Linköping University Medical Dissertation No. 1816

Proactive Primary Care for Older Adults at High Risk of Hospital Admission

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LINKÖPING UNIVERSITY

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“As is a tale, so is life. Not how long it is,
but how good it is, is what matters”

Seneca

CONTENTS

ABSTRACT

Demographic change is leading to a higher proportion of older adults in most parts of the world. A minority of older adults have poor health, but this group has high care needs due to frailty and/or multimorbidity. Guidelines for the management of frailty emphasise early detection of frailty and recommend comprehensive care approaches in primary care, but the evidence for these interventions is low. To provide effective and individualised care, the health system needs to identify these patients and develop proactive interventions to improve quality of life and avoid treatments that are of no benefit to the individual.

The aim of this thesis was to study the effects of a proactive primary care working model in which vulnerable older adults were identified and received individually tailored care, using an adaptation of comprehensive geriatric assessment (CGA).

Methods: A pragmatic controlled trial was conducted in 19 primary care practices in Sweden from 2017 to 2020. A predictive model, using electronic medical records to assess the risk of hospital admission, selected participants at high risk. Participants in the intervention practices were offered a comprehensive geriatric assessment in their primary care practice and subsequent follow-up by a team consisting of a nurse and the patient's doctor. A new CGA tool - PASTEL (Primary care ASsessment Tool for Elders) was used for assessment and care planning. The primary outcome for the intervention was hospital care days and secondary outcomes were hospital care episodes, mortality, outpatient visits, healthcare costs and cost-effectiveness. The outcomes were adjusted for age, sex and risk score and analysed according to intention-to-treat.

The predictive model was validated, and performance was assessed using the C-statistic. Focus group interviews were conducted to explore primary care nurses' and doctors' experiences with the new tool PASTEL.

Results: 1304 older adults were included in the trial. The mean age was 82.2 years, 51% were female. During the follow-up period of 24 months, the relative risk reduction of hospital care days in the intervention group was - 22% (CI 95% = -35% to - 4%, p = 0.02) compared with usual care. There was no significant difference in mortality and outpatient visits. The reduction in healthcare costs was - € 4324 (- € 7962 to - € 686, p = 0.02). The intervention was cost-effective compared with usual care, mainly due to lower costs.

The predictive model had an AUC of 0.69 (CI 0.68- 0.70). Primary care staff considered PASTEL valuable and feasible in the primary care context.

In conclusion, the results of this thesis indicate that vulnerable older adults at risk of hospitalisation can be identified by a predictive model. Proactive intervention with a comprehensive geriatric assessment adapted to primary care can reduce the need for hospital care. Future studies in similar contexts are needed to determine whether these results are generalisable.

SVENSK SAMMANFATTNING

Andelen äldre personer i befolkningen ökar vilket är en utmaning både för samhället i stort och för hälso- och sjukvården. Enbart en mindre del av de äldre har stora vårdbehov på grund av multisjuklighet eller skörhet. För att kunna rikta förebyggande insatser till de som behöver det mest behöver sjukvården strategier för att kunna identifiera sårbara personer.

Det övergripande syftet med denna avhandling var att utvärdera effekterna av ett proaktivt arbetssätt i primärvården. Äldre personer med hög risk för sjukhusinläggning erbjöds en utvidgad hälsobedömning, individuellt anpassade insatser och uppföljning på vårdcentral av ett team bestående av sjuksköterska och läkare.

I studien utvecklades en digital modell som genom sökning i journaldata bedömde risken att hamna på sjukhus under det kommande året. Analys av modellens tillförlitlighet visade att den kunde identifiera många av de som blev inlagda på sjukhus men att ett mindre antal personer med låg risk också fångades upp.

Ett nytt verktyg för hälsosamtal med fokus på skörhet - PASTEL (Primary care ASsessment Tool for Elders) utvecklades också för studien. Sjuksköterskor och läkare som hade använt PASTEL beskrev i fokusgruppsintervjuer att verktyget hjälpte dem att få en bredare bild av en äldre persons hälsa och att planera insatser som var anpassade till individens egna behov.

Det proaktiva arbetssättet infördes på nio vårdcentraler i Östergötland och utvärderades efter två år avseende effekter på behov av vårdinsatser och kostnadseffektivitet, i jämförelse med sedvanlig vård. De patienter som erbjudits det nya arbetssättet behövde i genomsnitt 22 % färre dagar på sjukhus och hade 17 % lägre sjukvårdskostnader jämfört med kontrollgruppen. Arbetssättet bedömdes vara kostnadseffektivt med hög sannolikhet.

Sammanfattningsvis ger avhandlingen stöd för fortsatt utveckling av digitala metoder för att identifiera sköra personer och erbjuda dem ett personcentrerat och proaktivt omhändertagande i primärvården. Insatser för att stärka omhändertagandet av sårbara personer i primärvården kan ge effekter i minskat slutenvårdsbehov. Detta är en viktig kunskap i omställningen till nära vård.

LIST OF PAPERS

I. Marcusson J, Nord M, Dong HJ, Lyth J. Clinically useful prediction of hospital admissions in an older population. BMC Geriatrics 2020;20(1):95.

II. Nord M, Lyth J, Alwin J, Marcusson J. Costs and effects of comprehensive geriatric assessment in primary care for older adults with high risk for hospitalisation. BMC Geriatrics. 2021;21(1):263

III. Nord M, Lyth J, Marcusson J, Alwin J. Cost-Effectiveness of Comprehensive Geriatric Assessment Adapted to Primary Care. Journal of American Medical Directors Association. 2022 May 13: S1525-8610(22)00303-6

IV. Nord M, Östgren CJ, Marcusson J, Johansson M. Staff experiences of a new tool for comprehensive geriatric assessment in primary care (PASTEL) : a focus group study. Scandinavian Journal of Primary Health Care. 2020;38(2):132-45.

ABBREVIATIONS

AUC	Area under the curve
CGA	Comprehensive geriatric assessment
CI	Confidence interval
CPG	Clinical practice guidelines
EQ-5D	Euro-Qol instrument with 5 dimensions
EQ-index	Euro-Qol instrument index
GP	General practitioner
HALE	Healthy life expectancy
HRQoL	Health related quality of life
ICER	Incremental cost-effectiveness ratio
ICOPE	Integrated care for older people
MICE	Multiple imputation with chained equations
NICE	National Institute for Health and Care Excellence
OECD	Organisation for Economic Cooperation and Development
PASTEL	Primary care assessment tool for elders
PPV	Positive predictive value
PRECIS	Pragmatic explanatory continuum indicator summary
QALY	Quality adjusted life years
ROC	Reciever operating characteristics curve
SD	Standard deviation
USD	United States Dollar
WHO	World Health Organisation

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Thank you all!

Linköping, 29 August 2022,

Magnus Nord

PROLOGUE

As a general practitioner (GP), I have often found that the health system in which I work does not adequately meet the needs of patients with complex health problems, particularly frail older adults. These patients do not fit into the usual routines and guidelines, and they have difficulty presenting their problems or even coming into contact with the healthcare system. Often, a lot of time and effort is required just to find out what their health problem is and what it means for them. If it is possible to suggest an intervention, this may involve working with relatives, community care, rehabilitation services and, of course, the patient. It may turn out that the intervention is not entirely in line with the patient's priorities, even if the plan is well developed. This is a demanding task that a GP can hardly manage alone.

So, it's not so hard to understand that sometimes we fail and hope that some other part of the health system will do better. But it is hard to understand that the health system has not yet been able to move further towards functioning integrated care. These patients should be the top priority because of their high need for care. And also, when teamwork is successful, it is very rewarding, both for the patient, for the staff involved and for the sustainability of the health system.

The desire to improve care for frail older people has been with me throughout my career. When Gun Lindgren, in 2016, hinted to me that a research project was planned under the direction of Professor Jan Marcusson, I did not hesitate for long. It was an opportunity to use my clinical experience in a different context and gain deeper knowledge, new skills and inspiration. The research project had extensions beyond the intervention itself (23), e.g. studies on implementation, older adults' experiences/attitudes and nurses' working conditions in community care. This made my PhD very suitable for a GP, a diverse mix of medicine, humanities, social sciences and uncertainty.

> *"...our most cruel failure in how we treat the sick and the aged is the failure to recognize that they have priorities beyond merely being safe and living longer; that the chance to shape one's story is essential to sustaining meaning in life.."*
>
> **Atul Gawande**, Being Mortal: Medicine and What Matters in the end

INTRODUCTION

Ageing and Health

An ageing population

The demography is changing towards a greater proportion of older people all over the world. In many western countries, the gain in life expectancy has been over 30 years during the 20th century. In countries like Spain, Japan and Sweden, the majority of children born after year 2000 will reach the age of 100 years if the current improvement in life expectancy will continue (1). This development has been evident in high-income countries for decades, but it is now also true in low and middle-income countries where the older population is growing even faster. For example, about 10 % of the population in Iran is currently over 60 years, but that proportion will rise to about one third in year 2050 (2).
However, in many high-income countries, life expectancy has not increased much in the last decade and in certain underprivileged groups it has decreased (3), even before the effects of the pandemic have been counted.

Finally, the increasing life expectancy is obviously very good news as it opens possibilities for a longer active life for billions of people. The crucial factor for the individual and the society to take advantage of this goldmine is of course health.

Health, disease, and disability in older people

The picture of older people's health is complex and not easy to interpret, as trends in different measures of health vary. In high-income countries, the number of years of life with illness has increased in the last decades, while at the same time the number of years of life with good self-perceived health has increased (2). The prevalence of the most severe levels of disability has decreased, while less severe disability is increasing (4).

Quality of life is primarily defined by function in daily life, i.e. functional ability (5), but a correlation between attitudes towards ageing and quality of life has been found in a large cross-sectional survey of older people. This supports the theory that positive attitudes towards physical and mental changes lead to a higher quality of life (6).

A phenomenon that adds to the complexity is the discrepancy between subjective health assessment and objective condition, which increases with old age: older adults tend to assess their health better despite declining functional ability (7).

Healthy life expectancy (HALE) is a measure that combines mortality and morbidity. It describes the number of years a person can live in good health at a given age (8). HALE increased globally by 5 years from 2000 to 2019 to 63.5 years at birth. This is mainly due to a decrease in perinatal deaths and infectious diseases (9). Unfortunately, HALE is not increasing at the same pace as life expectancy, especially at ages over 50. Accordingly, the theory of the "compression of morbidity" (10), that states that the time a person lives with disease will become shorter and shorter in the future, has been questioned. Between 2000 and 2019, the years lived without good health increased from 8.6 to 10 years, which means that morbidity has increased in most countries in the world (9). Other studies have found an improvement in self-rated health despite increasing disability (2). Explanations for this could include earlier diagnosis and better treatment of long-term conditions, as well as improvements in housing and support systems for disabled people in society.

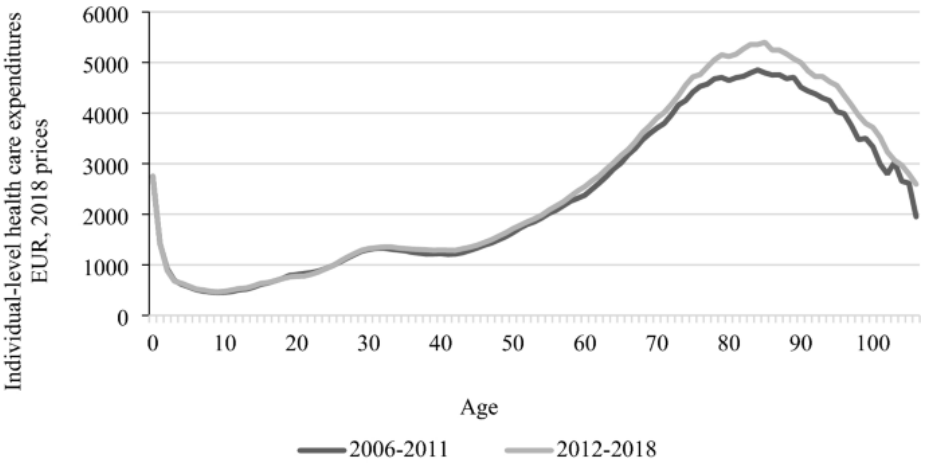
The main causes of disability are sensory impairment (vision, hearing, etc.), back and neck pain, chronic obstructive pulmonary disease, depressive disorders, falls, diabetes, dementia, and osteoarthritis (4). Prevention programmes have generally not been as successful for these conditions as for cardiovascular disease. In addition, it is estimated that multimorbidity among older adults will continue to increase over the next 15 years (11).

In summary, in the rapidly growing population of older adults, the vast majority live well with or without chronic conditions, while a small proportion are in poor health, either due to complex multimorbidity or increased vulnerability due to advancing age, i.e. frailty.

Healthcare costs related to old age

Over the past few decades, healthcare expenditures have steadily increased (12, 13). There is an ongoing debate as to whether increasing age per se is the reason for this development or whether the time remaining until death is the most important predictor of healthcare costs; the “red herring” hypothesis (14). Almost 50% of total healthcare costs are incurred by people over 65, who make up about 15% of the population (15). Healthcare costs are highest between 75 and 85 years of age in a study from Norway and then decline among the oldest old while costs for home care and nursing homes continue to rise also in this age group (15).

Figure 1: Healthcare expenditures over a life cycle.



From: Kollerup et al. 2022 (16).

A study from Denmark analysed the increase in healthcare expenditures comparing 2006-2011 with 2012-2018 and found a significant correlation between age and costs (Figure 1). The increase in costs was largely attributed to older adults over the age of 75 (16).

In high-income countries, between 8% and 11% of total healthcare costs are spent annually on the 1% of people who die that year (17). There is a risk that these funds are spent on pointless or inappropriate treatments (4). In the last month of life, costs and hospital care increase dramatically, and healthcare costs increase with the number of comorbidities (18). Palliative care interventions have been shown to reduce hospitalisation (19). Overuse of healthcare exists in many areas, but overuse of hospitalisation, especially in the last months of life, imposes significant costs on the health system (17, 20). It is therefore important both to consider cost-effectiveness and to have careful ethical discussions about end-of-life treatments in all age groups.

Older adults' views on ageing and caregiving

Gerontologists distinguish between the third and fourth ages in the ageing process (7), with the third age characterised by an active life with good physical and mental health and effective strategies for coping with the challenges of ageing (successful ageing). The fourth age of life is more characterised by the loss of mental and physical abilities and difficulties in adapting to these losses, as well as coping with the end of life (5, 21). Studies of

older adults' views on ageing and dying show considerable individual variation in the way older adults relate to the future and the end of life (22). Older people can both live active lives and begin to prepare for death by arranging their belongings and talking about death with friends and relatives (22).

Parallel to the intervention study on which this thesis is based, an interview study with participants in the intervention was performed (23). These older adults described a high acceptance of health problems and disabilities together with a strong desire to live independently in their own homes and maintain their important social relationships. Many of them wanted to take the day as it comes and not make plans to avoid disappointment, while others were able to make plans for the years ahead. Few of them had talked to anyone about end-of-life care. They expressed fear of losing independence and, to some extent, fear of pain and suffering (24).

Participants also expressed a desire to be involved in care planning and decision-making and felt that involvement in care was associated with continuity and good personal relationships with doctors, nurses, and other staff. Several participants wanted a care coordinator - 'a spider in the web' to help them navigate the complicated waters of the care system (25).

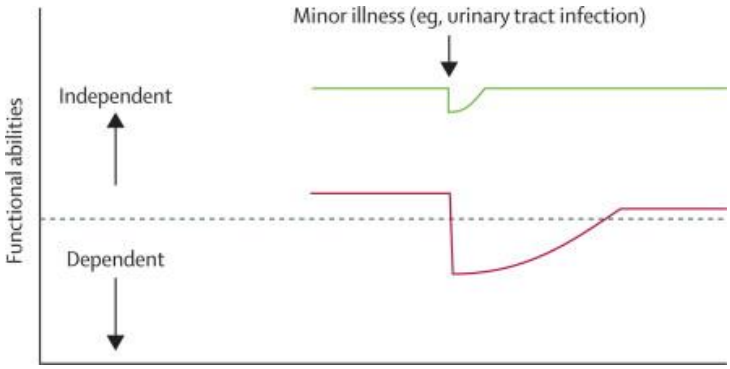
This is broadly consistent with other studies of frail and older adults' experiences of life, end of life and care (26-32). These studies support the idea that the range of existential and psychological expressions in older adults is as wide as their medical problems. Therefore, the ability of healthcare professionals to grasp and understand these considerations and preferences of the individual is of great importance in order to provide appropriate care (27, 33).

The vulnerable older adult

Frailty and multimorbidity

Frailty is characterised by an age-related decline in function in various organ systems, leading to increased vulnerability to stressors (34-37). This vulnerability leads to a reduction in a frail person's functional ability and a high risk of falls, hospitalisation, loss of autonomy and delirium, for example in the event of infection or other minor illness. As illustrated below in Figure 2, recovery from such an event also takes longer than for a robust person.

Figure 2: Vulnerability of frail older people



From: Clegg et al. 2013 (34). The green line represents a fit older adult and the red line represents one with frailty

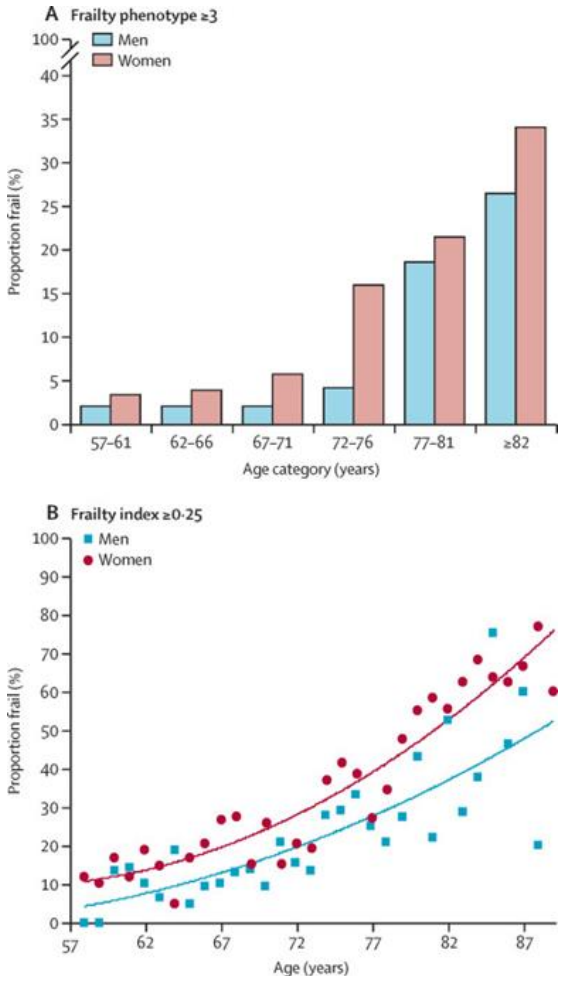
The construct of frailty has been increasingly used in geriatrics over the last 15 years, without a common definition (38). The *frailty phenotype* (39), introduced in 1999 by Linda Fried is one of the two most commonly used models, and focuses on signs of physical frailty: weakness, slow gait speed, low physical activity, weight loss and fatigue. Three of these signs/symptoms must be present for a person to be considered as frail.

Prefrailty is often described as increased vulnerability that is not yet fully established and more easily reversible; one or two symptoms of the frailty phenotype are present (40).

The *cumulative deficits model*, which defines frailty as an accumulation of various health deficits (diagnoses, symptoms, functional impairments, test scores), was elaborated by Kenneth Rockwood and Arnold Mitinsky (41, 42). Indeed, this model of frailty has clear links to multimorbidity (43, 44).

Despite numerous calls for a consensus on the definition of frailty, this has not yet been reached (45). Nevertheless, there is consensus that frailty is multifactorial, with both physical and psychological causes, and that it increases with age but is not an inevitable consequence of ageing (35). Furthermore, frailty is potentially reversible until the most severe stage, when it becomes part of the dying process (36).

Figure 3: The prevalence of frailty



From: Hoogendijnk et al. 2016 (46). Prevalence measured with two frailty models in a cohort of community-dwelling older adults in Amsterdam.

Different studies have found prevalence of frailty in older adults ranging from 3% to 50 %, depending on the setting, age group and screening tool used (Figure 3) (46, 47, 48). Frailty is more common among women and among people with low education and income.

Instruments used to detect and assess frailty

Numerous scales and instruments have been developed to detect and assess frailty. Systematic reviews (49-51) have described more than 50 different instruments. Most of them are designed for assessment by health professionals as the Clinical Frailty Scale (52), the FRAIL-scale (53) or the Tilburg Frailty Indicator (54), but there are also self-administered questionnaires like the PRISMA-7 (55). More recently, indices based on electronic medical records have been developed, e.g. the electronic Frailty Index (56). The different instruments include a range of items from 2 to 90, predominantly physical domains. Newer instruments also include psychological domains, and a few instruments have items describing social domains. The performance of these scales is presented as agreement with the frailty phenotype or frailty index and their ability to predict outcomes such as disability, hospitalisation, and death (49, 50).

Most reviews conclude that there is insufficient evidence to recommend any particular instrument. Few instruments are tested for both reliability and validity and the need for standardisation is emphasised (50). In addition, most instruments have low specificity and low positive predictive value, which means that they are more suitable for exclusion of frailty than for detecting frailty (57). This leads to the conclusion that these instruments are not suitable for population screening (51). However, some authors argue that screening with tools that use data from electronic medical records may prove to be an effective strategy, although evidence is limited (58).

Why should we care about frailty?

Frailty is first and foremost a risk marker. Frail older adults have two to four times higher risk of hospitalisation, disability, and death (59, 60). Frailty correlates with increased healthcare utilisation, even when multimorbidity and socioeconomic status are considered, and this increase begins before frailty is detected (61). Frailty itself is associated with loneliness, lower quality of life, falls, cognitive decline, reduced autonomy, and nursing home admission (35). Healthcare costs are 2-5 times higher for frail older adults than for those who are not frail (5, 61, 62), and a recent study from the UK estimated the additional healthcare costs due to frailty to be almost £6 billion per year in 2018 (63).

Intervention studies have shown that exercise/resistance training, protein-energy supplementation, individually tailored and comprehensive care, advice on healthy behaviours and social support for frail people can have an impact on physical function, care needs and levels of frailty. According to a review of systematic reviews on this topic (64), the level of evidence for all interventions and outcomes is low or very low. Meta-analyses are difficult to conduct due to the heterogeneity of participants, frailty assessment scales and outcome measures.

Evidence-based healthcare for older adults

Management of frailty

Recommendations for healthcare for older adults often target the management of multimorbidity and/or frailty. This is reasonable, as older adults without frailty or multimorbidity can follow standard recommendations for single conditions. However, as people age, the range of care needs and variations in health status increases. This means that healthcare have to be more comprehensive and individualised to address the health problems of older people (41).

Examples of recommendations on frailty and multimorbidity include NICE guidance on multimorbidity (65), Integrated Care for Older People (ICOPE, WHO) (66), Physical frailty (67) and Asia-Pacific CPG for the management of frailty (68). All of these recommendations indicate that the level of evidence for most of the recommendations is low, but they still have many common elements (69):

- Early detection of frailty and multimorbidity with significant disease burden
- Health assessment in case of suspected frailty
- Preparation of an individualised care plan/management plan
- Fatigue/weakness: prescription of physical activity and resistance training
- Malnutrition: nutritional counselling and/or supplementation
- Polypharmacy: optimisation of medication
- Treatment of all reversible medical conditions

ICOPE also recommends provision of hearing and vision aids, treatment of incontinence, initiation of fall prevention measures and support for carers (66).

The report "Healthy Ageing" (WHO) outlines public health measures to promote "healthy ageing" with the highest possible functioning throughout the ageing process and emphasises the importance of preventive measures. It also underlines the importance of an "age-friendly" society (2).

Functional ability is described as the interplay between an older adult's physical and mental resources and the environment. The reduction of barriers to participation in various activities are therefore important health-promoting measures.

Many recommendations emphasise the importance of primary care in both the detection and management of frailty and multimorbidity (69).

Comprehensive Geriatric Assessment

Comprehensive Geriatric Assessment (CGA) was introduced by geriatricians in the 1990s. It is described as a multidimensional, holistic assessment of an older person's health status, including medication and functional status, and the preparation of a management plan. In other words, CGA is a synthesis of the above recommendations in a practical working model. CGA was developed as a multi-professional team process for inpatients but has been further elaborated for outpatient and home settings. According to a review from 2018, the most common elements of a CGA are physical, psychological, socioeconomic, nutritional, and functional assessment (70). The assessment is often associated with follow-up by a case manager in the outpatient setting (71).
Studies of the effectiveness of CGA in hospitals have shown reductions in functional decline and nursing home admissions and increased survival (72). In outpatient and primary care settings, the results are contradictory (73-75). Although there is limited evidence for different interventions, CGA is proposed as the gold standard also for primary care (76). In Sweden, most research initiatives have been organised organized around a mobile team that has not been integrated into the ordinary primary care (77, 78).

Primary care in Sweden

Effective and accessible primary care is an essential component of the health system. Cross-national and in-country studies comparing primary care systems have demonstrated the impact of primary care on mortality, morbidity, healthcare costs and health equity (79). Recent evidence suggests that accessibility and continuity of the primary care physician correlates with fewer hospitalisations for chronic ambulatory care sensitive chronic conditions (80, 81). Also interventions that strengthen care coordination and continuity can prevent avoidable hospitalisations (82). Barbara Starfield, an American public health researcher, has defined four core elements of effective primary care: Comprehensive Care, Accessibility, Personal Continuity and Coordination (83).
Swedish primary care is struggling with insufficient accessibility and continuity, a fact that has been examined in two government public enquiries (84, 85). One of the proposed reasons is the low number of general practitioners (GPs) per capita compared to many other OECD countries. In 2019, there was 0.62 GPs/1000 inhabitants in Sweden compared to the UK (0.80), Norway (0.97) or the Netherlands (1.74/1000 inhabitants) (86). On the other hand, Swedish primary care is well equipped with nurses, physiotherapists, and other health professionals, which could enable working in teams with e.g. complex multimorbidity or frailty (84).

The above enquiries (84, 85) have also highlighted the lack of coordination of care between hospital, primary and community care and the need to shift resources from hospital to 'local care', i.e. primary and community care.

Research methods to study care models and complex interventions

Clearly, there is a need for further development and evaluation of primary care interventions that address the challenge of identifying and caring for vulnerable older adults.
Classic randomised controlled trials are reliable tools for controlled testing of a new treatment, examining a specific process in a closely monitored 'artificial' care context (87). Because older adults with multimorbidity or frailty are a very heterogeneous group, they have often been excluded from intervention studies, making interpretation of results difficult (2). The pragmatic study design is a method to study what happens when a new treatment or model of care is introduced into daily practice (88). The idea of the pragmatic design is to interfere as little as possible with the data collection and to avoid careful selection of study participants (89). There is an ongoing debate on how to describe/assess the degree of pragmatism. The PRECIS - tool is used to rank a study design on a continuum from pragmatic to explanatory in areas such as study outcomes, flexibility of intervention, level of expertise required of participating staff, etc (90). Examples of ethical challenges related to pragmatic studies include delineating risk to participants, defining usual care and dealing with the informed consent process for participants (91).

A clinical intervention can be more or less complex. Complexity is related to, for example, the number of interacting components of the intervention, the different groups of staff involved and the number of behaviours required of those delivering the intervention. The complexity of an intervention also depends on the number and type of outcomes to be measured (92). Interventions in primary care that include identification of frailty, assessment, care planning and coordination of care will inevitably be complex. It is important to accurately describe the underlying rationale and goals of the intervention so that they are clear enough for the actors involved. The more complex an intervention is, the more important it is to model the process of the intervention prior to a full evaluation to ensure that implementation can be successful (93).
Interventions targeting multimorbidity and frailty in primary care are thus a complex research topic for which there is limited evidence. At the same time, it is an important problem for both the health system and society that needs to be addressed, despite all the difficulties (94).

AIMS

General aim

The overall aim of this thesis was to study the effects of a proactive primary care working model in which vulnerable older people are identified and receive individually tailored care, using an adaptation of comprehensive geriatric assessment (CGA).

Specific aims

I. To develop and validate a predictive model based on routine healthcare data that identifies older people at high risk of hospital admission.

II. To investigate whether CGA adapted to primary care can reduce hospital care days in older adults at high risk of hospital admission, compared with usual care.

III. To determine the cost-effectiveness of a CGA intervention in primary care, compared with usual care.

IV. To explore staff experiences of PASTEL, a new CGA tool that is adapted to primary care.

METHOD

This thesis is based on four papers. An overview of the different designs, populations and methods is presented in Table 1.

Table 1. Overview of populations and methods

Paper	I	II	III	IV
Study design	Prospective cohort study	Pragmatic matched-controlled, multicenter intervention study	Within-trial cost-effectiveness study	Focus group interview study
Population	40,728	1604/1308	369	15 (3 focus groups)
Data collection	Healthcare database	Healthcare database	Healthcare database (healthcare costs) + postal questionnaire (HRQoL + community costs)	Audio recorded, transcribed interviews
Period	2015-2017	2017-2019	2017-2019	2017-2018
Analyses	Multivariable logistic regression	Generalized linear mixed model, Students' T-test, Qi -square test,	Multiple imputation for missing data, Students' T-test, Qi -square test, bootstrap analysis, multiple linear regression	Manifest qualitative content analysis
Exposure variable	Prediction model with 37 variables	CGA intervention	CGA intervention	--
Outcome	Hospitalisation	1: Hospital care days 2: Other healthcare utilization and healthcare costs	Incremental Cost-effectiveness Ratio (ICER)	--

Populations

Predictive model (paper I)

The population used for the development and validation of the predictive model was the total population of people aged 75-109 years in Region Östergötland, south-eastern Sweden (n= 40,728)

Intervention study (paper II)

The population consisted of people aged 75 years or more in 19 primary care practices in Östergötland. Together, these 19 practices had a population of 14,500 older people (about 36 % of the entire region).
From the total population of people aged 75 and over in these practices, 1604 older adults were selected in March 2017 using the predictive model (Figure 4). These 1604 participants had the highest risk score for hospital admission and accounted for 11 % of the population in the practices. No person was excluded, all participants who could be reached by the intervention practices were offered the intervention.

Cost-effectiveness analysis (paper III)

Out of the 1304 people enrolled in the study in paper II, 369 persons agreed to answer a questionnaire at three time points and participate in the health economic evaluation in paper III. There were 184 participants in the control group and 185 in the intervention group.

Experiences of PASTEL (paper IV)

The participants in the three focus groups were healthcare professionals in eight of the nine intervention practices. We gathered a purposive sample with attention to the participants profession, which practice they worked in and their experience of using PASTEL. Overall, they represented about 20% of the total staff using PASTEL in the intervention study (Table 2).

Figure 4: Flow of participants, paper II

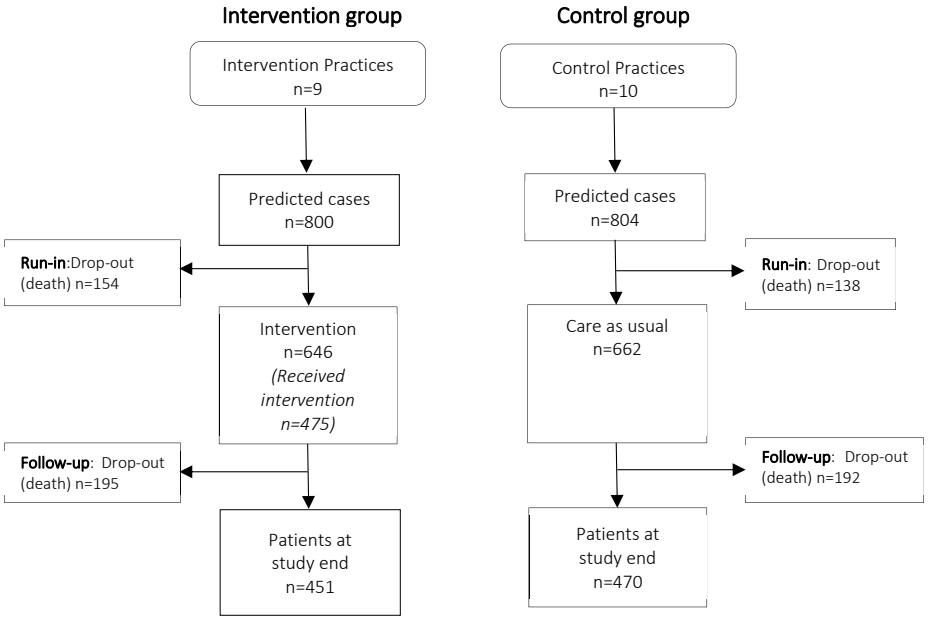


Table 2. List of participants in paper IV

Participant	Focus group (A-C)	Years of work experience	Sex	Number of PASTEL assessments
Nurse 1	A	8	F	25
Nurse 2	A	11	F	25
Nurse 3	A	11	F	3
GP 1	A	40	M	15
GP 2	A	25	F	5
Pharm 1	B	15	F	35
Nurse 4	B	25	F	3
Nurse 5	B	23	F	8
Nurse 6	B	33	F	45
Nurse 7	B	34	F	40
GP 3	B	25	M	30
Nurse 8	C	38	F	25
Nurse 9	C	10	F	20
GP 4	C	10	M	15
GP 5	C	32	F	8

GP: General Practitioner; F: female; M: male; Pharm: Pharmacist. Nurses were registered nurses or nurse practitioners.

Designs, outcomes, and statistical methods

The predictive model (paper I)

The process of developing the predictive model consisted of three steps: Selecting the variables, building the model, and validating the model. We obtained data on age, gender, healthcare contacts and diagnoses in a prospective cohort of 40 728 older adults during a 12-month period (November 2015 to October 2016). The dependent variable was hospitalisation during the following 12 months (November 2016 to October 2017). The data was randomly divided into two halves, a training set and a validation set. Then we used the training set to develop a predictive model and the other set to validate the model.

Selection of variables

Logistic regression was used to identify variables that were significantly related to hospital admission in the following year.

Building the model

The model was built using multivariable logistic regression with forward selection, adding a new variable if it increased performance.

Validation of the model

The performance of the model was assessed using the C-statistic by calculating the area under the curve (AUC) in a receiver operating characteristics curve (ROC). An AUC value greater than 0.5 indicates that a model has some ability to predict an outcome, and a value of 1.0 indicates perfect prediction with optimal sensitivity and specificity. The model was tested and validated with five sensitivity analyses, and external validation was performed with two additional datasets: one with a younger age group (65-75 years) and another from a different time period; year 2012 and 2013.

The intervention study (paper II)

Design

We conducted a pragmatic intervention study in the 19 primary care practices described above. Nine of these practices were intervention practices that had volunteered to participate in the project. As it was not possible to randomly select the participating practices, the control practices were assigned by the research group to match the size and location of the intervention practices.

According to the PRECIS-tool (95), the study design was pragmatic in almost all 10 different domains (recruitment, setting, flexibility, follow-up, etc.). We started collecting healthcare data after a 9-month run-in period during which participants were contacted and received the CGA. At the start of the follow-up period in January 2018, 1308 participants remained (Figure 4) and were followed for 24 months.

Intervention

We distributed a list of participants selected by the predictive model to intervention practices in March 2017. Participants in intervention practices were contacted by telephone and offered a comprehensive geriatric assessment (CGA) at the practice.

The assessments were based on the CGA tool PASTEL (Primary care ASsement Tool for ELders) developed by the research team for the intervention. The first part of PASTEL is an interview guide with about 25 items covering self-assessment of health status, important perspectives on geriatric health, and personal preferences and ideas about the future. It also includes physical measures and a medication review. The second part of PASTEL is a team meeting where the nurse, together with the patient's doctor, assesses the degree of frailty on the Clinical Frailty Scale and prepares a preliminary action plan based on a checklist in the PASTEL form.

An assessment took an average of one hour with the patient and about 15 minutes for the team meeting. After the team meeting, the patient was involved in care planning. Interventions were individualised based on the team's clinical judgement, there was no standard treatment. Intervention practices were encouraged to provide continuity and facilitate access to the doctor and nurse. Control practices provided care as usual and were not made aware of their participants.

Outcomes and analyses

The primary outcome was hospital care days. Secondary outcomes were number of outpatient visits, hospital care episodes, mortality, and healthcare costs. We analysed all outcomes according to intention-to-treat. T-test was used for continuous variables and Qi-square test for categorical variables. Generalised linear mixed models were used to compare the two groups, controlling for age, sex, and risk score. The mixed model analysis allowed us to control for differences associated with primary care practices by including these as a random intercept effect. Mortality was analysed using the Kaplan-Meier method. The hazard ratio was estimated by multivariable Cox regression. The results for the secondary outcomes must be interpreted with caution due to multiple testing.

The cost-effectiveness analysis (paper III)

Outcomes

The primary outcome was the incremental cost-effectiveness ratio (ICER).

$$\text{ICER} = \frac{Costs\ Intervention - Costs\ Care\ as\ Usual}{QALYs\ Intervention - QALYs\ Care\ as\ Usual}$$ (QALY = Quality Adjusted Life Years)

Two different perspectives of cost-effectiveness were examined: The *healthcare perspective*, which includes only healthcare costs, and the societal perspective, which includes all identified relevant costs. In this analysis, healthcare costs and costs for home help services and nursing home care were included in the *societal perspective*. The time period was the 24-month follow-up period.

Health-related quality of life (HRQoL) data were collected using a postal questionnaire sent to participants at baseline (June 2017), 10 months follow-up (October 2018) and 22 months follow-up (October 2019). We assessed HRQoL using the EuroQoL instrument with five dimensions and three levels (EQ5D-3L) (96). The five dimensions of EQ5D are mobility, self-care, pain/discomfort, anxiety/depression, and usual activities. The EQ-index score was obtained using the UK value set (97). Quality-adjusted life years (QALYs) were calculated by multiplying the time spent in a given health state with the EQ -index score of that period, and then adding the periods to a sum of QALYs for the entire follow-up period. The EQ -index was considered stable until the next measurement time point.

In the questionnaire, participants indicated how many hours per week they used home help services and whether they lived in a nursing home. The number of hours and the type of housing were considered unchanged until the next measurement point. We calculated costs of home help services and nursing home costs using the average price per hour of home help services and per day of nursing home stay reported by the Swedish Association of Local Authorities and Regions. Intervention costs incurred before the follow-up period (i.e. training and introduction of staff, CGA assessments and team meetings) were estimated by the research group as time spent by doctors and nurses in an average-sized primary care practice.

Statistical analyses

A considerable amount of data on HRQoL and community costs was missing from the postal questionnaires. We used the method of multiple imputation with chained equations (MICE) to process missing data. Ten imputed datasets were created, modelling the imputed data mainly by age, sex, risk score and cohabitation status. We adjusted all data for age, sex and risk score and analysed by intention-to-treat. We bootstrapped the data 10,000 times to describe the uncertainty of the analysis in two cost-effectiveness planes.

Experiences of PASTEL (paper IV)

PASTEL (the Primary care ASsement tool for ELders) is a tool developed for conducting a comprehensive geriatric assessment in primary care. The intention of PASTEL was to:

- Get a comprehensive picture of the health situation of older adults.
- Support encounters where patients can express their own thoughts and wishes
- Facilitate teamwork between nurses and doctors in primary care
- Promote interventions that meet the individual needs and personal priorities of patients

Design

We conducted three focus group interviews during the intervention between November 2017 and March 2018, when most assessments had been completed using PASTEL in intervention practices. The interviews lasted 60-75 minutes and took place in three different practices during working hours. Information about the study was repeated verbally before the interviews. Participants were encouraged to share and discuss both positive and negative experiences. We used an interview guide with three key questions and different follow-up questions depending on the discussions in the groups.

Key questions:

- What has been your experience of using PASTEL?
- How did you capture the patient's own expectations of care and thoughts about the future with PASTEL?
- What has been your experience of using PASTEL at the team meeting and in care planning?

One of the researchers (M. Johansson) moderated the interviews and the other (M. Nord) observed and co-moderated the interviews. The researchers have experience in working with geriatric patients and M. Johansson is also trained in qualitative research. M. Nord was already known to the participants, as he had introduced the tool PASTEL to the practices before the intervention and participated in research group visits to the practices. The interviews were audio recorded and transcribed verbatim.

Analysis

We analysed the data using manifest qualitative content analysis as described by Graneheim and Lundman (98). The researchers conducted each step of the analysis individually, discussed and then produced a joint version of the analysis. A third person with sound knowledge of qualitative methodology also reviewed the analysis at each step. Table 3 shows the process of forming codes and categories.

Table 3. Examples from the qualitative content analysis

Transcribed data	Condensed meaning unit	Code	Subcategory	Category
No, so I generally think that this patient group requires more eyes than mine, so to speak...	Patient group requires more eyes	Teamwork is needed	Challenges for the team	The winding road of actions and teamwork
I tried to focus on his (the patient's) story and experiences and then she (the wife) supported him when he could not really express what he meant …	Focuses on the patient's story and the relative supports when needed	Relatives are supportive	Participation of relatives can be helpful but sometimes unfavourable	Creating conditions for dialogue
…that is, you get a structured information …yes, it gives a holistic view, right, on all the problems	Get structured information and a holistic view	Structured information Holistic view	Structure gives the overview needed for action	A valuable tool for selected patient

Ethical considerations

The regional ethics committee in Linköping approved the studies in paper I - III. The participants in paper I consisted of the entire population of the Östergötland region who were over 75 years old. As the outcomes (use of care, mortality, and costs of care) were only analysed at group level, no individual consent was obtained.
The intervention in paper II and III was a model of care whose implementation in primary care had already been decided by the council of the region. The intervention was considered part of routine care and participants were not asked for their consent to take part in the study. The reason for this was that the intervention, which was based on international recommendations, was offered to participants independently of the research project and that they would only participate voluntarily. The researchers mainly observed the effects of the care model. The intervention was not perceived as potentially harmful or unpleasant. Data collected without consent (healthcare utilisation and costs) were not considered sensitive.
In the cost-effectiveness study (paper III), participants sent in an informed consent form along with the postal questionnaire to allow comparison of their responses with the healthcare utilisation data. If the intervention was effective and improved patients' quality of life, this treatment/care model was withheld from participants in control practises during the intervention. This fact needs to be weighed against the findings and evidence that the study can provide.
Ethical approval was not required for the study in paper IV as the interviews did not involve any personal or sensitive issues of the participants. Participants were informed about the study before they agreed to participate and were asked again in connection with the interviews.

RESULTS

Performance of the predictive model (paper I)

Twenty percent of the 40,728 older adults included in the analysis had an unplanned hospital admission during the 12-month observation period. In identifying variables for the model, 650 variables were tested, of which 233 showed a significant ($p < 0.001$) association with hospital admission in the training data set. The process of model building resulted in a model with 38 variables: age, sex, 4 healthcare utilisation variables and 32 diagnoses from both hospital care episodes and open-clinic visits.

The validation analysis yielded an AUC (area under the curve) for hospital admission over 12 months of 0.69 (95% confidence interval 0.68-0.70). The four most important variables alone (age, emergency-room visits, number of physician and non-physician visits) had an AUC of 0.67 (0.66-0.68). We examined collinearity, non-linearity and interaction between the variables and found no important effects that affected the performance of the model. The various sensitivity analyses also had no significant effect on the AUC value.

The proportion of the population classified as 'at risk of hospital admission' is important. From a clinical and practical perspective, the goal is to obtain a manageable number of at-risk individuals while still achieving acceptable sensitivity and specificity (Table 4).

Table 4. Falling proportions of predicted cases and corresponding cut-off values of risk score on the validation data set (n=20364)

Proportion predicted	Cut-off values (risk score)	No. of true positive cases	No. of false positive cases	No. of true negative cases	No. of false negative cases	Sensitivity	Specificity	Positive predictive value	Negative predictive value
90%	0.108	3869	14,416	1911	168	96%	12%	21%	92%
80%	0.120	3660	12,651	3676	377	91%	23%	22%	91%
70%	0.133	3447	10,801	5526	590	85%	34%	24%	90%
60%	0.148	3160	9016	7311	877	78%	45%	26%	89%
50%	0.165	2862	7303	9024	1175	71%	55%	28%	88%
40%	0.186	2501	5639	10,688	1536	62%	65%	31%	87%
30%	0.215	2050	4004	12323	1987	51%	75%	34%	86%
20%	0.258	1565	2486	13,841	2472	39%	85%	39%	85%
10%	0.349	904	1130	15,197	3133	22%	93%	44%	83%

Effects of the CGA intervention (paper II)

The characteristics of the 1304 participants are shown in Table 5. There were no significant differences between the two groups in terms of age, sex, risk score or number of previous hospital care days/episodes. Of the 646 participants in the intervention group, 475 (74%) participated in the intervention. The 171 older adults who did not participate in the CGA intervention had a significantly higher age and more previous hospital care days (Table 6).

Table 5: Baseline characteristics comparing intervention group (n=646) and controls (n=662) from 1 Jan 2018 until 31 Dec 2019

Measure	Intervention group	Control group	P value
Age, mean (SD)	83.0 (5.5)	83.3 (5.5)	0.39
Sex, number (%)			0.32
Men	325 (50%)	315 (48%)	
Women	321 (50%)	347 (52%)	
Risk score, mean (SD)	0.35 (0.18)	0.33 (0.17)	0.06
No. of previous hospital care days, mean (SD)			
Year 2017	6.4 (11.1)	5.4 (10.0)	0.10
Year 2016	8.4 (12.0)	7.9 (12.0)	0.48

Table 6: Baseline characteristics of the participants in the intervention group that were assessed or not.

Measure	Assessed n=475	Not assessed n= 171	P value
Age, mean (SD)	83.6 (5.2)	84,8 (6.0)	0.02
Sex, number (%)			
Men	234 (49.3)	91 (53.2)	
Women	241 (50.7)	80 (46.8)	
Risk score, mean (SD)	0.34 (0.17)	0.36 (0.20)	0.19
No. of previous hosp. care days, mean (SD)			
Year 2017	5.5 (10.1)	8.9 (13.1)	<0.001
Year 2016	7.2 (11.0)	11.5 (13.9)	<0.001

Primary outcome

The number of hospital care days was significantly lower in the intervention group than in the control group (8.5 days versus 10.3 days). The relative risk reduction was - 22% (Table 7).

The number of hospital care days over time is shown in Figure 5. The two groups show a similar and gradual increase in hospital days from 2011 to their peak in 2016, when they were identified by the predictive model. From 2017 onwards, hospital days gradually decrease in the intervention group, while the control group shows a stable need for hospital care.

Secondary outcomes

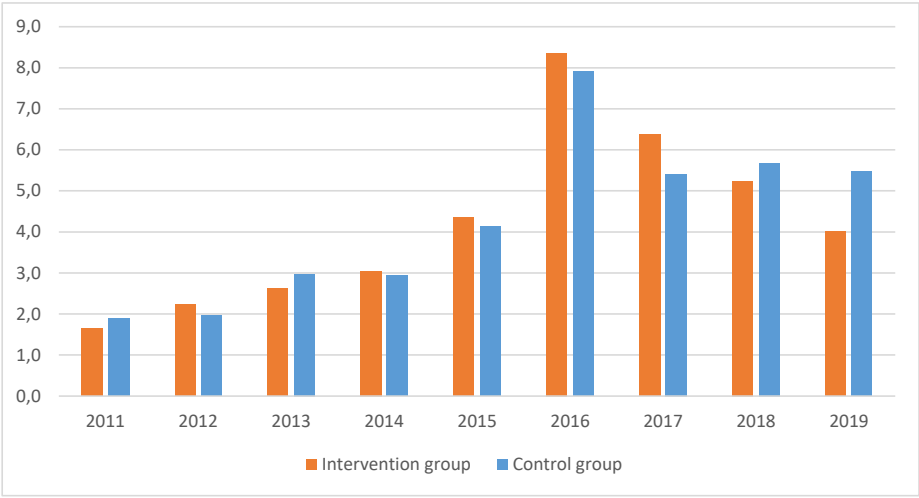
For hospital care episodes, the relative risk reduction in the intervention group was -17% (Table 7). Mortality did not differ between groups. The mean healthcare cost per person during the two years of follow-up was € 22,250 in the intervention group and € 25,245 in the control group. The adjusted mean difference was - € 4324 (Table 7). The main factor for the cost difference was lower hospital care costs.

Table 7: Results for primary and secondary outcomes of healthcare use comparing intervention group (n=646) and controls (n=662) from 1 Jan 2018 until 31 Dec 2019

Outcomes	Group	No. of events/ No. of participants	Event rates	Absolute risk-reduction	Relative risk-reduction (95% CI) *	P value
Total number of hospital care days	Intervention	5500/646	8.5	-1.8	-22% (-35% to -4%)	**0.02**
	Control	6833/662	10.3			
-No. of hospital care episodes	Intervention	922/646	1.4	-0.3	-17% (-30% to -2%)	**0.03**
	Control	1109/662	1.7			
Total Number of visits	Intervention	28,325/646	43.8	-0.7	-4% (-15 to 8%)	0.50
	Control	29,471/662	44.5			
-No. of primary care visits	Intervention	16,500/646	25.5	0.9	0% (-20% to 26%)	0.99
	Control	16,300/662	24.6			
-No. of emergency room visits	Intervention	1512/646	2.3	-0.3	-10% (-23% to 5%)	0.20
	Control	1718/662	2.6			
-No. of other outpatient care visits	Intervention	10,315/646	16.0	-1.3	-10% (-25% to 8%)	0.25
	Control	11,444/662	17.3			

Adjusted mean differences were analysed with mixed models using primary care practices as random intercept.
All models were adjusted for risk score, age, and sex. Significant results are marked with bold text.
* CI = Confidence interval

Figure 5: Mean number of hospital care days per year



Data comparing intervention group (n=646) and controls (n=662). Study years = year 2018-2019. Year 2017 was the run-in (introduction) period. In year 2016 patients were selected to the study with a risk algorithm that takes high healthcare consumption into consideration. The years 2011-2015 consist of data not included in the risk algorithm.

Cost-effectiveness of the intervention (paper III)

Participants

There were no significant differences between the control and intervention groups regarding baseline characteristics. This also includes data on educational level, housing type and cohabitation status from the study questionnaire. The comparison between this sub-sample and the participants in the original sample demonstrated that there were significantly more men in this analysis: 57% compared to 46% in the original sample. There were no significant differences in age or risk score.

Use of care and costs

Costs and resource use during the two years of follow-up are displayed in Table 8 and follow the pattern of the main sample; fewer hospitalisations and hospital care days, lower healthcare costs in the intervention group. Community costs did not differ significantly, but total costs were significantly lower in the intervention group.

Table 8. Costs per patient in Euro (€) during the follow-up period of the study

Type of cost	Control n = 184	Intervention n = 185		
	Mean € (SD)	Mean € (SD)	Adjusted mean difference (CI)*	P-value
Intervention costs	0 (0)	140 (0)	-140	n.a
Primary care costs	4471 (3679)	3901 (3104)	617 (-66 to 1301)	0.08
Secondary care costs	8166 (15,514)	6433 (10,571)	2260 (-152 to 4672)	0.07
Emergency room costs	1259 (1459)	1170 (1820)	120 (-205 to 445)	0.47
Hospitalization costs	12,744 (19,000)	9920 (15,266)	3134 (-225 to 6494)	0.07
Total healthcare costs	26,640 (30,656)	21,564 (21,104)	5991 (1135 to 10,848)	**0.02**
Nursing home costs	14,403 (43,300)	8067 (32,143)	6210 (-1389 to 13,809)	0.11
Home help service costs	8801 (37,298)	9711 (41,772)	-927 (-7273 to 5419)	0.77
Total community costs	23,204 (56,018)	17,778 (53,518)	5283 (-4227 to 14,793)	0.28
Total costs	49,844 (63,316)	39,342 (58,985)	11,275 (407 to 22,142)	**0.04**

*Unadjusted measures per group, but the differences between the groups were adjusted for age, sex, and risk score. 95% CI=Confidence intervals.
Note. Bold P-values are statistically significant (P<0.05)

Health-related quality of life and mortality

Health-related quality of life was stable over time in both groups and did not differ significantly between groups. Imputed values resulted in somewhat lower EQ-5D-index values than unimputed (Table 9). Mortality was 24.6% in the intervention group and 26.2% in the control group (mean difference 1.6%; 95% CI -0.1 to 4.1; P = 0.23).

Table 9. Health-related quality of life expressed as EQ-5D-index at baseline and during follow-up

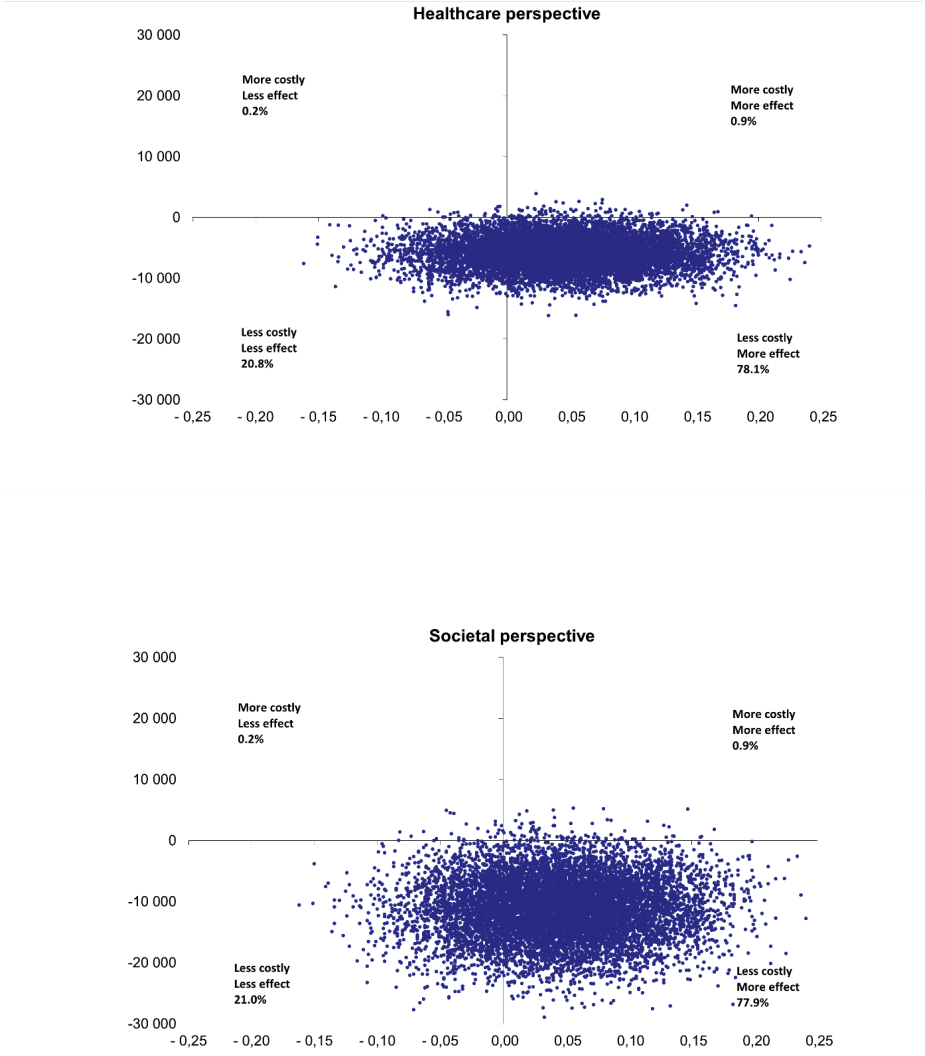
EQ-5D-index	Control n = 184	Intervention n = 185		
	Mean (SD)	Mean (SD)	Adjusted mean difference (95% CI) *	P-value
Baseline				
EQ-5D imputed, n= 369	0.56 (0.30)	0.58 (0.29)	-0.02 (-0.08 to 0.04)	0.44
EQ-5D without imputation, n= 345	0.55 (0.30)	0.58 (0.29)	-0.03 (-0.09 to 0.04)	0.41
Follow-up 1 (10 months)				
EQ-5D imputed, n=336	0.53 (0.45)	0.56 (0.34)	-0.03 (-0.11 to 0.06)	0.54
EQ-5D without imputation, n=236	0.57 (0.33)	0.59 (0.29)	-0.02 (-0.10 to 0.06)	0.65
Follow-up 2 (22 months)				
EQ-5D imputed, n = 276	0.53 (0.42)	0.56 (0.39)	-0.03 (-0.12 to 0.06)	0.56
EQ-5D without imputation, n = 180	0.58 (0.32)	0.60 (0.28)	0.02 (-0.08 to 0.09)	0.97

Cost-effectiveness analysis

The analysis demonstrated a non-significant difference in QALYs of 0.05, which is in favour of the intervention. In the healthcare perspective, total costs were € 5991 lower in the intervention group. In the societal perspective, the costs were € 11,275 lower. This means that the intervention was dominant in both perspectives (lower costs and more effect).

The uncertainty of the analysis is reflected in the cost-effectiveness planes (Figure 5). More than 77 % of the 10,000 observations in the bootstrap analysis were in the south-eastern quadrant, indicating lower costs and greater effect in both perspectives.

Figure 5. Cost-effectiveness planes



Two cost-effectiveness planes describing the incremental costs in Euro (y axis) and QALYs gained (x axis) from the analysis comparing the intervention with usual care in two perspectives. Bootstrapping with 10,000 iterations was used and incremental costs and QALYS were adjusted for age, sex, and risk score. The upper perspective includes healthcare costs and the lower includes community costs together with healthcare costs.

Staff experience of using PASTEL (paper IV)

In analysing the data from the three focus group interviews, four main categories and eleven subcategories were formed to describe the experiences with the assessments and team meetings (Table 10).

Table 10. Categories and subcategories

Category	Subcategory
A valuable tool for selected patients	• Structure gives the overview needed for action • Who is the right patient?
Creating conditions for dialogue	• Time and adaptation are important • Managing cognitive dysfunction • Participation of relatives can be helpful but sometimes unfavourable
Managing in-depth conversations	• Specific questions can create deep conversations • Talking about the future is valuable but not always appreciated • Death – a sensitive subject
The winding road of actions and teamwork	• Actions were often initiated during the interview • The team-meeting – a starting point for care planning • Challenges for the team

A valuable tool for selected patients

Participants considered PASTEL a tool that covered many important topics and was helpful in getting a holistic picture of an older person's health. The assessments were able to highlight important information that would not be brought up during a regular visit and were seen as good preparation for care planning. Opinions differed as to which patient would benefit most from a PASTEL-assessment. Some argued that the patient should be frail and have obvious health problems for the assessment to be valuable and time efficient. Others felt that most older patients could benefit, even those who were only prefrail or already known to the doctor or nurse.

Creating conditions for dialogue

Participants described how they changed the order of the topics, dealt with cognitive dysfunction, and included relatives in the conversations when they felt this could be helpful for the patient.

Managing deep conversations

Even though PASTEL contains several 'narrow' or multiple-choice questions, participants described deep conversations in which patients wanted to share their feelings and inner thoughts. Willingness to talk about the future or end of life varied widely among both staff and patients, but these conversations were seen as important and valuable when they occurred.

The winding road of actions and teamwork

Actions to support individual patients and strengthen their health were initiated at various points along the process of PASTEL-assessment, not just at team meetings. The assessment was seen as an action in itself and was a starting point for processes such as admission to home care. Several challenges were described: dealing with loneliness, motivating the older person to accept support, developing teamwork between doctor and nurses, and integrating physiotherapy and occupational therapy into the team.

DISCUSSION

Main findings

The thesis is based on a pragmatic, controlled intervention study comparing a proactive work model with usual primary care. The predictive model for hospital admission that selected participants for the intervention could be used in clinical practice. Interviews with staff in focus groups revealed that PASTEL was considered valuable and feasible in primary care.

The number of hospital care days was significantly lower in the intervention group and healthcare costs were reduced compared to the control group. The cost-effectiveness analysis indicated that the intervention had both more effect and lower costs.

Comparison with existing literature

As mentioned earlier, the results of previous CGA interventions in primary care are contradictory. The reduction in hospital care days from this intervention is comparable to certain previous interventions, both non-randomised (99) and randomised (77, 100). However, these interventions in the USA and Sweden differ in terms of setting, type of intervention and years since intervention which makes comparisons difficult.

Other interventions in the Netherlands and the United Kingdom have failed to demonstrate a reduction in hospitalisations (101-104). The authors suggest that this may be due to difficulties in targeting older adults who were frail enough or to follow-up periods that were too short. A summary of four ambitious interventions in the Netherlands also discusses whether usual primary care is 'too' effective to allow improvement through CGA interventions (105). In our case, we had a large sample, with a high initial incidence of hospitalisation that we were able to follow for 24 months with few missing data on the primary outcome. These characteristics could be an explanation for the positive effect.

Our intervention also had a better cost-effectiveness than three other comparable but more intensive interventions (106-108), mainly because of lower intervention and hospitalisation costs. Another three-arm study compared usual care with A: a nurse-led CGA intervention and B: repeated reports to GP from an electronic frailty screening. The results showed that

both intervention arms were cost-effective (109), suggesting that less intensive interventions may be an appropriate option.

Methodological considerations

Study design

The aim was to explore a rather simple working model that has the potential to be implemented directly in primary care and to be experienced as relevant and feasible in daily practice. We decided to adapt our CGA intervention to primary care by focusing on a small doctor-nurse team in which the nurse delivered the CGA. The working model required no more than 3 to 5 hours of introduction and was delivered by the ordinary staff of the practice. A more intensive intervention with more staff and regular follow-up for all participants would be more difficult to implement in a limited primary care context.

Therefore, a pragmatic study design was chosen. Participating staff had freedom to adapt the model to local circumstances, but at the same time the different components had to be sufficiently distinct to allow the study to be replicated. The intention with the pragmatic design was to capture the real-world effects of the intervention. Informed consent was not required from the participants, which most likely resulted in a representative and unselected sample for the intervention.

The study design also meant that we did not approach participants to collect medical data, which may have increased the likelihood that we could better capture the true effect of this intervention. Some of the intervention studies that did not demonstrate positive effects may have masked the effect by intervening more with control group participants.

An important weakness of the present study is the lack of cluster randomisation. It cannot be ruled out that there were differences between practices, for example in terms of commitment to caring for older adults. There may have been a bias in the selection of participating practices. However, the data on hospital days up to six years before the start of the intervention (Figure 5) showed no differences between participants in the two groups. We accounted for the possible differences between practices by using mixed model design in the analysis with the practice as a random intercept. An alternative design would have been to randomly assign individual participants to intervention or control. This would mean that staff from the same practice would use different working models and there would be an obvious risk of contamination between models. Recruitment of participants would also be more complicated with a risk of biased selection of

motivated participants. Finally, as randomisation was not feasible, the only options were matching practices instead of randomising or not perform a study at all.

The study does not include data on actions or referrals, which means that we cannot demonstrate how care in intervention practices differed from usual care with the exception of the PASTEL assessment. It is important to recognise that a study design that explores this would require medical records that are more standardised for research purposes, or a detailed study protocol that includes usual care practises. The latter would imply a lower degree of pragmatism and a result that is unlikely to reflect everyday care. In addition, a much larger sample is needed to allow for multiple comparisons, e.g. on referral rates or other measures.

Outcomes

The design allowed us to follow the effect over 24 months as outcomes were readily available through databases (health service utilisation and costs). These outcomes could be measured accurately, without risk of bias and with few missing data.

In contrast, outcomes in the cost-effectiveness analysis were based on self-report with a considerable amount of missing data. Multiple imputation allowed us to deal with missing data, but better reporting in administrative community registers would improve accuracy. This is important as community costs account for a large proportion of the total cost of care; around 45% in our analysis.

We measured health-related quality of life using EQ-5D, which is the standard instrument and allows comparison of cost-effectiveness between interventions. However, this instrument does not cover the social and existential aspects of health. Other instruments have been proposed to better capture the health of older adults (110, 111) but further research is needed before a new standard can be formed (21).

The effect of a complex intervention like this is likely to take time to determine. The trend in hospital care days over time, shown in Figure 2, suggests that the effect of the intervention was greater in the second year than in the first. However, longer follow-up periods than 2 years are difficult to interpret because of high mortality and other causes of dropout. At the same time, they could provide important information about both the course of frailty and the long-term effects of the care model. This is especially true for less frail patients, who are likely to require longer follow-up periods before a meaningful effect can be detected.

Choosing a primary outcome that is relevant to both staff and participants is an important feature of the pragmatic design. Hospitalisation implies a higher risk of institutionalisation and reduced autonomy. Maintaining autonomy and the ability to remain in one's own home is expressed as a very important goal by frail older adults (28, 30, 31).

Study sample/predictive model

The predictive model selected a sample that had a high mortality rate and a high initial rate of hospitalisation compared to many other studies (77, 100-102, 112). This fact suggests that the model managed to target vulnerable older adults. In addition, both the postal survey data and the health administrative data indicate that the two groups had similar characteristics.

The purpose of identifying vulnerable individuals is to reverse or slow the progression of frailty, reduce the risk of hospitalisation or institutionalisation, and improve functional ability and thereby quality of life (64). As the follow-up period was limited to two years, we needed to identify older adults who were sufficiently frail or at risk of frailty for the intervention to have an impact. At the same time, the population should not be too frail so that the primary care service is able to act in time. Even though the intervention was quite simple, problems with implementation and prioritisation in the practices led to an extension of the run-in period from 3 to 9 months. Analysis of dropouts from of the run-in period (Table 6) demonstrated that some of the most vulnerable individuals were not included in the intervention. To include them, extended primary care would be needed that is more mobile and can assess patients at home, bridging the gap between hospitalisation and open-clinic visits.

In developing the predictive model to select the population for the intervention, we chose a more definite outcome than frailty. As there is no consensus on the definition of frailty and it is difficult to define where on the spectrum of frailty someone becomes prefrail or frail, frailty is unsuitable for prediction. Hospitalisations are easy to identify and define and facilitate the validation of the model. This also enables comparisons with other prediction models.

At present, it is not clear how well this risk score fits with other measures of frailty, but the mortality, hospitalisation rates and comorbidity index of our participants (56% had three or more comorbidities; paper II) suggest that there is considerable overlap. Patterns of healthcare utilisation are strongly correlated with frailty and multimorbidity (61, 62).

A strength of our model is that we were able to include all residents in the region and obtain data on all healthcare visits, which increases reliability.

On the other hand, we cannot be sure that our model is generalisable outside the region or in any other primary care system, as the availability of data and the coding of events and diagnoses vary both between and within countries. Preliminary and unpublished analyses from a neighbouring region showed comparable AUC values, suggesting generalisability in Sweden. Future studies will be needed to confirm this and to investigate whether performance can be further improved and whether the feasibility of the model in daily practise is good enough for wider adoption.

With any modelling there is a risk of overfitting, which we have reduced through various techniques such as splitting the data into two sets, limiting the number of variables and sensitivity analyses. The results are in good agreement with two different American studies (113, 114). These papers conclude that information from administrative data has several advantages over data from questionnaires in terms of response rate, missing data, and data quality. The major advantage of using administrative data is that it is readily available and allows for regular updating of information as both the risk of hospitalisation and a person's frailty change over time (115).

The set of variables in the models differs to some extent from the predictive models in published papers (56, 113, 114, 116). In our model, we did not use any preunderstanding to select the variables in advance but left it to the computer to select them based on their correlation with hospital admission. A weakness is that we did not have data on socioeconomic and functional status or medication in our model. Low socioeconomic status is a known factor that increases frailty and predicts both death, hospitalisation, and institutionalisation (47). However, a striking fact from paper I is that age and healthcare utilisation alone predicted hospitalisation almost as well as the full model. This implies that diagnoses (and other important variables) are already built into the healthcare utilisation information and do not add very much to the model. Limiting the variables in the model would probably make it more generalisable.

The PASTEL assessment tool

One of the main features of the intervention was PASTEL, which was developed for the study. The main reason for developing a new instrument was to get one that was comprehensive but did not contain too many items and scales that could hinder dialogue with the patient and capture of the most important issues for the individual (117, 118). An alternative strategy, facilitating comparison with other interventions, would have been to select an existing instrument and validate it in the Swedish primary care context.

Comprehensive geriatric assessment is a construct for which there is no strict definition (70). As a result, there is no golden standard against which a new instrument could be validated. The experiences of primary care staff in focus group interviews are a first step in a validation process that needs to be continued in future studies.

Even if the predictive model selected people at high risk of hospital admission for assessment, PASTEL was sometimes felt to be too extensive and time-consuming. This should be kept in mind when discussing the optimal CGA tool for primary care. Methods for identifying vulnerable older adults are likely to become more accurate in the future, but healthcare professionals will still face a wide range of severity levels when assessing frailty in primary care, so tools need to be flexible. The focus group study found that nurses could adapt PASTEL and the different items to the individual and expand or reduce the assessment as needed. Adaptation could be an important feature of effective and person-centred assessment.

In the focus group study, I was one of the moderators of the interviews and was known to the participants as I led the implementation of PASTEL in the practices. This may have prevented participants from raising negative issues in the interviews, but at the same time it may have motivated participants and facilitated the conversation. However, as I was also involved in designing PASTEL, it certainly influenced my interpretation of the data and affected the reliability and trustworthiness of the analysis. To reduce bias, my co-author and I did the coding and grouping of the codes independently and brought in a third person without connection to the intervention for triangulation. We also conducted a manifest content analysis, which means that the analysis is close to the transcribed text.

A limitation of the study is the small number of participants, but we managed to get a representative sample from eight out of nine intervention practices. We believe that the results are generalisable in Swedish primary care and similar primary care contexts. However, the analysis should be repeated by an independent research group and in a different primary care context to increase trustworthiness and transferability.

Implications for research and practise

Developing the management of frailty and multimorbidity is an important task to improve the quality of life of vulnerable older adults and to maintain the stability of the health system. Awareness of this issue is growing among healthcare managers and policy makers, which means that a variety of different care models are already being implemented, often without organised evaluation. This can lead to the adoption of interventions that are not cost-effective or, at worst, harmful to patients, and to resources being diverted from patient groups that really need them.

The results of this intervention study contribute to the current state of knowledge but are not sufficient to conclude that this model of care is effective in other settings or should be widely implemented. To move forward, the development of research methods that can examine effectiveness in daily practice should continue. Pragmatic studies are a feasible option, but to investigate all aspects of this topic, it is necessary to use a variety of methods, both quantitative and qualitative.

Primary care is well suited for further research on this topic, as it is the first line of care for the population and can ensure continuity and coordination of care.

The most important strategy for improving comparability of studies is to establish standard outcome measures. These outcome measures should be as simple as possible to collect and as clearly defined as possible. Including frail older people in this process is one way to identify the outcomes that really matter to patients. Further research is also needed on their experience of interventions.

The use of predictive models to assess risk for both intervention studies and clinical practise increases the opportunity to work proactively. However, it is a new way of working in primary care and therefore implementation studies are important.

Our analysis suggests that a limited intervention for a targeted group of older adults is cost-effective. This may be an appropriate first step to implement as there was no indication of negative effects on quality of life or increased costs in primary care. Even if a new intervention is effective, it is important to consider that other patient groups may suffer from the diversion of resources.

Finally, this intervention contributes to the knowledge needed to shift resources and tasks from hospital care to primary care.

CONCLUSIONS

General conclusion

A proactive working model in primary care for vulnerable older adults can reduce the need for hospital care, compared with usual care. Predicting risk of hospital admission, holistic assessment and individually tailored care are important features of the working model.

Specific conclusions

I. Routine healthcare data can be used to predict hospital admission in older adults over the next 12 months with sufficient accuracy.

II. CGA adapted to primary care can significantly reduce hospital care days in older adults at high risk of hospital admission, compared with usual care.

III. The proactive CGA intervention, studied in this thesis, was cost-effective compared with usual primary care.

IV. PASTEL, a CGA tool, was found to be valuable for both health status assessment of older adults and subsequent care planning, and was considered feasible by primary care professionals.

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PAPER I

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RESEARCH ARTICLE Open Access

Clinically useful prediction of hospital admissions in an older population

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Abstract

Background: The healthcare for older adults is insufficient in many countries, not designed to meet their needs and is often described as disorganized and reactive. Prediction of older persons at risk of admission to hospital may be one important way for the future healthcare system to act proactively when meeting increasing needs for care. Therefore, we wanted to develop and test a clinically useful model for predicting hospital admissions of older persons based on routine healthcare data.

Methods: We used the healthcare data on 40,728 persons, 75–109 years of age to predict hospital in-ward care in a prospective cohort. Multivariable logistic regression was used to identify significant factors predictive of unplanned hospital admission. Model fitting was accomplished using forward selection. The accuracy of the prediction model was expressed as area under the receiver operating characteristic (ROC) curve, AUC.

Results: The prediction model consisting of 38 variables exhibited a good discriminative accuracy for unplanned hospital admissions over the following 12 months (AUC 0.69 [95% confidence interval, CI 0.68–0.70]) and was validated on external datasets. Clinically relevant proportions of predicted cases of 40 or 45% resulted in sensitivities of 62 and 66%, respectively. The corresponding positive predicted values (PPV) was 31 and 29%, respectively.

Conclusion: A prediction model based on routine administrative healthcare data from older persons can be used to find patients at risk of admission to hospital. Identifying the risk population can enable proactive intervention for older patients with as-yet unknown needs for healthcare.

Keywords: Prediction, Hospitalization, Older persons

Background

With an increase in the aging population worldwide, older age is generally associated with increased health-related needs and increased healthcare costs – but not by as much as previously expected [1]. Nevertheless, the association with both healthcare utilization and costs varies [2, 3] and in some high-income countries healthcare costs per person actually fall significantly after the age of 75 [4, 5]. Differences in provider systems, in the management of frail older people and in cultural norms, particularly near the time of death, may contribute to the fact that the association between age and healthcare costs is also strongly influenced by the healthcare system itself [1].

Even though the future challenges for the healthcare system due to an aging population might have been exaggerated, the present healthcare situation for the elderly population in many countries is insufficient and not designed according to their healthcare needs [6]. The healthcare of the aging population relates to morbidity, multimorbidity and frailty [7]. But, at the same time, several reports indicate that a majority of the aged population is satisfied with their health (see [8]), manage life at home and consider themselves to be healthy [9, 10]. Only a minority of the aged population needs hospital care. In most cases, the healthcare system does not separate the heterogeneous old-age population, but rather organizes both hospital and primary care using a passive and reactive (acting when symptoms or problems occur) approach.

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In order to detect elderly people with significant care needs (hospital care), there have been many attempts to define "frail" older people [11–13]. In this context, however, scales used for the prediction of persons in need of healthcare, some of which are frail, exhibit some major shortcomings. Firstly, "frailty" is not an easily defined medical condition for which there is a consensus on its operational definition [13–16]. Secondly, and from a clinical perspective more importantly, evaluation using clinical instruments requires trained staff for each individual evaluation and is not always easily applied within a broader clinical context where a primary geriatric perspective may not always be present (primary care, acute ward disciplines). A final limitation of the use of "frailty" scales in a wider clinical context is the fact that most elderly people (75% of 80+) seem to manage themselves at home, despite multi-morbidity and frailty. This was indicated in two separate studies on 85-year-olds (England, Sweden), concluding similar pictures of health and aging [9, 10]. A majority (> 75%) of the studied 85-year-olds managed their lives at home, rated themselves as healthy (80% rated their health good to excellent) and seldom used hospital care. Only $\frac{1}{4}-\frac{1}{3}$ of the aged population appeared to be high consumers of healthcare. These facts underline the difficulty of managing healthcare in an aged community. Our ability to detect individuals with possible needs, and to direct the care resources specifically towards those with greatest need of care prior to hospitalization, is not optimal.

Statistical or digital prediction models have been suggested as an evidence-based method to identify or select older persons in greater need of healthcare [17]. Earlier studies indicated that administrative data are useful in the prediction of hospital care [18], also for older adults in a group health cooperative [19]. More recently the use of a use of electronic administrative data to identify older community dwelling adults at high risk for hospitalization demonstrated good accuracy (AUC 0.678) [20]. In the present study we wanted to investigate a larger county population not limited to health insurance systems or other selection factors, to see whether we could develop a digital prediction model for older adults at high risk for hospital care that can be used in routine healthcare. If this group of elderly could be identified, proactive healthcare activities can be considered before hospital care takes place [21]. And some persons in need of hospital care could be directed to an appropriate clinic for care, instead of using the emergency care system.

Methods

This prediction model study is reported in accordance with the TRIPOD checklist [22].

Aim, design, setting and population

The aim was to develop and test a clinically useful model for predicting hospital admissions of older persons based on routine healthcare data. This is a prospective cohort study that included all residents aged 75–109 years in the county of Östergötland ($n = 40{,}728$) located in the south-east of Sweden. This age group constitutes 9.6% of the population, close to the national proportion of 9.2%. In the county of Östergötland, healthcare for the elderly is provided mainly by 43 healthcare centres in primary care and four hospitals, one of which is the University Hospital of Linköping.

Data source and study variables

The 12-month data were obtained between November 2015 and October 2016 from the computerized information system of the County Council of Östergötland, where statistics for all healthcare in the county are stored. For example, for the whole population there are records of the number of visits to primary or hospital care, number of days in hospital, diagnostic codes for each visit etc. We used unplanned in-ward hospital stays between November 2016 and October 2017 as the dependent variable. Several time periods were tested and the predicted cases were included in a intervention study [21]. We included number of physician visits, number of non-physician visits (to nurses, occupational therapists or physiotherapists), number of previous in-ward hospital stays, number of emergency room (ER) visits, age, gender and International Classification of Diseases, and 10th Revision, (ICD10)-codes grouped by two digits. For each diagnosis, two variables were constructed, one based on open-clinic visits and one based on hospital visits. To get good precision in the estimation of the coefficients and to get a reliable model over time, variables with number of observations less than 40 were excluded. All diagnosis variables were dichotomized into yes or no. People who died during the following prediction period were included in the analysis.

Model developing

The data was randomly divided into two halves, a training data set and a validation data set. The training set was used to build a prediction model and the validation set was used to validate this model. The prediction model algorithm was developed using multivariable logistic regression (LR) with forward selection) (see statistics below). The aim was to identify participants aged 75 or older who are likely to be hospitalized within the next 12 months.

Statistical analysis and external validation

The first step was to calculate the univariable association for each variable with 12-months unplanned hospital

admission. Because of large number of observations that could result in statistical significance for rather weak associations, only variables with p-values less than 0.001 was further included in the multivariable analysis.

Multivariable logistic regression was then used to identify significant factors predictive of unplanned hospital admission over a 12-month period. The model-building process consisted of three steps: selecting the variables, building the model, and validating the model. The best model was assessed by change in Akaike information criterion. A penalty factor of five was used to avoid overfitting and to reduce the number of variables in the final model. Collinearity was observed by calculating variance inflation factor for each variable in the final model and variables with a value above five were excluded. After the final model was made some further test was done in an attempt to further improve the model. First, we tested all 2-way interactions. Further, we tested to log-transform all numerical variables. Finally, we tested non-linearity for numerical variables by using restricted cubic splines. If an improvement in AUC was not achieved, the simplest model was chosen because we wanted a robust model that was easy to implement. Risk scores were calculated for all individuals.

Model performance measures: Overall discrimination was assessed using c-statistic, a measure of goodness of fit for binary outcomes in a logistic regression model. The area under the receiver operating characteristic (ROC) curve (AUC) is used to quantify the binary outcomes (hospital admission or not). The ROC curve is continually plotting every ideally possible sensitivity versus specificity across all threshold cut-off points. AUC reflects the accuracy of the predictive models and can be compared among the different models. AUC 0.5 means the model has no discrimination (the proportions of true cases and false positive cases are equal) whereas AUC 1.0 means the model has a perfect discrimination [23]. Five different sensitivity analyses were performed to assess how the prediction model changed in different settings. The first model included both unplanned and planned hospital admissions, the second model excluded people who died within the 12-month follow-up period and in the last two models, different follow-up periods 3-, and 6 months was tested. Lastly, we tested the least absolute shrinkage and selection operator (lasso) as an alternative selection method.

External validation was also performed in two additional data sets. One using the same time period as above but including ages 65–74 ($n = 51{,}104$). And another using the age group 75+ for year 2012 for prediction of unplanned hospital admission the following 12 months ($n = 38{,}121$).

All statistics were performed using R version 3.5.2 (R Core Team, Vienna, Austria). The Modern Applied Statistics with S (MASS) package was used for fitting the logistic model and the pROC package was used for estimating the AUC. The Lasso and Elastic-Net Regularized Generalized Linear Models (glmnet) package was used for fitting the lasso model. The Regression Modeling Strategies (rms) package was used for analysing with restricted cubic splines.

Ethical aspects

The study has been subject to ethical evaluation and was approved by the regional ethical review board in Linköping (Dnr 2016/347–31).

Results

In total, 40,728 individuals aged 75 years or older (57.7% women) were registered in the database. The demographic characteristics of these and their use of unplanned hospital care within 12-month subsequent period is given in Table 1. Even though the number of cases admitted to hospital (unplanned) decreased across the ages of 75 to 90+, the relative proportions of those in hospital increased (from 15 to 28%). Thus, it is more likely that a person 90+ years of age is admitted to hospital than a person aged 75–79.

In total, 650 variables were available for analysis where 233 showed a statistically significant ($p < 0.001$) association with 12-month unplanned hospital admission in the training data set. Table 2 presents the 20 most significant variables from the univariable analyses. The results from the multivariable final predictive model are presented in Table 3. The AUC of hospital admission over the subsequent 12 months was 0.69 (95% CI: 0.68–0.70) in the validation data set (Fig. 1). The best prediction variables were number of emergency-room visits, age, number of non-physician visits and number of physician visits, which alone resulted in an AUC of 0.67 (95% CI: 0.66–0.68). No collinearity problem existed as the highest variance inflation factor was 2.1 for number of emergency room visits. We found statistically significant interactions between number

Table 1 Characteristics of the population ≥ 75–109 years in relation to unplanned hospital admissions

Characteristic	Unplanned admission to hospital, n (%)		
	Train $n = 20{,}364$	Validation $n = 20{,}364$	Total $n = 40{,}728$
Total, *n* (%)	4130 (20.3)	4037 (19.8)	8167 (20.0)
Gender			
Male	1838 (9.0)	1834 (9.0)	3672 (9.0)
Female	2292 (11.3)	2203 (10.8)	4495 (11.0)
Age, years			
75–79	1328 (6.5)	1249 (6.1)	2577 (6.3)
80–84	1193 (5.9)	1119 (5.5)	2312 (5.7)
85–89	954 (4.7)	1014 (5.0)	1968 (4.8)
90+	655 (3.2)	655 (3.2)	1310 (3.2)

Table 2 The twenty most significant variables predicting the risk for unplanned admission to hospital

		Number	% unplanned hospital admission	Crude OR	95% CI
Total		20,364	20.3	–	–
Categorical Variables					
Diagnoses in hospital care					
E11 Type 2 diabetes mellitus	No	19,718	19.5	1 (ref)	–
	Yes	646	43.3	3.15	(2.69–3.70)
I10 Essential hypertension	No	18,174	18.3	1 (ref)	–
	Yes	2190	36.5	2.57	(2.33–2.82)
I25 Chronic ischaemic heart disease	No	19,663	19.5	1 (ref)	–
	Yes	701	42.9	3.11	(2.67–3.63)
I48 Atrial fibrillation and flutter	No	19,235	19.0	1 (ref)	–
	Yes	1129	42.2	3.12	(2.76–3.53)
I50 Heart failure	No	19,712	19.4	1 (ref)	–
	Yes	652	47.5	3.77	(3.22–4.41)
J44 Chronic obstructive pulmonary disease	No	20,046	19.8	1 (ref)	–
	Yes	318	47.8	3.70	(2.96–4.62)
N18 Chronic renal failure	No	20,179	20.0	1 (ref)	–
	Yes	185	53.0	4.51	(3.37–6.04)
Z92 Personal history of medical treatment	No	19,596	19.3	1 (ref)	–
	Yes	768	44.9	3.41	(2.94–3.94)
Z95 Presence of cardiac and vascular implants and grafts	No	19,741	19.6	1 (ref)	–
	Yes	623	42.2	3.00	(2.55–3.53)
Diagnoses in open-clinic visits					
I25 Chronic ischaemic heart disease	No	18,294	19.2	1 (ref)	–
	Yes	2070	30.0	1.80	(1.63–1.99)
I48 Atrial fibrillation and flutter	No	17,808	18.5	1 (ref)	–
	Yes	2556	32.4	2.11	(1.92–2.31)
I50 Heart failure	No	18,936	18.9	1 (ref)	–
	Yes	1428	38.9	2.73	(2.44–3.06)
R06 Abnormalities of breathing	No	19,445	19.5	1 (ref)	–
	Yes	919	35.8	2.30	(1.99–2.64)
R07 Pain in throat and chest	No	19,504	19.6	1 (ref)	–
	Yes	860	36.3	2.34	(2.02–2.70)
Z51 Other medical care	No	19,431	19.5	1 (ref)	–
	Yes	933	37.3	2.46	(2.14–2.82)
Continuous Variables[a, b]					
Age		81	(75–106)	1.05	(1.04–1.05)
Emergency room (ER) visits		0	(0–25)	1.52	(1.47–1.57)
Non-physician visits		4	(0–210)	1.02	(1.02–1.03)
Physician visits		3	(0–100)	1.08	(1.07–1.09)
Previous in-ward hospital stays		0	(0–16)	1.56	(1.50–1.62)

[a]Medians were reported as appropriate for continuous variables. [b]Range was reported as appropriate for continuous variables. *OR* Odds Ratio, *CI* Confidence interval. Hospital admissions within 12 months from the training sample ($n = 20,364$) expressed as crude odds ratios and 95% confidence intervals (CI) from univariable analysis. Variables are sorted by name and all p-values < 0.001

Table 3 The final predictive model from the multivariable logistic regression together with odds ratios (OR) and 95% confidence intervals (CI)

Variable	Beta Coefficient	OR[a]	95% CI	*p*-value
Intercept	−5.697	–	–	
Categorical Variables				
Male gender	−0.123	0.88	(0.82–0.95)	0.001
Diagnoses in hospital care				
C78 Secondary malignant neoplasm of respiratory and digestive organs	1.009	2.74	(1.39–5.49)	0.004
E11 Type 2 diabetes mellitus	0.317	1.37	(1.13–1.66)	0.001
G40 Epilepsy	0.840	2.32	(1.36–3.95)	0.002
Z93 Artificial opening status	0.791	2.20	(1.22–4.01)	0.009
Diagnoses in open-clinic visits				
A09 Other gastroenteritis and colitis of infectious and unspecified origin	0.559	1.75	(1.09–2.75)	0.02
C79 Secondary malignant neoplasm of other and unspecified sites	0.824	2.28	(1.51–3.41)	< 0.001
C83 Non-follicular lymphoma	0.986	2.68	(1.33–5.37)	0.005
D50 Iron deficiency anemia	0.335	1.40	(1.08–1.80)	0.01
E14 Unspecified diabetes mellitus	0.160	1.17	(1.03–1.34)	0.02
F10 Mental and behavioural disorder due to use of alcohol	0.917	2.50	(1.52–4.09)	< 0.001
G20 Parkinson's diseasae	0.548	1.73	(1.25–2.38)	< 0.001
I20 Angina pectoris	0.221	1.25	(1.04–1.49)	0.01
I25 Chronic ischaemic heart disease	0.128	1.14	(1.01–1.27)	0.03
I48 Atrial fibrillation and flutter	0.183	1.20	(1.08–1.34)	< 0.001
I50 Heart failure	0.276	1.32	(1.15–1.51)	< 0.001
I73 Other peripheral vascular disease	0.366	1.44	(1.08–1.90)	0.01
J44 Chronic obstructive pulmonary disease	0.520	1.68	(1.44–1.97)	< 0.001
J84 Other interstitial pulmonary disease	0.642	1.90	(1.11–3.20)	0.02
K50 Crohn disease	1.013	2.75	(1.41–5.29)	0.003
K56 Paralytic ileus and intestinal obstruction without hernia	0.727	2.07	(1.13–3.77)	0.02
M05 Rheumatoid arthritis	0.501	1.65	(1.17–2.31)	0.004
N08 Glomerular disorders	1.176	3.24	(1.26–8.51)	0.01
N18 Chronic kidney disease	0.422	1.53	(1.20–1.93)	< 0.001
R07 Pain in throat and chest	0.213	1.24	(1.05–1.46)	0.01
R10 Abdominal and pelvic pain	0.234	1.26	(1.07–1.48)	0.005
R41 Symptoms and signs involving cognitive function	0.359	1.43	(1.14–1.79)	0.002
R42 Dizziness and giddiness	0.245	1.28	(1.10–1.49)	0.002
R55 Syncope and collapse	0.384	1.47	(1.11–1.93)	0.006
R60 Oedema	0.376	1.46	(1.22–1.73)	< 0.001
S00 Superficial injury of head	0.476	1.61	(1.19–2.18)	0.002
S30 Superficial injury of abdomen, lower back and pelvis	0.709	2.03	(1.17–3.53)	0.01
X50 Overexertion and strenuous or repetitive movements	0.780	2.18	(1.16–4.04)	0.01
Continuous Variables				
Age	0.047	1.05	(1.04–1.05)	< 0.001
Non-physician visits	0.009	1.01	(1.01–1.01)	< 0.001
Physician visits	0.019	1.02	(1.01–1.03)	< 0.001
Previous in-ward hospital stays	0.099	1.10	(1.05–1.16)	< 0.001
Emergency room (ER) visits	0.123	1.13	(1.08–1.18)	< 0.001

OR Odds Ratio, *CI* Confidence interval
Based on a training sample (n = 20,364)

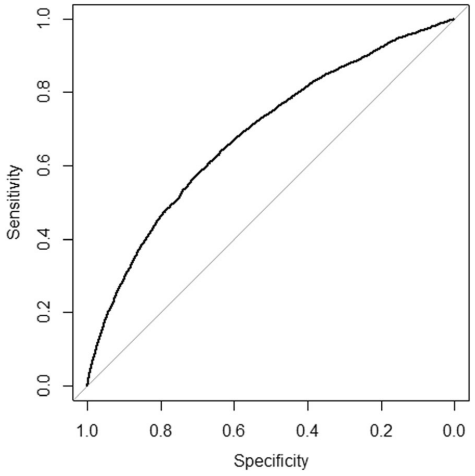

Fig. 1 The ROC curve for predicting unplanned hospitalization derived from logistic regression using the validation data set ($n = 20,364$). Area under ROC curve (AUC) = 0.69, (95% CI 0.68–0.70)

of emergency room visits and number of physician visits, between number of emergency room visits and previous in-patient care and between number of emergency room visits and number of non-physician visits. However, the effects were very small and we could not improve the AUC in the final model. Neither could log-transformation of the numerical variables improve AUC. We found evidence of non-linearity for age and number of emergency room visits, but the non-linearity components were quite small and we could not improve the AUC. Because AUC was not improved, we decided to select the final model without further alterations.

Outcome using different proportions of predicted cases and different time periods

The outcome of the case-finding model varies depending on the risk score used, with low-risk scores (cut-off value) including a large sample and high-risk scores resulting in a more targeted sample. The choice of risk score level is important in clinical practice since it will affect the proportion of predicted cases (Table 4). It is apparent that an increase in the cut-off value rapidly decreases the number of predicted cases and results in a corresponding loss of sensitivity. An important perspective from a clinical point of view is to decide on a manageable proportion of the predicted population that still enables a clinically meaningful sensitivity. As shown in Table 4, predicted proportions of 40 or 45% result in sensitivities of 62 and 66%, respectively. Using a 40% predicted population, we then investigated how different outcome periods would affect the quality of the predictions.

Sensitivity analysis

The main prediction model was based on unplanned hospital admissions ($n = 8167$), but a model including both planned and unplanned hospital admission ($n = 9354$) resulted in an AUC of 0.68 (95% CI: 0.67–0.69). The variables in the two models were almost identical and 85% of the variables in the planned/unplanned model was included in the unplanned model. Also, a model based on unplanned hospital admission excluding 2166 people who died within the 12 months follow up period was created resulted in an AUC of 0.67 (95% CI: 0.66–0.68). Excluding people resulted in a lower AUC but the model was similar to the main prediction model and 80% of the variables was present in the main prediction model. Two different time intervals were created based on unplanned hospital admission, where 3- ($n = 2503$) and 6-month ($n = 4664$) follow-up models resulted in AUC of 0.70 (95% CI: 0.68–0.71), and 0.69 (95% CI: 0.68–0.70), respectively. Using the lasso method did not improve the AUC (0.69 (95% CI: 0.68–0.70)) compared with the stepwise procedure method.

External validation

The main prediction model was also tested on two external samples for unplanned hospital admission over the 12 following months. Using the same time period as above for data collection (2015/2016), but for the age group 65–74 ($n = 51,104$) the AUC was 0.68 (95% CI: 0.67–0.69). Using the age group 75 years and older, but for another time point (2012) ($n = 38,121$), the AUC was also 0.68 (95% CI: 0.67–0.69).

Discussion

We used administrative routine healthcare data in order to develop a prediction model for unplanned admissions of older persons to hospital. Emergency-room visits, age, number of non-physician visits and number of physician visits were the most important variables for the model. The addition of the other 33 variables only slightly increased the AUC. The different sensitivity analyses showed similar AUC. The absence of larger impact by different medical diagnoses on the accuracy of the model, can be explained by the fact that the use of the healthcare system is the ultimate consequence of all diagnoses.

Strengths and limitations

The main strength of this study in comparison to earlier smaller and more selected studies is the large population including all inhabitants 75 years or older in a county without selection factors like insurance system or

Table 4 Falling proportions of predicted cases and corresponding cut-off values on a validation data set ($n = 20,364$)

Proportion predicted	Cut-off values	No. of true positive cases	No. of false positive cases	No. of true negative cases	No. of false negative cases	Sensitivity	Specificity	Positive predictive value	Negative predicted value
95%	0.101	3960	15,438	889	77	98%	5%	20%	92%
90%	0.108	3869	14,416	1911	168	96%	12%	21%	92%
85%	0.114	3780	13,485	2842	257	94%	17%	22%	92%
80%	0.120	3660	12,651	3676	377	91%	23%	22%	91%
75%	0.127	3544	11,659	4668	493	88%	29%	23%	90%
70%	0.133	3447	10,801	5526	590	85%	34%	24%	90%
65%	0.140	3322	9900	6427	715	82%	39%	25%	90%
60%	0.148	3160	9016	7311	877	78%	45%	26%	89%
55%	0.157	3001	8099	8228	1036	74%	50%	27%	89%
50%	0.165	2862	7303	9024	1175	71%	55%	28%	88%
45%	0.175	2682	6446	9881	1355	66%	61%	29%	88%
40%	0.186	2501	5639	10,688	1536	62%	65%	31%	87%
35%	0.199	2310	4813	11,514	1727	57%	71%	32%	87%
30%	0.215	2050	4004	12,323	1987	51%	75%	34%	86%
25%	0.234	1841	3213	13,114	2196	46%	80%	36%	86%
20%	0.258	1565	2486	13,841	2472	39%	85%	39%	85%
15%	0.294	1257	1775	14,552	2780	31%	89%	41%	84%
10%	0.349	904	1130	15,197	3133	22%	93%	44%	83%
5%	0.446	503	511	15,816	3534	12%	97%	50%	82%

specific care providers [19, 20]. The validity of a prediction tool is crucial for its possible usefulness in a broader clinical context [22] e.g. in other countries with similar structures for administrative healthcare data. It may be a weakness of the study that we were unable to include data from other counties or countries. But the external validity of our model was corroborated in two external samples, one using a different time period and one using a younger age group. Another limitation of the model is the lack of socio-economic and socio-demographic data, data not available in the administrative health care data. But considering that the important variables of the model as well its accuracy are strikingly corresponding to a study in an American context supports the validity of the model [19]. There are other risk adjustment-measures for hospitalization, but the AUC values are in the same range as reported in our study [18]. Since the outcome (accuracy) of our model is also in the same range as (or better than) studies in other countries and using similar, but not identical, settings, we modestly assume our data to be generalizable [24].

Use of the model in a clinical context

High accuracy (expressed as c-statistics) is to be expected for diagnostic tests like medical imaging or polygraph lie detection, but in mores complex settings, like some types of weather forecasting, c-statistics may in fact turn out to be 0.6–0.7 [23]. In a complex system with healthcare of "frail elderly" or "older persons with multi-morbidity" prediction of hospitalization of a population without a clear clinical definition (it is unlikely to obtain accuracy measures much higher than that. The accuracy expectations in a complex clinical context must be reasonable, in order to use the predictive tool in a clinically meaningful way. In a clinical context, sensitivity and specificity must be balanced so that a clinically meaningful outcome of the prediction is obtained. When an intervention is planned, the model must be able to find a reasonable number of the true cases (i.e. $\frac{2}{3}$ or $\frac{3}{4}$). But this cannot be combined with selecting too many false positive cases (low specificity). The model selected in our study, with AUC 0.69, can be regarded as a statistically accurate model which works for a clinically complex population. As illustrated in Table 4, the model must be managed in a clinically relevant context where there is a balance between the number of cases and non-cases selected by the model. We found that a predicted proportion of 40 or 45% of the population is a clinically meaningful reduction of the population to less than half, releasing healthcare resources from the other half with less probable needs. The selected 40 or 45% still contains 62 to 66% of the cases of the whole population. This is a

significant enhancement of the probability of reaching the correct target group with a planned proactive intervention. Translated into the reality of a general practitioner (GP) with 2000 listed patients (all ages), he or she would get a list of 50–70 predicted cases. This number of patients that can be screened through and prioritized (from high to low) by the GP who can exclude individuals who are apparently falsely predicted. It should be noted that the positive predicted value for the same proportion of predicted individuals (40%) was 31%. In clinical practice, this is of greater importance than the AUC value itself. If the clinician experiences that 20–30% of predicted individuals are true cases and more than 60% of all cases are detected, our experience is that they find the model to be clinically relevant.

Prediction enables proactive intervention

The meaning of the prediction was to use it in a clinical setting which during the next implementation phase was for clinical (intervention) purposes [21]. In clinical practice, the predicted population was transferred as patient lists to each primary care centre, who could plan and implement proactive interventions (e.g. home visits, telephone support, GP visits). Such interventions given to a poorly defined group of elderly people in a certain age-range or to a "multi-morbidity-group" with low predictive value for hospitalization are likely to direct healthcare resources towards groups that are not in need of them [21]. And interventions for small, specific groups that can be selected manually (newly hospitalized, specific medical diagnosis like heart insufficiency, "above a certain frailty index score") will miss large groups of elderly in need of healthcare or largely miss the wider care-flows of geriatric hospital care (low sensitivity), see e.g. [13]. Therefore, our healthcare providers now have decided that prediction of risk (for hospitalization) patients in the 75+ population will be introduced into routine primary care where stratified risk-lists will be used for the planning of proactive team-based intervention.

Frailty measures or administrative data?

Using clinical instruments with "frailty" as a predictor for hospital care has practical limitations since it requires a face-to-face meeting and also has poor accuracy for prediction of admission to hospital (AUC 0.52–0.57) [13]. In contrast, predictive models based on administrative healthcare data seem more reliable for the prediction of hospital admissions [18, 19, 25]. In clinical practice, using a digital predictive model combined with a geriatric assessment including a frailty measure is likely to be more useful than either instrument alone [21].

Conclusion

There is strong evidence for the value of geriatric-dedicated assessment, both in hospital and primary care [14, 26–28]. Prediction of the target population for these assessments/interventions enables the healthcare provider to direct proactive resources towards a group in greater need which may increase the capacity and cost-effectiveness of the interventions. We provide a clinically useful prediction model with acceptable accuracy for hospital admissions of older possibly frail persons. We indicate how it can be used in a clinical primary care context and how the healthcare can focus its resources to clinically relevant sub-populations. The method and models used can be generalized and implemented in most healthcare systems with electronic healthcare statistics. Prediction of patients at risk for hospitalization may certainly be one important way for the future healthcare system to meet increasing needs for care, but it must be used sensibly in clinical practice.

Abbreviations

AUC: Area under the receiver operating characteristics curve; CI: Confidence interval; C-statistics: Concordance-statistics, goodness of fit for binary outcome in a logistic regression; ER: emergency room; glmnet: Lasso and Elastic-Net Regularized Generalized Linear Models; GP: general practitioner; ICD10: International classification of diseases 10th revision; LR: Logistic regression; MASS: Modern Applied Statistics with S; OR: Odds ratio; PPV: Positive predictive value; pROC: Display and Analyze ROC Curves; Ref: Reference value; rms: Regression Modeling Strategies; ROC: Receiver operating characteristics; TRIPOD: Transparent reporting of multivariable prediction model for individual prognosis or diagnosis

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Authors' contributions

JM and JL designed the study. JL performed the statistical analysis. JM, MN, HJD and JL interpreted the data and participated in the framework construction of the manuscript. JM and JL wrote the manuscript. JM, MN, HJD and JL read, improved and approved the final version of the manuscript.

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Availability of data and materials

Due to ethical restrictions we are not allowed to submit our data-file outside our research environment. If other scientists want to explore or validate their own models on our data-set we will certainly be of assistance in doing so upon reasonable request to the corresponding author.

Ethics approval and consent to participate

The study has been subject to ethical evaluation and was approved by the regional ethical review board in Linköping (Dnr 2016/347–31). Since we used administrative data informed consent was not regarded as necessary by the board.

Consent for publication

Not applicable.

Competing interests
The authors declare that they have no competing interests.

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PAPER II

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RESEARCH ARTICLE Open Access

Costs and effects of comprehensive geriatric assessment in primary care for older adults with high risk for hospitalisation

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Abstract

Background: The healthcare system needs effective strategies to identify the most vulnerable group of older patients, assess their needs and plan their care proactively. To evaluate the effectiveness of comprehensive geriatric assessment (CGA) of older adults with a high risk of hospitalisation we conducted a prospective, pragmatic, matched-control multicentre trial at 19 primary care practices in Sweden.

Methods: We identified 1604 individuals aged 75 years and older using a new, validated algorithm that calculates a risk score for hospitalisation from electronic medical records. After a nine-month run-in period for CGA in the intervention group, 74% of the available 646 participants had accepted and received CGA, and 662 participants remained in the control group. Participants at intervention practices were invited to CGA performed by a nurse together with a physician. The CGA was adapted to the primary care context. The participants thereafter received actions according to individual needs during a two-year follow-up period. Participants at control practices received care as usual. The primary outcome was hospital care days. Secondary outcomes were number of hospital care episodes, number of outpatient visits, health care costs and mortality. Outcomes were analysed according to intention to treat and adjusted for age, gender and risk score. We used generalised linear mixed models to compare the intervention group and control group regarding all outcomes.

Results: Mean age was 83.2 years, 51% of the 1308 participants were female. Relative risk reduction for hospital care days was − 22% (− 35% to − 4%, $p = 0.02$) during the two-year follow-up. Relative risk reduction for hospital care episodes was − 17% (− 30% to − 2%, $p = 0.03$). There were no significant differences in outpatient visits or mortality. Health care costs were significantly lower in the intervention group, adjusted mean difference was € − 4324 (€ − 7962 to − 686, $p = 0.02$).

Conclusions and relevance: Our findings indicate that CGA in primary care can reduce the need for hospital care days in a high-risk population of older adults. This could be of great importance in order to manage increasing prevalence of frailty and multimorbidity.

Trial registration: clinicaltrials.gov Identifier: NCT03180606, first posted 08/06/2017.

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Background

Increasing health care needs among older adults are recognised as a major challenge to the healthcare system in developed countries [1, 2]. The majority of older adults is healthy, but frailty and multimorbidity increase with age. Frailty can be described as a state of increased vulnerability of the old person with increased risk of adverse outcomes [3], but there is a lack of consensus on its definition [4] and there are several different ways to measure frailty in research and clinical practice [5]. In this study we use the cumulative deficit model to assess frailty [6]. The prevalence of frailty in community-dwelling older adults is estimated to be 20–40% at the age of 75 years [7]. Frail older adults are high users of medical services and recent studies have demonstrated a two-to-three times higher incidence of unplanned hospital admissions among frail individuals compared with non-frail people [8, 9]. Numerous intervention-studies have been performed around the world during the last decades to identify effective treatments and strategies to manage increasing healthcare needs among older persons [10, 11].

Comprehensive geriatric assessment (CGA) is accepted as the gold standard for the management of frailty [12, 13]. CGA is described "a multidimensional, multidisciplinary process which identifies medical, social and functional needs and the development of an integrated/coordinated care plan to meet those needs" [14]. The positive effects of CGA include slowing down functional decline and reduction of hospitalisations and admissions to nursing homes [15, 16]. CGA has been modified and adapted to various settings; a wide range of CGAs using different instruments with different intensity has been studied in primary care [14, 16–18]. In spite of a great number of intervention studies, there is insufficient evidence for effectiveness of CGA in primary care regarding reduced mortality or inpatient care [11, 17]. There is also limited economic evaluation that suggests that CGA may save on hospital costs [19, 20]. One of the highlighted challenges in these studies is the identification of older adults in primary care that would benefit most from CGA interventions [17]. Recently, studies using electronic administrative and medical record health care data to detect frailty and predict risk for hospitalisation have provided new tools for this. Using algorithms is a way to detect and grade frailty that does not require manual and time-consuming contacts with patients [21–23]. A high electronic frailty index corresponds to high risk for hospitalisation [22].

Therefore, we decided to use an algorithm for prediction of hospitalisations to identify a target group for CGA [23]. As previous studies have identified difficulties in implementing complex interventions in primary care [24], we designed a CGA intervention that was person-centred and differentiated according to individual needs. We used a CGA tool with a limited set of items performed by a small nurse-physician team to adapt it to the primary care context [25].

The aim was to examine if comprehensive geriatric assessment adapted to primary care and delivered to a risk group identified by a prediction model can reduce unplanned hospitalisations.

Methods

We conducted a prospective multicentre trial at 19 primary care practices in the county of Östergötland in Sweden as previously described [26].

We rated the trial design as pragmatic according to all ten domains of the PRECIS-tool (Pragmatic Explanatory Continuum Indicator Summary) [27] as we studied the effects of implementation of a new work-mode without extra measurements or assessments in the intervention or control groups. As this work-mode was already decided by the county, participants were not asked for consent, in accordance with the decision of the ethical board.

We decided to start the collection of healthcare data (the follow-up period) when 90% of all available participants in the intervention group that accepted to participate had received the CGA (the run-in period). Our original plan was a run-in period of 3 months, but we had to prolong this period to 9 months because the start-up process required more time than expected. The staff information and training started in January 2017, recruitment of patients for CGA in April 2017 and the follow-up period of 24 months started in January 2018.

Setting

We were unable to randomise the practices, therefore we decided to compare the volunteering intervention practices with care-as-usual at matched practices in the county. We identified practices with similar locations, size and populations over 75 years of age and selected them as controls.

The practices were situated in both rural and densely populated areas with listed populations from 6000 to 21,000 inhabitants. Together, the 19 practices covered 40% of the total population aged 75 years and older across the county. Prior to the intervention, there was no tradition of performing CGA in primary care. Primary care in Sweden is financed by the county council and organised in primary care practices with a typical population of 6000–20,000 persons and an average workforce of 3–10 physicians, 6–15 nurses and administrative staff. Nurses are an important part of the workforce and have experience of working independently with both acute illness and chronic diseases, which makes them capable of performing a

significant part of the CGA. The intervention practices did not receive any extra staff linked to the intervention.

Staff training and monitoring

The practices in the intervention received an introductory visit of 2 h during the run-in period where researchers introduced the CGA tool, the concept of frailty and the other features of the intervention to the nurses and physicians involved. During the whole study period, we visited the practices every 6 months giving advice and answering questions. Between these visits, the nurses at the intervention practices had access to a supervisor via email or telephone for additional support. In addition, we organised network meetings every 6 months where nurses and physicians at the intervention practices shared experiences, discussed CGA and related topics. There was no interaction with the control practices.

Participants

We identified 1604 individuals aged 75 years or older at the participating practices in March 2017. We used a recently developed and validated prediction model that contains 38 variables identified with multivariable logistic regression [23]. Age and healthcare use are the principal predictors, together with diagnoses from inpatient care and outpatient visits. Data from the preceding 12 months of electronic medical records was extracted to calculate a risk score for unplanned hospital admission. Our participants constituted the 11% with the highest risk score of the aged population. There were no exclusion criteria; all the selected individuals were included. We distributed a list of participants to the intervention practices at the end of March 2017.

Sample size

We hypothesised a reduction in hospital care days of 20% as a result of the intervention based on an earlier study where a reduction was found for individuals at high risk [28]. In a pilot study, we found an incidence of hospitalisations over 60% in the predicted target population. A calculation based on this, a power of 0.8 and a significance level of 0.05 led to a minimum number of participants of 270 in each group. We estimated a drop-out rate of 30% giving a number of 380 participants in each group. Then we doubled the number of participants taking into account that the heterogeneity of the practices and the participants would lower the likelihood of detecting a meaningful intervention effect.

Intervention

The intervention comprised two main components. The first component involved presentation of the list of participants to the intervention practices. The list included the risk score and the number of hospitalizations, visits to emergency room and to any physician during the preceding 12 months for each participant. In this way, the practices were made aware of a group of older adults at high risk for hospitalisation.

The second component was the comprehensive geriatric assessment (CGA) performed by nurses at the intervention practices together with the listed/responsible physician of the participant. The CGA was carried out during the run-in period between April and December 2017. The primary care nurses contacted the participants in the intervention group by telephone and offered them a health evaluation/CGA and follow-up at the practice. Around 10% of the participants had greater reduction of mobility and received the CGA at home. We constructed an instrument for the CGA in this intervention, the Primary care Assessment Tool for Elderly (PASTEL) [25]. This 4-page form contains two parts. The first part is performed by a nurse and contains self-rating of health and about 20 items covering different perspectives of health and frailty including for example social network, vision, hearing, falls, incontinence, weight loss and psychological problems. This is followed by a medication review and physical measures. It ends with questions to the patient regarding the main concerns about their health and their needs in the future.

The second part is a template for a team meeting where the responsible physician and the nurse that performed the initial assessment together grade frailty with Clinical frailty scale [6] and review a check-list for further investigation and supportive actions, based on the assessment, medical records and personal knowledge. Typically, the assessment by the nurse lasted 1 h and the team meeting 15–30 min. In some cases, the participant was not known by the physician, and a visit for further medical assessment was planned. The participants did not participate in the team meeting, but was contacted by the nurse and involved in the care planning afterwards.

After the CGA, the participants were given care according to their individual needs. This included referral to occupational therapy, physiotherapy or other specialist services when needed. We encouraged the teams to provide continuity for the participants to both physician and nurse and to facilitate accessibility to the practices for the participants. The intervention had no standard treatment or action that was offered to all participants except the CGA described above. We instructed the teams to follow their clinical judgement and to individualise treatment and follow-up intervals. Control practices performed care as usual. We did not gather information about what specific actions the participants received.

Outcomes

Primary outcome was number of hospital care days.

Secondary outcomes were number of hospital care episodes and number of outpatient visits, health care costs and mortality. In analyses, outpatient visits were also subdivided into visits in emergency care, primary care and other outpatient care.

Using the unique 10-digit Swedish personal identity numbers, we linked patient data to the Care Data Warehouse in Östergötland (CDW) and Cost Per Patient database (CPP). The data warehouse includes all healthcare contacts (inpatient, outpatient and primary care) for both private care and public care, and the cost database includes costs for all contacts within public care. For an adequate assessment of cost data, all costs collected from CPP were adjusted to the price level of 2019 with an increase of historical costs with 3% per year. We converted costs to euros (one € = 10 SEK). Costs were missing in 11% of all contacts, mainly because of care given by private primary care providers. For these contacts, healthcare costs were imputed with the average cost calculated per contact type for existing data. Contact types were inpatient care, physician visit, and visit with a professional other than a physician. Less than 0.03% of contacts with missing costs were related to inpatient care. We also collected the number of co-morbidities from CDW as defined by the Royal College of Surgeons Charlson Score [29].

Statistical analysis

We compared baseline characteristics; risk score, age and gender, between the intervention group and the control group. All outcomes were analysed according to intention to treat. Continuous data were analysed with t-test and categorical data were analysed with $\chi 2$-test. We used generalised linear mixed models to compare the intervention group and control group regarding all outcomes, controlling for baseline covariates. We expected that two patients in the same primary care centre were likely to have more similar rates of the different outcomes than two patients in randomly different primary care centres. Therefore, our models included primary care centre as a random intercept effect. Risk score, age and gender were used as fixed covariates. For healthcare use data, we selected the distribution for our regression models based on an assessment of Pearson residuals. Since we found evidence of over-dispersion in healthcare use data, we preferred a negative binomial model with a log-link over a Poisson model. For cost data, we used a normal distribution with an identity link.

For healthcare use data, we calculated event rates for the two groups from actual data. From these event rates, absolute risk reductions for the intervention group were calculated. The relative risk reductions (RRRs) for the intervention group were analysed by the multivariable mixed count data models. For cost data, mean costs and mean differences between the groups were calculated from actual data. Adjusted mean differences were analysed by the multivariable mixed cost models.

We analysed mortality (1-overall survival) by the Kaplan-Meier method with any cause of death as an event and patients were censored by the end of follow-up 31 December 2019. Hazard ratio (HR) with 95% CIs between the intervention group and control group were estimated by multivariable Cox regression. The Cox regression was adjusted for the baseline covariates, risk score, age and gender.

For the primary outcome, the level of significance was set at 0.05 (two-tailed). Despite multiple secondary outcomes, we decided to keep the level of significance of 0.05 in order to detect meaningful differences. Therefore, these analyses should be interpreted with care. All analyses, except for Kaplan-Meier, were performed using SPSS version 25.0 (IBM Corp., Armonk, NY). The Kaplan-Meier plot was produced in R version 3.5.2 (R Core Team, Vienna, Austria).

Results

The 1604 participants were equally distributed between intervention and control practices. During the run-in period (1 April 2017–31 December 2017) there were 17% (control) and 19% (intervention) dropouts caused by death. Among the remaining 1308 participants, mean age was 83.2 years and 51% were female. In the intervention group, 475 of the 646 participants (74%) accepted the invitation to the comprehensive geriatric assessment (CGA) and received the intervention (Fig. 1).

Table 1 shows the characteristics of the participants. There were no significant differences regarding age, gender, risk score or comorbidities between the intervention and control groups.

Primary outcome

We found a significant reduction in hospital care days in the intervention group (8.5 days vs 10.3 days) during the 2 years of follow-up. Relative risk reduction (RRR) was −22% (−35% to −4%), $p = 0.02$ (Table 2).

Secondary outcomes

Relative risk reduction for hospital care episodes was −17% (− 30% to − 2%) $p = 0.03$. The number of outpatient visits to primary or secondary care did not differ significantly (Table 2). Mortality was similar in the two groups (Fig. 2), the adjusted Cox regression resulted in a HR of 1.1 (95% CI: 0.9 to 1.3, $p = 0.56$).

During the 2 years of follow-up, the average healthcare costs in the intervention group and the control group were € 22,250 and € 25,245 respectively (Table 3). When we adjusted for age, gender and risk score we found a significantly lower total cost in the intervention group

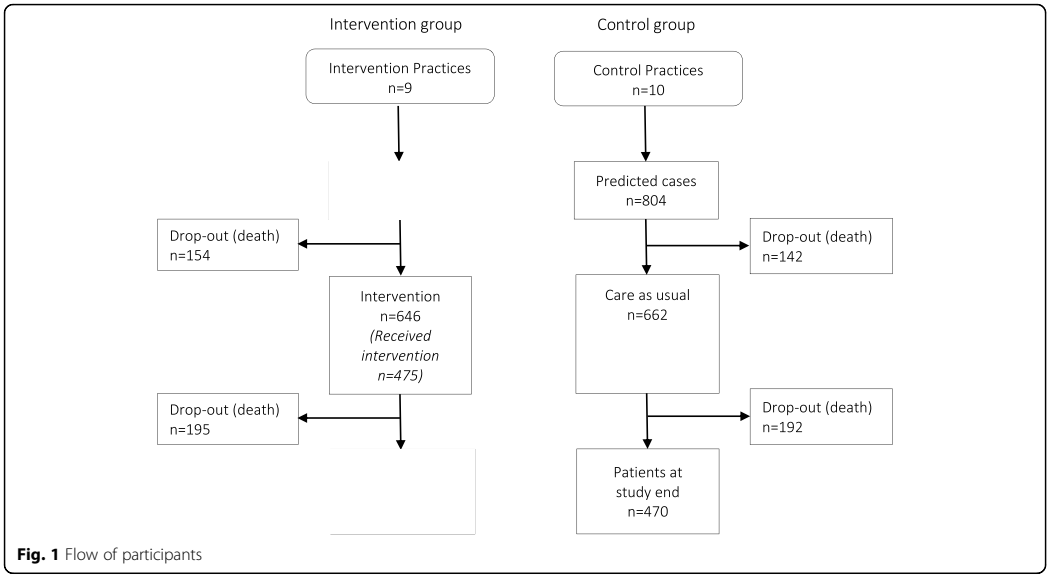

Fig. 1 Flow of participants

compared to the control group (€ - 4324, 95% CI: € - 7962 to - 686, $p = 0.02$). This corresponds to a 17% lower cost in the intervention group. A lower cost for hospital care episodes (€ – 2994, 95% CI: € -5690 to – 297, $p = 0.03$) in the intervention group compared to the control group was the main contributing factor for the lower total healthcare cost.

Discussion

This study combined CGA with digital prediction in primary care covering 19 practices and 1604 adults over 75 years of age. The intervention significantly reduced the risk for prolonged hospital stay, expressed as number of hospital care days (relative risk reduction RRR – 22%) in a high-risk population of older adults.

Our secondary outcome data indicated a decreased risk for hospital admission (RRR – 17%), without any significant risk difference in mortality or in the number of outpatient visits, including primary care visits. Altogether, this corresponded to a healthcare cost reduction of € 4324 (– 17%) for each patient in the intervention group during the 2 years of follow-up compared to usual care.

The principal strength of this trial is the pragmatic design of the intervention, allowing us to study the effects in a context very close to everyday practice. The design also allowed us to compare our intervention with usual care that was not affected by repeated visits and measurements of the controls, which could be confounders and mask the true effect [30]. Secondly, we did not exclude any of the individuals that we identified with the prediction model and we collected data relating to every participant from the healthcare database with very little missing data. Thirdly, we used a CGA tool with a limited set of items and scales and freedom for the staff to tailor further assessments and actions to the individual. We believe that this facilitates implementation and makes the work-mode adapted to the primary care context.

The trial has several limitations: Firstly, we could not randomise the participating practices. There may be differences between the practices that we are not aware of and that could influence the results. The mixed method analysis using primary care centres as the random intercepts adjusted the results to some extent for such differences.

Table 1 Baseline characteristics comparing intervention group and control group

Measure	Intervention group ($n = 646$)	Control group ($n = 662$)
Age, mean (SD)	83.0 (5.5)	83.3 (5.5)
Gender, number (%)		
Men	325 (50.3%)	315 (47.6%)
Women	321 (49.7%)	347 (52.4%)
Risk score, mean (SD)	0.35 (0.18)	0.33 (0.17)
Number of co-morbidities		
0	48 (7.4%)	47 (7.1%)
1	112 (17.3%)	95 (14.4%)
2	143 (22.1%)	126 (19.0%)
3 or more	343 (53.1%)	394 (59.5%)

Table 2 Results for primary and secondary outcomes of healthcare use comparing intervention group and control group from 1 Jan 2018 until 31 Dec 2019

Outcomes	Group	No. of events/No. of participants	Event rates	Absolute risk-reduction	Relative risk-reduction (95% CI)[a]	*P* value
Total number of hospital care days	Intervention	5500/646	8.5	−1.8	−22% (−35% to − 4%)	**0.02**
	Control	6833/662	10.3			
-No. of hospital care episodes	Intervention	922/646	1.4	−0.3	−17% (−30% to −2%)	**0.03**
	Control	1109/662	1.7			
Total Number of visits	Intervention	28,325/646	43.8	−0.7	−4% (−15 to 8%)	0.50
	Control	29,471/662	44.5			
-No. of primary care visits	Intervention	16,500/646	25.5	0.9	0% (−20 to 26%)	0.99
	Control	16,300/662	24.6			
-No. of emergency room visits	Intervention	1512/646	2.3	−0.3	−10% (−23 to 5%)	0.20
	Control	1718/662	2.6			
-No. of other outpatient care visits	Intervention	10,315/646	16.0	−1.3	−10% (−25 to 8%)	0.25
	Control	11,444/662	17.3			

[a]Relative risk reductions were analysed with mixed models using primary care centres as random intercept. All models were estimated by a negative binomial distribution with a log link and were adjusted for risk score, age and gender. *CI* Confidence interval. Significant results are marked with bold text

Secondly, we do not have data on what actions were given to each participant after the CGA, thus we cannot tell if the effect was conferred by the CGA itself or by the subsequent actions or referrals. This would have been valuable but our study design where we did not approach controls or participants that did not get the CGA did not allow us to collect these data. Furthermore, the statistical power of the study was not enough to detect differences related to the actions or referrals.

Thirdly, a longer run-in period than planned made the start of the intervention more outstretched. That may also have excluded a proportion of more frail individuals from participating, which possibly reduced the effect of the intervention.

Comparison with other studies

Our results support the hypothesis that CGA is effective in reducing healthcare needs in older adults. The size of the effect is comparable with other interventions that

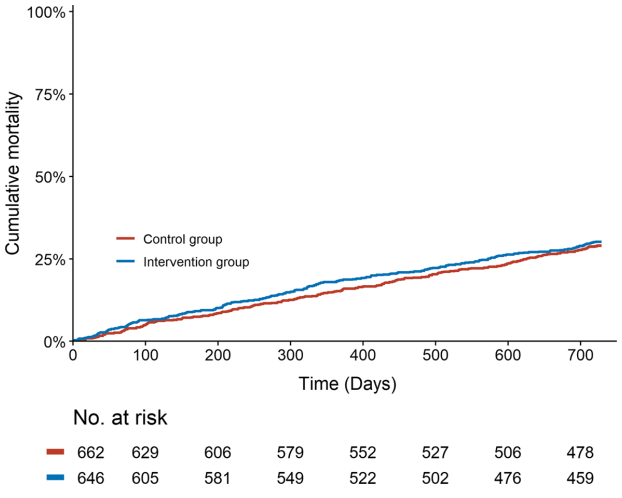

Fig. 2 Mortality comparing intervention group ($n = 646$) and controls ($n = 662$) from 1 Jan 2018 until 31 Dec 2019

Table 3 Results for healthcare costs (€) comparing intervention group ($n = 646$) and control group ($n = 662$) from 1 Jan 2018 until 31 Dec 2019

Outcomes	Group	Unadjusted mean cost (€)	Unadjusted mean difference (€)	Adjusted mean difference € (95% CI)[a]	*P* value
Total cost of hospital care episodes	Intervention	10,810	-2165	−2994 (− 5690 to − 297)	**0.03**
	Control	12,975			
Total cost of visits	Intervention	11,440	− 830	− 1369 (− 2923 to 186)	0.08
	Control	12,270			
-Cost of primary care visits	Intervention	4009	− 326	−297 (− 909 to 314)	0.34
	Control	4335			
-Cost of emergency room visits	Intervention	1253	− 131	− 170 (− 378 to 38)	0.11
	Control	1384			
-Cost of other outpatient care visits	Intervention	6178	− 373	− 855 (− 2205 to 495)	0.21
	Control	6551			
Total cost of visits and hospital care episodes	Intervention	22,250	− 2995	− 4324 (−7962 to −686)	**0.02**
	Control	25,245			

[a]Adjusted mean differences were analysed with mixed models using primary care centres as random intercept. All models were estimated by a normal distribution with a identity link and were adjusted for risk score, age and gender. *CI* Confidence interval. Significant results are marked with bold text

reduced hospitalisations, both randomised [28, 31, 32] and non-randomised. A number of other studies have failed to demonstrate reduction in hospitalisations or admission to nursing homes [33–37]. One of the suggested explanations for this is the difficulty in recruiting and following participants who are frail enough [38]. Our population had a substantially higher mean hospitalisation incidence and mortality than most comparable studies [28, 32–34, 37]. Other possible explanations for failure in other studies to observe significant effects include small samples and short follow-up times. Our design allowed us to access a big, high-risk sample that we could follow for 24 months and collect data from all participants. The prediction model that we used to select participants is based on healthcare needs, age and selected diagnoses [23]. The high mortality, co-morbidities and rate of hospitalisation among our participants support that this model concords with electronic frailty indexes [22] and other frailty measures [6].

There is a range of studied CGA interventions, from an intense geriatrician-led ambulatory unit intervention [32, 33, 39] to a more limited CGA with a team consisting of GP, a nurse and a social worker [15, 20, 40]. We decided to use a doctor-nurse team and a CGA tool with a relatively small set of items aiming for a differentiated and individualized intervention [25]. A more complex and intensive intervention would restrict the intervention to a smaller group and probably make it less feasible for broad implementation.

Conclusions

In this study, we have demonstrated that CGA can be performed in a primary care context and significantly reduce the need for hospital care. Furthermore, the prediction model succeeded to identify a target group that could benefit from this design of CGA. Future studies should compare the predictive ability of this model with frailty indexes from electronic healthcare data. Investigating specific components of CGA and their contribution to health outcomes will also be important.

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Authors' contributions

JM was the principal investigator and designed the study with contributions from MN, JL and JA. JM obtained the funding. MN was responsible for training and implementation at the practices. JL collected the data and performed statistical analyses. MN wrote the first draft of the article with contributions from JM, JL and JA. MN, JM, JL and JA critically revised the manuscript. All authors read and approved the final manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study has been subject to ethical evaluation and was approved by the *Regional ethical review board in Linköping* (Dnr 2016/347–31). The *Regional ethical board in Linköping* also waived off the need for informed consent by the participants as the decision to implement the new work-mode used in this study already was made by the county council of Östergötland. The

study was performed in accordance with the principles of the declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors performed this study while employed by Linköping University and/or the County Council of Östergötland. These organisations were also the funders of the study.

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PAPER III

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Original Study

Cost-Effectiveness of Comprehensive Geriatric Assessment Adapted to Primary Care

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Keywords:
Comprehensive geriatric assessment
primary care
frailty
hospitalization
pragmatic clinical trial
cost-effectiveness

A B S T R A C T

Objectives: To estimate the cost-effectiveness of a pragmatic trial of comprehensive geriatric assessment adapted to primary care, compared with care as usual.
Design: Within-trial cost-effectiveness study of a prospective controlled multicenter trial.
Setting and Participants: Nineteen primary care practices in Sweden. The original trial included 1304 individuals aged 75 years at high risk of hospitalization selected using a prediction model. From the original trial, 369 individuals participated in the cost-effectiveness analysis, 185 in the intervention group and 184 in the control group. Mean age was 83.9 years and 57% of the participants were men.
Methods: We obtained health care costs from administrative registries. Community costs and health-related quality of life data were obtained from a questionnaire sent to participants. Health-related quality of life was measured using EQ-5D-3L and quality-adjusted life years were calculated. We analyzed all outcomes according to intention to treat, and adjusted them to age, gender, and risk score (risk of hospitalization in the next 12 months). The primary outcome was the incremental cost-effectiveness ratio associated with the intervention at follow-up after 24 months.
Results: The difference in total cost (incremental cost) between intervention and control groups was USD 11,275 (95% CI 407 to 22,142). The incremental effect in quality-adjusted life years was 0.05 (95% CI 0.17 to 0.08). In the cost-effectiveness plane that illustrates the uncertainty of the analysis, 77.9 of the observations were within the south-east quadrant, implying lower cost and greater effect in the intervention group.
Conclusions and Implications: The results suggests that a primary care comprehensive geriatric assessment intervention delivered to older adults at high risk of hospitalization is cost-effective at follow-up after 24 months. The use of a prediction model to select participants and an intervention with a low cost is promising but requires further study.
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Many countries in the world are faced with the major challenge of managing increased health care needs among older adults. This is partly caused by an aging population and increasing incidence of frailty and multimorbidity.[1,2] Moreover, expectation of a healthy and active life and new treatments further increase the gap between what is possible and the resources available for health care.[3] In this context, prioritization is necessary in all parts of the health care system. The ability to succeed and make wise decisions regarding priorities is dependent on more evidence concerning the cost-effectiveness of treatments and care models.

There is an ongoing debate in research about how frailty should be defined, and various models have been proposed.[4] The World Health Organization report on healthy aging describes frailty as decreased intrinsic capacity (the composite function of the various organ systems) that makes the individual vulnerable to various stressors, with a risk of rapid loss of function.[3] Frailty is related to aging and multimorbidity but is not necessarily a consequence of these. Frailty is also

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described as a dynamic condition that can be delayed and, to a certain extent, reversed.[4] Economic evaluations have demonstrated health care costs for frail older adults that are 2 to 3 times higher than those for robust individuals.[5] The predominant sources of health care costs for frail individuals are hospitalization and post-acute care.[6]

In the absence of firm evidence of effective treatments and care models for managing frailty, there are several recommendations that highlight a holistic care strategy for frail older adults.[3,7,8] This includes a recommendation for comprehensive geriatric assessment (CGA) and the formulation of individualized and proactive care plans that encompass the values and priorities of the older adult.[9] Interventions using CGA in hospital and post-acute settings have demonstrated significant positive effects on survival and decreased admission to nursing homes, but there is still insufficient evidence.[10] A few studies also have demonstrated the cost-effectiveness of these interventions.[11,12]

Primary care has a role as the initial contact point and by providing continuity of care over time for all general health issues in the population, and recommendations support the notion that primary care should be the first-line management option for people with frailty and multimorbidity using comprehensive care models like CGA.[8] A lot of research has been conducted over the past 20 years and several comprehensive models for primary care have been evaluated[13–15]; however, there is still no convincing evidence for effective comprehensive care strategies, despite these numerous studies, and only a small number of them have evaluated the cost-effectiveness of the interventions.[16–20] These evaluations have mostly demonstrated higher costs in the intervention group and either small gains in functional ability or no significant effect compared with care as usual. Comparisons between studies are difficult, as the interventions have used a variety of outcome measures and different follow-up periods.

In Sweden, the research project "Proactive Healthcare for Frail Elderly Persons" studied the effects of CGA in primary care in a group of vulnerable older adults who were identified using a prediction model.[21] Predicting risk of hospital admission has been suggested as a way to identify vulnerable older adults without having to manually assess the person at a clinical appointment.[22–24] The intervention in "Proactive Healthcare for Frail Elderly Persons" demonstrated a relative risk reduction of 22% for hospital care days and 17% lower total health care cost compared with care as usual.[25] Therefore, we considered it important to also evaluate the cost-effectiveness of the intervention.

The aim of this study was to analyze the cost-effectiveness of a CGA intervention adapted to primary care delivered to a group of older adults at high risk of hospitalization.

Methods

Design

The present study is a within-trial cost-effectiveness analysis. The original study "Proactive Healthcare for Frail Elderly Persons" was a pragmatic matched-controlled trial at 19 primary care practices in southeast Sweden with follow-up over 24 months that has been described elsewhere.[25,26]

Participants

In the original study, we selected 1604 participants aged 75 years and older using a prediction model that calculates a risk score for hospitalization in the next 12 months using routine health care data. A total of 1308 participants were alive at the start of the follow-up period. A questionnaire was sent by mail to all participants on 3 occasions during the study, at baseline, at 10 months of follow-up, and at 22 months of follow-up. In connection with the baseline questionnaire, participants were asked for their consent to analyze their answers together with their health care utilization. In total, 369 individuals agreed to participate and were included in the present analysis. The study was registered at ClinicalTrials.gov (Identifier: ctgov:NCT03180606, first posted August 6, 2017) and was approved by the Regional Ethical Review Board in Linköping (Reg. no. 2016/347−31).

Intervention

Participants at the 9 practices involved in the intervention were invited to undergo CGA performed by primary care nurses. The assessment was performed using a new CGA tool; Primary care ASsessment Tool for ELders (PASTEL).[27] After the assessment, the nurse met with the responsible physician to jointly estimate the participant's degree of frailty and to plan further investigations and actions. All follow-up actions and activities were individually tailored; there was no standard treatment or follow-up. The assessment and care planning took place during the run-in period that lasted 9 months (April to December 2017) and the subsequent follow-up period lasted 24 months (January 2018 to December 2019)

The 10 control practices were matched to the intervention practices with respect to the number of registered older adults and socio-geographic location. The control practices provided care as usual.

Outcomes

Health-related quality of life and mortality

Health-related quality of life (HRQoL) was measured using the EQ-5D-3L instrument including EQ-5D-VAS, and was obtained from the questionnaires sent at baseline, and at follow-up after 10 months and 22 months.[28] We used the UK value set to convert the participants' answers to the EQ-5D index representing their health state.[29] These scores range from 0.594, representing lowest quality of life, to 1.00, representing full health.

Date of death was obtained from the Swedish Tax Agency's population register.

We calculated quality-adjusted life years (QALYs) by multiplying the time spent in a particular health state with the corresponding EQ-5D index (QALY weight) and then added the 3 periods to a sum of QALYs for the entire follow-up period. We considered the index value to be stable until the next measurement point.

Costs

The health care costs in the follow-up period were calculated using the care data warehouse linked to the cost-per-patient database of Region Östergötland. The care data warehouse contains all health care contacts for both public and private care providers and the cost-per-patient database includes total costs for all contacts within public health care. The cost calculations used in this study have previously been reported in more detail.[25] The costs of the intervention incurred during the run-in period (ie, introduction and education of the health care staff, together with time spent on assessments and team meetings) were estimated by the research group as the total hours spent by nurses and physicians at a primary care practice of average size. We then divided the sum total by the total number of participants at that practice. Gross salaries for physicians and nurses were obtained from the region's register.

The cost of home help services and nursing home costs were obtained from the questionnaire. Participants were asked to report the number of hours of home help services per week at baseline and the 2 follow-ups. They also reported the type of housing they were living in. We considered the reported hours of home help services and type of housing to remain unchanged until the next follow-up or death. We used an average price per hour for home help services and per day for nursing homes in the municipalities across the region, as reported to the Swedish Association of Local Authorities and Regions. All costs were converted to US dollars (USD 1 = SEK 10)

Table 1
Participant Characteristics at Baseline of the Study

	Control n = 184	Intervention n = 185	*P* value
Age, mean (SD)	84.1 (4.9)	83.8 (5.8)	.61
Sex, n (%)			.71
Women	78 (42.4)	82 (44.3)	
Men	106 (57.6)	103 (55.7)	
Educational level, n (%)			.92
No education	5 (2.7)	5 (2.7)	
Elementary and middle school	64 (34.8)	62 (33.5)	
Secondary school	17 (9.2)	21 (11.4)	
2-year high school	45 (24.5)	39 (21.1)	
3- or 4-year high school	19 (10.3)	18 (9.7)	
College/University	34 (18.5)	40 (21.6)	
Accommodation, n (%)			.52
Ordinary housing – Independent	130 (70.7)	138 (74.6)	
Ordinary housing – Home help services	42 (22.8)	39 (21.1)	
Nursing home	12 (6.5)	8 (4.3)	
Cohabitation status, n (%)			.43
Living alone	85 (46.2)	83 (44.9)	
Living with partner	98 (53.3)	98 (53.0)	
Living with children	1 (0.5)	4 (2.2)	
Risk score* (SD)	0.33 (0.18)	0.35 (0.19)	.44
Number of comorbidities,† n (%)			.61
0	8 (4.3)	13 (7.0)	
1	34 (18.5)	35 (18.9)	
2	34 (18.5)	38 (20.5)	
3	108 (58.7)	99 (53.5)	

*Risk of hospitalization in the coming 12 months (0–1), derived from the prediction model.
†Derived from medical records in the care data warehouse of the region.

Cost-effectiveness analysis

We analyzed the cost-effectiveness using 2 perspectives: the health care perspective, including costs for primary and secondary health care, and the societal perspective, which also included community costs for home help services and nursing home care. Incremental cost-effectiveness ratios were calculated for both the intervention group and care-as-usual groups by calculating cost/QALYs gained during the 24-month follow-up period. Adjusted data

Table 2
Resource Utilization and Costs During the Follow-up Period of the Study

Resource utilization per patient over 24 mo	Control n = 184	Intervention n = 185	Adjusted mean difference (95% CI)*	*P* value
	Mean (SD)	Mean (SD)		
Primary care				
Physician consultations	5.1 (4.0)	5.0 (4.6)	0.1 (0.8 to 1.0)	.84
Other consultations	21.5 (26.4)	19.6 (26.9)	2.1 (3.3 to 7.5)	.45
Secondary care				
Physician consultations	6.8 (8.0)	5.8 (6.7)	1.0 (0.4 to 2.5)	.17
Other consultations	16.0 (45)	12.3 (26)	5.2 (1.3 to 12.0)	.12
Emergency room visits	2.3 (2.6)	2.2 (3.6)	0.2 (0.5 to 0.8)	.60
Hospitalizations unplanned	1.5 (1.8)	1.2 (1.6)	0.4 (0.02 to 0.7)	**.04**
Hospitalizations planned	0.1 (0.4)	0.2 (0.5)	0.03 (0.1 to 0.1)	.51
Hospital care days, unplanned	10.0 (15.3)	6.9 (11.8)	3.2 (0.5 to 5.9)	**.02**
Hospital care days, planned	0.4 (1.7)	0.5 (1.8)	0.1 (0.4 to 0.3)	.66
Community care				
Nursing home, d	53.5 (161)	30.0 (120)	23 (5.1 to 51)	.11
Home help services, h	218 (926)	241 (1037)	23 (180 to 134)	.77
Cost per patient over 24 mo in USD	**Control n = 184**	**Intervention n = 185**	**Adjusted mean difference (CI)***	***P* value**
	Mean, USD (SD)	Mean, USD (SD)		
Intervention costs	0 (0)	140 (0)	140	n.a
Primary care costs	4471 (3679)	3901 (3104)	617 (66 to 1,301)	.08
Secondary care costs	8166 (15,514)	6433 (10,571)	2260 (152 to 4672)	.07
Emergency room costs	1259 (1459)	1170 (1820)	120 (205 to 445)	.47
Hospitalization costs	12,744 (19,000)	9920 (15,266)	3134 (225 to 6494)	.07
Total health care costs	26,640 (30,656)	21,564 (21,104)	5991 (1135 to 10,848)	**.02**
Nursing home costs	14,403 (43,300)	8067 (32,143)	6210 (1389 to 13,809)	.11
Home help service costs	8801 (37,298)	9711 (41,772)	927 (7273 to 5419)	.77
Total community costs	23,204 (56,018)	17,778 (53,518)	5283 (4227 to 14,793)	.28
Total costs	49,844 (63,316)	39,342 (58,985)	11,275 (407 to 22,142)	**.04**

Note. Bold *P* values are statistically significant ($P < .05$).
n.a, non applicable.
*Unadjusted measures per group, but the differences between the groups were adjusted for age, gender, and riskscore.

Table 3
HRQoL Expressed as EQ-5D-Index at Baseline and During Follow-up

	Control n = 184	Intervention n = 185	Adjusted mean difference (95% CI)*	*P* value
	Mean (SD)	Mean (SD)		
Baseline				
EQ-5D imputed, n = 369	0.56 (0.30)	0.58 (0.29)	0.02 (0.08 to 0.04)	.44
EQ-5D without imputation, n = 345	0.55 (0.30)	0.58 (0.29)	0.03 (0.09 to 0.04)	.41
Follow-up 1 (10 mo)				
EQ-5D imputed, n = 336	0.53 (0.45)	0.56 (0.34)	0.03 (0.11 to 0.06)	.54
EQ-5D without imputation, n = 236	0.57 (0.33)	0.59 (0.29)	0.02 (0.10 to 0.06)	.65
Follow-up 2 (22 mo)				
EQ-5D imputed, n = 276	0.53 (0.42)	0.56 (0.39)	0.03 (0.12 to 0.06)	.56
EQ-5D without imputation, n = 180	0.58 (0.32)	0.60 (0.28)	0.002 (0.08 to 0.09)	.97

*Unadjusted measures per group, but the differences between the groups were adjusted for age, gender, and riskscore.

concerning costs and effects were used in the cost-effectiveness analysis, and the data were bootstrapped through 10,000 iterations. Adjustments were made for age, gender, and risk score. The uncertainty of the cost-effectiveness analysis is described in 2 different cost-effectiveness planes that illustrate the 2 perspectives.

Statistical analysis

Because of missing questionnaires and missing data in included variables, a complete case analysis would have excluded at least 30% of the initial cohort, potentially introducing a bias if the excluded cases were a nonrandom sample. We therefore used the multiple imputation by chained equations (MICE) package in R to deal with missing data for those patients still alive at different time points. We used n = 10 imputed data sets. In the imputation modeling we included data concerning age, gender, risk score, level of education, and cohabitation status. EQ-5D items were also imputed using EQ-5D-VAS and previous EQ-5D items. Predictive mean matching was used for the imputation of EQ-5D-VAS, nursing home days, and hours of home care services. Multinomial logit models were used for type of accommodation, level of education, cohabitation status, and EQ-5D items. The EQ-5D index was computed after the imputations.

The baseline characteristics concerning age, gender, risk score, and Charlson score were compared between the control group and intervention group. Baseline characteristics for all participants were also compared between the population in the original study and the participants in the cost-effectiveness study. We assessed differences in continuous variables using Student's *t* test and for categorical variables using the χ^2 test.

Data were analyzed according to intention to treat. All outcomes were adjusted for age, gender, and risk score in order to correct for potential confounders. For the 10,000 simulated data sets generated using bootstrapping, adjusted mean values for costs and HRQoL for the intervention group and control group were estimated using multiple linear regression. To achieve this, the glm function, together with the EMMEANS and BOOT packages, were used in R. Remaining statistical analyses were performed in SPSS version 28 (IBM Corp).

Results

Baseline Characteristics

In total, 369 individuals were included in the analysis. Mean age was 83.9 years, and 57% of the participants were men. We found no significant differences between intervention group or control group with regard to the basic characteristics reported in Table 1. In the original trial (1304 participants), there were significantly more women; 54% compared with 43% in this study ($P < .001$). No statistically significant differences were found for age, risk score, or Charlson score.

Care Utilization and Cost

The use of health care and municipal care and related costs are shown in Table 2. There were significantly fewer hospital care days in the intervention group. Costs were significantly lower in the intervention group for hospital care, and in total. It was only the cost of home help services that was higher in the intervention group, though not significantly higher.

HRQoL and Mortality

At the first follow-up, there was a slight but not significant decrease in EQ-5D index scores in both groups, which was maintained at the second follow-up. There was no significant difference between participants in the intervention group and those in the control group (Table 3). The proportion who died during the follow-up period was 26.2% in the control group and 24.6% in the intervention group. There was no statistical significance in mortality between the groups (mean difference 1.6%; 95% CI 0.1 to 4.1; $P = .23$).

Table 4
Cost-Effectiveness Analysis

	Intervention	Control	Intervention - Control adjusted mean difference (95% CI)*	ICER
A: Societal Perspective				
Total costs in USD per patient	39,342	49,844	11,275 (407 to 22,142)	
QALYs	0.99	0.94	0.05 (0.17 to 0.08)	Dominant†
B: Health care Perspective				
Total Costs in USD per patient	21,564	26,640	5991 (1135 to 10,848)	
QALYs	0.99	0.94	0.05 (0.17 to 0.08)	Dominant†

*Unadjusted measures per group, but the differences between the groups were adjusted for age, gender, and riskscore.
†The intervention is more effective and costs less than care as usual.

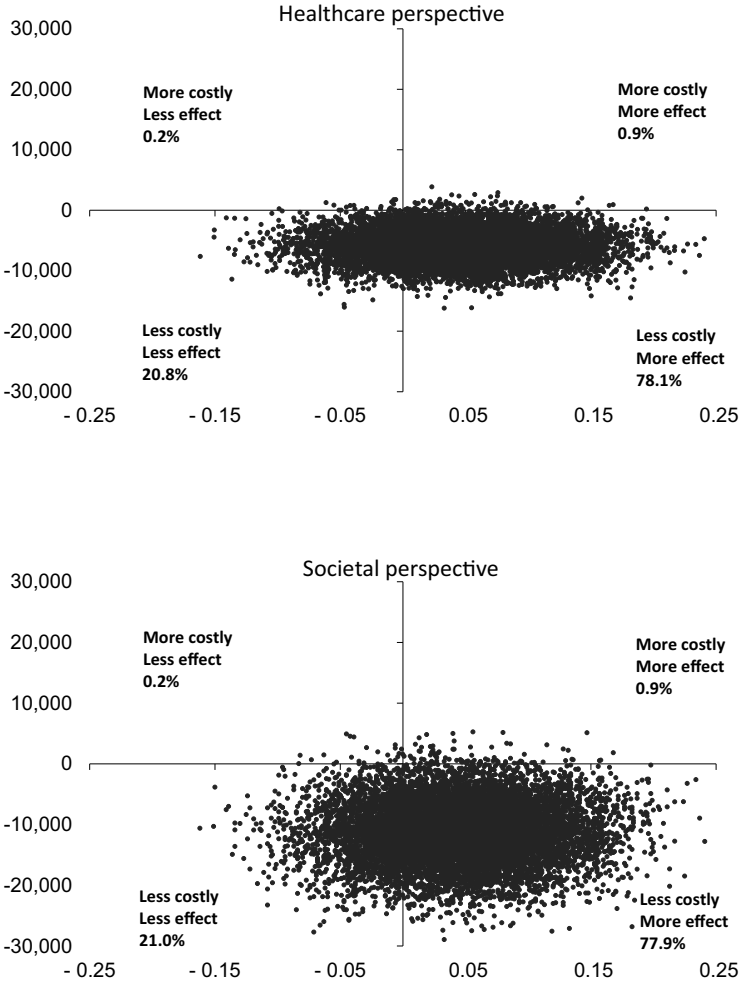

Fig. 1. Cost-effectiveness planes. Cost-effectiveness planes describing the incremental costs (y axis) and QALYs gained (x axis) from the analysis comparing the intervention with usual care in 2 perspectives. Bootstrapping with 10,000 iterations was used and incremental costs and QALYs were adjusted for age, gender, and riskscore. The upper perspective includes health care costs and the lower includes community costs together with health care costs.

Cost-Effectiveness Analysis

The cost-effectiveness analysis is shown in Table 4. The difference in mean QALYs was 0.05. Care as usual was inferior to the CGA intervention in both the societal and health care perspectives, as the intervention resulted in both lower costs and gains in QALYs. The cost-effectiveness perspectives in Figure 1 illustrate the uncertainty of the analysis based on the bootstrap analysis. The southeast quadrant, which implies lower costs and more effect, contains 78% of the observations, and 99% of the observations are located in the southern half of the plane, which implies lower costs.

Discussion

In this study, we found that the primary care CGA intervention is likely to be cost-effective from both health care and societal perspectives. This is mainly attributed to lower costs for both health care and municipal care in the intervention group, as the differences in QALYs derived from the EQ-5D-3L were small.

Earlier studies of primary care CGA interventions in older adults living in the community have presented conflicting evidence of cost-effectiveness. Comparisons are difficult because different measures of morbidity and frailty are used, and because of differences in

interventions and outcomes. A cost analysis of the GRACE intervention in Indiana published in 2009 demonstrated a lower incidence of hospitalization and emergency room visits for older adults with low income and a high risk of hospitalization in the second year of intervention.[30] In the third year of follow-up, health care costs were significantly lower. An intervention from Australia was considered cost-effective at a cost of approximately USD 11,000 for reversing frailty in one older adult.[19] The analysis demonstrated an effect in reducing frailty, no differences in QALYs, and higher health care costs. In very frail subjects, the intervention was more effective and less costly. In the Netherlands, 4 well-designed interventions were performed in primary care around 2010 to 2015.[16,18,20,31] None of these detected any significant differences in quality of life measures or physical functioning compared with care as usual. Three of them showed equal or higher health care costs for the interventions over 2 years of follow-up.[18,20,31] The authors highlighted the heterogeneity of participants combined with challenges of recruiting participants who were frail enough as possible reasons why the anticipated effects did not appear. Furthermore, the long time that was needed for implementation of these complex interventions could result in a lag before any positive effects of the interventions could be detected. However, in the fourth (U-PROFIT) trial, health care costs were slightly lower in the intervention groups, and the intervention was found to be cost-effective at a probability of 91% and a willingness-to-pay threshold of EUR 20,000 as early as after 12 months. This 3-arm trial demonstrated the cost-effectiveness of simply identifying frail individuals in primary care and a low additional effect of a nurse-led care intervention.

The strength of the present study is that the proactive intervention was well-adapted to current practice in primary care, which may have facilitated implementation and reduced intervention costs and primary care costs. We also think that the use of a prediction model to select a sample of older adults at high risk of hospitalization allowed us to target older adults who could benefit from the intervention. We obtained reliable data concerning health care use and costs from administrative registries, with very few missing data points. Our intervention was pragmatic and adapted to the primary care context, thereby reflecting the possible effects of a broader implementation. However, cost-effectiveness data should be interpreted with care outside the domestic context, as health care utilization patterns depend on local prerequisites. Although our results are in line with studies from both Europe and the United States, as mentioned previously, future studies must explore further the generalizability of our findings.[16,30]

There are certain weaknesses with our study. First, we could not include more than 28% of the total sample from the original study in this analysis because of informed consent. Nevertheless, the sample size is comparable to other studies, and we did not find any baseline differences between the sample in this analysis and the original study, except for a higher proportion of male participants, for which we adjusted. Second, it was not possible to randomize the practices that participated in the study. There may be differences between the practices that have influenced our results. Third, the costs for municipal care are uncertain, as the data were self-reported, resulting in large numbers of missing values, which is also the case for the HRQoL data. By using multiple imputation, data were supplemented in order to perform an analysis, but this introduces uncertainty that must be considered. We also rely on only 2 follow-up questionnaires after the baseline questionnaire and assume a stable need for municipal care until the next measuring point or death, which implies a risk for underestimation of the need for municipal care. However, we believe that this effect was similar in the 2 groups, as there was no significant difference in QALYs. Thereby, the comparison of municipal care between the groups should not be affected.

Conclusions and Implications

Our results indicate that a proactive CGA intervention in primary care for older adults with high risk of hospitalization is cost-effective under the premises of this study. The results suggest that a target group for CGA can be identified using a prediction model that uses data from medical records. It also supports the notion that a strategy for CGA with a low cost can still result in valuable effects. If the results can be reproduced, this could open up the possibility of CGA also being implemented in settings with scarce resources.

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PAPER IV

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RESEARCH ARTICLE

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Staff experiences of a new tool for comprehensive geriatric assessment in primary care (PASTEL): a focus group study

Primary care staff experiences of geriatric assessment

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ABSTRACT

Objective: Comprehensive geriatric assessment (CGA) is recommended for the management of frailty. Little is known about professionals' experiences of CGA; therefore we wanted to investigate the experiences of staff in primary care using a new CGA tool: the Primary care Assessment Tool for Elderly (PASTEL).

Design: Focus group interviews. Manifest qualitative content analysis.

Setting: Nine primary health care centres in Sweden that participated in a CGA intervention. These centres represent urban as well as rural areas.

Subjects: Nine nurses, five GPs and one pharmacist were divided into three focus groups.

Main outcome measures: Participants' experiences of conducting CGA with PASTEL.

Results: The analysis resulted in four main categories. **A valuable tool for selected patients**: The participants considered the assessment tool to be feasible and valuable. They stated that having enough time for the assessment interview was essential but views about the ideal patient for assessment were divided. **Creating conditions for dialogue**: The process of adapting the assessment to the individual and create conditions for dialogue was recognised as important. **Managing in-depth conversations**: In-depth conversations turned out to be an important component of the assessment. Patients were eager to share their stories, but talking about the future or the end of life was demanding. **The winding road of actions and teamwork:** PASTEL was regarded as a good preparation tool for care planning and a means of support for identifying appropriate actions to manage frailty but there were challenges to implement these actions and to obtain good teamwork.

Conclusion: The participants reported that PASTEL, a tool for CGA, gave a holistic picture of the older person and was helpful in care planning.

KEY POINTS

To manage frailty using comprehensive geriatric assessment (CGA) in primary care, there is a need for tools that are efficient, user-friendly and which support patient involvement and teamwork

- This study found that the Primary care Assessment tool for Elderly (PASTEL) is regarded as both valuable and feasible by primary care professionals
- Use of carefully selected items in the tool and allowing enough time for dialogue may enhance patient-centeredness
- The PASTEL tool supports the process of identifying actions to manage frailty in older adults. Teamwork related to the tool and CGA in primary care needs to be further investigated and developed

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Care planning; comprehensive geriatric assessment; focus group; frailty; primary care

Introduction

The growing elderly population is a major challenge for the health care system in developed countries. Although the majority of persons of old age consider themselves healthy and to live an independent life with relatively modest care needs, multimorbidity and frailty increase with age [1,2].

Various scales and instruments to detect and assess frailty have been developed, and many of them have been tested and validated within cohorts [3]. These

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scales use a wide range of items to capture symptoms or disability measures associated with frailty [4]. Frailty scales provide an estimation of the presence and the degree of frailty, which is valuable for identification, and prognostication of groups or individuals. To manage frailty, other tools are needed. Comprehensive care approaches such as the comprehensive geriatric assessment (CGA) are recommended widely [5]. CGA has been defined as 'a multidimensional, interdisciplinary diagnostic process focused on determining the medical, psychological, and functional capabilities of a frail elderly person to develop a coordinated and integrated plan for treatment and long-term follow-up' [6]. There is no consensus about which different items or scales should be included in CGA [7]. The effectiveness of CGA in a hospital setting has been well demonstrated but the evidence is conflicting regarding management in primary care [6,8–13]. According to the British Geriatric Association, CGA adapted to primary care should include 'a holistic medical review' resulting in an interactive individualised care plan taking into account personal priorities. This type of intervention is time-consuming; therefore, the selection of individuals for these programmes must be careful [5]. There are a number of instruments and programmes for primary care to support the CGA process, as presented in a recent review, but only a few of them have been tested for validity, reliability and feasibility [14]. They share basic components but are not easily comparable as most of them are presented briefly and the instrument itself is not accessible. Many of them use a set of assessment scales or a large set of items with a risk of being time-consuming and less feasible [15].

Very little is known about professionals' experiences of CGA instruments in primary care. We found only one study of professionals' experiences with conducting CGA [16] but the research was not coupled to a specific instrument or to the primary care setting.

In the intervention study, 'Proactive health care for frail elderly persons,' a new work model for frail older people in Swedish primary care was tested [17]. Planning this intervention, we found no primary care oriented CGA tool that was suitable for a Swedish primary care context. Therefore, we constructed 'The Primary care Assessment Tool for the Elderly' (PASTEL): a four-page form based on the holistic approach of CGA. A tool like PASTEL needs to be feasible to apply and should be regarded as valuable by the users in primary care. Accordingly, we wanted to examine their experiences, which could also add to the scarce knowledge on staff experiences of CGA in primary care in general.

Objective

The study aim was to investigate the staff experiences of using PASTEL, a tool for Comprehensive Geriatric Assessment in primary care.

Methods

Three focus group interviews were conducted from November 2017 to March 2018. Focus groups are often used in health research to let individuals with a common experience discuss and share their views and opinions in a way that individual interviews would not permit [18].

Setting

The new CGA tool (PASTEL) was a part of a proactive intervention for older adults at risk for hospitalisation that was implemented in April 2017 [17]. The intervention took place at nine primary care centres in the county of Östergötland in southeast Sweden. These centres represent urban as well as rural areas and different socioeconomic areas. They have a listed population ranging from 6000 to 21 000 inhabitants. The staff involved in the intervention had no previous experience of geriatric assessment in primary care. The participating primary care centres were presented with a list of patients with increased risk for hospitalisation selected with a statistical prediction model [19]. These patients were invited to an interview with a registered nurse guided by the PASTEL form.

PASTEL – the CGA tool

Experienced primary care professionals constructed the PASTEL form (Appendix): a general practitioner, a primary care nurse and a physiotherapist. It contains two main parts. The first part is an interview guide for nurses with mostly multiple-choice questions and a self-rating of health that was intended to be performed partly by telephone, followed by a checklist for brief physical examination together with a medication review. It is completed by three open-ended questions to the patient regarding the main concerns about their health and their needs in the future. The second part is used at a team meeting with the responsible physician and the interviewing nurse to make an estimation of frailty with the Clinical Frailty

Scale [20] and to decide on the need for further investigations including a checklist of actions to support the older adult.

The intention with PASTEL was:

To get a broad picture of the health situation of older adults.
To support encounters where patients could express their own thoughts and wishes.
To facilitate teamwork between nurses and physicians in primary care.
To promote actions according to the needs and personal priorities of patients.

Participants

We gathered a purposive sample with the intention to obtain a high degree of variation. Fifteen participants were invited and three of these cancelled due to a lack of time. The participants were homogeneous in the respect that they all had been part of the project and have used PASTEL. They were heterogeneous in terms of sex, profession, primary care centre (they represented eight out of nine participating primary care centres) and had various levels of experience in the field and different numbers of assessments with PASTEL (Table 1). The participants were invited by e-mail, and written information about the study was included with the e-mail. All participants were also thoroughly informed verbally about the study before the interviews started. The information included the aim of the study, a statement that participation was voluntary and an explanation of how confidentiality was handled. The importance of sharing all experiences about the assessment tool, positive as well as negative, was emphasised.

Procedures

The focus group interviews took place at three different primary care centres, as this was most convenient for the group members, and lasted for 60–75 min.

The interview guide included three key questions:

1. What are your experiences of using PASTEL?
2. How did you capture the patient's own expectations of care and thoughts about the future by using PASTEL?
3. What are your experiences of using PASTEL at the team meetings and for care planning?

The last author (MJ) had the role of the moderator and the first author (MN) functioned as a co-moderator during the interviews. The role of the moderator was to promote interaction among the group members and to create an open discussion environment [21]. MN mainly observed the discussion and posed a couple of supplementary questions. Both authors have a broad experience of working with frail patients of old age: MN as a general practitioner and MJ as an occupational therapist in geriatrics. MJ has previous training and experience in qualitative research. MN was responsible for the construction of PASTEL and for the implementation of the tool at the primary health care centres and was thereby already known by almost all the participants.

Data analysis

The interviews were audio recorded and transcribed verbatim. Qualitative content analysis as described by Graneheim [22] was used to analyse the material. The interviews were analysed in the following steps:

Table 1. List of participants.

Participants	Focus group	Years of work experience	Sex	Number of assessments
Nurse 1	1	8	F	25
Nurse 2	1	11	F	25
Nurse 3	1	11	F	3
GP 1	1	40	M	15
GP 2	1	25	F	5
Pharm 1	2	15	F	35
Nurse 4	2	25	F	3
Nurse 5	2	23	F	8
GP 3	2	25	M	30
Nurse 6	2	33	F	45
Nurse 7	2	34	F	40
Nurse 8	3	38	F	25
Nurse 9	3	10	F	20
GP 4	3	10	M	15
GP 5	3	32	F	8

GP: General Practitioner; F: female; M: male. Nurses were registered nurses or nurse practioners.

Table 2. Examples from the analysis.

	Condensed meaning unit	Code	Subcategory	Category
No, so I generally think that this patient group requires more eyes than mine, so to speak.	Patient group requires more eyes.	Teamwork is needed	Challenges for the team	The winding road of actions and teamwork
I tried to focus on his (the patients) story and experiences and then she (the wife) supported him when he could not really express what he meant …	Focuses on the patients story and the relative supports when needed.	Relatives are supportive	Participation of relatives can be helpful but sometimes unfavourable	Creating conditions for dialogue
That is you get a structured information … yes, it gives a holistic view, right, on all the problems.	Get structured information and a holistic view	Structured information Holistic view	Structure gives the overview needed for action	A valuable tool for selected patients

1. Open reading and listening to the interviews to get a good understanding of the content.
2. The meaning units of the text that were important to participants' experiences of using PASTEL were identified.
3. The meaning units were labelled into codes, resulting in 193 codes.
4. The codes were condensed and sorted into categories and subcategories.

All steps were first carried out separately by authors MN and MJ and then together. The software Open Code 4.03 was used during the analysis. During all steps, a critical discussion was held between the authors to widen their understanding of the content. A third person with extensive experience of qualitative methods and interviews also read the transcribed interviews and served as a discussion partner for each step during the analysis. This person was not involved in the construction of the tool nor the interviews in order to minimise bias in the analysis and enhance the trustworthiness of the study.

Results

Four main categories and 10 subcategories emerged (Table 3) that describe the participants' experiences of PASTEL which are presented below.

A valuable tool for selected patients

Structure gives the overview needed for action

The participants reported that the assessment tool was a valuable instrument in their work with frail older adults. Interviews using PASTEL gave a structured holistic picture of the individual's health situation and identified the patient's own thoughts and needs. The participants regarded the interviews as a good preparation for care planning and a means of support to identify actions.

They also stated that PASTEL provided an incentive to take a long-term and preventive approach in their work.

> I think for me it has really provided a structure. I think it has been very helpful, and as you say when you talk to your patients and their relatives, this makes you dig a bit deeper, an impression that you almost cover all areas (Nurse 7)

Who is the right patient?

Ideas about who was the right patient for assessment with PASTEL differed; some thought the interview could be too extensive and time-consuming for relatively healthy older people. The selection of patients in the intervention resulted in a considerable proportion of non-frail individuals and a great variation in degree of frailty. A few participants considered PASTEL to benefit non-frail elderly people as well. Some pointed out that although they met with well-known patients, the use of PASTEL provided valuable new information. Others found that patients living in nursing homes did not get much benefit from the assessment because their needs had already been identified and met by care planning, but there were examples when valuable information was presented also from these assessments. Many participants stated that it was important to meet the patient when frailty had put the patient in a situation where he/she was in need of action. At the same time, someone argued that health care professionals have to meet the patient before they can really tell if he/she has important needs.

> When you say that many patients are really well taken care of (already before the assessment), did you ever think: 'this was needless … we should have used the resources in another way' (moderator)

Table 3. Categories and subcategories.

Category	Subcategories
A valuable tool for selected patients	Structure gives the overview needed for action
	Who is the right patient?
Creating conditions for dialogue	Time and adaptation is important
	Managing cognitive dysfunction
	Participation of relatives can be helpful but sometimes unfavourable
Managing in-depth conversations	Specific questions can create deep conversations
	Talking about the future is valuable but not always appreciated
	Death – a sensitive subject
The winding road of actions and teamwork	Actions were often initiated during the interview
	The team-meeting – a starting point for care planning
	Challenges for the team

> No, I have had a good feeling about it. Still there is a lot that comes to light where we have been able to help in different ways… that can prevent… and I feel that the patients appreciate it … It feels like it gives them security too, a general sense of security. (Nurse 8)

> Yes and then to get this helicopter view in a way that we have some difficulties with …even if we have good knowledge we havent done the actual evaluation in the way we do now [with PASTEL] (GP4)

Creating conditions for dialogue

Time and adaptation are important

PASTEL interviews lasted about one hour on average. The participants (nurses) who had carried out the interviews described how they tried to adapt the tool to be useful in their work context and to meet the needs of the individual patients. The majority of participants stated that the initial telephone interview of PASTEL was difficult to perform due to, for example, hearing impairment, and that it felt inappropriate to ask some of the questions over the phone. As a result, most participants chose to carry out the entire interview during a visit. This was also believed to be more efficient. The participants reported that they managed to give the patients enough time in a context where they could more easily bring up their own questions compared with a regular medical visit where time often is scarce.

> And it gives the opportunity for patients to bring up issues that bother them when they're at the doctor's visit, and maybe they feel they want to, but then they notice that the doctor is stressed … And they walk out with their problem anyway, but here they may get the opportunity to bring up something they have thought about for a long time. (Nurse 6)

The majority of the participants preferred to start the interview with practical items like going through the medication list or talking about activities of daily living, saving questions about psychological health and thoughts about the future until later in the conversation. These questions often led to discussions about sorrow and loneliness.

Managing cognitive dysfunction

Each patient's cognitive ability determined how the participants adapted the questions and to what extent they needed to use other sources of information. Some questions needed to be rephrased one or two times to help the patient to express themselves. A few participants found that interviewing patients with more severe cognitive impairment did not add much to the picture, while others found it possible to adjust the questions to obtain valuable information in this context.

> I mean that the lady that I am thinking of, she suffers from dementia and has difficulties with answering for herself at all. So I think that an interview will be hard to carry out. (Nurse 3)
>
> For whom should that interview be carried out? (Nurse 2)
>
> You think that you wouldnt be able to capture what she really wants and thinks about… (Moderator)
>
> No, no exactly! (Nurse 3)
>
> But in the evaluation of that persons whole situation so to speak then [PASTEL] could be a support, even if you cannot interview her in the same way as if she were cognitively able. (GP 1)

Participation of relatives can be helpful but sometimes unfavourable

There was a great deal of interest from relatives in taking part in the interview. In most cases, the relatives provided support for the patient, but there were situations where the nurse took action to meet patients without a relative in order to capture the patients' own experiences and views.

Managing in-depth conversations

Specific questions can create deep conversations

Several participants indicated that PASTEL helped to create in-depth and meaningful conversations. This occurred despite the fact that the majority of the questions were specific, with multiple-choice alternatives. Questions about psychological factors opened up and deepened the conversation. The predominant experience was that the patients were openhearted and had a desire to share their stories. The conversations could be long and could often include stories of grief and loneliness. Sometimes it was difficult to limit the conversation in order to cover all questions during the same visit.

> My experience is that, it's like opening Pandora's box when they arrive, 'Someone will listen to me now,' and for a while I had, like five, six, seven assessment visits when everyone cried … it was like 'Now it's my time' and now everything comes out. It has sometimes been difficult to relate to this because you … there have been other things that needed to be talked about … A lot of grief and loneliness and fear of death and such heavy subjects coming up. (Nurse 1)

Talking about the future is valuable but not always appreciated

Many of the participants stated that the three open-ended questions about personal priorities and thoughts about future needs in PASTEL were very valuable. However, some of them thought that the questions were somewhat difficult, as the concept of 'the future' was considered too imprecise. In addition, some patients were not so interested in reflecting on the future, which gave rise to vague answers.

> And when you ask: 'How do you view your housing situation in the future?' It is a great question and it is relevant, but many of them, I was really surprised because, I mean they are old and ill, but they do not think a lot about the future. I mean in the way that (laughing): they get along now, they manage, they are OK … So they don't think about it. (Nurse 7)

Still, the open-ended questions were seen as a good summary of patients' own thoughts and needs. The answers could include anything from fears about suffering at the end of life to more practical things like how to take care of a wound or get help with cleaning windows.

Death – a sensitive subject

A couple of participants explained that the subject of death often came up during their interviews while others seldom or never touched on the subject with their patients. A discussion came up in all three focus groups about whether you should formulate specific questions about death and end of life. There were suggestions about having a more direct question about attitudes towards the level of care at end of life to capture fears and worries about suffering, while several participants pointed out that these questions must be personalised and could be inappropriate. Some perceived death as a sensitive subject and had concerns about what reactions could arise if brought up in the wrong context.

The winding road of actions and teamwork

It became clear in all focus groups that actions to handle frailty to support older people were initiated during the interview, and before and during the team meeting.

Actions were often initiated during the interview

The majority of the participants found that the interview worked as an action in itself when the nurses were listening, providing information and giving advice. An example of a more long-term intervention that occurred during the interview was the initiation of a process in which the patient became aware of, for example, the need for a change in the housing situation. Actions initiated by nurses before the team meeting included advice on medication management, wound dressing, coordination of home care, contact with occupational therapists regarding technical aids, referral to a physiotherapist or contact concerning activities and social support. Both GPs and nurses agreed that many of these actions would never have taken place without the assessment guided by PASTEL and that these actions could have a preventive effect, for example in preventing falls or making the elderly person more secure in his/her home. Loneliness was perceived as being difficult to deal with, and several participants stated that they had difficulty with finding resources that could provide psychosocial support for older persons in need.

> For me its quite an important thing about the elderly … many lonely people … they dont feel well at home and you have to pay attention and listen, or help them to get in contact with someone to talk to, at the church or anywhere … if they manage … (Nurse 4)

However, the process of initiating actions was not uncomplicated. One participant said she thought that

discussing, for example home care could raise expectations for patients that were not possible to realise and therefore one should be cautious about proposing different kinds of support. In addition, it was not unusual that patients declined to receive support or other actions. Someone reported that continuity and regular check-ups were what the patients appreciated most.

The team meeting – a starting point for care planning

The team meeting was primarily a discussion between the nurse who had conducted the interview and the responsible GP, and lasted 10–20 min per patient. Actions at the team meeting could be referral for additional investigation, initiation of home care or change in medication. Participants from the two primary care centres that had a pharmacist in their team appreciated the pharmacist's participation in the team meeting. The medication review and associated actions were generally regarded as some of the most important parts. Introducing a case manager nurse was an action that was valuable for the majority of the patients according to the participants. The assessment with the Clinical Frailty Scale was a part of PASTEL that was considered important for care planning and provided a moment when members of the team could merge their different views and impressions of the patient's condition.

Challenges for the team

There was a consensus among participants that teamwork is essential in the care of frail older adults in primary care. Several referred to the existence of structures in primary care developed for other groups of patients, like dementia or diabetes patients, but which had been previously lacking for this group of patients. They emphasised the importance of having regular team meetings and of limiting the timespan between the interview and the team meeting, as there is a risk of losing more subtle information. Nurses also pointed out the difficulty of presenting information that was said 'between the lines' and that was hard to document. There was a lot of responsibility for nurses in the team, which was considered mostly positive as long as there was mutual understanding and a team commitment to the task.

> Its a lot of responsibility on me and thats fine … but at the same time I've felt that the interest from my doctors to do this together with me has been a bit weak. Especially the team meeting has been a little like: 'Well we fill in the check-list right like you said here.' I dont think that is whats intended with the team meeting … It should be more precise, like who is responsible and who will do the follow-up (Nurse 9)

Some participants stated that teamwork was facilitated if the GP had good knowledge of and a long-term relationship with the patient. The lack of occupational therapists and physiotherapists connected to the team was considered a problem: these professionals seldom have contact with the primary care centres because they belong to a different organisation, the municipality. However, in small municipalities where there was just one primary care unit, it appears that good collaboration was easier to achieve.

> In that respect they are so fortunate in [a small community], you know. Every Thursday morning I meet all the nurses and occupational therapists in the municipality there, so a couple of times when we have had these frail ones … Then I can address it at that meeting so to speak and we decide what to do. (GP1)

Discussion

Main findings

The study results suggest that the assessment tool PASTEL assists in performing the important functions of comprehensive geriatric assessment (CGA) in primary care. The participants reported that an assessment with the tool gave a holistic picture of the patient and was helpful in care planning. PASTEL was regarded as beneficial also for pre-frail individuals but was sometimes experienced as too extensive for relatively healthy older adults. Nurses emphasised the importance of having enough time for the interview and adapted the tool to create good conditions for dialogue. These conditions together with patients desire to share their stories created deep and significant conversations according to the participants. Actions to support older people were identified and executed both during the interview with nurses and at the subsequent team meeting. PASTEL seems to play a significant role in this process but the participants also described challenges regarding teamwork and carrying out actions.

Strengths and limitations

A strength with this study is that we formed heterogeneous groups consisting of participants with different professions and levels of experience. In all focus groups, there were participants from two or three

primary care centres. The focus group method gave us an opportunity to encourage interaction between the participants. This helped to gather material as rich as possible regarding staff experiences of CGA in our intervention despite that the number of participants was limited.

The interviewing authors have a broad experience of working with frail patients in general practice and geriatrics. The fact that one of the interviewers (MN) was responsible for the implementation of PASTEL might have influenced the participants in their answers making them unwilling to criticise the tool. On the other hand, that may have motivated them to participate and share both positive and negative experiences. At the interviews we therefore let MJ lead the discussion and emphasised that we wanted all kinds of reflections and that their participation could help to improve the tool.

Being part of designing the intervention and working in primary care with frail individuals was an important part of the preunderstanding of the first author (MN). The advantage of this is a deeper understanding of the participants working situation but there is a potential risk of bias in the analysis. To address this issue the authors held critical reflexive discussions during the process of coding and categorising and we triangulated our coding and interpretation with an experienced researcher who was neither part of the intervention nor the construction of PASTEL. Minimising bias was also a reason for us to keep the analysis close to the text and at a low level of interpretation [23].

The experiences of our participants reflect the specific intervention they were part of [17]. They assessed patients selected with a digital prediction model [19], which limits generalisability to some extent. Still, a substantial part of the results reflects experiences of CGA in general, for example the challenge to capture the individual views and preferences of an older adult and to have conversations about the future or end of life. The generalisability of the results is likely to be limited to countries with similar cultures and primary health care systems but some of the findings are probably applicable to a wider context.

Comparison with existing literature

The study cannot answer the question of how PASTEL performs in comparison with other CGA tools but the participants experiences of the value of PASTEL in clinical practice is consistent with descriptions of CGA in previous studies [6,7]. PASTEL also covers most of the areas of unmet needs that older people themselves have identified as important [24]. The challenge of covering all the important aspects of CGA and ensuring that the tool remains feasible in a primary care setting is described by Stijnen et al. in a Dutch setting [25]. In Belgium, GPs perceived that the 300-item MDS-HC (Minimal Data Set-Home Care) was too extensive and that it gave little added value in establishing a personal management plan [15]. We did not use multiple validated scales for different aspects of frailty in PASTEL, but focused more on creating dialogue based on a relatively low number of questions. In addition to checking various items, the nurse must establish a trusting relationship with the elderly person to get a full picture of the patient's needs and to ensure acceptance of care [26]. A prerequisite for this is having enough time and letting patients share their stories [27]. Even if most of the nurses in our focus groups were experienced in communication, they still thought that PASTEL helped them to create in-depth conversations. The fact that PASTEL has an open structure with room for adaptation may have contributed to this. In a previous focus group study on staff experiences from both hospital and community care in Sweden, participants shared the view that experience and competence was more important than standardised testing [16]. This is in line with the views of our participants though they didnt have previous experience of CGA. To adapt the assessment to the individual to focus on indicators of quality of life and the person's own values, rather than using a lot of scales, was considered a high priority also in the recommendations from the American Geriatrics Society Expert Panel on Person-centred Care [28].

The challenge of tackling loneliness among elderly people was stressed by our participants. Evolving strategies to deal with this is essential. In a recent complex intervention study from England, a combination of different social activities and strengthening of networks in the local community showed promising results [29].

The selection of patients for this kind of thorough assessment is difficult, but is important in order to achieve meaningful actions, which is also stressed in frailty guidelines and in earlier studies [5,30]. The patients in this study were selected using a digital method and were invited to participate as a part of the intervention. A noticeable proportion of the selected patients was rather healthy or pre-frail older adults, which probably explains why the participants in some cases found the assessment too extensive. At the same time, someone stated that often you have to meet the individual to be able to assess frailty in a

reliable way. In the absence of a perfect screening method for frailty, we believe that an assessment tool like PASTEL should support adaptation to various stages of frailty. The interviewer should be able to conduct a shorter interview when there are no apparent signs of frailty and to prioritise more time for individuals with greater needs.

Continuity of care has been proven important, especially for patients with multimorbidity [31–33]. The value of a long-term doctor-patient relationship was brought up several times in the interviews [34]. For the more frail individuals with insufficient autonomy, there is an additional need for a nurse to take the role of a case manager [35]. This function forms a bridge between patients and their doctors and helps to coordinate care for the patients.

The teams at the primary care centres consisting of a nurse and a physician have probably an effective size for most occasions, but there is a need to expand the team in more complicated cases. This was pointed out as a concern by both GPs and nurses and is a demanding task for the integrative care system. The role of PASTEL and the function and organisation of a team for CGA need to be further investigated, considering that they are an essential part of CGA, and earlier research has indicated that CGA is less effective when it is performed by individual professionals compared with a team [36,37].

Meaning of the study

To provide good health care for the increasing population of frail elderly persons, primary care must evolve proactive strategies for recognition and treatment. Structured assessment is the first step in creating individualised care plans and there is a need for assessment tools that are both feasible and efficient in the primary care setting. We conclude that the CGA tool PASTEL was perceived as feasible and helpful in care planning. Furthermore, the tool can be useful for patients' involvement in care planning and thus supports a person-centred care approach in CGA.

Ethical approval

The intervention study received ethical approval from the regional ethics committee. Ref.: 2016/347-3. According to Swedish regulations, ethical approval was not required specifically for the focus group interview. However, the participants were informed thoroughly both in written form and verbally about the aim of the study, that participation was voluntary and how confidentiality would be handled. The study follows the principles of the declaration of Helsinki.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix:

Region Östergötland

Pastel assessment tool

Date of birth:..... **Dates:** Interview: .....

Name of patient:..... Visit: .....

Primary health care centre:..... Team meeting: .....

☐ Questionnaire was sent out by post.

Note: Ask for consent and fill in the assessment of communication and cognition.

Telephone interview

For some questions, it may be appropriate to fill in multiple boxes

1. Overall health
☐Excellent
☐Very good
☐Good
☐Moderate
☐Poor

2. Health today compared to one year ago
☐Much better
☐Somewhat better
☐About the same
☐A bit worse
☐Much worse

3. Vision
☐Good vision (with or without aids)
☐Poor vision

4. Hearing
☐Good hearing (with/without aids)
☐Poor hearing

5. Driver's licence
☐Yes, and is driving
☐Yes, but does not drive
☐No

6. Psychological factors	Often	Sometimes	No
Do you feel depressed?	☐	☐	☐
Do you feel worried?	☐	☐	☐
Do you feel lonely?	☐	☐	☐
Do you have pain?	☐	☐	☐
Do you have trouble sleeping?	☐	☐	☐

7. The last three months	Yes	No
Increased fatigue or reduced energy	☐	☐
Increased breathlessness	☐	☐
Increased dizziness and/or instability	☐	☐
Weight loss	☐	☐
Fallen once or more	☐	☐

8. Living condition
☐Live alone
☐With husband/wife/partner
☐With children/other person

9. Type of accommodation
☐Ordinary housing (independent)
☐Sheltered accommodation
☐Nursing home – permanent
☐Nursing home – temporary

10. Relatives/friends
☐Relatives/friends nearby (same city)
☐Relatives/friends but only a long distance away
☐No relatives/friends

11. Mobility
☒Indoor without aids
☐Indoor with aids
☐Outdoor (neighbourhood) with aids
☐Outdoor (neighbourhood) without aids
☐Able to take longer walks without aids

12. Technical aids
☐Lifter
☐Wheelchair
☐Hygiene aids
☐Walking aids indoors
☐Walking aids outdoors

13. Home care
☐Personal hygiene
☐Night care
☐Attendance
☐Personal alarm
☐Food/meal delivery
☐Help with support stocking
☐Cleaning

14. Medication
How many different medications do you take each day?
.....

Note: Send a medication list to the patient to fill in and bring to the visit.

15. Consent
☐Consent to share medical records within the county
☐Consent to share medical records outside the county

Assessment carried out by the interviewer

Communication
(the ability to express oneself comprehensibly and understand questions)
☐No impairment
☐Mild impairment
☐Severe impairment

Cognition
(memory, follows the conversation, insight, judgement)
☐No impairment
☐Mild impairment
☐Severe impairment

Region Östergötland

Pastel assessment tool

Visit to the health care centre

1. ADL (activity of daily living)

	Independent	Partly dep.	Dependent
Dressing	☐	☐	☐
Feeding	☐	☐	☐
Toileting	☐	☐	☐

2. Oral health (inspection)

	Yes	No
Has the patient any of the following:		
Problems in the mouth or throat	☐	☐
If yes, type of problem:		
In need of dentist referral	☐	☐
Wears dentures	☐	☐

3. Wounds (inspection)
☐Yes, type of wound: .....
☐No

4. Incontinence

Suffers from	Using aids
☐Yes	☐Pads
☐No	☐Indwelling catheter
	☐Intermittent catheter

5. Alcohol consumption per week
☐ None
☐ Less than one standard glass
☐ 1-4 standard glasses
☐ 5-9 standard glasses
☐ 10-14 standard glasses
☐ 15 or more standard glasses

6. Smoking
☐ Never smoked
☐ Smoker
☐ Stopped > 6 months ago
☐ Stopped < 6 months ago
☐ Passive smoker

7. Snuff
☐ Never used snuff
☐ Regular use
☐ Stopped > 6 months ago
☐ Stopped < 6 months ago

8. Exercise habits
☐ A walk of at least 30 minutes once a week
☐ A walk of at least 30 minutes a couple of times a week
☐ A daily walk of at least 30 minutes
☐ Other regular exercise .....
☐ No regular exercise
☐ Does not exercise at all

9. Review of medication list
Note deviations between what the patient actually takes and the list of medicines in medical records
☐Yes, there is a correspondence
☐No, there is not a correspondence
If no, what does not correspond:

.....

.....

.....

10. Medication aids and/or assistance
☐ Pill box
☐ Medication dispensing
☐ Assisted by a relative
☐ Assisted by home care
☐ Other assistance

Difficulties with intake/inhalation of medicines: large pills etc.
☐Yes
☐No

11. Side effects
☐Yes
☐No

If yes, what kind of side effects:

.....

.....

.....

Region Östergötland

Pastel assessment tool

Visit to the health care centre

12. Medical examination

Date:.....

Blood pressure.....

Pulse.....

Height.....

Weight.....

BMI.....

Oxygen saturation.....

COPD6.....
(not mandatory)

Blood samples
> 3 months since last test:
Take a new test and note the value below
< 3 months since last test: *note the latest value below*

Haemoglobin.....

Creatinine.....

(If other samples are taken, note below)

.....

.....

13. Additional questions to the patient

What help do you need? What is the most important to you?

.....

.....

.....

What are your thoughts about your future living condition/housing?

.....

.....

.....

What kind of assistance and support do you think you will need in the future (at home)?

.....

.....

.....

.....

Additional information:

Region Östergötland

Pastel assessment tool

Team meeting

Frailty Assessment:

In this box, we used the Clinical Frailty Scale, developed by Rockwood et al.:

Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, et al. A global clinical measure of fitness and frailty in elderly people. Canadian Medical Association Journal. 2005;173(5):489-95

Actions/referrals	Recommended		Priority	Planned	Finished
	Yes	No		(date)	(date)
Medical investigation	☐	☐	☐		
Medical treatment	☐	☐	☐		
Medication review	☐	☐	☐		
Case manager/contact nurse	☐	☐	☐		
Medical care plan	☐	☐	☐		
Coordinated care plan	☐	☐	☐		
Risk assessment (MNA, DFRI, Norton)	☐	☐	☐		
Functional assessment (physiotherapist)	☐	☐	☐		
Activity assessment (occupational therapist)	☐	☐	☐		
Communication support (speech therapist)	☐	☐	☐		
Cognitive testing	☐	☐	☐		
Social services assessment	☐	☐	☐		
Community-based home care	☐	☐	☐		
Palliative care/consultation	☐	☐	☐		
Psychosocial support	☐	☐	☐		
Other:					

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