# Identification of older hospitalized patients at risk for functional decline

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# Identification of older hospitalized patients at risk for functional decline

**Selectie van oudere patiënten opgenomen in het ziekenhuis met risico op functieverlies**

(met een samenvatting in het Nederlands)

**Proefschrift**

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**Jannita Geertruida Hoogerduijn**
geboren op 2 december 1948 te ‘s Gravenhage

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*Knowing is not enough; we must apply.*

*Willing is not enough, we must do.*

Goethe (1749-1832)

# Contents

Chapter 1

# General introduction

# Introduction

*Four months ago my mother was an independent and active lady of 76 years old, she only needed assistance in cleaning the house every two weeks as she had her whole adult life. Then she became ill, acquired pneumonia could not eat and did not drink enough. She was admitted to the hospital after a week because her situation deteriorated. She stayed in hospital for more than two weeks. She recovered from pneumonia. Now, three months later she looks so thin and vulnerable. She is tired and just sitting in her chair the whole day. She needs help every day with bathing, and we, her children are so worried. What is going on with our once so active mother?*
*This older patient was admitted for pneumonia and four days later a hypoactive delirium was diagnosed. Looking back, she entered the hospital already in this delirious status. The question is: is it possible to recognize this patient as being at risk for functional decline and is this decline preventable?*

## The ageing world

The population is ageing worldwide as a result of declining birth rates and improved health and longevity. By 2040, more than 28% of Europeans and 21% of the population in the USA is likely to be at least 65 years of age [1]. The fastest growing portion of the older population in many nations is the oldest group of the elderly, who are aged 80 and over [2]. In the Netherlands, currently 15% of the population is 65 years or older, of which 26% is 80 years and older [3].
The growing population of elderly adults is an important theme in national and international policies and plans of actions [4;5]. In addition to maintaining good physical and mental health, the promotion of functional independency enabling older people to live as independently as possible and participate in society, i.e., healthy ageing, is especially important [6]. In the concept of healthy ageing, the factors of functioning, health and wellbeing are strongly interdependent. Daily functioning is an important topic and is described in the International Classification of Functioning, Disability and Health of the World Health Organization as a key concept, which is viewed as an outcome of interactions between health conditions and contextual factors (personal and environmental factors). Being able to perform activities is one of the main components of this functioning [7;8].

The prevention of functional decline and preservation of independence and autonomy should be the focus of health care in addition to the prevention of diseases and death. This requires a shift from a focus mainly on diseases to a focus on the maintenance of functional independence and encouraging participation in society. The focus should thus shift from survival to surviving into old age unaffected by the threat of functional dependency [4;9;10].
Ageing is the result of a multidimensional process of physical, psychological and social change. Therefore, it is a challenge for health care professionals to focus on interventions that may prevent a functional decline or promote and strengthen an older person's potential for independent functioning in daily life. These physical, psychological and social changes are not the same for everybody. Distinctions may be made between "universal ageing" (age changes that all people share) and "probabilistic ageing," which is age changes that may happen to some, but not all people as they grow older, such as the development of geriatric syndromes and the onset of chronic diseases [11]. Syndromes refer to multifactorial health conditions that occur when the accumulated effects of impairments in multiple systems render (an older) person vulnerable to situational challenges [12;13]. The term syndrome when applied to the geriatrics population emphasizes the multiple causations of a unified manifestation, such as functional decline, delirium, incontinence and falls [12].
Many older persons are suffering from one or more chronic diseases, including arthritis, heart diseases, diabetes and chronic lung diseases [14-18]. In the Netherlands, two-thirds of all persons aged 65 and older suffer from more than two chronic diseases [14], and this multimorbidity is also highly prevalent in other countries [19;20]. Geriatric syndromes and multimorbidity may easily lead to disability [12;20-22]. Older persons with multimorbidity and geriatric syndromes have poorer self-rated health and functional status and a greater utilization of health care [20], notably a greater use of hospital care.
In the Netherlands, 16% of the population of those 70 years and older is admitted to the hospital yearly, whereas only 6% of people less than 70 years of age are hospitalized yearly [23]. Also, the number of hospital admissions in older patients has increased over the past 20 years despite an overall decrease in the percentage of hospital admissions for people less than 60 years of age. The largest increase was in women between the ages of 70 and 75, with an increase in hospital admissions of nearly 70% [23]. The expected increase in hospital admissions in older patients makes the development of interventions to prevent adverse outcomes of hospital admission in older patients even more important.

**Functional decline**

Hospitalization is a hazardous event for older persons because 30-60% of older patients experience a functional decline after being hospitalized [24-32]. This results in a decreased quality of life, loss of autonomy, increased length of hospital stay, increased risk for nursing home admission and readmission and an increased need for informal and professional health care at home [28;29;33-37]. According to Inouye, the decline in functioning is not only a problem in terms of decreased independence but also results in a decreased baseline functional status that is a risk factor for geriatric syndromes such as pressure ulcers, falls, delirium, incontinence and further functional decline [12].

A functional decline is mostly defined as a decline in the activities of daily living (ADL), such as bathing, dressing, transferring, using the toilet and using incontinence materials, and/or instrumental activities of daily living (IADL), including travelling, housekeeping and shopping. The most commonly used instruments to measure ADL are the KATZ Index or the Barthel Index and ADL are measured at different time points after hospital admission (at discharge, after three months or half a year or a year) [38-40].

In many cases, the functional decline cannot be attributed to the acute medical problem for which a patient was admitted to the hospital. Even when the disease is uncomplicated the patient may never return to his/her premorbid functional status [41]. A functional decline after a hospital admission is associated with personal factors, such as age and socio-economical status, visual and hearing problems, decreased mobility, decreased functional and cognitive status and also to the iatrogenic aspects of hospitalization, such as bed rest, infections and pressure ulcers [33;35;42-48]. There is not a single pathway leading to a loss of function [12;41].

**Identification of patients at risk for functional decline**

The differences between elderly individuals are considerable. At one end of the spectrum you see the active, well-off older person, at the other the vulnerable geriatric patient. Many older people possess the necessary capacities to enjoy their old age in a positive way and remain healthy and independent [49]. Not all older persons will suffer a functional decline after hospitalization. In general, the assumption is that some older people are more prone to the development of geriatric syndromes and complications during hospitalization that result in a functional decline.

Because the functional decline in older patients may be preventable, it is important to identify those patients who are at risk for a functional decline. These patients are most likely to

benefit from preventive and targeted interventions and it may help to optimize the discharge management for the most vulnerable patients [50]. Prevention could be realized in a three-step model focused on personalized care [51]: first, the identification of patients at risk for functional decline; second, applying a geriatric assessment for those at risk; and third, the implementation of targeted interventions for those at risk to prevent complications and functional decline. This prevention is a multidisciplinary task which calls for contributions by all health care professionals. Nurses could play an important role in prevention, as they are in a position to guide and observe patients at admission and 24 hours a day during their hospital stay.

## Scope of the thesis

As it is important to identify those elderly hospitalized patients who are most likely to develop a functional decline in order to prevent this negative outcome, the general aim of this thesis is as follows:
*To determine a prediction model to identify older patients at risk for functional decline after hospitalization, that is easy to use in clinical practice, as a first step in the prevention of a loss of function and independence.*

The first part of the thesis provides a literature review to identify predictors of functional decline and to identify screening instruments to predict functional decline that have been validated in older hospitalized patients (Chapter 2). Next the thesis describes a study to compare the discriminative values of three screening instruments in patients acutely admitted to the internal wards of a hospital (Chapter 3).
The central part of the thesis presents the development and internal and external validation of a new prediction model in two (multicenter) cohort studies. The predictors used in the instruments of the comparative study were combined with predictors found in the literature and mentioned by clinical experts in the development of the model. This new prediction model, a formula to calculate each individual patient's risk of developing a functional decline, was translated into a scorecard, and both were validated in an independent population of patients acutely admitted to the general internal wards of a hospital (Chapter 4).

Next, a multicenter cohort study was performed to validate this prediction model and score card in a new patient group; those admitted to the hospital for cardiac surgery (Chapter 5). The last part of the thesis describes a project to improve the quality of care for older patients on three wards (cardiac patients, cardiac surgery patients and patients with lung diseases) of an university hospital. A three-step program was developed, including risk assessment, comprehensive geriatric assessment and targeted interventions, based on the results of this study (risk assessment), literature and the experiences of clinical experts (geriatric assessment and interventions). This program was then implemented, evaluated and adjusted (Chapter 6). In the general discussion, the concept of functional decline is further detailed and the main findings of this study and the implications for clinical practice, education and further research are discussed (Chapter 7).

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Chapter 2

# A systematic review of predictors and screening instruments to identify older hospitalized patients at risk for functional decline

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## Abstract

**Aims and objectives**: To determine a valid, reliable and clinical user-friendly instrument, based on predictors of functional decline, to identify older patients at risk for functional decline. The predictors of functional decline are initially considered and, subsequently, the characteristics and psychometric qualities of existing screening instruments are investigated.
**Background**: Functional decline is a common and serious problem in older hospitalized patients, resulting in a change in quality of life and lifestyle. Studies have shown that 30 - 60% of older people develop new dependencies in activities of daily living (ADL) during their hospital stay. Adverse health outcomes such as mortality, a prolonged hospital stay, nursing home placement and increased dependency of older people at home are the results. Not only are the personal costs high but also, in a rapidly growing older population, the impact on healthcare costs is also high.
**Results:** Age, lower functional status, cognitive impairment, pre admission disability in instrumental activities of daily life (IADL), depression and length of hospital stay were identified as predictors of functional decline. Three screening instruments to identify hospitalized patients at risk for functional decline were found in the literature: the Hospital Admission Risk Profile (HARP), the Identification of Seniors At Risk (ISAR) and the Care Complexity Prediction Instrument (COMPRI). The reported validity was moderate. Reliability and the ease of use in the clinical setting were not well described.
**Conclusion:** These three instruments should be further tested in a hospitalized older population.
**Relevance to clinical practice:** Screening is a first step to identify patients at risk for functional decline and this will make it possible to treat patients who are identified so as to prevent functional decline. Because of their ability to observe and to guide the patients and the overall view they have, nurses play a key role in this process.

**Key words:** elderly, functional decline, hospitalization, nurses, risk assessment instruments, screening

## Introduction

Functional decline is a common and serious problem in older hospitalized patients, resulting in a change in quality of life and lifestyle. Many patients of 65 years and older suffer functional decline related to hospitalization and acute medical illness. Studies have shown that almost 30% of older people develop new dependencies in activities of daily living (ADL) during their stay in an acute hospital ward[1-3]. Others found up to 60% [4-8]. Functional decline is described as a loss of independence in self-care activities or as a deterioration in self-care skills. In the literature, a range of terms is used to describe functional decline such as loss of function, ADL decline, declining function, status decline, ADL status decline and functional impairment. Usually it is measured on a basic ADL scale (bathing, dressing, transferring from bed to chair, using the toilet) and/or an instrumental scale (IADL) (shopping, housekeeping, preparing meals, taking medications, handling finances, using public transportation). Functional decline is not strictly related to the medical problem that caused admission. Several factors play a role in this negative outcome, like the condition of the patient before admission, iatrogenic effects of the treatment, effects of bed rest and comorbidity [9-12]. Functional decline is associated with prolonged hospital stay, nursing home placement, hospital readmission and increasing mortality [4;13-19]. Personal and health-care costs are high and the need to prevent this negative outcome is pressing. Identifying patients at risk is an important step in preventing this event. Because of their ability to observe and to guide the patients, their frequent contact with patients, their involvement in ADL and the overall view they have, nurses play a key role in the prevention of functional decline.

## Aim

The aim of this review is to identify a valid, reliable and clinical user-friendly screening instrument to identify older hospitalized patients at risk for functional decline.
To determine the validity of a screening instrument a 'gold standard' should be used. However, there is no currently accepted gold standard to measure functional decline. Identification of predictors for functional decline and comparing these predictors with the items used in the instrument is a way to judge the validity of a screening instrument.

Choosing the best instrument to identify those elder patients at risk for functional decline should be based on the scientific qualities of the instrument [20]:

- Internal validity: the instrument is based on predictors known from the research literature.
- Validity: sensitivity and specificity and the positive and negative predictive values are at least moderate.
- Reliability: inter-rater and intra-rater reliability must be high with limited training required for its appropriate use.
- Clinical utility: the instrument must be easy to use in the hospital setting. It must be short and easy to administer and it must be capable of being applied by all nurses on a ward. The time needed for assessment and administration, the level of knowledge and training of the rater, and the impact on the respondents should be described.

## Objectives and methods

Two strategies were used to search relevant articles for this review. First, a computerized search on the period 1990 till February 2005 was carried out, using the following databases: Medline, PsycINFO, CINAHL,Cochrane Library, Cochrane Database of Systematic Reviews (CDSR), Database of Abstracts on Reviews and Effectiveness (DARE) and Cochrane Controlled Trial Register (CCTR); Second, reference lists of all selected articles were reviewed to identify other relevant papers.

**Search terms**

The Medline database was used to identify Medical Subjects Headings (MeSH) to select search terms. In addition to the MeSH terms we also used text words. Search terms referred to aspects of the population, the intervention and outcome. To maximize the number of retrieved articles, only the filters English and humans were used.

Overview of used MeSH terms and text words to search the electronic databases:

1) Population: *'*elderly*'* OR *'*elder*'* OR *'*aged*'* OR *'*aged, 80 and over*'* OR *'*frail elderly*'* AND *'*hospitalized patient*'* OR *'*hospital admission*'* OR *'*older patient*'*.

2) Intervention: *'*screening*'* OR *'*screening instrument*'* OR *'*risk assessment*'* OR *'*geriatric screening*'* OR *'*predictors*'* OR *'*predicting*'*.

3) Outcome: *'*functional decline*'* OR *'*functional status decline*'* OR *'*ADL decline*'* OR *'*decreased physical function*'* OR *'*decreased physical outcome*'* OR *'*impaired physical outcome*'* OR *'*ADL status decline*'*.
4) Combination of (1) and (2) and (3): 122 hits.
Based on title and abstract of the publication we excluded case reports, commentaries and guidelines.

**Inclusion criteria**

Predictors: the studied variables are predictors of the outcome measurement *'*functional decline*'*, predictors are tested in the hospital setting.
Screening instrument: instruments with the objective to identify older hospitalized patients at risk for functional decline and instruments which have been tested in a hospital population.

**Search results**

After completing the systematic search, we retrieved 37 articles based on clinical studies of predictors of functional decline and on screening instruments to identify older hospitalized patients at risk for functional decline.

## Results

The results are described in two parts. Firstly, an overview is given of the results of predictors of functional decline. Secondly, the results concerning the screening instruments are reported.

**Predictors of functional decline**

Ten studies were found of which two were reviews and eight were cohort studies.
The review of McCusker *et al*. (2002) focuses on the predictors of four outcomes: functional decline, nursing home admission, a composite outcome and any adverse outcome in hospitalized older people. Studies were included with data from different settings (community and hospital) and with other background problems (prolonged hospital stay because of social circumstances).

Table 1: Overview of Studies: Predictors of Functional Decline.

| Autor | Objective | Design | Setting/patients | Measurements | Significant predictors |
|---|---|---|---|---|---|
| Covinsky *et al.* (2003) | To describe the changes in ADL function occurring before and after hospital admission in older people hospitalized with medical illness and to assess the effort of age on loss of ADL function | Prospective observational study | The general medical service of two hospitals N=2293, aged 70 years and older | Two weeks before admission, at admission and at discharge. 5 ADL and 7 IADL | - Age $P<0.001$ (23%,28%, 38%, 50% and 63% in patients aged 70-74, 75-79, 80-84, 85-90 and ≥ 90,) |
| Covinsky *et al.* (1997a) | To determine whether symptoms of depression predict worse health status outcomes in acutely ill older medical patients | Prospective cohort study | Medical service of a teaching hospital N= 572, aged older than 70 years | One week before admission, at admission, at discharge and 30 and 90 days after discharge. Using 5 ADL and 7 IADL | - Depression , six or more symptoms on admission OR 2.47 |
| Mahoney *et al.* (1999) | To determine the association of mobility impairment with adverse outcomes at hospital discharge and three-month post discharge | Secondary analysis of a prospective randomised trial | Five hospitals N=1212, aged 70 years and older | At admission, hospital discharge and three-month after discharge. Using Katz scale Lawton scale | - Mobility impairment: use of a cane or a walker (adjusted OR 2.77) |
| Murray *et al.* (1993) | To determine whether delirium is associated with long-term loss of physical function (performing ADL) | Prospective study | Community acute-care hospital N=325, aged over 65 years | At hospital admission retrospective three-month before admission (interviewing the patients primary caregiver) and at three and six month after hospital discharge. Using Katz scale | - Delirium (as sole predictor P 0.009) (Mantel Hantzel Chi-square=6.54 $P<0.011$ for patients discharged to the community and MH Chi-square 5.82, $P<0.016$ for patients discharged to a nursing home) |

| | | | | | |
|---|---|---|---|---|---|
| Sager *et al.* (1996b) | To develop and validate an instrument for stratifying older patients at the time of hospital admission according to their risk of developing new disabilities in ADL following acute medical illness and hospitalization. | Multi center prospective cohort study | Five university affiliated hospitals and one community hospital, n= 448 and a validation cohort n= 379, aged 70 and older | At admission (also retrospectively), at discharge and three months after discharge. Using 6 ADL and 7 IADL | - Increased age (age < 75 years compared with 75-84 years adjusted OR 1.9, *P*<0.05 and ≥ 85 years, adjusted OR 3.5, *P*<0 .01))<br>- Lower cognitive functioning (adjusted OR 1.4, *P*< 0.05)<br>- Pre-existing IADL functioning (0-5 score compared with score 6 or 7: adjusted OR 2.6, *P*<0.01) |
| Sager *et al.* (1996a) | To identify the patient factors associated with an increased risk of developing disability associated with acute illness and hospitalization | Prospective cohort study | Five hospitals (HOPE study) N=1279 community dwelling patients, aged 70 years and older, hospitalized for acute medical illness | At admission (also preadmission), at discharge and three months after discharge. Using 6 ADL and 7 IADL | - Age (adjusted OR 1.7 *P*<0.050 ≥ 85 adj. OR 2.7 *P*<001 compared with age 70-75 years)<br>- Gender (only at discharge) (adjusted OR 1.4, *P*<0.05<br>- Pre admission IADL (adjusted OR 0.087, P<0.001<br>- Lower admission MMSE (three months after discharge, score 15-20 compared with 0-14 adj. adj. OR 1.8, *P*<0.05)<br>- Cancer (only at discharge) (adj. OR 2.3, P,0.05)<br>- Loss of ADL during hospitalisation (after three month) (adj. OR 3.7, P<0.001)<br>- Hospital length of stay (adj. OR 1.07 P<0.001only at discharge) |

| | | | | | |
|---|---|---|---|---|---|
| Wu *et al.* (2000) | To develop a model estimating the probability of a patient 80 years or older having functional limitations 2 and 12 months after being hospitalized | Prospective cohort study | Four teaching hospitals (HELP project)<br>N=804, aged 80 years or older, in hospital at least 48 hours | Two weeks before admission, on or around the fourth day of study entry, at 2 and 12 months later.<br>Katz scale and DASI | - Older<br>- Worse baseline functional status and quality of life<br>- ADL score at baseline(Chi Square 146.1, total Chi square 418.6)<br>- Depth of coma<br>- Lower serum albumine level<br>- Presence of dementia (OR 1.9)<br>- Depression (OR 1.5)<br>- Incontinence (OR 1.5)<br>- Bedrest (OR 2.4),<br>- Medical record<br>- Cancer (OR 1.3)<br>- Documentation of need for nursing home (OR 1.6) |
| Inouye *et al.* (1993) | To prospectively develop and validate a predictive index to identify on admission elderly hospitalized medical patients at risk for functional decline | Two prospective cohort studies in tandem | One hospital<br>N=188 for the development cohort and N=142 for the comparable group, aged 70 years and older | Baseline interview, self reported IADL two weeks before admission, interviews with nurses twice weekly and at discharge | - Pressure ulcer (RR 2.7)<br>- Cognitive impairment (RR1.7)<br>- Functional impairment RR 1.8)<br>- Low social activity (RR 2.4) |

The most important predictors in this review are age, diagnosis, ADL, cognitive impairment (including delirium) and residence. In the review of Miller and Weissert (2000) the strongest predictors of functional decline and other adverse outcomes are worse performance on physical function measures not based on ADL, greater illness severity and prior hospital use. Eight studies that met the inclusion criteria were found in the literature with the following outcomes: functional decline [6;21], decline in ADL function [1;22], functional outcome at follow up [2], number of ADL dependencies [23;24].

The eight studies were examined to determine the objective, design, setting and patients, measurements and the significant predictors. Table 1 gives an overview of the characteristics. Functional decline was measured mostly in a prospective cohort design, only one study used a secondary analysis of data of a prospective randomised trial [1]. One study used two prospective cohorts in tandem, to validate the outcomes of the first cohort [22]. The number of included persons varied as well as the inclusion criteria, but all studies were focused on older people in a hospital setting.

Different measuring instruments were used in the studies: Katz scale, used in four studies [1;6;23;24] five ADL [21] or six ADL were measured [2;25;26], or seven basic ADL skills were measured by nurses [22]. The measurement times were self-reported two weeks before admission and mostly shortly after admission, at discharge and/ or at a certain point after discharge.

The number of possible predictive variables was different in all studies. Three studies only investigated the effect of one predictor [6;21;24] one study examined the effect of two predictors [1], four investigated nine or more predictors, some of which were partially overlapping [2;22;23;26]. Covinsky *et al.* studied the association with age. The oldest patients are particularly high risk of poor functional outcomes because they are less likely to recover ADL function lost before admission and are more likely to develop new functional deficits during hospitalization [21]. In another study by Covinsky *et al.* symptoms of depression, severity of illness at admission, co morbidity and demographic characteristics, were examined. *'*Symptoms of depression*'* was the strongest predictor. Patients with six or more symptoms of depression on admission were more likely to be dependent in basic ADL than patients with 0-2 symptoms [24]. Mahoney *et al.* (1999) studied only mobility impairment, as indicated by the use of a cane or a walker, and this was significantly associated with functional decline. Murray *et al.* examined delirium, initial level of function and comorbidity as predictors. Delirium was the strongest predictor. The study demonstrates a strong association between the presence of delirium and worsening

physical function in two groups: patients discharged in the community and those discharged to a nursing home. Delirium persisted as the sole predictor of loss of function at three months after discharge ($P = 0.009$) [6]. Sager *et al*. investigated several variables such as cognitive function, discharge diagnosis, preadmission ADL and IADL, and demographic characteristics. Increasing age, decreasing levels of independent IADL function before admission and lower Mini-Mental State Examination (MMSE) scores on admission were the strongest predictors of functional decline [26]. In another study by Sager *et al.* (1996a) increasing age (75-84 years), gender, preadmission IADL disabilities, lower mental status scores on admission and rehospitalization were significant predictors. In the study by Wu *et al.* (2000), 26 variables were independent predictors, among them ADL score at baseline (the strongest predictor), poorer quality of life at baseline, demographic characteristics, coma, disease group (cancer being the strongest predictor), geriatric symptoms such as urinary incontinence, dementia, depression, bed rest, serum albumin level and the documented need for nursing home care. Inouye *et al.* (1993) investigated in a single prospective cohort study in tandem so as to develop and validate a predictive index to identify elderly hospitalized patients at risk for functional decline. Pressure ulcer, cognitive impairment, functional impairment and low social activity level were the predictors of functional decline.

**Screening instruments**

Three instruments that met the criteria of having been tested in the hospital setting were found in the literature. The Hospital Admission Risk Profile (HARP) identifies older hospitalized patients at risk for functional decline in the hospital setting [26]. The Identification of Seniors At Risk (ISAR) instrument is part of a two-step intervention developed to be used in the emergency department [27]. A short Care Complexity Prediction Instrument (COMPRI) detects patients at risk for complex care needs in the hospital setting [28]. This instrument is also part of a two-step instrument. Table 2 gives an overview of the main characteristics of the screening instruments.

*HARP*

Hospital Admission Risk Profile is developed in six acute-care hospitals in the US, as an instrument to classify older patients at the time of hospital admission according to their risk of developing new disabilities in ADL. The instrument has a list of 29 questions. In developing the instrument the study population was divided in a development (n=448) and a validation

(n=379) cohort. The study was part of a larger study, the Hospital Outcomes Project for the Elderly (HOPE). Elderly patients of 70 years and older were included.
Hospital Admission Risk Profile consists of three types of variables derived from this larger study to determine the strongest predictors of functional decline: age, cognitive function (measured by an abbreviated MMSE, 21 items) IADL (seven functions) prior to admission. These were significantly associated with the presence of new ADL disability at discharge. Functional status was measured by six ADL (bathing, dressing, transferring, walking, toileting and eating) at admission, discharge and three months after discharge by telephone interview. Three of the six predictors of our review were the basis of HARP (see Table 3).
In testing the HARP, the Area Under the Curve (AUC) proved to be moderate (AUC 0.65). The investigators ascribe this moderate predictive ability to the fact that HARP describes the patient variables but not the illness or process of care variables, both of which may be important in the development of disability in frail older patients. No further testing of reliability was found.
According to the authors, HARP can be seen as a simple instrument suitable to identify patients at risk of functional decline who could benefit from comprehensive discharge planning, specialised geriatric care and experimental interventions [26]. The way the instrument should be used, who can fill in the form, the required time to administer and the effect on the respondents are not described.

*ISAR*

Identification of Seniors At Risk is developed to identify elderly patients at risk for functional decline in the Emergency Department (ED) in Canada [27]. Included were patients aged 65 years and older who visited the ED at four hospitals during daytime, during a three-month period (*n*=1854). From another study of McCusker it is known that only 32% of the emergency department population was admitted to the hospital [29]. Identification of Seniors At Risk is developed as a two-step instrument. The first step includes screening to identify elderly patients at risk of adverse outcomes. The second step is a brief nursing assessment to those with an ISAR score of two or more using a checklist. The proposed screening tool (ISAR) consists of six self-report questions on functional dependence, recent hospitalization, impaired memory and vision and polymedication.

Table 2 Characteristics of Screening Instruments

| | **HARP** (Sager *et al.* 1996b) | **ISAR** (McCusker *et al.* 1999) | **COMPRI** (Huyse *et al.* 2001) |
|---|---|---|---|
| Objective | To develop and validate an instrument for stratifying older patients at the time of hospital admission according to their risk of developing new disabilities in ADL | To develop a self-report screening tool to identify older people at increased risk of adverse health outcomes | To develop a screening instrument to detect patients in medical ward at risk for complex care needs. It is used with an interdisciplinary instrument Intermed to predict poor discharge health status. |
| Setting | 4 University and 2 private non-federal acute-care hospitals in the US. | 4 Acute care hospitals in Montreal (Can).<br>2 community, 2 tertiary hospitals | 2 Dutch hospitals, internal wards |
| Population | Development cohort N=448<br>Validation cohort N=379<br>Patients aged 70 years and older | N=1673<br>Patients who came to the ED, aged 65 years and older, during three months | N= 275<br>All patients admitted to a general internal ward |
| Exclusion | Patients admitted for surgery, living in a nursing home before admission, or dying during hospitalization or during the three months after discharge, terminal illness, severe cognitive impairment, inability to give informed consent and admission to the IC | Patients not to be interviewed because of medical condition or cognitive impairment and no other informant available<br>Patients from a nursing home or chronically disease hospital | Patients admitted for one day, patients from another ward or hospital, patients readmitted within the study period and patients treated by the specialty dermatology or rheumatology |
| Design | Multi center prospective cohort study | Prospective-follow-up cohort | Cohort study |
| Measurement time | Within 48 hours after admission, at discharge, and three months after discharge | At admission, discharge, three months after discharge | At admission, within three days after admission for an extensive interview and at discharge |

| | | | |
|---|---|---|---|
| Used predictors | Demographic characteristics<br>6 ADL<br>7 IADL (self reported two weeks before admission)<br>MMSE, short version<br>Demographic info<br>LOS<br>Diagnostic categories (ICD-9-CM) | From 27 self-report (including demographic characteristics, ADL, diseases, geriatric problems, mental status, polymedication, alcohol use, social context and depression) to a six-item scale. Predictive evaluation of each item with chi-square and ROC and goodness-of-fit test. Univariate and multivariate measures. | Derived from an extensive list of 117 potential risk factors from another large study in 10 hospitals in Europe (n=2158). Correlation's with LOS 0.47, number of medications during hospital stay 0.49, complexity rating by a doctor 0.46, and complexity rating by a nurse 0.49) |
| Outcome-measurements | ADL functioning: bathing, dressing, transferring, walking toileting and eating) | Adverse health outcomes, death, institutionalization, decline in physical function. | - LOS<br>- number of days with laboratory tests<br>- number of days with diagnostic procedures<br>- medications<br>- number of consultations by medical and paramedical specialists<br>- number of non-standard nurse interventions<br>- medical complexity<br>- nursing complexity<br>- post discharge care needs<br>- mental health problems |
| Items in the instrument | -Age<br>-Lower MMSE<br>-Decreasing levels of independent IADL -function before admission | -ADL dependence<br>-Need for help in the recent past<br>-Visual and<br>-Cognitive impairment,<br>-History of hospitalization,<br>-Polymedication | 13 items (yes or no) of which 3 items to be rated by a nurse, 4 by a doctor and the 6 remains by a research nurse.<br>- expectations of the doctor (4 items)<br>- expectations of the nurse (3 items)<br>- patients health perception<br>- walking difficulties during the past three |

| | | | |
|---|---|---|---|
| | | | months<br>- more than 6 doctor visits during the past three months<br>- polymedication<br>- planned or unplanned admission<br>- retired patient or not |
| Sensitivity | Not described | Cut off 2 71%<br>-------- 3 44%<br>-------- 4 25% | Cut off 5/6 0.71, |
| Specificity | Not described | Cut off 2 57%<br>-------- 3 79%<br>-------- 4 91% | Cut off 5/6 0.63, |
| Positive predicive value | Not described | Not described | Cut off 5/6 0.70 |
| Negative predictive value | Not described | Not described | Cut off 5/6 0.64 |
| Area under the ROC curve | 0.65 | 0.71 | 0.73 |
| Reliability | | Not decribed | Not described |
| Clinical utility | Used for identifying older patients at risk for functional decline<br>It stratifies in low, intermediate and high risk. | A two-step instrument: screening at risk on a six-item scale, more detailed assessment in the second step. The first step is a simple, self-report instrument. | A two-step instrument to be used with Intermed which consists of 4 domains: biological, psychological, social and health care, with each 5 variables. Both nurses and doctors have to fill in the form. |

ISAR identifies older patients in the ED at increased risk of several adverse health outcomes and those with current disability. The items were selected based on face validity and ease of administration and predictive value. The study to validate the tool included patients aged 65 years and over, seen at four urban hospitals. To develop the scale measures ascertained at the ED to find the most predictive variables were based on literature, an existing instrument and an expert panel. This resulted in 27 self-report screening questions on social, physical and mental risk factors, medical history, use of hospital services, medications and alcohol. Of these the most predictive variables were used for the screening tool. The Older American Resources and Services (OARS) ADL scale was used to measure ADL at admission and by telephone at follow-up. Three of the six predictors of our review were the base of ISAR (see Table 3).

Sensitivity and specificity of ISAR were fair (overall AUC 0.71). No further testing of reliability was found. According to the authors, ISAR is easy to use, it is a short and quick instrument and it can be completed by patients or informants [27;30;31].

*COMPRI*

Care Complexity Prediction Instrument is developed to detect hospitalized patients at risk for complex care needs (including older patients at risk for functional decline), measured as poor discharge health status and extended length of stay. It was tested in two Dutch hospitals as part of a large international study. All patients admitted to one of two general internal medicine wards were included (*n*=275). Patients admitted for one day, readmitted within the study period and treated by the specialties dermatology or rheumatology were excluded. Patients who died were removed from the sample.

Care Complexity Prediction Instrument is part of a two-step instrument, a first screening for patients at risk and a second assessment. COMPRI consists of 13 dichotomized items, four items are rated by the doctor and three by the nurse. The remaining six items were rated by a research nurse based on a patient interview, during the development of the instrument. The outcome variables were the result of a large study to detect indicators for care complexity of patients with combined medical and psychiatric problems. The items were derived from an extensive list of 117 potential risk factors from another large study in 10 hospitals in Europe (*n*=2158) including hospital-based health-care use, administration status, predictions by the doctor and the nurse, severity of illness, living/working situation, stress/social support, ADL,

health perception, relation with doctors, past health-care use, drug abuse, compliance, emotional state.
Care complexity was measured on a scale with 10 complexity indicators. Three of the six predictors of our review were the base of COMPRI (see Table 3).
Sensitivity was good, specificity less, AUC is fair (0.73) as well as the positive (0.70) and negative predictive value (0.64). No further testing of reliability was found [28;32-34].

Table 3: Overview of the Predictors Used in the Development of the Screening Instruments

| | HARP | ISAR | COMPRI |
|---|---|---|---|
| Age | x | x | x |
| Lower functional status: ADL or IADL | | x | x |
| Lower cognitive functioning | x | x | |
| Lower pre admission IADL | x | | |
| Depression | | | |
| Hospital length of stay | | | x |

## Discussion and conclusion

For older patients hospital admission in itself is a risky event. Many older patients suffer from functional decline related to hospitalization. Identifying patients at risk for functional decline is a first step in assessing the degree of risk, to determine the risk factors and to prevent (further) functional decline by developing a model in which, stepwise, all risk factors are prevented by interventions, which is the aim of this program.
The objective of this review is to identify a screening instrument, based on the predictors of functional decline.
The variables that are most often identified as predictors are age (four studies), lower functional status (ADL or IADL) in four studies, followed by lower cognitive functioning (three studies), lower preadmission IADL, depression and hospital length of stay (each in two studies).

Three valuable screening instruments were identified: HARP, ISAR and COMPRI. Of the six predictors at least three were mentioned in the development of all 3 instruments.
All three instruments are built on a study to determine the predictors. The number of studied variables is different in the three studies and varies from 13 items (HARP) to 27 items (ISAR) and 117 items (COMPRI).
Identification of Seniors At Risk has been developed and tested in a multicenter study on the emergency department. The validity of ISAR is well described. The overall AUC 0.71 and the instrument has been tested and had a strong correlation with other validated scales. COMPRI was also developed and tested in a multicenter study. In COMPRI the AUC was also fair, 0.73. HARP was tested in a multicenter cohort study, the AUC was 0.65, which is moderate. All three instruments have been tested in a large population.
The reliability of all three instruments was not described, which is a weak point in the development and testing of a screening instrument. However, ISAR is a self-report instrument, (inter-rater) reliability is not an issue for this.
All three instruments are developed to identify patients at risk for functional decline. ISAR is developed and only used in the ED setting which is partly the population of the hospital. COMPRI is developed to predict all patients with complex care needs in the hospital setting, and not only older people. Only HARP is developed in the hospital setting to identify older patients at risk for functional decline.
To determine the suitability of an instrument for clinical use in a hospital, the clinical utility must be very well described. It must be short and easy to administer and it must be easy to use for all nurses on a ward. The time needed for assessment and administration, the level of knowledge and training of the rater and the impact on the respondents should be described. The clinical utility is not described for the HARP. The ISAR screening tool seems very easy to use for all nurses on a ward. This instrument is a self-rating scale. However, the impact on the respondents is not described. COMPRI is a more complex instrument. Because both doctors and nurses have to complete the form and the patients have to be interviewed by a (research) nurse, the clinical utility of the instrument does not seem to be so easy. More detailed information is not available. Possibly ISAR is the most user-friendly instrument because it is short, easy to complete by the patient or relatives and, therefore, easy to administer.
So as to be valid, predictors of functional decline should be the base of an instrument to identify older patients at risk of functional decline. Few studies with the outcome of

functional decline, investigated in the hospital setting, were identified. The studies are very different in methodological approach. Heterogeneity in the goals, different designs, different variables, different analysis, different measurements and measurement times, different numbers of variables make comparison and synthesis difficult.

Four of the eight predictor studies focused on a primary predictor, thus avoiding multiple tests of significant variables, and in this way giving a limited explanation for the phenomenon functional decline. The estimate of the effect of the co-variables is not described, and from other studies it is known that several predictors play an important role. The methods used to adjust the confounders are also not described. These single focused studies have a limited value in finding the strongest predictors of functional decline as a base for a screening instrument.

The exclusion in most of the studies of the patients who died poses problems in the interpretation of the effect of the measured predictors. It hypothesizes that dying does not connect with the determinants of functional decline, which is questionable. Excluding deaths gives a biased view of the effect of the measured variables.

Despite the considerable methodological differences between studies, they all point in the same direction. The strongest predictors of functional decline in the hospital setting are age, cognitive status, (pre)admission ADL and IADL and depression. This outcome is a little different from McCusker's *et al.*(2002) review and the study of Inouye *et al.*(1993). This has to do with the broader perspective and the methodological differences in these studies. However, cognitive and functional impairment are the common predictors in these studies.

Only a limited number of studies are focused on the outcome of functional decline. More studies focus on nursing home admission, length of stay, mortality and other adverse outcomes. Outcomes like nursing home admission are also dependent on other cultural and social variables like the availability of placements in a nursing home, consequences of living alone and the wishes of the patient and the family [35]. In those studies functional decline is one of the predictors of these adverse outcomes [4]. Measuring the predictors of adverse outcomes is an indirect way to measure functional decline and these outcomes may share some of the predictors of functional decline. It is important to notice that the findings of these studies are concurrent with the most important predictors of functional decline in this study.

Functional decline is also an important issue in community health care. The findings of this review are different from the findings of studies in the community. Only cognitive impairment and depression are common [36]. Of course preadmission decline in ADL/IADL is not a variable in these studies.

All three scales were based on a literature study, but the results were very diverse and ended up in different types and different numbers of variables included in the instrument. Validity of all three scales is moderate to fair, but reliability (inter-rater and intra-rater) and ease of use in the clinical setting are not well described, which is a weak point for HARP, ISAR and COMPRI. In the hospital setting many nurses are working on different shifts and that is also a reason why it is important to describe the clinical utility, which was not done for all three instruments. Because of the differences in settings, the differences in investigated populations and the different objectives of the three instruments it is not possible to identify one instrument as being the best to identify older hospitalized patients at risk for functional decline. On the other hand, the validity of these three instruments is moderate to fair which gives a perspective to choose one of them in the hospital setting after a new comparative study.

**Suggestions for further research**

Based on the findings of this review further study to compare the three instruments in the hospital setting ISAR, COMPRI, HARP is recommended. Further testing should include reliability, validity and clinical utility in the setting of the internal ward of a hospital. Functional decline in hospitalized older patients is a serious problem with a huge impact on the lives of patients and their families. To develop an intervention to prevent this event, it is important to start with a valid and reliable screening instrument.

**Contributions**

JH is the principal author and investigator of this study, responsible for the literature review, MS is the supervisor, MD, SR and NG have contributed and controlled the search strategy, the interpretation of the articles, the conclusions and the preparation and revision of this article.

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Chapter 3

# Identification of older hospitalized patients at risk for functional decline, a study to compare the predictive values of three screening instruments

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## Abstract

**Aims and objectives:** To establish a screening instrument for identifying older hospitalized patients at risk for functional decline by comparing the predictive values of three screening instruments: Identification of Seniors At Risk, Care Complexity Prediction Instrument and Hospital Admission Risk Profile.

**Background:** After being hospitalized, 30-60% of older patients experience a decline in functioning, resulting in a decreased quality of life and autonomy.

**Design:** A prospective cohort study.

**Methods:** Included were patients, aged 65 years and older, acutely admitted to a general internal ward of an university teaching hospital. Within 48 hours after hospital admission, baseline data were completed - demographic, cognitive, social and pre-admission functional status and the screening instruments. Three months after discharge, functional status was measured by telephone interview. The Katz index was used to measure functional status (six activities). Functional decline was defined as a decline of at least one point on the Katz index at three months after discharge compared to pre-admission state.

**Results:** Included were 177 patients; mean age of the patients was 77.6 years and 51.7 % were male. Functional decline was found in 27.8% of all patients.

Sensitivity, specificity and area under the receiver operating curve for Identification of Seniors At Risk (ISAR) were 93%, 39% and 0.67, respectively. The corresponding results for the care Complexity Prediction Instrument (COMPRI) were 70%, 62% and 0.69 and for the Hospital Admission Risk Profile (HARP) 21%, 89% and 0.56.

**Conclusion:** The discriminative values of both Identification of Seniors At Risk and care Complexity Prediction Instrument are fair. Hospital Admission Risk Profile shows the poorest results. Identification of Seniors At Risk shows the best ability to predict those patients at risk for functional decline and seems to be the easiest instrument in clinical practice.

**Relevance to clinical practice:** Identifying patients at risk for functional decline is a first step in prevention, followed by geriatric assessment and targeted interventions. Studying the validity of existing instruments is necessary before implementation in clinical practice.

## Introduction

Functional decline is a common and serious problem in hospitalized older patients.
After being acutely hospitalized, 30-60% of older patients experience a decline in functioning [1-3]. This functional decline is usually defined as a new loss of independence in self-care activities or as deterioration in self-care skills and is measured on an activity of daily living (ADL) scale (e.g. bathing, dressing, transferring from bed to chair, using the toilet) and/or an instrumental activities of daily living (IADL) scale (e.g. shopping, housekeeping, preparing meals, taking medications, handling finances, using public transport) [4;5]. Functional decline results in a change of health-related quality of life and in decreased autonomy and is associated with increased risks of hospital readmission, nursing home placement and mortality [4;6-10], so it leads to increased health care and personal costs.
Functional decline is not strictly related to the medical problem that caused admission and is not automatically recovered when the medical problem is treated. Several factors play a role in the occurrence of functional decline, such as the condition of the patient before admission, co-morbidity, iatrogenic effects of the treatment and effects of bed rest [11-14]. The most significant predictors of functional decline are age, lower functional status before hospital admission, impaired cognitive status, depression and prolonged length of hospital stay [15].
Based on the current literature, some screening instruments that might identify hospitalized older patients at risk for functional decline are available: the Identification of Seniors At Risk (ISAR) [16;17], the Care Complexity Prediction Instrument (COMPRI) [18-20] and the Hospital Admission Risk Profile (HARP) [21]. These instruments were developed and validated in different populations and are designed to predict functional decline or outcomes related to functional decline, such as complex care needs, poor discharge health status and extended length of stay. Their predictive values have not been compared in patients acutely admitted to the general internal ward of the hospital.
Therefore, the aim of this study is to establish a screening instrument for identifying older patients, acutely admitted to the general internal ward of the hospital, at risk for functional decline by comparing the predictive values of the three screening instruments.

## Methods

### Study population

All patients of 65 years and older acutely admitted to the Department of Internal Medicine of the Academic Medical Centre (AMC), a 1024-bed university teaching hospital were evaluated for eligibility. Patients were excluded from the study if they were too ill, came from another ward or were admitted from another hospital, did not stay at least 48 hours or did not speak or understand Dutch.

### Ethical considerations

The hospital's Medical Ethics Committee approved the study. Only patients who gave written informed consent were included in this study.

### Data collection

Patients were included in the study from October 2004 - November 2005. Within 48 hours after admission, all baseline data were completed by a trained research nurse who interviewed the patients. The baseline data consisted of demographic data (age, sex, living and social situation), cognitive status, pre-morbid functional status (i.e. two weeks before admission) and the three screening instruments, ISAR, COMPRI and HARP. A geriatrician completed the clinical data with the medical diagnoses. In the event of severe cognitive problems, the data were collected by interviewing the patient's proxy.
Three months after discharge, functional status was measured by telephone interview.

### Measurement instruments

*Functional decline*

The Katz index of independence in activities of daily living (Katz index) was used to determine functional status, measuring bathing, dressing, toileting, transferring, continence and feeding. The index was scored per item as 0 = independent and 1 = dependent. The total score ranged from 0 (total independence) to 6 (total dependence). Patients were asked to rate their ADL status as it stood two weeks before hospital admission in order to eliminate the effects of the illness that led to that admission [22;23].
Functional decline was defined as a decline of at least one point on the Katz index at three months after discharge compared to the pre-admission state.

*Cognition*

Cognitive functioning was measured using the Mini Mental State Examination (MMSE) on a scale of 0 (poor) - 30 (excellent) with a cut off < 24 indicating cognitive impairment [24;25].

*The screening instruments*

The ISAR was developed to identify patients at risk for mortality, functional decline, readmission and institutionalization, in the emergency departments (ED) of four university-affiliated hospitals in Montreal, Canada [17]. The instrument was validated in a study including patients aged 65 years and older (development sample n=997, validation sample n=676). It consists of six self-report questions with yes/no responses on functional dependence: premorbid and acute change in functioning, recent hospitalization, impaired memory and vision and polypharmacy. The items were selected on the basis of face validity, predictive value and ease of administration. The cut-off point is 2, indicating that patients with a score ≥ 2 are at risk of adverse health outcomes, including decrease in functional status. Sensitivity (72%), specificity (58%) and the area under the receiver operating curve (AUC) (0.71) were fair. Moreover, the ISAR was evaluated in 2004 in two independent groups of 1122 and 520 patients with a positive result in predicting severe functional impairment, the AUC was 0.86 [16]. According to these authors, the ISAR is easy to use as it is a short and quick instrument that can be completed by either patients or their informants [16;17].

The COMPRI was developed to screen hospitalized patients at risk for complex care needs, poor discharge health status and an extended length of stay. This instrument was validated in two Dutch hospitals in a study including patients admitted to a general medical ward (n=275). It was derived from a list of 117 potential risk factors. The items most predictive for length of stay and some other indicators for hospital-based care use were selected: doctors' and nurses' expectations about care complexity, premorbid health status and health care use [19]. The instrument has to be completed by three different respondents; four items are rated by the physician, three by the nurse and six by interviewing the patient. The cut-off point is 6, indicating that a score ≥ 6 is a patient in need of complex care. In the validation study, sensitivity (71%), specificity (63%) and the AUC (0.73) were fair and so were the positive (70%) and negative (64%) predictive value [18-20;26;26].

The HARP was developed in six acute care hospitals in the USA (n=827) as an instrument for classifying patients of 70 years and older according to their risk of developing new disabilities in six ADL functions (bathing, dressing, transferring, walking, toileting and

eating) during hospital stay and three months after discharge. It includes 25 questions and consists of three types of variables derived from a larger study to determine the strongest predictors of functional decline: age, an abbreviated MMSE and seven ADL and IADL functions, classified as 0 = no risk, 1 = intermediate risk and 2 = high risk. The cut-off points in this instrument are <2 (low risk), 2-3 (intermediate risk) and >3 (high risk). The AUC (0.65) proved to be fair. According to the authors, the HARP can be considered an easy-to-use instrument suitable for identifying patients at risk for functional decline, who could benefit from comprehensive discharge planning and specialised geriatric care [21].

**Measurements of predictive value**

The ability of a test to discriminate individuals with and without the outcome is evaluated using the AUC. The most important quality is the ability to predict which patient is at risk. For this reason, sensitivity and positive predictive value are key measurements. The ability to identify correctly those patients who are not at risk is also relevant so that over-treatment is precluded, and this is measured by the specificity and the negative predictive value.

**Statistical analysis**

Analysis was performed using SPSS, version 15 (Statistic Package for Social Studies, Inc. Chicago, Illinois). For nominal variables, percentages, means and numbers were calculated to describe the population. Student's *t*-test, Mann-Whitney and chi-square were used to compare the included patients with the deceased and missing patients. Sensitivity, specificity, positive and negative predictive value of all three instruments were calculated, and the discriminative value was measured by the AUC. The AUC can range from 0.5 (no discrimination) to 1.0 (perfect discrimination) [27].

## Results

During the inclusion period, 245 patients were eligible for this study. Mortality rate during hospital stay and within three months after discharge was 22.0% (n=50). Loss to follow up owing to difficulties in contacting the patient or the relative was 7.3% (n=18). Patients who died or were missed at follow up were significantly older. Baseline ADL and cognition

showed no significant differences. One hundred and seventy-seven patients were included in the analyses. The baseline characteristics of the patients are presented in Table 1.
Mean age was 77.6 years, and 51.7% were male. At admission, almost three quarters of all patients lived independently, and a little less than half of them lived with a partner. More than one third of the patients were cognitive impaired (MMSE score < 24). Mean length of stay was 11.6 days. The mean pre-admission ADL score of the patients was 1.0 (SD 1.4). Three months after discharge, the mean ADL score was 1.4 (SD 1.9). Two weeks before admission, 50.9% of patients were independent in performing their ADL. Decline in functional status was found in 27.8% (n=47) of the patients. Of these, 12.4% (n=21) developed a decline of 1 point, 15.5% (n=26) a decline ≥2 points. The ADL of 15.5% (n=26) of the patients improved 1 or more points.

The sensitivity, specificity and AUC (see Table 2 and Fig. 1) for the ISAR were 93%, 39% and 0.67, respectively. For the COMPRI, these values were 70%, 62%, and 0.69, while for the HARP three categories were calculated - low, intermediate and high risk. Sensitivity was respectively 61%, 40% and 21% specificity was respectively 68%, 81% and 89% and the AUC, 0.65, 0.60 and 0.56.

## Discussion

In this study, the predictive value of three instruments for identifying acutely hospitalized older patients at risk for functional decline were assessed and compared. None of the instruments is strong in predicting which patient is at risk while also giving a valid indication of those patients not at risk. The overall discriminative capacity of ISAR is comparable to that of COMPRI. HARP shows the lowest AUC score. The ISAR is the most sensitive instrument and has the best negative predictive value; these are the most important measurements for identifying patients at risk for functional decline. However, specificity and positive predictive value are poor, resulting in the identification of too many patients who are not at risk as patients at risk. This may lead to inefficient care by over-treatment. COMPRI shows the best specificity and positive predictive value, although its sensitivity is less than the ISAR. In our study, the HARP shows the lowest sensitivity and the highest specificity, leading to possible underestimation of the patients who are at risk and overestimation of those who are not at risk.

Table 1 Demographic and Clinical Characteristics (n=177)

| | |
|---|---|
| Age (yrs), mean (SD) | 77.6 (7.9) |
| Sex, male % (n) | 51.7 (91) |
| Living situation at admission % (n) | |
| Independent | 74.0 (128) |
| Nursing home | 3.5 (6) |
| Partly independent | 22.0 (38) |
| Else | 0.6 (1) |
| Social situation at admission % (n) | |
| Living alone | 12.9 (22) |
| Living with a partner | 46.2 (79) |
| Living alone after divorce or as a widow | 40.9 (70) |
| Cognitive impaired % (n) | 38.0 (65) |
| Premorbid ADL score, mean (SD) | 1.0 (1.4) |
| Premorbid independent in ADL % (n) | 50.9 (89) |
| ADL decline 3 months after discharge % | 27.8 (47) |
| (n) | 12.4 (21) |
| Decline of 1 point | 15.5 (26) |
| Decline ≥ 2 points | |
| Improved ADL ≥1 point | 15.5 (26) |
| Medical diagnosis (%) | |
| Infectious disease | 53 |
| Malignancy | 6 |
| Gastrointestinal bleeding | 3 |
| Water and electrolyte disturbances | 19 |
| Other | 19 |
| Length of stay (days), mean (SD) | 11.6 (11.8) |
| Deceased % (n) | 22.0 (50) |

ADL, activities of daily living.

Table 2 The Predictive Values of Three Screening Instruments Predicting Functional Decline in Older Hospitalized Patients Acutely Admitted to an Internal Medicine ward

| | **Sensitivity (%)** | **Specificity (%)** | **Positive predictive value (%)** | **Negative predictive value (%)** | **Area under the Curve (95% confidence interval)** |
|---|---|---|---|---|---|
| ISAR | 92.9 | 39.3 | 36.4 | 93.6 | 0.67 (0.58-0.77) |
| COMPRI | 70.2 | 62.0 | 41.8 | 84.3 | 0.69 (0.59-0.79) |
| *HARP* | | | | | |
| *Low risk* | 60.5 | 68.4 | 39.0 | 83.9 | 0.65 (0.54-0.75) |
| *Intermediate risk* | 39.5 | 80.7 | 40.5 | 80.0 | 0.60 (0.49-0.71) |
| *High risk* | 21.1 | 88.6 | 38.1 | 77.1 | 0.56 (0.45-0.77) |

COMPRI, the Care Complexity Prediction Instrument; HARP, the Hospital Admission Risk Profile; ISAR, the Identification of Seniors At Risk.

Some differences from the predictive value reported in earlier studies are found, which can be explained by the different backgrounds of the instruments. The ISAR was originally developed and validated in a population of older patients visiting the ED. A possible explanation for the lower values than in the original study may lie in the use of this instrument in a hospitalized population. The population visiting an ED is mostly ambulant, and it is known [28] that only about 35% of ED patients are expected to be admitted to hospital. The ISAR was validated in another study, which is a positive aspect.

The difference between our COMPRI results and the original study could be explained by the fact that the original purpose of this instrument was different. It was initially developed to identify all patients at risk for the need of complex care and patients at risk for an extended length of stay. These outcomes, however, overlap functional decline [21]. In the validation study of the COMPRI, all patients admitted to a medical ward were included - not only older patients, as in our study [26]. As patients at risk are generally older, this may have influenced the discrepancies between the validation study and our study.

Just as in our study, the psychometric qualities of the HARP were moderate in the original publication (AUC 0.56-0.65). The investigators explained this moderate predictive ability by stating that the HARP describes only patient variables. They did not include illness or process of care variables, both of which may be important in developing disability in older patients.

In the original validation study, patients of 70 years and older were included, which differs from our younger population (65 years and older). This could also explain the different results in the present study.

Some limitations in our study need to be addressed in relation to the findings.

First, the smaller number of patients included might have resulted in lower AUCs than in the original studies. In particular, the small number of patients who developed functional decline could have led to underestimation of the predictive qualities of all three instruments. However, this does not affect the differences between the instruments.

Second, there is no gold standard for measuring functional decline, the six ADL of the Katz index constitute an arbitrary measurement. In all studies, different definitions of functional decline were applied. Furthermore, the Katz index score is a dichotomous scale, which does not reflect the more differentiated patient reality. This may also lead to underestimation of decline in function.

Finally, 28% of the eligible patients were not included in the follow up owing to mortality or to difficulties in contacting the patient or relative three months after discharge. These patients were significantly older. This selective loss of patients may have led to underestimation of the group of patients suffering from functional decline after hospitalization. This may also have influenced the predictive value of all three instruments.

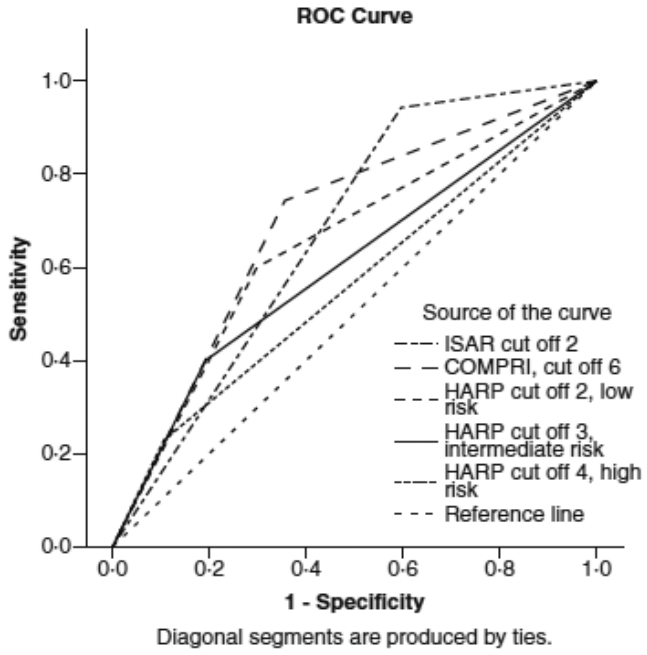
A further effort to refine the instrumentation to identify patients at risk for functional decline is therefore needed. In such studies, the validity and reliability of the instrument should be considered together with feasibility.

Successful implementation in clinical practice depends on acceptance of a scale by professionals. Acceptance is facilitated by applicability in daily practice, ease of use and the time it takes to administer. In none of the publications concerning ISAR, COMPRI or HARP or in this study were these aspects addressed. The ISAR is a short instrument with six questions with yes/no responses and can be administered in very little time by the ward nurses. The COMPRI consists of thirteen items of which four need to be rated by the physician, three by the nurse and six by interviewing the patient. On this basis, the ISAR seems to have the advantage for large scale implementation because of the smaller number of items and the greater ease of application.

Because the ultimate goal is prevention of functional decline, measurement of the instrumental activities of daily living (IADL) could be of interest too, not only because IADL are important for the patient's wellbeing, but also because they could act as an earlier marker of ADL decline.

The number of older people is growing in all western countries and health care professionals are faced with an older and more vulnerable group of patients. Functional decline after hospitalization is a serious problem, older patients themselves are aware and afraid of it, as was shown in a study by Huckstad (2002). 'Well, everybody loses their independence when they come to the hospital' was quoted by an older patient in this study [29]. To prevent functional decline, identification of patients at risk is an essential first step, which should be followed by a comprehensive geriatric assessment and targeted interventions in patients identified as high risk.

Figure 1 Area Under the Receiving Operating Characteristic Curve for the Identification of Seniors At Risk (ISAR), the Care Complexity Prediction Instrument (COMPRI), the Hospital Admission Risk Profile (HARP).



## Conclusion

For both ISAR and COMPRI, the discriminative value measured by the AUC is fair. HARP showed the poorest results. Taking everything into account, ISAR shows the best ability to predict those patients at risk for functional decline and seems to be the easiest instrument in clinical practice. Therefore, further development and study of ISAR is recommended, focussed on improving the positive predictive value and specificity in the population of hospitalized older patients.

### Relevance to clinical practice

Identifying patients at risk for functional decline is a first step in prevention, followed by geriatric assessment and targeted interventions. Studying the validity of existing instruments is necessary before implementation in clinical practice.

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### Contributions

Study design: SdR, MS, JK; data collection and analysis: SdR, JH; manuscript preparation: JH, SdR, MS, BB, JK.

### Conflict of interest

This study does not have any conflict of interest.

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Chapter 4

# The prediction of functional decline in older hospitalized patients

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## Abstract

**Context:** 30% to 60% of older patients experience functional decline after hospitalization. This is associated with a decrease in quality of life and autonomy and increase of readmission, nursing home placement and mortality. First step in prevention is the identification of patients at risk.

**Objective:** To develop and validate a prediction model to assess the risk of functional decline in acute hospitalized older patients.

**Design:** Development study: cohort study (n=492) (April 2006-April 2008). Validation study: secondary data analysis of a cohort study (n=484) in an independent population (November 2002-April 2006). Both with follow up after three months.

**Setting:** Development study: general internal medicine wards of two university hospitals and one regional hospital. Validation study: general internal wards of an university hospital.

**Participants:** All consecutive patients of 65 years and older acutely admitted and hospitalized for at least 48 hours. Development cohort: mean age 78 years, 44% male; validation cohort respectively 78 years and 47% male.

**Main outcome measure:** Functional decline was defined as a decline of at least one point on the Katz ADL index at follow-up compared to pre-admission status.

**Results:** 35% of all patients in the development cohort and 32% in the validation cohort suffered functional decline. The model could accurately predict functional decline with only four items. The AUC was 0.71. At threshold 2 sensitivity, specificity, positive and negative predictive values were 87%, 39%, 43% and 85%, respectively. This positive outcome was supported by the results in the validation study which were respectively 0.68, 89%, 41%, 41% and 89%.

**Conclusion:** Pre-admission need for assistance in instrumental activities of daily living, use of a walking device, need for assistance in traveling, and no education after age 14 are the predictors of a model to identify older patients at risk for functional decline following hospital admission.

## Background

Between 30% and 60% of older patients experience functional decline after hospitalization, resulting in a decline in health-related quality of life and autonomy [1;2]. This is associated with increased risk of readmission, nursing home placement and mortality [3-5]. Several factors play a role in the high occurrence of functional decline, such as the physical and cognitive condition of the patient before hospital admission, multimorbidity and iatrogenic complications [6;7]. The first step in prevention is identifying the patients at risk [8]. This can be followed by a comprehensive geriatric assessment (CGA) to guide preventive interventions throughout the hospital stay [8-10].

Some instruments to predict adverse health outcomes have been described in the literature [11-15]. However, these were not specifically developed to predict functional decline or have not been validated in acutely hospitalized patients.

We compared the discriminative ability of three of these instruments in a population of older patients acutely admitted to internal wards: Identification of Seniors At Risk (ISAR), Hospital Admission Risk Profile (HARP) and Complexity Prediction Instrument (COMPRI) [13-16]. None of these instruments showed good discriminative values in the targeted population. Therefore, the objective of this study is to develop and validate a prediction model to assess the risk of functional decline in acutely hospitalized older patients.

## Methods

### Participants

First a cohort study was conducted between April 2006 and April 2008 to develop and internally validate a prediction model. Patients aged 65 years and older who were acutely admitted to the internal medicine department of two university teaching hospitals and one regional teaching hospital and who could be interviewed within 48 hours after admission were invited to participate in the study. Of 1031 eligible patients, 809 consented to participate. Patients were excluded for the following reasons: too ill to participate (n=20); transferred from another ward (n=36); transferred to the ICU within 48 hours after admission(n=28) and unable to speak or understand the language (n=86). After data collection, 147 patients were excluded who were not able to demonstrate functional decline:

19 patients (3%) with a maximum score on the Katz index at baseline (who could not decline further) and 128 patients (20%) who died within three months after admission. Finally, 492 patients were included in the analysis.
Second an external validation study was conducted: a secondary data analysis of a cohort study in an independent population (November 2002-April 2006) of 484 patients admitted to the internal medicine wards of an university teaching hospital, using equal inclusion and exclusion criteria as in the development study.
For both studies written informed consent was obtained before inclusion.
The Medical Ethics Committee of the three hospitals approved the studies.

**Measurements**

Development study: within 48 hours after admission and three months after admission, data were assessed by specially trained research nurses and geriatricians. Baseline data included the following: demographic data (age, sex, race, living and social situation, number of years of education), premorbid functional status (patients were asked to describe the situation two weeks before admission to eliminate possible effects of the illness causing hospital admission), Activities of Daily Living (ADL) and Instrumental ADL (IADL) and potential predictors chosen from the literature including items of existing instruments as well as predictors suggested by experienced medical and nursing geriatric specialists. Potential predictors included cognitive status, previous delirium, nutritional status, use of devices, sensory impairments, continence, number of falls in the past three months and presence of a pressure ulcer. Medical data were obtained from the medical records.
The cognitive competence of the patient was verified at admission. In cases of severe cognitive problems (MMSE score <16 points), patient information was gathered from the patient's proxy. In patients with mild cognitive problems (MMSE score 16-20 points), the patient's answers were verified with the proxy; if the answers were different, the proxy's answers were used.
Three months after admission, functional status was recorded again by telephone interviews. The respondent was the same as the one interviewed at baseline (either the patient or the proxy).
Validation study: the relevant measurements were equal to the development study. For the validation were used: demographic data (age, sex, race, living and social situation) data to compose the prediction model, functional status (pre admission and three months after admission) and cognitive status.

Functional decline was defined as a decline of at least one point on the Katz ADL index at three months after admission compared to premorbid ADL status [17].

**Measurement instruments**

Functional status was measured using the Katz ADL index (six items: bathing, dressing, toileting, transferring, eating and the use of incontinence materials) [17]. The Lawton scale was used to measure IADL: grooming, walking, making telephone calls, traveling, shopping, preparing meals, housekeeping, medication intake and organizing financial matters [18]. In both scales, each item was scored 0 (independent) or 1 (dependent).

Cognitive function was measured using the Mini Mental State Examination (MMSE) on a scale of 0 (poor) to 30 (excellent), where a score < 24 indicated cognitive impairment [19].

Nutritional status was measured using the validated Short Nutritional Assessment Questionnaire (SNAQ). This scale consists of four questions: >6 kg weight loss in the prior six months (3 points); >3 kg weight loss in the prior month (2 points); decreased appetite (1 point); and the use of supplemental food or tube feeding (1 point). Patients with a score of 3 points out of 7 were considered malnourished [20].

## Data analysis

Percentages, means and standard deviations were calculated to describe both study cohorts. Student's t-test (continuous variables) and chi-square test (dichotomous variables) were used to test differences between groups of patients.

In the development study potential predictors associated with functional decline were identified using univariate logistic regression. Categorical and continuous variables were dichotomized. Items of existing screening instruments, of the IADL index and of the SNAQ were analyzed as individual predictors. Next, a multivariate logistic regression was conducted (backward procedure, accepting P-values $\leq 0.05$) with predictors based on three criteria: the number of cases (per ten cases, one predictor), P-value $\leq 0.15$ [21] and suggestions of clinically relevant predictors mentioned by geriatric specialists. The four best models were compared and validated in a bootstrap procedure (1000 samples drawn randomly with replacement) using the AUC with 95% CI to determine the discriminative value. The best model was recalibrated by shrinkage of the betas to prevent over-fitting using the formula of van

Houwelingen [22]. This was followed by recalculating the intercept in such a way that the total prediction of all cases of the recalibrated model was equal to the incidence of functional decline in the dataset. Finally, the prediction model was transferred into a scorecard by dividing the beta coefficients by the smallest predictor beta and rounding. Sensitivity, specificity and positive and negative predictive values were calculated. These were also measured in the external validation cohort as well as the AUC to determine the discriminative value.

In both databases several patients had values missing for one or more of the variables and these were imputed per database separately using the single linear regression method [23].

The analyses were performed using SPSS, version 15 (Statistic Package for Social Studies, Inc. Chicago, IL, USA) and the statistical package R version 2.8.1 for bootstrap procedures.

## Results

Baseline characteristics of both studies are shown in Table 1. In the development cohort mean age was 78 years, 44% were male, and 35% experienced functional decline. In the validation cohort this was respectively 78 years, 47% male and 32% of all patients suffered a functional decline of at least 1 point measured on the Katz index.

Development study: 35 variables were used in the univariate regression. Overall, 12 variables showed significant predictive values in the univariate analysis. Based on the 170 patients that showed functional decline, 17 predictors were selected for multiple logistic regression analysis: 15 predictors with P-values <0.15 and two clinically relevant predictors (previous delirium and visual impairment) with P-values >0.15.

The multiple logistic regression resulted in a model with six predictors independently associated with functional decline: premorbid need of assistance in IADL on a regular basis, hearing impairment, visual impairment, use of a walking device, need of assistance for traveling and no education after age 14. With these six predictors, four models were compared using a bootstrap with 1000 samples. Because there were no relevant differences between the AUCs of these models (range between 0.71 – 0.72), we preferred the model that was easiest to use in clinical practice with only four predictors. After shrinkage of the beta coefficients (factor 0.936), the intercept was recalculated.

Table 1 Demographic and Clinical Characteristics of Older Patients Acutely Admitted to a General Internal Ward, Baseline an Follow Up, Development and Validation Cohort

| | Development cohort (n=492) | Validation cohort (n=484) |
|---|---|---|
| Age, mean (SD) | 78 (8) | 78 (8) |
| Male, % (n) | 44 (218) | 47 (226) |
| Caucasian, % (n) | 92 (452) | |
| Living situation, % (n) | | |
| Dependent | 24 (116) | 30 (147) |
| Social situation, % (n) | | |
| Living alone | 49 (241) | 54 (259) |
| MMSE at admission, mean (SD) | 24 (7) | 23 (6) |
| < 24 points (cognitive impaired) % (n) | 34 (166) | 43 (207) |
| Admission reason, % (n) | | |
| Infectious disease | 43 (189) | 54 (260) |
| Diseases of the digestive system | 21 (92) | 33 (159) |
| Malignancy | 6 (26) | 17 (81) |
| Cardiovascular diseases | 6 (24) | 9 (45) |
| Other | 24 (104 | 17 (81) |
| Functional status 2 weeks before admission | | |
| Independent, % (n) | 54 (267) | 51 (249) |
| Functional status 3 months after admission | | |
| Independent, % (n) | 44 (216) | 47 (228) |
| Difference in functional status pre admission/ three months later, % (n) | | |
| -4 – -1 (improved function) | 11 (53) | 15 (73) |
| 0 no difference | 55 (269) | 53 (257) |
| ≥1 point decline (functional decline) | 35(170) | 32 (154) |

The result was a prediction model with the following probability of risk for functional decline: 1/1+exp (-(-1.93 + 0.48 x “pre-admission need for assistance in IADL on a regular base” + 0.81 x “use of a walking device” + 0.57 x “need for assistance in traveling” + 0.42 x “no education after age 14”)).

The AUC of this model was 0.71 (95% CI 0.66 - 0.76) and the Hosmer Lemeshow test showed a P-value 0.95 which indicates a good fitting model, see also Figure 1.

A scorecard, Identification of Seniors At Risk – Hospitalized Patients (ISAR-HP), was developed based on this prediction model by dividing the beta coefficients by the smallest predictor beta and rounding (Figure 2). At threshold 2 (score ≥2 indicating high risk for functional decline) the sensitivity, specificity and positive and negative predictive values were 87%, 39%, 43% and 85%, respectively. In total 70% of the patients were identified as patients at risk. Of this group 43% developed functional decline. Comparison of the true and false positives showed similarity in all aspects (predictors and IADL) except length of stay (LOS), which was similar for false positives and patients not at risk. For true positives LOS was nearly 1.5 times more.
Validation study: the AUC of the prediction model was 0.68 (95% CI 0.63-0.73), see also Figure 1. At the recommended threshold of 2 of the score card ISAR-HP sensitivity specificity, positive and negative predictive values were respectively 89%, 41%, the 41% and 89%.

Table 2 Independent Predictors of Functional Decline (n=492)

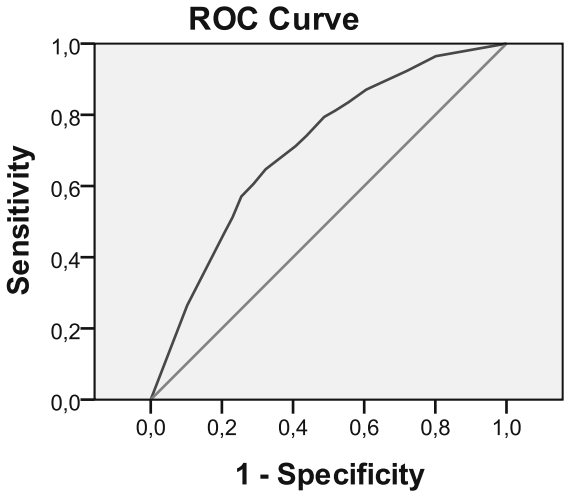
| Variable | Beta | Beta after shrinkage | P-value | OR (95%CI) |
|---|---|---|---|---|
| Pre-admission need for assistance in IADL | .52 | .48 | 0.03 | 1.7 (1.1-2.6) |
| Use of a walking device | .87 | .81 | <0.01 | 2.4 (1.5-3.7) |
| Need for assistance in traveling | .61 | .57 | <0.01 | 1.8 (1.2-2.9) |
| No education after age 14 | .45 | .42 | 0.03 | 1.6 (1.0-2.3) |

## Discussion

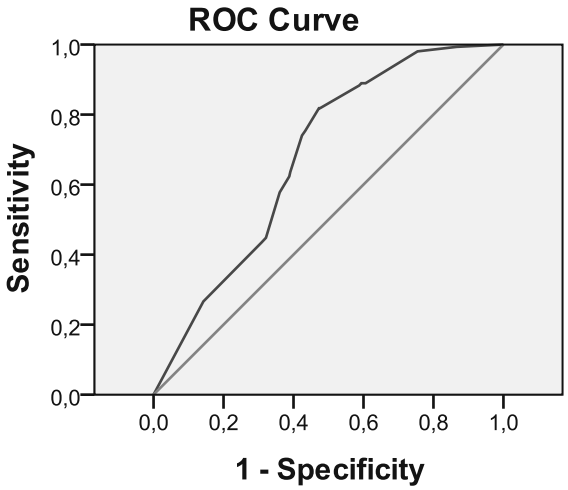
Older patients acutely admitted to an internal ward who are at risk for functional decline after hospitalization can be identified with only four predictors: pre-admission need for assistance in IADL on a regular basis, use of a walking device, need for assistance in traveling and no education after age 14. This prediction model was internally validated and in a second step validated in an independent population to establish that it can be generalized to a different population of patients. Based on the beta's of the prediction model a scorecard was developed, the Identification of Seniors At Risk - Hospitalized Patients (ISAR-HP).
To appreciate this study some aspects need to be addressed. In our study we missed some data (at random). Missing data will end up as missing cases in a multiple regression analysis.

To decrease bias and increase statistical efficiency, it is better to impute missing values than to perform complete-case analysis. So we optimized the dataset by imputation [23;24].
To enhance internal validity, we cross-checked the outcome of the multiple regression model in two ways: a forward procedure (entry P-value ≤0.05, removal P-value ≥0.10) and a 1000-samples bootstrap procedure (drawn randomly with replacement, using a forward and backward procedure accepting a P-value ≤0.05 and a selection of >50% in the 1000 samples). In these analyses, the results were equal, supporting the idea that the predictors used in the final model are the strongest for predicting functional decline after hospitalization. We also validated the best fitting model with a second 1000-samples bootstrap procedure. The bootstrap procedure is a method to see if the model is valid and not too optimistic in another population. This procedure has been shown to be superior to split-sample or cross-validation methods [24]. The AUC in the bootstrap samples was higher than in the prediction model, thus supporting the validity of the model. The general applicability of the prediction model is also supported by the differences in the population of the development study: the populations of the three hospitals in our development study were significantly different with respect to age, years of education, need for assistance in traveling, and functional decline. Finally we applied a secondary data analysis in an independent cohort study to externally validate the model. The prediction model and the score card showed a good performance with only slightly differences in the discriminative values. All these positive measurements show that the prediction model can be generalized to a different population.
We excluded the deceased patients from the analysis (n=128 in the development cohort and n=148 in the validation cohort) because we did not want to confuse the predictors of functional decline with those of mortality. The outcome of this study is relevant to patients at risk for functional decline rather than those at risk for mortality. Patients with a maximum score on the Katz index at baseline (n=19 for the development and n=12 for the validation cohort) were also excluded. Our aim was to prevent functional decline by identifying those at risk at hospital admission; it is open to discussion whether these vulnerable groups of patients should have been included as well. Therefore, we also measured the predictive value of the ISAR-HP in these groups of patients. In the development study for predicting mortality sensitivity was 81%; for identifying patients with a maximum Katz index score at baseline as at risk sensitivity was 100%; and for the combined group including the deceased and patients with a maximum score at baseline sensitivity was 85%. Also in the validation cohort the ISAR-HP showed good results for the combined group: sensitivity, specificity, positive and negative predictive values were 85%, 41%, 56% en 57% respectively.

Figure 1 Receiver Operating Characteristic Curve and Area Under the Operating Curve with 95% Confidence Interval




ROC curve of the prediction model in the development cohort: : AUC 0.71 (0.66-0.76)




ROC curve of the prediction model in the validation cohort: : AUC 0.68 (0.63-0.73)

Thus, in both cohorts the ISAR-HP can identify patients that are vulnerable at admission, including those who will die and those who are already dependent in six ADL.

In translating the prediction model to the scorecard, the choice of a threshold was based on the balance between the acceptable proportion of missed cases (false negatives) and reducing the number of patients unnecessarily qualified as at-risk (false positives). In general, a higher cut-off point leads to fewer subjects in the at-risk group. Because risk assessment can be seen as the first step in prevention that should be followed by a CGA, we preferred a high sensitivity (87%). This results in a relatively high percentage of false positives. A comparison of the false and true positives showed that the false positives were very similar to the true positives, which indicates that all these patients were meeting the criteria of frailty [25].

The predictors identified in our model were also relevant in previous studies, thereby supporting the face validity of the prediction model. Mahoney et al. concluded that using a cane or walker was the best predictor of adverse health outcomes [26]. The predictor “no education after age 14” is an indicator of the socioeconomic status of a person, which is also a well-known factor of health quality and a known predictor of functional decline [27;28].

Functional status, measured in different ways and in different populations, was also a strong predictor for further functional decline in several studies [6;15;29;30]. The predictors ‘need for

assistance in activities of IADL on a regular basis' and 'need for assistance in traveling' are both reflections of premorbid functional status.
Finally, all items of existing screening instruments were included as potential predictors. Only one item of the ISAR was a valid predictor in this study. This might be explained by the major differences between the original ISAR population (patients in the emergency department in Canada) and our study population.

## Conclusion

Based on this study in 492 older patients acutely admitted to the internal wards of three hospitals, functional decline after hospital admission can be adequately predicted by a model with four variables. The result of the validation in an independent population in 484 patients supports this conclusion. The strength of the model is that it relies on four simple questions to predict functional decline. The scorecard of this model, the ISAR-HP, will be easy to use in clinical practice and will be easy to administer.

Figure 2 Scorecard: Identification of Seniors At Risk - Hospitalized Patients (ISAR-HP)

| **ISAR-HP** | | |
|---|---|---|
| | YES | NO |
| 1. Before hospital admission, did you need assistance for IADL (e.g., assistance in housekeeping, preparing meals, shopping, etc.) on a regular basis? | 1 | 0 |
| 2. Do you use a walking device (e.g., a cane, rollator, walking frame, crutches, etc.)? | **2** | 0 |
| 3. Do you need assistance for traveling? | 1 | 0 |
| 4. Did you continue education after age 14? | 0 | 1 |
| Total score | | |
| Total score 0 or 1 = not at risk<br>Total score ≥2 = patient at risk for functional decline | | |

**Acknowledgement**

The ISAR is a widely known instrument, and we thank the developer of the ISAR for permission to denominate our scorecard ISAR-HP. We believe this will enhance implementation in clinical practice.

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**Author contributions**

Study concept and design: development study Korevaar, de Rooij, and Schuurmans.
Acquisition of data: Hoogerduijn, Buurman, Korevaar, de Rooij, Schuurmans.
Analyses and interpretation of data: Hoogerduijn, Buurman, Korevaar, Grobbee, de Rooij and Schuurmans.
Drafting the manuscript: Hoogerduijn, Grobbee and Schuurmans.
Critical revision of the manuscript for important intellectual content: Hoogerduijn, Buurman, Korevaar, Grobbee, de Rooij and Schuurmans.
Statistical expertise: Grobbee
Study supervision: de Rooij and Schuurmans.
Hoogerduijn, Buurman, de Rooij and Schuurmans had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
De Rooij and Schuurmans equally contributed to the study concept and design and the last author position is equally subscribed to de Rooij and Schuurmans.

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Chapter 5

# Predicting functional decline in older cardiac surgery patients: validation of a prediction model

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## Abstract

**Context:** A growing number of older and weaker patients undergo cardiac surgery. These patients are at an increased risk for functional decline after hospitalization, which leads to decreased quality of life and autonomy as well as increased risk of hospital readmission, nursing home placement and mortality. The first step in prevention and tailored care is to identify patients at high risk for functional decline. To date, there have been no risk profiles or tools to predict functional decline in cardiac surgery patients.

**Objective:** To validate a prediction model for hospital-related functional decline in older cardiac surgery patients, which has been previously developed and validated in internal medicine patients.

**Design:** A multicenter cohort study from January 2006 to April 2008 (n=475) with follow-up analyses three months after hospital admission. Setting: Cardiac surgery wards in two university teaching hospitals.

**Participants:** Patients ≥65 years of age consecutively admitted for cardiac surgery. Main outcome measure: Functional decline was defined as a decline of at least one point on the Katz ADL Index at follow-up, as compared to preadmission status.

**Results:** Approximately 16% of all patients and 20% of patients 70+ years of age exhibited functional decline. The prediction model accurately predicted functional decline using only four criteria: preadmission need for daily assistance in instrumental activities of daily living (IADL), use of a walking device, need for assistance in traveling and no education after age 14. The AUC of the prediction model was 0.72 (95% confidence interval (CI): 0.65-0.79) and that for patients 70+ years of age was 0.73 (95% CI: 0.66-0.80). The prediction model was translated into a scorecard: Identification of Seniors At Risk – Hospitalized Patients (ISAR-HP) The sensitivity and specificity, and the positive and negative predictive values of the ISAR-HP scorecard for patients 70+ years of age at a threshold of 1 were 85% and 48%, 29% and 93%, respectively.

**Conclusion:** Our results show that both the prediction model and ISAR-HP scorecard gave good discriminative values for older cardiac surgery patients, supporting the generalizability of this prediction model for this patient group.

## Introduction

Over the past few decades, an increasing number of older, weaker and higher-risk patients have undergone cardiac surgery. Improved cardiopulmonary bypass technology has allowed for safer procedures with reduced morbidity and mortality, even among the older patients (≥ 65 years) [1]. Older (≥ 65 years) patients account for nearly 60% of all patients receiving cardiac surgeries [2]. Because of the increasing aging population [3;4], the number of older cardiac surgery patients is estimated to rise over the next few decades.

In general, older individuals admitted to the hospital for acute health problems are at an increased risk for functional decline following discharge 5;6;6-8. This decline **is** primarily caused by the hospitalization itself and not primarily caused by the reason for hospitalization. Functional decline often results in decreased autonomy, increased dependency and decreased health-related quality of life. Furthermore, functional decline is associated with prolonged length of hospital stay, greater use of health resources, increased nursing home admission and higher mortality risk [9;10]. Functional decline is associated with complications like delirium, pressure ulcers, and depression and older cardiac surgery patients often suffer from these complications [11-15]. Identification of high risk patients is a first step to prevent this functional decline and a first step to provide tailored care for patients who would most likely benefit from preventive actions [16]. This risk assessment can then be followed by a comprehensive geriatric assessment (CGA) and targeted interventions to prevent functional decline [16;17]. Previous studies had not focused on identification of cardiac surgery patients at risk for functional decline.

Previously, a prediction model and scorecard to assess the risk of functional decline were developed and validated for older patients acutely admitted to the general internal medical wards, the Identification of Seniors at Risk – Hospitalized Patients (ISAR-HP) [18]. This prediction model exhibited a good discrimination with an AUC of 0.71 (95% CI: 0.66 - 0.76) and a good calibration performance expressed by a non significant Hosmer-Lemeshow Chi square P-value (*P*-value 0.95). At a threshold of 2, the sensitivity and specificity, and the positive and negative predictive values for the ISAR-HP scorecard were 87.1% and 39.4%, 43.1% and 85.2%, respectively [18]. Thus, the ISAR-HP scorecard can also be a valid tool for predicting high-risk functional decline in cardiac surgery patients.

Here, we aimed to validate the use of the ISAR-HP scorecard in older cardiac surgery patients.

## Methods

A multicenter cohort study was conducted in two university hospitals from January 2006 to May 2007 in the first hospital and from November 2006 to April 2008 in the second hospital. Study participants included patients 65+ years of age for cardiac surgery and were interviewed within 48 hours after admission. Patients who were unable to speak or understand Dutch were excluded from the study. An additional 26 patients (5%) who died within the study period were also excluded, as follow-up analysis on functional decline was not possible.
Of 501 eligible patients, a total of 475 patients were included in this study. All patients provided informed consent, and the Medical Ethics Committee of the two hospitals approved the study.

### Measurements

General and functional patient data were assessed by specially trained research nurses within 48 hours, and three months after, hospital admission. Upon admission, patients were interviewed for the following baseline data: demographic information (age, sex, race, living and social situation), ISAR-HP data and functional status. Follow-up functional status was assessed by telephone interview. Functional decline was defined as a decline of at least 1 point on the Katz Index of Independence in Daily Activities of Living (Katz ADL Index) at three months after admission compared to that at preadmission.

### Measurement tools

The ISAR-HP scorecard was developed using data from 492 patients acutely admitted to a general internal medicine ward and consisted of four criteria: preadmission daily need for assistance in instrumental activities of daily living (IADL), use of a walking device, need for assistance in traveling and no education after age 14. These criteria were scored as either 0 (not present) or 1 (present), except for the use of a walking device, for which presence was scored as 2 points. The optimal threshold was 2 in the development and validation study, and scores ≥2 indicated a high risk for functional decline.
Functional status was measured using the Katz ADL Index for six items: bathing, dressing, toileting, transferring, eating and use of incontinence materials [19]. In addition, the instrumental ADL was measured using the Lawton IADL scale, which assesses the

following: grooming, walking, making telephone calls, traveling, shopping, preparing meals, housekeeping, medication intake and organizing financial matters [20;20]. Each item was scored as either 0 (independent) or 1 (dependent).

Table 1 Demographic and Clinical Characteristics of Patients Admitted to Two Cardiac Surgery Units (*n*=475).

| | |
|---|---|
| Age, mean (SD) | 73 (5.2) |
| Male, % (*n*) | 64 (303) |
| Living situation, % (*n*) Independent | 94 (448) |
| Social situation, % (*n*) Living alone | 24.4 (116) |
| Education years after age 6, mean (SD) | 9.9 (3.6) |
| No education after age 14 % (*n*) | 38.5 (183) |
| Memory problems (yes%) | 12.2 (58) |
| Walking device (yes%) | 13.7 (65) |
| Needing assistance in traveling | 11.4 (54) |
| Preadmission functional status (2 weeks before admission), Katz score; Independent % (*n*) | 90 (425) |
| Follow-up functional status (3 months after admission), Katz score; Independent % (*n*) | 80 (378) |
| Difference in functional status at preadmission and at follow-up % (*n*) | |
| Between -4 and -1 = improved | 3 (13) |
| 0 = no difference | 82 (388) |
| ≥1 point = declined | 16 (74) |

### Analysis

Some patient data were missing for one or more of the variables. Missing data were imputed using the single linear regression method, with the addition of random error terms in the SPSS statistical software.

Percentages, means and standard deviations were calculated to describe the study population, and the discriminative value of the model was measured by the AUC. Sensitivity and specificity, and the positive and negative predictive values were calculated to determine the overall predictive value of the ISAR-HP scorecard.

Analyses were performed using the SPSS software, version 15 (Statistical Package for the Social Sciences, Inc. Chicago, IL, USA).

Table 2 ISAR-HP: Overview of Different Discriminative Values at Various Thresholds.

| **ISAR-HP** | **Sensitivity (%)** | **Specificity (%)** | **Positive predictive value (%)** | **Negative predictive value (%)** |
|---|---|---|---|---|
| Age 65 (*n*=475) | | | | |
| Threshold of 2 | 51 | 83 | 36 | 90 |
| Threshold of 1 | 80 | 51 | 23 | 93 |
| Age 70 (*n*=331) | | | | |
| Threshold of 2 | 56 | 82 | 43 | 88 |
| Threshold of 1 | 85 | 48 | 29 | 93 |
| Age 75 (*n*=187) | | | | |
| Threshold of 2 | 60 | 79 | 49 | 85 |
| Threshold of 1 | 89 | 39 | 33 | 92 |

## Results

Table 1 lists the demographic and clinical characteristics of the study population. The mean age of our patients was 73; 64% were male, and 94% lived independently. Approximately 16% of all patients and 20% of patients 70+ years of age exhibited functional decline.

The AUC of the prediction model for all patients was 0.72 (95% CI: 0.65-0.79), whereas that for patients 70+ years of age was 0.73 (95% CI: 0.66-0.80). An overview of the sensitivities and specificities, and the positive and negative predictive values at various thresholds is

shown in Table 2. The same values used in the development and validation study (age 65+ years and threshold of 2) resulted in a sensitivity of 51% and a specificity of 83%. However, assessing patients 70+ years of age at a threshold of 1 resulted in a sensitivity of 85% and a specificity of 48%.

## Discussion

The ISAR-HP scorecard was able to clearly identify the older patients admitted for cardiac surgery who were at greater risk for functional decline after hospitalization (Figure 1). This prediction model uses only four predictors: preadmission daily need for assistance in IADL, use of a walking device, need for assistance in traveling and no education after age 14.

The first steps in prevention are risk assessment followed by comprehensive geriatric assessment. We preferred to be more conservative and obtain a high sensitivity, which would identify all high-risk patients but would also include several low-risk patients and generate a number of false positives. At a threshold of 2, we obtained a sensitivity of 51% for patients 65+ years of age. Applying a threshold of 1 for patients 70+ years of age gave the best results with a sensitivity of 85% and a specificity 48%. Thus, including patients 65+ years of age in the analysis will generate more false positives.

Compared to the ISAR-HP findings in the development and validation study among internal medicine patients, our results for cardiac surgery patients gave somewhat higher AUC values. We obtained an AUC of 0.72, whereas the development and validation study had AUCs of 0.71 and 0.68, respectively.

However, there are several limitations of the present study that need to be addressed. To identify patients at high risk for functional decline, we advise assessing patients 70+ years of age using a threshold of 1. The development and validation study assessed patients 65+ years of age using a threshold of 2. Thus, differences observed between the two studies might be due to the difference in incidence of functional decline (35% in the former study versus 16% in this study). In addition, the patients in the development and validation study were older on average (mean age of 78 years) and likely more vulnerable than patients in our study, as patients were acutely admitted to the general internal wards.

We also excluded any deceased patients from our analysis ($n$=26) because we did not want to confound the prediction model of functional decline with mortality. Our aim was to prevent

functional decline by identifying those at risk upon hospital admission. However, it remains to be determined whether more vulnerable patients should be included in the analysis. We thus also predicted mortality with the ISAR-HP scorecard and showed a sensitivity of 92%, indicating that the ISAR-HP scorecard is also a good prediction tool for more vulnerable patients.

Figure 1. Scorecard: Identification of Seniors At Risk - Hospitalized Patients (ISAR-HP).

| **ISAR-HP** | | |
|---|---|---|
| | YES | NO |
| 1. Before hospital admission, did you need assistance for IADL (e.g., assistance in housekeeping, preparing meals, shopping, etc.) on a regular basis? | 1 | 0 |
| 2. Do you use a walking device (e.g., a cane, rollator, walking frame, crutches, etc.)? | **2** | 0 |
| 3. Do you need assistance for traveling? | 1 | 0 |
| 4. Did you continue education after age 14? | 0 | 1 |
| Total score | | |
| Total score 0 or 1 = not at risk<br>Total score ≥2 = patient at risk for functional decline | | |

## Conclusion

Of 475 older cardiac surgery patients examined, we found that 20% of patients 70+ years of age suffered from functional decline when comparing the functional status three months after hospital admission with that at preadmission. The functional decline after hospital admission can be accurately predicted using a four-variable model at a threshold of 1 for patients 70+ years of age. The ISAR-HP scorecard for this model is convenient for clinical use because of the small number of variables that need to be assessed and the ease with which information is collected.

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Chapter 6

# Tailored care for older hospitalized patients, innovation in an academic service partnership

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## Abstract

**Background:** Hospitalization can be a risk for older patients because 30-60% will develop functional decline following hospital admission. This results in prolonged length of stay, decreased autonomy, functional dependency and increased use of health care facilities. Because the proportion of older individuals is increasing, we expect an increase in the number of older patients admitted to the hospital, and the need to prevent functional decline and decrease length of stay is a priority for health care professionals.

**Methods**: A project to develop a program to prevent functional decline was organized in an academic service partnership in which participated an university Medical Center and an university of Applied Sciences. The program is based on evidence from the literature, existing protocols and guidelines and expertise of staff nurses and clinical nurse specialists and the advice of experts.

**Results:** A three-step care program (risk assessment, comprehensive geriatric assessment and targeted interventions) was developed as a best practice. This program was implemented in the three wards to help nurses and other health care professionals provide integrated care tailored to the specific needs of older patients.

**Conclusion:** The academic partnership resulted in tailored care program for patients ≥70 years to prevent functional decline and to decrease the length of hospital stay. In addition, the partnership enhanced the transition of research into clinical practice, optimized the use of existing resources and created an inspiring learning environment for nursing professionals and students.

## Introduction

Health care professionals from several wards of an university teaching hospital (i.e., cardiology, cardiac surgery and lung diseases) were alarmed by the increasing length of stay of older patients. Older patients showed more complications, such as delirium and falls, developed functional dependency and experienced delayed discharge. Because the older population is increasing, the need for interventions to prevent these complications has become a priority for health care professionals and management.

Studies have projected that there will be a significant jump in the world's elderly population by 2030. In Western Europe 28% and in the USA 21% of the population will be 65 and older by than [1]. The growth of the older population will lead to an increased number of older patients admitted to the hospital.

Hospitalization can be a risk for older patients as 30-60% of older patients experience functional decline as a result of hospitalization [2-6]. Functional decline is a loss of independence in self-care activities or a deterioration in self-care skills. More specifically, functional decline is often defined as a decline in the basic activities of daily living (ADL) (e.g., bathing, dressing, transferring from bed to chair and using the toilet) or in the instrumental activities of daily living (IADL) (e.g., shopping, housekeeping, preparing meals, taking medications, handling finances and using public transportation) [7].

Functional decline resulting from hospitalization has been shown to be related to a prolonged length of hospital stay, increased mortality rate, nursing home admission, increased dependency, decreased autonomy and quality of life [8;9]. Functional decline is not strictly related to the medical problem that initially caused hospitalization. Different pathways of functional decline, which are related to individual characteristics of patients and the iatrogenic aspects of hospitalization, have been described in the literature [10-13].

Aging has been associated with physical, psychological and social changes that increase susceptibility to various stresses and changes that represent loss of reserve function [6]. The individual response to the ageing process, the development of geriatric conditions (e.g., decreased mobility and visual and hearing problems), the development of geriatric syndromes (e.g., delirium and incontinence) and multimorbidity are all factors that contribute to the development of functional decline. Moreover, several studies have suggested associations between chronic diseases, such as coronary artery disease and congestive heart failure, and geriatric syndromes, such as delirium, falls, pressure ulcers and incontinence [14 10 15].

Furthermore, the effects of bed rest (e.g., immobility and pressure ulcers) and other hospital-related complications (e.g., malnutrition and infections) have been shown to be associated with functional decline [10;14-17].

Despite the problems older patients face during hospitalization, hospital care is mainly focused on medical problems. Thus, the needs of older patients based on their geriatric conditions and syndromes, which are often complex, fall outside the traditional disease model [18].

Not all older individuals respond equally to stress and illness, and not all older patients develop functional decline related to hospitalization. Identification of patients who are at risk for functional decline is the first step in effective and efficient hospital care for the older patients. This enables the separation of those patients who need more than regular care from those for whom regular hospital care will be sufficient. For those at risk, a comprehensive geriatric assessment (CGA), which is focused on geriatric conditions and geriatric syndromes, should be applied, and this should be followed by targeted interventions to prevent functional decline [19].

This article describes the development and implementation of an evidence-based, three-step tailored care program for older hospitalized patients to prevent functional decline and complications during hospitalization and decrease length of stay.

**Clinical setting and objective**

The care program was developed for patients ≥70 years who were admitted to the cardiology, cardiac surgery or lung diseases ward of an academic teaching hospital. The present program was based on the three-step DEFENCE model (Develop strategies Enabling Frail Elderly New Complications to Evade) (see Figure 1). The program should be incorporated in the electronic patient file (EPF) in such a way that it is easy for health care professionals to follow the different steps.

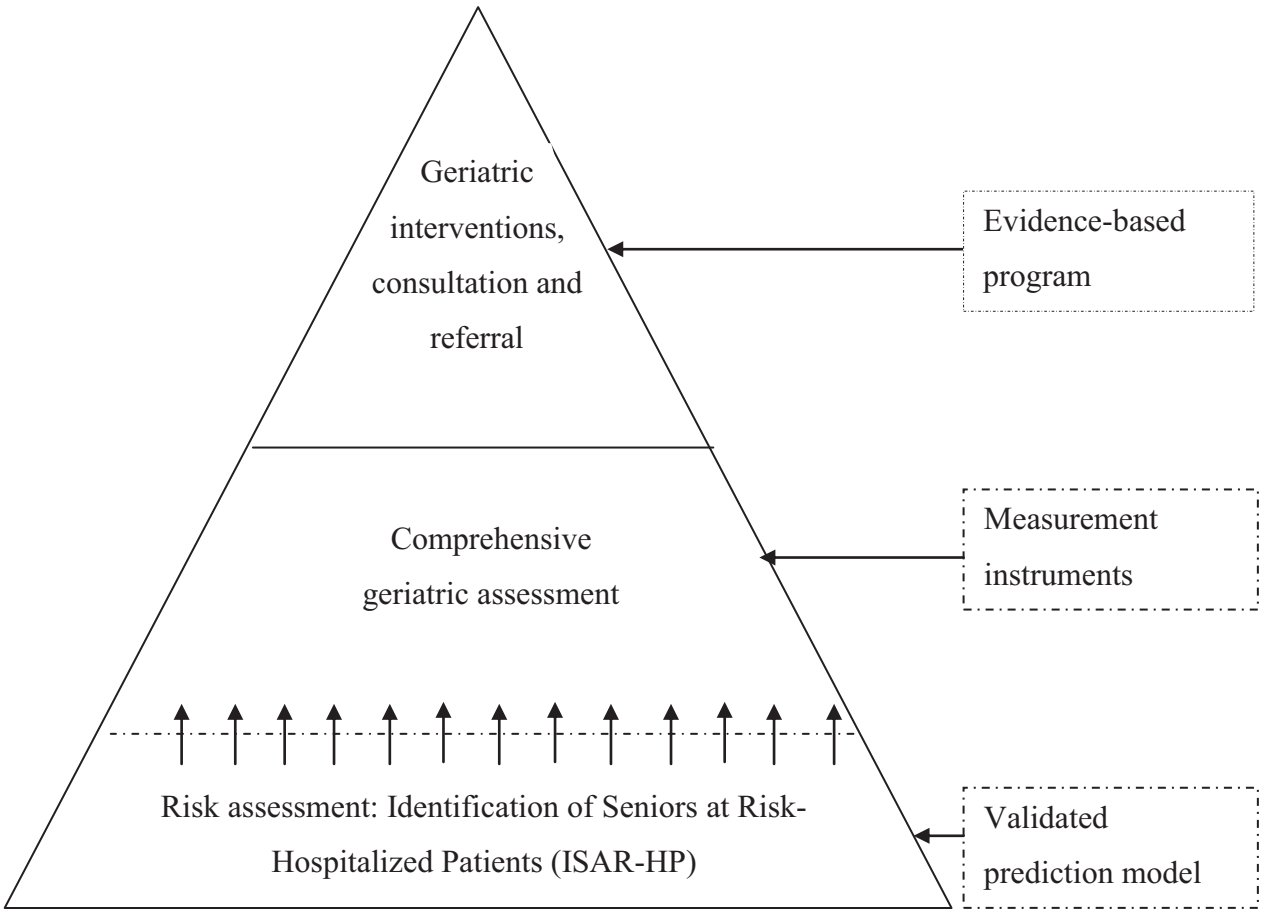
**Organization**

An academic service partnership was realized with two participants: the University Medical Center, Division of Heart and Lungs and the University of Applied Sciences, Faculty of Health. Two project leaders were responsible for organizing the project: a clinical nurse specialist from the hospital who focused on integration and implementation, and a nurse scientist from the University of Applied Sciences who focused on the development of the content. Each step of the program was developed by a group of eight final-year bachelor

students in nursing, and each group was supervised by the project leaders. During the process, a nursing research panel, which consisted of nurses from the three wards, clinical nurse specialists and several experts commented on the different products of the students. A steering committee, which consisted of a nurse manager, a nursing policy advisor and a professor in geriatric nursing, was ultimately responsible for the results of the project. Managers of the wards advised the steering committee and approved the program.

The project was funded by the University Hospital and the University of Applied Sciences.

Figure 1 The DEFENCE model: Develop strategies Enabling Frail Elderly New Complications to Evade



### Development process

The development process was equal for all three steps of the program. First, a literature study on each of the steps was conducted by the students. When available, existing guidelines and protocols were also studied. Secondly, based on the literature, the three steps were described and discussed within the student group and with the project leaders. This resulted in a draft that was discussed in the first Delphi round with the nursing research panel, and the draft was adjusted accordingly. The draft was then presented to the managers and clinical nurse specialists and experts from inside and outside the hospital for review. The revised version was discussed and adjusted in a second Delphi round with the nursing research panel, and its applicability was judged. After approval by the managers, the steering committee finally agreed on the different products.

### Incorporation in the electronic patient file

The tailored care program was developed so that all steps could be incorporated in the EPF within the original patient file program. The electronic system automatically leads the professional through the steps. Starting with the inclusion of the targeted patient group (i.e., patients 70 years and older), step one is the application of the screening instrument. A positive score automatically results in a comprehensive geriatric assessment to be filled in, the second step. Validated measurement tools with a threshold are automatically counted, and the threshold is applied. Finally, the program provides an overview of the geriatric conditions and syndromes for each patient, which is followed by targeted interventions. This third step involves describing and arranging these interventions into decision trees. A justification for all interventions is available for nurses to understand and defend the choices that are made. In addition, the program generates a standard discharge letter that lists the geriatric conditions and syndromes, and this is sent to the general practitioner.

## Results

### Content of the care program

*1. Risk assessment.* Although several screening instruments have been described in the literature [7], no screening instrument has been validated for this patient population. Therefore, we decided to validate in this patient population the “Identification of Seniors at Risk –

Hospitalized Patients (ISAR- HP)" prediction model, which was recently developed for older patients who were acutely admitted to general wards (submitted [20]). Data were collected by students who were supervised by a researcher. The ISAR-HP consists of four items, which determine preadmission need for daily assistance in IADL, use of a walking device, need for assistance in traveling and no education after age 14 (see Figure 2). The area under the receiver operating curve (AUC) of the prediction model in cardiac surgery patients ≥70 years was 0.73 (95% confidence interval (CI): 0.66-0.80). Patients ≥70 years with score ≥1 were deemed to be at risk for functional decline (not published [21]).

*2. Comprehensive geriatric assessment for patients at risk.* A list of 11 geriatric conditions and syndromes (related with functional decline) was determined (i.e., polypharmacy, mobility, malnutrition, incontinence, fall risk, pressure ulcers, visual and hearing problems, cognition, pain and depression). Valid measurement tools were studied to diagnose the geriatric condition or syndrome or risk of the development of a geriatric condition or syndrome. When a validated measurement tool was not available, specific questions were applied (see Table 1).

3. *Interventions*. For each of the 11 geriatric conditions and syndromes, interventions were studied, determined, described and arranged in decision trees. The interventions ranged from referring the patient to other health care professionals, to educational, preventive and care interventions (see Table 1). Although nurses should pay attention to all described conditions and syndromes, not all geriatric problems should be treated in the hospital. For example, visual impairment should not be treated in the hospital in all cases, mostly patients are referred to an optometrist. In this example, staff members, nurses and other health care workers should be alerted to the increased risk of falling as a result of the impairment. In many cases, interventions involve a multidisciplinary team, and the nurse can bring up and coordinate these interventions.

Discharge planning was also an important part of the program. After analysis of the situation on the wards, two points of action were identified. First, we found that medical specialists and nurses should improve the communication with patients and their caregivers. Discharge planning starts the day the patient enters the hospital, and patients and their caregivers should be informed about the discharge procedure as soon as possible. Secondly, we identified a need for improved continuity of care. At discharge, all patient problems and relevant data, such as medication intake, geriatric conditions and syndromes are described in a letter to the general practitioner.

Figure 2 Scorecard: Identification of Seniors At Risk - Hospitalized Patients (ISAR-HP)

| **ISAR-HP**<br>Cardiac surgery patients ≥ 70 year | | |
|---|---|---|
| | YES | NO |
| 1. Before hospital admission, did you need assistance for IADL (e.g., assistance in housekeeping, preparing meals, shopping, etc.) on a regular basis? | 1 | 0 |
| 2. Do you use a walking device (e.g., a cane, rollator, walking frame, crutches, etc.)? | **2** | 0 |
| 3. Do you need assistance for traveling? | 1 | 0 |
| 4. Did you continue education after age 14? | 0 | 1 |
| Total score | | |
| Total score 0 = not at risk<br>Total score ≥1 = patient at risk for functional decline | | |

**Implementation**

Within one year, the program was implemented as planned in three wards (one at a time), and the managers and staff of the wards supported the implementation. Training the nurses was an important aspect of the implementation, and several training rounds were organized to give all nurses the chance to participate in the educational program. Three training videos were made and used in the educational program. The training activities focused on improving knowledge of geriatric care, prevention of complications and appropriate use of measurement instruments. Improving competencies to work with the EPF was also part of the program. One staff nurse and one senior nurse in each ward were responsible for monitoring and supporting further implementation of the senior care program.

**Evaluation and adjustment**

The implementation was evaluated after nine months. Several newly employed nurses were not sufficiently aware of the special needs of older patients. Moreover, working with the EPF was difficult for some of these nurses. A specific training program with lectures and clinical lessons was organized. For one week, eight nursing students were available everyday to help nurses use the EPF and the senior care program.

The content of the program was also updated to meet new regulations from the National Department of Health to promote safe care for older patients. In addition, new outcomes from research studies were applied to the program.

## Discussion

Based on a need experienced in clinical nursing practice, a tailored care program, which followed the three-step DEFENCE model, was developed and implemented. The program was based on evidence found in the literature, clinical experiences and the advice of clinical nurse specialists and experts, and it was incorporated into the EPF. The application of the program in clinical practice was influenced by the knowledge of the specific needs of older patients and the competence to work with the EPF. A special training program was developed for the staff and repeated after nine months. Participation of the staff in the development, education, support of the clinical leaders and managers were the basic elements of effective implementation. In the development, the focus was on the use of validated measurement instruments and evidence-based interventions.

The first step in this program was to identify older patients at risk for functional decline based on the use of a screening instrument. In clinical practice, however, it is very difficult to predict outcomes when there are so many associated variables (e.g., the case of older patients). Functional decline is a complex phenomenon, and it cannot be predicted in 100% of patients. A screening instrument is a tool to help clinicians make the right decisions, and it should be used in combination with experienced clinical observations and a professional understanding of the problems of older patients.

With regard to interventions described for geriatric conditions and syndromes; in many cases these are not studied in patients admitted to regular clinical wards of a general hospital where the medical reason for admission is not specifically the geriatric problem. In other cases, there may simply be a lack of evidence of a specific intervention. For example, the problems of bed rest and immobility have been described in several studies [22;23], but an evidence-based intervention to mobilize patients has not been described [24]. Therefore, the present program also utilized the experiences of nurses and the advice of clinical nurse specialists and experts. This program was tailored to the needs of both the patients and the hospital wards involved in

the development process. The steps described in the program, however, are also applicable in other hospitals and hospital settings.
The development of content was mostly done by students. This was an exciting way for them to learn and improve their abilities to use research in clinical practice. In addition, they gained experience in writing reports, teamwork, cooperation and insight into the implementation process. Students were inspired by this program and their opinion towards working with older patients changed positively. This academic service partnership demonstrated a high level of innovation and optimized existing resources to incorporate research into clinical practice. In addition, it created an inspiring environment for both students and staff nurses.

## Conclusion

We developed a tailored care program for patients ≥70 years, which was based on the three-step DEFENCE model, to provide safe and effective care to older hospitalized patients, to prevent functional decline and complications during hospitalization and decrease the length of stay. This program was implemented in three wards of an academic teaching hospital (i.e., cardiology, cardiac surgery and lung diseases). The program will help nurses and other health care professionals to provide integrated care focused on the specific needs of older patients. The academic partnership enhanced the transition of research into clinical practice, optimized the use of existing resources and created an inspiring learning environment for nursing professionals and students. This project bridges the gap between research, education and clinical practice.

Table 1 Elements of the Comprehensive Geriatric Assessment and Targeted Interventions

| Topic | Aim | Measurement | Interventions (short overview) |
|---|---|---|---|
| Polypharmacy | To promote medication intake and adherence and prevent complications from medications | Do you use ≥5 medications?<br>Did you use ≥3 medications for more than 3 months?<br>Were the medications prescribed by different specialists?<br>Do you have problems with medication intake?<br>-If yes, what is difficult for you?<br>Do you think the prescribed medicines are improving your health situation?<br>Do you experience side effects from the medications?<br>-Did this affect your medication intake behavior? | Make an overview of all medications and prescriptions<br>Ask for "medications over the counter"<br>Consult pharmacist and medical doctor<br>Check and discuss adherence |
| Mobility | To maintain mobility as much as possible | Katz Index 6 questions:<br>Do you need assistance in bathing?<br>Do you need assistance in dressing?<br>Do you need assistance in using the toilet?<br>Do you need assistance in transferring?<br>Do you need assistance in eating?<br>Do you use incontinence materials?<br>2 additional questions:<br>Do you have problems in keeping balance?<br>Do you experience problems with mobility<br>-If yes, what kind of problems?<br>-If yes, use a fall-risk measurement tool | Start with discharge planning and organize home care<br>Inform and educate patient and family about the importance of mobilization<br>Promote and support self care activities (e.g., bathing, dressing, eating at the table, sitting in a chair and walking around), which should be supported by the family if possible<br>Mobilization scheme<br>Safe environment, be alert for risk of falling<br>Consultation and referral to a physiotherapist<br>Optimal day and night rhythm |

| | | | |
|---|---|---|---|
| Malnutrition | To identify malnutrition and treat it properly | MUST (malnutrition universal screening tool):<br>Quetelet index<br>Did you unintentionally lose weight in the past 6 months?<br>Are you ill in a way that caused you not to eat in the past 5 days, or is this a possibility in the coming period? | Inform medical doctor (reason for malnutrition?)<br>Consult dietician<br>Control food and fluid intake<br>Follow protocol (e.g., eating at the table, often small meals and snacks)<br>Be aware of the risk of pressure ulcers |
| Incontinence | To be aware of fall risk and risk of bladder infections | Do you have problems with continence (urination)?<br>-If yes, what kind of problems?<br>Do you unintentionally lose urine<br>-If yes, do you use incontinence materials?<br>Do you have to use the toilet during the night?<br>-If yes, use fall-risk measurement tool | Is incontinence diagnosed, if not discuss with medical doctor<br>Use the right incontinence materials<br>Be aware of the risk of pressure ulcers<br>Be aware of balanced fluid intake<br>Be aware of fall risk<br>Be aware of bladder infection and the development of delirium |
| Fall risk | To be aware of fall risk | Did you have ≥1 fall accident in the past 6 months?<br>-If yes use fall-risk measurement tool | Inform patient and family<br>Alert all health care professionals in the EPF<br>Follow protocol to prevent falls (e.g., safe environment and visual control) |
| Pressure ulcers | | Do you suffer a pressure ulcer, or do you have a painful, red spot on your skin?<br>Are you bedridden?<br>Do you have mobility problems and suffer incontinence?<br>-If yes use PrePURSE score list | Inform medical doctor<br>Apply skin inspection as prescribed<br>Follow protocol (e.g., appropriate mattress and wound care materials)<br>Be aware of the right food and fluid intake<br>Consult nurse specialist<br>Consult dietician if necessary |

| | | | |
|---|---|---|---|
| Visual problems | To be aware of fall risk and to encourage communication | Do you use spectacles or lenses?<br>Do you see well (with spectacles or lenses)? | Inform patient and family about the risk of falling<br>Referral to an optometrist |
| Hearing problems | To encourage communication and promote orientation | Do you use a hearing aid: left/right?<br>Can you hear everything (with or without hearing aid)? | Alert all health care professionals in the EPF<br>Be aware of the right use of audio-aids<br>Referral to diagnose and receive the right audio-aids |
| Cognitive problems | To pay attention to the risk of delirium or dementia, use of the Delirium Observation Scale | Do you have memory problems?<br>Did you need help in ADL in the past 24 hours?<br>Did you experience periods of confusion during hospital admission or during illness? | Risk of delirium: Three days DOS scale<br>If DOS is positive, follow protocol (e.g., inform patient and family, safe and quiet environment, adequate day and night rhythm)<br>Consult geriatrician or psychiatrist<br>Dementia diagnosed?<br>Risk of dementia: consultation of a geriatrician |
| Pain | To be aware of pain and treat it accordingly | Do you have pain?<br>-If yes, use Visual Analogue Scale to measure pain | Consult medical doctor<br>Control, observe and evaluate the medication |
| Depression | To be aware and start adequate diagnostics and treatment, or referral to psychiatrist, as needed | Geriatric Depression Scale 2 questions:<br>-Did you experience feelings of depression, or a melancholy mood last month?<br>-Did you feel less positive in daily activities?<br>-If yes, use Hospital Anxiety and depression (HADS) scale | Positive HADS: consult geriatrician or psychiatrist<br>Inform patient and family |

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Chapter 7

# General discussion

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Submitted as: Preservation of functional independency in older hospitalized patients

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# General discussion

*"Mrs. Smit (79 years old) was admitted to the hospital with pneumonia. Using the ISAR-HP, she was identified as a patient at risk for functional decline. A comprehensive geriatric assessment was applied: a bladder infection was diagnosed causing incontinence and delirium, she showed malnutrition and was at high risk for falls as she showed mobility and visual problems. She was treated for the medical problems (pneumonia, bladder infection and delirium), she and her family were informed about the nature of the problems, measures were installed to prevent falling and she received extra food supplies. Before discharge, she was informed about the importance of good visual capacity and fall prevention measures and referred to an optometrist. When the time came to return home everything was organized, together with the family. She could stay independent in her home and did not decline in functional status".*

## Introduction

Hospitalization is a risky event for older people, as 30-60% suffer a functional decline related to hospital admission resulting in increased dependence, decreased quality of life and autonomy, prolonged length of hospital stay, risk for nursing home admission and readmission and increased need for professional health care at home. This also poses a major burden for families and informal caregivers [5-14]. A functional decline, defined as a loss of the possibility to independently perform activities of daily living (ADL), such as bathing, dressing and toileting, and/or instrumental ADL (IADL), such as traveling, house cleaning and shopping, leads to a decreased functional status that also predicts further functional decline, the development of geriatric syndromes and other adverse events [3;15-18].
In many cases, a functional decline cannot simply be attributed to the acute medical problem for which a patient was hospitalized [14]. A functional decline is a geriatric syndrome that reflects a multifactorial etiology and different pathways leading to this negative functional outcome of hospitalization [3;14].
The expanding older population needs effective healthcare focused not only on the prevention and treatment of diseases but also on effective interventions to prevent or delay a functional decline [19;20]. Not all patients are at the same risk for the development of a functional decline.

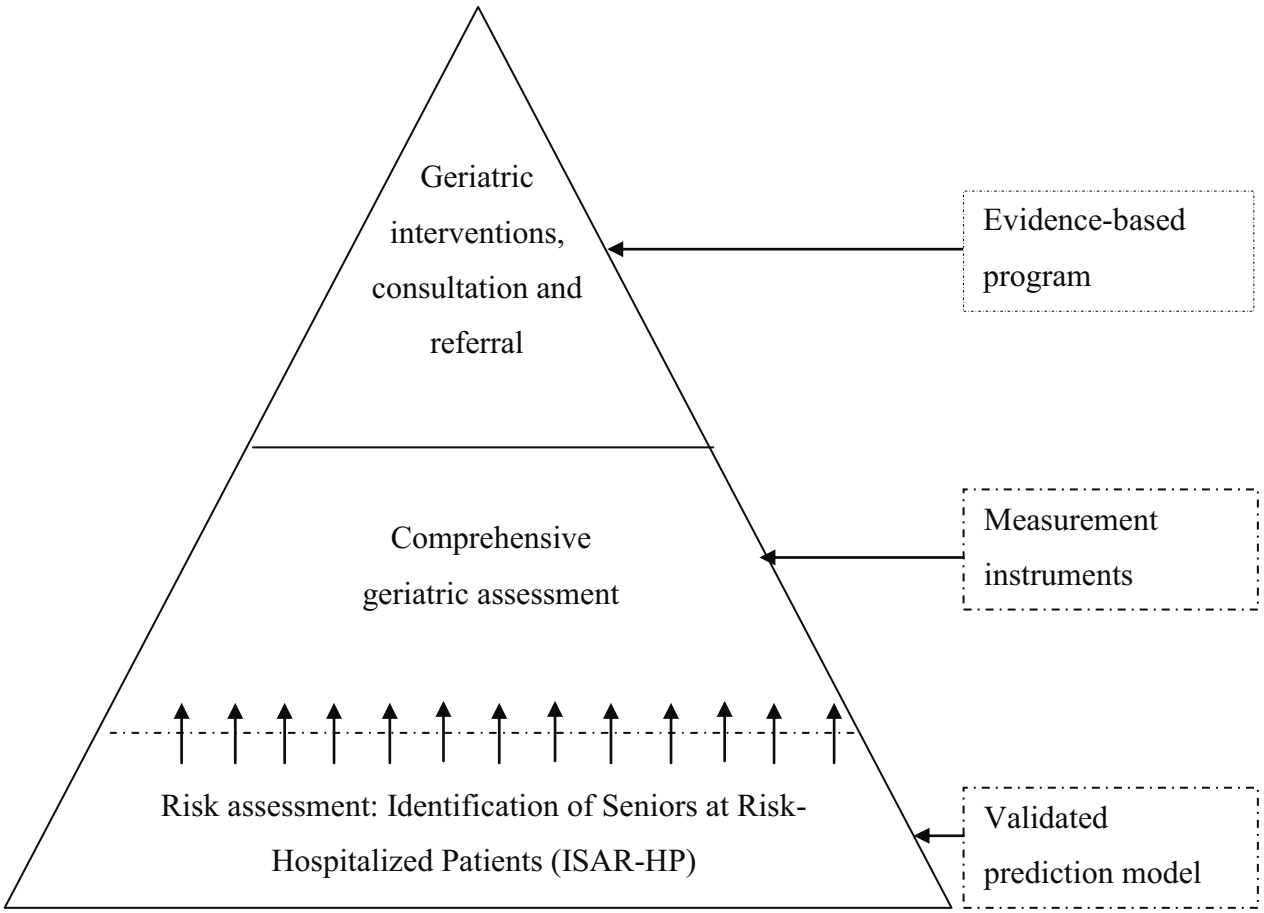
This depends on the functional, physical and cognitive status of the individual and on the influence of external factors. The heterogeneity among older persons is substantial [21-23]. In order to prevent or delay a functional decline and to provide tailored and efficient patient care, it is necessary to identify those patients at a high risk for functional decline following hospitalization. The prevention of functional decline could then be realized by following the three-step DEFENCE model (Develop strategies Enabling Frail Elderly New Complications to Evade): first, identification of patients at risk; second, a comprehensive geriatric assessment; and third, targeted interventions for those patients at risk (see Figure 1).
This chapter describes the concept of functional decline and presents the development and validation of a prediction model to identify older hospitalized patients at risk for functional decline as the first step of prevention. Implications for clinical practice, the education of health professions and recommendations for further research are made.

## Ageing and functional decline

The consequences of demographic changes worldwide, with a continuously growing older population pose a huge challenge. By 2025, about 28% of Europe's population and 21% of the population in the USA will be aged 65 years and over, and there will be a particularly rapid increase in the number of people aged 80 years and older [24;25]. This will have an enormous impact on health care because the number of older patients admitted to the hospital will also increase.
Traditionally, the focus in health care is on the prevention and treatment of diseases. However, the demands of the older population are not limited to maintaining good physical and mental health but also require the promotion of independence and participation in society [1;2;20]. The preservation of independence (the ability to carry out daily self-care activities and live independently in one's own home) and autonomy (self-determination) and maintaining a good quality of life are important for everybody, and particularly for older persons [26;27].
Ageing is associated with physical effects, such as a decline in muscle strength and aerobic capacity, diminished pulmonary ventilation and a diminished quality of senses and skin integrity [14]. These changes increase the susceptibility to illnesses and hospitalization and could initiate a cascade of events and complications that could finally result in a diminished quality of life and increased dependency. In 1993, Creditor proposed a model capturing the

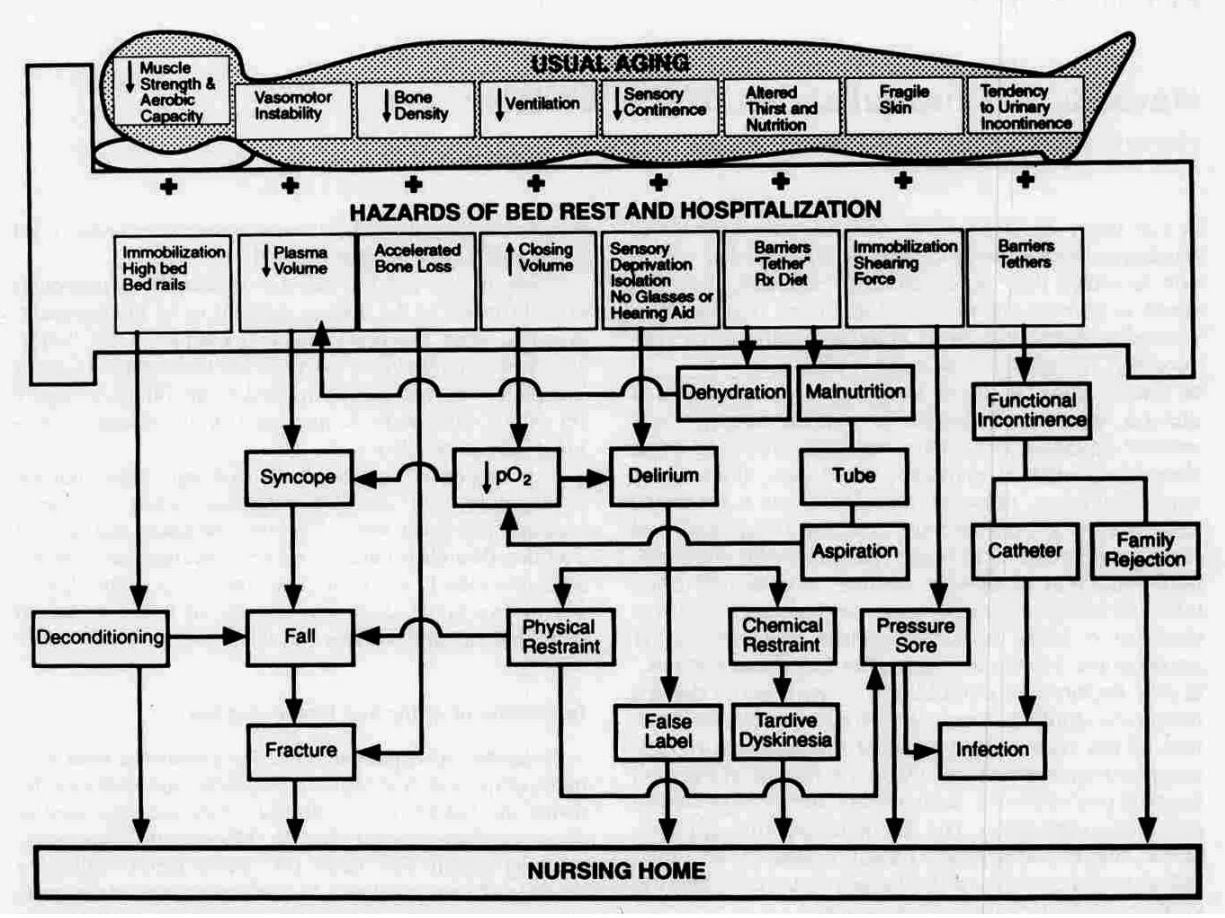
hazards of hospitalization of the elderly [14]. This model shows those factors related to the normal ageing process that are associated with hospitalization and bed rest that contribute to dependency (see Figure 2).

Figure 1 The DEFENCE model (Develop strategies Enabling Frail Elderly New Complications to Evade), a Three-Step Model to Prevent Functional Decline




Health and functional problems related to an older age, such as a cognitive and functional decline, visual and hearing problems, decreased mobility and malnutrition, are commonly described as geriatric conditions and/or geriatric syndromes. Geriatric syndromes are multifactorial in cause, occur especially in vulnerable older adults, are precipitated by a variety of acute insults and are typically episodic in nature [28]. Inouye describes five geriatric syndromes: pressure ulcers, incontinence, falls, functional decline and delirium[3]. Several studies have shown an association between geriatric conditions and syndromes and poor health outcomes including functional decline [3;28-30].

Figure 2 The Cascade to Dependency (Creditor, 1993)




Another common problem for older adults is the development of chronic diseases and the co-occurrence of multiple chronic diseases (multimorbidity) [31-36]. The presence of multiple diseases increases the likelihood of functional decline. As the number of diseases increases, the risk of difficulty performing ADL independently and decreasing mobility also increases [16;37-40].

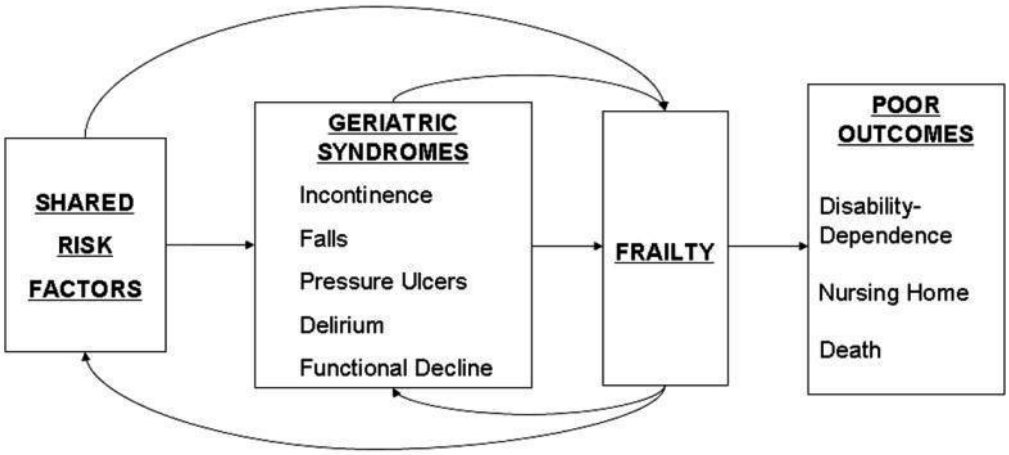
The normal process of ageing, the development of geriatric conditions and geriatric syndromes and multimorbidity are all independently associated with a functional decline, but they also amplify the effects when they occur in combination. Older adults each have an individual mix of the elements of ageing, which partly explains the heterogeneity of the older population and the different risk among patients in developing functional decline. In the literature, older persons suffering one or more of these problems are considered to be frail. Frailty can be defined as a physiologic state of increased vulnerability to stressors that results from decreased physiologic reserves and even the dysregulation of multiple physiologic

systems. Frailty is a state of high vulnerability for adverse health outcomes, including disability, dependency, falls, need for long term care and mortality [41-43].
Inouye describes a conceptual model that shows four shared risk factors (older age, cognitive impairment, functional impairment and impaired mobility) leading to geriatric syndromes, which in turn lead to frailty. Feedback mechanisms enhance the presence of shared risk factors and geriatric syndromes leading to the final outcomes of disability, dependence and death (see Figure 3) [3].
Both models, Creditor and Inouye, show the complex etiology of functional decline. There is not one single pathway leading towards functional decline and the causes are multifactorial. The iatrogenic aspects of hospital admission, such as bed rest, are a burden for older patients resulting in an acceleration of problems related to ageing and a loss of functional capacity [44;45]. For those who are already suffering geriatric conditions and syndromes, the development of new complications and an increase of geriatric syndromes (like delirium, falls, incontinence or pressure ulcers) are serious threats during hospital stay. These complications in turn will contribute to the development of a functional decline and will result in a prolonged length of stay with more threats.
Prevention starts with recognizing those vulnerable patients who are at risk for functional decline. The question is whether it is possible to identify older patients who are at risk for functional decline at the time of hospital admission because of the complexity of this multifactorial event and the heterogeneity of the older population.

## Identification of patients at risk for functional decline

The identification of at-risk patients is based on estimating the probability of the development of functional decline. Prognostic research rests on principles and methods to develop prediction models based on the clinical and nonclinical profiles of the individuals in the targeted group, which are aimed at addressing the variability among patients and thus uses a multivariable approach[46]. The performance of a model may be assessed in terms of calibration (Hosmer Lemeshow test) and discrimination (area under the receiving operation curve (AUC)) [47].

Figure 3 A unifying conceptual model demonstrates that shared risk factors may lead to geriatric syndromes, which may in turn lead to frailty. Feedback mechanisms enhancing the presence of shared risk factors and geriatric syndromes. Such self-sustaining pathways may result in poor outcomes involving disability, dependence, nursing home placement, and ultimately death, thus holding important implications for elucidating pathophysiological mechanisms and designing effective intervention strategies. (Inouye 2007)




To determine a prediction model to recognize patients at risk for functional decline, we performed a literature review to assess the availability and utility of prediction models. Three screening instruments were found: the Identification of Seniors At Risk (ISAR), which has six items and was developed and validated in Canada in patients in several emergency departments [48]; the Care Complexity Prediction Instrument (COMPRI), which has 13 items and was developed in the Netherlands to predict complexity in care for hospitalized patients [49]; and the Hospital At Risk Profile (HARP), which has 29 items and was developed in six acute care hospitals in the USA [50](Chapter 2). We compared the discriminative values of these instruments in a cohort study (n=177). The sensitivity, specificity and AUC for the ISAR were 93%, 39% and 0.67, respectively. The corresponding results for the COMPRI were 70%, 62% and 0.69 and for the HARP they were 21%, 89% and 0.56.

Given these results, in combination with the feasibility of using these instruments in clinical practice, the next step was the further development of the ISAR to be focused on improving the positive predictive value and specificity in the population of acutely hospitalized older patients. A multicenter cohort study in patients acutely admitted to general internal medicine departments was performed (n= 492). We used a univariate regression to assign the relative

weights of the six items of the ISAR and additional predictors of functional decline from previous studies related to personal factors (such as age and socio-economical status) and personal responses to the ageing process (such as visual and hearing problems, decreased mobility, functional and cognitive status) [23;51-55]. The best performing predictors were used in a multivariate logistic regression. This resulted in the Identification of Seniors At Risk - Hospitalized Patients (ISAR-HP), a simple model with only four predictors (one predictor from the original ISAR), which made it easy to use in daily clinical practice: the pre-admission need for assistance in IADL, use of a walking device, need for assistance in traveling, and no education after age 14. Two of these predictors concern IADL (need for assistance in IADL and traveling), and one is an example of limited mobility (use of a walking device). These findings support the results of other studies showing a lower functional status (ADL and IADL) were two of the five most-described predictors of functional decline and other more recent studies showing that functional impairment and impaired mobility are important risk factors for the development of functional decline [17;18;56;57]. Also, in the original ISAR, two of the six predictors were concerning a lower functional status (ADL en IADL) before admission [48]. The predictor “no education after age 14” is an indicator of the socioeconomic status of a person, which is also a well-known factor of health quality and a known predictor of functional decline [32;58]. The AUC of this model was 0.71. At a threshold 2 the sensitivity, specificity, positive and negative predictive values were 87%, 39%, 43% and 85%, respectively. This positive outcome was supported by the results in a validation study in an independent population (n=482). The AUC was 0.68, and the sensitivity, specificity, positive and negative predictive values were 89%, 41%, the 41% and 89%, respectively (Chapter 4). Even in a completely different population, for patients greater than 70 years of age admitted for cardiac surgery (n=475), this prediction model showed an AUC of 0.72, supporting the generalizability of the prediction model (Chapter 5). Approximately two thirds (70%) of the patients were identified as being at risk. For these patients, a comprehensive geriatric assessment was indicated. Based on this assessment, preventive and targeted interventions can be applied, thus enhancing the quality of care for older vulnerable patients. Our studies also show that about one third of the patients do not need this special care, thus enhancing the efficiency of care.

Given the heterogeneity of our study populations and the results of the two validation studies (an independent and a new population), the conclusion is that the prediction model ISAR-HP shows a good capacity to predict a functional decline in older hospitalized patients and will

be easy to use in clinical practice. The strength of the model is that it relies on four simple questions to predict a functional decline, an otherwise multifactorial and complex event.

## Implications for clinical practice, education and research

Functional decline as a result of hospitalization is a serious threat for older individuals as it has a high impact on the quality of life and health care demands. Hospitalization can, contrary to what people expect, change the prognosis of older persons in a negative sense by changing their life from independent to dependent.

Our study shows that with four simple questions, patients at-risk for a functional decline can easily be identified at hospital admission. This enables the separation of those patients who need more than regular care from those for whom regular hospital care will be sufficient. For those at risk, further steps to tailor preventive interventions can be taken.

However, the exact clinical pathway to functional decline is still unknown, as is the degree to which decline can be prevented. The scientific evidence on the effect of the comprehensive geriatric assessment and tailored interventions continues to accumulate. Should one further invest in research regarding these issues, or should one continue to put effort in changing practice?

The origin of the studies described in this thesis is in the problems faced in clinical practice. Because of their ability to observe and guide patients and the overall views they have, nurses should play a key role in the strategies to prevent functional decline. Recently, the results of a qualitative study regarding nursing care for delirious older patients was published [59]. The study showed a lack of knowledge, negative beliefs and attitudes in combination with a context in which the challenge of care for older people was hardly addressed. Other studies regarding care for older hospitalized patients found comparable results [60;61].

After the development of the ISAR-HP, we developed a three-step tailored care program to improve care for the older patients within an academic service partnership (a linkage between academic nursing schools and hospitals) (Chapter 6). The three steps to prevent functional decline were described based on the evidence from literature, existing protocols and guidelines and the expertise of staff nurses, clinical nurse specialists and other experts. The ISAR-HP was introduced and, in patients at risk, a geriatric assessment was done by nurses guiding targeted interventions. The program enhances the transition of available research

evidence combined with a best practice into clinical practice, optimizes the use of existing resources and creates an inspiring learning environment for professionals and students in nursing. The participation of staff nurses in the development of the program, education, clinical leadership and support by the managers were the basic elements of effective implementation. The project showed that cooperation in an academic service partnership is an efficient way to bridge the gap between research, education and clinical practice.

Many of the students who were involved in the project are at this time active professionals participating in professional organizations and/or studying in master programs. Working within the project made them aware of the challenges of the nursing profession and of the possibility to make a difference in the care of older people.

Given the growing number of older people in Western society and the growing need for care, any action to prevent functional decline, and thus to prevent or delay long-term care needs, cannot be withheld. A hospital admission is a moment in the continuity of people's lives; the shift in focus on the medical problem causing the admission to the continuity of daily living should be made in practice, in education and in further research. The coming older generation will be more aware of the importance to stay independent and autonomous.

We must not wait; we can make it happen today. As Goethe (1749-1832) wrote: *Knowing is not enough; we must apply. Willing is not enough, we must do.* The focus should not be only to gain more knowledge and insight. Much is known already, it is time for action.

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# Chapter 8

**Summary**

**Samenvatting**

**Dankwoord**

**List of publications, presentations and awards**

**Over de auteur**

# Summary

Between 30% and 60% of older patients experience functional decline after hospitalization, resulting in a decline in health-related quality of life and autonomy. This is associated with increased risk of readmission, nursing home placement and mortality, increased length of hospital stay and increased need for informal and professional health care at home. A decreased functional status is a risk factor for the development of geriatric syndromes such as pressure ulcers, falls, delirium, incontinence and further functional decline. Functional independency and autonomy are important subjects for older people, their families and also for our society. Older people wish to stay independent and wish to participate in our society. Functional decline is mostly defined as a decline in performing the activities of daily living (ADL), such as bathing, dressing, transferring and toileting and/or instrumental activities of daily living (IADL), such as traveling, housekeeping and shopping. This functional decline is not necessarily related to the medical reason for the hospital admission but is related to the pre-admission health status and the iatrogenic effects of hospitalization.

The population is ageing worldwide and the fastest growing portion of the older population in many nations is the oldest group of the elderly, those who are aged 80 and over. Many older people are admitted to a general hospital. In the Netherlands, 16% of the people of 70 years and older is admitted to the hospital yearly, whereas only 6% of the people under the age of 70 years of age are hospitalized yearly. The growing population of older people will lead to an increase of older patients admitted to a hospital in the nearby future. Therefore prevention of functional decline in hospitalized older patients is an important theme for health care professionals.

Not all older persons will respond equally to stress and illness, and not all older patients will develop functional decline related to a hospital admission. Effective and efficient hospital care for the older patients starts with the identification of those patients who are at risk for the development of functional decline. A geriatric assessment (focused on geriatric conditions and syndromes and multimorbidity) and targeted interventions to prevent and to treat complications related to functional decline are the next steps in the prevention of functional decline.

Therefore, the aim of this thesis was: *To determine a prediction model to identify older patients at risk for functional decline after hospitalization that is easy to use in clinical practice as a first step in the prevention of a loss of function and independence.*

Functional decline was defined as a decline of at least one point on the Katz ADL index (six items: bathing, dressing, toileting, transferring, eating and the use of incontinence materials) at three months after admission compared to premorbid ADL status.
In total one literature study and four prospective cohort studies (in total n=1628) were conducted to develop and validate this prediction model. In the cohort studies the same method was used. The premorbid functional status was measured within 48 hours after admission by interview; patients were asked to describe the situation two weeks prior to admission to eliminate possible effects of the illness causing hospital admission. At follow up, three months after admission, functional status was measured again by telephone interview. All measurements were done by specially trained research nurses and in one study by trained and carefully monitored nursing students.

The first step was to investigate the existing prediction models and to describe the predictors of functional decline by a literature review. Three screening instruments were found: the Identification of Seniors At Risk (ISAR), the Care Complexity Prediction Instrument (COMPRI) and the Hospital Admission Risk Profile (HARP). These instruments were developed and validated in different patient populations and different settings, the outcomes were also different and not validated for patients acutely admitted to the internal medicine wards of a hospital. The following most recognized predictors were identified: age, lower functional status, cognitive impairment, pre-admission disability in instrumental activities of daily life (IADL), depression and the length of hospital stay (Chapter 2).

Second step was to compare the discriminative values of these three screening instruments in the targeted patient group: patients 65 years and older, acutely admitted to the general internal medicine wards (n= 177). A functional decline was found in 27.8% of all patients. The sensitivity, specificity and area under the receiver operating curve (AUC) for the ISAR were 93%, 39% and 0.67, respectively. The corresponding results for the COMPRI were 70%, 62% and 0.69 and for the HARP they were 21%, 89% and 0.56. Conclusion was that the discriminative values of both the ISAR and COMPRI were fair. Based upon the measured sensitivity, the ISAR showed the best ability to predict those patients at risk for functional

decline and seems to be the easiest instrument to apply to clinical practice (Chapter 3).

Third step was the development of a new prediction model in a multicenter cohort study in two academic and one general hospital (n=492). Included were patients 65 years and older acutely admitted to the internal medicine wards. Based on findings in the literature, the opinion of experts and the items of this best performing screening instrument, the ISAR, 35 predictors of functional decline were determined. The predictive capacity of each of these was measured using a univariate logistic regression. Next, a multivariate logistic regression was conducted with the 17 best performing predictors, resulting in a prediction model with the following four final predictors: pre-admission need for assistance in IADL, use of a walking device, need for assistance in traveling, and no education after age 14. This model was internally validated in a 1000 samples bootstrap. The AUC of this model was 0.71 and the Hosmer Lemeshow test showed a P-value 0.95 which indicates a good fitting model.
A scorecard, Identification of Seniors At Risk – Hospitalized Patients (ISAR-HP), was developed based on this prediction model. At threshold 2 (score ≥2 indicating high risk for functional decline) the sensitivity, specificity and positive and negative predictive value were 87%, 39%, 43% and 85%, respectively. In total 70% of the patients were identified as patients at risk.
The prediction model and scorecard were subsequently validated in an independent population of patients admitted to the internal medicine wards of one university teaching hospital by a secondary data analysis of a cohort study (n=484). The positive outcome of the development study was supported by the results of the validation study: the AUC of the prediction model was 0.68. At the recommended threshold of 2 of the score card ISAR-HP the sensitivity, specificity, positive and negative predictive value were respectively 89%, 41%, 41% and 89% (Chapter 4).

Fourth step was to validate this prediction model was in a different population of two university hospitals: older cardiac surgery patients (n=475). For patients aged ≥70 using threshold 1, the sensitivity, specificity, positive and negative predictive value and the AUC of the score card were and 85%, 48%, 29%, 93% and 0.73 respectively. The results of this study showed a good discriminative value of the prediction model and the score card ISAR-HP in older cardiac surgery patients, which supported the generalizability of the prediction model (Chapter 5).

In clinical practice the need to enhance the quality of care for older patients is understood and health care professionals are aware of the complications many older patients are suffering. Therefore we finally developed a program to prevent functional decline. The program was organized in an academic service partnership in which participated a University Medical Center and a University of Applied Sciences. Both organizations appointed a project leader. The program was based on evidence from the literature, existing protocols and guidelines and expertise of staff nurses and clinical nurse specialists and the advice of experts. The care program was developed for patients 65 years and older who were admitted to the cardiology, cardiac surgery or lung diseases ward of an academic teaching hospital. It was based on the three-step DEFENCE model (Develop strategies Enabling Frail Elderly New Complications to Evade) that included risk assessment (ISAR-HP), geriatric assessment and targeted interventions. Each step of the program was developed by a group of eight final-year bachelor students in nursing, and each group was supervised by the project leaders. During the development process, a nursing research panel, which consisted of nurses from the three wards, clinical nurse specialists and several experts commented on the different products of the students. A steering committee, which consisted of a nurse manager, a nursing policy advisor and a professor in nursing science, was ultimately responsible for the results of the project. Managers of the wards advised the steering committee and approved the program. The program was incorporated in the electronic patient file (EPF) in such a way that it is easy for health care professionals to follow the different steps. We evaluated and adjusted the program after one year.
The basic elements of effective implementation were the participation of staff nurses in the development of the program, education, clinical leadership and support by the managers. The project showed that cooperation in an academic service partnership is an efficient way to bridge the gap between research, education and clinical practice (Chapter 6).

This thesis describes the development and validation of a prediction model to identify older patients at risk for functional decline after hospitalization, the ISAR-HP, that is easy to use in clinical practice as a first step in the prevention of functional decline.
The strength of the studies described in this thesis is that the developed prediction model can identify older hospitalized patients at risk for functional decline with only four predictors: pre-admission need for assistance in IADLs, use of a walking device, need for assistance in traveling, and no education after age 14. Although the use of this ISAR-HP will result in a number of false positives, a substantial part (around 30%) of the total population of older

patients will not need more specific geriatric care. Thus enhancing the efficiency.
This thesis also describes an example of an implementation of the results of scientific research into clinical practice, showing how the results of our studies can contribute to an increased safety and targeted care for older hospitalized patients.

Usual ageing is associated with physical, psychological and social changes that increase the susceptibility to various stresses (such as illness and hospitalizations) and changes that represent a loss of reserve function. Different pathways to functional decline are described in the geriatric literature. The individual response to ageing, the development of the geriatric conditions (such as decreased mobility, visual and hearing problems), the development of geriatric syndromes (such as delirium and incontinence) and multiple morbidities are all factors that contribute to the development of functional decline. Also, the iatrogenic aspects of hospitalization (such as the complications of bed rest, pressure ulcers and infections) are risk factors associated with functional decline.

The exact clinical pathway to functional decline is still unknown, as is the degree to which decline can be prevented. The scientific evidence on the effect of the comprehensive geriatric assessment and tailored interventions is not yet fully understood. Despite these facts and given the growing number of older people in Western society and the growing need for care, any action to prevent functional decline, and thus to prevent or delay long-term care needs, cannot be withheld. The coming older generation will be more aware of the importance to stay independent and autonomous. The focus of further development should not only be on scientific research but also on implementation of existing knowledge in clinical practice.

# Samenvatting

Van de oudere patiënten die in het ziekenhuis worden opgenomen ontwikkelt 30-60% blijvend functieverlies. Dit leidt tot een verminderde kwaliteit van leven en verlies van autonomie en het is geassocieerd met een verhoogde kans op heropname, plaatsing in een verpleeghuis, verhoogde mortaliteit, langere opnameduur en meer vraag naar informele en professionele zorg thuis na de ziekenhuisopname. Een verminderde functionele status is ook weer een risicofactor voor het ontwikkelen van zogenaamde geriatrische syndromen als decubitus, valincidenten, delirium, incontinentie en voor verder verlies van zelfstandig kunnen functioneren. Functionele zelfstandigheid en autonomie zijn belangrijke onderwerpen voor ouderen, hun familie maar ook voor de samenleving. Ouderen willen zo lang mogelijk onafhankelijk blijven en willen optimaal kunnen participeren in de maatschappij. Functieverlies wordt meestal gedefinieerd als een vermindering in het kunnen uitvoeren van de activiteiten van het dagelijks leven (ADL) zoals het zichzelf wassen of douchen, zich aankleden, zich verplaatsen in huis, en naar het toilet gaan. Ook instrumentele activiteiten van het dagelijks leven (IADL) kunnen hieronder vallen, zoals kunnen reizen, het huishouden doen en boodschappen doen. Functieverlies wordt niet per se veroorzaakt door de medische reden van opname maar staat in relatie tot de gezondheidstoestand van de patiënt vóór de opname. Ook de iatrogene aspecten van een verblijf in het ziekenhuis kunnen een rol spelen.

Wereldwijd groeit het aantal ouderen. De snelst groeiende groep daarbinnen zijn de ouderen van 80 jaar en ouder. Veel ouderen worden opgenomen in het ziekenhuis. In Nederland wordt 16% van de 70 plussers jaarlijks opgenomen in het ziekenhuis tegenover 6% van de mensen die jonger zijn dan 70 jaar. De groeiende groep ouderen zal ertoe leiden dat in de nabije toekomst ook meer ouderen worden opgenomen in het ziekenhuis. Daarom is de preventie van functieverlies een belangrijk thema voor de werkers in de gezondheidszorg.

Niet alle ouderen reageren hetzelfde op stress en op ziekte en niet alle ouderen zullen na een ziekenhuisopname te maken krijgen met blijvend functieverlies. Efficiënte en effectieve zorg voor de oudere patiënt in het ziekenhuis begint met het selecteren van patiënten die een verhoogd risico lopen op het ontwikkelen van functieverlies. Daarna volgen een geriatrische anamnese (gericht op de geriatrische problematiek) en doelgerichte interventies om complicaties in relatie tot functieverlies te voorkomen en te behandelen.

De doelstelling van dit proefschrift is dan ook: *Het vaststellen van een voorspellend model om oudere patiënten met een verhoogd risico op het ontwikkelen van blijvend functieverlies als gevolg van een ziekenhuisopname te kunnen selecteren. Dat model is eenvoudig in de klinische praktijk te gebruiken en is de eerste stap in het voorkomen van functieverlies en verlies van onafhankelijkheid.*

Functieverlies is gedefinieerd als een verlies van ten minste één punt op de Katz ADL index drie maanden na de ziekenhuisopname, vergeleken met de situatie zoals die twee weken vóór de opname was (zes items: zich kunnen wassen/douchen, aankleden, naar het toilet kunnen gaan, zich kunnen verplaatsen -bijvoorbeeld van bed naar stoel- , kunnen eten en gebruik van incontinentie materiaal.
Om dit voorspellend model te ontwikkelen en te valideren zijn in totaal één literatuurstudie en vier prospectieve cohort studies uitgevoerd (met in totaal n=1628). In de cohort studies is steeds dezelfde methode toegepast. De functionele status is gemeten binnen 48 uur na middels een interview: patiënten is gevraagd de situatie te beschrijven zoals die twee weken voor de opname was teneinde de mogelijke effecten van de ziekte die de opname veroorzaakte uit te sluiten. Bij de follow up, drie maanden na de opname, is de functionele status opnieuw gemeten door een telefonisch interview. Alle metingen zijn uitgevoerd door speciaal getrainde onderzoeksverpleegkundigen en in één studie door getrainde en speciaal begeleide studenten verpleegkunde.

De eerste stap was het uitvoeren van een literatuurstudie naar bestaande voorspellende modellen of screening instrumenten en naar de beschrijving van predictoren (voorspellende factoren) van functieverlies. Drie screening instrumenten zijn gevonden: de Identification of Seniors At Risk (ISAR), de Care Complexity Prediction Instrument (COMPRI) en de Hospital Admission Risk Profile (HARP). Deze instrumenten zijn ontwikkeld en gevalideerd in verschillende patiënten populaties en in verschillende soorten instellingen. De uitkomstmaten waren niet gelijk bij de drie instrumenten en de instrumenten waren niet gevalideerd in de populatie acuut opgenomen oudere patiënten op de interne afdeling van een ziekenhuis.
De meest beschreven predictoren waren: leeftijd, verminderde functionele status, cognitie beperkingen, beperkingen in de IADL vóór de ziekenhuisopname, depressie en opnameduur (Hoofdstuk 2).

De tweede stap was het vergelijken van het onderscheidend vermogen (discriminatieve waarde) van deze drie screening instrumenten in onze doelgroep: patiënten van 65 jaar en ouder, acuut opgenomen op de interne afdeling van het ziekenhuis (n=177). Van deze patiënten ontwikkelde 27.8% blijvend functieverlies. De sensitiviteit, specificiteit, en de area under the receiver operating curve (AUC) voor de ISAR waren respectievelijk 93%, 39% en 0.67. Voor de COMPRI was dit 70%, 62% en 0.69 en voor de HARP was dit 21%, 89% en 0.56. We concludeerden dat de discriminatieve waarde van de ISAR en de COMPRI redelijk goed waren Uitgaande van de hoogste sensitiviteit was de ISAR het beste instrument voor het selecteren van patiënten met verhoogd risico op functieverlies, en dit leek ook het meest eenvoudige instrument om te gebruiken in de dagelijkse praktijk (Hoofdstuk 3).

De derde stap was de ontwikkeling van een nieuw voorspellend model in een multicenter cohort studie in één algemeen ziekenhuis en twee universiteitsziekenhuizen (n=492). Dit betrof patiënten van 65 jaar en ouder, acuut opgenomen op de interne afdelingen van de ziekenhuizen. In totaal werden 35 predictoren van functieverlies vastgesteld, gebaseerd op bevindingen uit de literatuur, de mening van experts en de items van de ISAR, het beste screening instrument uit de vergelijkende studie. De voorspellende waarde van elk van deze 35 predictoren is vastgesteld met een univariate regressie. Vervolgens is een multivariate logistische regressie uitgevoerd met de 17 predictoren met de meest voorspelende waarde. Dit resulteerde in een voorspellend model met de volgende vier predictoren: hulp nodig hebben bij het verrichten van IADL vóór de opname, het gebruiken van een hulpmiddel bij het lopen, hulp nodig hebben bij reizen en geen onderwijs hebben gevolgd na het 14$^{de}$ jaar. Dit model is vervolgens intern gevalideerd in een 1000 samples bootstrap procedure. De AUC was 0.71 en de Hosmer Lemeshow test had een P-value 0.95, hetgeen duidt op een positieve “goodness of fit”.
Gebaseerd op dit model is een score kaart vastgesteld: de Identification of Seniors At Risk – Hospitalized Patients (ISAR-HP). Bij afkappunt 2 (score ≥2 betekent een verhoogd risico op het ontwikkelen van functie verlies) waren de sensitiviteit, specificiteit en positieve en negatieve waarde respectievelijk 87%, 39%, 43% en 85%. In totaal was 70% van de patiënten at risk.
Het voorspellend model en de score kaart zijn vervolgens gevalideerd in een onafhankelijke populatie (secondary data analysis) van patiënten die acuut opgenomen waren op de interne afdelingen van een universiteitsziekenhuis (n=484). De resultaten van deze validatie studie onderschreven de positieve uitkomst van de ontwikkelingsstudie, de AUC van het model was

0.68. Bij gebruik van de score kaart ISAR-HP en bij de aanbevolen afkapwaarde van 2 waren de sensitiviteit, specificiteit, positieve en negatieve predictieve waarde respectievelijk 89%, 41%, 41 en 89% (Hoofdstuk 4).

De vierde stap was het valideren van dit model in bij een andere populatie van oudere patiënten die opgenomen waren voor een cardio thoracale operatie in twee universiteitsziekenhuizen (n=475). Bij patiënten ouder dan 70 jaar en afkappunt 1 waren de sensitiviteit, specificiteit, positieve and negatieve predictieve waarde van de score kaart respectievelijk 85%, 48%, 29% en 93%. De AUC was 0.73. Dit resultaat in de populatie oudere cardio chirurgische patiënten staaft de generaliseerbaarheid van het voorspellend model en van de scorekaart ISAR-HP (Hoofdstuk 5).
In de praktijk wordt de behoefte aan het verbeteren van de kwaliteit van de zorg voor oudere patiënten onderkend en professionals zijn zich bewust van de complicaties die bij veel ouderen kunnen ontstaan. Om deze reden is tenslotte een programma ontwikkeld om functieverlies te voorkomen. Dit is uitgevoerd in een “academisch service partnerschap” waarbinnen een Universitair Medisch Centrum en een Hogeschool samenwerkten.
Het programma is gebaseerd op wetenschappelijke kennis zoals beschreven in de literatuur, bestaande protocollen en richtlijnen, en de expertise van verpleegkundigen, van verpleegkundig specialisten en van experts. Het zorgprogramma is ontwikkeld voor patiënten van 65 jaar en ouder die zijn opgenomen op de afdelingen cardiologie, cardio thoracale chirurgie en longziekten van een universiteitsziekenhuis. Het programma is gebaseerd op het drie staps DEFENCE model (Develop strategies Enabling Frail Elderly New Complications to Evade), bestaande uit: selectie van risico patiënten (ISAR-HP), geriatrische anamnese en gerichte interventies. Deze drie onderdelen van het programma zijn ieder ontwikkeld door een groep van steeds acht studenten van de Hogere Beroepsopleiding voor Verpleegkundigen (HBOV). Iedere groep is begeleid door de twee projectleiders. Experts op de verschillende terreinen en een werkgroep verpleegkundig onderzoek bestaande uit verpleegkundigen van de afdelingen en verpleegkundig specialisten becommentarieerden de ontwikkelde producten. Een stuurgroep bestaande uit de verpleegkundig manager, een verpleegkundig beleidsmedewerker en een hoogleraar verplegingswetenschap was eindverantwoordelijk voor de resultaten van het project. De afdelingshoofden adviseerden deze stuurgroep en ook zij accordeerden het programma. Het programma is opgenomen in het elektronisch patiënten dossier op een praktische en werkbare manier, waarbij de verschillende stappen gemakkelijk gevolgd kunnen worden. Dit programma is een jaar na invoering geëvalueerd en aangepast.

De belangrijkste elementen van effectieve implementatie waren participatie van de verpleegkundigen in de ontwikkeling van het programma, het organiseren van scholing, het gebruik maken van klinische leiderschap en de ondersteuning van de managers. Dit project laat zien dat een dergelijke samenwerking tussen een praktijk instelling en een hogeschool een efficiënte manier is om de kloof tussen onderzoek, onderwijs en beroepspraktijk te overbruggen (Hoofdstuk 6).

Dit proefschrift beschrijft de ontwikkeling en de validatie van een voorspellend model (de ISAR-HP) om oudere patiënten met een verhoogd risico op het ontwikkelen van blijvend functieverlies te kunnen selecteren. De ISAR-HP is eenvoudig te gebruiken in de praktijk en is de eerste stap in de preventie van functieverlies.
De kracht van dit proefschrift is dat het ontwikkelde model met slechts vier predictoren oudere patiënten met een verhoogd risico op functieverlies kan selecteren: hulp nodig hebben bij het verrichten van IADL vóór de opname, het gebruiken van een hulpmiddel bij het lopen, hulp nodig hebben bij reizen en geen onderwijs hebben gevolgd na het 14$^{de}$ jaar. Hoewel gebruik van de ISAR-HP zal resulteren in een aantal "vals positieven", zal tegelijkertijd een substantieel deel van de oudere patiënten (ongeveer 30%) worden geselecteerd als zijnde niet at risk. Aan deze ouderen hoeft geen extra zorg te worden geboden. Daarmee verbetert de efficiëntie van de zorg.
Dit proefschrift beschrijft ook een voorbeeld van het implementeren van de resultaten van wetenschappelijk onderzoek in de praktijk en laat zien hoe de resultaten van deze onderzoeken kunnen bijdragen aan een verbeterde veiligheid en doelgerichte zorg voor oudere patiënten in het ziekenhuis.

Het ouder worden gaat gewoonlijk gepaard met fysieke, psychologische en sociale veranderingen die ertoe leiden dat ouderen meer ontvankelijk zijn voor stress (zoals ziekte en ziekenhuisopname) en veranderingen die leiden tot een verlies aan reservecapaciteit. Verschillende wegen die kunnen leiden tot functieverlies zijn beschreven in de literatuur. De individuele reactie op het ouder worden, het ontwikkelen van geriatrische problemen (zoals een verminderde mobiliteit, gezicht- en gehoor problemen), de ontwikkeling van geriatrische syndromen (als delirium en incontinentie) en multimorbiditeit zijn allemaal factoren die kunnen bijdragen aan de ontwikkeling van functieverlies. Daarnaast bestaat er een verband tussen de iatrogene aspecten van een opname (zoals complicaties van bedrust, decubitus en infecties) en functieverlies.

De exacte weg naar functieverlies is niet bekend, zoals ook geen bewijs bestaat voor de mate waarin functieverlies kan worden voorkomen. Het wetenschappelijk bewijs ten aanzien van het effect van een geriatrische anamnese en doelgerichte interventies is niet geleverd. Gegeven de groei van het aantal ouderen in de Westerse wereld en daarmee de toenemende behoefte aan zorg,  is het echter nodig dat iedere actie die functieverlies en behoefte aan langdurige zorg kan voorkomen moet worden ingezet.
De komende generatie ouderen zal zich meer bewust zijn van het belang van onafhankelijkheid en autonomie. De focus van verdere ontwikkelingen moet niet alleen liggen op wetenschappelijk onderzoek maar ook op het implementeren van verworven kennis in de praktijk.

# Dankwoord

In 2002 startte het lectoraat Verpleegkundige en Paramedische Zorg voor mensen met Chronische Aandoeningen aan de Faculteit Gezondheidzorg van de Hogeschool Utrecht. De opdracht was het genereren van nieuwe kennis en het verspreiden van bestaande en nieuwe kennis in zowel de beroepsopleiding als in de beroepspraktijk: kenniscirculatie werd het kernbegrip. De start van dit lectoraat was ook de start van mijn werk als onderzoeker. Ik zie het als een voorrecht dat ik vanaf het begin betrokken ben geweest bij dit lectoraat en dat ik daardoor vanuit een positie binnen het Hoger Beroeps Onderwijs het wetenschappelijk onderzoek, zoals beschreven in dit proefschrift, heb kunnen verrichten. Het College van Bestuur van Hogeschool Utrecht en in het bijzonder prof. mr. Huib de Jong (portefeuillehouder onderzoek) dank ik voor de promotievoucher die ik kreeg en voor het stimulerende promotiebeleid. Ik dank de directie van de Faculteit Gezondheidszorg en in het bijzonder mr. Harm Drost (faculteitsdirecteur) voor het vertrouwen in mij en de belangstelling en de waardering voor het onderzoekswerk. De steun van de directie was de basis van waaruit ik kon werken. De directie van het Instituut voor Verpleegkundige Studies heeft het mogelijk gemaakt dat ik kon worden vrijgemaakt voor het werk in het lectoraat. Ik dank Wichert Duyvendak en Andre Boer (de voormalig en huidig directeur van IVS) voor het stimuleren van mijn onderzoekswerk en voor het scheppen van mogelijkheden om de verbinding te leggen met mijn internationale werkzaamheden. Mede dankzij hen is het voor studenten mogelijk geworden om te participeren in de onderzoeken van het lectoraat.

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# List of publications, presentations and awards

## Scientific publications

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

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**Hoogerduijn JG,** Buurman BM, Korevaar JC, Grobbee DE, de Rooij SE, Schuurmans MJ. *The prediction of functional decline in older hospitalized patients.* Submitted.

**Hoogerduijn JG,** Weldam S, van Barneveld RJ, Schuurmans MJ. *Tailored care for older hospitalized patients, innovation in an academic service partnership.* Submitted.

**Hoogerduijn JG**, Grobbee DE, Schuurmans MJ. *Preservation of functional independency in older hospitalized patients.* Submitted.

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 health outcomes.* Submitted.

Buurman BM, **Hoogerduijn JG,** de Haan RJ, Korevaar JC, Schuurmans MJ, de Rooij SE. *Standardized comprehensive geriatric assessment in older hospitalised patients: development of a 3-step approach to prevent functional decline.* Submitted.

**Hoogerduijn JG,** de Rooij SE, Grobbee DE, Schuurmans MJ. *Predicting functional decline in older cardiac surgery patients: validation of a prediction model.*

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**Lectures in Bachelor, Master and Post Undergraduate programs (Hogeschool Utrecht)**

Kenniscentrum Masterclasses (KMC)
HBOV (Bachelor Nursing)
Master Physician Assistant
Post HBO opleiding Longverpleegkundige (post undergraduate)
Post HBO opleiding Praktijkondersteuner in de Huisartsen Praktijk (post undergraduate)
Master Geriatrie voor de Fysiotherapie
Opleiding Mondhygiëne (Bachelor Dental Hygiene)
Utrecht Summerschool, Nursing in an International Context

**Awards and nomination**

Award: Best Innovative Care project: (Jan Bastiaanse award) for the project: "Sneller en Beter Thuis", The Netherlands Centre of Excellence in Nursing (LEVV), Utrecht, June 2009.

Award: Best Presentation Nursing Podium: "Sneller en Beter Thuis", University Medical Center Utrecht, Utrecht, February 2009.

Nomination: Best Product of Knowledge (Beste kennisproduct): for the project "Sneller en Beter Thuis", HBO raad (The Netherlands Association of Universities of Applied Sciences), 2009-2010.

# Over de auteur

In 1967 ben ik mijn carrière als leerling verpleegkundige begonnen in het Diaconessenhuis in Voorburg. In die tijd werd de opleiding tot verpleegkundige gedomineerd door het medisch model: vrijwel alle "vakken" betroffen de verschillende medische specialisaties. Het verplegen werd vooral gezien in het teken van "de verlengde arm zijn van de medicus". In 1973 volde ik de opleiding Maatschappelijke Gezondheidszorg. In die periode kwam de aandacht meer en meer te liggen bij het methodisch werken: de ontwikkeling van de (gestandaardiseerde) verpleegkundige anamnese, diagnose en het verpleegplan. De emancipatie van het beroep schreed voort en op de Hogere Opleiding in Nijmegen die ik in 1979 volgde verschoof de focus naar verpleegkundige theorievorming en dat bleef het thema tot begin jaren '90: de belangrijkste vragen daarbinnen waren: wat is verplegen, welk mensbeeld ligt daaraan ten grondslag en hoe geef je dat vorm in de praktijk. In het laatste decennium van de vorige eeuw werd het bedrijfsmatig denken in de zorg populair. In 1997 volgde ik de opleiding Gezondheidswetenschappen (verplegingswetenschap) en in die periode kwamen de begrippen kwaliteitszorg, transparantie en evidence based practice steeds meer op de voorgrond. Het uitvoeren van wetenschappelijk onderzoek en het schrijven van een proefschrift zijn dan ook een logisch vervolg op deze ontwikkelingen.

Beroepservaring heb ik opgedaan in het ziekenhuis, de wijkverpleging en de kraamzorg en waar ik ook heb gewerkt, al die jaren is naast de inhoud ook de positionering van het beroep belangrijk voor me gebleven. Onderwijs is een belangrijke schakel in de professionalisering van een beroep en mede daarom ging ik in 1981 als docent werken bij de opleiding Maatschappelijke Gezondheidszorg (MGZ) in Culemborg. Professionalisering gaat samen met het vergroten van kennis en dat zal dan ook een centrale plaats in moeten nemen bij de opleiding. Wil de verpleegkundige als gelijkwaardige en geloofwaardige partner multiprofessioneel werken, dan moet kennis paraat en actueel zijn. Al de jaren in het onderwijs heb ik mij bezig gehouden met het zoeken naar de verbinding tussen theorie, onderwijs en praktijk. Dat ik tijdens deze jaren van het verrichten van wetenschappelijk onderzoek dan ook een mooi project heb kunnen uitvoeren samen met verpleegkundigen, collega's en studenten, gericht op het vertalen van wetenschappelijke kennis naar beroepspraktijk en naar de opleiding was voor mij een bron van inspiratie.

Verplegen is een prachtig vak en ondanks de vele ontwikkelingen en veranderingen in de zorg en in de samenleving gaat het gelukkig nog steeds om goede zorg voor de patiënt. Voortdurend komt daarvoor nieuwe kennis beschikbaar en die kennis is niet begrensd door taal of land maar is in internationale fora beschreven en is beschikbaar voor iedereen. We zullen meer samen werken met onderzoeksgroepen in en buiten Nederland en leren van ontwikkelingen in andere landen.
Nieuwe kennis genereren, kennis verspreiden en samen werken, multidisciplinair, aan het verbeteren van de zorg voor ouderen zijn het leidmotief voor mij voor de komende jaren. De tijd van de passieve oudere is voorbij. Veel ouderen van de toekomst zijn hoger opgeleid, en zullen steeds meer gebruik maken van de digitale informatievoorziening en kunnen mede daardoor beter voor zichzelf opkomen. Het behoud van zelfstandigheid en autonomie zal een belangrijk thema blijven. Tegelijkertijd zal er altijd een groep ouderen zijn die kwetsbaar en zorgafhankelijk is. Voor mij zal de komende jaren de focus blijven liggen op het ontwikkelen en gebruiken van kennis gericht op behoud van de zelfstandigheid en autonomie van de oudere mens en het realiseren van de verbinding tussen wetenschap, onderwijs en beroepspraktijk.