variables. The independent variables associated with BI at discharge were identified with univariate linear regression analysis. Independent variables that were different between groups ($p < 0.25$) or that were associated with discharge BI ($p < 0.25$) were then entered in a multi-variate logistic or a linear stepwise regression analysis, respectively. All non-contributing variables ($p > 0.05$) were excluded, leading to the 'best-fit' model. Odds ratios (OR's) (logistic regression) and beta coefficients (linear regression) with corresponding 95% confidence intervals (CIs) were calculated for each of the contributing factors. The independent contribution of each of the factors was calculated using R^2 and R^2 change scores for the linear model and Nagelkerke R^2 for the logistic model, obtained by subsequently entering the selected variables into the model.

The Intra-class Correlation Coefficients (ICCs) were calculated to determine whether outcome measures of the participants were nested within the 15 participating nursing homes, which would require multi-level analysis.

RESULTS

Of 378 eligible patients, 186 met the inclusion criteria. The outcome data of 175 patients were available; 10 patients were transferred to another SNF during their rehabilitation on their behalf and 1 patient was lost to follow-up. Patients were excluded for various reasons: no informed consent (n= 73), unable to give informed consent (n= 64), expected short stay (n= 7), critically ill (n= 13), and other reasons (n=35). Table 1 presents the demographic and clinical characteristics of the included patients. The 192 excluded patients, with a mean age of 78 years (SD 10 years) and 40% men, were not significantly different from the included patients (T= 0.603, p = 0.569 and chi-square 1.208, p = 0.272, respectively). When corrected for expected short stay and expected death, the excluded patients did not differ in length of stay from the included patients (Mann-Whitney U 7862.5, p= 0.146). The patients excluded on the basis of an expected short stay were all discharged to an independent living situation in contrast to those excluded on the basis of legal incapacity. The latter patients were in most cases not successfully discharged (47% were transferred to chronic care units of nursing homes and 33% died). Moreover, the majority of the patients that were critically ill

Table 1: Demographic and clinical characteristics of the included patients (n=186).

Age years, median (range)	79 (53-100)
Male/ Female	85/101
First-ever stroke	82%
Hemorrhagic stroke	16%
Stroke location	
Left hemisphere	39%
Right hemisphere	49%
Other	12%
Length of stay in hospital days, median (range)	19 (6-76)
Length of stay in nursing home days, median (range)	85 (8-381)
Charlson index:	
- Myocardial infarction/instable angina pectoris	18%
- Diabetes mellitus	18%
- Congestive heart failure	16%
- Peripheral vascular disease	13%
- Chronic pulmonary disease	11%
- Kidney failure	9%

on admission died during their stay in the nursing home (70%). The ICC of both the outcomes successful discharge and discharge BI were both 0, indicating that multi-level analyses were not required.

Most included patients had sustained a first-ever stroke, while stroke type as well as stroke location showed expected distributions. Thirty-four percent of the patients showed multi-morbidity [22]. Seventy percent (n=123) of the patients were successfully discharged, whereas 30% (n=52) were not. Of this latter group, 16 patients (31%) died during their stay in the SNF. Causes of death were heart failure (n=5), recurrent stroke (n=5), pneumonia (n=3), sepsis (n=2), and cancer (n=1). Only 3 patients were still admitted at the end of the study period.

Discharge situation after rehabilitation

The differences in demographic, clinical and functional characteristics between patients who were successfully discharged and those who were not are shown in Table 2. In multivariate logistic regression, good visuospatial perception, low age, and good postural control were independently associated with successful discharge yielding a total explained variance of 33% (Table 3). When excluding the patients who died from the analyses, low age (OR 0.91, 95% CI 0.83-0.99), good postural control (OR 1.04, 95% CI 1.01-1.08), and good visuospatial perception (OR 0.95, 95% CI 0.89-1.00) explained 32% of the variance of successful discharge. The adjCI and the BI on admission did not further contribute to the prediction model.

Table 2: Demographic, clinical and functional characteristics for patients who were successfully discharged to an independent living situation within one year after admission (n=123) and those who were not (n=52).

Variable	Successful discharge	Unsuccessful discharge	Test statistic	p value
Age, years median (range)	78 (53-100)	82 (60-96)	2.884*	***0.005***
Partner present	29%	37%	0.972†	0.324
Length of hospital stay, median (range)	19 (6-58)	19 (6-76)	0.598*	0.551
Stroke location			4.059†	***0.044***
Left	51%	49%		
Right	33%	67%		
Adjusted Charlson index (range)	1 (0-8)	1 (0-10)	2104.5	***0.000***
Multimorbidity	28%	48%	6.829†	***0.009***
MI arm/leg, median (range)	162 (0-200)	106 (0-200)	1651.0	***0.000***
BBS, median (range)	38 (0-56)	4 (0-56)	1070.5	***0.000***
FAC, median (range)	3 (0-5)	1 (0-5)	1289.0	***0.000***
Frenchay arm test, median (range)	5 (0-5)	3 (0-5)	1289.0	***0.002***
Ten meter walking speed seconds, median (range)	12 (6-26)	10 (9-27)	108.0	0.482
Swallowing disorder	15%	40%	24.539†	***0.000***
Barthel index premorbid, median (range)	20 (6-20)	19 (1-20)	2553.5	0.391
Barthel index admission, median (range)	14 (1-20)	6 (1-20)	1355.0	***0.000***
Frenchay activities index, median (range)	26 ± (8-44)	23 ± (0-45)	-1.883*	***0.062***
SCT (omissions), median (range)	2 (0-44)	6 (0-56)	1134.5	***0.002***
MMSE, median (range)	23 (1-30)	23 (10-30)	1866.0	0.555
SAN, median (range)	7 (2-7)	6 (1-7)	2482.5	0.260
Apraxia	16%	26%	1.973†	***0.160***
GDS8 >3	22%	40%	5.522†	***0.019***

* Students T, † Chi-square test; other variables Mann Whitney U test.
MI motricity index (0-200), BBS Berg Balance Scale (0-56), FAC Functional Ambulation Categories (0-5), SCT Star Cancellation Test (0-54), MMSE Mini-Mental-State Examination (0-30), SAN Stichting Afasie Nederland score of the Aachen Aphasia Test (0-7), GDS8 Global Depression Scale eight-item version (a score > 3 is considered to reflect depression).

Table 3: Independent variables predicting successful discharge and functional status (Barthel Index) at discharge.

Model	Prognostic variables	Odds Ratio *	95% CI			p-value
				Wald	Cum NR^2	
Successful discharge	Star Cancellation Test	0.94	0.89-0.99	5.47	0.18	0.02
	Age	0.91	0.84-0.99	5.44	0.27	0.02
	Berg Balance Scale	1.03	1.00-1.07	4.51	0.33	0.03
		B			Cum R^2	
Functional status	Berg Balance Scale	0.16	0.11-0.20		0.41	0.00
	Star Cancellation Test	-0.16	-0.26--0.06		0.48	0.00

* Reflects probability per point.
Admission FAC and admission Berg Balance Scale had an intra-correlation coefficient that exceeded 0.9. FAC was not entered in the model.
Cum NR^2 Cumulative Nagelkerke's R^2
Cum R^2 Cumulative R^2

Functional status at discharge

The median BI for the entire group of 175 patients was 12 (range 1-20) on admission and 17 (range 1-20) at discharge. The patients who were successfully discharged showed an increase in BI from 14 on admission to 18 at discharge (p<.001), whereas those who were 'unsuccessful' showed a stable BI score of 6.

In bivariate regression analyses, age, stroke location, adjCI, Motricity Index arm and leg, BBS, FAC, SCT, SAN, water swallowing test, admission BI, FAI, apraxia, GDS8 and FAT were all associated with the BI at discharge. In multi-variate linear regression analyses, good postural control, and good visuospatial perception were independently associated with BI at discharge yielding a total explained variance of 48% (Table 3). The adjCI and the BI on admission did not contribute to the model.

DISCUSSION

Both good postural control and good visuospatial perception were independently associated with successful discharge and functional status at discharge. Postural control on admission was the most important determinant of discharge BI. The BBS alone accounted for 41% of the BI variance at discharge. In addition, age appeared to be a determinant of successful discharge. In contrast to our expectation, multi-morbidity as assessed with the adjCI did not contribute to the prediction of rehabilitation outcome.

Postural control has been identified as an important predictor of functional outcome after stroke in many previous studies, although the majority of these studies focused on trunk control [39, 116]. At least one other study found similar results as the present study using a more comprehensive measure of postural control. In their study, the BBS was also the most important factor determining discharge destination (home versus institutionalisation). On the other hand, Lin et al. [117] found only a marginal influence of postural control as assessed with the Fugl-Meyer balance scale on rehabilitation outcome, whereas others did not find any association of balance on rehabilitation outcome [42]. Balance seems to play an important role in elderly stroke patients, as was observed in this study as well as in the study done by Wee et al. (mean age 76 years) [118]. Unlike many previous studies, the initial disability did not contribute to the prediction of rehabilitation outcome in the present study. The most reasonable explanation for this finding is that the group differences in initial BI between 'successful' (BI 14) and 'unsuccessful' (BI 6) patients were relatively small compared with the differences in initial BBS score between these groups (BBS 38 versus 4, respectively). Since the initial BI and BBS scores were highly correlated among our patients (Spearman's Rho 0.85, p<.001), it is likely that the BI scores could not make an independent contribution to explaining variance of rehabilitation outcome.

In the present study, the presence of visuospatial hemineglect appeared to be another determinant of rehabilitation outcome. Indeed, earlier studies have shown that hemineglect in the acute phase post stroke is an important predictor of functional outcome [105, 119]. The reason why, in the present study, the contribution of visuospatial hemineglect to discharge BI was relatively weak may be 2-fold. First, in contrast to previous studies, this study included both right and left hemispheric stroke patients. Second, since visuospatial hemineglect has shown to be an important and unique determinant of postural control after stroke [120], it is possible that part of the influence of hemineglect on functional status at discharge in the present study may have been encompassed by the influence of balance on rehabilitation outcome discussed earlier.

In contrast to our hypothesis, multi-morbidity was not independently associated with rehabilitation outcome, although the prevalence of multi-morbidity differed significantly between 'successful' and 'non-successful' patients (28 and 48%, respectively). The patients that died during their rehabilitation did not influence these results. When we excluded the patients who died from the unsuccessful discharge group, the same set of determinants arose after analysis of the data. In line with our results, a previous study by Soares et al. [113] also found no independent contribution of the adjCI to rehabilitation outcome in patients with a first-ever stroke who were on average 78 years of age. Remarkably, in the latter study, age was not independently associated with rehabilitation outcome, which might be attributable to the fact that age was dichotomised (70-79 and ≥80 years) in the analysis. Only one recent study by Turhan et al.[31] found an independent contribution of adjCI to rehabilitation outcome, even though the mean adjCI was lower (1.06) than in the present study. However, this study was conducted in a single rehabilitation centre including much younger patients with a first-ever stroke (mean age 66 years). Thus, it is possible that multi-morbidity has a higher predictive value in relatively young compared with elderly survivors of stroke, perhaps related to a lower prevalence in the younger population. Lastly, depression is often considered to have a negative influence on rehabilitation outcome. [121, 122] However, in this study an independent association of the GDS8 with the outcome of rehabilitation could not be established.

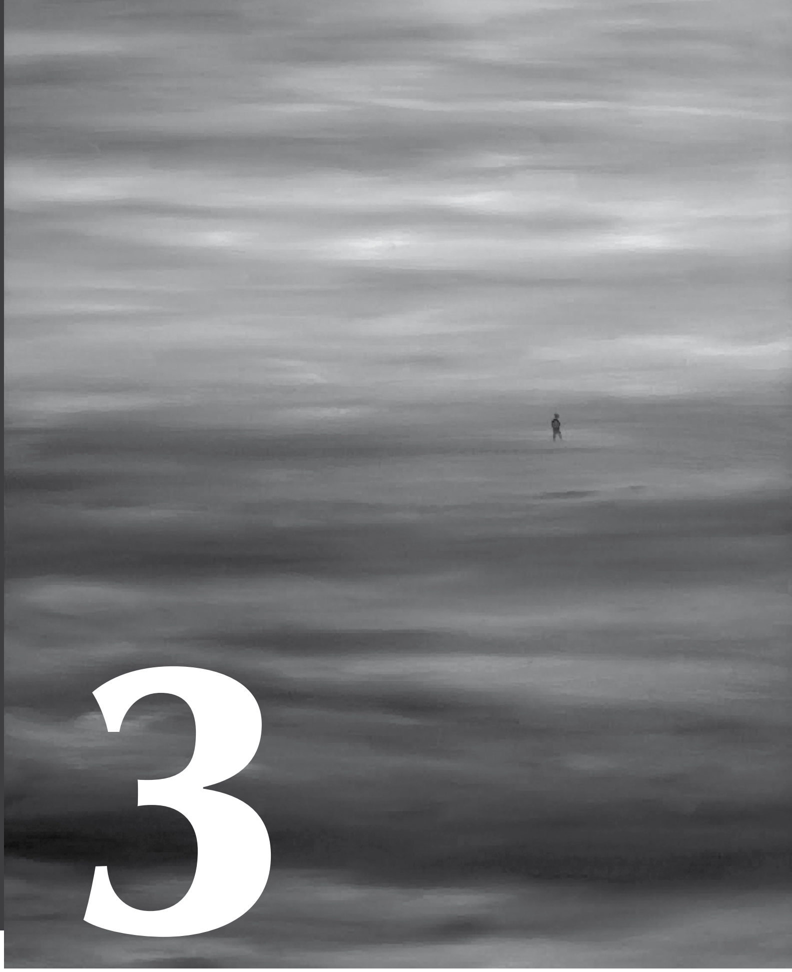
Strengths and limitations

As far as we are aware, this is the largest multi-centre prospective cohort study investigating the determinants of success of 'low intensity' rehabilitation in geriatric patients admitted to SNFs after stroke. The fact that the same set of determinants was found for 'living situation' and 'functional status' after rehabilitation supports the validity of both the independent and dependent variables.

Some limitations warrant further consideration. Although the prediction models accounted for 33 and 48% of the variance of successful discharge and functional status, respectively, a substantial proportion of the variance of these outcome measures still remained unaccounted for. Another limitation is the fact that we did not assess the influence of intercurrent diseases (originating or manifesting itself *during* the rehabilitation process) on rehabilitation outcome. In addition, since some of the patients excluded from this study had a high chance of unsuccessful discharge, the results are valid for those patients with stroke that are legally capable of admission.

Conclusion

This study shows that geriatric patients who receive 'low intensity' rehabilitation in SNFs after stroke have a fair prognosis for being discharged to an independent living situation within 1 year of admission. Good postural control appeared to be the most important determinant of functional status at discharge and made an independent contribution to successful discharge, while absence of visuospatial neglect made a much weaker, but still significant independent contribution. In addition to good postural control, good visuospatial perception and low age independently contributed to successful discharge. Although multi-morbidity was significantly more common in 'unsuccessful' patients, it showed no unique contribution to rehabilitation outcome. Thus, clinicians should assess and value postural control as the most important determinant of rehabilitation outcome in legally capable geriatric patients with stroke. In contrast, multi-morbidity as assessed with the adjCI is much less informative.



TO WHAT EXTENT CAN MULTIMORBIDITY BE VIEWED AS A DETERMINANT OF POSTURAL CONTROL IN STROKE PATIENTS?

Monica Spruit- van Eijk, Sytse U Zuidema, Bianca I Buijck, Raymond TCM Koopmans, Alexander CH Geurts.

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ABSTRACT

Objective To investigate the determinants of postural imbalance after stroke in geriatric patients admitted for low intensity rehabilitation in skilled nursing facilities (SNFs), particularly the role of multimorbidity.

Design Cross-sectional study design.

Setting Fifteen SNFs in the Netherlands.

Participants All patients that were admitted for rehabilitation after stroke in one of the participating SNFs were eligible (N=378).

Interventions Not applicable.

Main outcome measures The Berg Balance Scale (BBS) was selected as a measure of standing balance and the Functional Ambulation Categories (FAC) as a measure of walking balance.

Results Multimorbidity was present in 34% of the patients. The patients with multimorbidity differed from the patients without multimorbidity with respect to age, proprioception and vibration sense, but not for any of the cognitive tests, muscle strength, or sitting balance. Patients with multimorbidity had on average lower scores on both outcome measures. In linear regression analyses, both the BBS and FAC were best explained by multimorbidity, muscle strength, and the interaction between muscle strength and static sitting balance (overall explained variance 66% and 67%, respectively), while proprioception added only to the variance of the FAC.

Conclusion Multimorbidity was independently related to postural imbalance after stroke in patients admitted for rehabilitation in SNFs. Muscle strength and the interaction of muscle strength with static sitting balance were important determinants of both standing and walking balance, indicating these factors as essential targets for rehabilitation.

BACKGROUND

Both sitting balance and standing balance have been recognized as important predictors of functional recovery and rehabilitation outcome after stroke. [123-127] Wee et al. [123] found that a higher admission Berg Balance Scale score was associated with higher activities of daily living (ADL) scores at discharge from rehabilitation (accounting for 42% of the ADL variance). Balance as assessed with the Brunel Balance Assessment appeared to be the strongest predictor of recovery of mobility in a study performed by Tyson et al. [125] This conclusion was also drawn in an earlier study by Kollen et al.[127] using the Timed Balance Test. Particularly, impaired trunk control has been associated with poor functional outcome, impaired mobility and dependency in basic ADL. A recent study has shown that static sitting balance was a better predictor of functional abilities than dynamic sitting balance or trunk coordination, explaining most of the variance of the Barthel Index 6 months after stroke (total R^2 0.69). [124]

Despite the high predictive value of postural control with regard to functional outcome after stroke, the determinants of post-stroke postural imbalance have not yet been extensively studied. Van Nes et al. [128] focused on the influence of hemi-neglect on various aspects of postural control in the acute phase (< 2 weeks) of stroke. In a cross-sectional study, they collected data from 78 patients with a mean age of 71 years. Using the Trunk Control test, the Trunk Impairment Scale, the Berg Balance Scale, and the Functional Ambulation Categories as dependent variables, they consistently found that hemi-neglect, loss of muscle strength, and higher age made independent contributions to postural imbalance and together explained 64-72% of the variance of each outcome measure. In an earlier cross-sectional study of patients with a mean age of 71 years, Tyson et al. [129] found somatosensation (proprioception and tactile sensation) and muscle strength, rather than hemi-neglect or age, to be independently related to postural imbalance. Remarkably, Tyson et al. excluded 358 patients from 433 eligible patients for various reasons, including severe co-morbidities, whereas co-morbidities such as diabetes mellitus, [130] peripheral vascular disease, [131] and osteoarthritis [132] may be important determinants of postural control particularly in elderly patients. Van Nes et al., [128] did not control for the influence of co-morbidities.

Against this background, this study aimed to investigate the determinants of postural imbalance in geriatric patients admitted for 'low intensity' rehabilitation in Skilled Nursing Facilities (SNFs) after stroke. Usually, these patients have a high risk of multimorbidity leading to poor physical endurance, [2] making them less suitable for more intensive training programs in rehabilitation centers. The fall risk in these patients is considered to be extremely high, basically due to intrinsic balance problems, [133] rendering it important to know what the most critical determinants of postural imbalance are in the geriatric stroke population. More specifically, the influence of multimorbidity (as assessed with the stroke-adjusted Charlson Index) was compared to the influence of well-known determinants such as age, muscle strength, somatosensation, and hemi-neglect. It was hypothesized that multimorbidity, corrected for the effects of stroke itself, would make an independent contribution to postural imbalance in geriatric patients admitted for stroke rehabilitation in SNFs.

METHODS

This cross-sectional study is part of the Nijmegen GRAMPS study (Geriatric Rehabilitation in AMPutation and Stroke). All patients admitted to one of 15 participating SNFs in the Southern part of the Netherlands were eligible. No additional inclusion criteria were applied. Patients were excluded when they refused participation, were unable to give informed consent, were critically ill on admission, or when they were expected to have a short stay (shorter than two weeks). An extensive description of the study protocol has previously been published. [134]

Data collection

Data collection took place within the first two weeks of admission by well-instructed multidisciplinary teams. The two outcome measures to assess balance were the Berg Balance Scale (BBS) [135] and the Functional Ambulation Categories (FAC). [136] The BBS is an ordinal 14-item scale that assesses mainly standing balance, yielding a sum score ranging from 0-56 points. The FAC is an ordinal six-point scale that assesses walking balance, i.e. the level of (in)dependency of gait. A score 0 indicates total dependency and a score 5 indicates full independency of walking across all terrains (the use of a walking aid is allowed). Both outcome measures have shown good validity and reliability. [135-138]

As possible determinants of these outcome measures the following independent variables were collected: age (years), gender, length of hospital stay (days before admission to the SNF), type of stroke (hemorrhagic or ischemic), number of strokes (first-ever or recurrent stroke), stroke location (left, right, or other), multimorbidity, static sitting balance, muscle strength, cognition, hemi-neglect, vibration sense, and proprioception. Multimorbidity was assessed with the Charlson Index, adjusted for the consequences of stroke itself (adjCI). [115] In the adjCI, the items 'cerebrovascular disease' and 'hemiplegia' are left out, while severity levels of liver and renal diseases are clustered, and patients with diabetes and renal disease are scored in the category 'diabetes with end-organ damage'. According to Goldstein et al., an adjCI ≥ 2 reflects multimorbidity. In this study, trunk control was defined as static sitting balance. It was considered as a possibly important determinant of standing and walking balance and, therefore, used as an independent variable. [139] It was assessed using item three of the Trunk Control Test (sitting in a balanced position on the edge of the bed for at least 30 seconds, with the feet above the ground) [140] and registered as normal or impaired. Muscle strength of the affected upper and lower limb was measured using the Motricity Index [141] that ranges from 0 (complete paralysis) to 100 (normal strength). Six movements are observed, divided in arm (pinch grip, elbow flexion, and shoulder abduction) and leg (ankle dorsiflexion, knee extension, and hip flexion) movements. The 'side score' was calculated by summing the lower limb score and upper limb score for the affected side and dividing by two. The Mini-Mental-State-Examination (MMSE) [142] was used to obtain a global measure of cognition. The Star Cancellation Test (SCT) of the Behavioral Inattention Test was used to assess hemi-neglect. [143] Rough scores were used to determine the presence of hemi-neglect rather than the visual lateralization scores. [144] Apraxia was assessed using the Apraxia test reported by van Heugten et al. [145] This Apraxia test, differentiating between apraxia and non-apraxia, involves demonstration of object use and imitations of gestures. A score higher than 3 errors indicates apraxia. [145] Vibration sense was tested at the left and right halluces and assessed using a Rydel Seifer tuning fork (scoring range 0-8). The mean of three measurements was used for analysis. A mean score lower than three measured at the right or the left hallux was considered to indicate impaired vibration sense. Finally, proprioception at both ankle joints was tested by a physician and registered as impaired when the patient failed to indicate the correct position at the right or the left ankle.

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Statistical analysis

Intra-class Correlation Coefficients (ICCs) were calculated to determine whether outcomes were nested within the 15 participating nursing homes, which would require multilevel analysis. Patients with and without multi-morbidity were identified based on the adjCI (cut-off ≥ 2). Possible differences of independent and dependent variables between patients with and without multi-morbidity were calculated using independent samples T-tests for continuous variables and Chi-square tests for ordinal data. Univariate regression analyses were performed to identify the independent variables that were significantly associated with the BBS and FAC. Each independent variable that showed an association ($p<0.10$) was entered in a stepwise multivariate linear regression analysis for the BBS and FAC, separately. Relevant interaction terms were also entered in the model to allow for effect modification. The true adjCI, rather than the dichotomized score, was used in the multivariate regression analyses. The β and corresponding 95% confidence intervals (CIs) of independent variables in the model were calculated. Finally, to give an impression of the weight of each determinant in the model, the partial h^2 was calculated. Eta squared values describe the amount of variance accounted for in the sample. They do not sum to the amount of dependent variable variance accounted for by the independent variables. Since we performed separate multivariate analyses for the BBS and the FAC as dependent variables, the α-level was adjusted to $p=0.025$.

RESULTS

Of 378 eligible patients, 186 patients were included in this study. Reasons for exclusion were: no informed consent (n=73), unable to give informed consent (n= 64), expected short stay (n= 7), critically ill (n= 13), and other reasons (n=35). 'Other reasons' for exclusion were mainly logistic. For instance, during holidays merely every second patient was included to prevent too great a burden to the personnel. The patients that were eventually included did not differ from those who were excluded in terms of age (T=0.603, p=0.569), or gender (χ^2 =1.208, p=0.272). Moreover, they did not differ with regard to their length of stay in the SNF (Mann Whitney U=10,907.0, p=0.317). The ICCs of the BBS and FAC outcomes were 0.023 and 0.000, respectively, indicating that multilevel analyses were not necessary.

Based on the adjCI, seventy patients scored 0, 52 patients scored 1, 34 scored 2, 13 scored 3, and 17 patients scored 4 or higher. Thus, 34% of the patients were considered to suffer from multimorbidity. The most important comorbidities were myocardial infarction / unstable angina pectoris (18%), diabetes mellitus (18%), congestive heart failure (16%), peripheral vascular disease (13%), chronic pulmonary disease (11%), and kidney failure (9%). Table 1 shows the independent and dependent variables for all included patients as well as for the patients with (n=64) and without (n=122) multimorbidity, separately. Both the BBS and FAC scores were significantly (approximately 12-13% of the scoring range) lower in the patients

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Table 1: Independent and dependent variables for all patients together and for those with and without multimorbidity, separately.

variables	Total N=186	M- N=122	M+ N=64	P-value
Independent variables				
Age	78.6±8.2	77.7±8.6	80.2±7.4	***0.042***
Gender (m/f)	85/101	59/63	26/38	0.314
Length of hospital-stay	19	22.9±12.7	23.1±12.7	0.922
First-ever stroke	82%	81%	83%	0.780
Hemorrhagic stroke	16%	16%	14%	0.677
Stroke location				0.355
Left	45%	47%	40%	
Right	55%	53%	60%	
Adjusted Charlson Index	1.4±1.9	0.4±0.5	3.3±2.0	***0.000***
Impaired static sitting balance	23%	19%	29%	0.101
Motricity Index arm (0-100)	64.4±36.4	66.4±35.8	60.6±37.6	0.337
Motricity Index leg (0-100)	66.7±33.7	69.5±32.2	60.9±36.2	0.132
Motricity Index arm and leg (0-100)	65.4±34.0	67.8±33.0	60.6±35.6	0.202
Impaired position sense ankle	30%	25%	41%	***0.042***
Impaired vibration sense hallux	39%	33%	51%	***0.034***
Mini-Mental-State Examination (0-30)	22.2±5.5	22.1±5.7	22.4±5.1	0.712
Star Cancellation Test (omissions 0-54)	7.8±12.2	6.5±11.4	10.1±13.5	0.139
Apraxia	21%	20%	23%	0.677
Dependent variables				
Berg Balance Scale (0-56)	27.5±19.5	30.0±19.6	22.4±18.6	***0.016***
Functional Ambulation Categories (0-5)	2.5±1.8	2.7±1.8	2.1±1.7	***0.024***

M+ Patients with multimorbidity, M- Patients without multimorbidity

Table 2: Stepwise regression analyses for the Berg Balance Scale (BBS) and the Functional Ambulation Categories (FAC).

BBS	*β* (CI)	Partial h^2	FAC	*β* (CI)	Partial h^2
SSB	1.21 (-7.21- 9.63)	0.000	SSB	0.15 (-0.64- 0.94)	0.001
MI(side)	0.44 (0.35-0.53)*	0.379	MI(side)	0.04 (0.03-0.05)*	0.421
SSBxMI(side)	-0.29 (-0.44- -0.15)*	0.090	SSBxMI(side)	-0.02 (-0.04- -0.01)*	0.065
Adjusted CI	-1.41 (-2.38- -0.45)*	0.049	Adjusted CI	-0.15 (-0.26- -0.05)*	0.058
			Proprioc ankle	-0.49 (-0.90- -0.08) †	0.042
R^2	0.655		**R^2**	0.672	

SSB: static sitting balance; MI(side): side score of the Motricity Index; Adjusted CI: adjusted Charlson Index; Proprioc ankle: proprioception of the ankle.

* p<0.01

† p<0.025

with compared to the patients without multimorbidity. In addition, the patients with multimorbidity were on average 2.5 years older and more often had impaired vibration sense and ankle proprioception.

Univariate regression analyses indicated that Motricity Index, static sitting balance, gender, proprioception, neglect, apraxia, MMSE, and adjCI were all associated with both the BBS and FAC scores. Hence, these independent variables were stepwise entered in a multivariate linear regression analysis for the BBS and FAC, separately.

Table 2 shows the best-fit model for the BBS and the FAC scores. A higher adjCI was associated with lower BBS and FAC scores, indicating that multimorbidity had a negative impact on postural control. In addition, a higher MI was associated with higher BBS and FAC scores. Interestingly, static sitting balance alone did not make a significant contribution to either the BBS or FAC score variances, but the *interaction* between MI and static sitting balance did. In

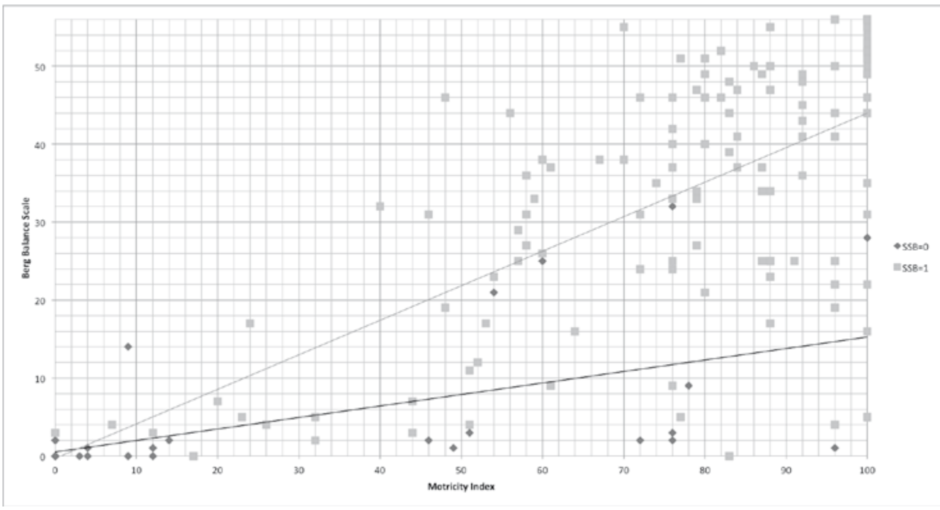

Figure 1: The relation between muscle strength (Motricity Index) and standing balance (Berg Balance Scale) for patients with normal (SSB=1) and impaired (SSB=0) static sitting balance.

patients with static sitting balance, the β (CI) for MI with regard to BBS was 0.44 (0.35-0.53), whereas in patients with impaired trunk control the β (CI) was 0.15 (0.03-0.26). For the BBS, the interaction between static sitting balance and MI is illustrated in Figure 1. Clearly, only in the presence of static sitting balance the MI makes a significant contribution to standing balance. With regard to the FAC, the β (CI) for MI in patients with and without static sitting balance was 0.04 (0.03-0.05) and 0.02 (0.01-0.03), respectively. Lastly, proprioception of the ankle made a significant contribution to the explained variance of the FAC score.

DISCUSSION

To our knowledge, this is the first study to investigate the determinants of postural imbalance after stroke in geriatric patients admitted for low intensity rehabilitation in SNFs, particularly the role of multimorbidity. In line with our hypothesis, multimorbidity was independently associated with standing (BBS) and walking balance (FAC), as was muscle strength of the affected body side. Interestingly, the latter relationship was modified by static sitting balance. This interaction indicates that the influence of muscle strength on postural control is much stronger when patients have a basic level of trunk control compared to the situation where trunk control is insufficient. Somatosensation (ankle proprioception) merely independently contributed to walking balance (FAC).

The notion that multimorbidity may affect postural control in geriatric patients has previously been addressed by Di Fazio et al. [146] They studied the effect of chronic diseases and their combination on functional recovery in disabled elderly patients. All patients received a rehabilitation program because of severe balance and gait disability. By multivariate regression analyses they revealed that the 'more disabling' conditions (i.e. combinations of chronic obstructive pulmonary disease (COPD), heart failure, peripheral arterial disease, diabetes mellitus, and cancer) were associated with poorer balance recovery. All single diseases in the 'more disabling' group had a negative impact on balance, but their combination led to more balance disability than just adding up the effects of each single disease. There may be many mechanisms by which multimorbidity affects balance. One type of causal pathway may be that both COPD and peripheral arterial disease are associated with muscular dysfunction, leading to decreased muscle strength. [147, 148] Another well-known mechanism is that patients with diabetes and cancer have a greater risk of (diabetic or toxic) polyneuropathy. [149-151] There may, however, be many more mechanisms that are not yet identified by which multimorbidity can cause postural imbalance in geriatric patients.

This study shows that muscle strength of the affected body side is a key determinant of postural control in geriatric patients with stroke. The importance of this relationship in the (sub)acute phase after stroke has previously been reported, [125, 128] but this is the first study to indicate that the influence of affected limb muscle strength on balance is strongly modified by trunk control. Indeed, figure 1 shows that the influence of limb muscle strength on balance is almost negligible in patients without static sitting balance, but quite strong in patients with static sitting balance. Apparently, trunk control is a prerequisite for limb muscle strength to become effective. In other words, only in patients with a certain capacity to maintain sitting balance, limb muscle strength is able to influence their standing balance and gait capacities. In others, these capacities are already severely limited because of the lack of sitting balance. Although trunk control has been identified as an important predictor of balance [152] as well as of the capacity to perform activities of daily living (ADL), [153] the interaction between trunk control and limb muscle strength in explaining postural control after stroke has not yet been reported. The most likely reason that this study was able to identify this interaction is the relatively high prevalence of trunk impairments in our geriatric stroke population. A higher prevalence of trunk impairments is probably related to a greater likelihood of vascular lesions in both cerebral hemispheres at relatively high age. [154] As a result, the aged brain may be more susceptible to the consequences of unilateral stroke, since there is less neural compensation available from the contralateral hemisphere. Since trunk muscles are bilaterally innervated, [154] they will be affected mainly when there are lesions in both hemispheres.

In contrast with some previous studies, [128, 155, 156] hemineglect did not significantly contribute to postural imbalance. On the one hand, this lack of association was also reported by Tyson et al. [129] and may indicate that hemineglect is not a consistently present causal factor of balance problems after stroke. On the other hand, it is known that hemineglect can substantially improve during the first weeks post stroke. [157] In the present study, patients were assessed on average 19 days after their stroke, at which point in time a considerable amount of spontaneous recovery of hemineglect might have taken place. [158] Indeed, the patients scored on average only 7.8 omissions on the SCT, which is merely 14% of the score range (0-54). As a result, the influence of hemineglect on balance and gait, although pathophysiologically existing, may be harder to prove statistically. In contrast with the study by Van Nes et al.,[128] no independent influence of age on postural imbalance was found. The most likely explanation for this discrepancy is less variation in age in the present geriatric study population compared to the hospital-based study by Van Nes et al. Indeed, in a longitudinal rehabilitation cohort with less age variation, Van Nes et al. [155] no longer found an independent effect of age on balance.

Study strengths and limitations

Strengths of this study are the relatively large sample size and the fact that multimorbidity was carefully assessed using the stroke-adjusted Charlson Index. A limitation is that trunk control was assessed only with the static sitting balance item of the Trunk Control Test. As a result, only a crude assessment of trunk impairments was possible. Another limitation is the relatively long post-stroke interval (on average 19 d) due to the fact that patients were included on admission in the nursing home and not during their stay in hospital. Certain

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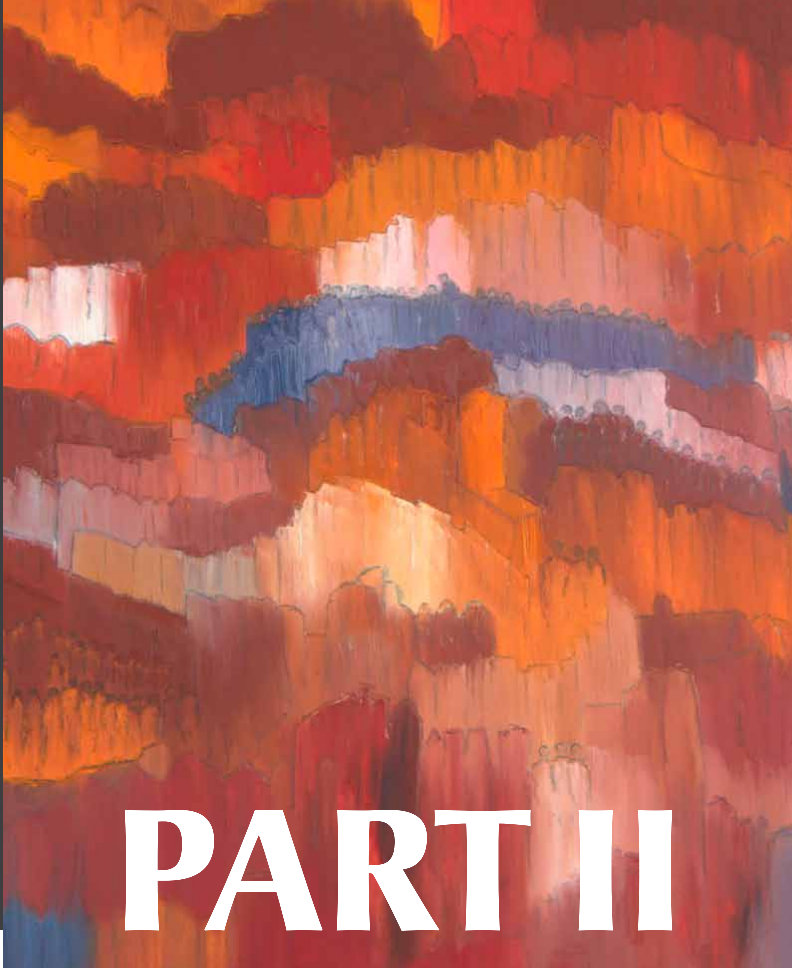
impairments (such as hemineglect [157] or muscle strength [159]) might have resolved spontaneously in some patients making it harder to establish their possible contribution to postural imbalance.

Conclusion

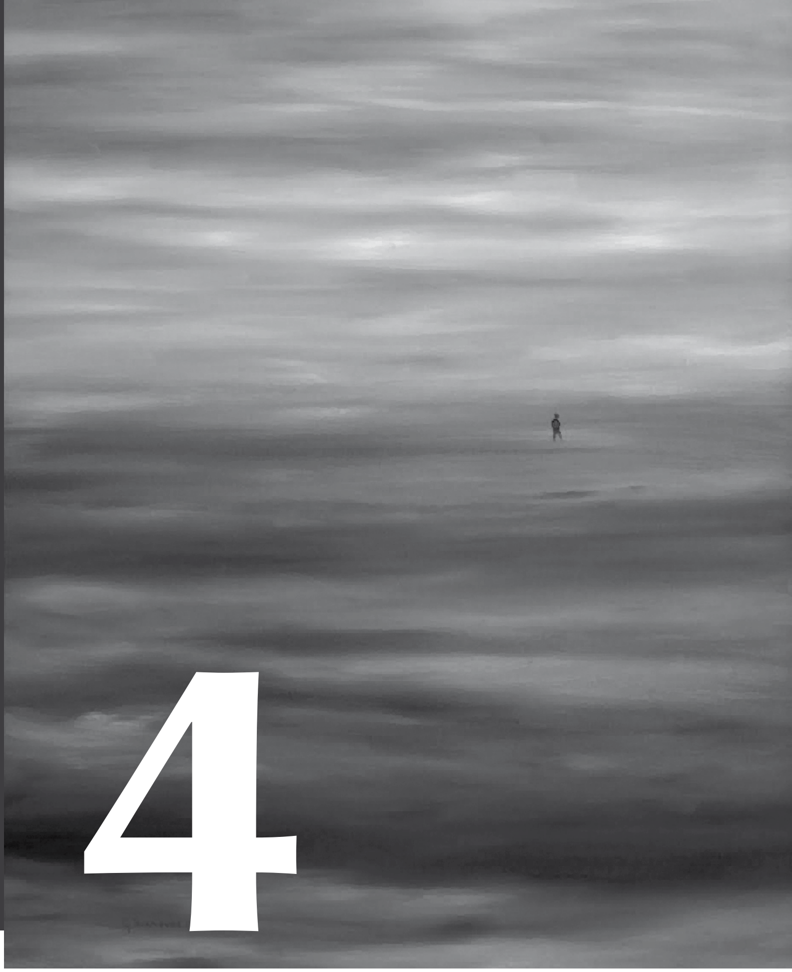
We found that multimorbidity independently contributes to postural imbalance after stroke in geriatric patients admitted for rehabilitation in skilled nursing facilities of nursing homes. Both standing and walking balance were best explained by a combination of multimorbidity, muscle strength of the affected body side, and the interaction between trunk control and limb muscle strength. Hence, to improve postural control in geriatric patients with stroke it seems important to treat comorbidity whenever possible and to train both trunk control and affected limb muscle strength to their maximum.



PART II

GERIATRIC REHABILITATION AFTER MAJOR LOWER LIMB AMPUTATION

'De Stad en de Vergadering'



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GERIATRIC REHABILITATION OF LOWER LIMB AMPUTEES IN NURSING HOMES; A STUDY PROTOCOL

Monica Spruit- van Eijk, Bianca I Buijck, Sytse U Zuidema, Harmen van der Linde, Alexander CH Geurts, Raymond TCM Koopmans.

Unpublished

ABSTRACT

Background After the acute care in hospital, lower limb amputees are often referred for rehabilitation to a rehabilitation center or a skilled nursing facility (SNF). From the literature it is known that factors determining discharge destination are amputation level, gender, age, and number of comorbidities. However, the existing literature is mainly retrospective and focuses on patients in rehabilitation centers. As a consequence, the results may have been confounded by selection bias. To our knowledge no studies have been published on the factors associated with successful outcome of rehabilitation of patients with lower limb amputation in SNFs.

Methods This study is part of the Geriatric Rehabilitation in AMPutation and Stroke (GRAMPS) study in the Netherlands. It is a longitudinal, observational, multicenter study in 11 SNFs in the Southern part of the Netherlands that aims to include at least 50 patients rehabilitating after major limb amputation. Only SNFs with a specialized rehabilitation ward and the provision of multidisciplinary care are selected. Patient characteristics, disease characteristics, functional status, cognition, behavior, and caregiver information are collected within two weeks after admission to the SNF. The first follow-up is at discharge from the SNF or one year after inclusion, and focuses on functional status and behavior. Successful rehabilitation is defined as discharge to an independent living situation within one year after admission. The second follow-up is three months after discharge in patients who have been rehabilitated successfully, and assesses functional status, behavior, and quality of life.

Discussion This is the first study that will provide more information about geriatric rehabilitation after major lower limb amputation in SNF patients. The patients admitted to SNFs differ from patients admitted to rehabilitation centers with respect to age, number of comorbidities, and amputation level. Therefore, factors associated with successful outcome will probably differ as well. By making use of multivariate logistic regression models the independency of associated factors will be established.

BACKGROUND

Worldwide incidence and prevalence rates of peripheral arterial disease (PAD) are not known, partly because the diagnosis is often unrecognized in primary care settings. [160] A substantial number of PAD patients undergo major lower limb amputation. In 2005, approximately 600.000 people in the United States with a comorbid diagnosis of diabetes mellitus underwent an amputation secondary to vascular disease. [161] The number of major lower limb amputations in the Netherlands shows a declining trend. In 2004, 1747 elderly, aged 65 years and older, underwent transfemoral amputation (TFA), transtibial amputation (TTA), or a disarticulation of the knee or ankle, whereas in 2007, this number had decreased to 1247. [162] Lower limb amputation was more often carried out in men, and in older age groups. Elderly lower limb amputees have reduced survival rates. Dillingham et al. found that one-year survival was merely 59% after major lower limb amputation for PAD. [163] The peri-operative mortality is approximately 10%, [164, 165] with lower mortality-rates in TTA than in TFA. [166, 167] These high mortality rates are probably related to a combination of the more progressed arterial disease and other comorbidity, typical of the elderly lower limb amputee. Cardiovascular diseases are one of the most important factors associated with perioperative [165, 168] as well as long-term mortality. [168, 169]

After the acute care in a hospital, patients with lower limb amputation are often referred for rehabilitation. Intensive rehabilitation programs are provided in rehabilitation centers, whereas less intensive rehabilitation programs are provided in skilled nursing facilities (SNF). Patients discharged to SNFs differ from those discharged to rehabilitation centers with respect to amputation level, gender, number of comorbidities, and age. [163] Yet, little is known about the factors associated with functional outcome of rehabilitation in lower limb amputees, especially when they are referred to an SNF. Only few, mostly retrospective studies, have investigated the outcomes of rehabilitation, while the use of different outcome measures and definitions of success make interpretation of results difficult. Table 1 illustrates the relationship between disease-related factors and outcome, known from existing literature. Age and comorbidity, related to progressed arterial disease, seem to be important in determining outcome, but other uniquely contributing factors cannot be determined because of inconsistency in predicting the outcome. More importantly, most studies were conducted in rehabilitation centers, implicating that the results may have been confounded by selection bias. Factors associated with successful rehabilitation of lower limb amputees in SNFs have not yet been studied. These will probably differ from rehabilitation centers, because of patient group differences.

To this end, we have set up a multicenter study in eleven SNFs in the Netherlands, with the primary goal to determine the factors that contribute to the success of rehabilitation in lower limb amputees in SNFs. Successful outcome is defined as discharge to an independent living situation. In addition, various functional scales are used as secondary outcome measures.

Table 1: Factors (not) associated with outcome after major lower limb amputation in the literature.

Outcome	Factors associated with outcome (based on multivariate regression)	Factors not associated with outcome
Prosthetic use	-Age >85yrs, stroke, dementia, amputation level [170]. -Age, standing balance test [70]. -Non-ambulation/ transfer only status before amputation, amputation level, homebound ambulatory status, age >60yrs, dementia, ESRD, CAD [169]. -Age, LOS, home nurse upon discharge [171].	-Age 50-59, history of smoking, nutritional deficiency, prior vascular surgery, and preoperative living status [169]. -Calcium concentration, need for assistive device, hypertension, hours of prosthetic use [171].
Mobility		
• **RMI**	-Age, bilateral amputation, homebound ambulatory status, ESRD [169]. -Age, LOS acute care, Doppler features of residual limb, initial BI [172].	-Amputation level, gender, CAD, and dementia [169]. -Gender, side of amputation, aetiology, presence of comorbidity, and RMI score on admission [172].
ADL		
• **BI**	-Age, diabetic aetiology [172].	-Gender, side of amputation, LOS acute care, presence of comorbidity, Doppler features of residual limb, BI score on admission, and RMI score on admission [172].
• **GARS**	-Age, standing balance test, 15 words test [70].	-Other comorbidity (other than DM or cardiopulmonary disease) [70].

ESRD end-stage renal disease, CAD coronary artery disease, LOS length of stay, RMI Rivermead mobility index, BI Barthel index, GARS Groningen activity restriction scale, DM diabetes mellitus.

METHODS

Study design

This prospective study is part of the Nijmegen Geriatric Rehabilitation in AMPutation and Stroke (GRAMPS) study and comprises three measurements. Baseline data (T0) are collected within two weeks after admission to the SNF. Patient and disease characteristics, functional status, cognition, behavior and caregiver information are registered (Table 2). The first follow-up (T1) is at discharge from the SNF, and focuses on functional status and behavior. Successful rehabilitation is defined as discharge from the SNF to an independent living situation within one year after admission. The second follow-up (T2) is at three months after discharge in patients who have been rehabilitated successfully and focuses on functional status, behavior and quality of life. Data collection has started in January 2008 and will end in July 2010.

Table 2: research instruments

	Instrument	discipline	T0	T1	T2
Patient	Patient characteristics	Physician	X		
	Co-morbidity: Charlson Index	Physician	X		
	Medication list	Physician	X	X	
Caregivers	Social situation	Nurse	X	X	X
	COOP WONCA	Nurse	X		
	Caregiver strain index	Researcher			X
Functional status	Position sense ankle	Physician	X		
	Vibration sense: Rydell Seiffer	Physician	X		
	Barthel index	Nurse	X	X	X
	Social activity: Frenchay activities index	Nurse	X		X
	One leg standing balance	Physio	X	X	X
	Functional Ambulation Categories	Physio	X	X	X
	Timed up and go test	Physio		X	X
	SIGAM mobility questionnaire	Physio		X	X
Cognition	Mini mental state examination	Psychologist	X		
	Clock drawing test	Psychologist	X		
	Hetero anamnestic cognition test	Nurse	X		
Behavior	Neuropsychiatric inventory	Nurse	X	X	X
	Neuropsychiatric inventory Nursing Home	Nurse	X	X	
	Global depression scale 8	Psychologist	X	X	X
Quality of life	RAND 36 version 2	Researcher			X

COOP WONCA The Dartmouth COOP Functional Health Assessment Charts / WONCA, Physio Physiotherapist

Patients

All patients who are consecutively admitted to one of the specialized rehabilitation wards of the 11 participating SNFs are eligible to participate in this study. All participating SNFs collaborate in the Nijmegen University Nursing Home Network of the Radboud University Nijmegen Medical Center. After admission patients are provided with oral information from the treating physician or nurse. In addition, all patients and their caregivers receive written information about the study. The patients indicate if they are interested to participate. No other inclusion criteria are applied. Inability to give informed consent is an exclusion criterion. The attending physician judges the legal capacity of his/her patients. In the case of doubt he/she consults the caregivers. The GRAMPS website (www.gramps.nl) provides extra information for interested patients and their caregivers.

Ethical approval

This research protocol was presented to the medical ethics committee of the district Nijmegen- Arnhem, the Netherlands. Ethics approval was not deemed necessary, because the design is observational and because legally incapable patients are excluded.

Instruments

Data are collected by the multidisciplinary teams that are specifically trained to perform the assessments. During collective meetings all team members of participating SNFs received the same instructions from the researchers. The outcome measures have been selected based on previously established reliability and validity, and are in accordance with other research in this area.

Patient characteristics

Patient characteristics as well as disease characteristics, medication use, and information about comorbid diseases, using the Charlson Index (CI), are collected. The CI comprises 19 categories of diagnoses derived from the International Classification of Diseases (9th Revision Clinical Modification ICD-9CM), and is based on a set of risk factors for one-year mortality risk. [49] The CI contains a weighted index for each disease at which the score is a significant predictor of one-year survival. One-year mortality rates for the different scores are: "0" 12%, "1-2" 26%, "3-4" 52% and ">5" 85%.

Functional status

The Barthel Index (BI), modified by Collin et al. in 1988, measures dependency in activities of daily living (ADL). [50] The BI is a valid and reliable instrument in patients with vascular risk factors, such as stroke. [50-53] The total score ranges from 0-20, with 20 representing complete functional independence. The BI is also used in amputation rehabilitation research. [172] The Frenchay Activities Index (FAI) is used for assessment of extended ADL. The FAI scores the actual activities undertaken by patients and has three domains: domestic housework, indoor activities and outdoor activities. [54] The 15-item questionnaire is a reliable and valid instrument for measuring functional outcome in amputation patients. [173] Even proxies give reliable information about FAI items. [57, 58]

The one- leg- standing balance test, first used by Schoppen et al., is used to assess standing balance on the unaffected leg. [70]

The Functional Ambulation Categories (FAC) measures (in)dependency of gait. [71] The FAC is an ordinal six-point scale with 0 indicating total dependency for walking and 5 indicating independent walking on all surfaces. The use of a walking device is allowed.

The Timed Up-and-Go test (TUG-test) is a valid and reliable instrument, and assesses physical mobility of elderly patients. [174] It can also be used for measuring the physical mobility of patients with an amputation of the lower extremity. [175] The TUG-test is only performed when FAC score is 3 or higher.

The SIGAM mobility questionnaire is a valid measurement for mobility in lower limb amputees. [176] It also provides information about the use of a prosthesis. In 2008, the SIGAM mobility questionnaire was translated into the Dutch language. [177] The interrater reliability was 100% in the original study as well as in the translation study, which also included SNF residents.

Cognition

The Mini- Mental- State- Examination (MMSE), developed by Folstein and McHugh, [75] is a screening instrument for cognitive impairment, and has a fair reliability and construct validity, with a high sensitivity for moderately-severe cognitive impairment and a lower sensitivity for mild cognitive impairment. [76] It comprises items testing orientation, attention, memory, language and constructive abilities. Bottom and ceiling effects have been described. [77] The Hetero-Anamnestic- Cognition list (HAC list), derived from the MMSE by Meijer in his AMDAS study, is used to explore the presence of premorbid cognitive disabilities. [78] The proxy, preferably a partner if present, is asked a few simple 'yes' or 'no' questions concerning orientation, attention and calculation, language, memory, and executive skills. Severity is judged on the basis of need of assistance or professional therapy required.

The Clock Drawing Test (CDT) provides a quick screening for cognitive impairment. In order to correctly draw a clock, the patient needs several domains of cognition: processing language, visualizing, recall, organization, planning and acting. The scoring system of Freedman et al. is used a score of 9 or less out of 14 items indicates cognitive impairment. [178]

Behavior

The Neuropsychiatric Inventory (NPI), originally developed for dementia patients, [88] gives a global impression of neuropsychiatric symptoms and is applicable in other patient groups as well. The NPI comprises 12 categories of problem behaviors: delusions, hallucinations, agitation/aggression, depression, anxiety, euphoria, disinhibition, irritability/lability, apathy, aberrant motor activity, sleeping disorder and eating disorder. If the interviewed person is a nurse, the NPI-NH (nursing home) is used, that measures severity, frequency and distress. If the interviewed person is the partner or a close relative than the NPI is used, that measures severity and emotional burden. [179] The NPI is a valid and reliable instrument [88] and has been translated into Dutch.

The eight item version of the Geriatric Depression Scale (GDS-8) is a shortened patient-friendly test derived from the GDS-15 version, and has been developed specifically for the nursing home population. [91] It is a valid test and indicates the presence of depression at a cut-off of 3 out of 8.

Quality of life

The RAND- 36, developed to measure health related quality of life in chronically ill patients, comprises eight dimensions: physical functioning, role limitations due to physical health problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems, and general mental health. It also contains an additional item about perceived health change. [92] The item scores of the dimensions need to be recoded according to the RAND health sciences program standards. [93] The RAND-36 has been translated into Dutch by van der Zee et al. and was found to be a valid, reliable, and sensitive measurement of general health. [94]

Caregivers

The Dartmouth COOP Functional Health Assessment Charts/ WONCA subscales physical fitness, daily activities, feelings and overall health are used to measure proxy's functional status. [95-97] Each subscale consists of a short title and an illustrated five-point response scale; scores 16 and up are indicative of high strain. [78]

The Caregiver Strain Index (CSI) is only used after discharge from the nursing home, when participation level of the patient plays a key role. [98] Optimal reintegration reduces the experienced strain of the caregivers. The CSI consists of 13 'yes' and 'no' questions, is an easy-to-use instrument to identify strain, and shows good validity. [99] A score of 7 or more positive responses indicates a high level of strain. [100] The CSI has been used caregivers of patients with various types of diseases, [101-103] but not yet in proxies of patients with lower limb amputation.

Power

Because only 250 patients per year receive rehabilitation after major lower limb amputation in Dutch SNFs, [180] it was decided that 50 patients should be an attainable number. [70]

Data analysis

All data is processed using the Statistical Package for Social Science 16.0 (SPSS 16.0). Different techniques will be used to analyze the data, depending on the research question.

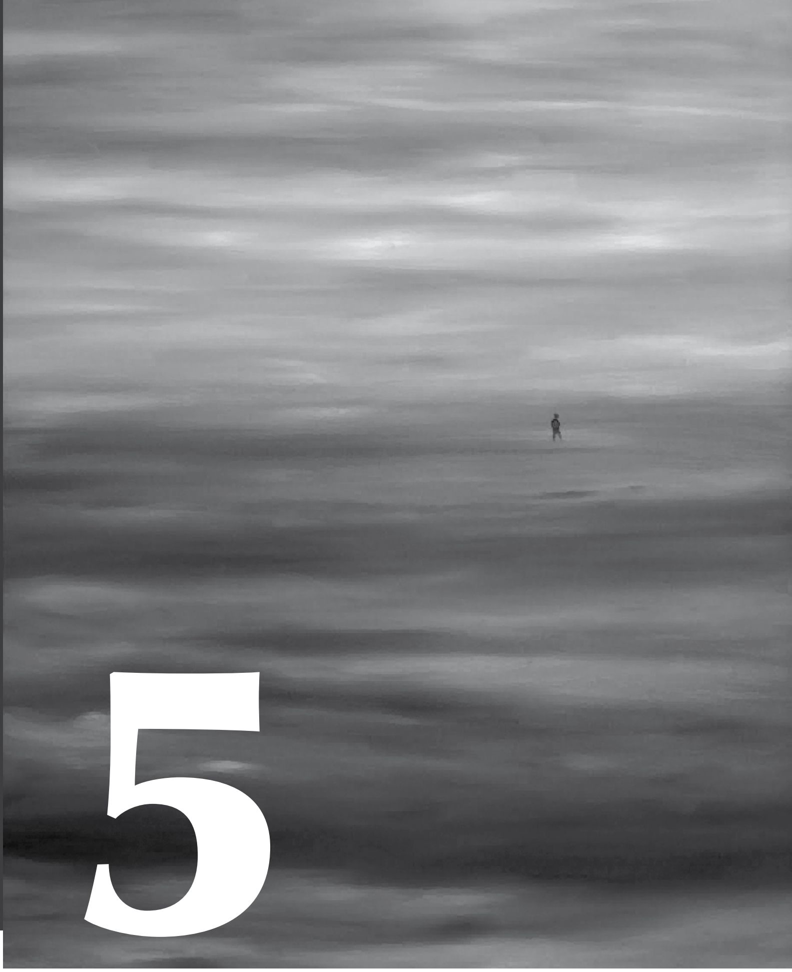
- Descriptive analysis will be used for general patient characteristics, disease characteristics, treatment, successful rehabilitation, and functional outcomes.
- Univariate analyses, parametric as well as non-parametric, will be performed for identifying the demographic and clinical factors that are associated with successful rehabilitation.
- Associated factors will then be tested in a multivariate logistic regression analysis to determine their contribution to successful rehabilitation.

DISCUSSION

To our knowledge, this is the first study that focuses on the factors of successful rehabilitation of patients with major lower limb amputation in SNFs. The patients admitted to SNFs differ from patients admitted to rehabilitation centers with respect to age, number of comorbidities, and amputation level. Therefore, factors associated with successful outcome will probably differ as well. By making use of multivariate logistic regression models the independency of associated factors will be established.

All outcome measures have proven to be reliable and valid, or have been selected in accordance with other research in this area.

Because legally incapable patients are excluded from this study, its external validity may be slightly affected. Therefore, general patient characteristics of the excluded patients are registered and compared to those of the included patients. Besides age, length of stay in the SNF, and discharge destination are recorded to compare both groups to test for selection bias. This multicenter study uses multidisciplinary teams to collect the data over a period of two-and-a-half years and, thus, may suffer from some measurement inaccuracies. To minimize these inaccuracies, over 75 persons from all participating SNFs received the same instructions about performing the outcome measures during collective meetings before the start of the study. To ensure the quality of data collection during the study, each SNF has 2 to 3 specially assigned professionals who maintain contact with the main researchers. In addition, a newsletter is provided every 6-8 weeks to keep everybody involved, informed, and motivated with regard to the progress of the study.



GERIATRIC REHABILITATION OF LOWER LIMB AMPUTEES: A MULTICENTER STUDY

Monica Spruit- van Eijk, Harmen van der Linde,
Bianca I Buijck, Sytse U Zuidema, Raymond TCM Koopmans.

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ABSTRACT

Objective The aim of this study was to determine factors independently associated with successful rehabilitation of patients with lower limb amputation in skilled nursing facilities (SNFs).

Methods All patients admitted to one of the 11 participating SNFs were eligible. Multidisciplinary teams collected the data. Successful rehabilitation was defined as discharge to an independent living situation within one year after admission. Functional status at discharge, as measured with the Barthel Index (BI), was a secondary outcome. Multivariate regression analyses were used to assess the independent contribution of each determinant to the two outcome measures.

Results Of 55 eligible patients, 48 were included. Mean age was 75 years. Sixty-five percent rehabilitated successfully. Multivariate analyses showed that presence of diabetes mellitus (DM) (OR 23.87, CI 2.26-252.47) and premorbid BI (OR 1.37, CI 1.10-1.70) were the most important determinants of successful rehabilitation, whereas 78% of the variance of discharge BI was explained by premorbid BI, BI on admission, and 1-leg balance.

Conclusion The presence of DM and high premorbid BI were associated with discharge to an independent living situation within one year after admission. Premorbid BI, admission BI, and 1-leg balance were independently associated to discharge BI.

BACKGROUND

The most common cause for lower limb amputation is peripheral arterial disease (PAD). Worldwide incidence and prevalence rates of PAD are not known, partly because the diagnosis is often unrecognized in primary care settings.[160] Usually, amputation occurs in elderly with underlying PAD or diabetes mellitus (DM).[181, 182] In 2005, approximately 600.000 people in the United States with a comorbid diagnosis of DM underwent an amputation secondary to vascular disease.[161]

Mortality rates are high after major lower limb amputation. Dillingham et al. found that more than 40% of PAD patients die in the first year after their amputation.[163] The perioperative mortality is approximately 10%[164, 165] with lower mortality-rates in transtibial amputations (TTA) than in transfemoral amputations (TFA).[166, 167] Cardiovascular diseases are one of the most important factors associated with peri-operative[165, 168] as well as long-term mortality.[168, 169]

After the acute care in a hospital, patients with lower limb amputation are often referred for rehabilitation. ´High intensity´ rehabilitation programs are provided in rehabilitation centers for relative young patients, whereas ´low intensity´ rehabilitation programs are provided in skilled nursing facilities (SNF) for frail elderly patients. Determinants of functional outcome after rehabilitation for lower limb amputation, especially for elderly patients that rehabilitate in SNFs, are not known. Most literature on determinants of functional outcome has been confined to rehabilitation centers.[70, 165, 168-172, 183-185] In these, mostly retrospective studies, amputation level,[165, 168-170] and age[70, 169-172] are found to be one of the most important factors determining outcome. Higher age is associated with a poorer outcome. Also, comorbidity, i.e. cardiovascular diseases[169, 184]/ congestive heart failure,[165] cerebrovascular[170, 184] diseases, and other vascular diseases (such as renal diseases)[169] are associated with negative outcomes, such as death or institutionalization. In a large retrospective, nation-wide study, Dillingham and Pezzin[163] examined the impact of discharge to alternative post-acute care settings after lower limb amputation, including SNFs. They found that high age and multimorbidity are usually the reason patients are referred to 'low intensity' rehabilitation in SNFs, rather than 'high intensity' rehabilitation. But it is unclear whether age, multimorbidity or other characteristics (ie functional status and cognition) predict rehabilitation outcome in SNFs in these elderly lower limb amputees.

For this reason, we have set up a multicenter study in 11 SNFs in the Netherlands, with the primary goal to determine the factors that independently contribute to the success of rehabilitation and to functional status at discharge after rehabilitation in SNFs.

METHODS

This study is part of the Dutch Geriatric Rehabilitation in AMPutation and Stroke (GRAMPS) study, which is a prospective, multicenter, cohort study primarily aimed at identifying determinants of rehabilitation outcomes in SNFs. From January 2008 until March 2010, multidisciplinary teams collected baseline data within two weeks after admission. Assessments were focused on demographic and clinical characteristics as well as on functional and cognitive status of the included participants. At discharge or (at the latest) one year after admission, outcome measures were collected in the same participants. The research methods were approved by the regional medical ethics committee.

Participants

All patients who were consecutively admitted to one of 11 SNFs, in the Southern part of the Netherlands, were eligible to participate in this study. The only inclusion criterion was rehabilitation for lower limb amputation. After admission, patients were provided with oral information from the treating elderly care physician or nurse. In addition, their caregivers received written information about the study. The patients themselves indicated whether they were interested to participate by giving their written informed consent, while the attending physicians judged their legal capacity. In the case of doubt, the caregivers were consulted. Patients who were legally incapable were excluded from participation. Demographic characteristics, length of stay in the nursing home and discharge destination were registered for the excluded patients as well.

Each participant was offered extensive multidisciplinary treatment by an elderly care physician, [186] a physiotherapist, an occupational therapist, a psychologist, a dietician, and nursing staff.

Outcome measures

The primary outcome measure was successful rehabilitation, which was defined as discharge to an independent living situation (i.e. home or residential home with or without assistance for (extended) activities of daily living/ADL) within one year after admission. Non-successful rehabilitation was defined as being transferred to nursing home chronic care unit, or death within one year after admission. The secondary outcome measure was functional status registered at discharge assessed with the Barthel Index (BI). [50] The total score ranges from 0-20, with 20 representing complete functional independence. The BI has been used in amputation rehabilitation research previously. [172]

Independent variables

Comorbidity was measured using the Charlson Index (CI). [49] The CI comprises 19 categories of diagnoses derived from the International Classification of Diseases (9th Revision Clinical

Modification ICD-9CM), and is based on a set of risk factors for one-year mortality risk. We excluded PAD and DM from the total score of the CI, because these two items reflect the condition being investigated, and DM was entered as a separate factor in the analyses. The attending elderly care physician also collected disease characteristics, related to the amputation; amputation level (upper versus lower), the presence of phantom pain, and wound healing problems. Upper amputation level was defined as disarticulation of the hip, TFA, and transgenual amputation, and lower amputation level as TTA, and minor amputation. Other relevant patient and disease characteristics were collected from patients' charts.

For evaluation of the functional status at baseline, various research instruments were selected. The BI was recorded as a measure of basic ADL. [50] In addition, the premorbid BI was estimated based on history taking. For the assessment of extended ADL, the Frenchay Activities Index was registered. [54] The FAI scores the actual activities undertaken by patients and has three domains: domestic housework, indoor activities and outdoor activities. The 15-item questionnaire is a reliable and valid instrument for measuring functional outcome in amputation patients. [173] The one- leg- standing balance test, first used by Schoppen et al., [70] was used to assess standing balance on the unaffected leg.

The Functional Ambulation Categories (FAC) measures (in)dependency of gait. [71] The FAC is an ordinal six-point scale with 0 indicating total dependency for walking and 5 indicating independent walking on all surfaces. The use of a walking device is allowed. Global cognitive functioning was measured using the Mini- Mental- State- Examination (MMSE). [75] It comprises items testing orientation, attention, memory, language and constructive abilities.

Statistical analysis

The data was processed using the Statistical Package for Social Science 16.0 (SPSS 16.0). First, the Intra-class Correlation Coefficients (ICCs) were calculated to determine whether outcome measures of the participants were nested within the 11 participating SNFs, which would require multilevel analysis. In addition, to exclude selection bias, differences in demographic characteristics between included and excluded patients were tested using t-tests, or non-parametric tests.

The two outcome measures were analysed separately using multivariate logistic (successful rehabilitation) and linear (BI at discharge) regression analysis. First, the association of each independent variable with the outcome measure was assessed in univariate analyses using t-tests or Mann Whitney U test for continuous variables and chi-square tests for categorical variables. The independent variables that were statistically significant ($p < 0.10$) associated with the outcome measure were entered in a multivariate regression analysis. Variables that were found to have high correlations with other variables in the model (Spearman's Rho > 0,9) were eliminated to allow for convergence of the model. Through backward stepwise elimination, all non-contributing variables ($p > 0,05$) were excluded, leading to the 'best-fit' model. Odds ratios and *b* coefficients with corresponding 95% confidence intervals (CIs) were

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calculated for each of the contributing factors. The independent contribution of each of the factors in the model was calculated using R^2 and R^2 change scores, obtained by subsequently entering the selected variables into the model. Interaction terms and possible confounders were also entered in the model to make allowance for possible effect modification, but were left out of the final analysis when they did not appear to reach statistical significance ($p < 0.05$).

RESULTS

Of 55 eligible patients, 48 participated in this study; 4 patients were legally incapable, and 3 patients did not give informed consent. Of the included patients, 45 underwent an amputation because of PAD with or without DM, 1 patient had a tumour, 1 patient had an osteomyelitis due to infected ostesynthesis, and 1 patient had a trauma, which required amputation. Table 1 shows the characteristics of participants. Patients excluded in the study did not differ in terms of age (mean age 70.5±15.4), gender, and length of rehabilitation stay (median 74 days, range 17-255days) from those included in the study (Mann Whitney U 151.0 p=.668), Chi square 0.982 p=.322 and Mann Whitney U 107.0 p=.324, respectively).

The median Charlson Index score modified for amputation was 2; 9 patients scored '0', 14 patients scored '1', 18 scored '2', and 7 scored '≥3'. Outcome data were available for all patients;

Table 1: patient characteristics and rehabilitation outcome of lower limb amputees in SNFs (n=48)

Age, years	75.2 (sd 8.6)
Male/ Female, n	18/30
Amputation level, n	
- Disarticulation hip	1
- Transfemoral	17
- Transgenual	5
- Transtibial	23
- Minor amputation	2
Median length of hospital stay, days	35 (range 12-129)
Wound healing problems	75%
Other skin problems	33%
Comorbidity, adjusted Charlson index*	2 (range 0-5)
Congestive heart failure	29%
Myocardial infarction/ instable angina	29%
Stroke	21%
Chronic pulmonary disease	19%
Median length of rehabilitation stay, days	142 (range 15-365)
Successful rehabilitation, n	31
Non-successful rehabilitation, n	17

* Charlson index with PAD and DM excluded.

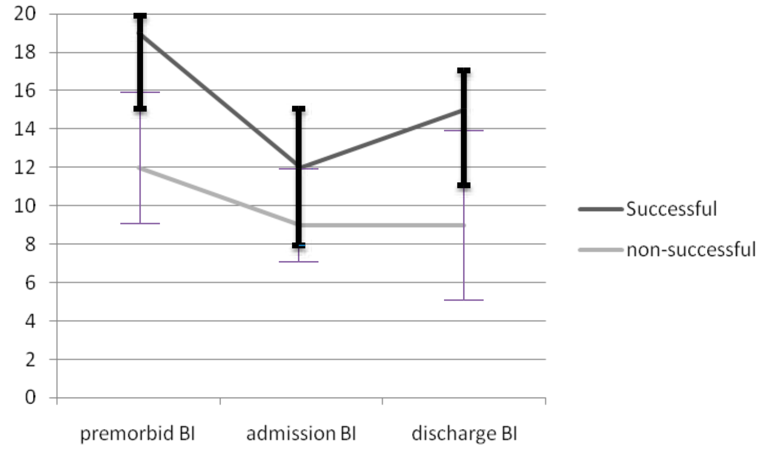
31 (65%) patients rehabilitated successfully, nine patients could not be discharged within one year after admission, and eight patients (17%) died during the rehabilitation process of which seven died of congestive heart failure. Eight patients were transferred to long-term care in a nursing home and ten patients were transferred to residential homes of whom three already resided in a residential home. Consequently, 15 patients had a change in living situation.

Description of the relation between functional outcome and discharge

Median BI increased from 11 (range 0-18) on admission to 15 (range 2-20) at discharge. Patients who rehabilitated successfully increased in BI during admission (Wilcoxon Z= -3.70 p:0.000), whereas non-successfully rehabilitated patients did not (Figure 1) (Wilcoxon Z= -0.09 p:0.932). Both successfully as well as non-successfully rehabilitated patients did not reach level of functional abilities as before amputation. The median discharge BI of patients with impaired 1-leg balance (1-leg balance not possible or possible with support) differs from those able to maintain balance without support (BI 11 and BI 17 respectively, Mann Whitney U= 58.5 p:0.030).

The ICC of the outcomes, successful rehabilitation and BI at discharge, of patients nested within the 11 wards were 0.28 and 0.17, respectively, warranting a multilevel model.

Figure 1: Barthel index scores of successfully and non-successfully rehabilitated lower limb amputees



Data are presented as median and 25-75% percentalis (error bars).
Differences between groups were significant at the premorbid and discharge level (Mann Whitney U= 98.5 p:0.001, and Mann Whitney U= 70.0 p:0.024 respectively).

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Successful rehabilitation

Presence of DM, higher premorbid BI score, and higher FAI score were significantly associated with successful rehabilitation (Table 2). In a multivariate, multilevel analysis, patient with DM and/ or patients with higher premorbid BI had higher odds of a successful rehabilitation (Table 3). There were no interactions between DM, age, and amputation level found. Also, the results were not confounded by age or amputation level.

Table 2: Univariate analyses for successful rehabilitation (SR) and non-successful rehabilitation (NSR), and for functional status at discharge (Barthel index) after rehabilitation for lower limb amputation in SNFs.

	SR	NSR	P	Barthel index		P
				R^2 %	*b*	
Age, mean†	74	76	0.436	19.3	-0.44	***0.005***
Male/Female	10/21	8/9	0.311	8.4	-0.29	***0.070***
Partner present	39%	50%	0.458	0.1	-0.03	0.849
Length of hospital stay, median‡	31	40	0.890	2.0	-0.04	0.794
Amputation level			0.263	4.9	-2.07	0.171
Upper	42%	59%				
Lower	58%	41%				
Phantom pain	58%	38%	0.181	2.2	0.15	0.364
Charlson index, median‡*	1	2	0.156	0.1	-0.34	0.833
Diabetes Mellitus	58%	24%	***0.022***	2.1	0.15	0.371
MMSE, median‡	26	27	***0.901***	9.4	0.31	***0.069***
BIpm, median‡	19	12	***0.001***	47.5	0.69	***0.000***
BIadm, median‡	12	9	0.142	56.6	0.75	***0.000***
FAI, median‡	18	8	***0.060***	21.2	0.46	***0.003***
FAC, median‡	1	0	0.198	21.8	0.47	***0.003***
1leg balance			0.459	41.3	0.64	***0.000***
Not possible	19%	19%				
With support	29%	50%				
Without support <10s	23%	19%				
Without support >10s	29%	13%				

P P-value, MMSE mini mental state examination, BIpm premorbid Barthel index, BIadm Barthel index on admission, FAI Frenchay activities index, FAC functional ambulation categories.

* Charlson index score without peripheral vascular disease and diabetes mellitus

† Students' T test

‡ Mann Whitney U

Others Chi square

Table 3: Multivariate, multilevel analyses for successful rehabilitation and functional status at discharge of lower limb amputees in SNFs.

Dependent	Independent		95%CI	R^2	P value
		Odds ratio			
Successful rehabilitation[1]	Diabetes Mellitus	23.87	2.26-252.47		0.008
	Barthel index pm*	1.37	1.10-1.70		0.005
		B			
Barthel index[2]	Barthel index adm	0.53	0.30-0.75	56.6	0.000
	Barthel index pm	0.35	0.16-0.53	14.8	0.001
	1-leg balance	1.33	0.48-2.17	6.8	0.003

pm premorbid, adm admission

Intercorrelation coefficient between correlates did not exceed 0.9.

Interaction terms were allowed but did not appear to be significant ($p > 0.05$) and therefore were left out of the final analysis.

[1)] Total explained variance of 47.4%, [2)] Total explained variance of 78.3%.

* reflects probability per point.

Discharge functional status

Factors that significantly correlated with discharge functional status were age, gender, MMSE, premorbid BI, BI on admission, FAI score, FAC score, and 1-leg balance (Table 2). Multivariate, multilevel analysis revealed premorbid BI, BI on admission, and 1-leg balance independently related to discharge BI (Table 3).

DISCUSSION

An important question in the rehabilitation of elderly amputees is the determination of the chance of success. This can be interpreted in different ways. Success, from a professional's point of view, is estimated by making use of discharge probability and functional outcome after rehabilitation of the patient. The purpose of this study was to explore determinants of successful rehabilitation and functional outcome after lower limb amputation in patients that are indicated for 'low intensity' rehabilitation.

This was the first prospective, multicenter study that dealt with patients with amputation that rehabilitate in SNFs. We found that the presence of diabetes combined with the premorbid functional status, measured with the Barthel Index (BI), was independently related to successful rehabilitation. Functional status at discharge, the secondary outcome measure, was determined by admission BI score, premorbid BI score, and 1-leg balance admission score and had an explained variance of 78%.

Pre-operative functional ability is important in predicting functional outcome after lower limb amputation. Specifically, a premorbid non-ambulatory or limited ambulatory status has been shown to have a negative impact on rehabilitation outcome. [165, 169, 184] The premorbid BI was, in this study, an important determinant of rehabilitation outcome. A second indicator for general physical condition in this study was the 1-leg balance test. This simple, easy-to apply test reflects several physical conditions, such as general balance, comorbidity affecting balance, and the condition of the unaffected limb, mainly muscle strength. The finding that balance predicted outcome was in line with Schoppen et al, [70] who found that patients who were able to stand without support had a significantly better outcome than patients that needed assistance to stand on the unaffected leg.

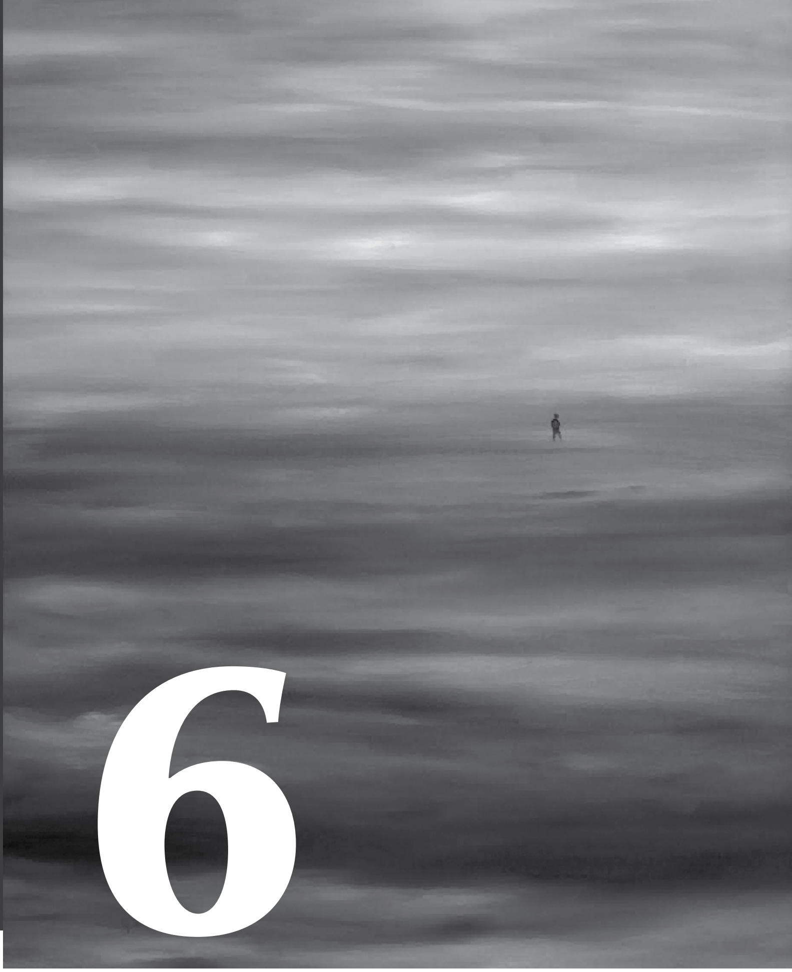
Surprisingly, patients with diabetes had higher odds of successful rehabilitation. Diabetics had 23.87 higher odds of being discharged to an independent living situation within one year after admission. Other researchers, that included the presence of diabetes as a separate factor in the model, did not find such an association. [70, 165] Patients with diabetes usually have a lower amputation level, compared to their non-diabetic counterparts. This is due to a different anatomic distribution of vascular occlusion. [187] Patients with DM and PAD have more pronounced arterial occlusion in their calves, usually leading to TTA. DM, in this study, was not confounded by amputation level.

The determinants age and amputation level, known from the literature, were both not independently associated with the rehabilitation outcome in this study. Compared to other previous studies, in which age turned out to be a predictor of successful rehabilitation, [169-172] the range of age of the included patients in the present study was probably too small to discriminate, and therefore age was excluded from the analysis. Amputation level was not a confounder for DM, as described above. It has long been accepted that amputation level is a major determinant of post-amputation functionality. However, this association could not be established in this patient sample.

Some limitations warrant further consideration. First, premorbid BI was an important determinant of outcome in this study. However in line with the literature, these results should be carefully interpreted, because of possible recall bias. The premorbid BI was assessed on admission to the SNF. Usually, but not always, the patient was accompanied by his/her partner, which gives lower chance of recall bias. Secondly, although a large number of SNFs participated, the low number of included patients limits the generalizability of the results. This study was performed in patients that were indicated for 'low intensity' rehabilitation, admitted to an SNF. All patients, who are not able to undergo 'high intensity' rehabilitation, are eligible to be admitted for such a rehabilitation program. This includes the patients with minor amputations, not able to be discharged home, and patients with cognitive disabilities. Legally incapable patients were excluded from participation in this study and the results of the 2 patients with minor amputations will probably not have affected the outcome. Finally, the determinants found after multivariate regression analyses should not be interpreted as predictors. Further investigation of these results in a new patient population is necessary.

The results of this study implicate the need to improve physical condition before amputation, or maybe, amputation in an earlier stage in elderly patients with extended multimorbidity. In that case, patients may still have physical reserve to ambulate. Some authors have suggested that earlier vascular surgical intervention could lead to better functional outcomes in a group with poor longevity and poor functional capacities, [188] much like the elderly with low physical endurance in an SNF, while others take it one step further by suggesting aggressive operative treatment in older, sicker patients. [169] This last statement is mainly related to the limited gain of functional rehabilitation in patients with premorbid low perseverance, usually due to multimorbidity. Prosthetic ambulation gives high stress to the cardiovascular and pulmonary system, due to increased energy costs. [189, 190]

In conclusion, the presence of DM and high premorbid BI were associated with discharge to an independent living situation within one year after admission. Premorbid BI, admission BI, and 1-leg balance were independently associated to discharge BI. Our study is consistent with the literature in that limited pre-operative functional abilities are associated with lower functional status at discharge and lower odds of being successfully rehabilitated. This underlines the importance of premorbid interventions, focusing not only on the vascular condition of the patient, but also on his physical functioning. Maybe, in some cases, earlier amputation will result in a lower level of amputation and therefore to a better functional outcome.



PREDICTING PROSTHETIC USE IN ELDERLY PATIENTS AFTER MAJOR LOWER LIMB AMPUTATION

Monica Spruit- van Eijk, Harmen van der Linde,
Bianca I Buijck, Alexander CH Geurts, Sytse U Zuidema,
Raymond TCM Koopmans.

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ABSTRACT

Study design Prospective design

Background The main determinants of prosthetic use known from literature apply to the younger patient with lower limb amputation. Studies aimed at identifying determinants of outcome of lower limb amputation in elderly patients with multimorbidity that rehabilitate in skilled nursing facilities (SNFs) are scarce.

Objectives To predict prosthetic use and physical mobility in geriatric patients admitted to SNFs for rehabilitation after lower limb amputation and the impact of multimorbidity.

Methods Univariate and multivariate logistic and linear regression analyses were used to identify determinants that were independently related to prosthetic use and the timed-up-and-go test (TUGtest).

Results Of 55 eligible patients, 38 had complete assessments on admission and at discharge. Fifty percent was provided with a prosthesis. Multimorbidity was present in 53% of the patients. Being able to ambulate independently, and having a transtibial amputation (rather than a higher level of amputation), without phantom pain determined prosthetic use (R^2=56%), while cognitive abilities, low amputation level, and pre-operative functional abilities were independently associated with the TUGtest (R^2=82%).

Conclusions Elderly patients referred to an SNF for prosthetic training have a high probability of using a prosthesis when having an independent ambulation after transtibial amputation, without phantom pain. These patients should be considered for prosthetic training.

BACKGROUND

The impact of a major lower limb amputation on mobility is high, especially in elderly patients. Learning to live with a lower limb amputation and to use a prosthesis in daily life activities demands good physical as well as cognitive capacities. Even young healthy patients with a traumatic lower limb amputation may need a considerable period to regain their pre-existent functional status, in which many of them only partially succeed. [191] Prediction of rehabilitation outcome, in particular prosthetic use, is of great interest to physicians and therapists as well as health insurance companies that reimburse the costs of the prosthesis and the rehabilitation process. From a patient perspective, an accurate prognosis of the outcome of rehabilitation is important as well. Several studies on rehabilitation outcome after lower limb amputation show that age, [70, 171, 172] amputation level, [165, 169, 170] stump problems, [191, 192] and cognitive abilities [70, 169, 193] are clinically important determinants. However, most of these studies have been conducted in rehabilitation centers with relatively young patients. [169, 171, 172, 191, 192] Only two studies focused specifically on the geriatric patients with lower limb amputation; Wong et al. [165] studied predictors of mortality, while Fletcher et al. [170] focused on predictors of successful fitting of a prosthesis in patients above the age of 65 years in a rehabilitation center.

At an advanced age, the most important reason for lower limb amputation is peripheral arterial disease (PAD). Patients with PAD often have other medical conditions, such as diabetes mellitus (DM), that may negatively influence their physical and mental capacities, which, in turn, may affect their prosthetic use. However, a consistent relationship between multimorbidity and prosthetic use has not been established in the literature. It has been reported that patients with coronary arterial disease are less likely to walk with a prosthesis. [184, 189] While cerebrovascular disease, [194] respiratory problems, [195] and 'other comorbidities than cardiopulmonary diseases and DM' [70] would also be independently and negatively associated with prosthetic use. However, other studies could not establish a significant and independent relationship between prosthetic use and comorbidities. [171] In a systematic review on predictors of prosthetic use after lower limb amputation, Sansam et al. concluded that the effect of comorbid conditions on walking with a prosthesis is not clear at all. [196] They found large differences between the used methodology and definitions of medical conditions in these studies. In all studies, single medical conditions were investigated in relation to prosthetic use, instead of multiple interacting diseases, often seen in geriatric patients. As a consequence, the influence of multimorbidity on prosthetic use in geriatric patients with a lower limb amputation is still unknown.

In the Netherlands, elderly patients with impaired physical capacities are often admitted to skilled nursing facilities (SNFs) for 'low intensity' rehabilitation after lower limb amputation. These patients usually suffer from multimorbidity and often additional cognitive impairments. [4] Literature suggests that they have a low probability of prosthetic use and obtaining ambulatory skills.[196] Although there is some literature on outcomes of patients who rehabilitated in skilled nursing facilities,[70, 197] there are no studies that have systematically investigated the probability and determinants of prosthetic use in this geriatric population. Therefore, the aim of this study was to determine the predictors of prosthetic use and the association with multimorbidity in geriatric patients with a major lower limb amputation admitted to SNFs. It was hypothesized that multimorbidity would have an independent negative influence on prosthetic use and ambulatory skills in this population.

METHODS

This study is part of the Dutch Geriatric Rehabilitation in AMPutation and Stroke (GRAMPS) study, which is a prospective, multicenter, cohort study primarily aimed at identifying determinants of rehabilitation outcome in SNFs. From January 2008 until March 2010, multidisciplinary teams collected data within two weeks after admission and at discharge from the rehabilitation ward, or at the latest one year after admission to the SNF. The regional medical ethics committee approved the study protocol.

Participants

All patients who were consecutively admitted to one of 11 SNFs in the Southern part of the Netherlands for rehabilitation after lower limb amputation were eligible. No additional inclusion criteria were applied. After admission, patients were provided with oral and written information about the study by the local elderly care physician or nurse. The patients gave their written informed consent, while the attending physicians judged their legal capacity. In the case of any doubt, the caregivers were consulted and asked for their written informed consent. Patients who were legally incapable on admission, and those who had minor amputations that did not require a prosthesis were excluded from participation. Demographic characteristics, length of stay in the SNF, and discharge destination were registered for the excluded patients as well.

Outcome measures

The primary outcome measure was prosthetic use, as assessed by the Special Interest Group of Amputee Medicine (SIGAM) classification.[176] The SIGAM measures mobility in patients with major lower limb amputation, which ranges from level A (not using prosthesis or use of cosmetic limb only) to F (normal or nearly normal use of prosthesis). We dichotomized the SIGAM in level A versus level B-F. In our study, we used the Dutch version called the SIGAM-WAP.[177] The Timed-Up-and-Go test (TUG)[175] was used as a secondary outcome measure to measure physical mobility. In the TUG, a physiotherapist measures time while a patient stands up from a sitting position, walks three meters (with or without a walking aid), turns, walks back, and sits down again. Both outcome measures were also assessed at discharge from the rehabilitation ward.

Independent variables

Multimorbidity was measured using the Charlson Index (CI). [49] The CI comprises 19 categories of diagnoses derived from the International Classification of Diseases (9th Revision Clinical Modification ICD-9CM), and is based on a set of risk factors for one-year mortality risk. We excluded PAD and DM from the total score of the CI, because these two items reflect the condition being investigated, and DM was entered as a separate factor in the analyses. Multimorbidity was defined as having a CI score of > 1. [115] The attending elderly care physician also collected characteristics, related to the amputation i.e.: amputation level (high versus low), the presence of phantom pain (patients were asked if they experienced phantom pain), stumppain (patients were asked if they experienced woundpain), and wound healing problems (these were assessed by the physician). A 'high' amputation level was defined as hip disarticluation, transfemoral amputation (TFA), or kneedisarticulation. A 'low' amputation level was defined as transtibial amputation (TTA). Other relevant characteristics, such as age, gender, and length of hospital stay, were collected from patients' charts.

For evaluation of the functional status at baseline, various research instruments were selected. The Barthel Index (BI) [50] was recorded as a measure of basic ADL. In addition, the preoperative BI was estimated based on history taking. For the assessment of extended ADL, the Frenchay Activities Index was registered. [54, 173] The FAI scores the actual activities undertaken by patients and has three domains: domestic housework, indoor activities, and outdoor activities. The one-leg-standing balance test, first used by Schoppen et al., [70] was used to assess standing balance on the unaffected leg, and is categorized in: not able to stand on one leg, able to stand on unaffected leg with support, able to stand on one leg without support < 10 seconds, and able to stand without support on unaffected leg without support > 10 seconds. The most obvious differences are observed between patients that can hold their balance and patients that cannot hold their balance while standing on the unaffected limb without support. [70] The Functional Ambulation Categories (FAC) measures (in)dependency of gait. [71] The FAC is an ordinal, six-point, scale with 0 indicating total dependency for walking and 5 indicating independent walking on all surfaces. The use of a walking device is allowed. Global cognitive functioning was measured using the Mini- Mental- State- Examination (MMSE). [75] It comprises items testing orientation, attention, memory, language and constructive abilities. The clock drawing test [178] gave additional information about cognitive abilities.

Statistical analysis

The data were processed using the Statistical Package for Social Science 16.0 (SPSS 16.0). First, the Intra-class Correlation Coefficients (ICCs) were calculated to determine whether outcome measures of the participants were nested within the 11 participating SNFs, which would require multilevel analysis. In addition, to exclude selection bias, differences in demographic characteristics between included and excluded patients were tested using t-tests, or non-parametric tests.

The association of each independent factor to prosthetic use was calculated using Chi square test, Students T test, and non-parametric tests when appropriate. The associated factors for the TUG test were obtained by univariate linear regression analysis. The associated variables that were statistically significant ($P < 0.10$) were subsequently entered in a multivariate regression model. Variables that were found to have high correlations with other variables in the model (Spearman's Rho > 0,9) were eliminated to allow for convergence of the model. Through stepwise elimination, all non-contributing variables were excluded, thus, leading to the best-fit model ($p < 0.05$). Odds ratios and *b* coefficients, with corresponding 95% confidence intervals, were calculated for each of the independent variables. The independent contribution of each of the factors in the model was calculated using (Nagelkerke) R^2 and R^2 change scores.

RESULTS

Of the 55 patients admitted for rehabilitation after amputation, 46 patients were included in this study. Four patients were legally incapable, three did not give informed consent, and two patients were admitted for rehabilitation after minor amputations. Of the included patients, 43 underwent an amputation because of PAD with or without DM, 1 patient had a tumour, 1 patient had an osteomyelitis due to infected ostesynthesis, and 1 patient had a trauma, which required amputation. The patients included in the analysis did not differ significantly from the excluded patients in terms of age (Mann Whitney U 168.0 p=0.375) or gender (Chi square 1.085 p=0.298). The duration of rehabilitation period between included and excluded patients was borderline significant (Mann Whitney U 101.50 p=0.060). The median length of stay of the included patients was 143 days (range 15-365), while the median length of stay of excluded patients was 64 days (range 17-255). Table 1 presents the characteristics of the included patients. The ICC of the outcome measure prosthetic use nested within the participating SNFs was 0, indicating that aggregation of data is allowed to perform further analysis.

Of the 46 included patients, eight patients died during the rehabilitation. Seven died of congestive heart failure. Outcome data, concerning the primary outcome measure prosthetic use, were therefore available for 38 patients, of which 31 could be discharged to an independent living situation within one year after admission. Fifty percent of the patients made use of a prosthesis at discharge from the rehabilitation program (Table 1). Of the 19 patients that were fitted with a prosthesis, only 2 patients were not discharged to an independent living situation and were transferred to nursing home long-term care units. Outcome data for the secondary outcome measure, TUG test, were available of 15 patients. Of the four randomly

Table 1: Patient characteristics (n=46) and prosthetic use (n=38) in patients with lower limb amputation in SNFs

Patient characteristics n=46	
Age (age)	75.4 (SD 8.7)
Male/female (n)	17/29
Amputation level (n)	
- Hip disarticulation	1
- Transfemoral	17
- Kneedisarticulation	5
- Transtibial	23
Multimorbidity (Charlson index>1)	54%
Diabetes mellitus	46%
Wound healing problems	22%
Stump pain	39%
Phantom pain	53%
Prosthetic use n=38	
SIGAM n	
A Not using prosthesis	19
B Transfers/ short distances	6
Ca Walk indoors with a frame	2
Cb Walk indoors with two crutches	2
Db Walk outdoors with two crutches	7
E Walk outdoors, occasional/no use walking aid	1
F Walk outdoors any weather/ anywhere without walking aid	1

missing values, two patients used their prosthesis for transfers or short distances only (SIGAM category B) and two used their prosthesis outdoors (SIGAM category Db). The mean TUG test at discharge was 33 seconds (SD 23).

Fifty-four percent of the patients had multimorbidity. The median CI score was 2 (range 0-5). Diseases of the vascular system were highly prevalent. Cardiovascular diseases (ischemic heart disease and/or congestive heart failure) were present in 46% of the patients, and 22% had had a stroke. Additionally, 13% had moderate-to-severe kidney disease. Chronic pulmonary diseases and diseases of the musculoskeletal system were present in 20% and 15% of the patients, respectively. The CI score did not significantly correlate with length of stay (Spearman's Rho -0.04, p: 0.820).

Predictors of prosthetic use and TUG test

Table 2 shows the univariate analysis of the potential predictors and the outcome parameters prosthetic use and TUG test at discharge from the rehabilitation ward. Amputation level (high versus low), the presence of phantom pain, pre-operative BI, FAC-score, and 1-leg balance were significantly significant associated with prosthetic use. Gender, amputation level, impaired wound healing, MMSE, and pre-operative BI were significantly associated with the TUG test.

Multivariate logistic regression analysis revealed low amputation level, the absence of phantom pain, and high FAC score to be independently associated with the use of a prosthesis, with a total explained variance of 55.6% (Table 3). The TUG test had a total explained variance of 81.7% with the MMSE, amputation level, and pre-operative BI as independent correlates. The MMSE was the most important determinant of TUG test at discharge (Table 3), accounting for nearly 60% of the explained variance.

Table 2: Associations for prosthetic use, and univariate linear analyses for Timed Up-and-Go test (TUG-test) after rehabilitation for lower limb amputation in SNFs.

	Prosthetic use			**TUG-test**		
	n=19	**n=19**		**n=15**		
	Yes	No	P-value	R^2	Beta	P-value
Age (years)[†]	73.6	77.4	0.153	0.08	0.79	0.296
Gender (M/F)[x]	6/13	5/14	0.721	0.30	0.45	***0.034***
Length of hospital stay (days)	35	32	0.879	0.05	0.25	0.424
Amputation level (n)[x]			***0.009***	0.25	-23.83	0.056
- High amputation	5	13				
- Low amputation	14	6				
Impaired wound healing[x]	16%	37%	0.141	0.27	29.02	***0.047***
Stump pain[x]	37%	42%	0.740	0.14	-16.48	0.177
Phantom pain[x]	47%	74%	0.097	0.13	16.59	0.182
Multimorbidity*[x]	53%	37%	0.328	0.01	1.01	0.936
CI score	2	1	0.819	0.00	-0.48	0.927
Diabetes mellitus[x]	58%	37%	0.194	0.00	-0.24	0.985
MMSE (0-30)	27	25	0.302	0.60	-5.90	***0.001***
Clock drawing test (0-14)	13	10	0.293	0.09	-6.19	0.325
Barthel Index po (0-30)	20	15	***0.004***	0.35	-5.58	***0.021***
Barthel Index adm (0-30)	12	9	0.306	0.06	-1.69	0.409
FAI (0-35)	25	16	0.386	0.11	-0.68	0.233
FAC (0-5)	2	0	***0.002***	0.08	-4.18	0.313
1-leg balance[x]			***0.011***	0.06	-7.88	0.389
- Not possible	11%	26%				
- With support	16%	53%				
- Without support <10s	37%	5%				
- Without support >10s	37%	16%				

CI score Charlson Index score, MMSE Mini-Mental-State Examination, po pre-operative, adm admission, FAI Frenchay Activities Index, FAC Functional Ambulation Categories,

* Multimorbidity was defined as Charlson index score (with PAD and DM excluded) >1.

[x] Chi square test, [†] Students T test, all others Mann Whitney U test.

Table 3: Multivariate analyses for prosthetic use and Timed Up-and-Go test (TUG-test) **of lower** limb amputees in SNFs.

Dependent	Independent		95%CI	R^2	P value
		Odds ratio			
Prosthetic use[1]	FAC	2.89*	1.23-6.83		0.015
	Phantom pain	7.27	1.02-51.94		0.048
	Amputation level	6.28	1.01-39.00		0.049
		B			
TUG-test	MMSE	-4.58	-6.92- -2.24	59.5	0.001
	Amputation level	-16.13	-29.87- -2.38	13.8	0.025
	Barthel index po	-2.96	-5.86- -0.07	8.4	0.046

FAC Functional ambulation categories, MMSE mini-mental-state examination, po pre-operative.
Amputation level: high versus low
Intercorrelation coefficient between correlates did not exceed 0.9
1) Total explained variance of 55.6%
* reflects probability per point

DISCUSSION

In this study, we found that good functional ambulation on admission, the absence of phantom pain, and low amputation level were independently associated with using a prosthesis after rehabilitation, while good cognition on admission, low amputation level, and preoperative functional independence are highly predictive for functional use of a prosthesis, accounting for almost 82% of the variance of the timed up-and-go test. Multimorbidity, which was hypothesized as being an important factor in determining prosthetic use, did not contribute significantly.

Pre-operative functional ability is important in predicting walking ability after lower limb amputation. Patients with a premorbid limitation in ambulation are not likely to walk with a prosthesis. [169] In contrast, postoperative functional ability does not seem to be related to prosthetic outcome. [196] Leung et al [198] found that the motor subscore of the Functional Independence Measure (FIM) nor the FIM total score on admission was correlated to prosthetic use in their sample of 33 patients with lower limb amputation. However, in the present study, ambulation ability after amputation was an important factor determining prosthetic use. Six of the seven patients that had an independent ambulation on admission (FAC > 3) received a prosthesis for walking. Consistent with the literature, we found pre-operative BI, rather than post-operative BI, to be independently related to prosthetic use. Apparently, when looking at the post-operative functional situation it is useful to evaluate ambulation, rather than global functional assessment.

Good cognitive abilities are a consistent factor, in the literature, predicting prosthetic use. Larner et al. [193] underlines the importance of learning skills in order to adequately use a prosthesis after major limb amputation. Others established a significant relation between cognitive abilities and the level of achieved mobility. [70, 199, 200] Furthermore, patients with dementia have low probability of wearing a prosthesis, and should be grouped with bedridden patients, who usually are best served with a palliative TFA, according to Taylor et al. [169] However, the outcome of patients with dementia with a knee disarticulation (KD) is not clear. The surgical procedure is less traumatic, [197] with the preservation of the thigh muscles, and therefore, patients with dementia could benefit from a KD instead of performing a TFA. [201] Cognitive abilities, in this study, were a major determinant of the TUGtest. However, they did not significantly contribute to having a prosthesis. This is probably due to the definition of prosthetic use in our study; meaning that prosthetic use is ranging from transfer only/ short distances (SIGAM B) to maximum walking ability outdoors (SIGAM F).

Amputation level is a known predictor for rehabilitation outcome and prosthetic use. Patients with a more distal amputation level achieve better walking abilities than patients with a higher amputation level. [164, 169, 170, 195, 202] The main reason for this finding probably is that the energy required for walking with a prosthesis after TFA is significantly higher compared to walking with a prosthesis after TTA. [189, 203] At the same time, this energy level may be negatively affected by other physical disabilities in elderly patients with an amputation.

Phantom pain is a common complication of limb amputation with high morbidity rates. [204] Some authors have suggested that prosthetic use alleviates phantom pain, [205] while others described increased pain sensations after prosthesis fitting. [206] Schoppen et al. [70] did not find any association between stump and/or phantom pain and prosthetic use in their sample of elderly patients. The presence of phantom pain, rather than the presence of stump pain, was independently associated to prosthetic use, in the present study.

Surprisingly, multimorbidity was not independently related to prosthetic use. Other authors did find an association between comorbidity and prosthetic outcome, [70, 171, 194, 195] but none of these studies have used a standardized comorbidity questionnaire. They focused on specific diseases or organ-system impairments. Multimorbidity was defined as having a Charlson Index score of more than 1, modified for amputation. This implicates that at least two more diseases, besides the index disease of PAD with or without DM, were present. This definition of multimorbidity was not arbitrary and has been used in other research, such as stroke research. [115] Multimorbidity was, in this study, evenly distributed between patients with and patients without a prosthesis. Therefore, it could not give an independent contribution to prosthetic use. Further research about the influence of multimorbidity on prosthetic use in all age groups, is still necessary.

An issue, not fully addressed in this paper, is whether geriatric patients with a lower limb amputation are best served in a 'low intensity' rehabilitation program provided in SNFs, or if they could achieve better results in a specialized rehabilitation center. The presence of multimorbidity is not a good outcome measure. Apparently, the pre-operative functional status has a strong relationship with rehabilitation outcome and, thus, gives a better understanding of the outcome compared to the number of interacting diseases. [207] The most important reason for admission to a low intensity rehabilitation program in SNFs is not the multimorbidity per se, but the existence of a fine balance between functioning and the decline of functional reserve, which makes an individual frail. Usually, frailty is accompanied by multimorbidity and high age. [5] Low intensity rehabilitation, combined with the specific skills of geriatric problems, is best addressed in SNFs. On the other hand, the number of patients annually admitted for rehabilitation in SNFs is low. In this study, only 55 patients were admitted to 11 SNFs in a period of one year, questioning the maintenance of appropriate quality for prosthetic training of the multidisciplinary team.

This is the first multicenter cohort study that aimed at identifying predictors for prosthetic use in elderly patients that rehabilitate in SNFs. Unlike other researchers, [170] we excluded the patients who died from the analyses. All patients that were admitted for rehabilitation after major lower limb amputation were eligible, and only a few dropped out because of legal incapability, not giving informed consent, or minor amputation. The excluded patients did not differ from the study population in terms of age or gender. The borderline significant difference in rehabilitation stay is largely due to the limited stay of the patients with minor amputations and the low number of excluded patients. No significant influence of SNFs on outcome measures was found, which underscores the comparability of patient groups, interventions and assessment procedures.

Some limitations warrant further consideration. First, the small number of included patients, in this study, is a major limitation. Despite this, the regression analyses revealed significant independent correlates, although with large confidence intervals. Second, however in line with the literature, the results of the pre-operative BI should be carefully interpreted, because of possible recall bias. The pre-operative BI was assessed on admission to the SNF. Usually, the patient was accompanied by his/her partner, which gives lower chance of recall bias. Third, gender and amputation level distribution is different compared to the literature. In our predominant female population, there was a high number of TFA. However, Dillingham et al. [208] described, in their statewide hospital discharge study, that patients discharged to an SNF were more likely to be older, female and with a higher level of amputation. Lastly, we did not assess the influence of disease, or the interactions between diseases, during the rehabilitation. These so-called intercurrent diseases also play an important role in the functioning of patients, and therefore, influence the rehabilitation process and probably the rehabilitation outcome.

The results of this study can offer clinicians helpful information in the decision-making process of providing a prosthesis after major lower limb amputation in geriatric patients. Geriatric patients with good ambulation after amputation, no phantom pain, and a low amputation level have a fair chance of using a prosthesis, and thus, should be given the opportunity to receive prosthetic training. Furthermore, good cognitive abilities, low amputation level, and pre-operative good functional status predict physical mobility with a prosthesis.

In conclusion, the results of this study indicate that elderly patients admitted for prosthetic training to SNFs are also able to successfully use a prosthesis.

SUMMERY AND GENERAL DISCUSSION

In this thesis, the results of the Geriatric Rehabilitation in AMPutation and Stroke study (GRAMPS study) are presented. GRAMPS is a large multicenter cohort study of geriatric patients that have been admitted to a skilled nursing facility (SNF) in the Southern part of the Netherlands for rehabilitation after stroke or major lower limb amputation. These patients often have a relatively high age (> 75 years), poor physical endurance, and usually suffer from multimorbidity. For these reasons, they are indicated for low-intensity rehabilitation programs. In the Netherlands, such programs are provided in SNFs.

SUMMARY

This thesis is divided into two parts. Part I (chapters 1-3) focuses on geriatric rehabilitation after stroke and part II (chapters 4-5) focuses on geriatric rehabilitation after major lower limb amputation.

Part I

In Chapter 1, the design of the stroke study is outlined. This study was a longitudinal, observational study in 15 SNFs in the Southern part of the Netherlands. All participating SNFs were selected based on the existence of a specialized rehabilitation ward and the provision of multidisciplinary care under the responsibility of an elderly care physician. The multidisciplinary teams collected data on admission and at discharge. Patient characteristics (age, marital status, living situation, Charlson Index, medication list) disease characteristics (stroke location, first stroke, admission date hospital, admission date SNF), and data about functional status (proprioception ankle, vibration sense hallux, Motricity Index, Trunk Control Test, Trunk Impairment Scale, Barthel Index, Frenchay Activities Index, one-leg standing balance, Frenchay Arm Test, Berg Balance Scale, Functional Ambulation Categories, 10m walking speed test, water swallowing test), cognition (Mini-Mental State Examination, Star Cancellation Test, Hetero- anamnestic Cognition List, Apraxia Test, SAN score), behavior (Neuropsychiatric Inventory, Neuropsychiatric Inventory-Nursing Home version, Geriatric Depression Scale 8-item version), and caregiver information (social situation, COOP-WONCA) were collected within two weeks after admission. The instruments at discharge (first follow-up) focused on behavior and functional status (Neuropsychiatric Inventory, Neuropsychiatric Inventory-Nursing Home version, Geriatric Depression Scale 8-item version, Barthel Index, one-leg standing balance, Frenchay Arm Test, Berg Balance Scale, Functional Ambulation Categories, 10m walking speed test). The patients that were successfully discharged to an independent living situation were re-assessed (second follow-up) for functional status (Barthel Index, Frenchay Activities Index, one leg standing balance, Frenchay Arm Test, Berg Balance Scale, Functional Ambulation Categories, 10m walking speed test), behavior (Neuropsychiatric Inventory, Geriatric Depression Scale 8-item version), and quality of life (RAND 36 version

2). All outcome measures that were used in this study have shown to be valid and reliable for use in rehabilitation research or were recommended by the Netherlands Heart Association guidelines.

Chapter 2 describes the determinants that were independently associated with successful discharge and functional status (Barthel Index) of geriatric patients after stroke rehabilitation, with a particular emphasis on the role of multimorbidity. Of 186 included patients, follow-up data of 175 patients were available. Of these, 123 (70%) were successfully discharged to an independent living situation. Multimorbidity, as indicated by the adjusted Charlson Index score >2, was present in 34% of the patients and significantly more present in patients that could not be discharged. Multivariate logistic regression analysis revealed good balance, absence of hemineglect, and relatively low age on admission as independently associated with successful discharge, while multivariate linear regression analysis showed good balance and absence of hemineglect to be independently associated to discharge functional status. The Berg Balance Scale (BBS) score on admission was the most important determinant of discharge Barthel Index, accounting for 41% of the explained variance. Multimorbidity did not independently contribute to rehabilitation outcome.

In Chapter 3, the determinants of postural control on admission were studied using a cross-sectional design. The BBS score was used as a measure of standing balance, whereas the Functional Ambulation Categories (FAC) score was used as a measure of walking balance. Patients with multimorbidity had on average lower scores on both outcome measures. Multivariate linear regression analyses showed that mainly muscle strength of the affected body side and multimorbidity were independently associated with the BBS, while proprioception of the ankle explained a small portion of the FAC variance. Interestingly, the influence of muscle strength on balance was modified by static sitting balance. Muscle strength of the affected body side made a significant contribution to standing and walking balance only in patients with adequate trunk control.

Part II

This section starts with an unpublished outline of the study design of the amputation part of the GRAMPS study. This longitudinal, observational study was conducted in 11 SNFs in the Southern part of the Netherlands. All patients that were indicated for rehabilitation after an amputation of one of the lower extremities were eligible to participate. Multidisciplinary teams collected data on admission and at discharge. Patient and disease characteristics (age, marital status, living situation, Charlson Index, amputation level, admission date hospital, admission date SNF), functional status (proprioception ankle, vibration sense hallux, Barthel Index, Frenchay Activities Index, one-leg standing balance, Functional Ambulation Categories), cognition (Mini-Mental State Examination, Hetero-anamnestic Cognition List, Clock Drawing Test), behavior (Neuropsychiatric Inventory, Neuropsychiatric Inventory-Nursing Home version, Geriatric Depression Scale 8-item version), and caregiver information (social situation, COOP-WONCA) were registered within the first two weeks after admission. The assessments at discharge (first follow-up) focused on behavior (Neuropsychiatric Inventory, Neuropsychiatric Inventory-Nursing Home version, Geriatric Depression Scale 8-item version), and functional status (Barthel Index, one leg standing balance, Functional Ambulation Categories, Timed Up-and-Go Test), which also comprised a Dutch version of the Special Interest Group of Amputee Medicine classification (SIGAM-WAP). The patients that were successfully discharged to an independent living situation were assessed three months after discharge with regard to functional status (Barthel Index, Frenchay Activities Index, one leg standing balance, Functional Ambulation Categories, Timed Up-and-Go test, SIGAM WAP mobility questionnaire), behavior (Neuropsychiatric Inventory, Geriatric Depression Scale 8-item version), and quality of life (RAND 36 version 2).

In chapter 5, the determinants that were independently associated with successful discharge and functional status after rehabilitation for lower limb amputation were studied. Of the 48 included patients, 31 (65%) were successfully discharged. Multivariate logistic regression analysis showed that presence of diabetes mellitus and premorbid activities of daily living (ADL) level were the most important determinants of successful discharge. Multivariate linear regression analysis revealed that premorbid ADL, ADL on admission, and one-legged standing balance capacity together explained 78% of the variance of the Barthel Index at discharge. Although highly prevalent, multimorbidity did not independently contribute to discharge probability or functional status at discharge.

Chapter 6 studied the determinants that were independently associated to prosthetic use. Of the 48 included patients, outcome data of 38 patients was available. Eight patients died during the rehabilitation, and 2 patients had undergone minor amputations that did not require a prosthesis. After rehabilitation, 19 patients (50%) were fitted with a prosthesis. Of these, only two patients were not able to be successfully discharged. They were transferred to a long-term care unit in a nursing home. Based on multivariate logistic regression analysis, it was concluded that patients with an independent ambulation with walking aid on admission (FAC score >3) with a transtibial amputation and without phantom pain had a high probability of being successfully provided with a prosthesis (SIGAM score>A).

GENERAL DISCUSSION

Main findings

This study aimed at determining the outcomes of patients indicated for low-intensity rehabilitation after stroke or major lower limb amputation, with a specific emphasis on multimorbidity. The functional assessments on admission and discharge showed the same distribution for patients that were successfully discharged and those who were not. The former group had a higher admission score that significantly increased towards discharge, whereas the latter group showed a stable score from admission to discharge. Multivariate regression analyses revealed which determinants made (the most important) independent contribution to rehabilitation outcome.

Balance was an important independent determinant of both stroke outcome as well as outcome after major lower limb amputation. In the stroke study, it was the most important factor determining functional status at discharge. Balance itself was best explained by muscle strength on the affected side, absence of multimorbidity, and the interaction between static sitting balance and muscle strength. This latter finding implies that the influence of muscle strength on balance, and thus on discharge Barthel Index, is much stronger in patients with sufficient static sitting balance. The importance of static sitting balance for functional abilities after stroke has previously been described. [124] The ability to maintain static sitting balance combined with good muscle strength of the hemiparetic leg early after stroke (<72 hours) gives an accurate prediction of the probability to regain gait 6 months after stroke. [139] Balance also played an independent role in determining functional abilities in patients after major lower limb amputation, but the association was not as strong as the influence of balance on stroke outcome. Being able to stand on the unaffected leg with the help of an aid, combined with high levels of pre-operative and post-operative independence, gave an accurate prediction of discharge functional abilities. Interestingly, pre-operative functional independence was also an important factor determining successful discharge after rehabilitation, rendering it important to improve functional abilities as much as possible before surgery or, in some cases, make the decision to amputate in an earlier stage.

Functional impact of multimorbidity and frailty

Contrary to our hypothesis, multimorbidity did not independently influence rehabilitation outcome in terms of discharge probability or functional status at discharge in patients with stroke or lower limb amputation. Although the prevalence of multimorbidity differed significantly between 'successful' and 'non-successful' stroke patients, it did not independently contribute to rehabilitation outcomes. Multimorbidity did, however, contribute to admission balance scores, giving support to the notion that relevant aspects of multimorbidity may have been encompassed in functional tests such as the Berg Balance Scale. This might be explained by the impact that diseases can have on physical functioning. For example, chronic obstructive pulmonary disease affects muscle strength in upper as well as lower extremities. [209] Lower extremity muscle weakness is, in turn, associated with balance problems, and thus, with a higher fall risk. [210, 211] Another example is the effect of polyneuropathy, causing muscle weakness and loss of sensibility, leading to balance problems and falls. [212] The consequence of having multiple diseases simultaneously may not just be the sum score of the number of diseases, but rather the functional impact of these diseases together, translated into functional disabilities. [213, 214] The reason that multimorbidity failed to make an independent contribution to rehabilitation outcome may, thus, be a statistical one. Due to the fact that multimorbidity was associated with admission balance, and both these factors were entered in the multivariate regression model, multimorbidity may have dropped out of the explanatory model. Another explanation may be that multimorbidity is not a right measure to distinguish frail elderly from vital elderly. Indeed, when looking at the frailty concept proposed by Fried et al., [5] frailty, disability, and multimorbidity are distinct, though partially overlapping syndromes. Although they have strong causal interrelations that help explain their frequent co-occurrence, multimorbidity is certainly not equivalent with frailty. Both multimorbidity and frailty independently predict disability, while disability, in turn, exacerbates frailty and multimorbidity. [6] There is not a clear definition of frailty, which makes interpretation of studies on frailty rather difficult. In the literature there are 'narrow' and 'broad' definitions, depending on the number of domains of functioning (physical, psychological, cognitive, social) involved, leading to different groups of frail people. A clear definition is necessary for future research on the influence of frailty on rehabilitation outcome as well as for studies on adequate patient selection for rehabilitation programs.

Although more prevalent in patients with lower limb amputation than in stroke patients, multimorbidity was not different between patients that could be successfully discharged and those who could not. Multimorbidity was not an independent factor determining who could be successfully fitted with a prosthesis either. Much more research is needed in the future to better predict rehabilitation outcome after lower limb amputation and the successfulness of prosthetic prescription in geriatric patients.

Study limitations

In this study, 15 SNFs participated with over 75 professionals that carried out the assessments. The number of persons performing the assessments could have compromised the results of this study. Nevertheless, all instruments used in this study were selected based on validity and reliability in rehabilitation outcome research. Another limitation of this study is the measurement of multimorbidity. The Charlson Index [49] is a valid and reliable research instrument to classify prognostic comorbidity and estimate risk of death in longitudinal studies. Goldstein et al. adjusted it for use in stroke outcome studies. [115] The advantages of the (adjusted) Charlson Index are that it is easily applicable, weighted for severity, and adjusted for the index disease(s) (stroke and amputation). It does not, however, give a complete representation of multimorbidity. The severity of each disease listed is not given. For example, a patient with COPD classified as GOLD I scores as high as a patient with COPD classified as GOLD IV, while the latter has a higher mortality risk. [215] In addition, an important disease missing in the Charlson Index, but of major importance to the geriatric population, is osteoarthritis. It brings about major disability related to ambulation [216] and ADL functioning. [217, 218] Another limitation of the studies in this thesis was the way intercurrent health problems were assessed during rehabilitation. It was hypothesized that these would make an important contribution to rehabilitation outcome. Unfortunately, the developed questionnaire was subject to recall bias, because the physicians had to fill it in afterwards, when they knew the outcome of rehabilitation. As a consequence, it was not possible to validly incorporate the intercurrent health problems into the analyses.

There are three important issues to be considered that could have compromised the external validity of the studies in this thesis. First, patients were excluded who were not able to give informed consent for participation. These patients usually had (pre-) dementia. Cognitive impairment frequently occurs after stroke [219-221] as well as in patients with peripheral arterial disease (PAD). [222, 223] Severe cognitive impairment is one of the reasons why patients are indicated for low intensity rehabilitation. [224] By excluding the patients with severe cognitive impairment, the between-subjects variability on the MMSE was reduced, which might be the reason that it failed to contribute to explaining successful discharge and functional status at discharge.

The second issue that could have compromised the external validity is the duration of hospital stay of the stroke patients. In the past decade, the number of days spent in the hospital after stroke dropped significantly in the Netherlands. A large national breakthrough collaborative improvement project for stroke care, the Edisse study, [13] found a decrease in hospital stay of more than 40% (from 19-25 days to 12-13 days) after introducing a quality improvement model for stroke services, whereas all other not-participating hospitals showed a reduction of only 5.7% (from 19 days to 18 days) in the same period. [225] The 23 included stroke services formed multidisciplinary teams, which worked together to improve quality of care. It turned out that the teams that scored high on team functioning made the greatest improvement in terms of length of hospital stay, indicating that good teamwork is an essential part of high-quality patient care. [225] There was no additional information on discharge destination of the patients in these stroke services, nor was there a correction for stroke severity or functional status. National figures, produced by the Dutch Heart Association, show that the mean hospital stay has dropped from 25-32 days in 1980 to 9-10 days in 2009. [226] These numbers, as well as the numbers of the breakthrough project, comprise all patients admitted to the hospital stroke unit, including patients with transient ischemic attacks and minor strokes with low levels of disability, that are directly discharged home and not just the patients that are indicated for rehabilitation in SNFs. In the stroke studies of this thesis, mean hospital stay was 23 days, which can be considered long. On the other hand, these patients form a clear selection of all patients admitted to acute stroke units, explaining the length of their stay in hospital. As a result, the baseline characteristics were registered three weeks after the stroke, which implies that a considerable amount of spontaneous recovery had already taken place. [227]

Thirdly, although a large number of SNFs contributed to the research of this thesis, the results can still not be generalized to all patients that are indicated for low intensity rehabilitation in SNFs after stroke or major lower limb amputation. It would, therefore, be good when the established determinants of rehabilitation outcome would be tested in an independent patient sample recruited in other nursing homes.

Implications for clinical practice

With a changing reimbursement system and, with this, the opportunity to select patients for different low-intensity rehabilitation programs, it is important for SNFs to have more information on the individual patient characteristics that are associated with rehabilitation outcome. With the results of this thesis, a first step can be made in identifying patients with a good probability of being successfully discharged after rehabilitation for stroke or major lower limb amputation.

For an optimal rehabilitation process, it is important for professionals to share a common understanding of functioning, preferably by using valid and reliable instruments. [2] To date, routine use of clinimetrics in SNFs is scarce, though it offers helpful and objective information on patients' progress. When considering a clinimetric core-set, it is important that all members of the multidisciplinary team are familiar with the tests. In the studies of this thesis, an extensive set of measures was used with the purpose of collecting as much information as possible about physical, cognitive and social functioning to build a best model to explain rehabilitation outcome with a limited set of independent determinants. A large set of instruments is neither feasible nor necessary for clinical practice. The most important outcome determinants should, however, be included. For stroke patients the core-set on admission should at least consist of valid instruments to assess balance, muscle strength and hemineglect. Together with the patient's age, these measures give a fair global indication of rehabilitation outcome in terms of discharge probability and ADL functioning at discharge probability. In addition, other studies indicate that an ADL score on admission is also highly predictive of ADL functioning in the long term. [228, 229] Discharge functional status of patients that are admitted to an SNF after lower limb amputation is best determined by measures of pre-operative and postoperative functional abilities, and the ability to stand on one leg. In addition, the assessment of diabetes mellitus is important in patients with lower limb amputation, because these patients have a better chance of being successfully discharged, independent of amputation level or age. Although the MMSE score on admission did not independently contribute to rehabilitation outcome, it seems important to know the learning abilities of cognitively impaired patients to plan an adequate rehabilitation process. Therefore, all stroke patients should undergo a concise neuro-psychological evaluation shortly after admission. Finally, although multimorbidity did not directly influence the outcome of rehabilitation, it may still influence the rehabilitation process. For instance, the presence of multiple chronic diseases in an advanced stage directly affects the physical performance of elderly. Although these conditions may not be cured, they can often be optimized, for example by screening and adjusting unnecessary or even harmful medication, or by regulating blood glucose levels in diabetes. Therefore, it is important for the elderly care physician to closely monitor and optimize the comorbidities of all patients admitted for rehabilitation in SNFs.

Implications for future research

This study raises several questions that need to be further investigated. The influence of both frailty and intercurrent health problems has not yet been studied. It is important to better define these possible determinants and investigate their influence on rehabilitation outcome. In the literature there are different definitions of frailty, varying from a purely medical perspective [5] to a complex interplay of biomedical and psychosocial aspects. [230] These definitions have some overlap, because they share a medical basis. Besides a clear definition of frailty, Fried et al. [5] also described a 'phenotype' of frailty, making it better measurable. It was defined as a clinical syndrome in which three or more of the following criteria has to be present: unintentional weight loss, muscle weakness (grip strength), self reported exhaustion, slow walking speed, and low physical activity. Although other instruments are available, this clinical approach to frailty can aid the research on determinants of outcome of low-intensity rehabilitation. Further studies on using this phenotypical approach are needed. Information about intercurrent diseases should be collected prospectively in order to determine their influence on outcome of low-intensity rehabilitation. Although therapy intensity was measured in individual patients, the impact of intensity on rehabilitation outcome could not be determined in this thesis due to the lack of a control group and the likely biased administration of therapy to individual patients. This issue needs further scientific evaluation. Finally, to investigate determinants of outcome of low-intensity rehabilitation in an early stage after stroke, data of patients that are expected to be discharged to an SNF should already be collected in the hospital phase.

Final conclusion

In conclusion, prediction of successful discharge and functional status at discharge is possible for stroke patients and patients with lower limb amputation that have been indicated for low-intensity rehabilitation in skilled nursing facilities. Such prediction gives the opportunity to better plan the rehabilitation process. From this perspective, it is important to use a core-set of functional assessments in daily clinical practice. These assessments will also help in sharing a common understanding of patients' functioning.

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SAMENVATTING

In dit proefschrift worden de resultaten gepresenteerd van de Geriatric Rehabilitation in AMPutation and Stroke (GRAMPS) studie. GRAMPS is een grote multicenter cohort studie, uitgevoerd in instellingen in het zuiden van Nederland. Het cohort bestaat uit geriatrische patiënten die zijn opgenomen op een gespecialiseerde afdeling van een verpleeghuis voor revalidatie na een cerebrovasculair accident (CVA) of een beenamputatie. Deze patiënten hebben vaak een hoge leeftijd (>75 jaar), een afgenomen conditie en hebben meestal multimorbiditeit. Om deze redenen komen geriatrische patiënten in aanmerking voor laag-intensiteit revalidatieprogramma's. In Nederland worden dergelijke programma's aangeboden in verpleeghuizen.

Dit proefschrift is onderverdeeld in twee delen. Deel I (hoofdstuk 1-3) beschrijft de geriatrische revalidatie na een CVA en deel II (hoofdstuk 4-5) beschrijft de geriatrische revalidatie na een beenamputatie.

Deel I

In Hoofdstuk 1 wordt een beschrijving gegeven van de opzet van het CVA deel van de GRAMPS studie. Het betreft een longitudinale, observationele studie, die werd uitgevoerd in 15 verpleeghuizen, gesitueerd in het zuiden van Nederland. Alle participerende verpleeghuizen werden geselecteerd op de aanwezigheid van een gespecialiseerde revalidatieafdeling. De behandeling werd aangeboden door een multidisciplinair team onder verantwoordelijkheid van een specialist ouderengeneeskunde. Het multidisciplinaire team verzamelde gegevens bij opname en ontslag. Patiëntkarakteristieken (leeftijd, burgerlijke stand, leefsituatie, Charlson Index, medicatielijst), ziektekarakteristieken (locatie CVA, eerste CVA, opnamedatum ziekenhuis, opnamedatum verpleeghuis) en gegevens over de functionele status (proprioceptie van de enkel, vibratiezin hallux, Motricity Index, Trunk Control Test, Trunk Impairment Scale, Barthel Index, Frenchay Activities Index, stabalans op 1 been, Frenchay Arm Test, Berg Balance Scale, Functional Ambulation Categories, 10m looptest, watersliktest), cognitie (Mini-Mental State Examination, Star Cancellation Test, hetero-anamnese lijst cognitie, Apraxie Test, Stichting Afasie Nederland/ SAN score), gedrag (Neuropsychiatric Inventory, Neuropsychiatric Inventory-Nursing Home versie, Geriatric Depression Scale 8-item versie) en informatie over mantelzorgers (sociale situatie, COOP-WONCA) werden binnen twee weken na opname in het verpleeghuis vastgelegd. De instrumenten bij ontslag (eerste follow-up) richtten zich op gedrag en functionele status (Neuropsychiatric Inventory, Neuropsychiatric Inventory-Nursing Home versie, Geriatric Depression Scale 8-item versie, Barthel Index, stabalans op 1 been, Frenchay Arm Test, Berg Balance Scale, Functional Ambulation Categories, 10m looptest). De patiënten die succesvol werden ontslagen naar een onafhankelijke leefsituatie werden opnieuw in kaart gebracht bij een tweede follow-up meting betreffende hun functionele status (Barthel Index, Frenchay Activities Index, stabalans op 1 been, Frenchay Arm Test, Berg Balance Scale, Functional Ambulation Categories, 10m looptest), gedrag (Neuropsychiatric

Inventory, Geriatric Depression Scale 8-item versie) en kwaliteit van leven (RAND-versie 2). Alle instrumenten die werden gebruikt in de GRAMPS studie zijn valide en betrouwbaar gebleken in eerder onderzoek over revalidatie of werden aangeraden in de richtlijnen van de Nederlandse Hartstichting.

Hoofdstuk 2 beschrijft de determinanten die onafhankelijk geassocieerd waren met succesvol ontslag en functionele status (Barthel Index) na de revalidatie van geriatrische patiënten met een CVA, met de nadruk op de rol van multimorbiditeit. Van de 186 geïncludeerde patiënten waren van 175 patiënten follow-up gegevens beschikbaar. Hiervan werden er 123 (70%) succesvol ontslagen naar een onafhankelijke leefsituatie. Multimorbiditeit, gedefinieerd als een adjusted Charlson Index score >2, was bij 34% van de patiënten aanwezig en significant meer aanwezig bij hen die niet-succesvol ontslagen konden worden. Multivariate logistische regressie analyse liet zien dat goede balans, afwezigheid van hemineglect en relatief lage leeftijd bij opname onafhankelijk geassocieerd waren met succesvol ontslag. Goede balans en afwezigheid van hemineglect waren onafhankelijk geassocieerd met functionele status bij ontslag. De Berg Balance Scale (BBS) score was de belangrijkste determinant van de Barthel Index bij ontslag, die 41% van de variantie verklaarde. Multimorbiditeit droeg niet onafhankelijk bij aan de uitkomst van revalidatie.

In Hoofdstuk 3 worden de determinanten van stabalans beschreven, waarbij gebruik werd gemaakt van een cross-sectionele studie opzet. De BBS bij opname werd gebruikt als maat voor stabalans, terwijl de Functional Ambulation Categories (FAC) bij opname werd gebruikt als maat voor loopvaardigheid. Patiënten met multimorbiditeit scoorden gemiddeld lager op beide uitkomstmaten. Uit multivariate lineaire regressie analyse bleek dat voornamelijk spierkracht van de aangedane zijde en het hebben van multimorbiditeit onafhankelijk geassocieerd waren met de BBS score bij opname. Proprioceptie van de enkel verklaarde een klein deel van de variantie van de FAC. Het opmerkelijke was dat de invloed van spierkracht op de stabalans gemodificeerd werd door de statische zitbalans (rompbalans). Spierkracht in de aangedane lichaamszijde droeg alleen significant bij aan de stabalans bij patiënten met een adequate rompbalans.

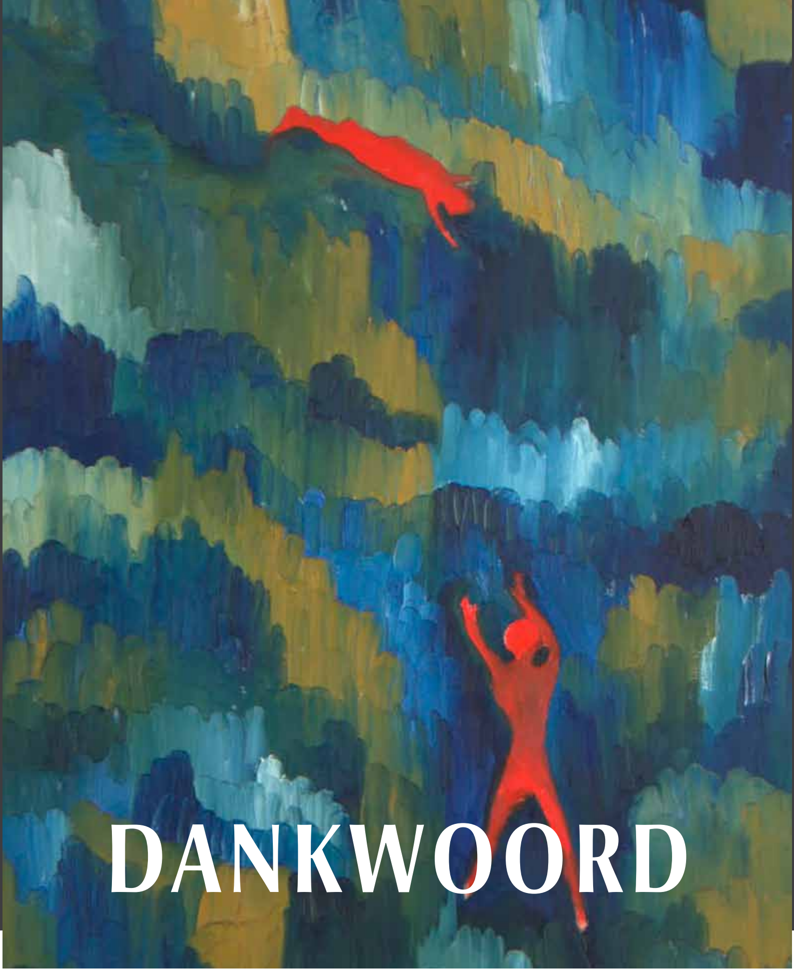
Deel II

Dit deel begint met een beschrijving van de opzet van het amputatiedeel van de GRAMPS studie. Deze longitudinale, observationele studie werd uitgevoerd in 11 verpleeghuizen in het zuidelijke deel van Nederland. Alle patiënten die een indicatie hadden voor revalidatie na een beenamputatie kwamen in aanmerking voor deelname aan het onderzoek. Multidisciplinaire teams verzamelden gegevens bij opname en ontslag. Patiëntkarakteristieken en ziektekarakteristieken (leeftijd, burgerlijke staat, leefsituatie, Charlson Index, amputatieniveau, opnamedatum ziekenhuis, opnamedatum verpleeghuis), functionele status (proprioceptie enkel, vibratiezin hallux, Barthel Index, Frenchay Activities Index, stabalans op 1 been, Functional Ambulation Categories), cognitie (Mini-Mental State Examination, hetero-anamnese lijst cognitie, kloktekentest), gedrag (Neuropsychiatric Inventory, Neuropsychiatric Inventory-Nursing Home versie, Geriatric Depression Scale 8-item versie) en informatie over mantelzorgers (sociale situatie, COOP-WONCA) werden binnen twee weken na opname geregistreerd. Bij ontslag werden vooral gegevens over gedrag (Neuropsychiatric Inventory, Neuropsychiatric Inventory-Nursing Home versie, Geriatric Depression Scale 8-item versie) en functionele status (Barthel Index, stabalans op 1 been, Functional Ambulation Categories, Timed Up-and-Go Test) geregistreerd. Tevens werd de Nederlandse vertaling van de SIGAM (Special Interest Group Amputation Medicine) mobiliteit vragenlijst ingevuld. Patiënten, die succesvol werden ontslagen naar een lichtere zorgvorm, werden drie maanden later opnieuw in kaart gebracht betreffende hun functionele status (Barthel Index, Frenchay Activities Index, stabalans op 1 been, Functional Ambulation Categories, Timed Up-and-Go test, SIGAM WAP mobiliteit vragenlijst), gedrag (Neuropsychiatric Inventory, Geriatric Depression Scale 8-item versie) en kwaliteit van leven (RAND 36 versie 2).

In Hoofdstuk 5 werden de determinanten van succesvol ontslag en functionele status bij ontslag onderzocht bij patiënten die revalideerden na een amputatie van de onderste extremiteit. Van de 48 geïncludeerde patiënten werden er 31 (65%) succesvol ontslagen. Uit een multivariate, logistische regressie analyse bleek dat het premorbide niveau van functioneren (ADL score) en het hebben van diabetes mellitus de belangrijkste determinanten van succesvol ontslag waren. Multivariate, lineaire regressie analyse liet zien dat een goede premorbide ADL score, een hoge ADL score bij opname en de mogelijkheid om op een been te staan bij opname tezamen 78% van de variantie van de Barthel Index bij ontslag bepaalden. Er kon geen onafhankelijke relatie met succesvol ontslag of functionele niveau bij ontslag worden aangetoond voor multimorbiditeit, ondanks de hoge prevalentie.

Hoofdstuk 6 beschrijft de determinanten die onafhankelijk geassocieerd zijn met prothesegebruik. Van de 48 patiënten die konden worden geïncludeerd waren er van 38 patiënten gegevens beschikbaar over de ontslagsituatie. Acht patiënten waren overleden vóór het einde van de revalidatie en twee waren er opgenomen met een ‘minor amputation’ waarvoor geen beenprothese nodig was. Aan het einde van de revalidatie werd bij 50% (n=19) een prothese aangemeten. Van deze patiënten waren er slechts twee die niet succesvol ontslagen konden worden en afhankelijk bleven van langdurige geïnstitutionaliseerde zorg. Multivariate logistische regressie liet zien dat patiënten met een transtibiale amputatie en zonder fantoompijn en met een onafhankelijk looppatroon bij opname (FAC>3) een hoge kans hadden om succesvol met een beenprothese te functioneren (SIGAM score >A).

DANKWOORD



'De Vrije Val'

Bij een promotie creëer je iets voorbij de horizon van de tijd. Zo is het mogelijk dat G. Sonneveld, de kunstenaar van de schilderijen opgenomen in dit boekje, na zijn overlijden voortleeft. Afhankelijk van het perspectief, onze context en gevoelens interpreteren wij gegevens die via onze zintuigen binnenkomen. Een mooi voorbeeld is het afgebeelde schilderij voor dit dankwoord. 'De vrije val' geeft de suggestie dat iemand valt in een leegte of grote diepte en wekt de indruk van een somber gevoel van de kunstenaar. Echter, zonder de titel, kan dit schilderij ook geïnterpreteerd worden als bieden van (onvoorwaardelijke) hulp. Dat vind ik het mooie van de 4 kunstwerken die in dit boekje zijn afgebeeld. Een ieder heeft zijn eigen associatie, vanuit zijn eigen context. Het bieden van onvoorwaardelijke hulp is een drijfveer van iedere arts, in elk geval is het voor mij een belangrijke motivatie om dit werk te kunnen uitvoeren.

Bij het starten van een promotieonderzoek kan niet voorspeld worden hoe een dergelijk traject verloopt. In het kort zou ik zeggen een pittige tijd met ups en downs. Onderzoek doen is leuk en draagt bij aan de wetenschappelijke onderbouwing van ons jonge vakgebied, maar er zijn ook zeker minder leuke factoren te benoemen. Op deze minder leuke momenten is het heel prettig als er een goed begeleidingsteam is. In dit dankwoord wil ik graag starten bij hen die de moeilijke taak op zich hebben genomen om mij te begeleiden naar dit succes. De beide promotores Raymond Koopmans en Sander Geurts en de beide co-promotores Sytse Zuidema en Harmen van der Linde dank ik voor hun aanmoediging en vertrouwen in mij. Raymond, het was vooral jouw enthousiasme en inspiratie die de motor was voor het opzetten en uitvoeren (en gemotiveerd blijven op sommige momenten) van de GRAMPS studie. Soms werden we wat tegengewerkt door de verschillende bladen en bleek het toch erg lastig om ons materiaal gepubliceerd te krijgen. Je bleef me motiveren en enthousiasmeren op de momenten dat ik dat nodig had. Dank daarvoor. Sander, jouw rol was met name die van de inhoudsdeskundige, vooral op het gebied van de CVA revalidatie. Voor mij was je echter veel meer dan dat. Ik heb veel geleerd van je kritische houding naar het kort, bondig en pakkend opschrijven van een artikel. Ik zal daar in de toekomst veel plezier van hebben! Sytse, je bent later gestart als copromotor en wat een aanwinst! Ik ben erg blij met de begeleiding rondom de uitvoer van analyses. Hoewel achteraf niet ingewikkeld, heb ik er toch als een berg tegenop gezien ze zelf uit te voeren. Ik hoop je in de toekomst nog eens te mogen consulteren en wil je heel veel succes wensen als aankomend hoogleraar in Groningen. Harmen, je bent ook later gestart in het traject. Dank voor je altijd aanwezig zijn wanneer ik de behoefte had om even iets kwijt te moeten. Het leven is inderdaad een feest! Ik ben het er helemaal mee eens. En als ik er dan toch iets aan toe mag voegen: 'je leeft maar een keer!'. In het kader van het begeleidingsteam, noem ik ook Ronald Rohling op deze plaats. Jij maakte het voor mij mogelijk om dit onderzoek te doen binnen SVRZ. Het is ook een beetje jouw succes. SVRZ heeft mij in staat gesteld om dit onderzoek uit te voeren. En tevens hebben zij mij geleid naar Bianca Buijck. Voor beiden ben ik de directie (huidige voorzitter Gabrielle Davits, voorheen Mirjam Drost, en directeur Rien Heijboer) van SVRZ heel dankbaar. Bianca, ik leerde jou kennen tijdens mijn zwangerschap. Aanvankelijk zou je mijn zwangerschapswaarneming doen, maar naar later bleek, heb je enkele maanden de dataverzameling van het GRAMPS onderzoek in je eentje gecoördineerd. Dat was een zware tijd voor je. Gelukkig werd dat beloond met je eigen promotietraject. Het was een vruchtbare periode, die ook voor jou werd beloond met je mooie zoon. We zijn een goed team! We hebben veel gespard over de data en de verdeling. Dat bleek uiteindelijk wel moeilijker dan gedacht. Jij bent gelukkig ook bezig met je laatste stukje en ik hoop dat bij het uitkomen van dit proefschrift ook meer duidelijkheid is over jouw promotiedatum. Ik ben trots op je en erg blij met jou als paranimf. Het is meer dan terecht om op deze plaats ook Frans Voncken te noemen. Je moest afstand nemen van je werk en dat was niet gemakkelijk voor je. Gelukkig kon het hele traject doorlopen worden. Dat was zonder jouw initiatief niet gelukt. Dank daarvoor!

Het derde schilderij 'de stad en de vergadering' geeft bij mij de associatie van het multidisciplinaire overleg. Op de revalidatieafdeling in het verpleeghuis is het multidisciplinaire werken onontbeerlijk. Met de huidige ontwikkelingen is het nog belangrijker om intensief samen te werken. Dit onderzoek is juist opgezet met deze multidisciplinaire samenwerking in het achterhoofd. We waren ons, bij de aanvang van het onderzoek, er zeer van bewust dat dit een ambitieus project zou worden waarin veel inzet van alle leden van het multidisciplinaire team nodig was. Om deze reden zijn er veel personen die de gegevens hebben verzameld. Uiteindelijk waren 15 verpleeghuizen zeer genegen om mee te werken. Op deze plaats wil ik alle medewerkers die hebben meegewerkt bedanken voor hun effort: Careyn (de Plantage), Curamus (de Blaauwe Hoeve), de Riethorst Stromenland (de Riethorst), de Wever (Jozefzorg, de Hazelaar), de Zorgboog (Sint Jozefsheil), Pantein (Madeleine), De Zorggroep (Martinushof), SVRZ (Gasthuis, Ter Valcke), SVVE de Archipel (Dommelhoef), Vitalis (Brunswijck, Peppelrode), Vivent (Mariaoord), ZZG Zorggroep (Margriet).

Onderzoek doen kan niet zonder dat er een netwerk van mensen is die motiveren, stimuleren en soms ook werkzaamheden overnemen. Dat laatste was vooral nodig in het laatste jaar van mijn promotietraject. Ik wil mijn directe collega's van de Zonnehuisgroep Vlaardingen dan ook graag op deze plaats danken dat zij soms mijn taken moesten overnemen, omdat ik vastliep in mijn planning. Dankzij het Zonnehuis, directeur Mark Janssen en hoofd medische dienst Roy Dutrieux, kon ik het laatste jaar rustig verder werken aan mijn onderzoek. Motiveren en stimuleren is vooral gebeurd door de mensen die wat nauwer verbonden zijn met mij. Goede vrienden, kennissen, familieleden en opleiders het zijn er teveel om persoonlijk te noemen. Een aantal hebben geen of weinig woorden nodig: Sarja, Gertrix (wat een gemis voor ons vak!), Petra, Cisca, Bahar, Gert-Jan (je staat erin!), Roland, Domus en Natascha (we hebben elk artikel gevierd!), mijn zus Carin (ik wens jou alle liefde die je verdient!), Marieke, Hans en Trudy (dank voor jullie steun en de extra Sem-tijd) en alle anderen die niet bij naam genoemd zijn. Allen hartelijk dank. Mijn tweede paranimf, Sharmila Boekhoorn, ik was bij al jouw belangrijke gebeurtenissen in je leven aanwezig. We kennen elkaar al zo lang en heel goed. Je had wat zorgen over mijn pad, maar dat is niet meer nodig. Ik heb het pad weer gevonden. Het is ook voor mij vanzelfsprekend dat je me naast staat op de dag van mijn promotie, zoals je dat bij al mijn belangrijke gebeurtenissen altijd hebt gedaan. In goede en in slechte tijden, je bent mijn maatje! Ook Tanja wil ik danken voor haar continue steun. Ik zeg steeds dat je mijn derde paranimf bent, omdat je me helpt met alle festiviteiten en administratieve zaken. Ik wens je dat al je dromen uitkomen. Je verdient het! Mijn gezin heeft de laatste tijd wat geleden onder mijn (fysieke en geestelijke) afwezigheid. Dat hoort er een beetje bij, zo aan het einde van een promotietraject, zeg ik ze steeds. Zij moeten een prominente plaats krijgen in dit dankwoord. Rob en Sem, dank voor jullie liefde en geduld.

De belangrijkste stimulans om alles te doen wat ik leuk vond, kreeg ik van mijn ouders. Die zeiden altijd tegen mij dat ik alles kon, als ik het maar wilde. Het tweede schilderij ('vrouw naar het licht') staat voor mijn moeder. Zij was, naast mijn vader, de belangrijkste persoon in mijn leven. De dingen in mijn leven waar ik het hardst voor heb moet werken en vechten, heeft zij niet meer mogen meemaken. Maar, zij is altijd bij me, in mijn hart. Ik draag dit manuscript op aan mijn ouders en aan mijn zoon Sem. Volo et valeo!

CURRICULUM VITAE

Monica van Eijk werd geboren op 10 november 1977, te Tilburg. In 1997 behaalde zij haar Atheneum diploma aan Scholengemeenschap Spieringshoek in Schiedam en werd de geneeskunde studie aangevangen aan de Erasmus Universiteit. De doctoraalfase van de geneeskunde studie werd afgesloten met een wetenschappelijk onderzoek op de afdeling neonatologie. Het onderzoek richtte zich vooral op asphyxie bij de geboorte. Samen met collega, en goede vriendin Sharmila, heeft ze onderzoek gedaan naar het effect van flaring bij VLBWs (premature pasgeborenen met een very low birth weight). Dit resulteerde in een concept artikel. Monica haalde in 2003 haar artsexamen en vanaf 2004 werkte zij in de functie van basisarts bij de Zorg en Welzijn Groep in Brielle (tegenwoordig Careyn), verpleeghuis de Plantage. In maart 2005 was de start van de opleiding tot verpleeghuisarts aan de VOVA (tegenwoordig VOSON), St Radboud Universiteit in Nijmegen. In de periode van de opleiding leerde Monica kennis maken met de afdeling en de onderzoekers. Gedurende de opleiding heeft zij geparticipeerd in de congrescommissie van de NVVA (tegenwoordig Verenso) als VAIO-lid. Het was vooral in deze 2 jaar dat Monica veel geleerde vakgenoten leerde kennen en zich meer verdiepte in de geriatrische revalidatie. De opleiding werd in maart 2007 afgesloten met een presentatie over een uitgevoerd empirisch onderzoek naar de invloed van probleemgedrag op de CVA revalidatie. Tijdens de uitvoer van het onderzoek kwam Monica in contact met Raymond Koopmans en Sytse Zuidema. In april 2007 werd zij benaderd door SVRZ om als onderzoeker in dienst te komen voor een groot opgezette multicenter studie naar determinanten van revalidatie uitkomst bij geriatrische patiënten die zijn opgenomen voor revalidatie na een CVA of amputatie in een verpleeghuis. In januari 2010 is Monica verhuisd van werkplek naar Zorgcombinatie Nieuwe Maas (tegenwoordig Zonnehuisgroep Vlaardingen). Tevens werkte zij in deze periode namens Verenso aan de CBO richtlijn 'amputatie en prothesiologie'.

Na hard werken, in een vruchtbaar begeleidingsteam, is dit proefschrift in 2012 tot stand gekomen.