Prevention of Functional Decline among Hospitalized Older People

Kirsten Asmus-Szepesi

Prevention of Functional Decline among Hospitalized Older People

Kirsten Asmus-Szepesi

Funding:
The study reported in this thesis was supported with a grant (grand number 60-61900-98-139) from The Netherlands Organisation for Health Research and Development (ZonMw) as part of the National Program of Care for the Elderly.

This thesis was realized with financial support from the Department of Public Health Erasmus MC Rotterdam and the Erasmus University Rotterdam.

Cover design: Celeste Asmus
Layout and design: Legatron Electronic Publishing
Printed by: Ipskamp drukkers
ISBN: 978-94-6259-477-7

Prevention of functional decline among hospitalized older people

Preventie van functieverlies bij oudere ziekenhuispatiënten

Proefschrift

Ter verkrijging van de graad van doctor
aan de Erasmus Universiteit Rotterdam
op gezag van de rector magnificus
Prof.dr. H.A.P. Pols
en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op
woensdag 18 februari 2015 om 15.30 uur
door

Kirsten Johanna Elisabeth Asmus-Szepesi
geboren te 's-Hertogenbosch

PROMOTIECOMMISSIE

Promotoren:

Prof.dr. E.W. Steyerberg
Prof.dr. J.P. Mackenbach

Overige leden:

Prof.dr. D.H.J.Deeg
Prof.dr. O.H. Franco
Prof.dr. A.P. Nieboer

TABLE OF CONTENTS

PART ONE

Introduction

CHAPTER 1

General introduction

INTRODUCTION

Among the Dutch population, 2,7 million people (16%) were aged 65 years and older [1] in 2012. According to the Central Bureau for Statistics, the population 65+ is expected to rise to a record of 4,7 million in 2040, which will be around 26% of the population [2]. The main reason for this rising ageing population is the tendency of people to live longer, e.g. because of medical technology improvements. Moreover, people are having fewer children nowadays in contrast to the birth wave after the Second World War [1]. The strong growth of the 65+ population has consequences for society, especially when health care utilization and associated costs are concerned, which both increase with age. When people get older, they often live with more physical and cognitive/psychological limitations, which in turn may lead to a higher demand of health care and associated higher costs. In 2011, average annual costs of illness for people under 65 years old were about 4,000 Euro and these average annual costs increased with age, from 6,500 Euro for people aged 65-69, to 12,000 Euro for people aged 75-79, up to 27,000 Euro for people aged 85-89 to a maximum of around 58,000 Euro for people aged 95 or older [3].

Functional decline and frailty

An especially vulnerable group within the 65+ population are hospitalized older people. Among this group, around 30 to 60 percent has been reported to develop functional decline during or after their hospital stay [4,5]. Previous studies have claimed that among hospitalized older people, functional decline is only partly (20%) related to the diagnoses for which people were admitted [6,7], thus implying that hospitalization itself leads to functional problems as well. Factors associated with functional decline during hospitalization, such as decreased food intake, long term bed rest, feelings of social isolation, and depression are numerous [7], and can be allocated to several domains:

1. ***Physical characteristics*** (e.g. age, functioning before hospital admission, admission diagnosis, comorbidity, blood levels, nutritional status, bed sores, and tendency to falls, [6,8-11]).
2. ***Psychological functioning*** (e.g. cognitive limitations, delirium, depression, fear, external locus of control, neuroticism, and traumatic life events, [6,12-15]).
3. ***Social aspects and economic environment*** (e.g. social activities, caregiver system, financial situation, and loneliness, [16-18]).

4. ***Living environment before hospital admission*** (e.g. independent or nursing home, [16,18]).
5. ***Aspects of (use of) health care*** (e.g. poly-pharmacy, and care needed before hospital admission, [7,18,19]).

Functional problems are not only affecting independent living and health related quality of life (HRQoL) of the older hospitalized population itself, but may also affect HRQoL and the subjective burden of care of the primary informal caregiver of the older person [20]. Thus, it is important that functional decline among hospitalized older people is avoided.

In this thesis functional decline is defined as a decrease in independence in activities of daily living (ADL), such as bathing or dressing, or instrumental activities of daily living (iADL), such as handling finances and preparing meals, in comparison to the pre-hospital situation. In addition, other domains of functioning are studied, such as cognition, HRQoL, loneliness, and depression. We used a short screening instrument, the Identification Seniors at Risk-Hospitalized Patients (ISAR-HP) to identify older patients at risk of functional decline [21,22]. We defined these at-risk patients as frail hospitalized older people, based on earlier research which showed that the ISAR, on which the ISAR-HP is based, is a useful screening tool for frailty and can be used to select high-risk patients who will more likely benefit from a geriatric approach or intervention independently of admission or discharge diagnosis [23]. Another reason to use the concept of frailty is the fact that it is "a marker of biologic age and physiologic reserve, which may have direct relevance to critical care, and clearly identifies a population at greater risk of adverse events, morbidity, and mortality" [24]. "Its recognition in critical care settings may enable improved prognostication and shared decision-making and identify vulnerable subgroups with specific needs who might benefit from targeted follow-up" [24]. Even though there is still no consensus on how to specifically define frailty, roughly there are two " schools of thought" (Table 1).

Table 1 | Two common frailty definitions

Organ and disease-based approach:
"A biological syndrome of decreased reserve and resistance to stressors, resulting from cumulative declines across multiple physiologic systems, causing vulnerability to adverse outcomes" (or the "Phenotype of Frailty") [25].
Health-based integral approach:
"Biological, psychological, social and environmental factors that interact across the life course are the determinants of frailty. The pathway from frailty to its adverse outcomes is affected by these various biological, psychological, social and societal modifiers" [26,27] "Life course determinants lead to diseases / decline in physiologic reserve which lead to physical frailty (decline in nutrition, mobility, physical activity, strength, endurance, balance, sensory functions) + psychological frailty (decline in cognition, mood, coping) + social frailty (decline in social relations and social support) which eventually lead to adverse outcomes (disability, health care utilization, death)" [28].

The organ and disease-based approach is heavily focused on biomedical factors. The "Phenotype of Frailty" [25], which is defined in table 1 is most often used within this approach. The second approach is the health-based integral approach, a more multidimensional approach due to its focus on a combination of physical (biological), psychological and social dimensions [26-28] (Table 1). We prefer the health-based integral definition of frailty since this definition should be broad enough to offer a framework for provision of integral care such as described and evaluated in this thesis. Defining frailty too narrowly (e.g. only physical elements), might lead to fragmentation of care instead of care that is focused on the individual as a whole [28].

Reactivation care for hospitalized older people

Whereas previously the focus of hospital professionals was mainly on treating the medical diagnosis only (and thus leading to fragmentation of care), more and more attention is now given to providing care that is not only focused on curing the medical diagnosis, but also on reactivation of the patient in order to function as independently as possible after hospital discharge. This reactivation may entail interventions focused on both physical as well as cognitive and social/emotional domains of the patient and in addition may include care for primary informal caregivers (see Table 2).

Table 2 | Elements in providing reactivation care for hospitalized older people

Early detection of patients at risk of functional decline
Multidisciplinary individualized geriatric care
Cooperation/coordination between hospital and external organizations such as home care
Case management from hospitalization to well after hospital discharge

Table 2 displays four important elements of providing successful reactivation care. These are early detection of older patients at risk of functional decline [16,29,30]; providing care that is multidisciplinary and focused on individual patient needs [31-34], case management [35,36] and finally, cooperation and coordination between the hospital and external organizations such as nursing homes, elderly homes, rehabilitation centers, homecare organizations and general practitioners [37]. Early identification of older patients at risk of functional problems and an early start of reactivation treatment is important since many older patients have already experienced functional decline within 48 hours of hospital admission, of which around 75% does not improve during their hospital stay [29]. Secondly, interventions that are multidisciplinary have shown to lead to a higher percentage of older patients who are discharged, a reduction of length of hospital stay and a reduction in hospital costs compared to regular care [33]. Multidisciplinary complex interventions at home have also led to a reduction in hospital and nursing home admissions, lower fall incidence and better physical functioning [32]. This stresses the importance of care provided after hospitalization and the importance of cooperation and coordination between the hospital and external organizations like nursing homes, rehabilitation centers, homes for the elderly and first line care. This will ensure that rehabilitation care is provided from hospitalization to well after discharge. Fourthly, case management has led to reductions in hospital and nursing home admissions, reduced length of hospital stay, improved access to health care, increased psychosocial support and improved communication with health professionals as valued by older patients and their informal caregivers [35-37].

The Prevention and Reactivation Care Program (PReCaP)

In recent years, the Dutch ministry of health has created policies aimed at promoting healthy aging by means of preventing and postponing illnesses as well as at preventing functional decline and improving self-reliance and societal participation among the older population [38]. Several of these projects have focused on transition of health care for older patients as part of the overlapping National Program of Care for the Elderly (NPO). This thesis is based on a transition project aimed at evaluating an integrated multidisciplinary reactivation program to prevent hospital related functional decline among older patients. This reactivation program is named the Prevention and Reactivation Care Program (PReCaP).

The PReCaP was developed to reduce hospital related functional decline among hospitalized older people by offering multidisciplinary, integrated and individualized patient care focused on physical, cognitive, social and psychological domains of functioning. In addition to usual geriatric care, the PReCaP consists of both treating the medical condition as well as reactivating the older patient (see Chapter 3). Most of its elements, have proved to be effective on their own, but were not yet evaluated as part of an integrated care program

consisting of different, individualized interventions. Therefore, this thesis aims to evaluate the effects of the PReCaP as a whole on patient functioning and HRQoL instead of focusing on the effects of different elements. We expected that treating older patients with a multidisciplinary, individualized intervention consisting of a combination of individual elements that have proved to be effective on their own, would be more effective than treating them with only one of the individual elements.

This thesis has two main aims, each consisting of several research questions. The first aim concerns prognosis of hospitalized older people at risk of functional decline. Specific research questions were:

i. How useful is a short screening questionnaire, the Identification Seniors At Risk-Hospitalized Patients (ISAR-HP) in identifying hospitalized older people at risk of poor physical functioning, cognitive functioning, HRQoL and mortality?
ii. Can the ISAR-HP predict health care costs of hospitalized older people?
iii. How often does functional decline occur among at-risk hospitalized older people and what are possible predictors of decline in (instrumental) activities of daily living?

The second aim concerns the effects of the Prevention and Reactivation Care Program (PReCaP) on patient functioning and HRQoL. Specific research questions were:

i. Do at-risk older hospitalized patients treated with the PReCaP have better functioning three months and twelve months after hospital admission than at-risk older hospitalized patients treated with usual forms of geriatric hospital care?
ii. Does an extra stay at the Center for Prevention and Recovery as part of the PReCaP lead to better functioning among older patients with complex problems than treatment with the PReCaP without a stay at the center?
iii. What are the effects of the PReCaP on healthcare costs of older patients as well as burden of care and HRQoL of their informal caregivers?

Outline of the thesis

This thesis consists of five parts. Part one (Chapters 1 to 3) is an introduction. Chapter one concerns the general introduction. Chapter 2 extensively describes the Prevention and Reactivation Care Program (PReCaP), including all its elements. Chapter 3 describes the overall study protocol of the process evaluation, effect evaluation, and cost effectiveness evaluation of the PReCaP on which this thesis was based.

Part two (Chapters 4 to 7) is focused on prognosis of hospitalized older people at risk of functional decline. Chapter 4 assesses the use of the ISAR-HP in identifying older patients at risk of poor functioning by comparing it to two other, more extensive questionnaires. Chapter 5 compares hospitalized older people with different ISAR-HP scores on physical functioning,

cognitive functioning, HRQoL, and loneliness. In addition, chapter 6 describes healthcare utilization and societal care costs of hospitalized older people with different ISAR-HP scores from hospital admission to twelve months after admission. Chapter 7 is an in depth study comparing decline in activities of daily living and instrumental activities of daily living among hospitalized older people and aims to identify predictors of decline such as ISAR-HP score, age, admission diagnosis and other possible predictors of (i)ADL decline.

Part three (Chapter 8 and 9) describes the effect evaluation of the PReCaP. Chapter 8 compares patient functioning and HRQoL of at-risk hospitalized older people who were treated before implementation of the PReCaP with patient functioning and HRQoL of older patients who were treated in the same hospital after implementation of the PReCaP. In addition this chapter compares patient functioning and HRQoL of at-risk hospitalized older people treated with the PReCaP with hospitalized older people who were treated with usual geriatric health care in two control hospitals. Chapter 9 describes the outcomes of a randomized clinical trial that took place within our intervention cohort. This trial compared PReCaP patients treated in the prevention and reactivation center (PRC)) after hospital discharge to PReCaP patients who did not receive extra treatment at the PRC after discharge.

Part four (Chapter 10) is a general discussion, which summarizes the main findings of this thesis in relation to the research questions and objectives stated in the introduction. In addition, it will discuss methodological issues and problems encountered. Finally, it will provide recommendations for future research in this area, with special attention to use of the ISAR-HP among hospitalized older people and implementation of integrated geriatric care programs such as the Prevention and Reactivation Care Program.

Part Five (Chapter 11 to 16) consists of all Chapter references (Chapter 11), as well as a summary in both English and Dutch (Chapters 12 and 13), acknowledgements (Chapter 14), curriculum vitae (Chapter 15) and the PhD portfolio of the Erasmus University.

CHAPTER 2

Integrated approach to prevent functional decline in hospitalized older people: the Prevention and Reactivation Care Program (PReCaP)

Annemarie JBM de Vos, Kirsten JE Asmus-Szepesi, Paul L de Vreede, Ton JEM Bakker, Ewout W Steyerberg, Johan P Mackenbach, Anna P Nieboer

BMC Geriatrics (2012), volume 12, **7**

ABSTRACT

Background

Hospital related functional decline in older patients is an underestimated problem. Thirty-five percent of 70-year old patients experience functional decline during hospital admission in comparison with pre-illness baseline. This percentage increases considerably with age.

Methods/design

To address this issue, the Vlietland Hospital in The Netherlands has implemented an innovative program (PReCaP), aimed at reducing hospital related functional decline among older patients by offering interventions that are multidisciplinary, integrated and goal-oriented at the physical, social, and psychological domains of functional decline.

Discussion

This paper presents a detailed description of the intervention, which incorporates five distinctive elements: (1) Early identification of hospitalized older people at risk of functional decline and, if necessary, followed by the start of the reactivation treatment within 48 hours after hospital admission; (2) Intensive follow-up treatment for a selected patient group at the Prevention and Reactivation Centre (PRC); (3) Availability of multidisciplinary geriatric expertise; (4) Provision of support and consultation of relevant professionals to informal caregivers; (5) Intensive follow-up throughout the entire chain of care by a case manager with geriatric expertise. Outcome and process evaluations are ongoing and results will be published in a series of future papers.

BACKGROUND

Hospital admission is considered a health risk for older patients. Thirty-five percent of 70-year old patients experience functional decline during hospital admission in comparison with pre-illness baseline. This percentage increases to 50% for 85-year old patients [6]. Functional decline in older patients is not necessarily related to the medical condition of the patient. Several other factors play a major role in the occurrence of the functional decline, including iatrogenic effects of the treatment and the effects of hospitalization, such as immobilization, isolation, and inaccessibility to fluids [13]. Furthermore, age, lower functional status before hospital admission, impaired cognitive status, depression and prolonged length of hospital stay are significant predictors of hospital related functional decline in older patients [8,11,39]. Functional decline can be defined as a new loss of independence in self-care activities or as deterioration in self-care skills, measured on an activities of daily living (ADL) scale (e.g. bathing, dressing, transferring from bed to chair, using the toilet) and/or on an instrumental activities of daily living (iADL) scale (e.g. shopping, housekeeping, preparing meals) [40,41]. Not only activities of daily living can be compromised. Functional decline may also result in physical and psychosocial problems, such as dehydration, malnutrition, falls, depression, and delirium [6,13,14].

Our earlier research demonstrated that 47% of the group of older patients (> 60 years) can be considered to be at risk of functional decline during hospitalization, due to the presence of four or more risk factors, including home care, history of falls, poly-pharmacy, weight loss (more than one kilogram in the past month), and psychiatric symptoms (anxiety, depression) [8]. It is anticipated that a considerable amount of these older patients at risk require intensive reactivation during hospital admission and after discharge in a hospital replacement care facility, often due to the patient's failure to recognize the potential problems or the unavailability of informal caregivers.

The literature demonstrates several approaches aimed at preventing functional decline in hospitalized older people with mixed results. The Comprehensive Geriatric Assessment (CGA) comprising of a screening for risks of adverse outcomes, a diagnostic assessment on the presence of geriatric conditions, and multidisciplinary tailored interventions, has most often been studied. Early screening of the older patient by means of the CGA has demonstrated a reduction in cognitive and functional decline in patients at risk [30,42], and has retained retaining quality of life and independence in activities of daily living [29]. The implementation of the CGA resulted in lower mortality rates in the older population after six months, but not after 12 months follow-up [43]. Multidisciplinary interventions, including physical training are associated with a reduction in functional decline [33,44], reduced length of hospital stay at the same costs compared to 'regular care' [32,33,44,45], lower (re) admissions to hospital and

nursing homes [31,46,47], reductions in fall incidence [32,48], and higher perceived health and life satisfaction among patients [31,49,50]. Evidence shows that these effects are present between six and twelve months after the start of the intervention with the largest effect at three months [51]. Various studies have emphasized the importance of utilizing specialized geriatric units, often in combination with multidisciplinary follow up-treatment, including case management after hospital discharge with rehabilitation services [34,47,51-53].

Hospital related functional decline in older patients is an underestimated problem. In the Netherlands, medical treatment and nursing care are mainly focused on the diagnosed illness, thereby neglecting reactivation care that may prevent functional decline in the older patient. The Prevention and Reactivation Care Program (PReCaP) [Zorgprogramma voor Preventie en Herstel (ZPH)] was developed to address this issue by utilizing a multidisciplinary, integrated and goal-oriented approach focused at early screening of risk factors of functional decline and the provision of a patient-oriented reactivation program. Given the large body of evidence, it is expected that this approach will lead to improved functional status and better HRQoL for older patients, reductions in fall incidence, reduced length of hospital stay, lower (re)admissions to hospital and nursing homes, improved mental well-being of informal caregivers, and lower mortality to twelve months after hospitalization [31-34,48-51,54-57].

There is a paucity of detailed descriptions of geriatric interventions in the international literature. This paper addresses this issue by presenting an outline of the Prevention and Reactivation Care Program (PReCaP) including community involvement; the roles and responsibilities of core staff; the setting and administrative structure; the care process – including identification and screening procedure, key interventions, use of the standardized Goal Attainment Scaling (GAS) method, follow-up treatment at the Prevention and Reactivation Centre (PRC), multidisciplinary approach, case management, provision of support to informal caregivers, quality assurance measures, and the expected outcomes and benefits.

METHODS/DESIGN

Overview

The Prevention and Reactivation Care Program (PReCaP) was developed in 2010 as a means to reduce hospital related functional decline among hospitalized older people by offering interventions that are multidisciplinary, integrated, and goal-oriented at the physical, social, and psychological domains of functional decline. The program combines existing treatment methods and innovative care paths for reactivation into a comprehensive care package that fits the individual needs of older patients and their informal caregivers. In contrast to the traditional care model (Table 1), in which the reactivation treatment is provided as a separate

element, the PReCaP integrates the treatment of the medical condition with reactivation of the older patient. Furthermore, the PReCaP includes the following distinct elements: (1) Early identification of older patients with a high risk of functional decline, and if necessary followed by the start of the reactivation treatment within 48 h after hospital admission; (2) Intensive follow-up treatment, for a maximum period of three months, of a selected patient group at the Prevention and Reactivation Centre (PRC) following referral from the multidisciplinary team. The intensive reactivation treatment is aimed at improving the older patients' ability to live independently in the home environment, and is delivered concurrently with specialized nursing home care, (para)medical care, and mental health care; (3) multidisciplinary geriatric expertise during hospitalization, during admission at the PRC, and in the home environment; (4) Provision of support and consultation of relevant professionals (e.g. psychologist) to informal caregivers; (5) Intensive follow-up, for a maximum period of six months, throughout the entire chain of care (from hospital to home) by a case manager with geriatric expertise.

Table 1 | The Prevention and Reactivation Care Program compared to usual geriatric care in the Netherlands

	Prevention and Reactivation Care Program	**Hospital care with follow-up care**	**Hospital care without follow-up care**
Hospital care	– Identification of vulnerable older patient within 48 h – Assessment of risk factors for functional decline – Start reactivation treatment within 48 h – Clinical geriatrician – Geriatric nurses	– Start reactivation treatment after discharge – No specific identification instrument	– Start reactivation path after discharge
Hospital replacement care	– Prevention and Reactivation Centre – Part of treatment plan – Continuation of (in hospital started) treatment focused on six domains of functional status – Availability of (para) medical disciplines	– Hospital replacement care – Admission is patient's choice – Care facility with option for treatment – No structured treatment plan, but separate elements – Limited number of (para) medical disciplines	– Hospital replacement care not available
Home care	– Geriatric care chain agreements with general practitioner and home care – Case management with geriatric expertise	– Follow-up care by home care organizations (not specialized in geriatrics)	– Follow-up care by home care organizations (not specialized in geriatrics)

Table 1 | The Prevention and Reactivation Care Program compared to usual geriatric care in the Netherlands *(Continued)*

	Prevention and Reactivation Care Program	Hospital care with follow-up care	Hospital care without follow-up care
Multidisciplinary approach	– Weekly multidisciplinary team meeting – Treatment and care focused on medical condition and functioning in six domains (i.e. physical, mental, social, financial, home, and care) – Goal-oriented approach	– Key professional is responsible for treatment and interdisciplinary consults – Discussion and collaboration focused on medical condition	– Key professional is responsible for treatment and consults – Discussion and collaboration focused on medical condition
Patient	– Patient oriented integrated treatment plan – Discussion treatment with patient during entire treatment path – Problem solving	– Separate treatment plans – Treatment coherence determined by patient	– Separate treatment plans – Treatment coherence determined by patient
Informal caregiver	– Part of treatment plan	– Individual choice	– Individual choice

Community involvement

The Geriatric Network Rotterdam area [Geriatrisch Netwerk Rotterdam en Omgeving (GENERO)] is a regional geriatric network, established to improve the quality of care and wellbeing of vulnerable older people in the region. The PReCaP incorporates the GENERO themes 'Improvement of coordination and continuity of care and welfare' and 'Timely observation of complex problems', which are based on the needs and requirements of older people and their informal caregivers. Older stakeholders have expressed concerns about the incapability of care providers in recognizing and addressing complex geriatric problems in a timely fashion, both in primary and secondary health care. Furthermore, older people have indicated that they require personal and expert attention, thereby involving their social system. In addition, older people and their informal caregivers prefer an integrated preventive care approach and a single contact person with geriatric expertise. Given the design of the PReCaP, it is anticipated that its interventions will address all these issues. GENERO organizes regular network meetings, brainstorm sessions, and forums for the older and their informal caregivers to monitor the relevance of interventions, to discuss the results, and to promote knowledge transfer.

Roles and responsibilities

The Argos Zorggroep has developed and initiated the PReCaP in 2010, and is responsible for the effective implementation of the program. The ongoing consultation and support to the program is provided by the following interdisciplinary experts: nursing home physician;

geriatric nurses; nurse practitioners; social workers; transfer nurses; case managers; and representatives from psychiatry, psychology, physiotherapy, occupational therapy, and dietetics. The specific role of each staff member is described in Table 2.

Table 2 | Prevention and Reactivation Care Program Interventions

Intervention Hospital	**PReCaP Core Staff**
Identification of patient at risk within 48 h after admission	Research nurse
Assessment of risk factors for functional decline	Research nurse
Consult with patient and relatives to discuss vulnerability and risk factors	Case manager or Geriatric nurse
Biweekly Multidisciplinary Team Meeting: – Analysis of the function diagnosis in relation to the medical diagnosis – Design GAS care plan including advice for additional treatment aimed at functional preservation	Geriatrician/geriatric nurse Nurse practitioner Social worker Transfer nurse Case manager
Geriatric consultation	Geriatrician/geriatric nurse Case manager/transfer nurse
Interdisciplinary consultation, e.g. psychiatrist, psychologist, physiotherapist, occupational therapist, dietician,	Geriatrician Case manager
Support and provide treatment to informal caregiver	Social worker/Psychologist
Review prognosis and discharge destination (in some cases register patient at hospital replacement care facility)	Geriatrician, Geriatric nurse Nurse practitioner Social worker/transfer nurse Case manager
Weekly telephone consultation informal caregiver	Case manager
Hand out flyer 'PReCaP Recovery Team' to patient	Case manager
Exit interview with patient and informal caregiver	Transfer nurse
Hand out flyer 'PRC to patient (if transfer to PRC)	Transfer nurse
Handover GAS care plan to physician hospital replacement care facility	Case manager or geriatrician
Home visit and support after hospital discharge until six months after hospital admission, including optional therapy	Case manager
Prevention and Reactivation Center	**PReCaP Core Staff**
Admission to PRC (including GAS care plan/medical handover)	Nurse practitioner
Review GAS care plan	Nursing home physician or nurse practitioner
Physical examination	Nursing home physician
Intake patient/informal caregiver	Nurse
Weekly Multidisciplinary Team Meeting: – First MTM after one week admission PRC – Review progress and adjust GAS care plan – Case manager home care attends MTM in week 9	Nursing home physician (coordinator) Nurse practitioner Case manager Psychiatrist (consult) Social worker (consult) Clinical geriatrician (consult)
Introduction and intake patient	Nurse

Table 2 | Prevention and Reactivation Care Program Interventions *(Continued)*

Prevention and Reactivation Center	PReCaP Core Staff
Treatment according to GAS care plan	Consulted disciplines
If needed additional treatment by PReCaP recovery team and other disciplines if indicated, e.g. behavioral therapist, dietician, music therapist, dance therapist, visual arts therapist	Case manager
Hand over diary to patient (incl. therapy appointments and treatment information)	Nurse
Support with activities according to diary	Nurse
Specialized nursing home care within the socio-therapeutic environment, e.g. psychologist, physiotherapist (3 times a week), occupational therapist, speech therapist, dietician, behavioral therapist, music therapist, dance therapist, visual arts therapist, social worker	Case manager
Review medication use	Nursing home physician
Support informal caregiver	Psychologist, Case manager
Assessment of Motor and Process Skills	Occupational therapist
Before discharge home visit (in week 9)	Occupational therapist

Implementation of the PReCaP will require an increased pro-active and methodological approach from involved staff due to the preventive and systematic nature of the program. Given the patient oriented approach, it is expected that implementation of the program will lead to increased collaboration between the involved disciplines and departments, and a possible shift in existing roles and responsibilities. For example, the social worker, the psychologist, or the case manager will provide informal caregiver support, depending on the individual situation and existing relationships.

Setting and administrative structure

Since 2010, the PReCaP has been implemented in the Vlietland hospital, Schiedam, a 450-bed regional teaching hospital, serving a large community as well as a referral population. The hospital has a collaborative agreement with the Argos Zorggroep regarding patient transfer to the PRC at the DrieMaasStede Nursing and Reactivation Centre, and in addition has collaborative liaisons with primary care providers in the region.

The administrative and decision making body of the PReCaP consists of a working group within the hospital and the PRC, and includes the program director/psycho-geriatrician, program leader, case managers, and geriatric nurses. The working group meets monthly to set goals and priorities for the program, establish program procedures and guidelines, monitor progress, address problems, and reach consensus on intervention issues.

An Implementation Taskforce (ITF) was established in 2009 to provide expert advice on the design and development of the PReCaP, to facilitate knowledge transfer, and to promote broad implementation of the PReCaP results in the chain of care for the older in the region as well as further afield in the future. During the development phase, the ITF acted as a sounding board for the PReCaP team. For example, they assisted in the decision-making process regarding the implementation of the program in different settings. In addition, the ITF advised in the assessment of the applicability of developed indicators to map out the care process, and on the contents and quality of the training program for geriatric nurses. Following the evaluation phase in 2012, it is anticipated that the ITF will develop an implementation plan for other geriatric care settings based on the results of the PReCaP program. The ITF meets four times per year, and consists of 15 members, represented by geriatricians, nursing home physicians, geriatric nurses, psychiatrists, rehabilitation specialists, general practitioners, patient council representatives, home care providers, and health insurance representatives. The composition of the ITF in terms of which members will be represented depends on the phase of the PReCaP, the specific parts of the implementation, and the results to be discussed.

Process of care

Identification and screening procedure

Every patient of 65 years or older and admitted to the Vlietland Hospital for at least two days is screened within 48 hours after admission to identify those at risk of hospital-related functional decline. In order to pre-test the developed identification- and screening methods, we conducted a pilot study in the Vlietland Hospital, which involved 460 patients and 200 informal caregivers. Based on the results of the pilot, we have selected the following two-step triage:

Step 1: Administer the Identification of Seniors at Risk-Hospitalized Patients (ISAR-HP) within 48 hours of hospital admission. The ISAR-HP is a validated four-item instrument to predict functional decline during hospital admission [21,22]. The instrument is administered to patients of 65 years or older who are expected to be in the hospital for more than 48 h. We have set the inclusion cut-off score at ≥ 1, in contrast to the cut-off score of ≥ 2 as earlier proposed [21], to be as inclusive as possible, while ensuring the inclusion of patients with at least one risk factor. Exclusion criteria are the inability to answer questions or to follow instructions due to cognitive problems (Mini Mental State Examination (MMSE) score < 12 [58]), the inability to understand the Dutch language, or a life expectancy of less than three months.

Step 2: Administer the Neuro-psychiatric Index (NPI-Q) and the Mini Mental State Examination (MMSE). The NPI-Q is a validated short version of the Neuropsychiatric Index, which aims to

identify neuropsychiatric symptoms in the last month, including aggression, delusions, and hallucinations [59]. The NPI-Q will be administered by means of a telephone interview with the informal caregiver, and aims to identify eligible patients for admission to the PRC, and to measure the emotional burden of the informal caregiver. The MMSE aims to measure cognitive functioning via interview questions related to: orientation in time and place; short-term and middle term memory; comprehension; and additional cognitive dimensions [60,61]. Based on the results from the pilot study, the inclusion criteria for admission to the PRC are set at either an ISAR-HP score of ≥ 2, an NPI-Q score of ≥ 3, or an MMSE score of > 12 and ≤ 27 to ensure inclusion of patients who will benefit most from treatment at the PRC.

Following the two-step triage written informed consent for participation in the study is obtained from participants.

Key interventions

The PReCaP interventions are presented in Table 2 earlier in this chapter and include a description of the core staff that is required to carry out the particular intervention. The identification and screening procedure is described above. Key interventions carried out by the PReCaP core staff include: biweekly multidisciplinary team meetings; design of the GAS care plan (see Goal Attainment Scaling); interdisciplinary consultation (psychiatrist, psychologist, physiotherapist, occupational therapist, dietician, behavioral consultant); case management; provision of support and treatment for the informal caregiver; and review of the prognosis and discharge destination.

Follow-up treatment at the prevention and reactivation center

A specific part of the PReCaP entails the intensive reactivation treatment at the Prevention and Reactivation Center (PRC) after hospital discharge, which is aimed at improving the patients' ability to live independently in the home environment. Therefore, the PRC provides specialized nursing home care in combination with intensive theme oriented reactivation treatment, paramedical treatment (e.g. physiotherapy, dietetics, occupational therapy); psychiatric treatment (including short term admission in a psychiatric hospital or a psycho-geriatric reactivation unit if necessary), and support and psychotherapy sessions for informal caregivers if required (Table 2). The PRC treatment is novel in the Netherlands, since there are no facilities that offer this type of intensive reactivation treatment for hospitalized older people with complex health problems. In order to maximize continuity, the same nurse with geriatric expertise executes case management during a stay at the hospital and PRC. The multidisciplinary team, consisting of the nursing home physician (coordinator), nurse practitioner, case manager, and (if consulted) paramedical professionals, psychologist, social worker, and clinical geriatrician, convenes weekly. During these meetings, the team accesses

the patient's data in the online GAS data base (see Goal Attainment Scaling), reviews and discusses the patient's progress, and adjusts the GAS care plan accordingly (after consulting the patient and the informal caregiver). The maximum admission period at the PRC is three months. On discharge from the PRC, the multidisciplinary team designs a care plan for the home setting, which contains advice on further treatment or support, and recommendations for specific health care providers. The case manager is responsible for handover of the care plan to the general practitioner, and liaises with primary care professionals and institutions about the implementation of the care plan. Given the large body of evidence, it is expected that the intensive reactivation treatment at the PRC will lead to improved functional status and better HRQoL for older patients [31-34,48-51,54-57]. Based on earlier research, we estimate that 10-20% of the patients of 65 years or older will benefit from the intensive reactivation program at the PRC (unpublished data).

Additional follow-up treatment routes

Depending on the patient's requirements and availability of beds, five additional follow-up routes for reactivation within the PReCaP are available: (1) Reactivation at a Cerebral Vascular Accident (CVA) unit, somatic reactivation unit or psycho-geriatric unit; (2) Day treatment at a somatic unit, psycho-geriatric unit or day treatment unit; (3) Admission to a retirement home; (4) Admission to a nursing home; and (5) Treatment at home. Regardless of the selected follow-up route, the PReCaP case manager coordinates the patient's care and monitors the patient's and informal caregiver's progress according to the GAS care plan. Additional disciplines can be consulted if necessary, e.g. occupational therapist, speech therapist, dietician, behavioral therapist, music therapist, psychomotor therapist, visual arts therapist, or social worker. If the patient receives treatment in the home setting, the case manager visits the patient monthly up until six months after hospital admission.

Goal attainment scaling

The Goal Attainment Scaling method (GAS) is used to evaluate complex interventions in frail older patients by means of facilitating the individualization of patients' goals according to their needs [62-65]. A modified version of the GAS was developed by standardizing the measurement through the application of a summary formula that calculates the extent to which the patients' goals are met [66,67]. Within 48 hours after admission, the patient's functional state, varying from totally functional dependent to independent, is scored for the six domains of functional decline: somatic, cognition, personality, emotional and rational experiences, social environment, and life history and/or trauma (Table 3). Simultaneously, a goal GAS-score of 1 or 2 points higher is determined for each domain of functional decline. This way, the GAS assists in formulating individual goals, developing a personalized treatment plan, monitoring both

the patient's and informal caregiver's progress, and adjusting the interventions in a timely manner when necessary.

Table 3 | Scoring used in Goal Attainment Scaling

Domain	Functional State Score				
	Totally functionally dependent (1-2)	Regularly functionally dependent (3-4)	No help needed, only guidance (5)	Functionally independent with adjustments and/or aids (6)	Independent (7)
Somatic					
Cognition					
Personality					
Emotional and rational experiences					
Social environment					
Life history and/or trauma					

Multidisciplinary approach

The PReCaP incorporates an integrated program combining different elements of care that are offered by a multidisciplinary team with geriatric expertise, including (but not limited to) a geriatrician, geriatric nurse, nurse practitioner, social worker, transfer nurse, and case manager (Table 2). It is anticipated that this approach will lead to improved functional status, reductions in fall incidence, reduced length of hospital stay, lower (re) admissions to hospital and nursing homes, improved mental well-being of informal caregivers, and lower mortality [31-34,48-51, 54-57].

Hospital and primary services are fully integrated in the PReCaP. Working agreements have been reached between and within the first line (e.g. general practitioner, home care organizations) and second line health care organizations (e.g. hospital, PRC). These agreements are considered important for an efficient and timely care process, and include referrals between primary and secondary health care; paramedic consultations during the hospital and PRC phase; and consultations between the general practitioner, home care, social work, paramedics (e.g. physiotherapy), municipality (in order to prevent long waiting lists for medical aids). The case manager coordinates alignment between hospital, PRC, general practitioner, and home care in the implementation of these agreements. The involved disciplines meet twice a week during the Multidisciplinary Team Meeting (MTM) to discuss new patients, to develop individual treatment plans, and to evaluate the current patients' progress.

Case management

The case manager with geriatric expertise acts as the patient's case manager throughout the entire chain of care, i.e. hospital care, hospital replacement care, and primary care until six months after hospital admission. In consultation with the PReCaP team and primary health care providers when patient is at home, the case manager coordinates the multidisciplinary care process, supports and motivates the patient in treatment adherence, and monitors the patient's risk factors for functional decline throughout the reactivation period. In other words, the case manager is the patient's liaison to ensure the most appropriate form of health care, and is a provider of treatment as well. Table 4 presents an overview of the specific case manager's tasks. Although case management has been valued for improving access to health care, increasing psychosocial support and improving communication with health professionals, it may not change overall hospital admissions due to increased case-finding [37].

Table 4 | Tasks case manager

Ensures follow-through of the treatment plan, which will be handed over to the general practitioner after hospital discharge
Establishes the follow-up multidisciplinary primary care team in consultation with the general practitioner
Includes home care in the multidisciplinary team
Maintains contact with representatives of the social support system and welfare organizations
Visits the patient and informal caregiver at home. The first visit takes place within two weeks after hospital or PRC discharge, followed by monthly visits (or more frequently if necessary) until six months after hospital admission
Motivates and provides support to the patient and informal caregiver in adhering to the treatment plan
Monitors the presence of risk factors for functional decline, e.g. use of medicines, weight, functioning of the informal caregiver
Liaises with the general practitioner, the multidisciplinary team, the hospital, and the PRC

Provision of support to informal caregivers

The GAS incorporates the social environment, including social activities and the informal care system in the evaluation of risk factors of functional decline, and targeted interventions. Informal caregiver support may not directly influence the patient's social environment, yet it is expected to increase the resources of the patient's social environment. This may include provision of guidance and information, as well as the opportunity to consult and receive treatment from relevant professionals (e.g. psychologist) aimed at reducing the burden on the informal caregiver [66].

Quality assurance measures

Before the start of the PReCaP, the Vlietland Hospital and Argos Zorggroep have developed an educational program to train geriatric nurses and nurse practitioners. To date, 50 geriatric nurses have been trained to work in the hospital, at the PRC or in the home care setting in order to ensure a streamlined chain of care in the PReCaP. Furthermore, the hospital working group, including program director/geriatrician, program leader, case managers, and geriatric nurses convenes monthly to discuss the implementation and quality of the intervention and to address implementation issues if necessary.

Evaluation

The PReCaP will be evaluated to determine the extent to which the PReCaP leads to improved geriatric care, which is cost-effective in comparison to current geriatric care in The Netherlands. The evaluation objectives are:

- To determine the validity of the PReCaP screening instruments;
- To identify the extent to which the PReCaP leads to the prevention of functional decline in older patients and improved HRQoL of informal caregivers;
- To determine the contribution of the treatment at the PRC to overall effectiveness of the PReCaP;
- To determine the extent to which the PReCaP leads to an improved structure and process of care in comparison to current geriatric care in The Netherlands (in particular with regard to the content of care, patient logistics and information logistics); and
- To quantify the cost-effectiveness of the PReCaP in comparison to current geriatric care in the Netherlands.

The evaluation will require a concurrent mixed methods design, in which a combination of qualitative and quantitative research methods will be used. Empiric evidence regarding the immediate effects of the PReCaP, including functional status and quality of life for the older and the informal caregiver, as well as data regarding the process aspects of the PReCaP will be collected. The latter may include modification of the intervention over time or a description of the contextual factors influencing the intervention effectiveness. A quasi-experimental research design will be used to evaluate the overall PReCaP, in which the impact on functional status and quality of life of the hospitalized older will be measured in a prospective cohort study. The specific PRC component will be evaluated using a randomized controlled trial design [68].

Three Dutch hospitals with different levels of geriatric care will participate in the evaluation study:

1. Vlietland Hospital, Schiedam, a 450-bed regional hospital with a geriatric department, hospital replacement care (PRC), and provisions for follow-up in primary care.
2. Sint Franciscus Gasthuis Rotterdam, a 613-bed teaching hospital with hospital replacement care (through a care hotel), but without a clinical geriatric department or provisions for follow-up in primary care.
3. Ruwaard van Putten Hospital, Spijkenisse, a 288-bed regional teaching hospital without a geriatric department, hospital replacement care, or provisions for follow-up in primary care

These hospitals were selected based on their comparable patient case mix and their different levels of geriatric care. The PReCaP is offered in the Vlietland Hospital (intervention setting). Conventional care ('care as usual') is offered in the control setting of the Sint Franciscus Gasthuis and the Ruwaard van Putten Hospital. Given that hospital replacement care is a common type of geriatric care in the Netherlands, the option for admission to an external hospital replacement care facility after hospital discharge will be offered to older patients in the two control settings.

Power calculation

Based on the average number of older patients admitted to the three hospitals annually, a sample of 1100 patients will be included in the intervention hospital (including 200 patients in the PRC). A sample of 500 patients will be included in both control hospitals. Based on the pilot results (Katz-15 ADL score), it is expected that a baseline population of n=1100 in the intervention hospital will result in approximately 700 patients analyzable at three months, and a group of 500 in the control hospitals will result in 300 patients analyzable at three months. Using an effect size of 0.25, this will produce statistical power of 95%.

Effect evaluation

The effect evaluation will measure the primary outcome data regarding physical functioning, functional decline risk factors, HRQoL, and experienced informal caregiver burden at three points in time, i.e. (1) at admission; (2) at three months after admission; and (3) at twelve months after admission.

Process evaluation

The process evaluation will measure the extent to which the PReCaP leads to a better structure and process of care, in comparison with current forms of geriatric care in the Netherlands. This involves the coordination of different forms of care, patient logistics, information logistics and

support. Improving coordination between care providers and the integrated care provision for older patients and their informal caregivers is expected to result in improved outcomes. Process data will be collected by utilizing a set of process indicators in order to objectively assess the impact of the implementation of the program [68].

Intervention fidelity

The intervention fidelity will be measured to determine adherence to the PReCaP protocol. Fidelity measurement is essential in order to maintain internal validity and to ensure a fair comparison of the results between the intervention and control settings. Results without a fidelity check may be due to an effective intervention or contamination from other interventions [69]. The issue of intervention fidelity also pertains to external validity. In order for a particular intervention to be adopted in other hospital settings, sufficient information about the method, fidelity, and effectiveness is essential [70-72].

The evaluation study commenced in March 2010. Allowing for the twelve-month follow-up measurements, the study is expected to be complete by June 2012.

DISCUSSION

Thirty-five percent of patients aged over 70 years function less well after hospital discharge compared to before hospital admission. Despite the high prevalence of predictors of functional decline, this percentage increases to 65% for patients aged 90 years and older, with only 20% of functional decline related to the hospital diagnosis [6]. To date, geriatric hospital care in the Netherlands focuses on the medical treatment with less attention for reactivation care aimed at preventing functional decline in the hospitalized older population. Furthermore, older patients are largely left to their own devices after hospital discharge. In order to retain the ability to cope and enjoy a HRQoL, reactivation care should be organized concurrently with medical treatment, commence as early as possible after hospital admission, and continue well after hospital discharge in a multidisciplinary, harmonized fashion [14,73,74].

This paper describes the Prevention and Reactivation Care Program (PReCaP), which incorporates a package of interventions aimed at retaining the older patient's functioning during and after hospital admission. The program starts within 48 hours after hospital admission, and includes an integrated individual treatment plan based on physical, mental and social domains of functional decline. Furthermore, hospital reactivation treatment is followed by intensive reactivation care in the Prevention and Reactivation Centre (PRC) for a selected group of older patients. After this intensive period, further treatment and support takes place in primary care for up to six months after hospital admission. A case manager with

geriatric expertise coordinates the multidisciplinary care plan in close collaboration with the general practitioner and home care; supports and motivates the older patient and informal caregiver to adhere to the care plan; and monitors risk factors of functional decline in the home situation.

The PReCaP is implemented in the Vlietland Hospital, Schiedam, the Netherlands since November 2010. Given the multidisciplinary approach and the complexity of the PReCaP, it is highly likely that deviations from the protocol will occur in daily practice. Therefore, an intervention fidelity study will be carried out to measure the extent to which the interventions are implemented according to the protocol. Moreover, it is anticipated that fidelity measurement will yield results regarding the barriers and enabling factors for adherence to the protocol. In turn, these results will assist in further refining the PReCaP and adapting the program for other hospital settings in which older patients at risk of functional decline can benefit from the PReCaP.

Authors' contributions

AJBMdV prepared the manuscript and revised it for important intellectual content. KJEA-S drafted the manuscript and revised it for important intellectual content. TJEMB designed the intervention protocol and revised the manuscript for important intellectual content. PLdV revised the manuscript for important intellectual content. JDHvW participated in the design of the evaluation study and revised the manuscript for important intellectual content. EWS participated in the design of the evaluation study and revised the manuscript for important intellectual content. JPM participated in the design of the evaluation study and revised the manuscript for important intellectual content. APN participated in the design of the evaluation study and revised the manuscript for important intellectual content. All authors approved final version of the manuscript to be published.

CHAPTER 3

Evaluation design of a reactivation care program to prevent functional loss in hospitalized older people: A cohort study including a randomized controlled trial

Kirsten JE Asmus-Szepesi, Paul L de Vreede, Anna P Nieboer, Jeroen DH van Wijngaarden, Ton JEM Bakker, Ewout W Steyerberg, Johan P Mackenbach (2011).

BMC Geriatrics, volume 11, **36**

ABSTRACT

Background

Hospitalized older people are at risk of hospital related functional loss. This evaluation aims to compare the effects of different levels of (integrated) health intervention care programs on preventing hospital related functional loss among hospitalized older people by comparing a new intervention program to two usual care programs.

Methods/Design

This study will include an effect, process and cost evaluation using a mixed methods design of quantitative and qualitative methods. Three hospitals in the Netherlands with different levels of integrated geriatric health care will be evaluated using a quasi-experimental study design. Data collection on outcomes will take place through a prospective cohort study, which will incorporate a nested randomized controlled trial to evaluate the effects of a stay at the prevention and reactivation center (PRC) for older patients with complex problems. The study population will consist of hospitalized people aged 65 years or older, at risk of functional loss, and admitted to one of three participating hospitals. Data is prospectively collected at time of hospital admission (T0), three months (T1), and twelve months (T2) after hospital admission. Patient and informal caregiver outcomes (e.g. health related quality of life (HRQoL), activities of daily living, burden of care, (re-) admission in hospital or nursing homes, mortality) as well as process measures (e.g. the cooperation and collaboration of multidisciplinary teams, patient and informal caregiver satisfaction with care) will be measured. A qualitative analysis will determine the fidelity of intervention implementation as well as provide further context and explanations for quantitative outcomes. Finally, costs will be determined from a societal viewpoint to allow for cost effectiveness calculations.

Discussion

It is anticipated that higher levels of integrated hospital health care for at-risk older patients will result in prevention of loss of functioning and loss of HRQoL after hospital discharge as well as in lower burden of care and higher quality of life of informal caregivers. Ultimately, the results of this study may contribute to the implementation of a national integrated health care program to prevent hospital related functional loss among hospitalized older people.

BACKGROUND

Hospital admission is considered a risk (especially for older patients), which increases with age [13]. Among 70-year olds who are admitted in the hospital, 35% show functional loss at time of discharge when compared to the period before hospital admission, and this percentage rises as high as 65% for patients aged 90 years or older [6]. Hospital related functional loss among hospitalized older people is often associated with the risk of developing complications due to an illness or its treatment [13]. Nevertheless, functional loss among older patients is only partly the result of the patient's diagnosed illness at admission and treatment thereof [6], implicating that a hospital stay by itself leads to functional loss as well. Functional loss may lead to renewed hospital admission, prolonged hospital stay, admission in a nursing home or early death [75,76]. Furthermore, it will lead to greater dependence, resulting in a higher burden of care for informal caregivers [5,6,42,77], higher utilization of professional health care and thus higher health care costs [15]. It is therefore important to prevent or reduce functional loss among hospitalized older people at an early stage [78].

Risk factors for functional loss are highly prevalent among older patients at time of hospital admission [8] and can be categorized into several domains: 1) **physical status** (e.g. age, functioning prior to admission to hospital, diagnosis, co-morbidities, low Body Mass Index/ malnutrition, tendency to fall); 2) **mental status** (e.g. cognitive problems, delirium, depression, anxiety); 3) **socio-economic situation** (e.g. financial environment) and **social environment** (e.g. living arrangements prior to admission) as well as aspects regarding care such as poly pharmacy [5,6,10-12,15-18,79-83]. Even though functional loss is a recurrent problem among hospitalized older people, hospital care is usually primarily focused on treating the medically diagnosed illness, thereby often neglecting reactivation care that may prevent functional loss. A "paralleled focused" treatment on reactivation treatment next to treatment of medical diagnosis may preserve functioning of hospitalized older people at risk, thereby possibly maintaining HRQoL and independence in (instrumental) activities of daily living in the period after discharge from the hospital, thereby leading to a lower burden of care for the informal caregivers of these older patients as well as lower health care costs at a societal level. This article describes the study design (e.g. methods, setting, population, strengths, and weaknesses) of an evaluation study of the Prevention and Reactivation Care program (PReCaP), a program that is developed to provide reactivation care parallel to regular medical care. The PReCaP will be compared to the usual care offered in two control-hospitals.

Description of the PReCaP

The PReCaP is developed to prevent and/or reduce hospital related functional loss among at-risk older patients by offering an individualized treatment plan that is based on problem-solving

principles. It includes interventions that are integrated, multidisciplinary and goal-oriented at physical, social, and psychological domains of functional loss and combines existing treatment methods and routes for reactivating at risk older people into an individual care package.

The PReCaP consists of several important elements: Firstly, it aims to identify hospitalized older people at risk of functional loss at an early stage after hospital admission (= within 48 hours of admission). This will make early implementation of interventions possible, which may prevent functional decline and promote a quick return to independent living as well as preserve HRQoL [29,42]. Secondly, the program consists of a combination of integrated interventions offered by a specialized multidisciplinary reactivation team with geriatric expertise. Based on existing literature, this approach is expected to lead to reductions in fall incidence, improved functioning, reduced length of hospital stay, lower (re)admissions to hospital and nursing homes, improved mental well-being of informal caregivers and higher perceived health and life satisfaction among patients as well as better coordination of treatment and follow up between different health care providers and finally, lower mortality [31-34,48-51,54,55,57,84]. Thirdly, the multidisciplinary team uses Goal Attainment Scaling (GAS) to develop and monitor a personalized treatment plan. The GAS method has been successful in maintaining/ improving functioning of older patients with complex health issues [64,85] and has been standardized for this population [66]. The GAS method consists of several phases: The multidisciplinary team identifies the baseline status of the patient and determines a goal. Then the team will monitor the development per patient and their informal care system by measuring progress regularly, making it possible to adjust interventions and/or goals when necessary. A final GAS measurement will take place to set up a follow up treatment plan before the patient is discharged to the home environment. The fourth element of the program is the possibility for older patients with complex problems to be referred by the multidisciplinary team to a stay at the Prevention and Reactivation Center (PRC). The PRC offers a combination of interventions aimed at improving an older patient's ability to live as independently as possible in the home environment by providing extra-intensive thematic reactivation treatment alongside regular provisions. It includes specialized nursing home care, paramedical care, specialized mental health care, and treatment and consultations for primary informal caregivers if needed. Patients stay at the reactivation center for a maximum of three months, after which the multidisciplinary team will develop an individual care-plan for follow up after discharge. Finally, the PReCaP will provide support to patients and their informal caregivers by means of a case manager with geriatric expertise who is involved in all aspects of care throughout the period of hospital stay as well as during the follow up period after hospital discharge (irrespective of their destination after discharge whether this is their independent home, the center for prevention and recovery, a nursing home or any other setting). The case manager is involved in identifying at-risk patients in the hospital, coordinating the individual's care plan, coordinating follow up health care for

a patient after discharge (e.g. in cooperation with general practitioner, home care or other first line care providers) and aims to support and motivate the patient in treatment adherence. In addition, the case manager monitors a patient's risk factors for functional loss throughout all phases of care and may plan extra treatment if necessary as well as improve the care process where possible. Previous programs focused on case management or follow up care have lead to reductions in hospital admissions, nursing home admissions as well as a reduction in length of hospital stay [35,36]. Furthermore, case management may lead to improved access to health care, increased psychosocial support and improved communication with health professionals as valued by patients and their informal caregivers [37].

Even though earlier studies have shown the benefits of specialized multidisciplinary geriatric inpatient reactivation interventions (as well as similar programs for older people living at home), insufficient data is available on programs offering a combination of abovementioned successful elements of care, their cost-effectiveness, and on how to define the patient group that benefits the most from these programs [36,43,86-89]. To our knowledge, the current evaluation of the new intervention program is the first to offer results on the effects of a combination of several successful elements of care as well as offer clear patient eligibility criteria for such an integrated program.

Objectives of the evaluation

This evaluation study entails an effect, process and cost evaluation of offered geriatric health care and has four main objectives. First of all, the study aims to determine to what extent the PReCaP, in comparison with other usual forms of geriatric care, leads to a retention in functioning and HRQOL of at-risk hospitalized older people, a reduction in the burden of care for the older patient's primary informal caregiver, shorter lengths of hospital stay, and a reduction of 'wrong bed' problems as well as (re-) admission to hospitals, nursing homes and mortality. In addition, it will show the extent to which PReCaP care including a stay at the PRC leads to better functioning and HRQoL of older patients in need of complex care. Secondly, the study aims to determine to what extent the screening instruments used in the program detect increased risk of functional loss and to determine how criteria for screening should be adjusted to optimally link the offered interventions to the needs of individual hospitalized older people at risk. Thirdly, the evaluation will determine to what extent the PReCaP, in comparison with other, usual forms of geriatric care in the Netherlands, leads to a better structure and process of care. Finally, the cost-effectiveness of the PReCaP (both including and excluding a stay at the PRC) will be determined in comparison with other usual forms of geriatric hospital care in the Netherlands.

METHODS/DESIGN

Evaluation design

This evaluation study uses a concurrent mixed methods design (a combination of qualitative and quantitative research methods) to evaluate screening criteria, effects, processes and costs of the care provided in the three participating hospitals. It consists of a quasi-experimental study as well as a nested randomised controlled trial. Within the quasi-experimental study, the data collection of health care costs and outcomes on functional status and quality of life for patient and caregiver as well as other outcome measures such as cognitive functioning, duration of hospital stay and mortality of patients will be measured using a prospective cohort design. The PRC component will be evaluated using a randomized controlled trial. Patients eligible for a stay at the PRC will be randomized to PReCaP treatment with a stay at the PRC or PReCaP treatment without a stay at the PRC. The effects of a stay at the PRC will be measured three months after hospital admission and the effects of a PRC stay in combination with PReCaP aftercare at home will be evaluated twelve months after hospital admission. In addition, a set of quantitative process indicators will be collected both for PReCaP treatment with and without a stay at the PRC (e.g. which disciplines were involved in treatment, how soon after admission the treatment started). For an in-depth evaluation of the effects of the program, data is collected on the differences in the healthcare processes between the three participating hospitals as well as differences in offered follow up care between the three hospitals. Qualitative data will be collected through interviews, observations and document analysis at similar times as the effect evaluation. These qualitative measures will support the comparison of the quality of care processes between the three hospitals.

The study protocol was approved by the medical ethics committee of the Erasmus Medical Centre, Rotterdam, the Netherlands, under protocol number MEC2011-041.

Setting

Three hospitals with different levels of geriatric care will be compared in this evaluation. The first hospital (Ruwaard van Putten, Spijkenisse) offers care without clinical geriatrics, with hospital replacement care through a care hotel and no follow up in primary care. The second hospital (St. Franciscus Gasthuis, Rotterdam) offers care with coordinated discharge and hospital replacement care (through a care hotel) and without follow up in primary care. The third hospital (Vlietland + Argos Zorggroep, Nieuwe Waterweg, Noord) is the intervention hospital and offers the new hospital based PReCaP which includes clinical geriatrics, intensive reactivation care after hospital stay (through the Prevention and Reactivation Center, or PRC) and with follow up in primary care (through case management). The three hospitals have been

chosen as they are similar in patient case mix as well as offer geriatric care in different dosages and with different elements of care.

Pilot study

A pilot study was conducted in the intervention hospital (Vlietland hospital) to choose the best triage instruments to identify hospitalized older people eligible for the PReCaP. Furthermore, the pilot results will be used to identify possible practical implementation problems in preparation for the main evaluation study and serve as a base for power calculations for the main study. In the pilot study, all patients of 65 years or older who were admitted to the Vlietland hospital between June 2010 and October 2010, were asked to participate. Around 460 patients and 200 informal caregivers were included at baseline (within 48 hours after hospital admission) and of this group around 300 patients and 160 informal caregivers completed questionnaires at the 3-month follow up (see Figure 1: Flow chart pilot study). Follow up measurements at twelve months after hospital admission were finalized in November/December 2011.

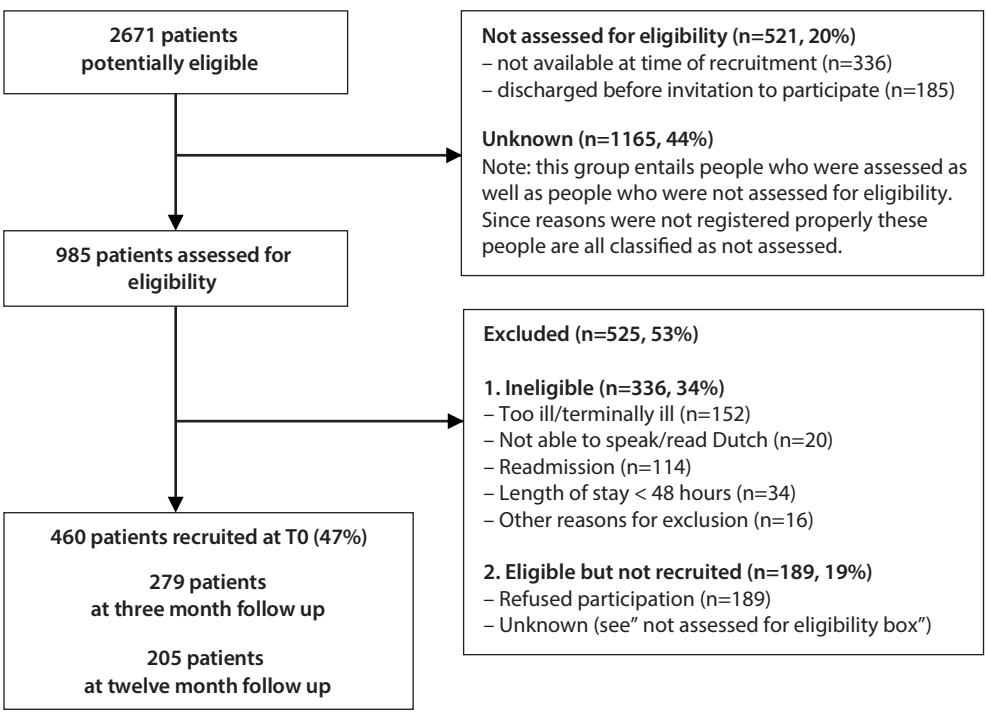


Figure 1 | Flow chart pilot study

Participants

Population

The target population of the study consists of older people aged 65 years and older who are at risk of functional loss and are admitted to one of three hospitals for at least two days. All patients will receive the usual care offered by each of the hospitals. All relevant hospital departments will be included in the study and admission may be elective or acute. Figures 2 and 3 (flowcharts) provide an overview of the flow of patients in the study. Through a first screening step, all patients at risk of functional loss will be identified with the Identification Seniors At Risk- Hospitalized Patients (ISAR-HP) [21,41]. These at-risk patients will be eligible to receive the PReCaP and therefore will be asked to participate in the study. In the Vlietland hospital, an additional screening will take place using the short Neuropsychiatric Inventory [59,90] and the Mini Mental State Examination [58] to identify older patients eligible for a stay at the PRC. This group will then be randomised to program care including a stay at the PRC (n=200) or program care excluding a stay at the PRC (n=200). The primary informal caregivers of the participating patients will be asked to answer several questions about the patient in a telephone interview as well as fill out mailed paper questionnaires on HRQoL, burden of care and other outcomes at time of hospital admission of the patient, three months after hospital admission and twelve months after hospital admission. Furthermore, health care professionals from each participating hospital will be asked to complete a survey on processes of health care.

Inclusion criteria

- Patients aged 65 years or older
- Admitted in one of the participating hospitals and staying > 48 hours
- At risk of functional loss (ISAR HP ≥ 1)

Additional criteria for a stay at PRC

- ISAR HP ≥ 2 and/or MMSE ≤ 27 and/or NPI ≥ 3

Exclusion criteria

- Unable to answer questions or follow instructions (e.g. due to severe cognitive problems (MMSE score < 12 /delirium/coma) within 48 hours of admission in the hospital
- Not able to understand the Dutch language
- Life expectancy < 3 months.

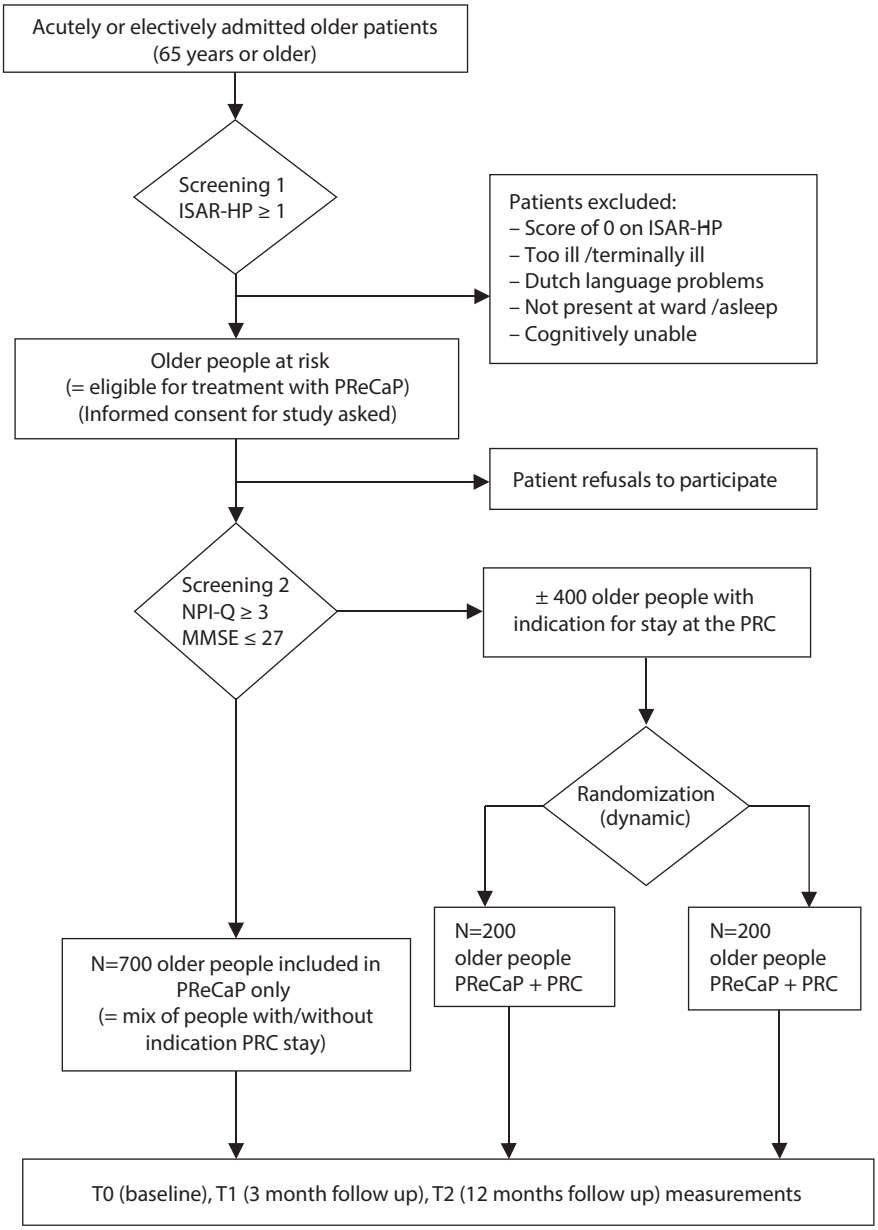


Figure 2 | Flow chart intervention hospital

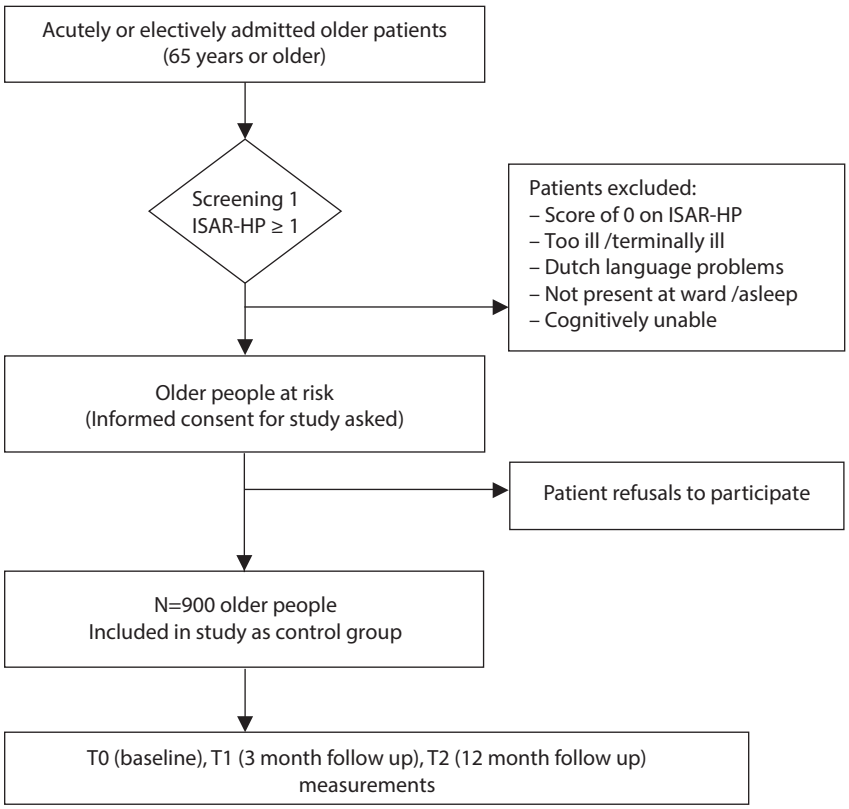


Figure 3 | Flow chart control hospitals

Power calculation and effect size

For the prospective cohort we expect to be able to collect a sample size of around 1100 older patients in the intervention hospital (900 patients treated with the PReCaP and 200 patients treated with the PReCaP including a stay at the PRC). Samples of minimal 500 to 600 older patients will be collected in each of the two control hospitals. These estimations are based on the average number of older patients who are admitted to the different hospitals during our inclusion period of one year. According to preliminary pilot results on activities of daily living (Katz-15 ADL score), a population of n=500 in the control hospitals will lead to around n=300 persons analyzable at three months, whereas a baseline population of n=1100 in the intervention hospital will lead to around 733 persons analyzable at three months. Using an effect size of 0.25 this will lead to a power of 95% [21]. Furthermore, to detect a smaller effect size (Cohen's D of 0.2), n=1100 in the intervention hospital and n=500 for the control hospitals will lead to a power of 83%. If possible, we will aim for a larger sample size in the control

hospitals than the expected n=500, (preferably 900), which will lead to N=733 analyzable in the intervention hospital versus n=600 analyzable in the control hospitals, with an effect size of 0.2 leading to a power of 95%. Abovementioned sample sizes are large enough to allow for reliable analysis per subgroup (e.g. subgroup of specific diagnoses) and sets of risk factors.

Randomization

Dynamic randomization will be used to select older patients who receive PReCaP treatment at the PRC. It is estimated that the population of patients eligible for PReCaP treatment at the PRC will be higher than the actual amount of patients that can be treated due to restrictions on available personnel, materials and budget. Therefore, randomization criteria will change dependent on what is logistically possible (= dynamic). Since the PRC has a maximum capacity of 200 patients per year at this time, dynamic randomization will be carried out by computer where the chance of referral to the program and a stay at the PRC will be reduced accordingly as fewer resources are available to provide care and fewer places in the PRC are available.

Blinding

Treatment allocation is by definition un-blinded, but since the PReCaP is in fact the usual care provided in the intervention hospital it is possible to maximize blinding of data collectors by describing the three offered health care programs as usual care in all communications, thereby concealing treatment allocation. Furthermore, blinded analyses of data will take place when possible.

Data collection

There is no clear consensus on the time period during which effects of interventions on physical functioning HRQoL will be maintained. In some studies effects were present at six to twelve months after the start of the intervention, with the largest effect present around three months [32,51]. Therefore, main data collection of older patient and caregiver outcomes takes place at time of hospital admission (T0), three months after hospital admission (T1) and twelve months after hospital admission (T2). Trained research nurses and students will administer questionnaires to patients by means of interviews at T0, T1 and T2. Furthermore, informal caregivers will receive paper questionnaires sent by mail. Patient and caregiver outcome measures will then be compared between the three hospitals. In addition a survey is administered among personnel of the three hospitals at one time during the second half of the inclusion period. Additional information on screening, patient and caregiver outcomes, process measures, and costs is collected from patient files and hospital ICT systems at time of discharge, both during the intervention and in retrospect. Based on the pilot results we expect around 60% of patients analyzable at 3 month follow up. Loss to follow up is minimized by

making house calls and interviewing the patients in person [91]. Tables 1 to 4 show a complete overview of outcome variables and data collection instruments for screening, effect evaluation, process evaluation and cost evaluation.

Demographics and triage (table 1)

Screening: identification of older patients at risk of functional loss

Screening data is gathered within 48 hours of hospital admission in order to identify older patients at risk of functional loss at an early stage. Based on the pilot results the Identification of Seniors At Risk-hospitalized patients (ISAR-HP) is chosen as the main screening instrument in order to achieve information on a combination of factors that have shown to be important in predicting functional loss. The ISAR-HP questionnaire is administered to the older patient and consists of four questions on educational level and need of help with travelling, walking or housekeeping in the period before hospital admission [21]. A patient is considered at risk of functional loss and is therefore eligible for treatment with the PReCaP if he/she scores one or higher on the ISAR-HP. This is a different score from the originally set cut off score of 2 or higher [21], and can be explained by the differences in characteristics and diagnoses of the studied population. In addition, the NPI-Q and MMSE are administered in order to identify older patients who are eligible for an additional stay at the PRC as part of the PReCaP. Patients will be considered eligible for a stay at the PRC when they score 2 or higher on the ISAR-HP and/or 3 or higher on the NPI-Q and/or 27 or lower on the MMSE. The Neuropsychiatric index (NPI-Q) is the validated short version of the NPI [59]. It aims to identify neuropsychiatric symptoms present in the patient in the last month by means of twelve symptoms (e.g. delusions, aggression, hallucinations) and also measures the emotional burden of the caregiver. The NPI is administered to the primary informal caregiver of the older patient by means of a telephone interview at time of hospital admission. The Mini Mental State Examination (MMSE) measures cognitive functioning by means of interviewing the older patient using questions on orientation in time and space, short-term and middle-term memory, comprehension and other cognitive dimensions [58,92].

Demographics

Data on demographics (e.g. age, socioeconomic status, marital status, and gender) is gathered at T0, T1 and T2 by means of the Minimal Data Set (MDS) and hospital registries. The MDS is developed in light of the national program for elderly care in the Netherlands and aims to compare older people as well as their caregivers participating in different projects in the Netherlands by measuring demographics, HRQoL, ADL functioning, experienced health and health care utilization (patient-level) as well as demographics, experienced health and burden of care, HRQoL, and objective burden of care of the informal caregiver. The MDS is a

combination of (parts of) validated questionnaires and is administered by trained research nurses and trained students (e.g. medical students or other students who have experience with research and/or elderly care), who interview patients at T0, T1 and T2. The data is collected from informal caregivers by means of mailed paper questionnaires, which are self-administered by informal caregivers and then sent back to researchers. A reminder including an extra copy of the questionnaire is sent to informal caregivers in cases where they did not send back the first questionnaire. Additional data on demographics as well as data for other elements of the evaluation (e.g. medication, diagnosis, specialist consults) is collected from medical registries after hospital discharge.

Table 1 | Data collection of patient and informal caregiver demographics and triage

Evaluation	Variables + Instruments	Data collection methods	Data collection time			Notes:
			T0	T1	T2	
General						
Patient	*Demographics*					
	– MDS (age, ethnicity, SES, education)	– Interview patient	X	X	X	Only partly measured at T1 and T2
	– Other information	– Patient hospital files	X			+ from hospital information systems
Informal caregiver	*Demographics*					
	– MDS (relation to patient, SES etc.)	– Mailed paper questionnaire	X	X	X	Only partly measured at T1 and T2
Screening						
Patient						
	– ISAR-HP	– Interview patient	X			Risk of functional loss
	– MMSE (cognitive functioning)	– Interview patient	X			
	– NPI-Q (neuro-psychiatric functioning)	– Phone interview caregiver	X			

* T0=within 48 hours of hospital admission; T1=3 months after hospital admission; T2=12 months after hospital admission; MDS=Minimal Data Set; ISAR-HP=Identification Seniors At Risk (Hospitalized Patients); MMSE=Mini Mental State Examination; NPI-Q=Neuro-Psychiatric Index

Effect evaluation (table 2a and 2b)

All outcome data of the older patient are collected by the same means as the MDS described above.

Quality of life (patient)

The EuroQol (EQ6D) is administered to measure HRQoL among patients and their caregivers. It is part of the MDS and will be used to calculate cost-utilities of health care [93]. The Dutch version of the SF-20 is administered and aims to score six sub-dimensions such as physical functioning, social functioning and experienced health [61]. The SF-20 is chosen since it is quick and many of its questions are already part of the MDS. The SF-20 has shown good test-retest reliability and acceptable convergent and discriminative validity for a group of older people, even though some precaution is advised in using the questionnaire with older people living at home [94]. The short version of the Social Production Function Scale SPF-IL scale measures social well-being by means of the dimensions "affection", "behavior confirmation" and "status" as well as physical well-being by means of the dimensions "comfort" and "stimulation" [95].

Table 2a | Effect evaluation: Data collection of patient outcome variables

Effect evaluation	Outcome variables + instruments	Data collection methods	Data collection times			Notes
			T0	T1	T2	
	HRQoL					
	SF-20	Interview patient	X	X	X	Part of MDS
	EQ-5D	Interview patient	X	X	X	Part of MDS
	SPF_IL	Interview patient		X	X	
	Physical performance					
	Katz -15	Interview patient	X	X	X	Part of MDS
	Short Physical Performance Battery	Interview patient ("do" test)		X	X	
	LAPAQ (physical activity)	Interview patient		X	X	
	Cognitive/Psychological/Social					
	NPI (neuro-psychiatric functioning)	Interview caregiver	X	X	X	
	MMSE (cognitive functioning)	Interview patient	X	X	X	T1 and T2: MMSE short
	Geriatric Depression Scale (depression)	Interview patient	X	X	X	
	Global Deterioration Scale (dementia)	Phone interview informal caregiver	X	X	X	
	Loneliness scale Gierveld (social network)	Interview patient	X			

Table 2a | Effect evaluation: Data collection of patient outcome variables *(Continued)*

Effect evaluation	Outcome variables + instruments	Data collection methods	Data collection times			Notes
			T0	T1	T2	
	Intramural Residence	Medical registries		X		
	(Re-)admission hospital/ nursing home	Interview patient/ caregiver		X	X	
	Mortality	Medical registries		X	X	
	Patient self-management					
	SMA-S	Interview patient		X	X	

*T0=within 48 hours of hospital admission; T1=3 months after hospital admission; T2=12 months after hospital admission; * MDS=Minimal Data Set; SF-20=Short Form 20; EQ6D=EuroQol; SPF-IL=Social Production Function questionnaire; SPPB=Short Physical Performance Battery; LAPAQ=LASA physical activity questionnaire; MMSE=Mini Mental State Examination; NPI = neuro-psychiatric index; ; GeDS=Geriatric Depression Scale; GloDS =Global Deterioration Scale; ARS=Activity restriction scale; CSI=Caregiver strain index; SRBS=Self-rated burden scale; SMA-S=Self Management Ability Scale

Table 2b | Effect evaluation: Data collection of informal caregiver outcome variables

Effect evaluation: Informal caregiver outcomes	Outcome variables + instruments	Data collection methods	Data collection times			Notes
			T0	T1	T2	
	Health related quality of life					
	EQ-6D	Mailed paper questionnaire	X	X	X	Part of MDS
	SF20	Mailed paper questionnaire	X	X	X	5 items part of MDS
	Carer QoL	Mailed paper questionnaire	X	X	X	Part of MDS
	Burden of care					
	ARS (objective)	Mailed paper questionnaire	X	X	X	Part of MDS
	Questions on time spent on care tasks	Mailed paper questionnaire	X	X	X	
	CSI (subjective)	Mailed paper questionnaire	X	X	X	
	SRBS (subjective)	Mailed paper questionnaire	X	X	X	Part of MDS

*T0=within 48 hours of hospital admission; T1=3 months after hospital admission; T2=12 months after hospital admission; * MDS=Minimal Data Set; SF-20=Short Form 20; EQ6D=EuroQol; P; SPF-IL=Social Production Function Questionnaire; SPPB =Short Physical Performance Battery; LAPAQ=LASA physical activity questionnaire; MMSE=Mini Mental State Examination; NPI=neuro-psychiatric index; GeDS=Geriatric Depression Scale; GloDS=Global Deterioration Scale; ARS=Activity restriction scale; CSI=Caregiver strain index; SRBS=Self-rated burden scale

Physical functioning (patient)

The Katz-15 index of activities of daily living measures function over time by means of questions on several domains such as bathing, dressing, toileting, transferring, continence and feeding [96,97]. The LAPAQ (LASA Physical Activity Questionnaire) is an interview administered questionnaire measuring frequency and duration of activities such as household activities, walking, gardening, and sports [98]. The SSPB (short physical performance battery) is an objective physical performance test consisting of repeated chair stands (number of stands and amount of time standing), balance testing (three different stands), and walking (2.44 meters). This test is necessary in order to see if the results from the subjective physical performance tests are in agreement with measured objective physical capabilities [99,100].

Cognitive and neuropsychiatric functioning (patient)

The NPI and MMSE (see screening for explanation) are administered to measure cognitive and neuro-psychiatric functioning of patients of over time, with the short version of the MMSE being administered at follow up instead of the longer version that was administered at time of hospital admission. Nevertheless, the results are still comparable using existing and tested transformation scores. The Global Deterioration Scale (GDS) measures a patient's stage of dementia by means of 7 levels, from 1 (normal functioning) to 7 (very serious dementia) and is administered to the informal caregiver of the patient [101].

Social and psychological functioning (patient)

The Geriatric Depression Scale (GDS-15) identifies and measures functional as well as mood symptoms of depression [102]. The GDS-15 has been validated in geriatric inpatients as well as in primary care and community living older [103,104]. The Loneliness scale consists of 11 questions and measures social functioning of the patient [105].

Self-management (patient)

The SMA-S (Self Management Ability Scale) measures the ability of a person to manage his/her own general daily life activities in the past months. It contains items on several subjects such as activities the patient initiates; activities the patient starts now but expects to benefit from later; general activities; combining activities; the success or failure of activities; and dealing with adverse experiences [106].

HRQoL (caregiver)

The carer quality of life questionnaire (Carer QoL) measures quality of life of caregivers and is part of the MDS [107]. The EuroQol is also administered to the caregiver as part of the MDS (see Quality of Life patients).

Burden of care (caregiver)

Objective burden of care of the caregiver is measured using the Activity Restriction Scale [108] and additional questions on objective burden of care [109,110]. Subjective burden of care is measured with the Self Rated Burden Scale and Caregiver Strain Index or CSI [111,112].

Process evaluation (table 3)

The process evaluation will look at process indicators thereby showing the extent to which the PReCaP leads to better structure and process of care in comparison with other usual forms of geriatric care in two other hospitals in the same region (e.g. improvements in coordination between care-providers, patient logistics, information logistics and support). In addition, the process evaluation will focus on how and to what extent the PReCaP is actually implemented according to plan. This requires instruments that are sensitive for specific interventions and which are connected with the expected alternations in the outcomes of care for the older patient and his/her informal caregiver. In order to do this, sub-domains of the care process from a patient, caregiver and professional point of view will be measured. In addition, qualitative data is gathered to explain quantitative outcomes. Described processes and provided interventions will be linked to outcomes in order to provide a complete description of the evaluation of this transition project.

Process of care (patients)

Patient experiences with delivered care are measured at T1 by means of the Patient Assessment of Chronic Illness Care (PACIC) questionnaire, and consists of questions on care received in the last 3 months [113]. In addition, specific experiences with hospital care delivered during total hospital stay around T0 are measured with the (Hospital) Consumer Assessment of Healthcare Providers and Systems ((H)CAHPS), which consists of questions on treatment by nurses and doctors, hospital environment, experiences with hospital stay as well as discharge from the hospital, and general appreciation for the hospital [114]. Registering process indicators involves a continuous measurement of the care provided to older patients and their informal caregiver. For the moment it does not appear possible to make use of an Electronic Patient File (EPD) in all three hospitals. Therefore, process indicators will be collected partly from existing registrations. Research nurses and students collect the remaining indicators. Insight into the care process is provided by covering the topics of 'determining vulnerability', 'provided medical care (diagnostics and treatments)', and 'the extent of multidisciplinary meetings'.

Table 3 | Process evaluation: Data collection of process outcome variables

Process evaluation	Outcome variables + instruments	Data collection methods	Data collection times			Notes
			T0	T1	T2	
	Patient experiences with quality of care					
	PACIC	Interview patient		X	X	
	(H)CAPHS	Interview patient		X		
	Caregiver experiences with quality of care					
	SASC – adapted for elderly care	Mailed paper questionnaire			X	(+ additional self-formulated questions)
	Process of care delivery hospital					
	Process indicators (own formulation)	Medical registers	X			+ time after hospital discharge
	Process of care delivery professional view					
	TCI (+ own formulation additional questions)	Mailed paper questionnaire	Last month inclusion period			
	ACIC (only partly)	Mailed paper questionnaire	Last months inclusion period			
	RCSP	Mailed paper questionnaire	Last months inclusion period			

* T0=within 48 hours of hospital admission; T1=3 months after hospital admission; T2=12 months after hospital admission * PACIC=Patient Assessment of Chronic Illness Care; (H)CAPHS=(Hospital) Consumer Assessment of Healthcare Providers and Systems; SASC=Satisfaction with Stroke Care Questionnaire; TCI=Team Climate Inventory; ACIC=Assessment of Chronic Illness Care; RCSP=Relational Coordination Survey for Professionals

Experiences quality of care (caregiver)

The SASC (Satisfaction with Stroke Care Questionnaire) originally measures patient satisfaction with stroke care. For current research, it has been adapted to caregiver satisfaction with the care for frail older patients after discharge. It covers subjects on both the acute and chronic phase of care: experienced caregiver respect and information provision during the older patients' hospital stay; the amount of caregiver support and information provision after older discharge [115,116].

Process of care (professional)

The TCI (Team Climate Inventory) has been used as an improvement tool for assessing team function to identify areas that could be improved. It contains 14 items on several team

dimensions such as: task orientation and support for innovation [117]. The ACIC (Assessment of Chronic Illness Care) is a practical quality-improvement tool to evaluate the delivery of care for chronic illness in six areas: community linkages; self-management support; decision support; delivery system design; information systems and organization of care [118]. The RCSP (Relational Coordination Survey for Professionals) measures the relational dynamics of coordinating work. The self-administered questionnaire contains 8 items. Different professionals are asked how frequently, timely and accurately they solve problems and share goals with other professionals while treating vulnerable older people [119].

Qualitative process measures

Qualitative measures will complement the quantitative data collection, thereby strengthening the study design by providing the mixed method component mentioned earlier. Qualitative measures will provide additional in-depth information on the context in which the implementation of care and interventions takes place (structure). An audit study based on expert opinion and literature will provide information on general quality of care (e.g. by means of showing/evaluating differences and similarities in the care and interventions that are provided in the three hospitals). Furthermore, a fidelity study will collect information on the differences between planned and actual implementation of care and interventions in the hospitals (is care implemented as it should be by the professionals?). Finally, case studies by means of qualitative interviews with professionals as well as observations within the hospitals will provide further information and insight as they provide a context in which quantitative outcomes can be placed.

Cost-effectiveness evaluation (table 4)

A cost-utility analysis will compare cost differences (incremental costs) of provided health care in the three hospitals with the difference in health effects measured in quality adjusted life years (QALYs). QALYs combine alterations in quantity and quality of life (mortality and morbidity) into a combined generic instrument. Data on quality of life will be measured by means of the EQ6D and SF20 for older patients and by means of the EQ6D, CarerQoL and SF-20 for the primary informal caregiver (see effect evaluation). Cost information is gathered by means of hospital information systems, patient files and questionnaires for both patient and primary caregiver at baseline (T0), after three months (T1) and after 12 months (T2). A societal perspective is used; taking into account both direct and indirect costs within as well as outside health care. Data collection on utilization of care in hospital (nursing days, diagnostic and therapeutic activities and out-patient visits), nursing home (days), rehabilitation (admissions/ outpatient), and home care (care hours according to product clusters) will take place centrally,

according to a standard method, by means of standardized files and standard cost diaries as well as through patient and caregiver questionnaires.

Data analysis

Screening

Data will be gathered on risk factors for functional decline and predictive models for functional decline at 3 and 12 months can be developed using multivariate regression techniques and data from control settings. The quality of the predictive models will be assessed by explained variance for continuous outcome measures and by ROC-curves for dichotomous outcome measures. The quality of the model that fits the program eligibility criteria will be compared to models with other risk factors involved and/or other cut-off points on the screening instruments. This way the added value of another screening method can be objectively assessed. These analyses were already partly done using preliminary pilot study results but will be repeated using final results of the main evaluation study. Furthermore, main study results will be used to evaluate the validity of the model(s) with internal validation techniques (bootstrapping) and cross validation between the three settings whereby each setting acts as a test-population for model(s) developed in the other settings [120].

Effect evaluation and process evaluation

Effects and process evaluation of the PReCaP

Corrections will take place by means of 'analysis of covariance' for baseline differences in determinants between the locations that could explain differences in functioning or health related quality of life. Multiple regression analysis will be administered for various outcome variables such as linear regression for continuous outcomes; logistic regression for dichotomous outcomes; proportional odds regression for orderly outcomes and Cox proportional hazards regression for events that occur over time (such as death). Analysis of outcomes at three and twelve months will take into account dependency of these outcomes within persons. The degree of exposure to integrated, multidisciplinary care within the intervention location (process evaluation) will also be correlated with effect measurements in order to see whether greater exposure leads to greater effects. Regression analysis will trace sub-group effects and an interaction term will be included in the model, between type of hospital and sub group (e.g. older patients at high risk of functional loss in comparison to older patients at relatively lower risk of functional loss)

Table 4 | Cost effectiveness evaluation: Data collection health care volumes and prices

Outcome variables	Data collection methods	Data collection times	Notes
Health care volumes			
Costs of period first hospital admission: – amount of hospital days (days admitted) – total days/time admitted at ICU – amount of consults medical/ paramedical – amount of large scans and diagnostics – amount of large treatments/ operations – wrong bed days	Hospital registries	Time of discharge from the hospital	
– -amount of days admitted – amount of consults medical/ paramedical – time/amount of multidisciplinary meetings	Hospital registries, sample interviews professionals, registration by professionals center for prevention and reactivation	Start to end of inclusion period	
Health care utilization patient (homecare/ nursing home/ older home/ hospital admissions/ general practitioner/ ambulance/ etc.	Interview patient and mailed paper questionnaire primary caregiver	T0, T1, and T2	
Average time per consult	Interviews professionals	Sample during inclusion period	
Amount of hours informal care and work/leisure time/etc. missed	MDS + questionnaire caregiver	T0, T1, and T2	
Amount of hours (multidisciplinary) coordination	Interviews professionals		
Health care prices			
– Price per hospital day – Price per day/hour admitted at ICU – Price of consults medical/paramedical – Price of large scans and diagnostics – Price of large treatments/operations	DBC information + manual for cost research	Retrospective	Similar calculations for PRC, care hotels, nursing homes/ older home care, rehabilitation centers, extramural care etc.)
– Average travel costs		Literature	
– Costs of home care	Integral costs per product cluster	Retrospective	
– Costs informal care by primary caregiver	Market price/missed wages/missed leisure time/homework	Retrospective	

T0=within 48 hours of hospital admission; T1=three months after hospital admission; T2=twelve months after hospital admission

Effects and process evaluation of the PRC

A randomized controlled trial will be analyzed according to the "intention to treat" principle. The process evaluation will study which treatments are carried out in exactly which way. Since differences in case mix and treatment regiments that differ from the PReCaP can confound the relation between the PReCaP and its expected effects, analysis will be corrected for these possible confounders. For example, data regarding diagnoses of older patients at admission and discharge will be collected and quantitative, clinical treatment data is collected during intake, which is focused on medical diagnosis in order to correct for differences in treatment regiments. The randomization leads to balance between arms of the randomized controlled trial in observed and unobserved predictors of functional decline. Important baseline characteristics are taken into account in analyses to correct for imbalance that might occur by coincidence, thereby increasing power.

Cost-effectiveness evaluation

Primary outcome measure is costs per QALY. A cost-utility analysis will compare cost differences (incremental costs) with the difference in health effects measured in QALYs. In order to calculate costs, the volume of care will be linked to the actual, integrated cost prices per medical service [121]. Net costs per nursing day will be calculated as well as the costs for diagnostics and therapy with help from the manual of cost research in economic evaluations [122] and will be judged for usability according to recent DBC-information. Wrong bed days will be estimated according to the method of Van Straten [123]. The extra costs of a stay at the PRC (e.g. training, availability specialist care doctors and nurses, mobilization, extra physiotherapy etc.) in comparison with the usual geriatric care provided in PReCaP will be measured, making a distinction between once-only costs and structural costs [124]. Integrated costs per day nursed at the PRC will be calculated with aid of the activity base costing method [121]. Data on personnel, material costs, diet-related costs, accommodation and overheads will be accessed using center registries and information systems, and extra information is collected through regular observation and self-registration of professional activities. Integrated costs per hour, per product cluster, will be used for home-care. For the remaining extramural care (general practitioner care, physiotherapy, social services etc.) costs will be assessed with information from cost manual and recent cost-price research. Costs are discounted at a constant discount rate of 4% per year. Future health effects are discounted at a constant discount ratio of 1.5% per year. Net savings could occur on balance during hospital care, whilst a stay at the PRC as well as home care will lead to use of additional means. This valance of savings and extra costs cannot be indicated in advance. It is expected that continuity of care will possibly lead to considerable savings [125].

DISCUSSION

The aim of this evaluation study is to compare outcomes, processes and cost effectiveness of the PReCaP. This program is provided for "at risk" older patients and will be compared to the usual care provided in two control hospitals.

Strengths

First of all, this study uses a mixed methods design of quantitative and qualitative measures that provide information on three elements as stated by Donabedian [126]: structural issues (e.g. materials, personnel, organization and coordination of care) as well as on processes (e.g. activities of professional in diagnosing and treating the patient) and patient and caregiver outcomes such as physical functioning and HRQoL. According to Donabedian, the combination of these elements allows for better interpretation of findings, as one method may strengthen interpretation in cases where another method cannot explain variances or outcomes. Qualitative data may generate further hypotheses that may be explained by quantitative process and outcome data. It can also provide a context within which outcomes can be explained more in-depth. Secondly, a pilot study was conducted at the intervention hospital before implementing the PReCaP, which optimized beforehand the triage for selecting patients to be included in the main study as well as the power calculations and the practical implementation of the main study. In addition, several practical and implementation problems were encountered in the pilot study (e.g. logistics within hospital, personal communication with hospital personnel etc.), making it possible to prevent similar problems and sources of bias when conducting the main study. Within the cohort study, dynamic randomization will be implemented in order to prevent extra bias. Conducting personal interviews through house calls at three months and 12 months after hospital admission will minimize missing data as well as loss to follow up. Finally, the evaluation will contain a cost-effectiveness study that will improve/increase current knowledge on the feasibility of implementing transition programs such as the PReCaP.

Weaknesses

This study is mainly a cohort study and not a randomized controlled trial (except for the evaluation of a stay at the PRC). Nevertheless a cohort study seems our best option for several reasons: Firstly, during hospital treatment, contamination of a control group would be inevitable within one hospital since the same personnel will be treating patients from different groups at the same departments [127]. Secondly, the PReCaP will be the standard care provided in the intervention hospital thereby making randomization within the hospital not possible. Furthermore, randomization of treatments between hospitals is not possible

since each hospital already has its own standard provided care. Thirdly, during the follow up period after hospital discharge people already have their own regular general practitioner (GP) whose practice is usually close to the patient's home and who is familiar with the patients health and history, making it unrealistic to randomize patients among GP's [127] or home care organizations as well as other first line practitioners. Finally, by conducting a prospective cohort study we aim to investigate health care as provided in a real life situation, thereby improving the generalizability of the study.

Another weakness of this study might be the fact that possible transitions within the three hospitals unrelated to the study may influence outcomes (e.g. at the time of writing this protocol plans exist for starting up specialized clinical geriatric care in the St. Franciscus Gasthuis in light of implementation of national guidelines on elderly care). This may alter differences in levels of health care provided by the hospitals over time thereby influencing outcome and process results. Nevertheless, these changes reflect how health care transitions evolve in real life situations, making the outcomes very valuable nonetheless. Furthermore, transitions will be monitored closely by means of our quantitative and qualitative process evaluation. We will use a methodological approach that combines qualitative and quantitative (mixed) research methods, enabling a thorough and comprehensive evaluation of the PReCaP for older people at risk of hospital related functional loss. The introduction of complex, multi component interventions such as the PReCaP is sensitive to an array of influences such as details of implementation and context [128,129] and as such calls for embracing a wide range of scientific methodologies. Such a wide range of scientific methodologies helps to obtain information on both mechanisms and contexts, adds to the knowledge on the feasibility and costs of different forms of integrated health care, and highlights the factors that are likely to influence the success and failure of integrated health care for hospitalized older people at risk of hospital related functional loss.

Clinical implications

The results of the study will help determine the most effective way of identifying and treating at-risk hospitalized older people in order to prevent unnecessary hospital related functional loss among this group and keep them as independent as possible for as long as possible after they are discharged. In addition, the study may show effective ways to lower the burden of care for primary informal caregivers of older patients at risk of functional loss as well as improve their HRQoL. Furthermore, the results will increase knowledge on practical issues of implementing a transition in health care and on ways to improve coordination between first and second line care.

Research implications

By comparing costs, effects and processes of different levels of integrated health care programs offered in three hospitals, this study will extend our knowledge on how to prevent hospital related functional loss among at-risk hospitalized older people in a more cost-effective way. This in turn may lead to further research on creating and evaluating similar (improved) integrated health care programs thereby strengthening the health care offered to older patients at risk of hospital related functional loss at both a regional and national level.

PART TWO

Prognosis of Functional Decline

CHAPTER 4

Comparison of the ability of four screening tools to predict poor functioning of hospitalized older people after hospital discharge

Linda. E. Flinterman, Kirsten J. E. Asmus-Szepesi, Paul L. de Vreede, Yvonne Vergouwe; Ton J. E. M. Bakker; Anna P. Nieboer; Johan P. Mackenbach; Ewout W. Steyerberg

Submitted for publication

ABSTRACT

Hospitalized older people are at risk of poor functioning after hospital discharge. Screening to identify older at risk of functional decline can reduce this risk. We studied the predictive ability of four screening instruments in hospitalized older people and compared different cut-off points to identify older patients at high risk of poor functioning. We included 460 patients aged 65 years and older who were admitted to a community hospital in the Netherlands for at least 48 hours. The Identification Seniors At Risk (ISAR), Identification Seniors At Risk Hospitalized Patients (ISAR-HP), the Score Hospitalier d'Évaluation du Risque de Perte d'Autonomie (SHERPA), and a safety management questionnaire (VMS) were administered at hospital admission (baseline). Functioning was determined at baseline and three months after inclusion. The definition of functioning included disability of instrumental activities of daily living, disability in activities of daily living, and death. The ability of the instruments to predict poor functioning was quantified with the area under the receiver operating characteristic curve (AUC).

The SHERPA and ISAR-HP performed best in predicting functional status at three months. The ISAR-HP is shorter and easier to administer compared to the SHERPA. The four instruments could only moderately predict functional decline. We conclude that the ISAR-HP is a promising, tool to identify patients with poor functioning during follow-up.

INTRODUCTION

Several screening instruments were developed to identify hospitalized older people at risk of poor functioning after hospital admission [4,130-132]. Patients identified as 'at risk' by such screening instruments could benefit from extra treatment to improve functioning after hospital admission. However, there is no 'gold standard' for determining the risk of functional decline for hospitalized older people. Previously developed screening tools differ significantly, since they were developed in different hospital departments, for patients of different age categories, and with different outcome definitions of functioning [4,131-133]. Since screening instruments vary in length, type of predictors considered, and scoring system, it is unclear which instrument is most useful when identifying hospitalized older people at risk of poor functioning after hospital discharge.

We compared the predictive ability of four simple screening instruments for hospitalized older people in order to identify the screening instrument that most accurately predicts risk of poor functioning after hospital discharge in a general hospital population of patients aged over 65. We compared the Identification Seniors At Risk (ISAR) [134], the Identification Seniors At Risk Hospitalized Patients (ISAR-HP) [135], the Score Hospitalier d'Évaluation du Risque de Perte d'Autonomie (SHERPA) [4], and a safety management questionnaire (VMS) [130]. We used the same outcome definition for all four screenings instruments and studied their predictive ability to define at-risk older patients at different cut-off points.

METHODS

Patients

The study was conducted at a 450-bed hospital in and urban area in the Netherlands from May 2010 until December 2010. All patients aged 65 and older who were admitted for > 48 hours were eligible for this study. Patients were excluded if they had a life expectancy of less than three months according to the medical staff, if they were not able to answer questions due to language problems, cognitive problems, a delirium, or a coma.

Data collection

A trained researcher interviewed older patients at hospital admission (baseline) and at 3-month follow-up. Baseline interviews were performed within 48 hours after hospital admission and included demographic data, living conditions, physical functioning, cognitive functioning, the ISAR, ISAR-HP, and part of the SHERPA. The remaining screening information of both SHERPA and VMS were obtained from patient medical files. At 3-month follow-up, participants were

interviewed at their home. The Medical Ethics Committee of the Erasmus University Medical Center approved the study and all participants signed an informed consent form at time of inclusion.

Screening tools

The ISAR [132] consists of seven questions on functional impairment before hospital admission, each with a yes/no response. Questions include functional status, previous hospitalization, visual impairment, cognitive functioning, use of more than three types of medication, and age. Age is scored 0-2 and all other questions 0-1, leading to a scoring range of 0-8, with a score two or higher showing risk of poor functioning.

The ISAR-HP [131] was developed for patients aged 65 and older who were acutely admitted to a department of internal medicine. The scale includes four yes/no questions on need of assistance for instrumental activities of daily living (iADL), use of a walking device, need of assistance when travelling and educational level. The scoring range is 0-5, including two points for the walking aid question. A score of two or more points is considered an increased risk of functional impairment.

The SHERPA [4] was developed for patients older than 70 and admitted to an emergency department. The SHERPA stratifies hospitalized older people into high, moderate, mild and low risk of functional decline three months after hospital discharge. The score is based on 32 questions about age, dependence of instrumental activities of daily living (iADL) using the Lawton Scale [136], cognitive functioning using the Mini Mental State Examination (MMSE21) [60], history of falls in the previous year, and self-perceived health. The scoring range is 0-11.5. Patients with a score of six or more are identified as the high-risk category.

The VMS [130,133] is a Dutch safety screening instrument which has been recently implemented in all hospitals as part of a screening protocol for all patients 70 and older who were admitted for at least 48 hours. The VMS screening was developed by a Dutch organization that develops safety programs for health organizations and hospitals in the Netherlands [130]. The VMS consists of 13 questions and is a combination of four tools; the Katz-ADL questionnaire [96], history of falls within the previous 6 months, the short nutritional assessment questionnaire (SNAQ) [137] on nutritional status, and three questions estimating the risk of delirium. The VMS measures risk of functional decline on a four-point scale. If someone younger than 80 years scores positive on three or four of the scales, the patient is considered at risk of functional loss. Patients 80 years and older are at risk when one scale is positive [133].

Functioning

Patient functioning was measured in an absolute sense by means of functional status and in a relative sense by functional decline. Functioning was determined using a combination of the

Katz15-ADL scale [138], which is a modified combination of the Katz6-ADL [96], the Lawton (iADL) Scale [136], and death. For the Katz15 all items were scored one or zero, with a maximum score of 15 points and higher scores reflecting higher independence. Patients who died during follow-up received a total score of zero points. We used a cut-off of 13 or more points to define good functioning. Those with less than 13 points were defined as patients with poor functioning. Functional decline was defined as a decline of one or more points at three-month follow-up compared to baseline.

Statistical analysis

We used the area under the receiver operating characteristics (ROC) curve to determine the ability of the four screening instruments to predict poor functioning. The area under the ROC curve (AUC) is a widely used summary measure of test accuracy, ranging from 0.5 (no better than chance performance) to 1 (100% accuracy) [139]. We considered the sensitivity and specificity for different cut-off points of the screening instruments to identify 'at risk' patients. A complete case analysis was performed. All analyses were performed using SPSS version 20 (IBM Corp. Armonk, NY).

RESULTS

Baseline

Of the 2184 patients aged 65 or older who were hospitalized for at least 48 hours, 1724 were excluded because they were either not willing to participate, or repeatedly unavailable (e.g. off ward or receiving medical care) before discharge. A total of 460 patients signed an informed consent and were included in this study. Mean age of the participants was 76 years and 56% were women. At admission, 15% of patients were completely independent in daily life (Table 1).

Table 1 | Baseline characteristics of patients 65+ and admitted > 48 hours

Characteristics	N=460
Women, N (%)	256 (56%)
Age, median (25^{th}-75^{th} percentile)	76 (70-82)
Length hospital admission, median (25^{th}-75^{th} percentile)	5 days (4-8 days)
Marital status, N (%)	
Married	246 (54%)
Widowed	154 (34%)
Living together, not married	11 (2%)
Living alone, not widowed	49 (11%)
Baseline Katz15-ADL, median (25^{th}-75^{th} percentile)	11 (7-13)

Screening tools

Baseline ISAR and ISAR-HP information was complete, but VMS and SHERPA data were complete for 258 (56%) and 251 (55%) patients respectively (Table 2). In total, 207 (45%) patients answered all four of the questionnaires, 95 (21%) patients filled in three of the questionnaires, and 158 (34%) patients only filled in both ISAR tools. One hundred patients (22%) had low risk of poor functioning according to all scored screening tools. While most patients scored positive on at least one screening instrument, none of the patients were indicated as high risk of poor functioning (positive score) on all four screening instruments.

Functioning at admission and at 3 month follow-up

At 3-month follow-up, 44 patients had died (9.6%) and 139 patients (30%) declined to participate. Of the included patients, 162 (35%) had a good functional status at admission, and 161 (35%) had a good functional status (score >= 13) at 3 months.

Table 2 | Baseline values of screening tools

Screening test	N patients (%)	Median (25^{th}-75^{th} percentile)
ISAR	460 (100)	2 (1-4)
– 0 points	54 (12)	
– 1 point	74 (16)	
– 2 points	113 (25)	
– 3 points	84 (18)	
– 4 points	71 (15)	
– >4 points	64 (14)	
ISAR-HP	460 (100)	2 (0-4)
– 0 points	128 (28)	
– 1 point	92 (20)	
– 2 points	59 (13)	
– 3 points	56 (12)	
– 4 points	78 (17)	
– 5 points	47 (10)	
SHERPA	251 (100)	3.5 (0-2)
– Low (0-3 points)	120 (48)	
– Mild (3.5-4.5 points)	41 (16)	
– Moderate (5-6 points)	36 (14)	
– High (>6 points)	54 (22)	
VMS* (positive score)	258 (38)	

*A positive score on the VMS was defined according to Heim et al. [133]; Patients were positive if they were 80 years or older and scored 1 or more points or when they were younger than 80 and scored 3 or more points

The SHERPA and ISAR-HP had the best predictive abilities for three month functioning, with an AUC of 0.82 (95%CI 0.76-0.88) and 0.82 (95%CI 0.77-0.87) respectively. The SHERPA had a very high specificity of 89% at 3-month follow up, but a low sensitivity of 55% at a cut-off of five or more points. The ISAR-HP with a cut-off of zero had a sensitivity of 90% and specificity of 51% for functioning at 3 months (Table 3). At 3-month follow-up, 88 patients (27%) showed decline in functioning, including 44 deaths. Another 40 patients declined one to six points in functioning compared to baseline. A total of 58 patients (18%) were stable in functioning at three months, and 175 patients (55%) showed improvement in functioning with 1 to 10 points during the first 3 months after hospital admission. All four tests moderately predicted functional decline at 3 months (AUC ≤ 0.69, Table 3).

Table 3 | AUC, sensitivity and specificity of functional status and functional decline at 3 months of follow up

		Functional status at 3 months			Functional decline at 3 months		
Test	**Cut-off**	**AUC**	**Sens***	**Spec#**	**AUC**	**Sens***	**Spec#**
ISAR	> 0	0.79 (0.74-0.84)	99%	20%	0.64 (0.57-0.71)	94%	13%
	> 1		89%	45%		83%	32%
	> 2		71%	79%		63%	60%
ISAR-HP	> 0	0.82 (0.77-0.87)	90%	51%	0.59 (0.52-0.66)	76%	33%
	> 1		74%	78%		60%	57%
	> 2		61%	88%		49%	68%
SHERPA	> 3 Mild	0.82 (0.76-0.88)	78%	76%	0.59 (0.49-0.69)	58%	52%
	> 4.5 Moderate		55%	89%		42%	70%
	> 6 Severe		38%	98%		31%	84%
VMS		0.75 (0.67-0.82)	52%	83%	0.69 (0.60-0.79)	56%	74%

*Sens=sensitivity; #Spec=specificity; ~A positive score on the VMS was defined according to Heim et al. [133]; Patients were positive if they were 80 years or older and scored 1 or more points or when they were younger than 80 and scored 3 or more points

DISCUSSION

The ISAR-HP and SHERPA were able to adequately identify hospitalized older people with low functioning at 3-month follow-up with an AUC of 0.82. The SHERPA had a high specificity and the ISAR-HP had a high sensitivity for the cut-off points used. None of the instruments were able to predict functional decline accurately. We found that a different cut-off may be needed when an overall hospital population is tested instead of the populations used for the development of these screening tests.

We were not able to find the same ability of the ISAR, ISAR-HP and SHERPA to predict functional decline as was reported earlier [4,131-133]. The ISAR had an AUC of 0.70 in the development study, while we found an AUC of 0.64 [132]. The same trend was seen for the ISAR-HP and SHERPA. The previous study reporting on the sensitivity and specificity of the VMS did not report the AUC, but the sensitivity and specificity values were comparable to those found in this study [133]. Previous studies that assessed the ISAR or SHERPA also found a lower AUC for functional decline than the development studies [6,41,81]. The differences in our AUC compared to earlier reported AUCs' might be explained by the fact that we used a different source population and a different definition of functioning. Previous studies defined functioning differently, using several points of decline on different ADL scales, decline in iADL and combinations of ADL, re-admission and death [41,131,133,140,141].

Some limitations should be mentioned. Firstly, we assessed functioning during hospital admission and did not measure pre-morbid functioning of our patients. Therefore, fewer patients had functional decline during follow-up compared to previous studies [4,6,81,131], which might have influenced the low predictive ability of functional decline for the four screening instruments. Secondly, we did not have the VMS and SHERPA for all patients. Parts of the SHERPA and the VMS were obtained from the medical files of the patients. These parts were part of the standard medical care given in the hospital and should be recorded in the medical files. However, the information was not recorded or incomplete for almost 50% of patients. Patients with missing information from their medical files for the VMS and SHERPA did not differ in age, sex and functioning at baseline from patients with complete information.

Thirdly, a large number of older people were not willing to participate in our study or were not reached before discharge from the hospital. However low inclusion rates were expected as previous studies among older populations suffered from low participation rates as well [44,50, 53,135].

Of the four screening instruments compared in this study, the ISAR-HP and SHERPA were most suitable to identify hospitalized older people at risk of poor functioning. The ISAR-HP predicted functioning at 3-month follow-up with a good discriminative ability and a high sensitivity at the studied cut-offs. Furthermore, the ISAR-HP is an easy tool with only four simple questions and a straightforward scoring. The SHERPA is not as easy to use in older people and has a more complicated scoring system. Therefore, the ISAR-HP is the easiest test to use in the general hospital population. However, each screening tool is only an indication and additional clinical judgment from the medical team is required to improve the estimated likelihood of poor functioning or functional decline. The medical team should also consider what kind of additional treatment might be beneficial to avoid poor functioning.

CONCLUSION

In conclusion, we found that in a general hospital population, the ISAR-HP is a promising, simple tool to identify older patients at risk of poor functioning at 3-month follow up.

Authors' contributions

LF performed the statistical analysis and drafted the manuscript. KA collected data and revised the manuscript. PV participated in the design of the study and revised the manuscript. YV contributed in the statistical analysis and revised the manuscript. TB, AN, JM and ES conceived of the study, participated in its design and revised the manuscript. All authors read and approved the final manuscript.

CHAPTER 5

Prognosis of hospitalized older people with different levels of functioning: a prospective cohort study

Kirsten J.E. Asmus-Szepesi, Paul, L. de Vreede, Linda E. Flinterman, Anna P. Nieboer, Ton J.E.M. Bakker, Gerard, J.J.M. Borsboom, Johan P. Mackenbach, Ewout W. Steyerberg.

Age and Ageing (2013), **0**: *1-6*

ABSTRACT

Background

Hospitalized older people are at risk of poor functioning after hospital discharge. We aimed to validate the predictive ability of the Identification Seniors At Risk-Hospitalized Patients (ISAR-HP) screening questionnaire to identify hospitalized older at risk of functional dependence by comparing groups with different ISAR-HP scores on cognitive and physical functioning, mortality, health related quality of life (HRQoL), and loneliness.

Design

A longitudinal prospective cohort study.

Setting

A 450-bed hospital in the Netherlands.

Subjects

Four hundred and sixty patients 65 years or older admitted between June 2010 and October 2010.

Methods

Participants were classified into five risk groups at hospital admission using the ISAR-HP. We interviewed older patients at hospital admission and at three and twelve months after admission using validated questionnaires to score HRQoL, physical functioning, cognitive functioning and loneliness. Differences in survival were quantified by a concordance statistic (c).

Results

Cognitive functioning, physical functioning, loneliness, and HRQoL differed significantly between groups during 1-year follow-up after hospital admission (all comparisons $p < .05$), with high-risk groups having lower scores than low-risk groups for functioning and loneliness, although not always for HRQoL. The lowest risk group (ISAR-HP=0) scored consistently higher on functioning and HRQoL than all other groups. Mortality differed significantly between groups ($p < .001$, c=0.67).

Conclusion

The ISAR-HP can readily distinguish hospitalized older people with good functioning from hospitalized patients with low functioning and low HRQoL after hospital admission. The ISAR-HP may hence assist in selecting older patients who may benefit from individually tailored reactivation treatment next to treatment of their medical condition.

INTRODUCTION

Hospitalized older people are at risk of functional decline, which may lead to lower reported health related quality of life (HRQoL), renewed hospital admission, or early death [6,75,76]. Multidisciplinary, individualized reactivation care focused on physical functioning, cognitive functioning, and social-emotional functioning [80,142] may prevent functional dependence caused by complications or other hospital stay related causes [6,8,82]. Identifying hospitalized older people at risk of functional dependence is important, as it allows for reactivation treatment to be tailored to individual patients [8,11,143].

Several instruments may identify older patients at risk of low functioning [4,140,144]. The Identification Seniors At Risk-Hospitalized Patients (ISAR-HP) is an easily administered questionnaire specifically designed for hospitalized seniors [21,145]. We studied if the ISAR-HP is predictive of physical functioning, cognitive functioning, HRQoL, loneliness, and mortality at three and twelve months after hospital admission.

METHODS

Data collection

Patients aged 65 years or older from a regional hospital in the Netherlands were interviewed by trained research-assistants at hospital admission (T0, baseline). Follow up interviews were held three months (T1) and twelve months (T2) after admission [32,51] in the participant's home environment for maximum compliance and reliability [91].

The ISAR-HP was administered within 48 hours of hospital admission. It consists of four yes/no questions regarding ability to travel independently, ability to walk, educational level, and independence in housekeeping. Scores range from 0 to 5, two points can be given for walking ability, with higher scores corresponding to higher risk for low functioning. Other questionnaires included the Mini Mental State Examination (MMSE) for cognitive functioning [92]), the Katz 6-item Index of independence in basic activities of daily living (ADL, [96]) the Lawton instrumental activities of daily living (iADL) scale [146], for physical functioning, the Loneliness scale [105] for loneliness and the Short Form-20 (SF20, [61]) to measure six subdomains (physical functioning, role functioning, social functioning, mental health, current health perceptions, and pain) of HRQoL (see the study protocol [23] for more details, NTR2317).

Statistical analysis

Older patients who were lost to follow up were compared to included patients on baseline characteristics (e.g. age, gender), functioning and HRQoL. Since no significant differences were

found, analyses were simply performed using available cases. Differences between groups were assessed using the Kruskall Wallis test. A linear mixed model of repeated measurements estimated differences in means between ISAR-HP groups over time, both unadjusted and adjusted for possible confounders (i.e. age, gender and multi-morbidity). Survival differences were analyzed with a concordance statistic (c), Kaplan Meier curves, and a Cox proportional hazards model. Analyses were performed using SPSS 20.0 (SPSS Inc., Chicago, IL) and R Software (version 2.7.1, The R Foundation for Statistical Computing, Vienna, Austria). The medical ethics committee of the Erasmus Medical Centre, Rotterdam, the Netherlands approved the study, protocol MEC2011-041.

RESULTS

Patient recruitment

Between June and October 2010 a total of 2671 patients aged 65 years or older from a regional hospital in the Netherlands were approached. We excluded patients who refused participation, stayed in-hospital for less than 48 hours, were unable to follow instructions, were terminally ill, participated during previous admission or were not contacted in time before discharge. Four hundred and sixty patients signed an informed consent form and participated. At T1 and T2, 279 and 205 people were interviewed respectively with 118 lost to follow up and 63 dead before T1, and 58 more lost to follow up and 16 more dead before T2.

Baseline characteristics

Mean age ± SD was 76 ± 9 years, and 56% of the participants were female (Table 1). People with higher ISAR-HP scores were older, more likely female, less likely married, more likely to live independently alone and more often had two or more diseases than participants with lower ISAR-HP scores. Half of the participants (52%) had cognitive problems at hospital admission, 39% was dependent in basic activities of daily living, and 39% had symptoms of loneliness (Table 1).

Functioning and HRQoL outcomes

ISAR-HP groups differed significantly in ADL functioning, iADL functioning, cognitive functioning and loneliness at all times (baseline, T1, T2: $p < 0.05$, Figure 1A). High-risk ISAR-HP groups were more dependent in ADL and iADL than low risk groups, with the clearest distinction between ISAR-HP 0 versus other groups. All groups scored lower on cognitive functioning, and higher on loneliness than group 0. At T1, all groups had higher ADL and iADL functioning than at admission (both $p < 0.001$, Figure 1A1 and 1A2), with iADL functioning

Table 1 | Baseline Characteristics, Functioning and HRQoL for all participants and ISAR-HP groups.

Variable	All N=460	ISAR-HP 0 N=128	ISAR-HP 1 N=92	ISAR-HP 2 N=59	ISAR-HP 3 N=56	ISAR-HP 4+ N=125	p value*
Age, mean (SD)	76 (7.2)	73 (5.8)	75(6.4)	77 (6.8)	78 (6.9)	80 (7.0)	< 0.001
Gender, female, n (%)	256 (56)	51 (40)	43 (53)	38 (64)	38 (68)	86 (70)	< 0.001
Married n (%)	257 (56)	91 (71)	60 (65)	33 (56)	25 (45)	48 (38)	< 0.001
Living environment pre-hospital admission, n (%)							< 0.001
Independent alone	181 (39)	31 (24)	33 (36)	25 (42)	30 (54)	62 (50)	
Independent with others	262 (57)	97 (76)	59 (64)	31 (53)	25 (45)	50 (40)	
Older home/nursing home	17 (4)	0 (0)	0 (0)	3 (5)	1 (2)	13 (10)	
Multi-morbidity (two or more diseases), n (%)	337 (73)	77 (60)	66 (72)	40 (68)	45 (80)	109 (87)	< 0.001
Dependent in ADL, n (%)	181 (39)	44 (34)	21 (23)	23 (39)	22 (39)	71 (57)	< 0.001
Lawton (iADL, score 0 dependent-8 indep.), mean (SD)	4.8 (2.1)	5.6 (2.3)	5.4 (2.1)	4.5 (2.0)	4.6 (1.9)	3.9(1.6)	< 0.001
Cognitive functioning, n (%)							< 0.001
No problems	220 (48)	95 (74)	34 (37)	26 (45)	27 (48)	38 (31)	
Moderate to light problems	216 (48)	32 (25)	54 (59)	29 (50)	27 (48)	74 (61)	
Severe problems	18 (4)	1 (1)	3 (3)	3 (5)	2 (4)	9 (7)	
Symptoms of loneliness (Loneliness scale), n (%)	178 (39)	35 (27)	42 (46)	19 (32)	24 (43)	58 (47)	0.007
HRQoL (SF 20, score 0 to 100)							
Physical functioning, mean (SD)	51 (33)	73 (28)	59 (29)	48 (32)	37 (27)	29 (25)	< 0.001
Role functioning, mean (SD)	48 (48)	76 (42)	60 (46)	36 (45)	34 (45)	23 (39)	< 0.001
Social functioning, mean (SD)	68 (36)	76 (32)	78 (31)	65 (36)	63 (39)	56 (39)	< 0.001
Mental health, mean (SD)	74 (19)	81 (15)	73 (18)	74 (15)	69 (19)	69 (22)	< 0.001
Health perceptions, mean (SD)	47 (26)	56 (26)	50 (25)	47 (25)	43 (26)	36 (24)	< 0.001
Pain, mean (SD)	55 (44)	52 (44)	51 (3)	59 (41)	52 (44)	57 (45)	0.179

* p value calculated using chi square test for categorical variables and Kruskall Wallis test for continuous variables

significantly higher at T2 compared to baseline ($p < 0.001$, Figure 1A2). Most groups had higher cognitive functioning at T1 than at baseline ($p=0.024$, Figure 1A3), while loneliness did not differ over time (figure 1A4). The magnitude of the changes differed between groups over time for ADL, iADL, and cognitive functioning ($p < 0.05$).

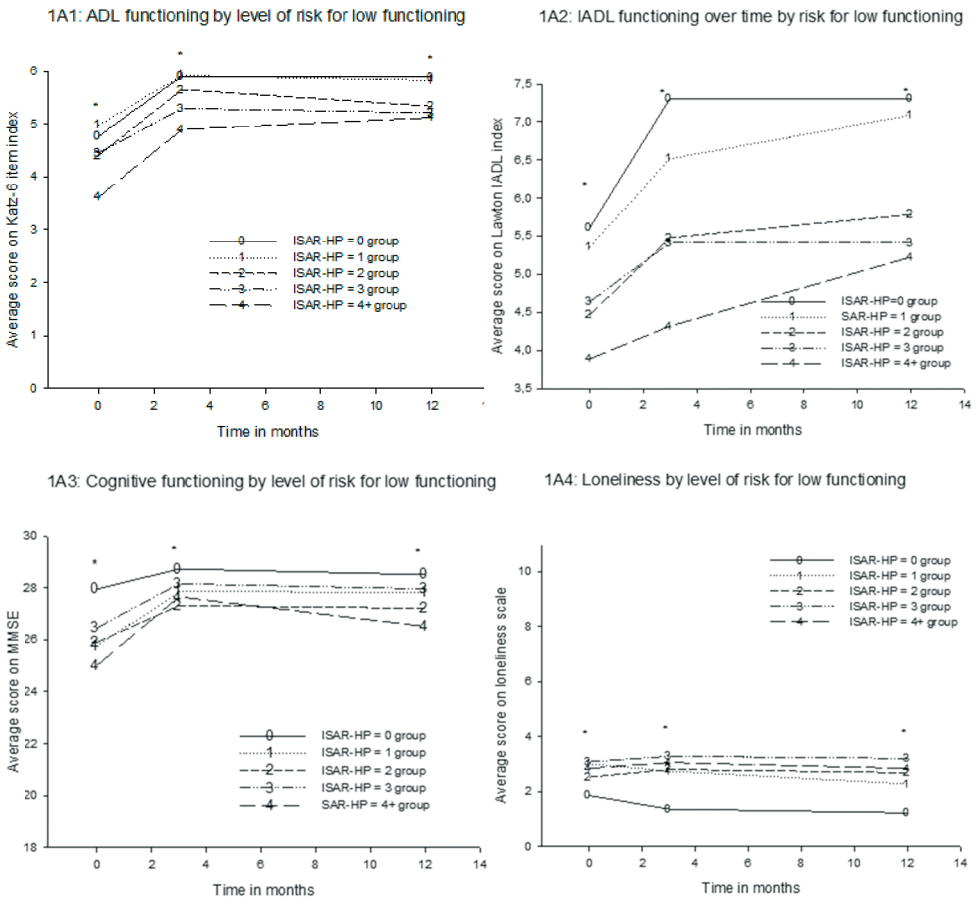


Figure 1A | Average functioning of older patients with different levels of risk for low functioning at hospital admission, three, and twelve months after admission

* average scores are significantly different between groups at 0.05 level

Figure 1B shows that all HRQoL outcomes, except for pain at T0, mental health at T2 and current health perceptions at T2, differed significantly between ISAR-HP groups, with high-risk groups reporting lower HRQoL than low-risk groups ($p < 0.05$). Group 0 differed most clearly from other groups on mental health, physical functioning, role functioning, and current

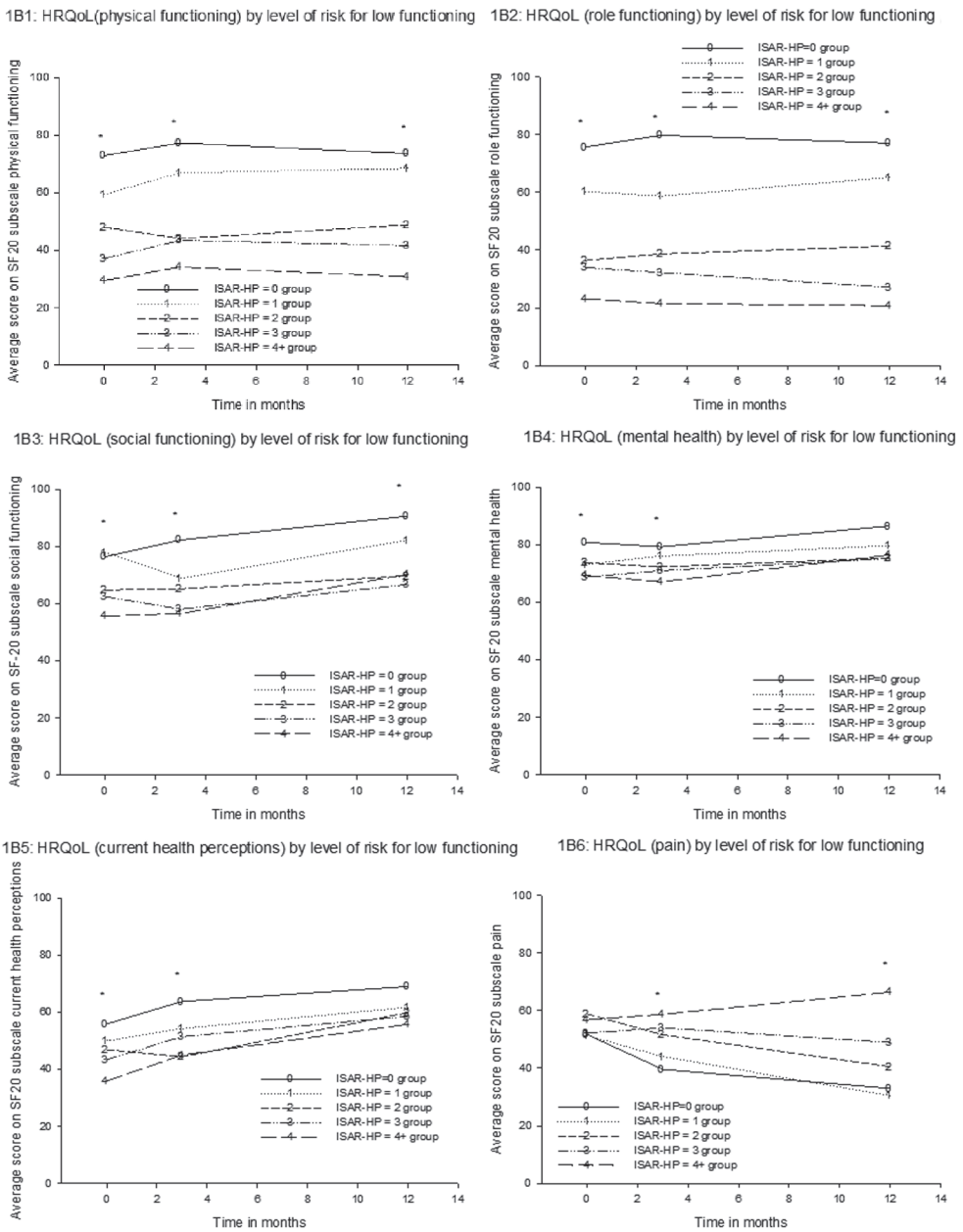


Figure 1B | Average HRQoL of older patients with different levels of risk for low functioning at hospital admission, three, and twelve months after admission

* average scores are significantly different between groups at 0.05 level;
Note: For HRQoL pain (see 1B6), higher scores correspond to higher pain and thus lower HRQoL, whereas for the other HRQoL subscales a higher score reflects better HRQoL

health perceptions. Group 1 scored similar to group 0 on social functioning, while group 2, 3 and 4+ scored significantly lower on social functioning than group 0. On pain only group 4 differed clearly from group 0. Between admission and three months after admission, physical functioning, current health perceptions and pain changed significantly ($p=0.007$; $p < 0.001$; $p=0.016$). Between T1 and T2, scores on social functioning, mental health, current health perceptions, and pain differed significantly ($p < 0.001$; $p < 0.001$; $p < 0.001$; $p=0.033$ respectively). The magnitude of the changes on the subscales did not differ between groups over time (see Appendices 1 and 2).

Differences in mortality between groups

Mortality differed significantly between ISAR-HP groups with one-year survival rates of 89%, 91%, 90%, 75% and 69% for ISAR-HP groups 0, 1, 2, 3, 4+ respectively (log rank test, $p < 0.001$). The hazard ratios for the ISAR-HP groups 3 and 4+ were 2.4 (95%CI 1.1-5.1) and 3.3 (95%CI 1.8-6.0) compared to the ISAR-HP=0 group ($p<0.001$). The ISAR-HP could reasonably predict mortality up to one year among hospitalized older people (c-statistic 0.67).

DISCUSSION

We found that ISAR-HP groups differed on ADL functioning, iADL functioning, HRQoL-physical functioning and HRQoL-role functioning, thus supporting our hypothesis that the ISAR-HP predicts the level of risk of low functioning in these domains. Differences in cognitive functioning, loneliness, and the HRQoL subscales social functioning, mental health, current health perceptions and pain were less consistent, but still statistically significant between groups.

Limitations included that our detailed comparison by five groups left us with relatively small numbers to analyze at follow-up times. Nevertheless, the groups showed clear differences on most outcomes. We measured functioning at admission instead of pre-admission, which may have led to lower reported baseline functioning and HRQoL. This may well explain the clear improvement in ADL and iADL functioning between admission and T1. Measuring pre-admission functioning should be considered in future studies for validation of our findings.

We performed available case analysis since loss to follow up patients did not differ significantly from included patients on age, gender, marital status, functioning and HRQoL. Nevertheless, differences between patients lost to follow up and included patients on other variables (e.g. diagnosis), which were not analyzed while possibly associated with adverse outcomes for those lost to follow up may have biased our results.

A cut-off of ISAR-HP 0 versus 1+ could best distinguish between older patients at risk and those not at risk in our analysis. Cut-off scores of 1 or 2 have been suggested earlier [21,68], but the choice of a cut-off of 1 or 2 will depend on the clinical context. Overall, our results support a broad view of functioning including physical functioning, cognitive functioning and dimensions such as mental health and social functioning. This broader view is often discussed in relation to the concept of 'frailty', which has not yet been defined clearly and consistently [147]. Originally, the concept of frailty was predominantly medically focused; using the physical domain to identify frail older people [25]. This focus is now increasingly challenged by a more integral concept including not only physical functioning, but also cognitive and psychological functioning [28]. Our results support this integral view of frailty.

Our results have clinical implications. Adequate identification of hospitalized older people at risk of low physical and cognitive functioning, increased loneliness, and low HRQoL may improve multidisciplinary, individually tailored treatment focused on specific individual needs, thus helping older patients regain or maintain independence in daily life [32]. Further study of such multidisciplinary interventions is urgently required.

CONCLUSION

The ISAR-HP is a simple tool that adequately identifies hospitalized older people at risk of low physical and cognitive functioning, mortality, loneliness and, to a lesser extent, HRQoL at three and twelve months after hospital admission. Further studies should evaluate treatments tailored to the needs of these risk groups, thereby focusing on both medical condition and domains of reactivation care, such as cognitive functioning. Consequently, older patients may have a better prognosis after hospital discharge, thus preventing dependence on informal and formal health care and its associated costs.

Appendix 1 | Mixed modeling results comparing functioning of ISAR-HP groups over time (T0 T1 and T2) with reference group ISAR-HP score=0

Variable	ISAR-HP = 1	ISAR-HP = 2	ISAR-HP = 3	ISAR-HP = 4+
Katz-6 ADL difference unadjusted (CI 95)	0.2 (-0.3 to 0.7)	-0.4 (-0.9 to 0.2)	-0.3 (-0.9 to 0.2)	-1.2 (-1.6 to -0.7)
Katz-6 ADL difference adjusted* (CI 95)	0.3 (-0.2 to 0.8)	-0.2 (-0.7 to 0.4)	-0.05 (-0.6 to 0.5)	-0.8 (-1.3 to -0.4)
Lawton IADL difference unadjusted (CI 95)	-0.3 (-0.8 to 0.3)	-1.1 (-1.7 to -0.5)	-1.0 (-1.6 to -0.4)	-1.7 (-2.2 to -1.2)
Lawton IADL difference adjusted* (CI 95)	-0.1 (-0.6 to 0.4)	-0.9 (-1.5 to -0.3)	-0.6 (-1.3 to -0.0)	-1.3 (-1.8 to 0.8)
MMSE (cognitive functioning) difference unadjusted (CI 95)	-2.2 (-3.0 to -1.4)	-2.0 (-3.0 to -1.1)	-1.5 (-2.5 to -0.5)	-2.9 (-3.7 to -2.1)
MMSE (cognitive functioning) difference adjusted* (CI 95)	-2.1 (-2.9 to -1.2)	-1.8 (-2.7 to -0.8)	-1.1 (-2.2 to -0.1)	-2.4 (-3.3 to -1.6)
Gierveld loneliness difference unadjusted (CI 95)	1.1 (0.4 to 1.8)	0.9 (0.1 to 1.7)	1.5 (0.7 to 2.3)	1.3 (0.7 to 1.9)
Gierveld loneliness difference adjusted* (CI 95)	1.0 (0.3 to 1.7)	0.8 (0.0 to 1.6)	1.3 (0.5 to 2.2)	1.1 (0.4 to 1.9)

* adjusted for age, gender, and multi-morbidity (= two or more comorbidities)

Appendix 2 | Mixed modeling results comparing HRQoL of ISAR-HP groups over time (T0 T1 and T2) with reference group ISAR-HP score=0

Variable	ISAR-HP = 1	ISAR-HP = 2	ISAR-HP = 3	ISAR-HP = 4+
SF20 physical functioning difference unadjusted (CI 95)	-10.3 (-16.5 to -4.0)	-25.9 (-33.2 to -18.6)	-35.2 (-42.7 to -27.8)	-44.2 (-50.0 to -38.3)
SF20 physical functioning difference adjusted* (CI 95)	-9.5 (-15.7 to -3.2)	-25.8 (-33.3 to -18.4)	-34.2 (-41.9 o -26.5)	-43.0 (-49.6 to -36.4)
SF20 role functioning difference unadjusted (CI 95)	-15.6 (-24.7 to -6.5)	-37.9 (-48.6 to -27.2)	-45.2 (-56.0 to -34.3)	-54.9 (-63.4 to -46.3)
SF20 role functioning difference adjusted* (CI 95)	-14.0 (-23.0 to -5.0)	-37.0 (-47.8 to -26.1)	-42.7 (-54.0 to -31.4)	- 51.9 (-61.5 to -42.3)
SF20 social functioning difference unadjusted (CI 95)	-5.0 (-12.2 to 2.2)	-14.8 (-23.2 to -6.4)	-18.1 (-26.7 to -9.5)	-23.1(-29.9 to -16.4)
SF20 social functioning difference adjusted* (CI 95)	-4.3 (-11.4 to 2.9)	-15.1 (-23.7 to -6.5)	-17.5 (-26.4 to -8.6)	-22.5 (-30.1 to -14.9)
SF20 mental health difference unadjusted (CI 95)	-6.5 (-10.5 to -2.5)	-7.2 (-11.9 to -2.5)	-10.9 (-15.7 to -6.1)	-12.1(-15.9 to -8.4)
SF20 mental health difference adjusted* (CI 95)	-5.8 (-9.9 to -1.8)	-5.9 (-10.7 to -1.1)	-9.1 (-14.1 to -4.1)	-10.1 (-14.4 to -5.8)
SF20 current health perceptions difference unadjusted (CI 95)	-6.7 (-12.8 to -0.6)	-10.4 (-17.5 to -3.3)	-13.1 (-20.3 to -5.9)	-19.2 (-24.9 to -13.5)
SF20 current health perceptions difference adjusted* (CI 95)	-6.4 (-12.2 to -0.6)	-12.4 (-19.3 to -5.4)	-14.0 (-21.2 to -6.8)	-20.6 (-26.8 to -14.5)
SF20 pain difference unadjusted (CI 95)	0.4 (-8.3 to 9.2)	9.7 (-0.6 to 20.0)	8.0 (-2.5 to 18.5)	13.0 (4.7 to 21.3)
SF20 pain difference adjusted* CI 95)	-1.5 (-9.7 to 6.7)	7.1 (-2.9 to 17.0)	4.0 (-6.4 to 14.3)	9.2 (0.3 to 18.0)

* adjusted for age, gender and multi-morbidity

CHAPTER 6

Formal and informal care costs of hospitalized older people at risk of poor functioning: A prospective cohort study

Kirsten JE Asmus-Szepesi, Marc A. Koopmanschap, Linda E. Flinterman, Ton JEM Bakker, Johan P Mackenbach, Ewout W Steyerberg

Archives of Gerontology and Geriatrics (2014), http://dx.doi.org/10.1016/j.archger.2014.04.014

ABSTRACT

Background

Hospitalized older people are at risk of poor functioning after hospital discharge. We aimed to relate formal and informal care costs to level of risk for low functioning of hospitalized older people up to one year after admission.

Methods

We studied 460 patients 65 years or older who were admitted to a 450-bed hospital in the Netherlands between June 2010 and October 2010. Participants were classified into five risk groups at hospital admission using the Identification Seniors At Risk-Hospitalized Patients (ISAR-HP). Patients were interviewed at hospital admission and at three and twelve months after admission using validated questionnaires to measure health care utilization. Informal caregivers were interviewed by mailed paper questionnaires at the same time as patients. We estimated costs per unit from hospital information systems and nationally representative research.

Results

Mean healthcare costs were €30k euro per person per year, with one third for initial hospital stay (€9,8k), one third for formal healthcare costs between hospital discharge and twelve month follow up (€10,3k), and one third for informal healthcare costs between hospital discharge and twelve month follow up (€9,5k). Informal and formal healthcare costs were almost double for older patients with the highest risk score compared to older patients not at risk ($p<0.001$).

Conclusion

Older patients with high-risk scores at hospital admission have substantially higher formal and informal care costs in the year after initial hospital admission than older patients with low risk scores. This implies that substantial investments may be made in preventive interventions for at-risk hospitalized older people.

INTRODUCTION

Hospitalized older people are at risk of poor functioning after discharge from the hospital compared to functioning before hospital admission [6]. Problems in functioning after hospital discharge are only partly explained by the patient's medical condition at hospital admission, implying that a hospital stay may in itself cause functional problems, for example due to social isolation or inactivity as a result of bed rest [82]. Poor functioning may lead to renewed hospital admission, nursing home admission, early death, high dependence on informal and formal care, resulting in higher societal healthcare costs [5,6,42,75,76,148,149]. Risk of poor functioning is closely linked to frailty as shown by an integral framework that links frailty to problems in physical functioning, cognitive functioning as well as social and psychological functioning [27, 150]. Simple classifications of risk of problems in daily functioning are possible with instruments such as the Identification Seniors at Risk-hospitalized patients (ISAR-HP) [151,152]. Insights in formal and informal healthcare costs are largely lacking for older people with different levels of risk of poor functioning, while such knowledge is relevant to the implementation of future preventive programs [153,154]. We aimed to compare formal and informal care costs from hospital admission to one year after admission for hospitalized older people with different levels of risk of poor functioning as identified by the ISAR-HP.

METHODS

Patients

A total of 2671 patients of 65 years or older were admitted to a 450-bed general hospital in the Netherlands between June and October 2010. We excluded patients who refused participation, were admitted for less than 48 hours, were unable to follow instructions due to cognitive problems or language problems, were terminally ill or were not reached before discharge for known or unknown reasons. This left 460 patients in the study that signed an informed consent form.

Data collection

At hospital admission, older patients were assessed for risk of low functioning using the ISAR-HP. The ISAR-HP consists of four yes/no questions regarding educational level, (in)dependence in traveling and housekeeping, and walking ability before admission. Scores range from 0 to 5, including two points for walking inability, with higher scores corresponding to higher risk of poor functioning. Trained research assistants interviewed patients within 48 hours of hospital admission (baseline, T0) using validated questionnaires. Follow up interviews were held at

three and twelve months after admission (T1 and T2 respectively) at the participant's home environment.

Patient interviews at baseline included questions on demographics (e.g. age, gender) and healthcare utilization before admission (e.g. general practitioner contacts). Cognitive functioning was measured using the Mini Mental State Examination (MMSE), with higher scores corresponding to better cognitive functioning [92]. Physical functioning was measured using the Katz 6-item Index of independence in basic activities of daily living (ADL) [96], and the Lawton scale [146], which measures instrumental activities of daily living (iADL) such as the ability to use the telephone or handle finances. Higher scores on both scales reflect higher independence in ADL and iADL. Health related quality of life (HRQoL) was measured with the EQ5D [93]. The Caregiver Strain Index (CSI) [112] measured subjective burden of care for the informal caregiver in the period before hospital admission.

At T1 and T2, formal health care utilization data was collected in interviews with the patients at their home environment. Costs per unit of healthcare consumption were retrieved from hospital information systems or estimated using nationally representative unit-costs research [155]. Valuation of formal healthcare such as length of stay in hospital, nursing home, rehabilitation center or elderly home were measured by applying cost per day estimates. Formal homecare services were measured in costs per hour, while visits to the general practitioner were based on average costs per contact. Costs of aids and modifications to the living environment were estimated using current retail prices (see Appendix 1). Informal homecare utilization in hours per week was measured by paper questionnaires sent to primary informal caregivers of participating patients. Informal homecare costs were divided into housekeeping, personal help and help going outdoors. Costs per hour for informal homecare domains were estimated using the proxy good method [156].

Statistical analysis

ISAR-HP scores were divided into 0, 1, 2, 3 and 4+. Differences between ISAR-HP groups were assessed using the chi-square test for categorical variables and the t-test for continuous variables. Missing values for costs were assumed to be missing at random, conditional on observed baseline characteristics and outcome variables [157]. A multiple imputation procedure was implemented to complete missing information from older patients and their informal caregivers. The imputation model included a rich set of baseline variables (e.g. age, gender, frailty (Appendix 2; [158]). The imputation model for societal costs also accounted for death and length of survival during the study period. Before imputation, all healthcare utilization and costs between T1 and T2 were set to zero for people who died before T1. After imputation of costs, their average costs between hospital admission and three month follow up were multiplied by a factor proportional to their survival time (survival days/total days T1

follow up). Similarly, average formal and informal costs between T1 and T2 were multiplied by a factor proportional to the survival time (survival days/total days study period) for people who died between T1 and T2. We used predictive mean matching to generate imputations to avoid impossible values such as negative costs. The multiple imputation procedure generated ten completed data sets, which were stacked for a pooled analysis. We compared ISAR-HP groups on their costs for initial hospital admission, and their formal and informal healthcare after hospital admission using a t-test as well as by testing for trends. The sensitivity of results to the imputation process was assessed by comparison to results from complete case analysis. All analyses were performed using SPSS version 21.0 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp).

RESULTS

Patient recruitment

Between hospital admission and T1, 118 out of 460 participants (26%) had been lost to follow up, 63 participants (14%) had died, and 279 people (61%) were interviewed. Between T1 and T2 another 58 participants (13%) were lost to follow up and 16 people (3%) died, whereas 205 participants (45%) were interviewed in their home environment at T2. Patients who were lost to follow up did not differ on baseline characteristics from included people, but were slightly more at risk.

Baseline characteristics

Mean age was 76 ± 7 years, with 56% female participants (Table 1). Most participants were married (56%), lived independently with others (57%) and had two or more comorbidities (73%). Patients with higher ISAR-HP scores were older, more likely female, less often married, more likely to live independently alone and more often had two or more diseases than patients with lower ISAR-HP scores. Older patients with higher ISAR-HP scores, especially score 4+ showed worse physical functioning, cognitive functioning and HRQoL (all $p < 0.001$) than older patients with lower ISAR-HP scores. Furthermore, patients with higher risk scores had more often been admitted to the hospital in the year before initial hospital admission and had used more informal care before initial hospital admission. Informal caregivers of patients in lower ISAR-HP groups were more likely partners, while patients with higher ISAR-HP scores were more likely to receive informal care from others (e.g. children, friends). Finally, informal caregivers of patients with higher ISAR-HP scores reported a higher burden of care before initial hospital admission (Table 1).

Table 1 | Baseline Characteristics, Functioning and HRQoL for 460 hospitalized older people according to ISAR-HP score

Variable	All N=460	ISAR-HP 0 N=128	ISAR-HP 1 N=92	ISAR-HP 2 N=59	ISAR-HP 3 N=56	ISAR-HP 4+ N=125	p value[1] group diff.
Age, mean (SD)	76 (7.2)	73 (5.8)	75(6.4)	77 (6.8)	78 (6.9)	80 (7.0)	< 0.001[2]
Women, n (%)	256 (56)	51 (40)	43 (47)	38 (64)	38 (68)	86 (69)	< 0.001[1]
Married/living together, n (%)	257 (56)	91 (71)	60 (65)	33 (56)	25 (45)	48 (38)	< 0.001[1]
Living environment, n (%)							< 0.001[1]
Independent alone	181 (39)	31 (24)	33 (36)	25 (42)	30 (54)	62 (50)	
Independent with others	262 (57)	97 (76)	59 (64)	31 (53)	25 (45)	50 (40)	
Multi-morbidity (≥ 2), n (%)	337 (73)	77 (60)	66 (72)	40 (68)	45 (80)	109 (87)	< 0.001[1]
ADL[5] (Katz), mean (SD)	4.4 (1.8)	4.8 (1.6)	5.0 (1.5)	4.4 (1.8)	4.5 (1.4)	3.6 (1.9)	< 0.001[2]
IADL[6] (Lawton), mean (SD)	4.8 (2.1)	5.6 (2.3)	5.4 (2.1)	4.5 (2.0)	4.6 (1.9)	3.9 (1.6)	< 0.001[2]
Cognition (MMSE), mean (SD)	26.3 (3.8)	27.9 (2.7)	25.7 (4.0)	25.9 (4.0)	26.5 (3.4)	25 (4.3)	< 0.001[2]
HRQoL, EQ5D, mean (SD)	0.61 (0.3)	0.67 (0.27)	0.69 (0.26)	0.61 (0.3)	0.58 (0.29)	0.50 (0.29)	< 0.001[2]
Hospitalization in 12 months before T0, n(%)	160 (35)	31 (24)	30 (33)	17 (29)	20 (36)	62 (50)	0.001[1]
Presence informal carer, 1 or more, n (%)	241 (52)	80 (62)	43 (47)	34 (58)	28 (50)	56 (45)	0.026 [1]
Age informal carer[3], mean (SD)	65 (11)	65 (9.4)	67 (12)	69 (12)	65 (12)	62 (12)	0.049[2]
Sex informal carer, women[3], n (%)	126 (70)	40 (73)	22 (71)	17 (59)	16 (70)	31 (76)	0.623[1]
Informal carer, Living with patient[3], n (%)	112 (63)	44 (82)	26 (79)	18 (62)	10 (44)	14 (35)	< 0.001[1]
Relation informal carer with patient[3]:							0.001[1]
Husband/wife/partner, n (%)	112 (62)	44 (80)	26 (79)	18 (62)	10 (44)	14 (34)	
Other, n (%)	69 (38)	11 (20)	7 (21)	11 (38)	13 (56)	27 (66)	
CSI[4,3], mean(SD)	3.2 (3)	2.18 (2.8)	3.22 (2.7)	3.13 (3.0)	3.63 (2.9)	4.13 (3.2)	0.018[2]
Informal care in week before T0, n (%)°	111 (69)	24 (49)	17 (61)	21 (81)	17 (81)	32 (89)	0.001[1]

[1] p-value measured with chi square for categorical variables; [2] p-value measured with t- test for continuous variables; [3]N=smaller population than 460 (informal care; N= 160, CSI N=147, living together with patient N=179, age informal caregivers, N=185); [4]CSI=Caregiver Strain Index; [5]ADL=activities of daily living and [6]IADL=Instrumental activities of daily living

Patients with complete cost data for initial hospital admission more often had two or more illnesses (multi-morbidity) than patients with missing hospital admission cost data (Appendix 3, p=0.010). Second, length of hospital stay was significantly higher for patients with missing formal costs data than for patients with complete formal cost data (8 versus 5.5 days respectively; $p < 0.001$). Finally, people with missing formal costs were at higher risk of poor functioning than people with complete formal cost data (ISAR-HP scores 3 and 4+ versus 0 and 1 respectively).

Health care utilization

Higher ISAR-HP scores showed longer length of hospital stay (Table 2a; 9 to 6 days for scores 4+ and 0 respectively). Between hospital discharge and T1, patients with higher ISAR-HP scores were more likely to have contacted the GP (14% for scores 0 and 1 and 26%, 19% and 22% for scores 2, 3 and 4+ respectively), more often had used formal home care (16%, 29%, 45%, 65% and 75% for scores 0, 1, 2, 3 and 4+ respectively) and more often had acquired aids and modifications than patients with lower ISAR-HP scores (Table 2a ; 17% and 18% for scores 0 and 1 and 39%, 42% and 32% for scores 2, 3 and 4+ respectively). Informal care did not differ significantly between groups during this period (Table 2b).

Between T1 and T2, higher ISAR-HP groups were more likely to have used formal homecare than groups with lower ISAR-HP scores while the use of other formal healthcare domains did not differ between groups (Table 2a). Higher ISAR-HP scores were associated with more days of informal care per week than lower ISAR-HP scores when personal care and housekeeping were concerned, whereas the opposite association was shown for informal help with outdoor activities (Table 2b).

Societal care costs from initial hospital stay to one year after initial hospital admission

After multiple imputation of missing cost data, average costs were 29696 euro per person per year. One-third of these costs were initial hospital admission costs, 23% (10% formal healthcare and 13% informal healthcare) were costs between hospital discharge and T1, and 45% (formal health care 25% and informal health care 20%) were costs consumed between T1 and T2 (Figure 1, appendix 4a to 4d). A clear trend for ISAR-HP groups was apparent (Jonckheere-Terpstra Test statistic $p < 0.001$), with formal healthcare costs up to twofold for patients with higher risk scores (ISAR-HP scores of 2, 3, and 4+) compared to people with the lowest ISAR-HP scores (ISAR-HP scores 0 and 1 respectively), and informal care costs up to twofold for at-risk patients (ISAR-HP scores 1, 2, 3, 4+ respectively) compared to patients not at risk (ISAR-HP score=0).

Table 2a | Formal health care utilization for 460 hospitalized older people according to ISAR-HP score

Variable	All N=460	ISAR-HP 0 N=128	ISAR-HP 1 N=92	ISAR-HP 2 N=59	ISAR-HP 3 N=56	ISAR-HP 4+ N=125	p value[2] group diff.
Initial hospital stay, n (%) Length, mean (SD)	7.1(6)	6.3(6)	6.3(4)	6.7(5)	7.0(6)	8.7(7)	0.002
ICU stay, n (%)	9(3)	3(4)	2(4)	1(3)	1(3)	2(3)	0.999
Length, mean (SD)[1]	5.5(8)	3(2)	1(0)	1(0)	23(0)	8(9)	
Hospital procedures, mean (SD)	116 (112)	124 (167)	100 (74)	105 (65)	115 (84)	124 (104)	0.423
Hospital procedures ≥ €100, mean (SD)	11 (7)	11 (8)	11 (6)	10 (5)	11 (7)	12 (9)	0.478
Between discharge and T1:							
Readmission hospital, n (%)	46 (17)	16 (18)	8 (13)	7 (23)	4 (13)	11 (18)	0.744
Length, mean (SD)[1]	9 (10)	6 (4)	15 (16)	12 (13)	6 (4)	7 (6)	
Admission older home, n (%)	23 (8)	2 (2)	4 (6)	3 (10)	3 (10)	11 (18)	0.020
Length, mean (SD)[1]	33 (33)	18 (14)	52 (54)	39 (0)	13 (1)	31 (29)	
Admission nursing home, n (%)	2 (1)	0 (0)	0 (0)	0 (0)	1 (3)	1 (2)	0.319
Length, mean (SD)[1]	35 (10)	0 (0)	0 (0)	0 (0)	42 (0)	28 (0)	
Admission rehab center n (%)	6 (2)	1 (1)	1 (2)	0 (0)	2 (7)	2 (3)	0.376
Length, mean (SD)[1]	32 (26)	7 (0)	70 (0)	0 (0)	46 (5)	13 (11)	
GP contacts, n (%)	49 (18)	12 (14)	9 (14)	8 (26)	6 (19)	14 (22)	0.016
Amount GP consults mean (SD)[1]	2 (2)	1 (0,7)	3 (4)	2 (1)	1 (0.4)	3 (3)	
Formal homecare:							
Housekeeping, n (%)	113 (41)	14 (16)	18 (29)	14 (45)	20 (65)	47 (75)	< 0.001
Hours/week, mean (SD)[1]	4 (2)	3 (1)	3 (2)	4 (2)	3 (1)	4 (2)	
Personal care, n (%)	41 (15)	5 (6)	3 (5)	4 (13)	5 (16)	24 (38)	< 0.001
Hours/week, mean (SD)[1]	4 (3)	3 (3)	2 (1)	1 (1)	3 (2)	5 (4)	
Nursing care, n (%)	9 (3)	2 (2)	1 (2)	0 (0)	1 (3)	5 (8)	0.009

[1]means are based on people who have used formal health care; [2]p-value using healthcare items yes/no, measured with chi-square test; [3]no information available

Table 2a | Formal health care utilization for 460 hospitalized older people according to ISAR-HP score *(Continued)*

Variable	All N=460	ISAR-HP 0 N=128	ISAR-HP 1 N=92	ISAR-HP 2 N=59	ISAR-HP 3 N=56	ISAR-HP 4+ N=125	p value[2] group diff.
Hours/week, mean (SD)[1]	17 (27)	[3]	4 (0)	0 (0)	0 (0)	20 (29)	
Aids or modifications, n (%)	73 (28)	15 (17)	11 (18)	12 (39)	13 (42)	22 (35)	0.007
Between T1 and T2:							
Readmission hospital, n (%)	64(25)	20(25)	14(26)	9(27)	10(35)	11(18)	0.748
Length, mean (SD)[1]	9(12)	5(4)	14(14)	6(4)	18(24)	9(9)	
Admission older home, n (%)	7(3)	2(3)	0(0)	1(3)	2(8)	2(5)	0.419
Length, mean (SD)[1]	62(58)	18(15)	0(0)	49(0)	102(94)	84(0)	
Admission nursing home, n (%)	2(1)	0(0)	1(2)	0(0)	0(0)	1(2)	0.576
Length, mean (SD)[1]	11(5)	n/a	14(0)	0(0)	0(0)	7(0)	
Admission rehab center, n (%)	5(2)	1(1)	1(2)	1(3)	1(4)	1(2)	0.938
Length, mean (SD)[1]	53(29)	70(0)	84(0)	56(0)	49(0)	7(0)	
GP contacts n (%)	31(15)	10(14)	5(11)	7(24)	6(26)	3(7)	0.196
Amount GP consults mean (SD)[1]	1(0.6)	1(0.6)	1(0)	1(1)	1(1)	1(1)	
Formal homecare:							
Housekeeping, n (%)	84(40)	11(15)	14(30)	11(38)	17(71)	31(78)	<0.001
Hours/week, mean (SD)[1]	4 (2)	3(1)	3(1)	3(1)	4(2)	4(2)	
Personal care, n (%)	22(10)	1(1)	2(4)	4(14)	4(17)	11(28)	<0.001
Hours/week, mean (SD)[1]	4(2)	5(0)	2(1)	2(1)	2(1)	5(2)	
Nursing care, n (%)	9(4)	3(4)	1(2)	1(3)	2(8)	5(13)	0.035
Hours/week, mean (SD)[1]	2(2)	[3]	2(0)	1(0)	2(1)	3(3)	
Aids or modifications, n (%)	45(21)	8(11)	7(15)	8(28)	9(38)	13(32)	0.241

[1]means are based on people who have used formal health care; [2]p-value using healthcare items yes/no, measured with chi-square test; [3]no information available

Table 2b | Informal health care utilization for 460 hospitalized older people according to ISAR-HP score

Variable	All N=460	ISAR-HP 0 N=128	ISAR-HP 1 N=92	ISAR-HP 2 N=59	ISAR-HP 3 N=56	ISAR-HP 4+ N=125	p value[1]
Between discharge and T1:							
Informal care, days/week mean (SD)[1]	4.5 (2.7)	5.5 (2.4)	5.1 (2.5)	4.6 (2.8)	3.6 (3.0)	3.9 (2.8)	0.056
Housekeeping, n (%)	55 (55)	14 (42)	8 (47)	8 (89)	8 (53)	17 (63)	0.459
Hours p week, mean (SD)[1]	10 (12)	12 (12)	6 (6)	12 (9)	8 (12)	11 (15)	
Personal care, n (%)	17 (17)	3 (10)	3 (18)	4 (36)	1 (7)	6 (21)	0.333
Hours p week, mean (SD)[1]	9 (12)	20 (25)	3 (1)	5 (5)	9 (0)	9 (8)	
Help outdoor activities, n (%)	53 (53)	10 (31)	8 (50)	9 (82)	7 (47)	19 (70)	0.096
Hours p week, mean (SD)[1]	5 (6)	8 (10)	2 (2)	6 (5)	3 (1)	5 (5)	
Between T1 and T2:							
Informal care, days/week, mean (SD)[1]	4.6 (2.7)	5.6 (2.5)	5.8 (1.8)	5.5 (2.8)	4.0 (2.8)	3.1 (2.4)	0.022
Housekeeping, n (%)	56 (51)	16 (39)	10 (63)	7 (50)	7 (54)	16 (62)	0.354
Hours p week, mean (SD)[1]	11 (13)	13 (13)	6 (6)	12 (9)	11 (14)	13 (16)	
Personal care, n (%)	15 (14)	5 (12)	0 (0)	4 (29)	3 (23)	3 (12)	0.182
Hours p week, mean (SD)[1]	6 (6)	4 (3)	0 (0)	11 (10)	2 (1)	8 (3)	
Help outdoor activities, n (%)	56 (51)	13 (32)	6 (36)	8 (62)	6 (46)	23 (89)	< 0.001
Hours p week, mean (SD)[1]	5 (4)	5 (3)	10 (5)	7 (7)	3 (1)	4 (3)	

Note: informal health care information has a high percentage of missings due to lower participation of patient informal caregivers; [1]means are based on people who have provided informal health care, [2]p-value is based on means of the people who used healthcare

Costs of initial hospital stay did not vary with age, sex, living environment, multi-morbidity and death during the course of our study (Appendix 5). Formal care costs were higher for women than men (12280 and 7842 euro respectively; p=0.038), and higher for patients living independently alone than for patients living independently with others (12994 and 8312 euro respectively; p=0.001). Costs of informal healthcare differed between deceased and non-deceased older patients (4524 and 10598 euro respectively; p=0.003).

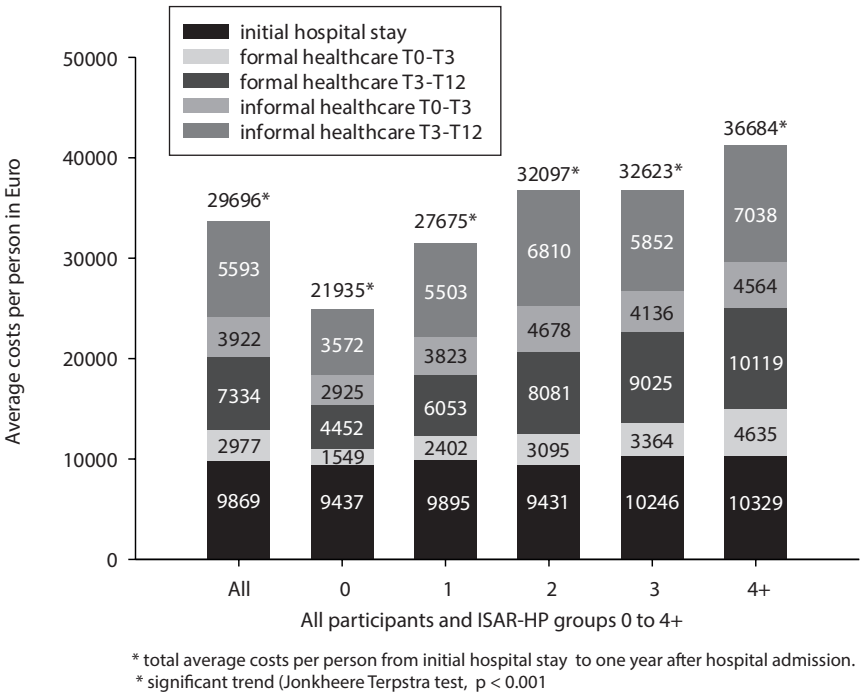


Figure 1 | Average healthcare costs for 460 hospitalized older people according to ISAR-HP score

Note: T3=3 month follow up; T12=twelve month follow up

DISCUSSION

Hospitalized older people with higher levels of risk of poor functioning had substantially higher costs of care in the year after initial hospital admission than hospitalized older people with lower risk-levels or who were not frail. We performed a detailed analysis of both formal and informal care costs, which appeared to follow a rather similar trend with increasing risk (Figure 1).

An earlier study showed that older people who are both mentally and physically frail have higher formal care costs per household than older people who were either mentally or physically frail [154]. Another study showed higher average health expenditures for frail older people compared to a relatively healthy group, a high comorbidity group, and a functional impairment group (244%, 81% and 72% higher respectively) [153]. Furthermore, functional decline has been associated with end of life hospital use as well as higher costs [159-161]. Other studies corroborate our findings that older people and especially older people living alone had more homecare and thus higher care costs than younger people or people who were living with others [154,159]. The added value of our study to those mentioned above is the setting and specific patient population (hospitalized older people) and the fact that we could make comparisons to older patients that were not at risk in our analysis.

Total costs of initial hospital stay did not clearly differ between risk groups. This may be explained by the heterogeneity of the population, e.g. the large variety of diagnoses among the risk groups. Also, even though higher risk groups had slightly longer length of hospital stay with higher associated costs than patients at low risk, these higher costs were countered by the lower costs of diagnostics and procedures for high-risk groups. Finally, in line with earlier studies our results showed that older people who had higher formal homecare costs received lower informal homecare and vice versa [154].

Our study had some limitations. A high percentage of data was missing, especially for informal healthcare items. A state-of-the-art multiple imputation procedure was performed in order to include patients with missing values in all cost calculations. After multiple imputations, costs were estimated higher than in the original data, which is explained by the higher loss to follow up in the groups at risk. These at-risk patients would have needed more health care if included in the study for the entire twelve months. Contrary to earlier findings [154] we did not find any differences in costs between older people who died and older people who did not. This may be due to the limitation that we missed high costs that occurred in the period shortly before death. We had included death and loss to follow up into our imputation model, but still we may have underestimated the care costs for the deceased.

Strengths of our study include its high internal validity due to the prospective collecting of detailed cost data and the fact that all 460 participants were eventually included in the analysis.

We recognize that risk of low functioning is related, but may not be considered equal to frailty, which is a more comprehensive concept [162]. Definitions of frailty vary from a more organ and disease-based approach with a focus on biomedical (physical) factors [25,163] of a more health-based integral approach focused on a combination of physical, psychological and social dimensions [27,150]. However, all definitions have in common that a frail person is at risk of loss in one or more domains of functioning, as supported by the following definition of

frailty: 'Frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical psychological, social) that are caused by the influence of a range of variables and which increases the risk of adverse outcomes" [150]. Previous results of our study showed lower physical and cognitive functioning and worse HRQoL up to one year after hospital admission for hospitalized older people with higher ISAR-HP scores compared to hospitalized older people with lower scores [164], which might support a future definition of older people with higher ISAR-HP scores as more frail than older people with lower ISAR-HP scores.

CONCLUSION

Risk of poor functioning among hospitalized older people is associated with substantially higher healthcare costs up to one year after hospital admission compared to older patients not at risk. Since differences in costs are especially apparent in the period after hospitalization, integrated and individualized care focused on preventing functional loss after hospitalization among high-risk groups is important. This care, next to improving health and independence in daily life of the older population, might substantially reduce healthcare costs for this population in the future. By providing a better insight in one year formal and informal care costs of these risk groups, we hope to improve informed decision making on implementation of interventions that improve independent functioning after hospitalization and consequently reduce societal healthcare costs of at-risk hospitalized older people.

Appendix 1a | Prices for healthcare units and their sources: initial hospital stay and informal healthcare after initial hospital stay

Healthcare items	Price per unit (Euro)	Source and remarks
Initial hospital stay items:		
One day general hospital care	435	Manual for cost research 2010 *
One day ICU care	2183	Manual for cost research 2010 *
Hospital procedures		Prices of all procedures and diagnostics during initial hospital stay were provided by the hospital financial administration. Since procedures were divers and numerous (from 1 to 90 procedures per patient) they are not listed in detail here.
Informal healthcare items:		
Housekeeping per hour	12,50	Proxy Good method **
Personal care per hour	12,50	Proxy Good method **
Help in mobility outside home environment per hour	12,50	Proxy Good method **

* Hakkaart-van Roijen L, Tan SS, Bouwmans CAM. Manual for cost research: methods and standard costprices for economic evaluations in healthcare. College for health care insurance. actualized version 2010 [122]; ** Koopmanschap MA, van Exel JN, van den Berg B, Brouwer WB. An overview of methods and applications to value informal care in economic evaluations of healthcare [165].

Appendix 1b | Prices for healthcare units and their sources: formal healthcare after initial hospital stay

Formal healthcare items	Price per Unit (Euro)	Source and remarks
One day general hospital care	435	Manual for cost research 2010 *
One day nursing home care	238	Manual for cost research 2010 *
One day older home care	90	Manual for cost research 2010 *
One day rehabilitation center care	340	Manual for cost research 2010 * (Treatment data not available, thus treatment costs of 110 euro per hour are excluded)
GP contact	28	Manual for cost research 2010 (standard price for all consults)
Housekeeping per hour	24	Manual for cost research 2010 *
Personal care per hour	44	Manual for cost research 2010 *
Nursing care per hour	65	Manual for cost research 2010 *
Aids and adjustments:		Costs for aids and adjustments were estimated based on current retail prices as found on several Dutch websites: weighted averages were used if appropriate and both service life of equipment as labor costs were taken into account
Alarm	32,40	162 / 5 (service life) = 32,40
Compression stockings and braces	85,41	Weighted average of aids: tool to put on compression stockings (126,50) + compression stockings (40)+ braces (100) =(3*126,50 + 4*40 + 4*100) / 11 = 85,41
Chairs	179,84	Weighted average of aids and adjustments: shower chair (170)/toilet frame (110)/electrical relaxing chair (695) =(55*170 + 7*110 + 2*695) /64 = 179,84
Supporting grips, thresholds	77,68	Weighted average: handles and grips (2*22,5 + 1*30 labor = 75)/threshold (3*30 = 90)= (78 * 75 + 17*90) /95 = 77,68
Adjustable beds	206	1030/ 5 (service life) = 206 per year
Crutches/Canes/ Walking frame	32,05	Weighted average aids: crutches (38),walking cane (16), walking chair (45) = (35*38 + 17*16 + 5*45) / 57= 32,05
Rollator/ Wheelchair	170/138	
Scooter	378	1890 / 5 (service life)=378
Toilet adjustments	48	240 / 5 (service life) = 48
Stoma-bags	5110	3,50 * 4 per day * 365 days = 5110 per year
Elevators	574,58	Weighted average aids: stair lifts (2000+3*30 labor)/5(service life)=580 + active lifter (2500/5=500) = 515 = (12 * 580 + 1*515) / 113 = 575
Gripping aid	18	
Swivel cushion / turning aid	35	
Bathing aid	21	63/3 (service life)=21
Aid to get up from bed	38	190/5 (service life) =38
Home trainer	36	180 / 5 = 36
Leg prosthesis	400	4000/10 = 400

*Hakkaart-van Roijen L, Tan SS, Bouwmans CAM. Manual for cost research: methods and standard costprices for economic evaluations in healthcare. College for health care insurance. actualized version 2010 [122].

Appendix 2 | Variables used in imputation

Imputed variables[1,2,3]**:**
– Costs nursing days initial hospital stay
– Costs ICU days initial hospital stay
– Costs procedures initial hospital stay
– Costs readmission hospital, nursing home, older home, rehabilitation center (each separately imputed) from discharge to T3
– Costs readmission hospital, nursing home, older home, rehabilitation center (each separately imputed) from T3 to T12
– Costs GP contacts from discharge to T3 and from T3 to T12
– Costs formal homecare (housekeeping, personal care, nursing were separately imputed) from discharge to T3 and from T3 to T12
– Costs of acquiring medical aids or modifications in living environment due to health from discharge to T3 and from T3 to T12
– Costs of informal homecare (housekeeping, personal care, help outside the house, separately imputed) from discharge to T3 and from T3 to T12
Variables used to impute missing values:
– Costs readmission hospital, nursing home, older home, rehabilitation center (each separately imputed) in 12 months before T0
– Costs GP contacts in 12 months before T0
– Costs formal homecare (housekeeping, personal care, nursing were separately imputed) in 12 months before T0
– Costs of acquiring medical aids or modifications in living environment due to health in 12 months before T0
– Costs of informal homecare (housekeeping, personal care, help outside the house, separately imputed) in week before T0
– ISAR-HP individual variables (4) and total ISAR-HP score in group 0, 1,2,3, or 4+)
– Individual items of ADL (Katz-6 item index) and iADL (Lawton Brody) questionnaires
– Multi-morbidity (prevalence yes/no of certain illnesses or health problems)
– Mortality (deceased or not) and diagnosis
– Age and gender patient
– Length of initial hospital stay
– Length of survival
– Lost to follow up groups
– Cognitive functioning (total score MMSE)
– Health related quality of life (EQ5D total score)

[1] in total 27 cost variables imputed [2] available cases of imputed variables were also used to impute missings of other variables; [3] See appendix 4a to 4d for specific rates of missing data for imputed variables.

Appendix 3 | Comparing characteristics of participants with missing costs to participants with complete costs

Characteristics	Costs initial hospital stay* 53% (partly) missing			Costs formal health care** 64% (partly) missing			Costs informal health care 90% (partly) missing		
	Complete costs N =214	Missing costs N =246	p-value diff.	Complete costs N =165	Missing costs N =295	p-value diff.	Complete costs N =46	Missing costs N =414	p-value diff.
Age, mean (SD)	76.6 (7.4)	76.3 (6.9)	0.737	75.7 (6.6)	76.9 (7.4)	0.100	75.8 (6.2)	76.5 (7.3)	0.503
Women, n (%)	129 (60)	127 (52)	0.062	101 (61)	155 (53)	0.073	30 (65)	226 (55)	0.169
Married/living together, n (%)	117 (55)	140 (57)	0.696	88 (53)	169 (57)	0.721	26 (57)	231 (56)	0.804
Living environment, n (%)			0.405			0.172			0.943
Independent alone	82 (38)	99 (40)		70 (42)	111 (38)		18 (39)	163 (39)	
Independent with others	121 (57)	141 (57)		193 (56)	169 (57)		27 (59)	235 (57)	
Multi-morbidity (≥ 2), n (%)	169 (79)	168 (68)	**0.010***	122 (74)	215 (73)	0.806	39 (85)	298 (72)	0.063
ADL (Katz) at T0, mean (SD)	4.4 (1.7)	4.4 (1.8)	0.951	4.6 (1.6)	4.3 (1.8)	0.157	4.5 (1.8)	4.4 (1.8)	0.797
IADL (Lawton) at T0, mean (SD)	4.8 (2.1)	4.9 (2.1)	0.619	4.9 (2.1)	4.8 (2.1)	0.571	4.7 (2.1)	4.8 (2.1)	0.763
Cognition (MMSE) at T0, mean (SD)	26.0 (4.0)	26.5 (3.6)	0.128	26.7 (3.7)	26.0 (3.9)	0.059	26.5 (3.8)	26.3 (3.8)	0.622
HRQoL (EQ5D), mean (SD)	0.62(0.3)	0.60 (0.3)	0.459	0.63 (0.3)	0.60 (0.3)	0.291	0.62 (0.3)	0.61 (0.3)	0.854
Length initial hospital stay, mean (SD)	7.2 (5.4)	7.1 (6.5)	0.863	5.5 (5.1)	8.0 (6.3)	**< 0.001***	6.2 (4.7)	7.2 (6.1)	0.266
ISAR-HP scores, n (%)			0.384			< 0.001*			0.295
ISAR-HP=0	52 (24)	76 (31)		60 (36)	68 (23)		16 (35)	112 (27)	
ISAR-HP=1	41 (19)	51 (21)		41 (25)	51 (17)		7 (15)	85 (21)	
ISAR-HP=2	27 (13)	32 (13)		24 (15)	35 (12)		2 (4)	57 (14)	
ISAR-HP=3	30 (14)	26 (11)		16 (10)	40 (14)		7 (15)	49 (12)	
ISAR-HP=4+	64 (30)	61 (25)		24 (15)	101 (34)		14 (30)	111 (27)	

[1]p value for t-test differences in means; [2] p value for chi-square differences; * = significant p-value

Appendix 4a | Average healthcare costs of initial hospital admission for 460 participants by ISAR-HP score, before and after multiple imputation

	All		ISAR-HP = 0		ISAR-HP = 1		ISAR-HP = 2		ISAR-HP = 3		ISAR-HP = 4+	
Costs	**O[1] N=460 (valid %)**	**MI[2]**	**O[1] N=128 (valid %)**	**MI[2] n=128**	**O[1] n=92 (valid %)**	**MI[2] n=92**	**O[1] n=59 (valid %)**	**MI[2] n=59**	**O[1] n=56 (valid %)**	**MI[2] n=56**	**O[1] n= 25 (valid %)**	**MI[2] n=125**
Initial hospital stay												
Nursing days	3092±122	3091±121	2754±241	2756±239	2749±204	2752±201	2905±290	2905±290	3045±330	3045±324	3793±271	3793±271
missing (%)	0.7	-	0.8	-	1	-	0	-	2	-	0	-
ICU days	386±212	406±185	249±157	167±102	77±54	93±78	59±59	52±51	1395±1395	951±898	443±414	803±534
missing (%)	38	-	38	-	38	-	37	-	36	-	41	-
Procedures	6372±292	6372±220	6589±659	6514±426	7251±614	7050±474	6510±866	6474±644	6208±896	6250±654	5634±468	5732±405
missing	25	-	35	-	23	-	25	-	27	-	14	-
Total:	9955+-492	9869+-362	10385+-1144	9437+-609	10292+-980	9895+-600	9759+-1127	9431+-753	10251+-1407	10246+-1342	9332+-908	10329+-847
missing (%)	53	-	59	-	55	-	54	-	46	-	49	-

[1] original data including percentage missings; [2] data after multiple imputation

Appendix 4b | Average formal healthcare costs from discharge initial hospital stay up to one year for 460 participants by ISAR-HP score, before and after multiple imputation

Costs	All		ISAR-HP = 0		ISAR-HP = 1		ISAR-HP = 2		ISAR-HP = 3		ISAR-HP =4+	
	O[1] N=460 (valid %)	MI[2]	O[1] N=128 (valid %)	MI[2] n=128	O[1] n=92 (valid %)	MI[2] n=92	O[1] n=59 (valid %)	MI[2] n=59	O[1] n=56 (valid %)	MI[2] n=56	O[1] n=125 (valid %)	MI[2] n = 125
T0-T1:												
Readm hospitals	569±126	593±180	410±125	401±178	746±387	716±326	1151±589	862±410	268±170	547±434	476±185	594±316
missing	40	-	31	-	32	-	47	-	45	-	50	-
Readm nursing home	109±79	214±131	0	115±147	0	40±151	0	177±380	575±575	580±463	192±192	296±229
missing	39	-	30	-	30	-	47	-	43	-	49	-
Readm elderly home	163±58	495±324	36±29	309±388	290±193	414±278	121±121	591±552	75±53	259±202	285±149	806±417
missing	41	-	30	-	30	-	51	-	45	-	53	-
Readm rehabil. center	235±118	432±272	26±26	242±311	372±372	555±502	0	448±782	967±675	798±513	138±114	365±313
missing	39	-	30	-	30	-	47	-	43	-	49	-
GP consults	10±2	18±7	5±2	8±4	12±6	15±6	12±5	20±11	6±3	15±10	18±7	30±15
missing	42	-	30	-	33	-	51	-	45	-	54	-
Formal homecare	978±223	1096±282	178±58	390±164	375±102	559±225	661±161	853±343	800±148	1004±376	3202±1001	2371±611
missing	44	-	34	-	32	-	51	-	50	-	57	-
Aids and adjustments	79±11	129±36	43±16	83±29	56±23	103±39	94±29	145±71	90±23	161±57	140±32	172±45
missing	39	-	30	-	30	-	47	-	43	-	49	-
Total T0-T1	**2116±309**	**2977±800**	**718±147**	**1549±726**	**1890±619**	**2402±916**	**2124±641**	**3095±1463**	**2239±794**	**3364±1042**	**4551±1103**	**4635±1096**
missing	**45**	**-**	**35**	**-**	**33**	**-**	**51**	**-**	**52**	**-**	**58**	**-**

[1] original data including percentage missings; [2] data after multiple imputation

Appendix 4b | Average formal healthcare costs from discharge initial hospital stay up to one year for 460 participants by ISAR-HP score, before and after multiple imputation *(Continued)*

Costs	All		ISAR-HP = 0		ISAR-HP = 1		ISAR-HP = 2		ISAR-HP = 3		ISAR-HP =4+	
	O[1] N=460 (valid %)	MI[2]	O[1] N=128 (valid %)	MI[2] n=128	O[1] n=92 (valid %)	MI[2] n=92	O[1] n=59 (valid %)	MI[2] n=59	O[1] n=56 (valid %)	MI[2] n=56	O[1] n=125 (valid %)	MI[2] n = 125
T1-T2												
Readm hospitals	981±198	1882±1753	510±138	1127±1335	1407±534	1782±1544	704±245	1844±2262	2455±1266	2971±2093	725±283	2258±2193
missing	45	-	37	-	45	-	42	-	50	-	52	-
Readm nursing home	36±27	118±120	0	60±97	116±116	148±156	0	111±129	0	103±122	51±51	167±199
missing	44	-	37	-	42	-	47	-	48	-	50	-
Readm elderly home	130±70	423±289	39±32	294±244	0	222±256	130±130	534±445	630±529	688±482	128±128	531±427
missing	45	-	37	-	42	-	42	-	48	-	53	-
Readm rehabil. center	352±174	781±824	294±294	640±706	539±539	886±1014	560±560	1260±1669	574±574	872±1112	40±40	581±684
missing	44	-	37	-	42	-	42	-	48	-	52	-
GP consults	4±1	11±5	4±1	9±5	3±1	8±5	8±3	14±8	8±3	13±7	2±1	12±6
missing	47	-	30	-	43	-	46	-	50	-	55	-
Formal homecare	1855±250	4031±1421	465±151	2276±1270	983±234	2907±1496	1327±344	4208±1962	3029±647	4275±1467	4533±951	6463±1636
missing	48	-	40	-	45	-	47	-	48	-	60	-
Aids and adjustments	50±12	89±44	19±11	46±39	78±43	100±58	59±29	113±92	65±19	102±58	57±24	108±42
missing	44	-	37	-	42	-	42	-	48	-	53	-
Total T1-T2	**3404±463**	**7334±3176**	**1296±362**	**4452±2608**	**3207±1129**	**6053±3213**	**2788±985**	**8081±4800**	**6859±2089**	**9025±3834**	**5400±1127**	**10119±3375**
missing	**49**	**-**	**40**	**-**	**47**	**-**	**47**	**-**	**52**	**-**	**61**	**-**
Total T0-T2	**6045±830**	**10312±3682**	**2286±481**	**6001±3081**	**5672±2011**	**8455±3798**	**5312±1478**	**11178±5785**	**10577±3526**	**12389±4433**	**13314±2714**	**14754±3920**
missing	**63**	**-**	**53**	**-**	**54**	**-**	**59**	**-**	**70**	**-**	**80**	**-**

[1] original data including percentage missings; [2] data after multiple imputation

Appendix 4c | Average informal healthcare costs from discharge initial hospital stay up to one year for 460 participants by ISAR-HP score, before and after multiple imputation

Costs	All		ISAR-HP = 0		ISAR-HP = 1		ISAR-HP = 2		ISAR-HP = 3		ISAR-HP =4+	
	O[1] N=460 (valid %)	MI[2] N=460	O[1] N=128 (valid %)	MI[2] n=128	O[1] n=92 (valid %)	MI[2] n=92	O[1] n=59 (valid %)	MI[2] n=59	O[1] n=56 (valid %)	MI[2] n=56	O[1] n= (valid %)	MI[2] n=125
T0-T1	1374+-276	3922+-501	1414+-604	2925+-585	621+-265	3823+-908	2333+-837	4678+-956	862+-382	4136+-882	1827+-596	4564+-626
missing	79	-	75	-	83	-	88	-	73	-	79	-
T1-T2	1879+-465	5593+-985	1475+-571	3572+-796	1268+-977	5503+-1391	3900+-2473	6810+2135	1880+-1403	5852+-1633	1908+-891	7038+-1574
missing	75	-	69	-	84	-	80	-	75	-	72	-
T0-T2	5503±1266	9515±1142	4324±1497	6497±1018	3229±2260	9326±2002	25473±2180	11489±2539	4340±3036	9988±2114	6010±2783	11602±1809
missing	89	-	87	-	91	-	97	-	86	-	88	-

[1] original data including percentage missings; [2] data after multiple imputation

Appendix 4d | Average total healthcare costs from start initial hospital stay up to one year after admission for all participants and for ISAR-HP groups, before and after multiple imputation

Costs	All		ISAR-HP = 0		ISAR-HP = 1		ISAR-HP = 2		ISAR-HP = 3		ISAR-HP =4+	
	O[1] N=460 (valid %)	MI[2] N=460	O[1] N=128 (valid %)	MI[2] n = 128	O[1] n = 92 (valid %)	MI[2] n = 92	O[1] n = 59 (valid %)	MI[2] n = 59	O[1] n = 56 (valid %)	MI[2] n = 56	O[1] n = (valid %)	MI[2] n = 125
Total	28995±6839	29696±4032	8670±1682	21935±3387	57290±30755	27675±4766	39862±6539	32097±6922	17232±0	32623±5503	34414±8583	36684±4575
missing	96	-	95	-	97	-	97	-	98	-	96	-

Note: total costs = sum of total initial hospital stay costs, formal health care T0-T12, and informal healthcare T0-T12

[1] original data including percentage missings; [2] data after multiple imputation

Appendix 5 | Total costs according to age, sex, living environment, multi-morbidity, and death

Characteristics	Costs initial hospital stay original N=460 (valid%)	Costs initial hospital stay imputed	p value[1]	Costs formal health care original N=460 (valid%)	Costs formal health care imputed	p value[1]	Costs informal health care original N=460 (valid%)	Costs informal health care imputed	p value[1]
Age			0.716			0.070			0.099
65-75, n=213	10183 (748)	10131 (534)		5351 (1296)	9815 (4398)		7014 (2130)	8686 (1452)	
missing (%)	54	-		63	-		90	-	
76-85, n= 186	10016 (797)	9628 (529)		6511 (1216)	9506 (2941)		5064 (1917)	9318 (1151)	
missing (%)	56	-		60	-		88	-	
Over 85, n=61	9119 (1131)	9688 (1169)		7463 (1949)	14501 (4766)		1899 (1016)	13009 (2637)	
missing (%)	46	-		77	-		90	-	
Sex			0.227			0.038			0.185
Men, n=204	9854 (802)	9377 (505)		3532 (730)	7842 (3069)		3388 (1696)	8283 (1298)	
missing (%)	58	-		68	-		91	-	
Women, n=256	10021 (624)	10260 (523)		7671 (1260)	12280 (4307)		6693 (1716)	10497 (1456)	
missing (%)	50	-		60	-		88	-	
Living environment			0.684			0.003*			0.402
Independent alone, n=181	9655 (715)	9779 (593)		9013 (1442)	12994 (4181)		2124 (468)	10211 (1632)	
missing (%)	55	-		61	-		90	-	
Independent with others, n=262	10391 (717)	10092 (485)		3849 (939)	8312 (3597)		7805 (1992)	8961 (1128)	
missing (%)	54	-		64	-		89	-	

[1]tests of significance were carried out on the imputed costs using the t-test

Appendix 5 | Total costs according to age, sex, living environment, multi-morbidity, and death *(Continued)*

Characteristics	Costs initial hospital stay original N=460 (valid%)	Costs initial hospital stay imputed	p value[1]	Costs formal health care original N=460 (valid%)	Costs formal health care imputed	p value[1]	Costs informal health care original N=460 (valid%)	Costs informal health care imputed	p value[1]
Multi-morbidity			0.359			0.668			0.173
yes n=337	9890 (553)	9665 (375)		6918 (999)	10572 (3389)		6522 (1495)	10032 (1125)	
missing (%)	50	-		64	-		88	-	
no, n=123	10199 (1089)	10427 (882)		3659 (1420)	9599 (4800)		859 (547)	8099 (1657)	
missing (%)	63	-		63	-		93	-	
Deceased during study period			0.258			0.113			0.003*
yes, n=84	9914 (1536)	10743 (1042)		0 (0)	4579 (1725)		0 (0)	4524 (854)	
missing (%)	61	-		95	-		95	-	
No, n=376	9962 (512)	9679 (378)		6192 (847)	11555 (4301)		5982 (1354)	10598 (1352)	
missing (%)	52	-		56	-		88	-	

[1]tests of significance were carried out on the imputed costs using the t-test

CHAPTER 7

Predictors of decline in (instrumental) activities of daily living among hospitalized older patients

Kirsten J.E. Asmus-Szepesi, Linda E. Flinterman, Anna P. Nieboer, Ton J.E.M. Bakker, Johan P. Mackenbach, Ewout W. Steyerberg

Submitted for publication

ABSTRACT

Aim

Hospitalized older people are at risk of functional decline in (instrumental) activities of daily living ((i)ADL)). We aimed to identify predictors of functional decline.

Methods

We studied 2612 hospitalized at-risk patients aged 65 years or older and admitted to one of three community hospitals in the Netherlands. Patients were interviewed at hospital admission to score (pre-hospital) functioning. We selected patients with a score ≥ 1 at the Identification Seniors at Risk- Hospitalized Patients (ISAR-HP) questionnaire. We studied the effects of age, sex, living environment, diagnosis, comorbidities, cognitive functioning, depression, neuropsychiatric functioning, and ISAR-HP on (i)ADL decline at three months with logistic regression.

Results

Three-months after hospital admission, 22% (n=584) patients were lost to follow up. Of the remaining 2028 patients, 11% (n=233) had died and 17% (n=347) had declined in ADL. The ADL items washing and dressing declined most. iADL declined in 50% (n=1020, including deaths), apparent in all iADL items except for telephoning. Cognitive functioning, neuro-psychiatric functioning, depression, comorbidities, and pre-admission (i)ADL were significantly associated with ADL and iADL decline. Age, living environment, and ISAR-HP score were predictive of ADL decline but not of iADL decline. The predictors explained 30% of ADL but only 14% of iADL decline.

Conclusions

Hospitalized older people decline more in iADL (50%) than in ADL (28%) after hospitalization, with iADL being more dynamic over time and more difficult to predict. This implies that individualized intervention programs might have more impact when focused on specific instrumental activities of daily living instead of mostly targeting basic activities of daily living.

INTRODUCTION

Hospitalized older people are at risk of functional decline, commonly defined by a loss of activities of daily living (ADL) or instrumental activities of daily living (iADL). Functional decline is a leading complication of hospitalization among older patients [13,29,74]. It leads to lower health-related quality of life (HRQoL), higher healthcare utilization and associated costs, and early death [6,39,76].

Earlier studies have shown that many older patients decline in ADL during or before hospitalization compared to their baseline level longer before hospitalization. Many do not return to baseline ADL during their hospital stay [6,166,167]. The general goal of hospitals to reduce length of stay may hamper assessment and proper treatment of individualized patient needs that go beyond the medical diagnosis [168].

Many previously reported studies only included patients with acute medical symptoms and/or admitted non-electively [6,81], whereas electively admitted patients with non-acute illnesses may also be at risk of functional decline before or during hospitalization. Earlier studies were mainly focused on ADL functioning and not on iADL functioning. Nevertheless, iADL functioning is important in maintaining independence at home, especially due to its relation to cognitive decline [169-171]. Knowledge of ADL and iADL trajectories up to three months after admission is necessary in order to further individualize and thus strengthen future interventions aimed at retaining independent living among hospitalized elderly.

We aimed to describe the extent to which ADL and iADL of hospitalized older people decline or improve between baseline, hospital admission, and three month follow up. In addition, we aimed to describe differences between ADL and iADL decline and to identify predictors of ADL and iADL decline.

MATERIALS AND METHODS

Patients

Between February 2011 and September 2013, we included patients of 65 years and older admitted both electively and acutely to one of three community hospitals in the Netherlands. Patients were eligible if they scored 1 or higher on the Identification Seniors at Risk- Hospitalized Patients (ISAR-HP) questionnaire [21,152]. Exclusion criteria included low cognitive functioning (MMSE ≤ 18), not speaking Dutch, and a life expectancy of less than 3 months, and hospitalized for less than 48 hours [68]. Patients who were willing to participate and who signed an informed consent form were interviewed at hospital admission and three months after hospital admission using validated questionnaires.

At hospital admission, data was collected on several potential predictors such as age, sex, marital status, living environment before admission, cognitive functioning (MMSE [58]), neuropsychiatric functioning (NPI, [59,90]), depression (Geriatric Depression Scale [172]), comorbidities, and both ADL [96] and iADL functioning [136] pre admission and at hospitalization. At three months follow up patients were interviewed again on current ADL and iADL functioning.

Statistical analysis

We described which patients declined or remained stable in ADL and iADL before hospital admission and the percentages of these groups that had either stabilized/improved or declined in ADL and iADL at three month follow up compared to baseline. We analyzed the effects of possible predictors on ADL and iADL decline between baseline and three month follow up with logistic regression, both unadjusted and adjusted for the possible confounders age, sex, ISAR-HP score and ICD10 group. We performed analyses including deaths as decline in functioning, and measured the explained variability (R^2) for each predictor and the multivariate model. All analyses were performed using SPSS version 21.0 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp). The medical ethics committee of the Erasmus MC, Rotterdam, the Netherlands approved the study protocol, under protocol number MEC2011-041.

RESULTS

Patients

During the inclusion period, we assessed 7783 participants for eligibility, of whom 44% (n=3431) were excluded and 23% (n=1778) refused participation, leaving 2612 recruited patients at baseline. At three month follow up, 22% (n=584) were lost to follow up (Figure 1a and 1b). Of the remaining 2028 patients who were included in the analysis 11% (n=233) had died. We coded these deaths as decline in ADL and decline in iADL.

Baseline characteristics

Hospitalized older people who participated had a median age of 79 years, 63% were women, 44% were married, 48% lived independently alone, and 6% were admitted to the hospital from a nursing home (Table 1). Most patients were independent in ADL and iADL scores, and about 20% of patients had cognitive problems at hospital admission (Table 1).

Table 1 | Baseline characteristics of study population

Characteristic	N=2612
Age, median (25th-75th)	79 (72-84)
Women, n (%)	1637 (63)
Married or living together, n (%)	1140 (44)
Living independently alone, n (%)	1249 (48)
Admitted from nursing home, n (%)	16 (0.6)
ADL 2 weeks before admission, median (25th-75th)	6 (5-6)
IADL 2 weeks before admission, median (25th-75th)	6 (5-7)
Cognitive problems (MMSE < 24), n (%)	516 (20)
Neuro Psychiatric Index (NPI) score[1], median (25th-75th)	2.9 (0-6.1)

[1]Note: Only 33% complete cases of NPI scores, therefore, incomplete scores (66%) were imputed with single imputation

ADL and iADL transitions

Approximately 29% (n=580) of the 2028 patients had declined in ADL functioning at three-month follow up compared to baseline (figure 1a). Of these 580 patients, 44% (n=253) were stable between baseline and hospital admission and thus declined after hospitalization, whereas 56% (n=327) patients had already declined between baseline and hospital admission (Figure 1a). Of the remaining 1448 patients who were either stable in ADL or had improved ADL at three months compared to baseline, 37% (n=533) patients had declined before hospital admission and recovered between hospital admission and three month follow up. The ADL items washing and dressing declined most over time (Figure 2a).

At three month follow up, around 50% (n=1020) of the 2028 patients had declined in iADL compared to baseline (figure 1b). Of these 1020 patients, 54% (n=548) were stable at hospital admission and thus had declined after hospital admission, whereas 46% (n=472) had already declined before hospitalization. Among the remaining 1007 patients with either stable or improved iADL at three month follow up compared to baseline, 42% (n=425) patients had declined before hospital admission but recovered within the three months after hospital admission (Figure 1b). All iADL items showed decline, except for telephoning (Figure 2b).

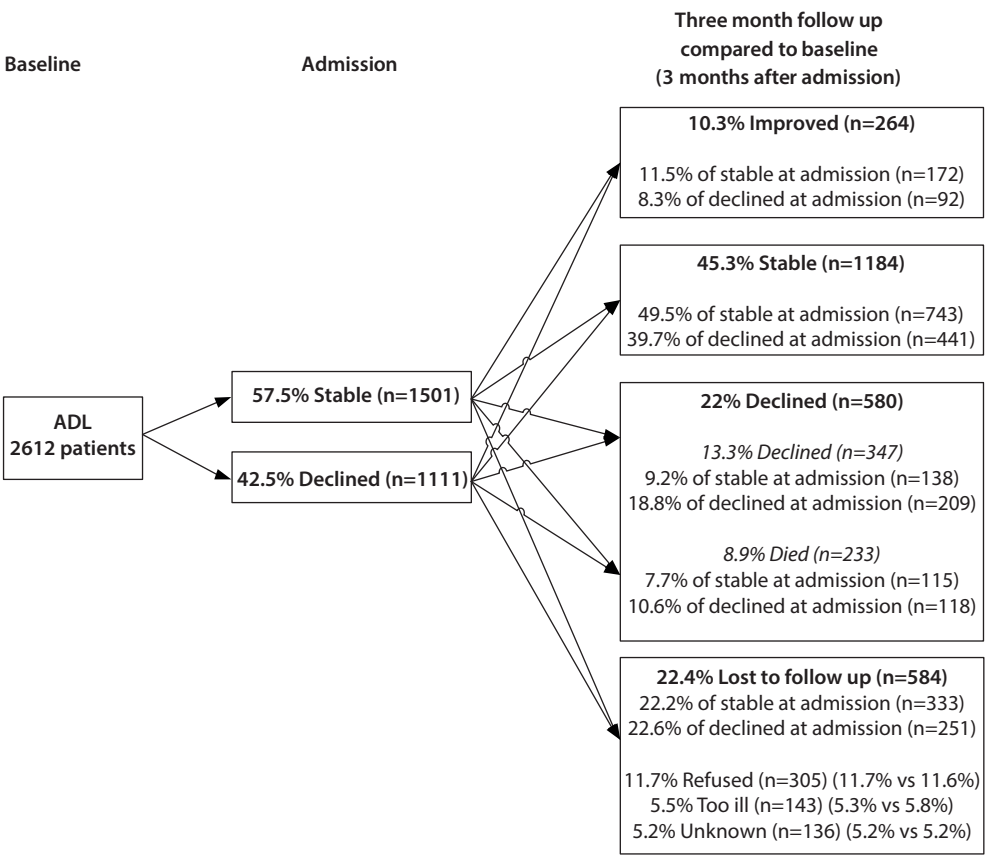


Figure 1a | ADL transitions between baseline and 3-month follow up

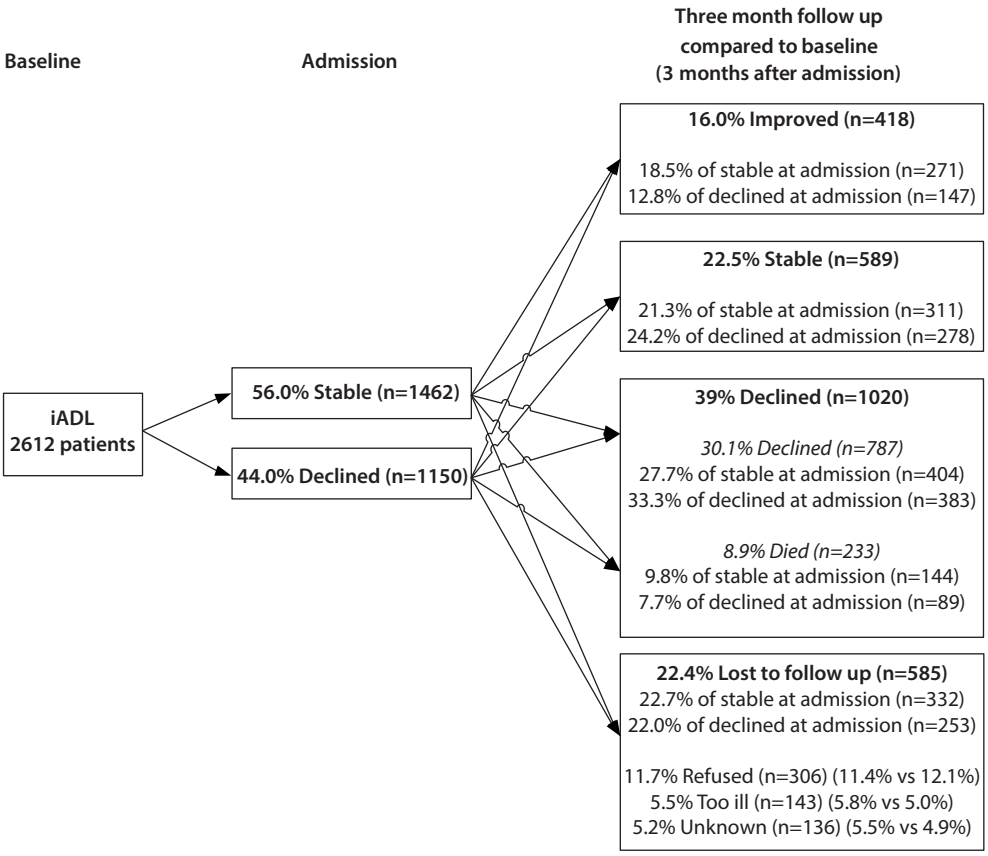


Figure 1b | iADL transitions between baseline and 3-month follow up

Predictors of ADL and iADL decline

Age was a predictor of ADL decline, with an 1.4 to almost 5-fold increased risk of ADL decline in patients aged 70-74 to > 89 respectively compared to patients aged 65-69 (Table 2). No differences in ADL decline were found in women versus men. People who lived dependently at an elderly home before hospitalization had a 2.6-fold increased risk of ADL decline compared with patients living independently. Patients with an MMSE score of 18-20 and 21-24 had a 2.8-fold and 1.5 fold increased risk of ADL decline compared with patients with a score of 25-30. Patients with an ISAR-HP score of 4 or 5 were at higher risk of ADL decline than patients with score 1 (ORs 2.0, CI95 [1.4-2.7] and 2.3, CI95 [1.6-3.3]). Loneliness did not predict ADL decline, but the NPI did with a 1.9 to almost 4-fold increased risk of ADL decline in patients who scored 3-5 to ≥ 11 respectively compared to patients with an NPI score of 0 (Table 2). Patients with symptoms of depression were 2.3 times more likely to decline in ADL functioning

than patients without symptoms of depression. Finally, older people who had declined in ADL before hospitalization were more likely to show decline after hospitalization than people who remained stable before hospitalization (OR 2.1, CI95 [1.7-2.6], Table 2). Of the comorbidities we studied, only diabetes, malignancies, and history of falls were predictors of ADL decline (ORs 1.5, 1.7, and 1.4 respectively). The explained variability varied from around 0 for most comorbidities to 12% for the NPI score at baseline. In total 30% of the variance in ADL was explained by our predictors.

Sex, living environment, ISAR-HP score, and loneliness were not clearly predictive of iADL decline (Table 2). Older patients, patients with a lower MMSE score and patients with depressive symptoms were more likely to decline in iADL than patients without depressive symptoms (Table 2). The NPI score was predictive of iADL decline, with 2.4 and 3-fold increased risk patients who scored 6-10 or ≥ 11 respectively compared to patients with an NPI score of 0 (Table 2). Patients who experienced a stroke in the past were more likely to decline than patients without a history of stroke (OR 1.8, CI95 [1.3-2.6]). Patients who had declined before hospitalization were slightly more likely to decline after hospitalization than patients who were stable before hospitalization (OR1.3 [1.1-1.5], Table 2). The explained variability varied from around 0 for most comorbidities to 5% for the NPI score at baseline, and 14% for the combination of predictors.

We performed additional analyses by checking for differences in diagnoses, but most medical diagnoses were equally divided between the different trajectory groups.

Table 2 | Predictors of decline in ADL and iADL with death as decline

Predictor	Decline at 3 months					
	ADL crude OR (95%CI)	ADL adjusted[a] OR (95%CI)	R^2	iADL crude OR (95%CI)	iADL adjusted[a] OR (95%CI)	R^2
Sex (women)	1.0 (0.8-1.2)	0.9 (0.8-1.1)	0.0%	0.9 (0.7-1.1)	0.9 (0.7-1.0)	0.1%
Age						
65-69	1(ref)	1(ref)	6.7%	1(ref)	1(ref)	1.8%
70-74	1.4 (1.0-2.1)	1.4 (1.0-2.1)		0.9 (0.7-1.3)	0.9 (0.7-1.3)	
75-79	1.9 (1.3-2.7)	1.9 (1.3-2.7)		1.3 (0.9-1.7)	1.2 (0.9-1.7)	
80-84	2.5 (1.7-3.6)	2.5 (1.7-3.6)		1.4 (1.0-1.8)	1.4 (1.0-1.8)	
85-89	4.3 (3.0-6.3)	4.3 (3.0-6.3)		1.7 (1.2-2.3)	1.7 (1.2-2.3)	
=>90	4.7 (2.9-7.4)	4.7 (2.9-7.5)		2.3 (1.5-3.5)	2.3 (1.5-3.6)	
Living situation						
Independent	1(ref)	1(ref)	3.4%	1(ref)	1(ref)	0.6%
Elderly home	3.6 (2.5-5.2)	2.6 (1.8-3.8)		1.4 (1.0-2.1)	1.2 (0.9-1.8)	
Nursing home	2.3 (0.7-7.6)	1.5 (0.4-5.0)		4.7 (1.0-21.2)	3.7 (0.8-17.1)	
MMSE						
25-30	1(ref)	1(ref)	3.4%	1(ref)	1(ref)	2.5%
21-24	1.7 (1.4-2.2)	1.5 (1.2-1.9)		1.8 (1.5-2.3)	1.7 (1.4-2.2)	
18-20	3.3 (2.2-4.9)	2.8 (1.9-4.1)		2.1 (1.4-3.2)	2.0 (1.3-2.9)	
ISAR-HP						
1	1(ref)	1(ref)	4.2%	1(ref)	1(ref)	0.5%
2	1.2 (0.9-1.7)	1.2 (0.8-1.7)		1.0 (0.8-1.4)	1.0 (0.8-1.4)	
3	1.4 (1.0-2.0)	1.3 (0.9-1.8)		1.2 (0.9-1.6)	1.2 (0.9-1.6)	
4	2.4 (1.8-3.2)	2.0 (1.4-2.7)		1.4 (1.1-1.8)	1.2 (1.0-1.6)	
5	2.8 (2.0-3.9)	2.3 (1.6-3.3)		1.2 (0.9-1.6)	1.1 (0.8-1.5)	
Loneliness						
Not lonely	1(ref)	1(ref)	2.5%	1(ref)	1(ref)	0.3%
Moderately lonely	1.8 (1.5-2.2)	1.6 (1.3-2.0)		1.2 (1.0-1.4)	1.1 (0.9-1.3)	
Severely lonely	1.5 (0.9-2.4)	1.3 (0.8-2.1)		1.4 (0.9-2.2)	1.3 (0.9-2.1)	
Very severely lonely	1.3 (0.5-3.1)	1.5 (0.6-3.7)		1.0 (0.4-2.2)	1.1 (0.5-2.3)	
Depression	2.4 (1.9-3.0)	2.3 (1.8-3.0)	3.6%	1.6 (1.3-2.0)	1.5 (1.2-1.9)	1.0%
NPI (partly imputed)						
0	1(ref)	1(ref)	12%	1(ref)	1(ref)	5.0%
1-2	0.9 (0.7-1.3)	0.8 (0.6-1.2)		1.2 (0.9-1.5)	1.1 (0.8-1.4)	
3-5	1.5 (1.2-2.0)	1.3 (1.0-1.8)		1.1 (0.9-1.4)	1.0 (0.8-1.3)	
6-10	2.5 (1.9-3.4)	2.1 (1.5-2.8)		1.8 (1.4-2.4)	1.6 (1.2-2.1)	
>=11	3.3 (2.2-4.9)	2.7 (1.8-4.0)		2.3 (1.6-3.4)	2.0 (1.3-2.9)	

[a] Adjusted for age, sex, ISAR-HP score, and admission diagnosis

Table 2 | Predictors of decline in ADL and iADL with death as decline *(Continued)*

Predictor	Decline at 3 months					
	ADL crude OR (95%CI)	ADL adjusted[a] OR(95%CI)	R^2	iADL crude OR (95%CI)	iADL adjusted[a] OR (95%CI)	R^2
Comorbidities						
Diabetes	1.4 (1.2-1.8)	1.5 (1.2-1.9)	0.8%	1.1 (0.9-1.4)	1.1 (0.9-1.4)	0.1%
Stroke	1.3 (0.9-1.9)	1.3 (0.9-1.9)	0.2%	1.9 (1.3-2.6)	1.8 (1.3-2.6)	0.9%
Heart failure	0.9 (0.8-1.1)	0.9 (0.7-1.1)	0.0%	1.0 (0.8-1.2)	0.9 (0.8-1.1)	0.0%
Malignancies	1.5 (1.1-2.0)	1.7 (1.2-2.2)	0.6%	1.1 (0.9-1.5)	1.2 (0.9-1.5)	0.0%
Incontinence	1.3 (1.0-1.6)	1.1 (0.9-1.4)	0.3%	1.0 (0.8-1.2)	1.0 (0.8-1.2)	0.0%
Arthritis	0.8 (0.7-1.0)	0.8 (0.7-1.0)	0.3%	0.8 (0.7-1.0)	0.9 (0.7-1.0)	0.2%
Osteoporosis	1.3 (1.0-1.6)	1.3 (1.0-1.6)	0.4%	0.9 (0.4-1.0)	0.9 (0.7-1.1)	0.2%
Falls	1.6 (1.3-2.0)	1.4 (1.1-1.8)	1.1%	1.2 (1.0-1.5)	1.2 (0.9-1.4)	0.2%
Hearing problems	1.4 (1.2-1.7)	1.1 (0.9-1.4)	0.8%	1.2 (1.0-1.4)	1.0 (0.8-1.2)	0.2%
Vision problems	1.2 (1.0-1.5)	1.0 (0.8-1.3)	0.2%	1.1 (0.9-1.4)	1.1 (0.9-1.3)	0.1%
Decline hospitalization	2.2 (1.8-2.7)	2.1 (1.7-2.6)	4.5%	1.2 (1.0-1.4)	1.3 (1.1-1.5)	0.2%

[a] Adjusted for age, sex, ISAR-HP score, and admission diagnosis

DISCUSSION

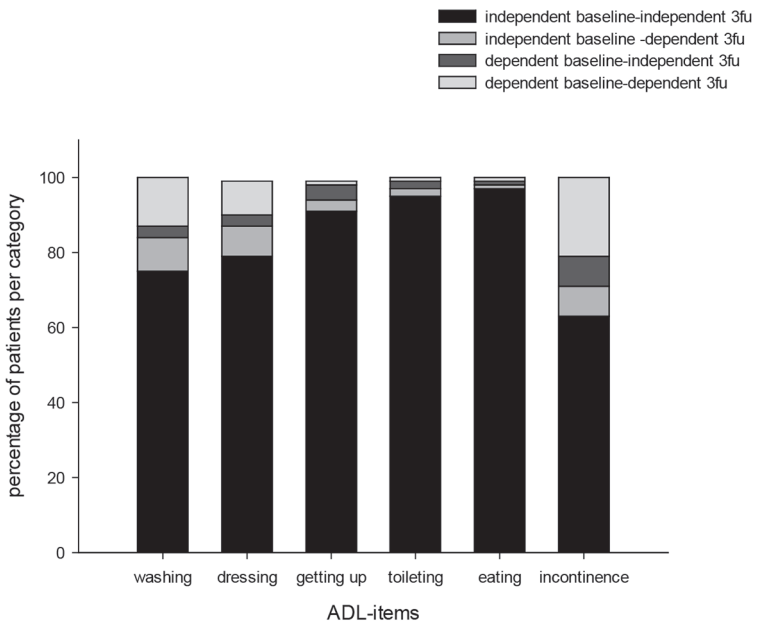
Three months after hospital admission, iADL is more often declined as well as improved compared to baseline than ADL. iADL is hence more variable over time. Age, living environment, cognitive functioning, neuro-psychiatric problems, depression, ISAR-HP score and some comorbidities were associated with ADL decline, but only to a lesser extent with iADL decline.

The influence of predictors in this study, especially cognitive and neuro-psychiatric problems, are in line with earlier studies describing the link between cognition and functional status, with decreased cognitive functioning leading to higher decline in ADL and especially iADL outcomes [169,170,173]. We further note that the fact that patients did not recover to baseline does not necessarily imply that the provided healthcare is ineffective. For example, a patient admitted acutely with a stroke might not recover fully to his or her baseline functioning due to irreversible damage as a result of the stroke itself even though state of the art medical and paramedical interventions have improved the patient's recovery to some extent. A recent longitudinal study among a general population of people aged 85 years or older confirms our findings that ADL and iADL transitions are dynamic and might only be partly preventable by interventions [171]. Moreover, we confirmed that depression, chronic disease, cognitive impairment and neuro-psychiatric problems were predictors of decline in functioning [171].

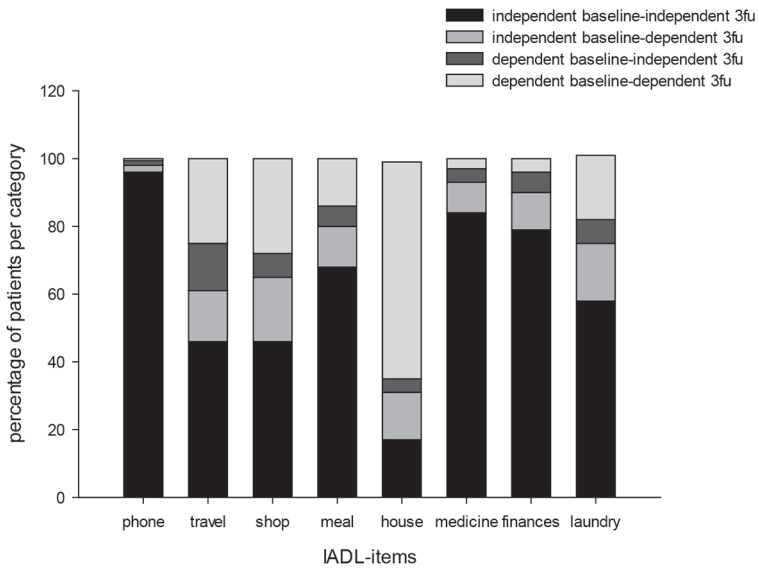
Our study had some limitations. Firstly, we did not include ADL and iADL functioning at time of hospital discharge, and were therefore unable to distinguish between decline during hospital stay and decline after hospital stay. An earlier study reported not only a high decline in ADL at discharge, but also reported that between discharge and three month follow up, another 40% of patients reported new decline in ADL or iADL compared to pre admission [81]. We did not use discharge as the time of follow up [6,167] due to the bias as a result of varied lengths of stay among patients. Neither did we use a fixed length of stay (e.g. 4 days) since many patients might not have had time to recover to their baseline functioning yet purely due to the natural course of their specific medical diagnosis. Instead, we assessed patients from two weeks before admission to three months after, since interventions should aim at recovering baseline ADL and iADL [167] after returning home. Secondly, our analyses showed that values for R^2 were relatively low. Other factors such as delirium, multi-pharmacology, medical complications, and nutritional status, might also be predictive of ADL and iADL decline [6,13,14].

Our study had some strong elements as well. Where earlier studies focused mainly on ADL decline [6,167], we expanded our focus to include iADL trajectories as well. We thus identified that specific iADL disabilities are more dynamic over time, with higher rates of decline but also higher rates of improvement than ADL activities. Also, decline in iADL and ADL are both related to cognitive and neuro-psychiatric predictors, whereas iADL decline is less related to age and living situation than ADL decline [171]. By focusing future individualized interventions on specific cognitive and neuro-psychiatric problems we might improve firstly iADL functioning, and secondly ADL functioning.

In conclusion, and contrary to earlier findings, the majority of hospitalized older people who declined before hospital admission or after hospital admission, have recovered three months after hospital admission. Nevertheless, individualized intervention programs are still necessary, and should focus more on specific instrumental activities of daily living and preventing associated cognitive and neuro-psychiatric decline than on targeting basic activities of daily living. Since iADL seems less related to predictors that cannot be changed by interventions, such as age and living environment and in addition is more dynamic than ADL, iADL might be more readily improved through hospital interventions than basic ADL. Future studies on such interventions are necessary in order to see if they indeed will lead to improved functioning among hospitalized older people.



Appendix 1a | ADL transitions per ADL-item between baseline and 3 month follow up



Appendix 1b | iADL transitions per iADL-item between baseline and 3 month follow up

PART THREE

Outcomes of the Prevention and Reactivation Care Program (PReCaP)

CHAPTER 8

Evaluation of the Prevention and Reactivation Care Program (PReCaP) for hospitalized older people: a prospective non-randomized controlled trial

K.J.E. Asmus-Szepesi, L.E. Flinterman, M.A. Koopmanschap, A.P. Nieboer, T.J.E.M. Bakker, J.P. Mackenbach, E.W Steyerberg

Clinical Interventions in Aging, accepted for publication

ABSTRACT

Background

Hospitalized older people are at risk of functional decline. We evaluated the effects and care costs of a specialized geriatric rehabilitation program aimed at preventing functional decline among at-risk hospitalized older people.

Methods

This prospective non-randomized controlled trial was performed in three hospitals in the Netherlands. One hospital implemented the Prevention and Reactivation Care Program (PReCaP), while two other hospitals providing usual care served as control settings for a between-hospital comparison. Within the PReCaP hospital we compared patients enrolled before and after implementation of the PReCaP. Hospitalized patients 65 years or older and at risk of functional decline were interviewed at baseline, and 3 and 12 months using validated questionnaires to score functioning, depression, and health related quality of life (HRQoL). We estimated costs per unit of care from hospital information systems and national data sources. We used adjusted general linear mixed models to analyze functioning and HRQoL.

Results

Between-hospital analysis showed no difference in activities of daily living (ADL) and instrumental activities of daily living (iADL) between PReCaP patients and control groups. PReCaP patients did have slightly better cognitive functioning (MMSE; +0.4, 95%CI [0.2-0.6]), lower depression (GDS-15; -0.9, 95%CI [-1.1 to -0.6]) and higher perceived health (SF-20; +5.6, 95%CI [2.8-8.4]) than control patients. Analyses within the PReCaP hospital showed no improvement over time in functioning, depression, and HRQoL. One-year healthcare costs were higher for PReCaP patients both for the within-hospital analysis (+€7k) and the between-hospital analysis (+€2.5k).

Conclusion

Our care program (PReCaP) is not effective in preventing functional decline. It may possibly provide some benefits to hospitalized patients at risk of functional decline with respect to cognitive functioning, depression, and perceived health. Further evaluations of integrated intervention programs to limit functional decline are required.

BACKGROUND

Hospitalized older people are at risk of functional decline, commonly defined by a loss of activities of daily living (ADL) or instrumental activities of daily living (iADL) [6]. Functional decline leads to lower health-related quality of life (HRQoL), higher healthcare utilization and associated costs, and early death [6,75]. Hospitalized older people at risk of functional decline are also at higher risk of cognitive impairment, problems in social and psychological functioning, multi-morbidity, or other geriatric symptoms such as malnutrition and falls [135,164]. Hospital care should focus on this multitude of geriatric problems in addition to treating the medical diagnosis for which patients are admitted [31,86,166,174]. The Prevention and Reactivation Care Program (PReCaP) is a preventive program supplementary to usual care for hospitalized older people and has been developed and implemented at three departments (i.e. geriatrics, internal medicine and cardiology) of a regional hospital in the Netherlands. The supplementary nature of the PReCaP entails that the patient receives usual care from the professionals of the department they are staying at, and in addition, receive PReCaP care from a multidisciplinary team that is not connected to a specific department but is active across hospital departments. Thus, the care that this team provides is supplementary to the usual care patients already receive at their specific departments. The PReCaP aims to reduce hospital-related functional decline among hospitalized older people by offering multidisciplinary, integrated and goal-oriented care focused on physical, social and psychological domains of functioning [175]. Important elements of the PReCaP are: early identification of patients at risk of functional decline using the Identification Seniors At Risk-Hospitalized Patients questionnaire (ISAR-HP [152]); intensive follow-up and treatment for older patients with complex problems at the prevention and reactivation center (PRC); multidisciplinary geriatric expertise; support for informal caregivers; and geriatric case-management from hospital admission to well after discharge [175,176]. Previous studies evaluated these elements separately [31,37,65,166]. We aimed to evaluate the effects of the PReCaP on patient (i)ADL functioning and HRQoL compared to usual care. We also evaluated its effects on mortality, (re)admissions, falling, healthcare costs, as well as on HRQoL and burden of care of informal caregivers.

METHODS

The Vlietland hospital (PReCaP hospital) is a 450-bed regional hospital, which employs 131 medical specialists and 1782 staff members. The hospital has a geriatric unit with 22 beds (including four beds for patients suffering from delirium), direct access to hospital replacement care, and provisions for follow-up in primary care through the PReCaP [177].

The Sint Franciscus Gasthuis (control hospital), is a 613-bed top clinical teaching hospital (150 medical specialists; 2300 staff members) with onsite hospital replacement care, but without a clinical geriatric unit or provisions for follow-up in primary care [177]. The Ruwaard van Putten Ziekenhuis (RvP, control hospital), Spijkenisse is a 288-bed regional hospital (70 medical specialists; 1000 staff members). The RvP does not have a geriatric unit, hospital replacement care, or provisions for follow-up in primary care [177].

This quasi-experimental study consisted of two parts. We first conducted a pre-implementation study in the PReCaP hospital, which included patients 65 years or older and admitted to the PReCaP hospital between May 2010 and October 2010, and their informal caregivers. This period served as a comparison before implementation of the PReCaP. The pre-implementation study served also to select a suitable instrument to identify older patients at risk of functional decline, and to generate data needed for power calculations [68]. We then conducted a prospective non-randomized controlled trial. Here, we included patients aged 65 years or older and admitted to the departments of Geriatrics, Internal Medicine or Cardiology of the PReCaP hospital post-implementation, or to the departments of Internal Medicine or Cardiology of one of two control hospitals providing usual care, between February 2011 and September 2013. We excluded patients who were unable to answer questions due to severe cognitive problems (MMSE < 12) or language problems, who had a life expectancy of less than three months, who scored 0 on the ISAR-HP, or were admitted for < 48 hours.

Trained research nurses or research assistants administered the ISAR-HP at hospital admission to select patients at risk of functional decline. The ISAR-HP consists of four yes/no questions regarding inability to travel independently, inability to walk, educational level, and housekeeping dependence. Scores range from 0 to 5, with higher scores corresponding to higher risk of functional decline [21,152]. Patients with ISAR-HP score one or higher were considered at risk of functional decline [164] and were eligible for participation in this study. We first performed an analysis within the PReCaP hospital (within hospital analysis), in which we compared at-risk patients treated with usual care before implementation of the PReCaP with at-risk patients treated with the PReCaP post-implementation. We then compared at-risk patients treated with the PReCaP post-implementation with at-risk patients of two control hospitals (between hospitals analysis).

Data collection

Primary outcomes were ADL and IADL functioning. Cognitive functioning, HRQoL, depression, falling, readmission to the hospital, (re)admission to a nursing home or elderly home, and survival of the older patient were secondary outcomes. Other secondary outcomes were burden of care and HRQoL of primary informal caregivers as well as costs of care. After obtaining informed consent, trained research nurses or trained research assistants interviewed

patients in hospital within 48 hours of admission and in the patient's personal environment at three and twelve months after hospital admission using validated questionnaires. Informal caregivers were sent paper questionnaires to fill out and return by postal mail at the same time patients were interviewed.

ADL and iADL were scored using the Katz 6-item Index [96] and the Lawton scale [136] respectively. Questionnaires used to score secondary outcomes included the (short) version of the Mini Mental State Examination (MMSE) [58] for cognitive functioning, the EuroQol (EQ5D [178]) and the Short Form-20 (SF20 [61]) for HRQoL, the Geriatric Depression Scale (GDS-15 [172] for depression. HRQoL and subjective burden of care of informal caregivers were collected with the EQ5D and the Caregiver Strain Index (CSI) [112] respectively (see study protocol [68] for more details). Survival data were collected by telephone, either by trying to reach patients and their families for follow up interviews or by calling general practitioners at 12 month follow up.

Costs per unit of healthcare consumption were retrieved from hospital information systems or from nationally representative unit-costs research [155]. Cost-per-day estimates were applied to evaluate length of stay in hospital or nursing/elderly home. Formal homecare services were measured in costs per hour, general practitioner visits were based on average costs per contact, and costs of aids/modifications were estimated using current retail prices. Informal homecare utilization was collected among primary informal caregivers by mailed paper questionnaires. Costs per hour for informal homecare were estimated using the proxy good method [156].

Sample size

Based on the average number of older patients who are admitted to the different hospitals during our inclusion period of one year, we expected to be able to collect a sample size of around 1100 patients in the intervention hospital (900 patients treated with the new intervention program and 200 patients treated with the new intervention program including a stay at the PRC). Samples of minimal 500 to 600 patients were expected in each of the two control hospitals. According to our baseline study results on activities of daily living (Katz-15 ADL score), a population of n=500 in the control hospitals would lead to around n=300 persons analyzable at three months, whereas a baseline population of n=1100 in the PReCaP hospital would lead to around 733 persons analyzable at three months. Using an effect size of 0.25 this would lead to a power of 95% [21]. Furthermore, to detect a smaller effect size (Cohen's D of 0.2), n=1100 in the intervention hospital and n=500 for the control hospitals would lead to a power of 83%. As expected, we collected a sample size of around 900 post-implementation patients in the PReCaP hospital, and samples of at least 500 patients in each of the two control hospitals [68]. We controlled for case mix differences by only including patients

from the departments of geriatrics, internal medicine, and cardiology for analyses of changes over time within the PReCaP hospital. For between-hospital analysis we included patients from internal medicine and cardiology only, since control hospitals had no geriatrics department. The two control hospitals were pooled into one group to increase statistical power for analyses on the impact of the intervention, after verifying that no major differences existed between these two hospitals.

Statistical methods

We analyzed differences in patient outcomes and informal caregiver outcomes within the PReCaP hospital and between the PReCaP hospital and control hospitals with general linear mixed models (GLMM) of repeated measurements. We used pairwise comparisons with fixed time and hospital effects and a random intercept, which resulted in a mean difference with 95% confidence intervals (CI). We adjusted GLMM analyses for potential confounders sex, age, ISAR-HP, baseline score of the studied outcome variable, and admission diagnosis. Falling and (re)admissions were analyzed using logistic regression adjusted for sex, age, ISAR-HP, baseline score of studied outcome variable, and admission diagnosis. Survival was analyzed using Kaplan Meier plots and multivariable Cox regression. All analyses were performed using SPSS version 21.0 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp). Missing values for costs were assumed to be missing at random, conditional on observed baseline characteristics and outcome variables [157]. Thus, we performed a multiple imputation procedure with predictive mean matching, generating five completed data sets including a rich set of baseline variables (e.g. age, gender, ISAR-HP) and accounting for death and length of survival. The medical ethics committee of Erasmus MC, Rotterdam, the Netherlands approved the study protocol under protocol number MEC2011-041.

RESULTS

Participants

Of the 985 pre-implementation patients who were assessed for eligibility in the PReCaP hospital, 34% were excluded and 19% refused participation, leaving 460 recruited patients (Figure 1a). We controlled for case mix differences by excluding people with an ISAR-HP score of 0 or who were admitted to other departments than geriatrics, internal medicine or cardiology, leaving 143 patients for analysis. Of the 2811 PReCaP post-implementation patients assessed for eligibility, 46% were excluded, 20% refused, and 959 (34%) patients were recruited and analyzed.

After controlling for case mix by selecting patients from cardiology and internal medicine departments, 699 (73%) of the post implementation PReCaP patients were included for between-hospital analysis (Figure 1b). Of the 4972 patients assessed for eligibility in the control hospitals, 43% were excluded and 24% refused, leaving 1676 patients. We included 540 (32%) patients from cardiology and internal medicine departments for the comparative analysis. Patient characteristics between loss to follow-up patients and complete cases were similar for all hospital groups (Appendix 2).

Pre-implementation PReCaP patients were significantly younger, more often men, more often married, and more often lived independently with others than post-implementation PReCaP patients (Table 1). Furthermore, they had slightly higher ADL and iADL scores, were less likely to have multi-morbidity, and had lower ISAR-HP scores than post-implementation PReCaP patients. Patients from the control hospitals were significantly more often women than post-implementation PReCaP patients, but these groups did not differ on other baseline characteristics (Table 1).

Components of PReCaP received

All PReCaP post-implementation patients were screened with the ISAR-HP and about 90% received case-management. However, only around 50% of the patients were discussed in a multidisciplinary meeting (MDM) [177]. Most PReCaP patients were discharged to their home independently, with homecare or with outpatient rehabilitation (83%, see Appendix 3).

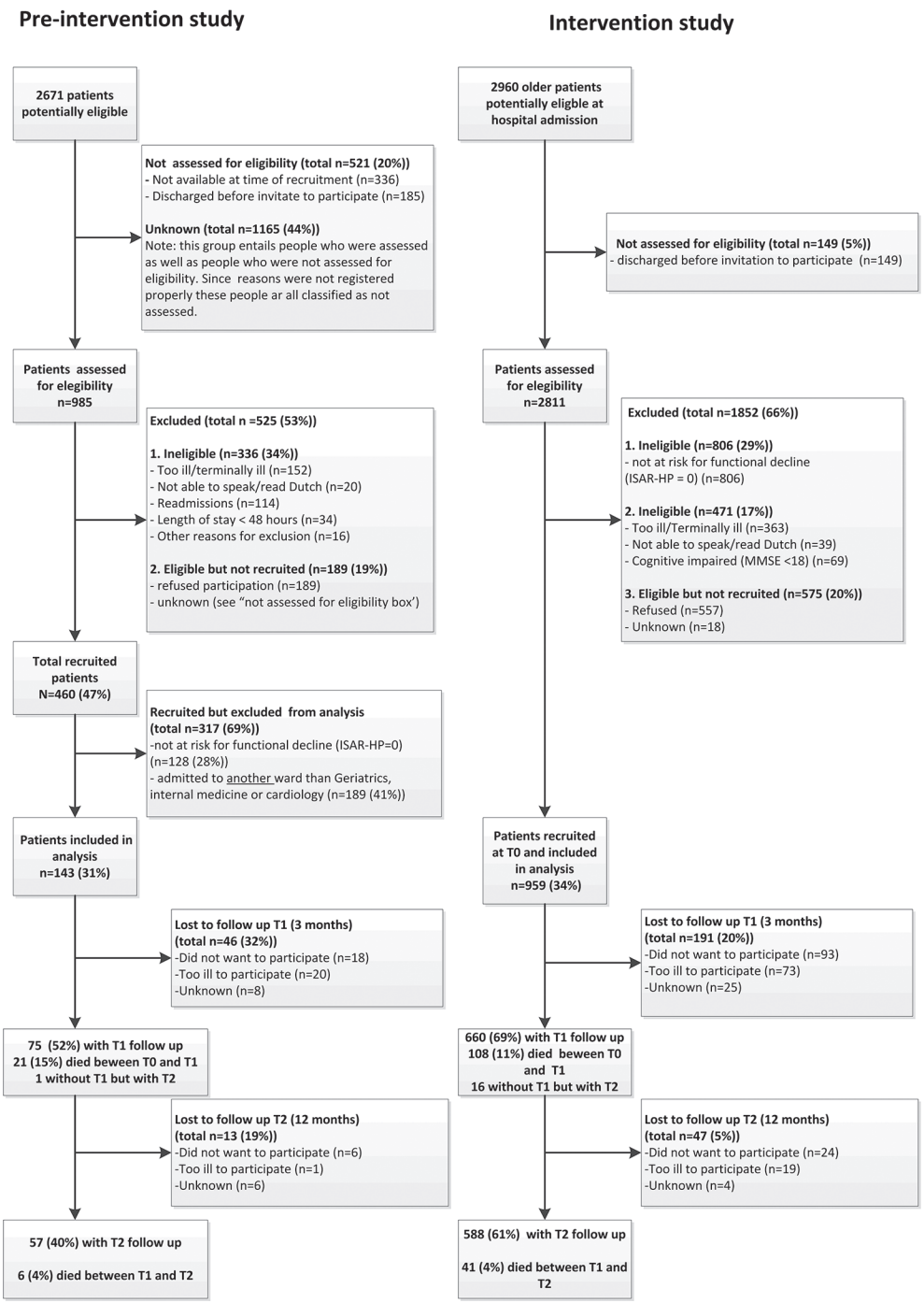


Figure 1a | Flow chart within hospital comparison

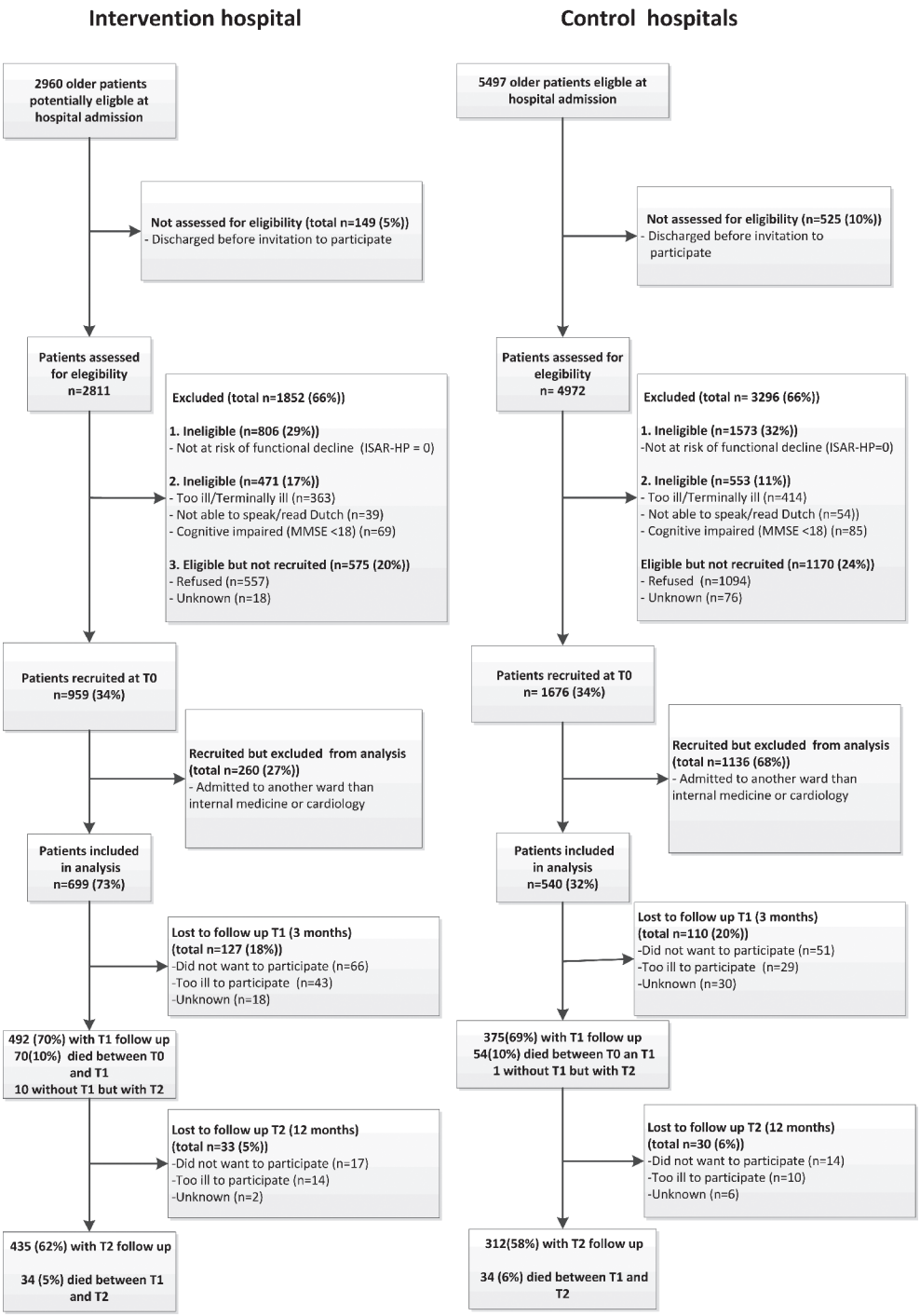


Figure 1b | Flow chart between hospitals comparison

Table 1 | Baseline characteristics of patients

	Within-hospital comparison[1]			Between-hospital comparison[2]		
	Pre-intervention N=143	Intervention N=959	p[11]	Control hospitals N=540	Intervention hospital N=699	p[11]
Age, mean (sd)	78.2 (7.5)	80.0 (7.4)	.008	78.6 (7.4)	78.7 (7.3)	.164
Sex, men, n (%)	69 (48)	369 (39)	.026	197 (37)	299 (43)	.025
Married/living together, n (%)	74 (52)	393 (41)	.005	225 (42)	323 (46)	.055
Living independently alone, n (%)	60 (42)	475 (50)	.045	267 (49)	327 (47)	.360
Living independently with others, n (%)	75 (52)	392 (41)		232 (43)	328 (47)	
Length of admission (days), median ($25^{th}75^{th}$)	6[4,9]	7[4,11]		5[3,9]	6[4,10]	
Two or more illnesses, n (%)	101 (71)	438 (87)	.000	301 (84)	359 (87)	.165
ISAR-HP[3] *Score*			.006			.291
Score=1, n (%)	40 (28)	189 (20)		132 (24)	171 (25)	
Score=2, n (%)	25 (18)	145 (15)		93 (17)	124 (18)	
Score=3, n (%)	23 (16)	157 (16)		119 (22)	118 (17)	
Score=4, n (%)	36 (25)	282 (29)		131 (24)	173 (25)	
Score=5, n (%)	19 (13)	186 (19)		65 (12)	113 (16)	
Katz-6[4] **pre-admission**, mean (sd)	NA	5.1 (1.3)	n/a	5.3 (1.1)	5.3 (1.1)	.754
Katz-6 during admission, mean (sd)	4.8 (1.5)	4.4 (1.7)	.016	4.7 (1.6)	4.7 (1.5)	.416
Lawton[5] **pre-admission**, mean (sd)	NA	5.3 (1.9)	n/a	5.7 (1.8)	5.6 (1.8)	.162
Lawton during admission, mean (sd)	5.2 (2.0)	4.7 (1.9)	.012	5.0 (1.9)	4.9 (1.9)	.636
HRQo[6]						
EQ5D[7], mean (sd)	0.63 (0.31)	0.61 (0.30)	.286	0.62 (0.3)	0.64 (0.3)	.268
SF-20[8]-physical functioning, mean (sd)	42 (30)	45 (31)	.278	46 (29)	47 (30)	.533
SF-20-role functioning, mean (sd)	39(45)	31(42)	.053	33(41)	35(43)	.814
SF-20-social functioning, mean (sd)	65(41)	63(34)	.174	60(35)	64(35)	.084
SF-20-mental health, mean (sd)	72(21)	71(20)	.298	70(20)	73(19)	.018

Table 1 | Baseline characteristics of patients *(Continued)*

	Within-hospital comparison[1]			Between-hospital comparison[2]		
	Pre-intervention N=143	Intervention N=959	p[11]	Control hospitals N=540	Intervention hospital N=699	p[11]
SF-20-current health perceptions, mean (sd)	40(26)	36(23)	.132	35(24)	34(23)	.998
SF-20-physical pain, mean (sd)	48(45)	60(41)	.010	64(39)	62(41)	.758
MMSE(short)[9], mean (sd)	20.1(2.4)	19.4(2.4)	.005	19.9(2.3)	19,7(2.4)	.150
GDS-15[10], mean (sd)	NA	3.8(2.8)	n/a	3.6(2.8)	3.6(2.7)	.694
Falling during 6 months before T0						
In home environment, n (%)	30(21)	342(36)	.001	174(33)	211(30)	.450
Outside home environment, n (%)	27(19)	190(20)	.003	107(20)	137(20)	.927
Hospital admission, year before T0, n (%)	61(43)	295(31)	.000	186(35)	234(34)	.637
Admission diagnoses (most frequent), n (%)						
Cardiovascular, n (%)	63(44)	213(22)		122(23)	196(28)	
Infection, inflammation, n (%)	2(1)	48(5)		40(7)	35(5)	
Pulmonary, n (%)	12(8)	48(5)		11(2)	28(4)	
Gastrointestinal, n (%)	8(6)	49(5)		42(8)	30(4)	
Neoplasms/blood/blood forming organs, n (%)	12(8)	48(5)		40(7)	33(5)	
Surgery, n (%)	6(4)	21(2)		35(6)	18(3)	
Other, n (%)	9(6)	377(39)		204(38)	244(35)	
Unknown, n (%)	31(22)	155(16)		46(9)	115(16)	

[*]Within hospital comparison compares patients from the baseline study (pre-implementation of the PReCaP) with patients treated with the PReCaP (post implementation) [2] between hospital comparison concerns the comparison between PReCaP patients and control patients; data from control hospitals are pooled and analysis is performed on patients from cardiology and internal medicine departments to control for initial case-mix differences; [3] ISAR-HP=Identification Seniors At Risk-Hospitalized Patients, score 0-5, with higher score reflecting higher risk of functional decline; [4]ADL=activities of daily living measured by the Katz-6, score 0 to 6 with higher scores reflecting higher independence; [5]IADL= instrumental activities of daily living measured by the Lawton-Brody IADL index, score 0 to 8, with higher scores reflecting higher independence; [6]HRQoL=health-related quality of life; [7]EuroQOL, score 0-1, with higher score reflecting higher HRQoL; [8]SF-20=short-form 20, score 0-100 with higher scores reflecting better HRQoL, except for physical pain, which is reversed; [9] MMSE=Mini Mental State Examination (short version), score 0-23, with higher score reflecting better cognitive functioning; [10] GDS-15=Geriatric Depression Scale-15, score 0 to 15, with higher scores reflecting more symptoms of depression; [11] p-value differences measured with chi square for categorical variables and non-parametric Kruskall Wallis for continuous variables

Functioning, HRQoL and survival

No substantial differences in ADL, iADL, cognitive functioning, HRQoL, depression, and risk of falling from hospital admission to one year after were found between pre-implementation and post-implementation PReCaP patients (Table 2 and 3). Even though differences were not significant, they generally were in favor of the post-implementation PReCaP group. On the other hand, these patients were at higher risk of readmission to the hospital within three months of initial admission (Table 3; OR 3.7; 95%CI [1.8-7.6]) than pre-implementation patients. Survival did not differ between groups (HR 1.18 [0.79-1.77]).

Physical functioning, falling, and HRQoL subscales other than perceived health did not differ between post-implementation PReCaP patients and control patients (Table 2 and 3). Post-implementation PReCaP patients had somewhat higher cognitive functioning (MMSE 0.4 [0.2-0.6]), less symptoms of depression (GDS15 -0.9 [-1.1 to -0.6]), and perceived their health after hospitalization as better (5.6 points at SF-20 current health perceptions (95%CI: [2.8-8.4]), than control patients in the year after hospital admission (Table 2, Appendix 4). As expected, patients from the PReCaP hospital post-implementation were much more likely to be admitted to a nursing home within three months of initial hospital admission (OR 9.5 [2.7-34]) than control patients, since stay at the Center for Prevention and Recovery was part of the PReCaP (Table 3). Mortality did not differ between groups (HR 1.20 [0.89-1.62]).

Impact on informal caregivers

Approximately 26% of pre-implementation PReCaP patients and 36% of post-implementation PReCaP patients received informal care. In both groups, around 70% of informal caregivers were women and average age was 65 and 63 years for pre-implementation and post-implementation patients respectively. Around 63% and 46% of informal caregivers were patients' partners in the pre- implementation and post-implementation group respectively. GLMM adjusted for age, sex, baseline scores, and ISAR-HP showed no differences in HRQoL (EQ5D -0.09 [-0.16 to -0.02]), and burden of care (CSI -0.02 [-0.08 to 0.05]) between caregivers of pre-implementation and post-implementation PReCaP patients.

Between-hospital comparisons showed that around 25% to 32% of patients received informal care before hospital admission in the PReCaP hospital post- implementation and control hospitals respectively. More than 65% of informal caregivers were women, 50% were partners, and average age of informal caregivers was 63 years among both groups. HRQoL and burden of care did not differ between informal caregivers from both groups (EQ5D 0.0 [-0.0 to 0.0] and CSI -0.3 [-0.8 to 0.3]).

Table 2 | Comparison of patient outcomes within hospital and between hospitals using generalized linear mixed modeling*

WITHIN HOSPITAL	Unadjusted overall effects				Adjusted overall effects[1]			
	Mean(SE) pre-intervention	Mean(SE) intervention	Mean diff (95% CI)[1]	p value	Mean(SE) pre- intervention	Mean(SE) intervention	Mean diff (95% CI)[2]	p value
EQ5D	0.74(0.03)	0.65(0.01)	-0.08(-0.14 to -0.02)	.008	0.71(0.03)	0.65(0.02)	-0.06(-0.12 to 0.001)	.053
SF-20								
Physical functioning	47 (3.1)	45 (1.1)	-2.74 (-9.22 to 3.73)	.405	47 (2.7)	45 (1.6)	-1.72 (-6.90 to 3.46)	.514
Role functioning	38 (3.9)	33 (1.4)	-4.67 (-12.8 to 3.46)	.260	32 (3.7)	33 (2.0)	1.61 (-5.53 to 8.74)	.659
Social functioning	67 (3.4)	69 (1.2)	2.61 (-4.40 to 9.62)	.465	65 (3.5)	70 (1.9)	5.23 (-1.53 to 11.99)	.129
Mental health	75 (1.8)	75 (0.6)	0.25 (-3.48 to 3.98)	.896	74 (1.7)	74 (1.0)	-0.06 (-3.28 to 3.16)	.971
Current health perceptions	50 (2.7)	51 (1.0)	1.65 (-3.99 to 7.30)	.565	47 (2.7)	51 (1.5)	3.39 (-1.85 to 8.64)	.204
Physical pain	45 (4.0)	49 (1.4)	3.34 (-5.03 to 11.70)	.434	51 (4.4)	47 (2.4)	-3.22 (-11.68 to 5.23)	.454
Katz ADL	5.35 (0.13)	5.13 (0.05)	-0.21 (-0.48 to 0.06)	.125	5.29 (0.12)	5.30 (0.07)	0.02 (-0.22 to 0.25)	.895
Lawton IADL	5.62 (0.22)	5.06 (0.08)	-0.56 (-1.02 to -0.10)	.018	5.39 (0.21)	5.19 (0.13)	-0.20 (-0.59 to 0.19)	.304
MMSE short	20.8 (0.24)	20.8 (0.08)	0.01 (-0.48 to 0.50)	.976	20.6 (0.26)	20.9 (0.15)	0.24 (-0.25 to 0.73)	.338
GDS-15[2]	3.00 (0.27)	2.47 (0.10)	-0.52 (-1.08 to 0.04)	.069	3.10 (0.31)	2.57 (0.17)	-0.53 (-1.12 to 0.07)	.082

* Effects measured over time from hospital admission to 12 months after admission; [1] analyses controlled for initial differences in case-mix as well as age, sex, admission diagnosis (ICD10), baseline score, and ISAR-HP score ; [2] no baseline data available for GDS15 in pilot thus not adjusted for baseline GDS-15 score; * significant differences at α=0.001 level

Table 2 | Comparison of patient outcomes within hospital and between hospitals using generalized linear mixed modeling* *(Continued)*

BETWEEN HOSPITALS	Unadjusted overall effects				Adjusted overall effects[1]			
	Mean(SE) controls	Mean(SE) intervention	Mean diff (95% CI)[1]	p value	Mean(SE) controls	Mean(SE) intervention	Mean diff (95% CI)[2]	p value
EQ5D	0.67 (0.01)	0.68 (0.01)	0.01 (-0.03 to 0.04)	.666	0.69 (0.02)	0.69 (0.02)	-.001 (-0.03 to 0.03)	.935
SF-20								
Physical functioning	46 (1.5)	48 (1.3)	1.20 (-2.67 to 4.98)	.552	47 (1.9)	48 (1.9)	0.99 (-2.05 to 4.03)	.524
Role functioning	34 (1.8)	37 (1.6)	2.82 (-1.83 to 7.46)	.234	37 (2.5)	40 (2.4)	3.05 (-0.90 to 6.99)	.130
Social functioning	68 (1.5)	71 (1.4)	3.84 (-0.20 to 7.87)	.063	70 (2.3)	73 (2.3)	2.37 (-1.36 to 6.11)	.213
Mental health	75 (0.9)	76 (0.8)	0.91 (-1.40 to 3.22)	.441	78 (1.2)	77 (1.2)	-0.75 (-2.63 to 1.13)	.435
Current health perceptions	47 (1.2)	52 (1.1)	5.00 (1.80 to 8.20)	.002	45 (1.8)	51 (1.7)	5.58 (2.82 to 8.35)	.000*
Physical pain	53 (1.8)	49 (1.6)	-4.46 (-9.17 to 0.25)	.064	53 (2.9)	49 (2.8)	-3.25 (-7.72 to 1.22)	.154
Katz ADL	5.22 (0.06)	5.28 (0.05)	0.06 (-0.08 to 0.21)	.399	5.26 (0.06)	5.30 (0.06)	0.04 (-0.06 to 0.13)	.479
Lawton IADL	5.49 (0.09)	5.39 (0.08)	-0.10 (-0.34 to 0.15)	.434	5.43 (0.12)	5.40 (0.12)	-0.03 (-0.22 to 0.15)	.733
MMSE short	20.6 (0.10)	20.9 (0.09)	0.35 (0.08 to 0.62)	.010	20.5 (0.15)	21.0 (0.14)	0.41 (0.18 to 0.64)	.000*
GDS-15	3.07 (0.13)	2.36 (0.11)	-0.71 (-1.04 to -0.38)	.000*	3.09 (0.17)	2.22 (0.17)	-0.88 (-1.15 to -0.61)	.000*

* Effects measured over time from hospital admission to 12 months after admission; [1] analyses controlled for initial differences in case-mix as well as age, sex, admission diagnosis (ICD10), baseline score, and ISAR-HP score ; [2] no baseline data available for GDS15 in pilot thus not adjusted for baseline GDS-15 score; * significant differences at α=0.001 level

Table 3 | Falling and (re)admissions within hospital and between hospitals using logistic regression

WITHIN HOSPITAL	Three month follow-up (T1)		Twelve month follow-up (T2)	
	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Falling	1.9 (0.9-3.7)	1.6 (0.8-3.3)	1.9 (0.9-3.7)	1.5 (0.7-3.1)
Hospital readmission	3.6 (1.9-6.7)	3.7 (1.8-7.6)*	1.1 (0.6-2.2)	1.1 (0.5-2.6)
Nursing home admission	n/a	n/a	1.7 (0.2-13.1)	1.2 (0.1-12.5)
Older home admission	1.5 (0.4-6.6)	1.0 (0.2-4.9)	0.1 (0.03-0.7)	0.03 (0.0-0.5)

BETWEEN HOSPITALS	Three month follow-up (T1)		Twelve month follow-up (T2)	
	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)	Unadjusted OR (95%CI)	Adjusted* OR (95%CI)
Falling	1.0 (0.7-1.4)	1.0 (0.7-1.4)	0.9 (0.6-1.3)	0.9 (0.6-1.3)
Hospital readmission	0.8 (0.6-1.2)	0.9 (0.6-1.3)	1.3 (0.9-1.8)	1.3 (0.9-1.8)
Nursing home admission	7.4 (2.2-24.7)	9.5 (2.7-33.5)*	2.0 (0.4-11.3)	4.2 (0.4-44.1)
Older home admission	0.8 (0.4-1.7)	0.6 (0.3-1.3)	0.2 (0.04-0.91)	0.2 (0.0-1.0)

* Significant difference; adjusted for age, sex, ICD-10 admission diagnosis, ISAR-HP score, and admissions/falling incidence before initial hospital admission

Costs

Average care costs were 14,286 euro per person per year in the pre-implementation PReCaP group and 21,251 euro per person per year in the post-implementation PReCaP group (Figure 2). All subdomains of costs were higher for post-implementation PReCaP patients except for informal healthcare costs between discharge and 3-month follow-up (1,119 euro for post- implementation group versus 1,374 euro for the pre-implementation group; Figure 2, Appendix 5). Formal healthcare costs between hospital discharge and 3-month follow-up were more than twofold and costs between 3 and 12-month follow-up around 1.5 times higher for post- implementation PReCaP patients than for pre-implementation patients (Figure 2; Appendix 5a to 5c).

Between-hospital analysis showed average costs from hospital admission to one year after admission were 16,476 euro for control patients compared to 18,292 euro for PReCaP patients. Costs of hospital stay as well as formal healthcare costs were higher for PReCaP patients than for control patients. Formal healthcare costs were especially higher between three and twelve months follow up (4,751 euro for controls and 5,676 euro for PReCaP patients). Informal healthcare costs were somewhat lower for the PReCaP patients than for controls (Figure 2; Appendices 5a to 5c).

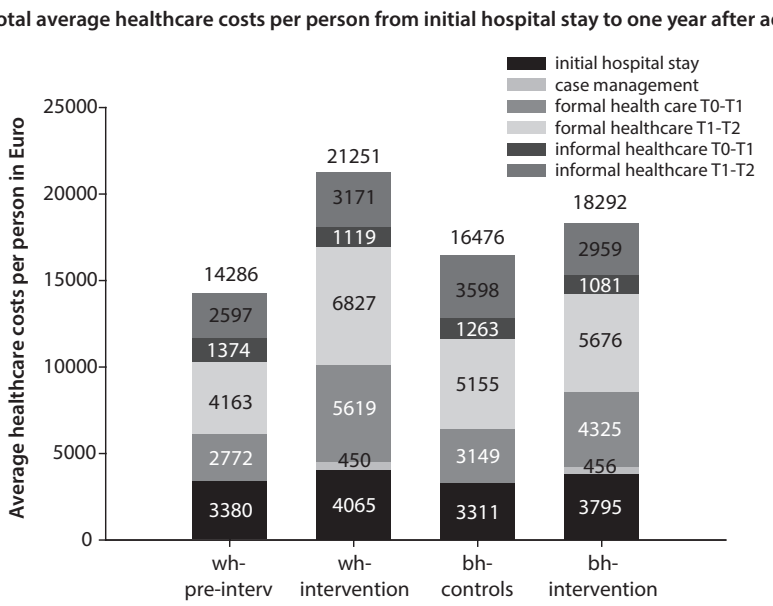


Figure 2 | Healthcare costs within hospital and between hospitals from admission to one year after admission

Costs are shown after imputation of missing values; see appendix 2a-2d for comparison to costs in complete cases

DISCUSSION

The PReCaP had no effect on decline in ADL and iADL, in both the within-hospital analysis over time and the between-hospital analysis. Older patients from internal medicine or cardiology departments who were treated with the PReCaP had slightly higher cognitive functioning, less symptoms of depression, and higher perceived health the year after admission than older patients treated with usual care in the control hospitals. Clinical relevance was limited though [179]. No relevant differences were found in HRQoL and burden of care of informal caregivers, both within hospital analysis over time as well as between hospital analysis. Costs of care from hospital admission to one year after were higher for patients treated with the PReCaP. The higher costs of the PReCaP and its small effects on ADL and iADL suggest that the PReCaP, in its current supplementary form, is unlikely to be cost-effective.

This study has several limitations. In our attempts to control for selection bias [180], we included only 143 pre-implementation patients and 959 post-implementation patients within the PReCaP hospital comparison over time. We included 699 post-implementation PReCaP patients and 540 control patients for between-hospital-comparison for the same reason. Even though low inclusion rates are expected when conducting studies among older populations [135], our results may not be generalizable to a general hospital population. Loss to follow-up was substantial, which might be expected among a frail hospitalized older population, but baseline characteristics were similar for patients with or without complete follow-up.

Compliance of patients to treatment and recommendations suggested by the nurse or physicians may have affected our results, but we have no precise data available. Nevertheless, since patients have received the majority of the intervention during their hospital stay we expect compliance rates to be relatively high.

Since a group of older patients in the study were independent in both ADL and iADL before hospital admission, a ceiling effect may have occurred. Nevertheless, when we removed the patients who were independent in both ADL and iADL before hospital admission from our analysis, results were similar.

When collecting data on hospital readmissions, we did not distinguish between planned and unplanned readmissions. Since planned readmissions may not be preventable by hospital interventions we would recommend distinguishing between planned and unplanned readmissions in future evaluations with hospital readmissions as an outcome.

The real life context in which the PReCaP was implemented and evaluated may be considered a strength. Nevertheless, it was a weakness as well, since many elements of the PReCaP proved difficult to implement [176]. Problems in implementation might be due to the inherent nature of a supplementary complex intervention such as the PReCaP. The PReCaP focuses on functioning, continued assessments throughout hospital stay, avoiding complications, promoting independent functioning, and providing support throughout hospital stay and after discharge, which all may have contributed to prevention of hospital-related disability [166]. We aimed to evaluate the PReCaP as a whole instead of its separate elements [86,88]. We recognize that geriatric patients often have multiple problems in different domains (e.g. cognitive, physical, social). These problems are difficult to isolate and may change back and forth over time [166,174]. Therefore, implementation and evaluation of geriatric care programs such as the PReCaP are complicated. In addition, patient characteristics, social support, resources and environment will also influence the patient's ability to live independently at home after discharge [181]. It is therefore unclear whether differences in cognitive functioning, depression and perceived health between the intervention and control hospitals can be attributed solely to implementation of the PReCaP.

Secondly, practical problems interfered with implementation of the PReCaP, such as a lack of capacity within the PReCaP hospital (e.g. not enough trained personnel available). In addition, the intervention hospital dealt with many changes (e.g. financial problems; management changes) that hampered the implementation of the intervention [176]. Moreover, improvements in geriatric care offered in the control hospitals limited the contrast between the PReCaP hospital and control hospitals [177].

Thirdly, the setting in which the PReCaP was implemented might have influenced results. Earlier literature suggests that providing consultative multidisciplinary care supplementary to usual care at different hospital departments might be less effective than providing multidisciplinary care from day one by a dedicated integrated team from within an inpatient geriatric unit [166]. The PReCaP contained multidisciplinary geriatric care, including regular multidisciplinary meetings, and use of goal attainment scaling to plan individualized care. Since this care was offered supplementary to usual care, implementation of the PReCaP elements often started days after the patient was admitted, which may have reduced effects on patient outcomes [177]. Another, similar suggestion concerns home rehabilitation as an effective setting for improving mobility and functioning [182], since patients will be better able to benefit from rehabilitation if they are able to live in their own home environment. In this study, the case manager might facilitate rehabilitation in the home setting by contacting external organizations to offer home rehabilitation for patients who might benefit. Nevertheless, this would be additional treatment after the PReCaP has ended and as such is not a part of the PReCaP, which for the most part takes place during hospital stay.

CONCLUSION

The PReCaP did not prove effective in preventing functional decline. It may possibly provide some benefits to hospitalized patients at risk of functional decline with respect to cognitive functioning, depression, and perceived health. We recommend optimization and further evaluation of integrated intervention programs on a small scale before implementing such programs on a large scale.

Appendix 1 | PReCaP elements and the extent to which they were executed

	Adherence	PReCaP Core Staff
Day 1		
1. Identification of patient at risk within 48 hours after admission	Always (often on time) (sometimes later)	Research Nurse
2. Assessment of risk factors for functional decline	Always(often on time) (sometimes later)	Research Nurse
3. Consultation with patient and relatives to discuss vulnerability and risk factors	Often	Case manager / Geriatric Nurse
Day 2		
4. Patient discussed in biweekly Multidisciplinary Team Meeting (MTM)	Always	Geriatrician/Geriatric nurse/ Nurse practitioner/ Social worker/ Transfer nurse/Case manager
5. Design GAS care plan including advice for additional treatment aimed at functional preservation	Always	Geriatrician/Geriatric nurse/ Nurse practitioner/ Social worker/ Transfer nurse/Case manager
Day 3-5		
6. Consultation following MTM	Often	Case manager/ Geriatric nurse/ Transfer nurse/ Geriatrician
7. Consultation with patient and relatives to discuss vulnerability and risk factors	Seldom	Case manager/ Geriatric nurse
8. Interdisciplinary consultation following MTM	Often	Psychiatrist/Psychologist/ Occupational therapist/ Dietician/ Physical therapist
Day 6-7		
9. Support and provide treatment to informal caregiver (conditional)	Never	Social worker/ Psychologist
10. Medication use review	Never	Pharmacist
11. Treatment by PReCaP Recovery Team (conditional)	Sometimes Seldom	Case manager Art therapist
Day 8-9		
12. MTM - Review prognosis and discharge destination (in some cases register patient at hospital replacement care facility)	Sometimes	Geriatrician/Geriatric nurse/ Nurse practitioner /Social worker/ Transfer nurse/Case manager
13. Weekly telephone consultation informal caregiver	Always	Case manager
14. Consultation with patient and relatives to discuss vulnerability and risk factors	Seldom	Case manager/ Geriatric nurse
15. Hand out flyer 'PReCaP Recovery Team' to patient	Always	Case manager
16. Execution PReCaP care plan	Sometimes	Physiotherapist/dietician/ occupational therapist
Before day 12		
17. Exit interview with patient and informal caregiver	Sometimes	Case manager/ Transfer nurse
18. Flyer 'PReCaP to informal care giver's home address (if transfer to PRC) (conditional)	Always	Case manager
19. Handover GAS care plan to physician hospital replacement care facility	Sometimes	Case manager/Geriatrician

Never=0%; Seldom=1-33%; Sometimes=34-66%; Often=67-99%; Always=100%; Table based on article by de Vos et al. (2013) [176]

Appendix 2 | Characteristics patients LFU (excl. deaths) and with complete follow up for baseline, PReCaP, and control groups

	Within hospital comparison[1]				Between hospital comparison[2]			
	Baseline N=143 (pre-intervention)		PReCaP N=959 (post-intervention)		Controls N=550		PReCaP N=699	
	LFU n=60	Complete FU n=56	LFU n=238	Complete FU N= 572	LFU n=140	Complete FU n=312	LFU n=160	Complete FU n=435
Age, mean (sd)	79.0 (7.9)	76.5 (7.0)	80.0 (7.7)	79.5 (7.3)	79 (7.8)	78 (7.0)	78 (7.4)	79 (7.3)
Sex, *men*, n (%)	29 (48)	28 (50)	82 (35)	210 (37)	38 (27)	118 (38)	62 (39)	174 (40)
Married/living together, n (%)	31 (52)	29 (52)	92 (39)	242 (43)	58 (42)	128 (41)	69 (43)	204 (47)
Living independently alone, n (%)	25 (42)	24 (43)	110 (46)	296 (52)	57 (41)	164 (53)	71 (44)	211 (49)
Living independently with others, n (%)	33 (55)	28 (50)	99 (42)	237 (42)	63 (45)	130 (42)	77 (48)	203 (47)
Length of admission (days), mean(sd)	8.2 (6.2)	6.4 (4.5)	8.9 (7.2)	8.7 (7.8)*	8.5 (9.4)	6.7 (6.3)	8.3 (6.9)	8.3 (8.3)
Two or more illnesses, n(%)	44 (73)	38 (68)	105 (86)	249 (87)	69 (82)	184 (87)	78 (84)	215 (87)
ISAR-HP[3] Score								
Score=1, n (%)	17 (28)	20 (36)	42 (18)	122 (21)	35 (25)	76 (24)	37 (23)	111 (26)
Score=2, n (%)	8 (13)	13 (23)	31 (13)	97 (17)	20 (14)	58 (19)	26 (16)	85 (20)
Score=3, n (%)	8 (13)	9 (16)	38 (16)	98 (17)	25 (18)	73 (23)	26 (16)	75 (17)
Score=4, n (%)	19 (32)	9 (16)	71 (30)	160 (28)	39 (28)	71 (23)	40 (25)	104 (24)
Score=5, n (%)	8 (13)	5 (9)	56 (24)	95 (17)	21 (15)	34 (11)	31 (19)	60 (14)
Katz-6[4] pre-admission, mean (sd)	-	-	-	-	5.3 (1.1)	5.3 (1.1)	5.2 (1.2)	5.4 (1.0)
Katz-6 during admission, mean (sd)	4.9 (1.5)	5.1 (1.2)	4.3 (1.7)	4.7 (1.6)	4.6 (1.7)	4.8 (1.5)	4.7 (1.6)	4.9 (1.4)
Lawton[5] pre-admission, mean (sd)	-	-	-	-	5.6 (1.8)	5.9 (1.7)	5.3 (1.9)	5.9 (1.7)
Lawton during admission, mean (sd)	5.4 (1.7)	5.3 (2.2)	4.4 (2.0)	5.1 (1.8)	4.9 (1.8)	5.1 (1.9)	4.6 (1.9)	5.2 (1.8)

* one outlier (129 days) was excluded from LFU analysis; [1]within hospital comparison compares patients from the baseline study (pre-implementation of the PReCaP) with patients treated with the PReCaP (post implementation) [2] between hospital comparison concerns the comparison between PReCaP patients and control patients; data from control hospitals are pooled and analysis is performed on patients from cardiology and internal medicine departments to control for initial case mix differences; [3]ISAR-HP=Identification Seniors At Risk-Hospitalized Patients, score 0-5, higher score=higher risk of functional decline; [4]ADL=activities of daily living measured by the Katz-6, score 0 to 6, higher scores=higher independence; [5]IADL=instrumental activities of daily living measured by the Lawton-Brody IADL index, score 0 to 8,=higher scores ==higher independence; [6]HRQoL=health-related quality of life; [7]EuroQOL, score 0-1, higher score=higher HRQoL; [8]SF-20=short-form 20, score 0-100, higher scores=better HRQoL, physical pain reversed; [9] MMSE=Mini Mental State Examination (short version), score 0-23, higher score=better cognitive functioning; [10] GDS-15=Geriatric Depression Scale-15, score 0 to 15=more symptoms of depression

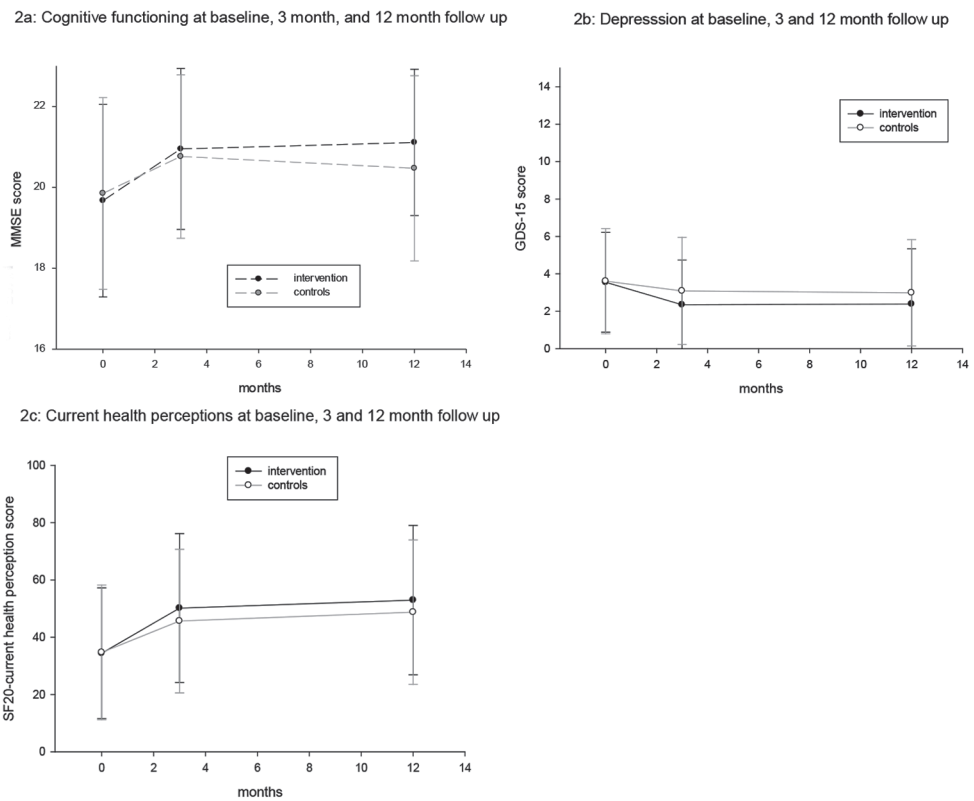
Appendix 2 | Characteristics patients LFU (excl. deaths) and with complete follow up for baseline, PReCaP, and control groups *(Continued)*

	Within hospital comparison[1]				Between hospital comparison[2]			
	Baseline N=143 (pre-intervention)		PReCaP N=959 (post-intervention)		Controls N=550		PReCaP N=699	
	LFU n=60	Complete FU n=56	LFU n=238	Complete FU N= 572	LFU n=140	Complete FU n=312	LFU n=160	Complete FU n=435
HRQoL[6]								
EQ5D[7], mean (sd)	0.62 (0.3)	0.65 (0.3)	0.60 (0.3)	0.63 (0.3)	0.59 (0.3)	0.63 (0.3)	0.63 (0.3)	0.66 (0.3)
SF-20[8]-physical functioning, mean (sd)	43 (31)	44 (29)	43 (31)	49 (30)	44 (29)	48 (29)	45 (30	50 (30)
SF-20-role functioning, mean (sd)	39 (44)	44 (29)	27 (39)	37 (44)	28 (39)	36 (42)	32 (41)	39 (44)
SF-20-social functioning, mean (sd)	69 (40)	66 (40)	63 (35)	65 (33)	59 (32)	62 (35)	65 (37)	66 (34)
SF-20-mental health, mean (sd)	72 (25)	73 (18)	69 (20)	72 (20)	68 (21)	71 (20)	72 (19)	73 (20)
SF-20-current health perceptions, mean (sd)	41 (26)	40 (28)	38 (24)	37 (23)	32 (22)	37 (24)	37 (24)	36 (23)
SF-20-physical pain, mean (sd)	44 (45)	52 (45)	59 (42)	62 (40)	64 (38)	63 (39)	64 (40)	63 (40)
MMSE(short)[9], mean (sd)	20 (2.6)	20 (2.5)	19 (2.7)	20 (2.2)	19 (2.8)	20 (2.2)	19 (2.7)	20 (2.2)
GDS-15[10], mean (sd)	-	-	-	-	4.0 (2.9)	3.3 (2.7)	3.3 (2.4)	3.4 (2.7)
Falling during 6 months before T0								
In home environment, n (%)	11 (18)	9 (16)	88 (38)	195 (34)	52 (38)	93 (30)	49 (31)	129 (30)
Outside home environment, n (%)	13 (22)	9 (16)	51 (22)	109 (19)	24 (18)	69 (22)	33 (21)	84 (20)
Hospital admission year before T0, n (%)	3 (5)	1 (2)	61 (26)	176 (31)	48 (36)	105 (34)	47 (30)	143 (33)

* one outlier (129 days) was excluded from LFU analysis; [1]within hospital comparison compares patients from the baseline study (pre-implementation of the PReCaP) with patients treated with the PReCaP (post implementation) [2] between hospital comparison concerns the comparison between PReCaP patients and control patients; data from control hospitals are pooled and analysis is performed on patients from cardiology and internal medicine departments to control for initial case mix differences; [3]ISAR-HP=Identification Seniors At Risk-Hospitalized Patients, score 0-5, higher score=higher risk of functional decline; [4]ADL=activities of daily living measured by the Katz-6, score 0 to 6, higher scores=higher independence; [5]IADL=instrumental activities of daily living measured by the Lawton-Brody IADL index, score 0 to 8,=higher scores ==higher independence; [6]HRQoL=health-related quality of life; [7]EuroQOL, score 0-1, higher score=higher HRQoL; [8]SF-20=short-form 20, score 0-100, higher scores=better HRQoL, physical pain reversed; [9] MMSE=Mini Mental State Examination (short version), score 0-23, higher score=better cognitive functioning; [10] GDS-15=Geriatric Depression Scale-15, score 0 to 15=more symptoms of depression

Appendix 3 | Patient destination after hospital discharge for PReCaP patients

Destination	(N=699) n(%)
Home	449(68)
Home with homecare	47(7)
Home with outpatient rehabilitation	50(8)
Home with daycare nursing home	4(0.6)
Older home	13(2)
Nursing home (short term)	22(3)
Nursing home (long term)	10(1)
Other hospital	5(1)
Other rehabilitation center	11(2)
Other/Unknown	88(13)



Appendix 4 | Crude means and standard deviations of cognitive functioning, depression and current health perceptions over time, for intervention and control hospitals separately

Appendix 5a | Average formal healthcare costs of initial hospital stay and PReCaP case management for within and between hospital comparisons, before and after multiple imputation

Costs	WITHIN HOSPITAL				BETWEEN HOSPITAL			
	Pre-intervention		Intervention		Controls		Intervention	
	O[1] n=143 mean (SE)	MI[2] n=143 mean (SE)	O[1] n=959 mean (SE)	MI[2] n =959 mean (SE)	O[1] n=540 mean (SE)	MI[2] N=540 mean (SE)	O[1] n=699 mean (SE)	MI[2] n=699 mean (SE)
Nursing days initial hospital stay, mean(SE)	3378 (207)	3380 (204)	4164 (168)	4065 (144)	3291 (147)	3311 (132)	3849 (149)	3795 (127)
missing (%)	1	-	15	-	11	-	15	-
Case management, mean(SE)	n/a	n/a	450 (5)	450 (5)	n/a	n/a	456 (5)	456 (5)
Missing(%)	n/a	-	0	0	n/a	-	0	-

[1] original data including percentage missings; [2] data after multiple imputation

Appendix 5b | Average formal healthcare costs from discharge initial hospital stay up to one year for within hospital and between-hospital-comparison, before and after multiple imputation

	WITHIN HOSPITAL				BETWEEN HOSPITAL			
	Pre-intervention		Intervention		Controls		Intervention	
Costs	**O[1] n=143**	**MI[2] n=143**	**O[1] n=959**	**MI[2] n=959**	**O[1] n=540**	**MI[2] n=540**	**O[1] n=699**	**MI[2] n=699**
T0-T1:								
Readm hospitals, mean (SE)	942 (354)	878 (181)	693 (105)	799 (143)	953 (169)	1124 (182)	677 (102)	765 (142)
Missing, (valid%)	49	-	34	-	32	-	30	-
Readm nursing home, mean (SE)	0 (0)	0	1420 (248)	1309 (226)	141 (104)	201 (128)	1040 (244)	1004 (227)
missing, (valid%)	48	-	35	-	32	-	31	-
Readm elderly home, mean (SE)	49 (37)	46 (18)	227 (47)	235 (47)	175 (49)	206 (51)	201 (51)	190 (43)
missing, (valid%)	50	-	34	-	33	-	30	-
Readm rehabil. center, mean (SE)	222 (222)	207 (116)	2441 (296)	2104 (260)	445 (145)	526 (140)	1418 (261)	1295 (227)
missing, (valid%)	48	-	34	-	32	-	31	-
GP consults, mean (SE)	20 (7)	19 (3)	4 (0.5)	5 (0.6)	8 (1)	7 (1)	5 (0.6)	5 (0.8)
missing, (valid%)	50	-	40	-	37	-	35	-
Formal homecare, mean (SE)	1686 (748)	1557 (367)	1187 (73)	1036 (52)	990 (136)	944 (92)	1028 (63)	937 (52)
missing, (valid%)	51	-	43	-	38	-	39	-
Aids and adjustments, mean (SE)	70 (21)	65 (11)	114 (22)	130 (29)	130 (40)	140 (36)	110 (26)	130 (35)
missing, (valid%)	48	-	34	-	32	-	31	-
Total T0-T1, mean (SE)	3001 (893)	2772 (429)	4965 (420)	5619 (378)	2326 (234)	3149 (308)	3741 (380)	4325 (390)
missing, (valid%)	52	-	48	-	44	-	42	-

[1] original data including percentage missings; [2] data after multiple imputation

Appendix 5b | Average formal healthcare costs from discharge initial hospital stay up to one year for within hospital and between-hospital-comparison, before and after multiple imputation *(Continued)*

Costs	WITHIN HOSPITAL				BETWEEN HOSPITAL			
	Pre-intervention		Intervention		Controls		Intervention	
	O[1] n=143	MI[2] n=143	O[1] n=959	MI[2] n=959	O[1] n=540	MI[2] n=540	O[1] n=699	MI[2] n=699
T1-T2:								
Readm hospitals, mean (SE)	1126 (296)	1053 (166)	1229 (155)	1005 (224)	1289 (321)	1292 (323)	1378 (190)	1058 (183)
missing, (valid%)	44	-	48	-	33	-	46	-
Readm nursing home, mean (SE)	114 (84)	107 (48)	1028 (460)	902 (323)	35 (27)	263 (269)	438 (335)	439 (269)
missing, (valid%)	43	-	48	-	33	-	46	-
Readm elderly home, mean (SE)	187 (114)	175 (64)	24 (15)	44 (23)	188 (87)	177 (94)	15 (11)	27 (20)
missing, (valid%)	43	-	48	-	34	-	46	-
Readm rehabil. center, mean (SE)	441 (310)	414 (176)	1411 (367)	1380 (300)	223 (122)	251 (117)	1098 (372)	1017 (264)
missing, (valid%)	43	-	48	-	33	-	46	-
GP consults, mean (SE)	5 (2)	5 (1)	6 (0.7)	7 (1.6)	8 (1)	9 (2)	6 (0.8)	7 (2)
missing, (valid%)	46	-	55	-	38	-	51	-
Formal homecare, mean (SE)	2486 (516)	2356 (367)	3416 (722)	3416 (340)	2992 (313)	3091 (206)	2739 (296)	3065 (153)
missing, (valid%)	48	-	53	-	35	-	49	-
Aids and adjustments, mean (SE)	57 (26)	53 (15)	55 (12)	71 (16)	53 (9)	73 (18)	58 (16)	62 (12)
missing, (valid%)	43	-	49	-	34	-	47	-
Total T1-T2, mean (SE)	4449 (857)	4163 (447)	5725 (888)	6827 (662)	4403 (523)	5155 (504)	4751 (481)	5676 (502)
missing, (valid%)	49	-	56	-	39	-	52	-
Total T0-T2, mean (SE)	9173 (1969)	6935 (684)	10880 (1382)	12445 (895)	6585 (667)	8304 (665)	8735 (841)	10001 (748)
missing, (valid%)	69	-	71	-	58	-	66	-

[1] original data including percentage missings; [2] data after multiple imputation

Additional file 5c | Average informal healthcare costs from discharge initial hospital stay up to one year for 460 participants by ISAR-HP score, before and after multiple imputation

	WITHIN HOSPITAL				BETWEEN HOSPITAL			
	Pre-intervention		Intervention		Controls		Intervention	
Costs	**O[1] n=143**	**MI[2] n=143**	**O[1] n=959**	**MI[2] n=959**	**O[1] n=540**	**MI[2] n=540**	**O[1] n=699**	**MI[2] n=699**
T0-T1, mean(SE)	1307 (531)	1374 (111)	1168 (133)	1119 (68)	1800 (279)	1263 (106)	1107 (148)	1081 (75)
Missing, (valid%)	80	-	80	-	82	-	79	-
T1-T2, mean(SE)	2321 (1020)	2597 (324)	2074 (333)	3171 (412)	3207 (740)	3598 (597)	2220 (419)	2959 (333)
missing, (valid%)	71	-	78	-	79	-	79	-
T0-T2, mean(SE)	7394 (3017)	3971 (410)	6212 (1046)	4289 (419)	8356 (2340)	4861 (671)	6153 (1294)	4040 (346)
missing, (valid%)	88	-	93	-	94	-	93	-

[1] original data including percentage missings; [2] data after multiple imputation

CHAPTER 9

A dedicated center for prevention and reactivation (PRC) to improve functioning of older patients after hospital admission: a randomized clinical trial

Linda E. Flinterman, Kirsten J.E. Asmus-Szepesi, Ton J.E.M. Bakker, Anna P. Nieboer, Johan P. Mackenbach, Ewout W. Steyerberg

Submitted

ABSTRACT

Background

During hospital admission, many older patients experience functional decline, which cannot be solely related to their medical condition.

Objectives

We aimed to assess the effectiveness of a dedicated center to prevent functional decline among older hospitalized patients with complex problems.

Design

Randomized (2:1) clinical trial to compare outcomes between an experimental group and a control group receiving usual care.

Setting

Community hospital in the Netherlands

Participants

Patients aged 65 and older and hospitalized between November 2011 and June 2013. Eligible patients were hospitalized for at least two days, had an ISAR-HP≥ 2 or an MMSE from 18 to 27 or an NPI-score≥ 3. Exclusion criteria were cognitive problems or a life expectancy≤ 3 months.

Intervention

Participants were randomized to either the Prevention and Reactivation Center (PRC) or usual care after discharge.

Measurements

Patients were compared on ability to perform (instrumental) activities of daily living, HRQoL, survival, and risk of (re-)admission at three and twelve months after hospital admission. The effect of the PRC was analyzed using an "intention to treat" approach and an "as treated" approach.

Results

We randomized 146 older patients to the PRC, and 76 to usual care. However, 54% of patients who were randomized to the PRC were not treated there, mainly due to patients' preferences for their home situation. Instead, 69 patients were treated in the PRC and 153 patients received usual care. In both the intention to treat and as treated analysis, no differences were found between the experimental and control group.

Conclusion

Treatment in the PRC is not relevant for many hospitalized older people and does not contribute to better outcomes. Further research to develop effective interventions to prevent functional decline of hospitalized older people is required.

INTRODUCTION

During hospital admission, approximately 35% of patients aged 65 and older experience functional decline which is not related to the medical condition they were admitted for [6]. Therefore, many hospital studies and programs have started to identify these older patients at risk of decline shortly after admission in order to give individualized integrated multidisciplinary care that avoids or counters unnecessary functional decline [4,7,183,184]. These programs focus on both the period of hospital admission and the period shortly after hospital discharge.

One of these programs is the Prevention and Reactivation Care Program or the PReCaP [68,175]. In the PReCaP study, patients aged 65 years and older and hospitalized for at least 48 hours were screened within three days after admission for risk of functional decline during hospital admission. A multi-disciplinary team developed a personalized care plan and a case manager guided patients through hospital admission up to maximally six months after discharge. For high-risk patients, an additional part of the program was a stay at a dedicated center for prevention and reactivation (PRC) after discharge from the hospital. The PRC aims to improve the ability of patients at high risk of functional decline to live independently in their home environment after discharge.

In this study we tested the hypothesis that a stay in the PRC after hospital discharge improves (instrumental) activities of daily living. Additional outcomes studied were health related quality of life (HRQoL), the risk of additional hospital admissions, and survival.

METHODS

Population and study design

We conducted a single center study with imbalanced randomization (2:1). This trial was embedded in a larger cohort study, the PReCaP study [68,175,176]. Eligible participants were patients aged 65 or over and admitted to the intervention hospital for at least 48 hours [68,175]. Furthermore, patients were eligible when they had an ISAR-HP score of 2 or higher and/or an MMSE score from 18 to 27 and/or an NPI score of 3 or higher. Exclusion criteria were inability to answer questions or follow instructions due to severe cognitive problems (MMSE<18/delirium/coma), inability to understand the Dutch language, and a life expectancy shorter than three months according to hospital medical staff. Patients were included at the departments of Geriatrics, Cardiology, and Internal Medicine of the Vlietland Hospital, a 450-bed community hospital in Schiedam. The PRC was situated in the Marnix Rehabilitation Center for the Elderly in Vlaardingen, the Netherlands. Patients were included in the study from November 2011 to September 2013. Eligible patients who were willing to participate in the trial and had given

their informed consent were randomized to a stay in the PRC or to usual care after discharge from the hospital.

Intervention

Supplementary to usual hospital care, a specialized multidisciplinary reactivation team with geriatric expertise developed a personalized treatment plan using Goal Attainment Scaling (GAS) [64,85] for all included patients. The GAS method has shown to be successful in maintaining/improving functioning of older patients with complex health issues. In addition to the personalized treatment plan, all participants were assigned a case-manager who guided patients through their hospital admission and provided extra support after hospital discharge. The case-manager was responsible for implementation of the personalized treatment plan during hospitalization as well as after hospital discharge. Participants randomized to the PRC were placed there after hospital discharge and stayed for a maximum period of three months. The PRC aims to improve patients' ability to live independently in their home environment. To reach this goal, the PRC combines specialized nursing home care with an intensive, theme oriented reactivation treatment, paramedical treatment, and psychiatric treatment [175]. Treatments provided at the PRC were physiotherapy, occupational therapy, psychotherapy, a dietician, speech therapy, image therapy, music therapy, social welfare, psychomotor therapy and systemic therapy. The PRC continued the personalized treatment plan that was made during hospital stay. Patients who were randomized to care as usual moved back home or to an elderly home or nursing home after discharge from the hospital, based on both the clinical judgment of the reactivation team and the patients' preference.

Measurements

The primary effect endpoint was the mean difference in ability to perform (instrumental) activities of daily living ((i)ADL) independently at 3 and 12 months after hospital admission between patients placed at the PRC and patients receiving usual care. Additional endpoints tested were mean difference in health related quality of life at 3 and 12 months after hospital admission, risk of and duration of readmissions to a hospital or nursing home within 3 months after hospital admission, and survival up to 12 months after hospital admission.

Sample size was determined by the capacity of the PRC and the period in which financing for the cohort in which this study was embedded was available. Randomization was performed by computer with a ratio of 2:1 for placement in the PRC. Due to the nature of the intervention, blinding for the treating physician and patients was not possible. The multidisciplinary reactivation team determined eligibility of patients for a stay in the PRC during their meetings two times a week, whereas a member of the research staff who was not involved in treatment of participants performed the randomization.

All participants were interviewed at hospital admission and at 3 and 12 months after hospital admission. ADL and iADL were measured with the Katz [96] and Lawton [136] questionnaire respectively. Current (i)ADL and (i)ADL two weeks before admission were scored at hospital admission. Health related quality of life was measured with the EuroQol (EQ5D) [178] questionnaire at hospital admission and at 3 and 12 months after admission. In the PRC, types of therapies followed were registered for all patients. For the patients who were not placed in the PRC, therapies received were retrieved from the registration of case-managers.

Statistical analysis

We performed an intention to treat analysis as well as an as treated analysis in which patients were analyzed according to the actual treatment received. Primary endpoint was mean difference in (i)ADL during 3 and 12 months after hospital admission for those staying at the PRC versus usual care. Effects of (i)ADL at 3 months after hospital admission were estimated by means of linear regression. Effects of (i)ADL and HRQoL over 12 months were estimated with a generalized linear mixed model (GLMM). With this model, differences between groups over time during 12 months after hospital admission were estimated. Both the linear regression and the mixed model were adjusted for baseline measurements for the intention to treat analysis, and adjusted for baseline measurement, age, sex, marital status, living situation and education for the as treated analysis. The risk of admission to a hospital or elderly/nursing home three months after hospital admission was estimated with logistic regression. Length of stay in days was estimated from questionnaires and patient registries. Survival was plotted with Kaplan Meier curves, and hazard ratios were calculated with Cox regression. Risk of admission and survival were adjusted for age, sex, marital status, living situation and education for the as treated analysis. Since loss to follow-up and reasons for loss to follow-up were comparable in both groups, a complete case analysis was performed for logistic regression. The GLMM can handle missing data as long as data are missing at random. This trial was registered at the Netherlands National Trial Register with number NTR2317. The Medical Ethical Committee of the Erasmus University Medical Center approved the study. All participants gave written informed consent at time of inclusion.

RESULTS

Participants

We assessed 723 patients for eligibility between November 2011 and June 2013. Of these patients, 28% did not meet the inclusion criteria, 21% declined to participate, and 20% were excluded for other reasons (Figure 1). Thus, 222 patients (31%) were included and randomized

in this study. Of these patients, 146 were randomized to treatment in the PRC and 76 were randomized to care as usual. Although patients agreed to a possible stay at the PRC after hospital admission, 45 (31%) of patients who were randomized to the PRC preferred their home situation, and 21 (14%) went to another institute than the PRC after they were discharged from the hospital (Figure 1).

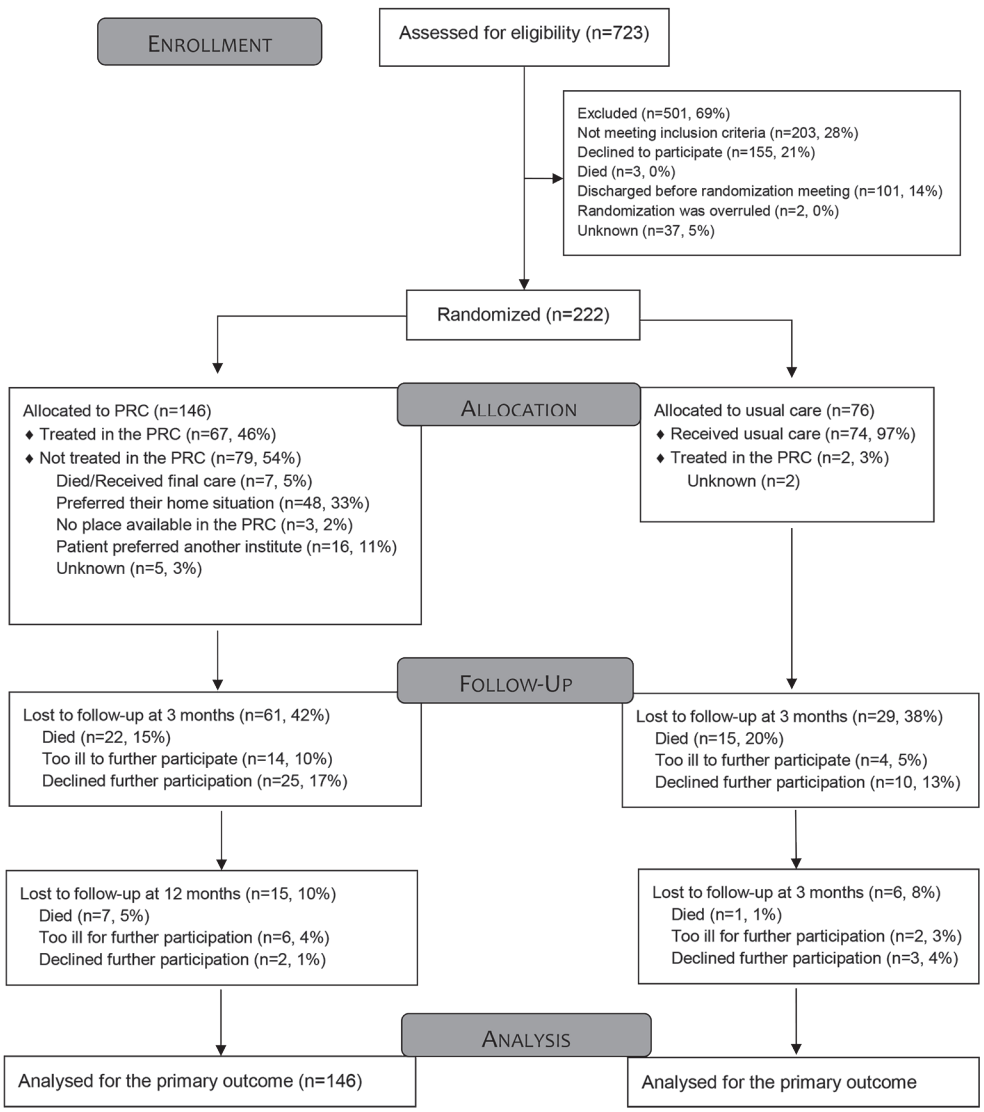


Figure 1 | Flowchart of participants

After randomization, patients were similar on baseline characteristics (Table 1). Patients were most likely to be women and mean age was 82. If patients were compared for the as treated analysis, patients truly placed in the PRC were less likely to be married, more likely to live alone and had a lower education than patients not placed in the PRC (Table 1).

Table 1 | Baseline characteristics of participants

Characteristics	Intention to treat		As treated	
	Dedicated center (N=146)	Usual care (N=76)	Dedicated Center (N=69)	No dedicated center (N=153)
Sex (% men)	37%	32%	30%	37%
Age (median (25^{th}-75^{th} percentile), years)	83 (77-87)	83.5 (79-87)	83 (77-87)	83 (78-87)
Marital status (% married)	33%	32%	21%	37%
Living situation (% living alone)	56%	51%	74%	46%
Education level (%>10 years)	36.9%	39.5%	31.4%	40.4%
ISAR-HP	4.0 (3.0-4.0)	4.0 (3.0-4.0)	4.0 (3.0-5.0)	4.0 (3.0-4.0)
MMSE	24 (22-26)	24 (22-26)	24 (22-26)	24 (22-26)
ADL (Katz6)	5.0 (4.0-6.0)	5.0 (4.0-6.0)	5.0 (4.0-6.0)	5.0 (4.0-6.0)
IADL (Lawton)	5.0 (3.0-6.0)	4.0 (3.0-6.0)	5.0 (4.0-7.0)	5.0 (3.0-6.0)
EQ5D	0.5 (0.3-0.8)	0.5 (0.2-0.7)	0.5 (0.2-0.7)	0.5 (0.3-0.8)
Duration of hospital stay (days)	10 (8-14)	11 (8-16)	11 (8-14)	11 (8-15)
N of comorbidities	3 (2-5)	4 (3-6)	3 (2-4)	4 (3-6)

Estimates are medians with interquartile range unless specified otherwise

Activities of daily living

At 3-month follow-up, 28% of patients randomized to the intervention and 31% of the participants in the control group increased in ADL function in the intention to treat analysis. Thirty-two percent of patients randomized to the PRC and 30% of control participants increased in iADL function at 3-month follow-up. Both groups of patients had, on average, a lower ADL and iADL at hospital admission compared to the period before admission. ADL improved after admission for both intervention and control group up to a level similar to before hospital admission. Improvement of (i)ADL over time did not differ between the intervention and control group compared to baseline (Table 2a). Furthermore (i)ADL did not differ between the two groups shortly after a stay in the PRC (3-month follow-up) or over time (12-month follow-up) (Table 2a).

Similar results were found when an as treated analysis was performed. No clear difference was seen shortly after a stay in the PRC or after 12 months of follow-up after adjustment for confounding factors (Table 2b).

Health related quality of life (HRQoL), admissions and survival

At baseline, HRQoL did not differ between the two groups in the intention to treat analysis. No clear difference in the mean values of HRQoL was seen over time, but both groups increased slightly in their HRQoL during follow-up (Table 2a). The same was true when the groups were compared as treated (Table 2b).

Table 2a | Effect of the dedicated center on different outcomes: intention to treat analysis

	3 month follow-up	12 month follow-up
Endpoint	B (95% CI) Dedicated center vs. no usual care*	Mean difference dedicated center vs. usual care*#
ADL	0.24 (-0.16 to 0.64)	0.19 (-0.21 to 0.59)
iADL	0.42 (-0.25 to 1.09)	0.33 (-0.33 to 0.99)
EQ5D	-0.02 (-0.12 to 0.08)	-0.06 (-0.18 to 0.06)
	OR (95% CI) dedicated center versus usual care	
Hospital admission	0.91 (0.28 to 2.97)	
Admission to elderly home	0.10 (0.01 to 0.92)	
Admission to nursing home	1.19 (0.46 to 3.04)	

*Adjusted for baseline value, #results from mixed model

Table 2b | Effect of the dedicated center on different outcomes: as treated analysis

	3 month follow-up	12 month follow-up
Endpoint	B (95% CI) dedicated center vs. no dedicated center*	Mean difference dedicated center vs. no dedicated center*#
ADL	0.09 (-0.33 to 0.50)	0.21 (-0.25 to 0.66)
iADL	-0.02 (-0.74 to 0.70)	0.43 (-0.39 to 1.25)
EQ5D	-0.01 (-0.11 to 0.10)	0.04 (-0.07 to 0.15)
	OR (95% CI) dedicated center vs no dedicated center$	
Hospital admission	0.44 (0.07 to 2.74)	
Admission to elderly home	Not applicable	
Admission to nursing home	2.16 (0.68 to 6.82)	

#results from mixed model; *Adjusted for baseline value, age, sex, multi morbidity, marital status, education and living situation; $Adjusted for age, sex, multi morbidity, marital status, education and living situation

Risk of readmission to a hospital or nursing home within three months after discharge from the hospital did not differ between groups in the intention to treat analysis. Patients appointed to the PRC were less likely to be admitted to an elderly home within three months after discharge from the hospital (Table 2a). Numbers were small though, with only one patient in the intervention group and five in the control group who were admitted to an elderly home. Thereby, patients appointed to the PRC were admitted at there and thus were less likely to be admitted to an elderly home during the first three months. In the as treated analysis, similar results were found (Table 2b).

Total length of stay at an elderly/nursing home or hospital was much longer during the first 3 months and during the year after hospital admission for patients placed in the PRC compared to those not placed in the PRC. The difference in duration of stay during the first 3 months could be explained by the duration of stay at the PRC itself. The mean duration of a stay at the PRC was 78 days, which explains the difference in duration of admission during the first 3 months after hospital admission. However, at 12 months after admission, patients placed in the PRC were more likely to be (re)admitted for a longer period of time compared to patients not placed in the PRC (Table 3).

Table 3 | Duration of admission and therapies provided (as treated)

	Intention to treat		As treated	
	Dedicated center	**Usual Care**	**Dedicated center**	**No dedicated center**
Duration of stay at the dedicated center (median, 25th-75th percentile)	0 (0-18)	0 (0-0)	30 (5-76)	0
Days case-management	142 (82-238)	115 (71-217)	171 (100-233)	148 (70-229)
Days (re)admission within 3 months# (median, 25th-75th percentile)	57 (5-90)	42 (14-75)	83 (57-90)	24 (0-60)
Days (re) admission within 12 months# (median, 25th-75th percentile)	97 (21-158)	56 (24-143)	136 (99-226)	28 (0-97)
Physiotherapy	52%	24%	81%	25%
Occupational therapy	30%	11%	55%	9%
Psychotherapy	23%	18%	39%	13%
Image therapy	1%	0%	1%	0%
Dietician	34%	12%	67%	9%
Speech therapy	4%	3%	4%	3%
Music therapy	10%	5%	17%	5%
Social welfare	27%	9%	51%	7%
Psychomotor therapy	8%	3%	10%	4%
Systemic therapy	0%	0%	0%	0%

#Number of days (re)admitted to a hospital, elderly home, nursing home or revalidation clinic during follow up

Nineteen percent (n=29) of the patients in the intervention group and 18% (n=14) of patients in the control group died in the year after hospital admission. Survival did not differ over time between the two groups HR 1.22 (95CI 0.65-2.31)) (Figure 2a). When patients were compared according to their received treatment 16% (n=11) of patients staying at the PRC and 21% (n=32) of patients receiving care as usual died during follow-up. Over time, survival did not increase for those placed in the PRC (HR 0.69 (95CI 0.32-1.49). Figure 2b shows that of the patients who received care as usual were more likely to die during the first two months after hospital admission compared to patients admitted to the PRC. This is in line with the fact that 4% of patients were not placed in the PRC because they received final care.

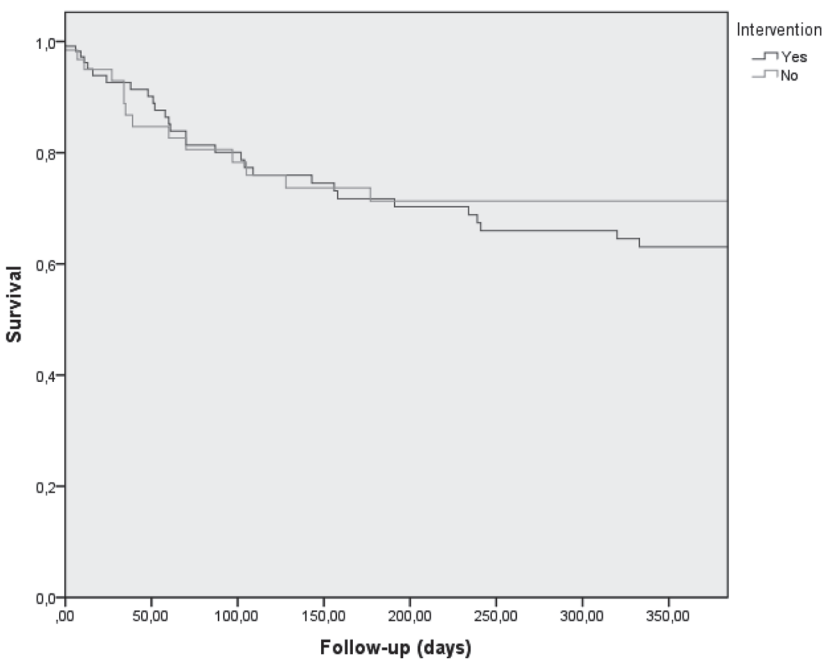


Figure 2a | Survival for those with and without the intervention

Duration of stay at the PRC, case-management and types of therapies received

Patients placed in the PRC remained there for a mean duration of 78 days, ranging from 5 to 293 days. In both the intention to treat and the as treated analysis the duration of case-management was extended with a month for patients placed in the PRC compared with patients in usual care or not at the PRC (Table 3).

Patients at the PRC were more likely to receive several types of therapies compared to patients not placed in the PRC (Table 3). However, therapies were systematically registered for patients in the PRC, whereas registration of therapies for patients not staying at the PRC depended on the case-managers. The case-managers only registered therapies when the patient mentioned them during their visits. Therefore, the number of therapies received by the patients not staying at the PRC is likely to be an underestimation of the number of therapies actually received.

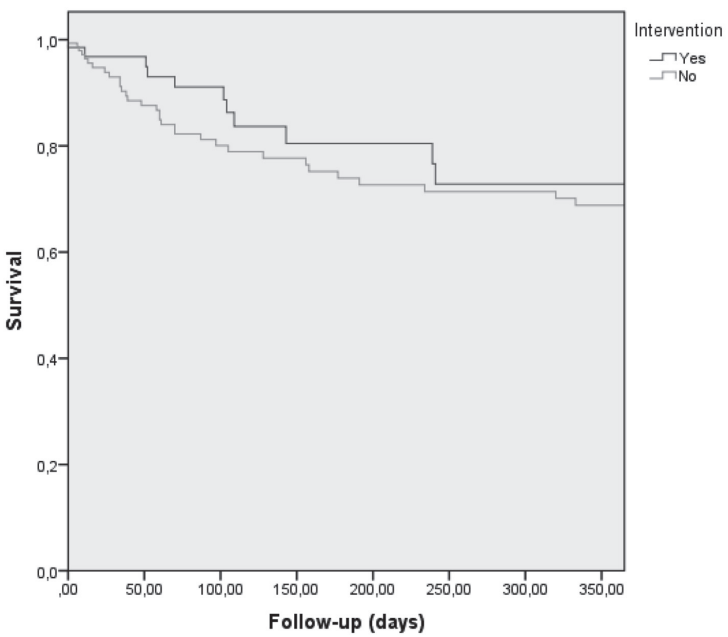


Figure 2b | Survival for those who actually received and not received the intervention (as treated analysis)

DISCUSSION

In this randomized trial, instrumental activities of daily living, activities of daily living, HRQoL, hospital or elderly/nursing home admission, and survival did not differ between patients randomized to the PRC or usual care. Neither were effects found in the as treated analysis. Moreover, admission duration and duration of case-management of patients in the PRC was longer, making cost effectiveness of the PRC unlikely.

Some limitations should be mentioned. Firstly, only 222 patients could be included in this study due to high refusal rates, either due to unwillingness to be 'forced' into a specific kind of treatment after hospital admission or due to the patients' preference for their home situation above a stay at the PRC. These refusal rates may indicate a lack of willingness of patients to undergo lengthy treatments in a dedicated center for prevention and rehabilitation that would also be seen in real life. This intervention is therefore unlikely to be a practical solution to counter functional decline of older patients during hospital admission.

Secondly, only 46% of patients allocated to the PRC were actually treated at the center. This can partly be explained by the fact that the PRC started in an old building and was only moved to a new location especially built after the start of the study. Therefore, patients were less attracted to the PRC at the beginning of the study than during the last few months of the study. Furthermore, patients preferred either to go home or to a facility closer to their home or where they had been living before. The intention to treat analysis therefore shows the effects one would find in real life would the PRC be implemented.

Since the effects of the PRC were diluted by preference of patients to their home environment or other institutions above a stay at the PRC, we performed an as treated analysis to study the undiluted effect of the PRC as well [185]. Differences between groups in the as treated analysis may have been largely caused by different preferences of the patients, which could not be measured. It is therefore unlikely that our analysis was fully adjusted for all confounders, and clear conclusions could not be drawn.

Thirdly, most therapies given at the PRC are also available outside the center. The most frequent therapies were physiotherapy, occupational therapy and advice of a dietician. All of these therapies are also common in usual care, albeit at a lesser intensity. Thereby, the more unique therapies of the PRC such as psychomotor therapy and systemic therapy were only given to a few patients. All patients had a case-manager who was responsible to implement their personalized treatment plan in both the PRC and usual care. Furthermore, 21% of the patients randomized to usual care received a geriatric revalidation program elsewhere. This may have diluted effects as well.

Previous studies found beneficial effects for geriatric rehabilitation programs which were similar in set up to the PRC [86,186-188]. These previous studies had stricter in and exclusion criteria compared to ours. For example, they only included patients who would have been admitted to an elderly or nursing home and excluded patients who were able to go home after hospital admission [186-188]. We included patients who were able to go home (30%) as well, which may have diluted the effect of the PRC. However, these patients were present in both groups and therefore the dilution effect of these patients is expected to be small.

Total length of institutionalization was much longer for patients at the PRC compared to patients not randomized to a stay at the PRC. Previous studies did either not mention total

length of stay because they compared a stay at a facility such as the PRC to a stay at a nursing home [186,188], or they found an increase in length of stay for patients admitted to a dedicated center [187].

We studied a broad group of patients, while previous studies that have found results of extensive programs for older patients were focused on one specific sub-group of geriatric patients (e.g. patients with stroke or admitted to the emergency department [49,189,190]). As geriatric patients mostly have several comorbidities next to their indication for hospital admission, it is difficult to decide which treatments will improve their (i)ADL most and/or if it is possible to improve their (i)ADL at all. Future studies should therefore aim to either find a specific group of geriatric patients with special needs or focus on one specific kind of therapy in order to create a larger contrast, and hopefully larger effect between groups.

In conclusion, treatment in the PRC is not relevant for many hospitalized older patients and does not contribute to better outcomes. Further research to develop effective interventions to prevent functional decline of hospitalized older patients is required.

PART FOUR

Discussion

CHAPTER 10

General discussion

Main findings on the identification of older hospitalized patients at risk of functional decline using the ISAR-HP

Research question 1: ***Can the ISAR-HP be used as a screening instrument to identify hospitalized older patients at risk of poor physical functioning, cognitive functioning, health related quality of life and mortality?***

The ISAR-HP was found useful in identifying patients at risk of low physical functioning, cognitive functioning, HRQoL, and higher loneliness and mortality, as it readily distinguished good functioning older patients from patients with low functioning and low HRQoL after hospital admission (Chapter 4). The ISAR-HP may hence assist in selecting patients who may benefit from individually tailored reactivation treatment next to treatment of their medical condition. In addition, the ISAR-HP has good discriminative ability and is easier to use among hospitalized older people compared to other tools, since it consists of only four simple questions and a straightforward scoring system (Chapter 5).

Research question 2: ***Can the ISAR-HP predict health care costs of hospitalized older people?***

The ISAR-HP can be used to predict one-year healthcare costs of hospitalized older people. Hospitalized older people with high ISAR-HP risk scores at hospital admission had substantially higher formal and informal care costs in the year after initial hospital admission than patients with low risk scores (Chapter 6).

Research question 3: ***How often does functional decline occur among at-risk hospitalized older people and what are possible predictors of decline in (instrumental) activities of daily living?***

Three months after hospital admission, around 28% of the hospitalized older people had declined in activities of daily living (ADL), whereas 50% had declined in instrumental activities of daily living (iADL), compared to the pre-hospital situation. iADL more often declined but also more often improved than ADL, reflecting a more dynamic pattern over time. Age, living environment, cognitive functioning, neuro-psychiatric problems, depression, ISAR-HP score and some comorbidities were associated with ADL decline, but not as much with iADL decline (Chapter 7).

Main findings on the effect evaluation of the PReCaP aimed at preventing functional decline among at-risk hospitalized older people

Research question 1: ***Do at-risk older hospitalized patients treated with the PReCaP have better functioning three months and twelve months after hospital admission than at-risk hospitalized patients treated with usual forms of geriatric hospital care?***

Hospitalized older people who were treated with the PReCaP did not show better functioning, depression, and HRQoL in the year after hospitalization than patients treated at the same hospital before implementation of the PReCaP (Chapter 8). Similarly, patients at risk of functional decline and treated with the PReCaP did not differ in ADL and iADL from usual-care patients treated in two control hospitals. PReCaP patients did have slightly better cognitive functioning, lower depression, and higher perceived health when compared to usual-care patients from the two control hospitals (Chapter 8).

Research question 2: ***Is the PReCaP cost-effective and does it lead to better health related quality of life and lower burden of care for informal caregivers when compared to usual geriatric hospital care?***

Overall, one-year healthcare costs were higher for patients treated with the PReCaP, both in comparison to patients treated at the same hospital before implementation of the PReCaP and in comparison to patients from the two control hospitals. The higher costs of the PReCaP and its small effects on ADL and iADL suggest that the PReCaP is unlikely to be cost-effective (Chapter 8). Health related quality of life and burden of care did not differ between informal caregivers of patients treated with the PReCaP and informal caregivers of patients treated in the same hospital before implementation of the PReCaP or patients treated with usual care in the control hospitals (Chapter 8).

Research question 3: ***Does a stay at the prevention and reactivation center (PRC) in addition to regular PReCaP care lead to better outcomes for patients with complex health problems than PReCaP treatment without a stay at the PRC.***

Our randomized clinical trial did not show any added value of a stay at the PRC for patients with complex health problems, both in an intention to treat analysis and in an as-treated analysis (Chapter 9).

METHODOLOGICAL CONSIDERATIONS

Design, Setting and Population

Design

We chose to perform a prospective non-randomized controlled trial and not a randomized controlled trial (except for the evaluation of a stay at PRC) for several reasons. First of all, contamination of a control group within the intervention hospital would be unavoidable since the same personnel would have treated patients from both groups in the same environment [127]. Furthermore, after implementation, the PReCaP was considered standard care in the intervention hospital. Randomization between hospitals was impossible since each hospital already had its own standard provided care. Since patients generally have their own regular general practitioner (GP) whose practice is usually close to the patient's home and who is familiar with the patients health and history, it was unrealistic to randomize patients among GP's [127] during the follow up period after hospital discharge. Finally, by conducting a prospective cohort study we aimed to investigate health care as provided in a real life situation, thereby improving the generalizability of the study.

Given the multidisciplinary approach and the complexity and multi-component interventions of the PReCaP, we expected deviations from the protocol in daily practice [128,129,175]. To better interpret our findings, we used a mixed methods design of quantitative and qualitative measures to provide information on three elements: structural issues (e.g. materials, personnel, organization and coordination of care), processes (e.g. activities of professional in diagnosing and treating the patient), and patient and caregiver outcomes such as physical functioning and quality of life [126]. A combination of these elements allows for better interpretation of findings, as one method may strengthen interpretation in cases where another method cannot explain variances or outcomes.

Setting

Lack of contrast between provided care in intervention and control hospitals

Our results may have been influenced by the lack of contrast between the intervention hospital and control hospitals. Transitions within the three hospitals that were unrelated to the study may have influenced outcomes. For example, the St. Franciscus Gasthuis has started scaling up their specialized clinical geriatric care in light of the implementation of national guidelines on elderly care. The lack of contrast between the hospitals in provided health care was supported by a qualitative analysis of hospital processes [177]. Results of this analysis showed that the three hospitals, even though they used different methods, all screened patients at admission in order to develop personalized care. They all used similar standardized care plans concerning the nursing care process, with exception of the Vlietland hospital geriatric unit and the SFG

cardiology unit, where patient independence in daily activities was emphasized more. Even though the Vlietland hospital employs three geriatricians and three geriatric nurses who provide specialized geriatric care for older patients hospital wide, the control hospitals employ consultative psychiatric nurses who often provide advise for (psycho) geriatric patients. Furthermore, all three hospitals employ transfer nurses who coordinate post discharge follow up care of older patients [177]. Finally, coordination and management, even though different in the three hospitals, were comparable in their ultimate goals and thus lacked contrast [177].

Implementation problems in the intervention hospital

In the intervention hospital setting several PReCaP implementation problems were encountered, such as a lack of motivated personnel at the start of the implementation, and multidisciplinary meetings that were only performed in around 50% of the cases [176,177]. These problems prevented quick startup and proper implementation of the PReCaP. Further financial and political issues in the Vlietland hospital lead to participation of only three departments whereas the original plans included all hospital departments. Furthermore, since the control hospitals did not have a geriatric unit, and geriatric patients admitted to the geriatric unit of the Vlietland hospital were generally older and at higher risk than patients from other departments and other hospitals, these geriatric patients were difficult to compare with other patient groups. The issues stated above reflect how health care transitions evolve in real life situations, making the outcomes difficult to interpret, but very valuable nonetheless [175].

Population

Inclusion

The study had relatively low inclusion rates, with especially high refusals of patients who were randomized to admission to the PRC. However, low inclusion rates were expected as previous studies among older populations suffered from low participation rates as well [44,50,53,135].

Furthermore, the patients included in our study were an extremely heterogeneous group due to multi-morbidity, differences in functional status as well as a multitude of medical diagnoses. Even though this can be expected among an older population [177], it made comparisons between hospitals more complicated. Furthermore, it is expected that underreporting of geriatric conditions may lead to lower recognition of geriatric conditions during hospital stay [191], adding to the heterogeneity of the patient group as well.

Burden of questionnaires

Both interviewed patients and informal caregivers who filled out the paper questionnaires independently considered the length of the questionnaire as well as the nature of some of the

questions a relatively high burden. We therefore shortened the questionnaire after conducting our pilot study and when the burden for patients was still too high, the interview was cut short and finished at another time or the remaining questions were left behind for the patient to fill out independently later. Nevertheless, the experienced burden may have been one of the causes of our limited inclusion rate and relatively high loss to follow up.

INTERPRETATION OF RESULTS

Using the ISAR-HP as a screening tool for risk of poor functioning

We compared groups of hospitalized older people with different ISAR-HP scores on cognitive and physical functioning, mortality, HRQoL, and loneliness at three and twelve months after hospital admission. Cognitive functioning, physical functioning, loneliness, and HRQoL differed significantly between groups during 1-year follow-up after hospital admission with high-risk groups having lower scores than low-risk groups for functioning and loneliness, although not always for HRQoL. The lowest risk group (ISAR-HP=0) scored consistently higher on functioning and HRQoL than all other groups, and mortality differed significantly between groups as well. These results are in line with and complement earlier findings that patients identified as low risk of functional decline by the ISAR-HP had fewer geriatric conditions and that a lower percentage of this group experienced functional decline twelve months after hospital admission than patients identified as intermediate or high risk of functional decline [135]. Other studies found other predictors as well, such as residence, cognitive impairments including delirium, gender, chronic disease and depression [15,171].

The ISAR-HP compared to other screening instruments

We also compared the ISAR-HP to three other screening instruments, the ISAR, the VMS and the SHERPA. Of the four screening instruments, the ISAR-HP and SHERPA were most suitable to identify hospitalized older people at risk of poor functioning, with the SHERPA showing high specificity, but low sensitivity and the ISAR-HP a high sensitivity and somewhat lower specificity for functioning at 3 months. Since the ISAR-HP has higher sensitivity and we did not want to miss any patients at risk we preferred the ISAR-HP instead of the SHERPA. In addition, the ISAR-HP is shorter and easier to administer than the SHERPA and an earlier study on SHERPA found only moderate performance [4] of this instrument in acutely admitted older patients. It is important to consider that each screening tool only gives an indication though and additional clinical judgment from the medical team is required to improve the estimated likelihood of poor functioning or functional decline. The medical team should also consider what kind of additional treatment might be beneficial to avoid poor functioning. A recent review of seven

widely used screening instruments to identify hospitalized older people at risk of functional decline showed that the ISAR, besides being the mostly reported instrument, seems the most useful as well due to its quick and easy administration, and efficiency [192]. The reviewed studies evaluated screening instruments mostly among patients in emergency departments though, whereas our study tested them among a population consisting of acutely as well as electively admitted patients. Furthermore, instruments predicting problems in functioning are difficult to compare due to heterogeneity of functional outcomes as well as hospital settings [193]. Since none of the tools cover the risk of functional decline sufficiently, it is plausible that this many different tools have been developed and additional research needs to improve screening of frail hospitalized older people further [193]. In light of the high prevalence or risk of functional decline among emergency department visitors over 65 years old, a recent study suggests to routinely screen all people aged 65 years or older who present at an emergency department without being admitted as an inpatient in order to identify possible risk of functional decline and if indicated, appropriate interventions [194], stating also today's importance of screening hospitalized older people for risk of functional decline.

The ISAR-HP as a predictor of care costs

We studied formal and informal care costs in relation to level of risk of low functioning of hospitalized older people up to one year after admission using the ISAR-HP. Results showed that mean healthcare costs were €30k euro per person per year, with one third for initial hospital stay, one third for formal healthcare costs between hospital discharge and twelve month follow up, and one third for informal healthcare costs between hospital discharge and twelve month follow up Informal and formal healthcare costs were almost doubled for people with the highest risk score compared to people not at risk. Thus, the ISAR-HP was able to predict one-year health care costs of hospitalized older people. A study examining resource utilization and costs after acute stroke in older patients showed no difference in one year costs between an intervention group and usual care group but total annual costs per patient did show a very large variation related to stroke severity at onset [195], which is in line with our results showing higher costs for patients at higher risk of functional decline at time of hospitalization.

Predictors of ADL and iADL decline

We studied the extent to which ADL and iADL of older hospitalized patients declined or improved between pre-hospital admission and hospital admission and pre-hospital admission and three month follow up. In addition, we studied differences between ADL and iADL decline and tried to identify predictors of ADL and iADL decline, such as age, sex, marital status, living environment before admission, cognitive functioning, neuropsychiatric functioning, depression, comorbidities and both ADL and iADL functioning pre-admission and at

hospitalization. The fact that iADL was more dynamic, with both higher decline as well as higher improvement rates than ADL is in line with earlier studies showing that cognition affected performance in iADL activities for people with different levels of cognition [196,197], whereas ADL was only affected above a certain degree of cognitive impairment [196,198]). Results on predictors of ADL and iADL functioning were also in line with recent studies, which showed that several patient characteristics that were identified within 24 hours of hospitalization, such as multi-morbidity, cognitive impairment, functional impairment, and age were associated with adverse hospitalization and readmission [9,199].

Effects of the PReCaP

In the intervention hospital, we compared at-risk patients treated pre-implementation of the PReCaP with at-risk patients treated post-implementation of the PReCaP (= within hospital analysis). We also compared at-risk patients of the PReCaP hospital post-implementation with at-risk patients of the two control hospitals (= between hospitals analysis). As mentioned in our results, there were no significant differences in physical functioning, HRQoL, mortality in the year after hospitalization between groups in either analysis. In the between-hospital-analysis, PReCaP patients did have slightly better cognitive functioning, lower depression, and higher perceived health when compared to usual-care patients from the two control hospitals.

An earlier randomized controlled trial to evaluate a multicomponent intervention (including specially designed environment, nursing care plans for rehabilitation, patient-centered care and planning patient discharge to home) to improve functional outcomes and process of care in hospitalized older people showed that patient and provider satisfaction were higher in the intervention group [44]. Similar to our study, this study found no significant group differences in length of stay, costs, home healthcare visits, and hospital readmissions or self-reported measures of functioning at hospital discharge though. A cluster randomized controlled trial evaluating an interdisciplinary primary care approach to prevent functional decline in community dwelling frail older people found no evidence either for the effectiveness of such an approach [200]. In contrast to our results, another evaluation of a multifaceted transitional care intervention reported improved functional ability and independence and improved walking ability in the 6 months after hospital discharge. This study included an individually tailored exercise program and continued nursing support by telephone. The greatest improvements in ADL and iADL were noted within four weeks after discharge [201]. This intervention had a longer duration than the PReCaP though (24 weeks). It included intensive exercise programs in the home environment after discharge, whereas the PReCaP included case-management only after hospital discharge. A recent non-blinded randomized controlled trial evaluating a care program integrating hospital emergency department care with care provided to older patients after discharge to the home environment [202]. This study also showed the potential

to reduce dependency in ADLs. It included emergency department patients only, as well as patients who were 80 years or older or 65 to 79 years old with at least one chronic disease and dependency in at least one ADL. In contrast, our evaluation entailed a more-diversified group of patients aged 65 years or older admitted both acutely and electively to several hospital departments. Earlier results showed that people with depressive symptoms at admission had higher multi-morbidity, greater functional impairment and greater cognitive impairment at admission and that these patients had higher mortality in the three years after admission [149]. Thus, depression is an important factor in functional decline. In addition, depressive symptoms three months after hospitalization were associated with lower daily living skills and social support after hospitalization [203]. Taking into account the results of abovementioned studies we would have expected to see less functional decline among PReCaP patients compared to control patients, since we found lower symptoms of depression among PReCaP patients than control patients. Nevertheless, depression is probably one of many factors that influence functional decline and our results were only marginally significant, which may explain why we did not find similar associations in our study.

Effects of the Prevention and Reactivation Center (PRC)

We conducted a randomized (2:1) clinical trial to compare ability to perform (instrumental) activities of daily living, HRQoL, survival, and risk of (re-)admission at three and twelve months after hospital admission of patients treated with the PReCaP including a stay at the Prevention and Reactivation Center (PRC) with patients treated with the PReCaP excluding a stay at the PRC. We used both an "intention to treat" approach and an "as treated" approach. In both approaches, we did not find any added value of a stay at the PRC. Contrary to our results on the PRC, a recent review on the effects of early-in hospital physical rehabilitation programs on physical functioning among geriatric patients acutely admitted to the hospital showed functional benefits, but researchers also admitted that further research is needed to assess the feasibility of such programs [204].

RECOMMENDATIONS FOR RESEARCH AND PRACTICE

Use of the ISAR-HP to screen at-risk hospitalized older people

Our results showed that the ISAR-HP is a simple tool that adequately identifies hospitalized older people at risk of low physical and cognitive functioning, mortality, loneliness and, to a lesser extent, HRQoL, as well as societal care costs at three and twelve months after hospital admission. As mentioned before, each screening tool gives only an indication of risk though and additional clinical judgment from the medical team is required to improve the identification of

older patients at risk of functional decline. Nevertheless, the ISAR-HP seems an adequate tool to perform a first screening for hospitalized older people at risk of poor functioning though.

Treating at-risk hospitalized older people with the PReCaP

Complex interventions such as the PReCaP include several components, which are difficult to evaluate due to problems in developing, identifying, documenting and reproducing the intervention [127,128]. Thus, a phased approach to both development and evaluation of complex interventions has been proposed to help define clearly where the research process stands [127,205] (see Table 1).

Table 1 | Phases of evaluating complex interventions

1: Preclinical or theoretical phase
2: Define components of the intervention
3: Define trial and intervention design
4: Methodological issues main trial
5: Promoting effective implementation

From Campbell et al. 2000 [127]

Evaluating a total intervention package instead of its elements

Important questions in evaluating complex interventions such as the PReCaP are: "How does the intervention work; What are its active ingredients and how are they effective" [206] (see Table 1, phase 1 and 2). The elements of the PReCaP were developed or chosen based on earlier evidence. Nevertheless, many of those studies have focused on a great variety of interventions, but not often on a total intervention package such as the PReCaP. Focusing on a total package is more complicated, since you are dependent on a mix of interventions per individual based on individual need and on communication structures between professionals, patients, and informal caregivers as well as infrastructures such as availability of personnel and materials. Part of the research evidence on which the PReCaP has been based has focused on certain elements of the PReCaP only. For example, An earlier review on goal attainment scaling proved useful among psychogeriatric patients with cognitive disorders, but was based on a small amount of studies that showed mixed results [62]. Goal attainment scaling did detect clinically important changes in a mobile geriatric assessment team for community dwelling older people [64]. A systematic review included nine (quasi) randomized controlled trials on supporting discharge of hospitalized older people from hospital to home [89]. Results of this review showed that supporting discharge from hospital to home is of value since a higher percentage of people remained at home six to twelve months after hospital admission if their

discharge had been supported. However, the effects of supported discharge on hospitalization were unclear and there was an absence of good research data on functional status, patient and caregiver satisfaction. In addition, evaluation of complex interventions requires use of qualitative and quantitative evidence [127]. Even though qualitative and quantitative methods were combined in our evaluation, researchers had no effect on the development and implementation of the intervention, the PReCaP itself (see Table 1, phase 2 and 3), which was the responsibility of the intervention hospital and its personnel. Therefore, it is possible that the lack of effects of our evaluation were due to the evaluation trial being conducted too early in the development stage of the PReCaP [206], when the effectiveness of the different PReCaP ingredients as well as feasibility of both implementation of the program as well as starting an evaluation trial in the current hospital setting were still questionable.

Variety of settings and population in earlier research evidence

Table 2 shows the importance of context in basing complex interventions on existing evidence. Research evidence for elements of the PReCaP or complex interventions similar to the PReCaP have mostly been studied in the acute care of hospitalized older people [31,49,54,189] or among non-hospitalized older people still living in the community [32,35,43,207,208]. These populations are different from the hospitalized older people included in the evaluation of the PReCaP, which consisted of both acutely and electively admitted hospitalized older people. Furthermore, among earlier studies on complex programs, a substantial variation was found in format of care, involvement of health-care professionals, intensity of care provided, and settings in which care was provided [32,55]. Another noteworthy point is the large variety of outcome measures by which physical functioning has been reported so far [32,174]. Finally, earlier research evidence did not suggest that one format of care provision was actually better than another, supporting the possibility that different formats of care are tailored to the needs and preferences of individuals and are thus suited for specific groups [32].

Table 2 | Importance of context in research evidence for complex interventions

Is the problem the same?
Is the context the same?
What are appropriate outcomes?

From Campbell et al 2007 [128]

Recommendations concerning the PReCaP

Based on the previously described methodological considerations and the abovementioned research evidence on which the PReCaP was based we should be cautious with interpreting

our results with respect to the lack of effects of the PReCaP on patient and caregiver outcomes. It is possible that the intervention indeed does not work in its current form for the population that we included in our study. Nevertheless, considering the many limitations of our study and the results of qualitative structure and process evaluations, the PReCaP might be successful in another setting or for a different population. For example, the PReCaP might possibly be more successful in geriatric units when offered as basic care such as in the geriatric unit of the intervention hospital in this study. Instead, the PReCaP is currently provided for older patients from other units next to the geriatric unit. For these patients, treatment from the PReCaP multidisciplinary team is offered in addition to treatment from their medical specialist but not as basic care. This structure is comparable to the Inpatient Geriatric Consultation Service, but the effects of the consultation services are still in question [31,53,177,209]. Results from ACE and Geriatric Evaluation Management Units suggest that integrating a variety of disciplines into the multidisciplinary team in a geriatric unit is more effective than consultation services [31,33,86,177] or treatment at general wards [45]. This would suggest that implementing the PReCaP in a specialized geriatric unit would be more effective than its current implementation hospital wide. Recently, a similar construction in the form of a geriatric-friendly emergency department has also been suggested for acutely admitted older patients [210]. Another option is implementation among acute care patients only. Programs focused on early comprehensive geriatric assessment, diagnostic accuracy and completeness, and multidisciplinary management for frail older patients during their admission have shown promise. Nevertheless, motivation of care personnel is important for such programs to be successful [73]. An evaluation of function-focused care, in which nursing staff engaged patients in care activities showed that this way of care can have a positive effect on the functioning of hospitalized older people as well [211]. It is difficult to predict for which patients the PReCaP is most suited though, just as it has been difficult to predict the best suited patients in other studies on integrated rehabilitation care programs [212].

The definition and interpretation of functional decline

There are many interpretations of functional decline, varying from a reduction of one or two or more points on ADL or iADL scales, to sometimes including or excluding readmission and death as decline and often including or excluding cognitive functioning and other factors. As pointed out in the introduction, we chose a broad view of functioning including physical functioning, cognitive functioning and dimensions such as mental health and social functioning, which we linked to an integrated concept of frailty. To measure risk of decline in functioning, we used the ISAR-HP with a cut-off of ISAR-HP 0 versus 1+, since this would best distinguish older patients at risk from those not at risk in our specific study. Cut-off scores of 1 or 2 have been suggested earlier [21,68], but the choice of a cut-off of 1 or 2 will depend on the clinical context.

The dynamics of ADL and iADL transitions

We should further note that the fact that patients did not recover to baseline does not necessarily imply that the provided healthcare is ineffective. For example, a patient admitted acutely with a stroke might not recover fully to his or her baseline functioning due to irreversible damage as a result of the stroke itself even though state of the art medical and paramedical interventions have improved the patient's recovery more than other usual care interventions would have. Nevertheless, the results would not reflect success since the patients did not recover to their original status. A recent longitudinal study among a general population of people aged 85 years or older confirms our assumption that ADL and iADL transitions are dynamic and might only be partly preventable by interventions. It also confirmed our findings that depression, chronic disease, cognitive impairment and neuro-psychiatric problems were possible predictors of decline in functioning [171].

Distinguishing between general and hospital-related functional decline

A related issue concerning functional decline is the question if we are actually able to distinguish hospital related functional decline from functional decline as a result of a medical diagnosis? Are we in fact able to separate medical diagnosis from other factors that cause functional decline such as hospital admission itself? Unfortunately, we did not include ADL and iADL functioning at time of hospital discharge, and were therefore unable to distinguish between decline during hospital stay and decline after hospital stay. We did not use discharge as follow up as earlier studies did [6,167] due to the bias as a result of varied lengths of stay among patients. Neither did we use a fixed length of stay (e.g. 4 days) since many patients may not have had time to recover their baseline functioning yet purely due to the natural course of their specific medical diagnosis. We were able to assess patients from two weeks before admission to admission and from admission to three months and twelve months later. We included baseline measurements to distinguish between patients who declined before admission and patients who declined after admission and our primary outcome was decline between baseline and 3 month follow up since interventions should aim at recovering baseline ADL and iADL [167] after returning home. But even if we would have been able to, how can we distinguish functional decline as a result of the stay itself from functional decline as a result of the natural course of the medical diagnosis or specific treatments of medical diagnosis or related factors such as age and social status? It might therefore not be realistic to expect hospital programs to aim for fully regaining functioning to the standard before hospital admission.

In conclusion, we should aim to further study other prognostic factors and underlying gradients of frailty or risk of functional decline, thereby allowing and improving the design of interventions that can mediate this risk and improve patient outcomes. Further studies should evaluate treatments focused on both medical condition and domains of reactivation

care, but tailored to the needs of risk groups, for example patients with cardiovascular diseases [213]. Consequently, patients may have a better prognosis after discharge. This will prevent dependence on informal and formal health care and associated costs and instead will help older people remain independent in daily life as long as possible after hospital discharge.

PART FIVE

Miscellaneous

CHAPTER 11

References

1. Giesbers H, Verweij A, de Beer J: **Vergrijzing: Wat zijn de belangrijkste verwachtingen voor de toekomst?** *Volksgezondheid Toekomst Verkenning, Nationaal Kompas Volksgezondheid\Bevolking\Vergrijzing* 2013.

2. **Prognose bevolking kerncijfers, 2012-2060** [http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=81593NED&D1=a&D2=0&D3=0-1,3,8,13,18,23,28,33,38,43,l&HD=130605-0940&HDR=G1,G2&STB=T]

3. **Kosten van Ziekten tool**. *Bilthoven: RIVM,* <http://wwwkostenvanziektennl> *Kosten van Ziekten, 18 november 2013* 2011.

4. Cornette P, Swine C, Malhomme B, Gillet JB, Meert P, D'Hoore W: **Early evaluation of the risk of functional decline following hospitalization of older patients: development of a predictive tool**. *Eur J Public Health* 2006, **16**(2):203-208. Epub 2005 Aug 2002.

5. Covinsky KE, Justice AC, Rosenthal GE, Palmer RM, Landefeld CS: **Measuring prognosis and case mix in hospitalized elders. The importance of functional status**. *J Gen Intern Med* 1997, **12**(4):203-208.

6. Covinsky KE, Palmer RM, Fortinsky RH, Counsell SR, Stewart AL, Kresevic D, Burant CJ, Landefeld CS: **Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age**. *J Am Geriatr Soc* 2003, **51**(4):451-458.

7. Volpato S, Onder G, Cavalieri M, Guerra G, Sioulis F, Maraldi C, Zuliani G, Fellin R, Italian Group of Pharmacoepidemiology in the Elderly S: **Characteristics of nondisabled older patients developing new disability associated with medical illnesses and hospitalization**. *J Gen Intern Med* 2007, **22**(5):668-674.

8. Bakker TJ, Duivenvoorden HJ, van der Lee J, Krulder JW, Driesen JJ, Ribbe MW: **[Prevalence and prognostic importance of riskfactors for long hospital stay within elderly patients admitted to a hospital; a clinical-empirical study]**. *Tijdschr Gerontol Geriatr* 2010, **41**(4):177-186.

9. Boyd CM, Landefeld CS, Counsell SR, Palmer RM, Fortinsky RH, Kresevic D, Burant C, Covinsky KE: **Recovery of activities of daily living in older adults after hospitalization for acute medical illness**. *J Am Geriatr Soc* 2008, **56**(12):2171-2179.

10. Fortinsky RH, Covinsky KE, Palmer RM, Landefeld CS: **Effects of functional status changes before and during hospitalization on nursing home admission of older adults**. *J Gerontol A Biol Sci Med Sci* 1999, **54**(10):M521-526.

11. Hoogerduijn JG, Schuurmans MJ, Duijnstee MS, de Rooij SE, Grypdonck MF: **A systematic review of predictors and screening instruments to identify older hospitalized patients at risk for functional decline**. *J Clin Nurs* 2007, **16**(1):46-57.

12. Avila-Funes JA, Amieva H, Barberger-Gateau P, Le Goff M, Raoux N, Ritchie K, Carriere I, Tavernier B, Tzourio C, Gutierrez-Robledo LM *et al*: **Cognitive impairment improves the predictive validity of the phenotype of frailty for adverse health outcomes: the three-city study**. *J Am Geriatr Soc* 2009, **57**(3):453-461. Epub 2009 Feb 2022.

13. Creditor MC: **Hazards of hospitalization of the elderly**. *Ann Intern Med* 1993, **118**(3):219-223.

14. Inouye SK: **Delirium in older persons**. *N Engl J Med* 2006, **354**(11):1157-1165.

15. McCusker J, Kakuma R, Abrahamowicz M: **Predictors of functional decline in hospitalized elderly patients: a systematic review**. *J Gerontol A Biol Sci Med Sci* 2002, **57**(9):M569-577.

16. Bakker TJ, Duivenvoorden HJ, Schudel WJ: **Psychogeriatric reactivation in a psychiatric-skilled nursing home: a clinical-empirical exploration**. *Int J Geriatr Psychiatry* 2001, **16**(1):1-6.

17. Nusselder WJ, Looman CW, Mackenbach JP: **Nondisease factors affected trajectories of disability in a prospective study**. *J Clin Epidemiol* 2005, **58**(5):484-494.

18. Stuck AE, Walthert JM, Nikolaus T, Bula CJ, Hohmann C, Beck JC: **Risk factors for functional status decline in community-living elderly people: a systematic literature review**. *Soc Sci Med* 1999, **48**(4):445-469.

19. Bjorkman IK, J. F, Schmidt IK, Bernsten CB: **Pharmaceutical Care of the Elderly in Europe Research (PEER) Group: Drug-drug interactions in the elderly**. *The Annals of Pharmacotherapy* 2002, **36**(11):1675-1681.

20. Kanauchi M Fau - Kubo A, Kubo A Fau - Kanauchi K, Kanauchi K Fau - Saito Y, Saito Y: **Frailty, health-related quality of life and mental well-being in older adults with cardiometabolic risk factors**. *Int, J Clin Pract* 2008 Sep(1742-1241 (Electronic)).

21. Buurman BM, Parlevliet JL, van Deelen BA, de Haan RJ, de Rooij SE: **A randomised clinical trial on a comprehensive geriatric assessment and intensive home follow-up after hospital discharge: the Transitional Care Bridge**. *BMC Health Serv Res* 2010, **10**:296.

22. Hoogerduijn JG: **Identification of Older hospitalized Patients at Risk for Functional Decline**. In*; Oisterwijk, the Netherlands: Utrecht University*. 2011.

23. Salvi F, Morichi V, Grilli A, Lancioni L, Spazzafumo L, Polonara S, Abbatecola AM, De Tommaso G, Dessi-Fulgheri P, Lattanzio F: **Screening for frailty in elderly emergency department patients by using the Identification of Seniors At Risk (ISAR)**. *J Nutr Health Aging* 2012, **16**(4):313-318.

24. Bagshaw SM, McDermid RC: **The role of frailty in outcomes from critical illness**. *Curr Opin Crit Care* 2013, **19**(5):496-503.

25. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, Seeman T, Tracy R, Kop WJ, Burke G *et al*: **Frailty in older adults: evidence for a phenotype**. *J Gerontol A Biol Sci Med Sci* 2001, **56**(3):M146-156.

26. Bergman H, Beland F, Karunananthan S, Hummel S, Hogan D, Wolfson C: **Developpement d'un cadre de travail pour comprendre et etudier la fragilite. Pour L'initiative canadienne sur la fragilite et le vieillissement**. *Gerontologie et societe* 2004, **109**(2):15-29.

27. Bergman H, Ferrucci L, Guralnik J, Hogan DB, Hummel S, Karunananthan S, Wolfson C: **Frailty: an emerging research and clinical paradigm--issues and controversies**. *J Gerontol A Biol Sci Med Sci* 2007, **62**(7):731-737.

28. Gobbens RJ, Luijkx KG, Wijnen-Sponselee MT, Schols JM: **Towards an integral conceptual model of frailty**. *J Nutr Health Aging* 2010, **14**(3):175-181.

29. Hirsch CH, Sommers L, Olsen A, Mullen L, Winograd CH: **The natural history of functional morbidity in hospitalized older patients**. *J Am Geriatr Soc* 1990, **38**(12):1296-1303.

30. Inouye SK, Studenski S, Tinetti ME, Kuchel GA: **Geriatric syndromes: clinical, research, and policy implications of a core geriatric concept**. *J Am Geriatr Soc* 2007, **55**(5):780-791.

31. Baztan JJ, Suarez-Garcia FM, Lopez-Arrieta J, Rodriguez-Manas L, Rodriguez-Artalejo F: **Effectiveness of acute geriatric units on functional decline, living at home, and case fatality among older patients admitted to hospital for acute medical disorders: meta-analysis**. *Bmj* 2009, **338:b50.**(doi):10.1136/bmj.b1150.

32. Beswick AD, Rees K, Dieppe P, Ayis S, Gooberman-Hill R, Horwood J, Ebrahim S: **Complex interventions to improve physical function and maintain independent living in elderly people: a systematic review and meta-analysis**. *Lancet* 2008, **371**(9614):725-735.

33. de Morton NA, Keating JL, Jeffs K: **The effect of exercise on outcomes for older acute medical inpatients compared with control or alternative treatments: a systematic review of randomized controlled trials**. *Clin Rehabil* 2007, **21**(1):3-16.

34. Saltvedt I, Mo ES, Fayers P, Kaasa S, Sletvold O: **Reduced mortality in treating acutely sick, frail older patients in a geriatric evaluation and management unit. A prospective randomized trial**. *J Am Geriatr Soc* 2002, **50**(5):792-798.

35. Bird SR, Kurowski W, Dickman GK, Kronborg I: **Integrated care facilitation for older patients with complex health care needs reduces hospital demand**. *Aust Health Rev* 2007, **31**(3):451-461; discussion 449-450.

36. Hansen FR, Spedtsberg K, Schroll M: **Geriatric follow-up by home visits after discharge from hospital: a randomized controlled trial**. *Age Ageing* 1992, **21**(6):445-450.

37. Sheaff R, Boaden R, Sargent P, Pickard S, Gravelle H, Parker S, Roland M: **Impacts of case management for frail elderly people: a qualitative study**. *J Health Serv Res Policy* 2009, **14**(2):88-95.

38. Harbers MM: **Preventie gericht op ouderen samengevat**. *Volksgezondheid Toekomst Verkenning, Nationaal Kompas Volksgezondheid Bilthoven: RIVM,* <http://wwwnationaalkompasnl> *Nationaal Kompas Volksgezondheid\Preventie\Gericht op doelgroepen\Ouderen* 2009.

39. Boyd CM, Landefeld CS, Counsell SR, Palmer RM, Fortinsky RH, Kresevic D, Burant C, Covinsky KE: **Recovery of Activities of Daily Living in Older Adults After Hospitalization for Acute Medical Illness**. *J Am Geriatr Soc* 2008, **56**(12):2171-2179.

40. Hebert R, Brayne C, Spiegelhalter D: **Factors associated with functional decline and improvement in a very elderly community-dwelling population**. *Am J Epidemiol* 1999, **150**(5):501-510.

41. Hoogerduijn JG, Schuurmans MJ, Korevaar JC, Buurman BM, de Rooij SE: **Identification of older hospitalised patients at risk for functional decline, a study to compare the predictive values of three screening instruments**. *J Clin Nurs* 2010, **19**(9-10):1219-1225. Epub 2010 Mar 1216.

42. Inouye SK, Peduzzi PN, Robison JT, Hughes JS, Horwitz RI, Concato J: **Importance of functional measures in predicting mortality among older hospitalized patients**. *Jama* 1998, **279**(15):1187-1193.

43. Stuck AE, Egger M, Hammer A, Minder CE, Beck JC: **Home visits to prevent nursing home admission and functional decline in elderly people: systematic review and meta-regression analysis**. *Jama* 2002, **287**(8):1022-1028.

44. Counsell SR, Holder CM, Liebenauer LL, Palmer RM, Fortinsky RH, Kresevic DM, Quinn LM, Allen KR, Covinsky KE, Landefeld CS: **Effects of a multicomponent intervention on functional outcomes and process of care in hospitalized older patients: a randomized controlled trial of Acute Care for Elders (ACE) in a community hospital**. *J Am Geriatr Soc* 2000, **48**(12):1572-1581.

45. Asplund K, Gustafson Y, Jacobsson C, Bucht G, Wahlin A, Peterson J, Blom JO, Angquist KA: **Geriatric-based versus general wards for older acute medical patients: a randomized comparison of outcomes and use of resources**. *J Am Geriatr Soc* 2000, **48**(11):1381-1388.

46. Ellis G, Langhorne P: **Comprehensive geriatric assessment for older hospital patients**. *Br Med Bull* 2004, **71**:45-59.

47. Van Craen K, Braes T, Wellens N, Denhaerynck K, Flamaing J, Moons P, Boonen S, Gosset C, Petermans J, Milisen K: **The effectiveness of inpatient geriatric evaluation and management units: a systematic review and meta-analysis**. *J Am Geriatr Soc* 2010, **58**(1):83-92. Epub 2009 Dec 2009.

48. Gillespie LD, Gillespie WJ, Robertson MC, Lamb SE, Cumming RG, Rowe BH: **Interventions for preventing falls in elderly people**. *Cochrane Database Syst Rev* 2001(3):CD000340.

49. Caplan GA, Williams AJ, Daly B, Abraham K: **A randomized, controlled trial of comprehensive geriatric assessment and multidisciplinary intervention after discharge of elderly from the emergency department--the DEED II study**. *J Am Geriatr Soc* 2004, **52**(9):1417-1423.

50. Naylor MD, Brooten D, Campbell R, Jacobsen BS, Mezey MD, Pauly MV, Schwartz JS: **Comprehensive discharge planning and home follow-up of hospitalized elders: a randomized clinical trial**. *Jama* 1999, **281**(7):613-620.

51. Cunliffe AL, Gladman JR, Husbands SL, Miller P, Dewey ME, Harwood RH: **Sooner and healthier: a randomised controlled trial and interview study of an early discharge rehabilitation service for older people**. *Age Ageing* 2004, **33**(3):246-252.

52. Cohen HJ, Feussner JR, Weinberger M, Carnes M, Hamdy RC, Hsieh F, Phibbs C, Courtney D, Lyles KW, May C *et al*: **A controlled trial of inpatient and outpatient geriatric evaluation and management**. *N Engl J Med* 2002, **346**(12):905-912.

53. Kircher TT, Wormstall H, Muller PH, Schwarzler F, Buchkremer G, Wild K, Hahn JM, Meisner C: **A randomised trial of a geriatric evaluation and management consultation services in frail hospitalised patients**. *Age Ageing* 2007, **36**(1):36-42.

54. Nikolaus T, Specht-Leible N, Bach M, Oster P, Schlierf G: **A randomized trial of comprehensive geriatric assessment and home intervention in the care of hospitalized patients**. *Age Ageing* 1999, **28**(6):543-550.

55. Ouwens M, Wollersheim H, Hermens R, Hulscher M, Grol R: **Integrated care programmes for chronically ill patients: a review of systematic reviews**. *Int J Qual Health Care* 2005, **17**(2):141-146. Epub 2005 Jan 2021.

56. Weingarten SR, Henning JM, Badamgarav E, Knight K, Hasselblad V, Gano A, Jr., Ofman JJ: **Interventions used in disease management programmes for patients with chronic illness-which ones work? Meta-analysis of published reports**. *Bmj* 2002, **325**(7370):925.

57. Wells JL, Seabrook JA, Stolee P, Borrie MJ, Knoefel F: **State of the art in geriatric rehabilitation. Part I: review of frailty and comprehensive geriatric assessment**. *Arch Phys Med Rehabil* 2003, **84**(6):890-897.

58. Kempen GI, Brilman EI, Ormel J: **[The Mini Mental Status Examination. Normative data and a comparison of a 12-item and 20-item version in a sample survey of community-based elderly]**. *Tijdschr Gerontol Geriatr* 1995, **26**(4):163-172.

59. Kaufer DI, Cummings JL, Ketchel P, Smith V, MacMillan A, Shelley T, Lopez OL, DeKosky ST: **Validation of the NPI-Q, a brief clinical form of the Neuropsychiatric Inventory**. *J Neuropsychiatry Clin Neurosci* 2000, **12**(2):233-239.

60. Folstein MF, Folstein SE, McHugh PR: **"Mini-mental state". A practical method for grading the cognitive state of patients for the clinician**. *J Psychiatr Res* 1975, **12**(3):189-198.

61. Kempen GI: **[Assessment of health status of the elderly. Application of a Dutch version of the MOS scale]**. *Tijdschr Gerontol Geriatr* 1992, **23**(4):132-140.

62. Bouwens SF, van Heugten CM, Verhey FR: **Review of goal attainment scaling as a useful outcome measure in psychogeriatric patients with cognitive disorders**. *Dement Geriatr Cogn Disord* 2008, **26**(6):528-540. Epub 2008 Dec 2002.

63. Joyce BM, Rockwood KJ, Mate-Kole CC: **Use of goal attainment scaling in brain injury in a rehabilitation hospital**. *Am J Phys Med Rehabil* 1994, **73**(1):10-14.

64. Rockwood K, Howlett S, Stadnyk K, Carver D, Powell C, Stolee P: **Responsiveness of goal attainment scaling in a randomized controlled trial of comprehensive geriatric assessment**. *J Clin Epidemiol* 2003, **56**(8):736-743.

65. Rockwood K, Stolee P, Fox RA: **Use of goal attainment scaling in measuring clinically important change in the frail elderly**. *J Clin Epidemiol* 1993, **46**(10):1113-1118.

66. Bakker TJ, Duivenvoorden HJ, van der Lee J, Olde Rikkert MG, Beekman AT, Ribbe MW: **Integrative Psychotherapeutic Nursing Home Program to Reduce Multiple Psychiatric Symptoms of Cognitively Impaired Patients and Caregiver Burden: Randomized Controlled Trial**. *Am J Geriatr Psychiatry* 2011, **19**(6):507-520.

67. Bakker TJEM, van der Lee J: **[Integrative reactivation and rehabilitation (IRR): A rehabilitation program for frail elderly who suffer from multiple psychiatric functioning disorders]**. *Tijdschrift voor Verpleeghuis Geneeskunde* 2009, **34**(1):24-28.

68. Asmus-Szepesi KJ, de Vreede PL, Nieboer AP, van Wijngaarden JD, Bakker TJ, Steyerberg EW, Mackenbach JP: **Evaluation design of a reactivation care program to prevent functional loss in hospitalised elderly: a cohort study including a randomised controlled trial**. *BMC Geriatr* 2011, **11**:36.

69. Horner S, Rew L, Torres R: **Enhancing intervention fidelity: a means of strengthening study impact**. *J Spec Pediatr Nurs* 2006, **11**(2):80-89.

70. Mowbray CT, Holter MC, Teague GB, D. B: **Fidelity Criteria: Development, Measurement, and Validation**. *American Journal of Evaluation* 2003, **24**(3):315-340.

71. Perepletchikova F, Kazdin AE: **Treatment Integrity and Therapeutic Change: Issues and Research Recommendations**. *Clinical Psychology: Science and Practice* 2005, **12**(4):365-383.

72. Santacroce SJ, Maccarelli LM, Grey M: **Intervention fidelity**. *Nurs Res* 2004, **53**(1):63-66.

73. Allen S, Bartlett T, McCubbin C, Williams A: **Benefits of an Older Person's Assessment and Liaison Team in Acute Admissions Areas of a General Hospital**. *Pragmatic and Observational research* 2010(1):1-6.

74. Inouye SK, Bogardus ST, Jr., Baker DI, Leo-Summers L, Cooney LM, Jr.: **The Hospital Elder Life Program: a model of care to prevent cognitive and functional decline in older hospitalized patients. Hospital Elder Life Program**. *J Am Geriatr Soc* 2000, **48**(12):1697-1706.

75. Boyd CM, Landefeld CS, Counsell SR, Palmer RM, Fortinsky RH, Kresevic D, Burant C, Covinsky KE: **Recovery of activities of daily living in older adults after hospitalization for acute medical illness**. *J Am Geriatr Soc* 2008, **56**(12):2171-2179.

76. de Rooij SE, Govers A, Korevaar JC, Abu-Hanna A, Levi M, de Jonge E: **Short-term and long-term mortality in very elderly patients admitted to an intensive care unit**. *Intensive Care Med* 2006, **32**(7):1039-1044. Epub 2006 May 1039.

77. Covinsky KE, Wu AW, Landefeld CS, Connors AF, Jr., Phillips RS, Tsevat J, Dawson NV, Lynn J, Fortinsky RH: **Health status versus quality of life in older patients: does the distinction matter?** *Am J Med* 1999, **106**(4):435-440.

78. Health Council of the Netherlands: **Prevention in the elderly: Focus on functioning in daily life**. The Hague: Health Council of the Netherlands; 2009. publication no. 2009/07.

79. Lang PO, Meyer N, Heitz D, Drame M, Jovenin N, Ankri J, Somme D, Novella JL, Gauvain JB, Couturier P *et al*: **Loss of independence in Katz's ADL ability in connection with an acute hospitalization: early clinical markers in French older people**. *Eur J Epidemiol* 2007, **22**(9):621-630. Epub 2007 Jul 2025.

80. Mackenbach JP, Borsboom GJ, Nusselder WJ, Looman CW, Schrijvers CT: **Determinants of levels and changes of physical functioning in chronically ill persons: results from the GLOBE Study**. *J Epidemiol Community Health* 2001, **55**(9):631-638.

81. Sager MA, Franke T, Inouye SK, Landefeld CS, Morgan TM, Rudberg MA, Sebens H, Winograd CH: **Functional outcomes of acute medical illness and hospitalization in older persons**. *Arch Intern Med* 1996, **156**(6):645-652.

82. Volpato S, Onder G, Cavalieri M, Guerra G, Sioulis F, Maraldi C, Zuliani G, Fellin R: **Characteristics of nondisabled older patients developing new disability associated with medical illnesses and hospitalization**. *J Gen Intern Med* 2007, **22**(5):668-674. Epub 2007 Mar 2001.

83. Wu HY, Sahadevan S, Ding YY: **Factors associated with functional decline of hospitalised older persons following discharge from an acute geriatric unit**. *Ann Acad Med Singapore* 2006, **35**(1):17-23.

84. Weingarten SR, Henning JM, Badamgarav E, Knight K, Hasselblad V, Gano A, Jr., Ofman JJ: **Interventions used in disease management programmes for patients with chronic illness-which ones work? Meta-analysis of published reports**. *Bmj* 2002, **325**(7370):925.

85. Rockwood K, Joyce B, Stolee P: **Use of goal attainment scaling in measuring clinically important change in cognitive rehabilitation patients**. *J Clin Epidemiol* 1997, **50**(5):581-588.

86. Bachmann S, Finger C, Huss A, Egger M, Stuck AE, Clough-Gorr KM: **Inpatient rehabilitation specifically designed for geriatric patients: systematic review and meta-analysis of randomised controlled trials**. *Bmj* 2010, **340:c1718.**(doi):10.1136/bmj.c1718.

87. Cutchin MP, Coppola S, Talley V, Svihula J, Catellier D, Shank KH: **Feasibility and effects of preventive home visits for at-risk older people: design of a randomized controlled trial**. *BMC Geriatr* 2009, **9**:54.

88. Eklund K, Wilhelmson K: **Outcomes of coordinated and integrated interventions targeting frail elderly people: a systematic review of randomised controlled trials**. *Health Soc Care Community* 2009, **17**(5):447-458. Epub 2009 Feb 2024.

89. Hyde CJ, Robert IE, Sinclair AJ: **The effects of supporting discharge from hospital to home in older people**. *Age Ageing* 2000, **29**(3):271-279.

90. Kat MG, de Jonghe JF, Aalten P, Kalisvaart CJ, Droes RM, Verhey FR: **[Neuropsychiatric symptoms of dementia: psychometric aspects of the Dutch Neuropsychiatric Inventory (NPI)]**. *Tijdschr Gerontol Geriatr* 2002, **33**(4):150-155.

91. Homs MY, Steyerberg EW, Eijkenboom WM, Tilanus HW, Stalpers LJ, Bartelsman JF, van Lanschot JJ, Wijrdeman HK, Mulder CJ, Reinders JG *et al*: **Single-dose brachytherapy versus metal stent placement for the palliation of dysphagia from oesophageal cancer: multicentre randomised trial**. *Lancet* 2004, **364**(9444):1497-1504.

92. Folstein MF, Folstein SE, McHugh PR: **"Mini-mental state". A practical method for grading the cognitive state of patients for the clinician**. *J Psychiatr Res* 1975, **12**(3):189-198.

93. EuroQol Group: **EuroQol--a new facility for the measurement of health-related quality of life.** . *Health Policy* 1990, **16**(3):199-208.

94. Carver DJ, Chapman CA, Thomas VS, Stadnyk KJ, Rockwood K: **Validity and reliability of the Medical Outcomes Study Short Form-20 questionnaire as a measure of quality of life in elderly people living at home**. *Age Ageing* 1999, **28**(2):169-174.

95. Nieboer A, Lindenberg S, Boomsma A, Bruggen ACV: **Dimensions Of Well-Being And Their Measurement: The Spf-Ll Scale**. *Social Indicators Research* 2005, **73**(3):313-353.

96. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW: **STUDIES OF ILLNESS IN THE AGED. THE INDEX OF ADL: A STANDARDIZED MEASURE OF BIOLOGICAL AND PSYCHOSOCIAL FUNCTION**. *Jama* 1963, **185**:914-919.

97. Weinberger M, Samsa GP, Schmader K, Greenberg SM, Carr DB, Wildman DS: **Comparing proxy and patients' perceptions of patients' functional status: results from an outpatient geriatric clinic**. *J Am Geriatr Soc* 1992, **40**(6):585-588.

98. Stel VS, Smit JH, Pluijm SM, Visser M, Deeg DJ, Lips P: **Comparison of the LASA Physical Activity Questionnaire with a 7-day diary and pedometer**. *J Clin Epidemiol* 2004, **57**(3):252-258.

99. Fisher S, Ottenbacher KJ, Goodwin JS, Graham JE, Ostir GV: **Short Physical Performance Battery in hospitalized older adults**. *Aging Clin Exp Res* 2009, **21**(6):445-452.

100. Guralnik JM, Seeman TE, Tinetti ME, Nevitt MC, Berkman LF: **Validation and use of performance measures of functioning in a non-disabled older population: MacArthur studies of successful aging**. *Aging (Milano)* 1994, **6**(6):410-419.

101. Reisberg B, Ferris SH, de Leon MJ, Crook T: **The Global Deterioration Scale for assessment of primary degenerative dementia**. *Am J Psychiatry* 1982, **139**(9):1136-1139.

102. Sheikh JI, Yesavage JA: **Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version**. *Clinical Gerontology* 1986, **5**:165-173.

103. de Craen AJ, Heeren TJ, Gussekloo J: **Accuracy of the 15-item geriatric depression scale (GDS-15) in a community sample of the oldest old**. *Int J Geriatr Psychiatry* 2003, **18**(1):63-66.

104. Lyness JM, Noel TK, Cox C, King DA, Conwell Y, Caine ED: **Screening for depression in elderly primary care patients. A comparison of the Center for Epidemiologic Studies-Depression Scale and the Geriatric Depression Scale**. *Arch Intern Med* 1997, **157**(4):449-454.

105. De Jong Gierveld J, Van Tilburg T: **The De Jong Gierveld short scales for emotional and social loneliness: tested on data from 7 countries in the UN generations and gender surveys**. *Eur J Ageing* 2010, **7**(2):121-130. Epub 2010 Apr 2019.

106. Schuurmans H, Steverink N, Frieswijk N, Buunk BP, Slaets JP, Lindenberg S: **How to measure self-management abilities in older people by self-report. The development of the SMAS-30**. *Qual Life Res* 2005, **14**(10):2215-2228.

107. Brouwer WB, van Exel NJ, van Gorp B, Redekop WK: **The CarerQol instrument: a new instrument to measure care-related quality of life of informal caregivers for use in economic evaluations**. *Qual Life Res* 2006, **15**(6):1005-1021.

108. Williamson GM, Schulz R: **Pain, activity restriction, and symptoms of depression among community-residing elderly adults**. *J Gerontol* 1992, **47**(6):P367-372.

109. Brouwer WB, van Exel NJ, van de Berg B, Dinant HJ, Koopmanschap MA, van den Bos GA: **Burden of caregiving: evidence of objective burden, subjective burden, and quality of life impacts on informal caregivers of patients with rheumatoid arthritis**. *Arthritis Rheum* 2004, **51**(4):570-577.

110. van den Berg B, Spauwen P: **Measurement of informal care: an empirical study into the valid measurement of time spent on informal caregiving**. *Health Econ* 2006, **15**(5):447-460.

111. Robinson BC: **Validation of a Caregiver Strain Index**. *J Gerontol* 1983, **38**(3):344-348.

112. van Exel NJ, Scholte op Reimer WJ, Brouwer WB, van den Berg B, Koopmanschap MA, van den Bos GA: **Instruments for assessing the burden of informal caregiving for stroke patients in clinical practice: a comparison of CSI, CRA, SCQ and self-rated burden**. *Clin Rehabil* 2004, **18**(2):203-214.

113. Glasgow RE, Wagner EH, Schaefer J, Mahoney LD, Reid RJ, Greene SM: **Development and validation of the Patient Assessment of Chronic Illness Care (PACIC)**. *Med Care* 2005, **43**(5):436-444.

114. Arah OA, ten Asbroek AH, Delnoij DM, de Koning JS, Stam PJ, Poll AH, Vriens B, Schmidt PF, Klazinga NS: **Psychometric properties of the Dutch version of the Hospital-level Consumer Assessment of Health Plans Survey instrument**. *Health Serv Res* 2006, **41**(1):284-301.

115. Boter H, De Haan RJ, Rinkel GJ: **Clinimetric evaluation of a Satisfaction-with-Stroke-Care questionnaire**. *J Neurol* 2003, **250**(5):534-541.

116. Cramm JM, Strating MM, Nieboer AP: **Validation of the Caregivers' Satisfaction with Stroke Care Questionnaire: C-SASC hospital scale**. *J Neurol* 2010, **22**:22.

117. Ouwens M, Hulscher M, Akkermans R, Hermens R, Grol R, Wollersheim H: **The Team Climate Inventory: application in hospital teams and methodological considerations**. *Qual Saf Health Care* 2008, **17**(4):275-280.

118. Bonomi AE, Wagner EH, Glasgow RE, VonKorff M: **Assessment of chronic illness care (ACIC): a practical tool to measure quality improvement**. *Health Serv Res* 2002, **37**(3):791-820.

119. Gittell JH, Fairfield KM, Bierbaum B, Head W, Jackson R, Kelly M, Laskin R, Lipson S, Siliski J, Thornhill T *et al*: **Impact of relational coordination on quality of care, postoperative pain and functioning, and length of stay: a nine-hospital study of surgical patients**. *Med Care* 2000, **38**(8):807-819.

120. Steyerberg EW, Bleeker SE, Moll HA, Grobbee DE, Moons KG: **Internal and external validation of predictive models: a simulation study of bias and precision in small samples**. *J Clin Epidemiol* 2003, **56**(5):441-447.

121. Rutten FFH VIB, Van Ommen R, Van Hout BA, Huijsman R.: **Kostenberekening bij gezondheidszorgonderzoek; richtlijnen voor de praktijk**. Utrecht: STG/Jan van Arkel; 1993.

122. Hakkaart- van Roijen L; Tan SS; Bouwmans CAM.: **Handleiding voor kostenonderzoek, methoden en standaard kostprijzen voor economische evaluaties in de gezondheidszorg.** *College voor zorgverzekeringen* Geactualiseerde versie 2010.

123. van Straten A, van der Meulen JH, van den Bos GA, Limburg M: **Length of hospital stay and discharge delays in stroke patients**. *Stroke* 1997, **28**(1):137-140.

124. Van Exel J, Koopmanschap MA, Van Wijngaarden JD, Scholte Op Reimer WJ: **Costs of stroke and stroke services: Determinants of patient costs and a comparison of costs of regular care and care organised in stroke services**. *Cost Eff Resour Alloc* 2003, **1**(1):2.

125. Struijs JN, van Genugten ML, Evers SM, Ament AJ, Baan CA, van den Bos GA: **Future costs of stroke in the Netherlands: the impact of stroke services**. *Int J Technol Assess Health Care* 2006, **22**(4):518-524.

126. Donabedian A: **The quality of care. How can it be assessed?** *Jama* 1988, **260**(12):1743-1748.

127. Campbell M, Fitzpatrick R, Haines A, Kinmonth AL, Sandercock P, Spiegelhalter D, Tyrer P: **Framework for design and evaluation of complex interventions to improve health**. *Bmj* 2000, **321**(7262):694-696.

128. Campbell NC, Murray E, Darbyshire J, Emery J, Farmer A, Griffiths F, Guthrie B, Lester H, Wilson P, Kinmonth AL: **Designing and evaluating complex interventions to improve health care**. *Bmj* 2007, **334**(7591):455-459.

129. Lemmens KM, Rutten-Van Molken MP, Cramm JM, Huijsman R, Bal RA, Nieboer AP: **Evaluation of a large scale implementation of disease management programmes in various Dutch regions: a study protocol**. *BMC Health Serv Res* 2011, **11**:6.

130. de Rooij SE, Emmelot-Vonk MH, Evers A, Knijnenburg CMR, Kok RM, Nijs K, Roks CMAA, Scheffer AC, Schuurmans M, Vervest AMJS *et al*: **VMS Veiligheidsprogramma.** http://wwwvmszorgnl/_page/vms_inline?nodeid=4571 *&subjectid=6702&configid=6484* 2009.

131. Hoogerduijn JG, Buurman BM, Korevaar JC, Grobbee DE, de Rooij SE, Schuurmans MJ: **The prediction of functional decline in older hospitalised patients**. *Age and Ageing* 2012, **41**(3):381-387.

132. McCusker J, Bellavance F, Cardin S, Trepanier S, Verdon J, Ardman O: **Detection of older people at increased risk of adverse health outcomes after an emergency visit: the ISAR screening tool**. *J Am Geriatr Soc* 1999, **47**(10):1229-1237.

133. Heim N: **Kwetsbare patienten opsporen met VMS**. *Medisch Contact* 2013, **68**:94-96.

134. McCusker J, Bellavance F, Cardin S, Trepanier S, committee Tiosars: **Screening for Geriatric problems in the Emergency Department: Reliability and Validity**. *Academic Emergency medicine* 1998, **5**:883-893.

135. Buurman BM, Hoogerduijn JG, van Gemert EA, de Haan RJ, Schuurmans MJ, de Rooij SE: **Clinical characteristics and outcomes of hospitalized older patients with distinct risk profiles for functional decline: a prospective cohort study**. *PLoS One* 2012, **7**(1):e29621.

136. Lawton MP, Brody EM: **Assessment of older people: self-maintaining and instrumental activities of daily living**. *Gerontologist* 1969, **9**(3):179-186.

137. H.M. K, J.C. S, H.C.W. DV, N.J. W, M.A.E. vB-dvdS: **Development and validation of a hospital screening tool for malnutrition: the short nutritional assessment questionnaire (SNAQ)**. *Clinical nutrition*, **24**:75-82.

138. Weinberger M, Samsa GP, Schmader K, Greenberg SM, Carr DB, Wildman DS: **Comparing proxy and patients' perceptions of patients' functional status: results from an outpatient geriatric clinic**. *J Am Geriatr Soc* 1992, **40**(6):585-588.

139. Murphy AH, Winkler RL: **A general framework for forecast verification.** *Monthly Weather Review* 1987, **115**:1330–1338.

140. Dendukuri N, McCusker J, Belzile E: **The identification of seniors at risk screening tool: further evidence of concurrent and predictive validity**. *J Am Geriatr Soc* 2004, **52**(2):290-296.

141. McCusker J, Bellavance F, Cardin S, Belzile E, Verdon J: **Prediction of hospital utilization among elderly patients during the 6 months after an emergency department visit.** *Annals of Emergency medicine* 2000, **36**(438-445).

142. Cameron ID, Schaafsma FG, Wilson S, Baker W, Buckley S: **Outcomes of rehabilitation in older people - functioning and cognition are the most important predictors: An inception cohort study**. *J Rehabil Med* 2012, **44**(1):24-30.

143. Ferrucci L, Guralnik JM, Studenski S, Fried LP, Cutler GB, Jr., Walston JD: **Designing randomized, controlled trials aimed at preventing or delaying functional decline and disability in frail, older persons: a consensus report**. *J Am Geriatr Soc* 2004, **52**(4):625-634.

144. Sager MA, Rudberg MA, Jalaluddin M, Franke T, Inouye SK, Landefeld CS, Siebens H, Winograd CH: **Hospital admission risk profile (HARP): identifying older patients at risk for functional decline following acute medical illness and hospitalization**. *J Am Geriatr Soc* 1996, **44**(3):251-257.

145. Hoogerduijn JG, Buurman BM, Korevaar JC, Grobbee DE, de Rooij SE, Schuurmans MJ: **The prediction of functional decline in older hospitalised patients**. *Age Ageing* 2012, **41**(3):381-387. Epub 2012 Feb 2028.

146. Lawton MP, Brody EM: **Assessment of older people: self-maintaining and instrumental activities of daily living**. *Gerontologist* 1969, **9**(3):179-186.

147. Abellan van Kan G, Rolland Y, Houles M, Gillette-Guyonnet S, Soto M, Vellas B: **The assessment of frailty in older adults**. *Clin Geriatr Med* 2010, **26**(2):275-286.

148. **[Practical Guide on Frail Elderly]. 2009. Safety management system (VMS) expert group on frail elderly (online),** [http://www.vmszorg.nl]

149. Covinsky KE, Kahana E, Chin MH, Palmer RM, Fortinsky RH, Landefeld CS: **Depressive symptoms and 3-year mortality in older hospitalized medical patients**. *Ann Intern Med* 1999, **130**(7):563-569.

150. Gobbens RJ, Luijkx KG, Wijnen-Sponselee MT, Schols JM: **Toward a conceptual definition of frail community dwelling older people**. *Nurs Outlook* 2010, **58**(2):76-86.

151. Buurman BM, Parlevliet JL, van Deelen BA, de Haan RJ, de Rooij SE: **A randomised clinical trial on a comprehensive geriatric assessment and intensive home follow-up after hospital discharge: the Transitional Care Bridge**. *BMC Health Serv Res* 2010, **10**:296.

152. Hoogerduijn JG, Buurman BM, Korevaar JC, Grobbee DE, de Rooij SE, Schuurmans MJ: **The prediction of functional decline in older hospitalised patients**. *Age Ageing* 2012, **41**(3):381-387.

153. Liu LF, Tian WH, Yao HP: **Utilization of health care services by elderly people with National Health Insurance in Taiwan: the heterogeneous health profile approach**. *Health Policy* 2012, **108**(2-3):246-255.

154. McNamee P, Gregson BA, Buck D, Bamford CH, Bond J, Wright K: **Costs of formal care for frail older people in England: the resource implications study of the MRC cognitive function and ageing study (RIS MRC CFAS)**. *Soc Sci Med* 1999, **48**(3):331-341.

155. Hakkaart-van Roijen L, Tan SS, Bouwmans CAM: **Manual for cost research: methods and standard costprices for economic evaluations in healthcare. College for health care insurance.** actualized version 2010.

156. Koopmanschap MA, van Exel JN, van den Berg B, Brouwer WB: **An overview of methods and applications to value informal care in economic evaluations of healthcare**. *Pharmacoeconomics* 2008, **26**(4):269-280.

157. Little RJA, Rubin DB: **Statistical analysis with missing data**: Wiley; 2002.

158. Mackinnon A: **The use and reporting of multiple imputation in medical research - a review**. *J Intern Med* 2010, **268**(6):586-593.

159. de Meijer C, Koopmanschap M, TB DU, van Doorslaer E: **Determinants of long-term care spending: age, time to death or disability?** *J Health Econ* 2011, **30**(2):425-438.

160. de Meijer CA, Koopmanschap MA, Koolman XH, van Doorslaer EK: **The role of disability in explaining long-term care utilization**. *Med Care* 2009, **47**(11):1156-1163.

161. Kelley AS, Ettner SL, Morrison RS, Du Q, Sarkisian CA: **Disability and decline in physical function associated with hospital use at end of life**. *J Gen Intern Med* 2012, **27**(7):794-800.

162. Collard RM, Oude Voshaar RC: **[Frailty; a fragile concept]**

163. **Frailty; een kwetsbaar begrip**. *Tijdschr Psychiatr* 2012, **54**(1):59-69.

164. Rockwood K: **Frailty and its definition: a worthy challenge**. *J Am Geriatr Soc* 2005, **53**(6):1069-1070.

165. Asmus-Szepesi KJ, de Vreede PL, Flinterman LE, Nieboer AP, Bakker TJ, Borsboom GJ, Mackenbach JP, Steyerberg EW: **Prognosis of hospitalised older people with different levels of functioning: a prospective cohort study**. *Age Ageing* 2013.

166. Koopmanschap MA, van Exel JN, van den Berg B, Brouwer WB: **An overview of methods and applications to value informal care in economic evaluations of healthcare**. *Pharmacoeconomics* 2008, **26**(4):269-280.

167. Covinsky KE, Pierluissi E, Johnston CB: **Hospitalization-associated disability: "She was probably able to ambulate, but I'm not sure"**. *Jama* 2011, **306**(16):1782-1793.

168. Wakefield BJ, Holman JE: **Functional trajectories associated with hospitalization in older adults**. *West J Nurs Res* 2007, **29**(2):161-177; discussion 178-182.

169. Kleinpell RM, Fletcher K, Jennings BM: **Reducing Functional Decline in Hospitalized Elderly**. 2008.

170. Luck T, Luppa M, Wiese B, Maier W, van den Bussche H, Eisele M, Jessen F, Weeg D, Weyerer S, Pentzek M *et al*: **Prediction of incident dementia: impact of impairment in instrumental activities of daily living and mild cognitive impairment-results from the German study on ageing, cognition, and dementia in primary care patients**. *Am J Geriatr Psychiatry* 2012, **20**(11):943-954.

171. Njegovan V, Hing MM, Mitchell SL, Molnar FJ: **The hierarchy of functional loss associated with cognitive decline in older persons**. *J Gerontol A Biol Sci Med Sci* 2001, **56**(10):M638-643.

172. van Houwelingen AH, Cameron ID, Gussekloo J, Putter H, Kurrle S, de Craen AJM, Maier AB, den Elzen WPJ, Blom JW: **Disability transitions in the oldest old in the general population. The Leiden 85-plus study**. *Age* 2014, **36**(1):483-493.

173. Yesavage JA, Brink TL: **Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version** *Clinical Gerontology : A Guide to Assessment and Intervention* 1986, **5**:165-173.

174. Narain P, Rubenstein LZ, Wieland GD, Rosbrook B, Strome LS, Pietruszka F, Morley JE: **Predictors of immediate and 6-month outcomes in hospitalized elderly patients. The importance of functional status**. *J Am Geriatr Soc* 1988, **36**(9):775-783.

175. Buurman BM, Hoogerduijn JG, de Haan RJ, Abu-Hanna A, Lagaay AM, Verhaar HJ, Schuurmans MJ, Levi M, de Rooij SE: **Geriatric conditions in acutely hospitalized older patients: prevalence and one-year survival and functional decline**. *PLoS One* 2011, **6**(11):e26951.

176. de Vos AJ, Asmus-Szepesi KJ, Bakker TJ, de Vreede PL, van Wijngaarden JD, Steyerberg EW, Mackenbach JP, Nieboer AP: **Integrated approach to prevent functional decline in hospitalized elderly: the Prevention and Reactivation Care Program (PReCaP)**. *BMC Geriatr* 2012, **12**:7.

177. de Vos AJ, Bakker TJ, de Vreede PL, van Wijngaarden JD, Steyerberg EW, Mackenbach JP, Nieboer AP: **The Prevention and Reactivation Care Program: intervention fidelity matters**. *BMC Health Serv Res* 2013, **13**:29.

178. de Vos AJBM, van Wijngaarden JDH, Bakker TJEM, Mackenbach JP, Nieboer AP: **Clinical Geriatric Care in the Netherlands: A Regional Comparison**. *BMC Geriatr (submitted)* 2014.

179. EuroQol G: **EuroQol--a new facility for the measurement of health-related quality of life**. *Health Policy* 1990, **16**(3):199-208.

180. Norman GR, Sloan JA, Wyrwich KW: **Interpretation of changes in health-related quality of life: the remarkable universality of half a standard deviation**. *Med Care* 2003, **41**(5):582-592.

181. Paddison C, Elliott M, Parker R, Staetsky L, Lyratzopoulos G, Campbell JL, Roland M: **Should measures of patient experience in primary care be adjusted for case mix? Evidence from the English General Practice Patient Survey**. *BMJ Quality & Safety* 2012.

182. Yaffe K, Fox P, Newcomer R, Sands L, Lindquist K, Dane K, Covinsky KE: **Patient and caregiver characteristics and nursing home placement in patients with dementia**. *Jama* 2002, **287**(16):2090-2097.

183. Clegg A, Barber S, Young J, Iliffe S, Forster A: **The Home-based Older People's Exercise (HOPE) trial: a pilot randomised controlled trial of a home-based exercise intervention for older people with frailty**. *Age Ageing* 2014.

184. Boyd CM, Xue QL, Simpson CF, Guralnik JM, Fried LP: **Frailty, hospitalization, and progression of disability in a cohort of disabled older women**. *Am J Med* 2005, **118**(11):1225-1231.

185. Landefeld CS: **Improving health care for older persons**. *Ann Intern Med* 2003, **139**(5 Pt 2):421-424.

186. Hernan MA, Hernandez-Diaz S: **Beyond the intention-to-treat in comparative effectiveness research**. *Clin Trials* 2012, **9**(1):48-55. doi: 10.1177/1740774511420743. Epub 1740774511422011 Sep 1740774511420723.

187. Applegate WB, Miller ST, Graney MJ, Elam JT, Burns R, Akins DE: **A randomized, controlled trial of a geriatric assessment unit in a community rehabilitation hospital**. *N Engl J Med* 1990, **322**(22):1572-1578.

188. Fleming SA, Blake H, Gladman JR, Hart E, Lymbery M, Dewey ME, McCloughry H, Walker M, Miller P: **A randomised controlled trial of a care home rehabilitation service to reduce long-term institutionalisation for elderly people**. *Age Ageing* 2004, **33**(4):384-390. Epub 2004 May 2019.

189. Rubenstein LZ, Josephson KR, Wieland GD, English PA, Sayre JA, Kane RL: **Effectiveness of a geriatric evaluation unit. A randomized clinical trial**. *N Engl J Med* 1984, **311**(26):1664-1670.

190. McCusker J, Verdon J, Tousignant P, de Courval LP, Dendukuri N, Belzile E: **Rapid emergency department intervention for older people reduces risk of functional decline: results of a multicenter randomized trial**. *J Am Geriatr Soc* 2001, **49**(10):1272-1281.

191. Runciman P, Currie CT, Nicol M, Green L, McKay V: **Discharge of elderly people from an accident and emergency department: evaluation of health visitor follow-up**. *J Adv Nurs* 1996, **24**(4):711-718.

192. Buurman BM, van Munster BC, Korevaar JC, de Haan RJ, de Rooij SE: **Variability in measuring (instrumental) activities of daily living functioning and functional decline in hospitalized older medical patients: a systematic review**. *J Clin Epidemiol* 2011, **64**(6):619-627.

193. Beaton K, Grimmer K: **Tools that assess functional decline: systematic literature review update**. *Clin Interv Aging* 2013, **8**:485-494.

194. De Saint-Hubert M, Schoevaerdts D, Cornette P, D'Hoore W, Boland B, Swine C: **Predicting functional adverse outcomes in hospitalized older patients: A systematic review of screening tools**. *J Nutr Health Aging* 2010, **14**(5):394-399.

195. Grimmer K, Beaton K, Kumar S, Hendry K, Moss J, Hillier S, Forward J, Gordge L: **Estimating the risk of functional decline in the elderly after discharge from an Australian public tertiary hospital emergency department**. *Aust Health Rev* 2013, **37**(3):341-347.

196. Claesson L, Gosman-Hedstrom G, Johannesson M, Fagerberg B, Blomstrand C: **Resource utilization and costs of stroke unit care integrated in a care continuum: A 1-year controlled, prospective, randomized study in elderly patients: the Goteborg 70+ Stroke Study**. *Stroke* 2000, **31**(11):2569-2577.

197. Gold DA: **An examination of instrumental activities of daily living assessment in older adults and mild cognitive impairment**. *J Clin Exp Neuropsychol* 2012, **34**(1):11-34. Epub 2011 Nov 2014.

198. Mariani E, Monastero R, Ercolani S, Rinaldi P, Mangialasche F, Costanzi E, Vitale DF, Senin U, Mecocci P, Re GSG: **Influence of comorbidity and cognitive status on instrumental activities of daily living in amnestic mild cognitive impairment: results from the ReGAl project**. *Int J Geriatr Psychiatry* 2008, **23**(5):523-530.

199. Aguero-Torres H, Thomas VS, Winblad B, Fratiglioni L: **The impact of somatic and cognitive disorders on the functional status of the elderly**. *J Clin Epidemiol* 2002, **55**(10):1007-1012.

200. Borenstein J, Aronow HU, Bolton LB, Choi J, Bresee C, Braunstein GD: **Early recognition of risk factors for adverse outcomes during hospitalization among Medicare patients: a prospective cohort study**. *BMC Geriatr* 2013, **13**:72.

201. Metzelthin SF, van Rossum E, de Witte LP, Ambergen AW, Hobma SO, Sipers W, Kempen G: **Effectiveness of interdisciplinary primary care approach to reduce disability in community dwelling frail older people: cluster randomised controlled trial**. *BMJ-British Medical Journal* 2013, **347**.

202. Courtney MD, Edwards HE, Chang AM, Parker AW, Finlayson K, Bradbury C, Nielsen Z: **Improved functional ability and independence in activities of daily living for older adults at high risk of hospital readmission: a randomized controlled trial**. *J Eval Clin Pract* 2012, **18**(1):128-134.

203. Eklund K, Wilhelmson K, Gustafsson H, Landahl S, Dahlin-Ivanoff S: **One-year outcome of frailty indicators and activities of daily living following the randomised controlled trial; "Continuum of care for frail older people"**. *BMC Geriatr* 2013, **13**(1):76.

204. Ciro CA, Ottenbacher KJ, Graham JE, Fisher S, Berges I, Ostir GV: **Patterns and correlates of depression in hospitalized older adults**. *Arch Gerontol Geriatr* 2012, **54**(1):202-205. Epub 2011 May 2012.

205. Kosse NM, Dutmer AL, Dasenbrock L, Bauer JM, Lamoth CJ: **Effectiveness and feasibility of early physical rehabilitation programs for geriatric hospitalized patients: a systematic review**. *BMC Geriatr* 2013, **13**:107.

206. Blackwood B: **Methodological issues in evaluating complex healthcare interventions**. *J Adv Nurs* 2006, **54**(5):612-622.

207. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M: **Developing and evaluating complex interventions: the new Medical Research Council guidance**. *Bmj* 2008, **337:a1655.**(doi):10.1136/bmj.a1655.

208. Melis RJ, van Eijken MI, Teerenstra S, van Achterberg T, Parker SG, Borm GF, van de Lisdonk EH, Wensing M, Rikkert MG: **A randomized study of a multidisciplinary program to intervene on geriatric syndromes in vulnerable older people who live at home (Dutch EASYcare Study)**. *J Gerontol A Biol Sci Med Sci* 2008, **63**(3):283-290.

209. Wilhelmson K, Duner A, Eklund K, Gosman-Hedstrom G, Blomberg S, Hasson H, Gustafsson H, Landahl S, Dahlin-Ivanoff S: **Design of a randomized controlled study of a multi-professional and multidimensional intervention targeting frail elderly people**. *BMC Geriatr* 2011, **11**:24.

210. Deschodt M, Flamaing J, Haentjens P, Boonen S, Milisen K: **Impact of geriatric consultation teams on clinical outcome in acute hospitals: a systematic review and meta-analysis**. *BMC Med* 2013, **11:48.** (doi):10.1186/1741-7015-1111-1148.

211. Carpenter CR: **Deteriorating Functional Status in Older Adults After Emergency Department Evaluation of Minor Trauma-Opportunities and Pragmatic Challenges**. *J Am Geriatr Soc* 2013, **61**(10):1806-1807.

212. Boltz M, Resnick B, Capezuti E, Shuluk J, Secic M: **Functional decline in hospitalized older adults: can nursing make a difference?** *Geriatr Nurs* 2012, **33**(4):272-279.

213. Pereira SR, Chiu W, Turner A, Chevalier S, Joseph L, Huang AR, Morais JA: **How can we improve targeting of frail elderly patients to a geriatric day-hospital rehabilitation program?** *BMC Geriatr* 2010, **10**:82.

214. Abraham J, Reichstein R, Richter C, Sadowski K, Muller-Werdan U: **Situation of acute inpatient geriatric patients. A retrospective analysis of health care processes of geriatric and non- geriatric patients with acute myocardial infarction**. *Z Gerontol Geriatr* 2014, **47**(1):27-34.

CHAPTER 12

Summary

Hospitalized older people are at risk of functional decline during or after their hospital stay. Such decline may be due to physical characteristics (e.g. age, diagnosis), psychological functioning (e.g. delirium, depression), social aspects and economic environment (e.g. caregiver system, loneliness), and living environment before admission, or aspects of (use of) healthcare (e.g. poly pharmacy). Functional decline leads to dependence in daily activities, lower quality of life, higher burden of care for informal caregivers, and higher healthcare costs. In this thesis, we describe the prognosis of hospitalized older people at risk of functional decline by evaluating the usefulness of a short screening instrument, the ISAR-HP in identifying hospitalized older people at risk of functional decline. Secondly, we evaluate the effects of the Prevention and Reactivation Care Program (PReCaP) on patient functioning and health related quality of life (HRQoL). We also describe the effects of a stay at the Prevention and Reactivation Center on older patient outcomes in a randomized clinical trial.

Part one of this thesis consisted of an extensive introduction, consisting of a general introduction (Chapter 1) and two additional chapters (Chapter 2 and 3). In Chapter 2 we described the Prevention and Reactivation Care Program (PReCaP). The PReCaP aims to reduce functional decline among hospitalized older people by offering interventions that are multidisciplinary, integrated, and goal-oriented at the physical, social and psychological domains of functional decline. It consists of five distinct elements, which are early identification of older patients at high risk of functional decline; intensive follow up treatment for a selected patient groups at the Prevention and Reactivation Center (PRC); availability of multidisciplinary geriatric expertise: provision of support and consultation of relevant professionals to informal caregivers and intensive follow up throughout the entire care process by a case manager with geriatric expertise. In Chapter 3 we described the overall study protocol of the evaluation of the PReCaP. The evaluation entailed the comparison of older patients from three hospitals with different levels of geriatric care. The study design was quasi-experimental and included a process evaluation, effect evaluation, and cost effectiveness evaluation. In this chapter we described the study population, which consisted of hospitalized patients 65 years or older and at risk of functional decline according to the Identification Seniors At Risk- Hospitalized Patients (ISAR-HP) questionnaire. Data was prospectively collected at hospital admission and three and twelve months after admission. Primary patient outcomes were activities of daily living (ADL) and instrumental activities of daily living (iADL), whereas secondary patient outcomes were health related quality of life (HRQoL), cognitive functioning, loneliness, depression, mortality, and readmission. Burden of care and health related quality of life of primary informal caregivers as well as process measures such as cooperation and collaboration of multidisciplinary teams and patient satisfaction with care, were part of the evaluation. Furthermore, a protocol for a qualitative evaluation was described to determine the fidelity of the intervention implementation and provide further context and explanation for quantitative

outcomes. Finally, the cost effectiveness evaluation describing costs from a societal viewpoint were described.

Part two (Chapters 4 to 7) was focused on prognosis of hospitalized older people at risk of functional decline. Chapter 4 assessed the use of the Identification Seniors At Risk–Hospitalized Patients (ISAR-HP) in identifying patients at risk of poor functioning by comparing it to the Identification Seniors At Risk (ISAR), the Score Hospitalier d'Évaluation du Risque de Perte d'Autonomie (SHERPA), and a safety management questionnaire (VMS). We administered the questionnaires to 460 patients aged 65 years or older and admitted to a community hospital in the Netherlands for at least 48 hours. Functioning was determined at baseline and three months after inclusion. The ISAR-HP and SHERPA performed best in predicting functional status at three months. Since the ISAR-HP is both shorter and easier to administer and has better sensitivity than the SHERPA, the ISAR-HP is a promising tool to identify patients with poor functioning at three months after hospitalization. Chapter 5 compared hospitalized older people with different ISAR-HP scores on physical functioning, cognitive functioning, health-related quality of life, and loneliness. We administered the ISAR-HP to 460 patients of 65 years and older from a community hospital between June and October 2010. Patients were classified into five risk-groups according to their ISAR-HP score. Results showed that cognitive functioning, physical functioning, loneliness, and HRQoL differed significantly between groups during 1-year follow-up after hospital admission, with high-risk groups having lower scores than low-risk groups for functioning and loneliness, although not always for HRQoL. The lowest risk group (ISAR-HP=0) scored consistently higher on functioning and HRQoL than all other groups. Mortality differed significantly between groups as well. Thus, the ISAR-HP was able to distinguish good functioning older patients from patients with poor functioning and poor HRQoL after hospitalization. Chapter 6 described healthcare utilization and societal care costs of hospitalized older people with different ISAR-HP scores from hospital admission to twelve months after admission. Formal and informal care costs were related to level of risk of low functioning of hospitalized older people up to one year after hospitalization. Participants were classified into five risk groups using the ISAR-HP and health care utilization was measured by interview using validated questionnaires and paper questionnaires for informal caregivers were sent by postal mail. Hospitalized older people with high-risk scores had substantially higher formal and informal care costs in the year after initial hospital admission than hospitalized older people with low risk scores. This implies that substantial investments may be made in preventive interventions for at-risk hospitalized older people. Chapter 7 describes decline in activities of daily living and instrumental activities of daily living among hospitalized older people and aimed to identify predictors of decline such as ISAR-HP score, age, admission diagnosis and other possible predictors of (i)ADL decline. We studied 2612 hospitalized older people at risk of functional decline according to the ISAR-HP score ≥ 1. Around 17%

of the patients had declined in ADL at three-month follow up, whereas around 50% of the patients had poorer iADL than before hospitalization. Cognitive functioning, neuro-psychiatric functioning, depression, comorbidities, and pre-admission (i)ADL were significantly associated with ADL and iADL decline. Age, living environment, and ISAR-HP score were predictive of ADL decline but not so much of iADL decline

Part three (Chapter 8 and 9) describes the effect evaluation of the PReCaP. In chapter 8 we compared patient functioning and HRQoL of at-risk hospitalized older people who were treated before implementation of the PReCaP with patient functioning and HRQoL of older patients who were treated in the same hospital after implementation of the PReCaP. More importantly, it compared patient functioning and HRQoL of at-risk hospitalized older people treated with the PReCaP with hospitalized older people who were treated with usual geriatric health care. We did not find any effect of the PReCaP on ADL and iADL. The PReCaP may possibly provide some benefits to hospitalized patients at risk of functional decline with respect to cognitive functioning, depression, and perceived health though. Further evaluations of integrated intervention programs to limit functional decline are therefore required. In Chapter 9 we describe the outcomes of a randomized clinical trial that took place within our intervention cohort. This trial compared PReCaP patients treated in the prevention and reactivation center (PRC)) after hospital discharge to PReCaP patients who did not receive extra treatment at the PRC after discharge. Of the 146 patients randomized to the PRC and 76 to usual care, 69 patients were actually treated in the PRC, whereas 153 patients received usual care. Therefore we performed an intention to treat as well as an as treated analysis. Both analyses showed no differences in patient outcomes between the experimental group and control group. We therefore concluded that treatment in the PRC is not relevant for hospitalized older people as it does not contribute to better outcomes.

Part four (Chapter 10) is a general discussion, which summarized the main findings of this thesis in relation to the research questions and objectives stated in the introduction. In addition, it discussed methodological issues and problems encountered. It interpreted our results using past and current literature. Finally, it provided recommendations for future research in this area, with special attention to use of the ISAR-HP among hospitalized older people and implementation of integrated geriatric care programs such as the Prevention and Reactivation Care Program.

Overall, this thesis shows that the ISAR-HP is a simple tool that can adequately identify hospitalized older people at risk of low physical and cognitive functioning, mortality, loneliness and, to a lesser extent, HRQoL, as well as societal care costs at three and twelve months after hospital admission. As mentioned before, each screening tool only gives an indication of risk though and additional clinical judgment from the medical team is required to improve the identification of older patients at risk of functional decline.

Furthermore, based on the methodological considerations and research evidence on which the PReCaP was based we should be cautious in interpreting the lack of effects of the PReCaP on patient and caregiver outcomes. It is possible that the intervention indeed does not work in its current form for the population that we included in our study. Nevertheless, considering the many limitations of our study, the results of qualitative structure and process evaluations, and the complex nature of the PReCaP itself, the PReCaP might be successful in a different setting or for a different older population. Further studies should evaluate treatments focused on both medical condition and domains of reactivation care, but tailored to the needs of separate risk groups, for example patients with cardiovascular diseases [213] only. Consequently, patients may have a better prognosis after discharge, thus preventing dependence on informal and formal health care and associated costs but instead, remaining independent as long as possible.

CHAPTER 13

Samenvatting

Oudere ziekenhuispatiënten lopen risico op functieverlies tijdens of na hun verblijf in het ziekenhuis. Dit functieverlies kan het gevolg zijn van fysieke kenmerken (e.g. leeftijd, diagnose), psychologisch functioneren (e.g. delier, depressie), sociale aspecten en/of economische omgeving (e.g. mantelzorg systeem, eenzaamheid), en leefomgeving voor ziekenhuisopname of aspecten van zorggebruik (e.g. polyfarmacie). Functieverlies kan leiden tot afhankelijkheid in dagelijkse activiteiten, lagere kwaliteit van leven, hogere zorgbelasting voor mantelzorgers en hogere gezondheidszorgkosten. In dit proefschrift evalueren we de bruikbaarheid van een kort screeningsinstrument, de ISAR-HP (Identification Seniors at Risk-Hospitalized Patients) om oudere ziekenhuispatiënten met risico op functieverlies te identificeren. Ten tweede evalueren we de effecten van het "Zorgprogramma voor Preventie en Herstel" ("Prevention and Reactivation Care Program" or PReCaP) op het functioneren en de kwaliteit van leven van oudere ziekenhuispatiënten. Hierbinnen beschrijven we tevens de effecten van een verblijf in het "Preventie en Reactivering Centrum" ("Prevention and Reactivation Center" or PRC) op patiënt uitkomsten in een gerandomiseerd klinisch onderzoek.

Deel een van dit proefschrift bestaat uit een uitgebreide inleiding, welke bestaat uit een algemene inleiding (Hoofdstuk 1) en twee extra inleidende hoofdstukken (Hoofdstuk 2 en 3). Hoofdstuk 2 beschrijft het Zorgprogramma voor Preventie en Herstel ("Prevention and Reactivation Care Program" of "PReCaP"). De PReCaP heeft als doel het reduceren van functieverlies bij oudere ziekenhuispatiënten door het aanbieden van multidisciplinaire, geïntegreerde en doelgerichte interventies op fysieke, sociale- en psychologische domeinen van functieverlies. De PReCaP bestaat uit vijf duidelijke elementen: De vroege identificatie van oudere ziekenhuispatiënten met risico op functieverlies; intensieve follow-up behandeling voor een specifieke patiëntengroep in het Preventie en Reactivering Centrum (PRC); beschikbaarheid van multidisciplinaire geriatrische expertise; ondersteuning en consultatie van specialisten voor mantelzorgers; en intensieve follow-up gedurende het hele zorgtraject vanaf ziekenhuisopname door een case manager met geriatrische expertise. Hoofdstuk 3 beschrijft het studieprotocol van de gehele evaluatie van de PReCaP. Deze evaluatie bestaat uit een vergelijking van oudere ziekenhuispatiënten uit drie ziekenhuizen met verschillende vormen van geriatrische zorg. Het studie design is quasi-experimenteel en omvat een proces evaluatie, effect evaluatie en kost-effectiviteit evaluatie. De studie omvat een populatie bestaande uit oudere ziekenhuispatiënten van 65 jaar of ouder met risico op functieverlies volgens de ISAR-HP vragenlijst. Data is prospectief verzameld bij ziekenhuisopname en drie en twaalf maanden na opname. Primaire patiënt uitkomsten zijn activiteiten van het dagelijks leven (ADL) en instrumentele activiteiten van het dagelijks leven (iADL). Secundaire uitkomsten zijn kwaliteit van leven, cognitief functioneren, eenzaamheid, depressie, mortaliteit en (her) opname in ziekenhuis of andere instelling. Kwaliteit van leven en belasting van de extra zorg voor informele mantelzorgers en proces maten zoals samenwerking van multidisciplinaire

teams en tevredenheid van patiënten met de zorg zijn ook geëvalueerd. Ook beschrijven we in het protocol een kwalitatieve evaluatie die de zorgvuldigheid in de uitvoering van het zorgprogramma moet bepalen en het mogelijk maakt de kwantitatieve resultaten te verklaren en in de juiste context te plaatsen. Tenslotte beschrijft het protocol een kost effectiviteit analyse die de totale kosten vanuit de maatschappij evalueert.

Deel twee (hoofdstuk 4 t/m 7) is gericht op de prognose van oudere ziekenhuispatiënten met risico op functieverlies. Hoofdstuk 4 bekijkt het gebruik van de ISAR-HP in het identificeren van oudere ziekenhuispatiënten met risico op functieverlies door het te vergelijken met drie andere instrumenten, namelijk de Identification Seniors at Risk (ISAR), de Score Hospitalier d'Évaluation du Risque de Perte d'Autonomie (SHERPA) en een veiligheidsmanagement screening (VMS). De vragenlijsten zijn afgenomen bij 460 ziekenhuispatiënten van 65 jaar of ouder en opgenomen in een streekziekenhuis in Nederland voor tenminste 48 uur. Functioneren is gemeten bij opname en 3 maanden na opname. De ISAR-HP en de SHERPA presteren het beste in het voorspellen van functionele status op drie maanden. Omdat de ISAR-HP korter en makkelijker af te nemen is en omdat het een betere sensitiviteit heeft dan de SHERPA is de ISAR-HP een veelbelovend instrument dat gebruikt kan worden voor identificatie van oudere ziekenhuispatiënten met problemen in functioneren drie maanden na ziekenhuisopname. Hoofdstuk 5 vergelijkt oudere ziekenhuispatiënten met verschillende ISAR-HP scores op fysiek functioneren, cognitief functioneren, kwaliteit van leven en eenzaamheid. De ISAR-HP is afgenomen bij 460 oudere ziekenhuispatiënten tussen juni en oktober 2010. Patiënten zijn verdeeld over vijf risicogroepen volgens hun ISAR-HP score (0, 1, 2, 3, 4+) en geïnterviewd bij ziekenhuisopname en drie en twaalf maanden na ziekenhuisopname met behulp van gevalideerde vragenlijsten. De resultaten laten zien dat cognitief functioneren, fysiek functioneren, eenzaamheid en kwaliteit van leven significant verschillen tussen ISAR-HP groepen gedurende de eenjarige follow up, met lagere scores voor functioneren en soms kwaliteit van leven voor hogere risicogroepen dan voor lagere risicogroepen en hogere scores op eenzaamheid voor hogere risicogroepen dan voor lagere risicogroepen. De laagste risicogroep (ISAR-HP=0) scoort consistent hoger op functioneren en kwaliteit van leven dan alle andere risicogroepen. Mortaliteit verschilt ook significant tussen risicogroepen. Deze resultaten laten zien dat de ISAR-HP in staat is om goed functionerende oudere patiënten te onderscheiden van patiënten met slechter functioneren en lagere kwaliteit van leven na ziekenhuisopname. In hoofdstuk 6 beschrijven we zorggebruik en maatschappelijke zorgkosten van oudere ziekenhuispatiënten met verschillende ISAR-HP scores van ziekenhuisopname tot twaalf maanden na ziekenhuisopname. Dit hoofdstuk heeft als doel formele en informele zorgkosten te relateren aan de mate waarin oudere ziekenhuispatiënten risico lopen op laag functioneren tussen ziekenhuisopname en een jaar na opname. Deelnemers zijn weer geclassificeerd in vijf groepen volgens hun ISAR-HP score en zorggebruik is gemeten in een interview met behulp

van gevalideerde vragenlijsten (patiënten) of via gevalideerde vragenlijsten per post verstuurd (mantelzorgers). Kosten per eenheid zijn geschat door middel van ziekenhuisgegevens en nationaal representatief onderzoek. Dit hoofdstuk laat zien dat oudere ziekenhuispatiënten met hogere ISAR-HP risico scores substantieel hogere formele en informele zorgkosten in het jaar na de ziekenhuisopname hebben dan oudere ziekenhuispatiënten met lagere risico scores. Dit suggereert dat investeren in preventieve interventies voor oudere ziekenhuispatiënten die risico op functieverlies lopen voordelen kan opleveren. Hoofdstuk 7 beschrijft de achteruitgang in de algemene dagelijkse activiteiten (ADL) en de instrumentele dagelijkse activiteiten van 2612 oudere ziekenhuispatiënten met ISAR-HP score 1 of hoger en heeft als doel de identificatie van predictoren van achteruitgang in ADL en iADL, zoals ISAR-HP score, leeftijd en opnamediagnose. Resultaten laten een achteruitgang zien in ADL tussen baseline en 3 maanden na opname bij ongeveer 17% van de patiënten, terwijl ongeveer 50% van de patiënten slechter iADL functioneren laat zien 3 maanden na ziekenhuisopname. Cognitief functioneren, neuro-psychiatrisch functioneren, depressie, comorbiditeiten en (i)ADL voor opname lijken significant geassocieerd te zijn met ADL en iADL achteruitgang. Leeftijd, leefomgeving en ISAR-HP score voorspellen ADL achteruitgang, maar niet zozeer iADL achteruitgang.

Deel drie (hoofdstuk 8 en 9) beschrijft de effect evaluatie van de PReCaP. In hoofdstuk 8 vergelijken we het functioneren en kwaliteit van leven van oudere ziekenhuispatiënten met risico op functieverlies die voor implementatie van de PReCaP zijn behandeld (usual care in interventieziekenhuis) met ziekenhuispatiënten met risico op functieverlies die behandeld zijn na implementatie van de PReCaP (PReCaP patiënten). Verder vergelijken we deze laatste groep, de PReCaP patiënten, met patiënten die in dezelfde periode zijn behandeld met gewoonlijke geriatrische zorg in twee controle ziekenhuizen. In beide vergelijkingen verschillen ADL en iADL niet tussen de groepen. De PReCaP kan wellicht gunstig zijn voor oudere ziekenhuispatiënten met risico op functieverlies wat betreft cognitief functioneren, depressie en subjectieve gezondheid. Verdere evaluaties van geïntegreerde interventie programma's met als doel het terugdringen van functieverlies zijn daarom nodig. In hoofdstuk 9 beschrijven we de uitkomsten van een gerandomiseerde klinische studie welke plaats heeft gevonden binnen onze evaluatie. Deze studie vergelijkt PReCaP patiënten behandeld binnen het centrum voor preventie en herstel (PRC) na ontslag uit het ziekenhuis met PReCaP patiënten die geen extra zorg in het PRC hebben gekregen na ontslag uit het ziekenhuis. Van de 146 patiënten gerandomiseerd naar de PRC en 76 gerandomiseerd naar usual care zijn uiteindelijk 69 patiënten werkelijk in het PRC behandeld, terwijl 153 patiënten usual care hebben ontvangen. Daarom zijn zowel een intention to treat en een as treated analyse gedaan. Beide analyses tonen geen verschil in uitkomsten tussen de experimentele groep en controle

groep. Een behandeling in het centrum voor preventie en herstel draagt niet bij aan betere uitkomsten en lijkt daarom niet relevant voor de meeste oudere ziekenhuispatiënten.

Deel vier (hoofdstuk 10) bevat een algemene discussie en bevat een samenvatting van de belangrijkste bevinden van dit manuscript gerelateerd aan de onderzoeksvragen en doelen zoals beschreven in de introductie. Verder beschrijft dit hoofdstuk methodologische zaken en problemen van het onderzoek en interpreteert het de resultaten aan de hand van literatuur. Tenslotte worden aanbevelingen gedaan voor toekomstig onderzoek in dit veld, met speciale aandacht voor het gebruik van de ISAR-HP bij oudere ziekenhuispatiënten en implementatie van geïntegreerde geriatrische zorg programma's zoals de Prevention and Reactivation Care Program.

Dit proefschrift laat zien dat de ISAR-HP een simpel hulpmiddel is dat bij ziekenhuisopname oudere ziekenhuispatiënten kan identificeren die risico lopen op laag fysiek en cognitief functioneren, hoge sterfte, eenzaamheid, hogere maatschappelijke zorgkosten en in mindere mate kwaliteit van leven drie en twaalf maanden na de ziekenhuisopname. Zoals eerder beschreven geven screenings instrumenten zoals de ISAR-HP slechts een indicatie van risico en is extra klinisch oordeel van professioneel medisch personeel nodig om verdere identificatie van oudere ziekenhuispatiënten met risico op functieverlies te verbeteren.

Op basis van de methodologische vraagstukken die zijn besproken en eerdere onderzoeksresultaten vanuit de literatuur op basis waarvan de PReCaP was ontwikkeld, moeten we voorzichtig zijn met de interpretatie van het gebrek aan effecten van de PReCaP op patiënt en mantelzorger uitkomsten van dit onderzoek. Het is mogelijk dat de interventie inderdaad niet effectief is in zijn huidige vorm voor de populatie die we in deze studie hebben bekeken. Echter, wanneer we de tekortkomingen van deze studie, de resultaten van de kwalitatieve structuur en proces evaluaties meenemen in combinatie met de complexiteit van de PReCaP zelf, is het mogelijk dat de PReCaP succesvol zou kunnen zijn in een andere setting of bij een andere populatie ouderen. Verdere studies zouden zich kunnen richten op het evalueren van behandelingen die zich tevens richten op de medische diagnose in combinatie met reactivering, maar specifiek toegespitst moeten worden op de behoeften van aparte risicogroepen, bijvoorbeeld enkel oudere patiënten met cardiovasculaire aandoeningen [212]. Dit zou kunnen leiden tot betere prognoses voor deze patiënten na ontslag uit het ziekenhuis. IN plaats van afhankelijkheid van formele en informele zorg en daarbij behorende kosten kunnen deze oudere patiënten langer onafhankelijk blijven in het dagelijks leven.

CHAPTER 14

Dankwoord

Vijf jaar, driehonderd MGZ seminars, tachtig stuurgroepen, tientallen geriatriecongressen, vijf publicaties, vele gezellige sociale werkuitjes, ruim driehonderd kopjes koffie, honderdvijftig kaascroissantjes, wat extra rimpels, een (bijna twee…) kinderen, een proefschrift en dan tenslotte.... het dankwoord!

Ewout, bedankt voor je flexibele, enthousiaste en rechtdoorzee begeleiding de afgelopen jaren. Als promotor gaf je me veel vrijheid en verantwoordelijkheid en het was fijn om te weten dat ik altijd bij je binnen kon lopen, wel of geen afspraak. ik heb met zeer veel plezier met je samengewerkt (en Stefan en ik hopen stiekem alsnog een keer een huiskamer-vioolconcert mee te maken ☺). Johan, bedankt voor je begeleiding tijdens mijn promotietraject. Je bracht het overzicht in mijn artikelen en proefschrift en wist altijd de juiste vragen te stellen die meestal de kern van de tekst of het probleem blootlegden. Dit gaf altijd weer "food for thought" en heeft de visie en structuur van mijn proefschrift naar een hoger niveau getild. De leden van de kleine commissie, prof.dr. Deeg en prof.dr. Franco wil ik hartelijk bedanken voor het beoordelen van het manuscript. Ook de overige commissieleden wil ik hartelijk bedanken voor hun interesse en bereidheid met mij van gedachten te wisselen over mijn proefschrift. Anna, behalve lid van de kleine commissie was je ook coauteur van een meerderheid van mijn artikelen en lid van onze projectgroep. Ik wil je dan ook niet alleen bedanken voor het beoordelen van het proefschrift manuscript en de vele drafts van artikelen, maar ook voor de gezellige en prettige samenwerking van de afgelopen jaren.

Ook de overige leden van de projectgroep en anderen die aan dit project hebben bijgedragen wil ik graag bedanken voor hun inzet en de fijne samenwerking. Paul, tijdens mijn eerste drie jaren bij MGZ was jij mijn dagelijks begeleider en coördinator van het project en ik wil je bedanken voor al je hulp en tips in deze periode. Leuk dat we elkaar nu af en toe nog zien en ik ben blij dat het goed met je gaat. Rianne, jij was een belangrijke spil in de dataverzameling in de drie ziekenhuizen, waar dit hele proefschrift op is gebaseerd. Bedankt voor je inzet en natuurlijk voor de ontzettend gezellige samenwerking en ik wens je heel veel succes met je volgende project(en). Linda, toen jij kwam werken op MGZ als nieuwe coördinator was het project al in volle gang, wat misschien in het begin niet zo makkelijk was. Maar jij hebt dit fantastisch opgepakt en je bijdrage aan het verbeteren van de database en hulp bij het analyseren van de data hebben mij ontzettend veel geleerd en tevens de basis gelegd voor de meeste artikelen in dit proefschrift. Eva, bedankt voor je inzet als data coördinator en de gezellige gesprekken (en wie weet ga je je artikel over mantelzorgers ooit nog indienen als start van een eigen promotietraject ;-)). Jacq, onze promovenda-bijklets-sessies waren altijd erg gezellig. Je aanstekelijke enthousiasme en je kracht om alles op een positieve manier te interpreteren waren zeer welkom tijdens dit interessante maar ook complexe en daarom soms lastige project ;-)). Jeroen en Annemarie, jullie wil ik natuurlijk ook bedanken voor de goede samenwerking en jullie belangrijke bijdrage vanuit iBMG aan de proces evaluatie. Deze is van groot belang gebleken bij de interpretatie van onze resultaten. Marc, ondanks dat onze kosten

effectiviteit analyse niet zo uitgebreid is uitgevoerd als oorspronkelijk gepland heb ik veel van je geleerd bij het verzamelen van de kosten data en natuurlijk door het volgen van de "health technology assessment" cursus bij iBMG. Bedankt hiervoor. Ton, zonder jouw initiatief was dit project er niet geweest en ik waardeer je input als coauteur van de hoofdstukken in dit proefschrift. Verder wil ik Gerard en Caspar bedanken voor hun statistische input en Menno en Frank voor hun ondersteuning op het gebied van de databeheer van het project. Tenslotte wil ik alle datacoördinatoren, data verzamelaars en alle andere betrokkenen vanuit de participerende ziekenhuizen bedanken voor hun bijdrage aan dit project, inclusief natuurlijk de patiënten die hebben meegewerkt aan het onderzoek.

Alle andere collega's van MGZ, bedankt voor de gezelligheid, de leuke uitjes, de koetjes en kalfjespraat bij de kopieermachine en het delen van jullie onderzoekservaringen. De dames van het secretariaat wil ik bedanken voor hun praktische ondersteuning en de leuke gesprekken. Sanne, ik heb met name veel met jou te maken gehad als het om praktische ondersteuning ging en ik heb enorme waardering voor je hulpvaardigheid en bereikbaarheid; van afspraken inplannen tot het inbinden van proefschriften tot het opzoeken van informatie en zo kan ik nog wel even doorgaan. Bedankt voor al je hulp! Dan wil natuurlijk mijn "roomies" noemen, Elise en Astrid! Zonder jullie waren de afgelopen jaren een stuk minder gezellig geweest. Het was fijn om lief en leed te kunnen delen en ik ben blij dat we elkaar nog steeds af en toe zien met een kopje koffie… wat mij natuurlijk brengt op "de koffieclub" en de andere koffieclubleden Nikki, Jitske, Nanda en Linda. Meiden, ons bijna dagelijkse kopje koffie was erg gezellig en oh zo nodig af en toe als een van ons (of meerderen van ons) er even doorheen zaten, maar ook zo handig om even lekker over andere dingen te praten dan werk. Leuk dat we nog steeds contact hebben en elkaar op de hoogte houden via de koffieclub- whatsapp groep (en soms alsnog in het onderwijscentrum met een lekkere cappucinootje ;-)).

Dan natuurlijk mijn lieve ouders en schoonouders. Bedankt voor al jullie steun en interesse gedurende mijn promotietraject. Jullie hebben het hele promotietraject zoveel makkelijker gemaakt door onder andere regelmatig op jullie lieve kleindochter te passen.

Celes, de voorkant van het proefschrift is prachtig geworden, dank je wel! En het kon natuurlijk niet anders dan dat mijn huwelijksgetuige ook mijn paranimf zou zijn. Het was en blijft heerlijk gezellig dat mijn 'kleine zussie' zo dichtbij woont en we elkaar tussen onze drukke schema's in veel kunnen zien en bij kunnen kletsen.

Yunintje, jouw geboorte was het hoogtepunt van de afgelopen 5 jaar, met stip op nummer 1, I love you! (en je gaat zeker een fantastische grote zus worden ☺).

Steef, natuurlijk mijn paranimf en al bijna 20 jaar mijn steun en toeverlaat…. zonder jou was dit proefschrift er nooit gekomen. Ik "walk good" omdat jij altijd naast me loopt, Lufulvdw!

Kirsten

CHAPTER 15

Curriculum Vitae

Kirsten Asmus-Szepesi was born in 's Hertogenbosch, the Netherlands on January 19, 1979. In 1997 she graduated from secondary school at the Erfgooierscollege in Huizen. From 1999 to 2005 she studied Clinical Psychology at the University of Amsterdam where she graduated in 2005 with a Master's dissertation on "*Family Centered Psychological Care for Chronically Ill Children and Adolescents: The Integration of Three Models*".

In 2005 and 2006 she worked as a psychologist at the MICO Care Center for children with learning disabilities and as a health researcher at the University of the West Indies in Kingston Jamaica. In 2007 she worked as a monitor and reporting officer for a Palestinian NGO in Ramallah, Palestinian Territories on a water-sanitation project in Gaza. From 2007 to 2009 she studied Public Health at the London School of Hygiene and Tropical Medicine, from which she graduated with a specialization in Health Promotion in 2009. In 2010 she was employed at the Erasmus MC, department of Public Health as a junior researcher. She studied the effects of an integrated care program to prevent functional decline among hospitalized older people, of which the results are presented in this thesis.

CHAPTER 16

PhD Portfolio

SUMMARY OF PHD TRAINING AND TEACHING

Name PhD student: Kirsten Asmus Erasmus MC Department: Public Health Research School: Medical Decision Making	PhD period: 2010-2014 Promotor(s): E. Steyerberg, J. Mackenbach Supervisor: E.Steyerberg

1. PhD training		
	Year	**Workload**
General courses		
– Conceptual Foundation of Epidemiologic Study Design	2010	**0.7 ECTS**
– Clinical Decision Analysis	2010	**0.7 ECTS**
– Clinical Trials	2010	**0.7 ECTS**
– Biomedical English Writing and Communication	2013	**4.0 ECTS**
Specific courses (e.g. Research school, Medical Training)		
– Modern Statistical Methods (NIHES)	2010	**4.3 ECTS**
– Health Technology Assessment (iBMG)	2011	**5.0 ECTS**
– Presenting course (workshop + preparation)	2012	**1.0 ECTS**
Seminars/journal clubs/workshops (attending)		
– Weekly seminars Public Health at Erasmus MC	2010-2014	**2.0 ECTS**
– GENERO seminars/meetings	2010-2014	**1.0 ECTS**
Presentations and (Inter)national conferences		
– Nederlands Congres Volksgezondheid	2010	**1.0 ECTS**
– Frailty seminar University of Tilburg	2010	**1.0 ECTS**
– VII IAGG European Congress *"HEALTHY AND ACTIVE AGEING FOR ALL EUROPEANS – II"*	2011	**1.0 ECTS**
– GENERO ouderenforum	2011	**1.0 ECTS**
– Ouderen in beeld (congres RINO Groep)	2012	**1.0 ECTS**
– Geriatriedagen	2013	**1.0 ECTS**
– Congres Nationaal Programma Ouderenzorg	2013	**1.0 ECTS**
– Seminar presentation MGZ	2014	**1.0 ECTS**
– Congres Gotenborg Zweden	2014	**1.0 ECTS**
Other		
Peer reviews for international medical journals		
– International Journal of Nursing Studies	2012	**6.0 hrs**
– Journal of American Geriatrics Society	2014	**7.0 hrs**
– Archives of Gerontology and Geriatrics	2014	**6.0 hrs**
Teaching Supervising community project 3d year medical students	2013	**1.0 ECTS**
TOTAL	**2010-2014**	**30 ECTS**

*** 1 ECT= 28 hours**