Physical Fitness in Hospitalized Frail Elderly Patients

Kristina Åhlund

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Kristina Åhlund

Department of Medical, Health and Caring Sciences
Linköping University, Sweden
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To my family
Johan, Vilgot and Elvira

En liten darrig gumma
vill lägga sig och dö
när vinden drar i springan
och ingen skottar snö

När ingen går på stigen
och ingen bär in ved
och hon är klen och uschlig
och stel i varje led

Men när det börjar knoppas
på träden i april
då vill hon gärna leva
ja, leva lite till!

Britt G Hallqvist

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ABSTRACT

Demographic research shows that the proportion of older people in society is increasing. More people age well, but there are also more people getting old with disability and multimorbidity. The large diversity in functioning illustrates the heterogeneity of aging. Accelerated aging may lead to frailty, which is a geriatric syndrome, often used as a marker of biologic age and associated with decreased physiologic reserves, increased vulnerability and the risk of adverse health outcomes. Frail elderly people are frequent visitors within emergency hospital care and physical decline is common. Unfortunately, elderly patients with substantial multimorbidity are often excluded from clinical trials.

Physical fitness comprises a set of measurable health- and skill-related outcomes, such as cardiorespiratory endurance and muscle strength. A decrease in physical fitness may affect the prognosis negatively. However, previous research indicates that it may be possible to reverse frailty and improve physical fitness. It is therefore of the utmost interest to identify frailty and study how care is best provided, in order to prevent, reduce and postpone adverse health consequences.

The overall aim of this thesis is to study physical fitness in a group of frail elderly patients, within clinical hospital health care. The patients' physical fitness will be evaluated and compared in different care settings during and after hospitalization. The aim is also to study the long-term consequences of changes in physical fitness in relation to mortality. To better understand the underlying factors for participation in physical activity and exercise, patients' perceptions of the phenomena will be explored.

This thesis consists of four papers based on two studies comprising frail elderly patients with substantial multimorbidity, in connection with an in-hospital episode.

Paper 1 was an observational study with a cross-sectional design (n=408). Different components of physical fitness were measured during an index hospital stay and the results showed that hospitalized frail elderly patients performed below previously described age-related reference values. Furthermore, physical fitness was associated with the degree of frailty, rather than the chronological age.

Paper 2 was a prospective controlled trial, with two parallel groups. The patients included in the intervention group (n=206) were cared for at an emergency medical care unit providing care according to Comprehensive Geriatric Assessment and

care (CGA). The control group (n=202) was cared for at conventional emergency medical care units. The multi-professional care approach at the CGA unit was shown to be beneficial, in terms of a greater proportion of patients who preserved or improved their function during the first three months after discharge from hospital, compared with conventional care.

Paper 3 had a prospective approach when evaluating the association between physical fitness and one-year mortality in those 390 patients discharged alive from a hospital care episode. The results showed that physical fitness during in-hospital care and the change in physical fitness during the first months after discharge were associated with one-year mortality.

In **Paper 4**, the patients' perspective in terms of physical activity and exercise was explored. The theme of "Meaningfulness and risk of harm in an aging body" emerged, followed by the three categories of physical activity as part of daily life, goals of physical activity and exercise and prerequisites for physical activity and exercise.

These studies highlight the importance of a greater focus on physical fitness in hospitalized elderly patients. A careful assessment and a multi-professional approach may lead to beneficial results and better survival even in a group of frail elderly patients with severe multimorbidity. To increase physical activity and exercise in this group of patients, health care probably needs to improve the means of communicating the benefits and goals of exercise and facilitating them so that the risk of harm is reduced.

Key words: Physical fitness, frailty, in-hospital care, comprehensive geriatric assessment

SVENSK SAMMANFATTNING

Demografisk forskning visar att andelen äldre i samhället ökar. Fler människor åldras välmående, men det är också fler människor som åldras med funktionshinder och multisjuklighet. Det finns en stor variation i fysisk funktionsförmåga hos äldre, vilket speglar åldrandets heterogenitet. Hos människor med ett snabbt åldrandeförlopp ses en påverkan på fysiologiska faktorer, vilka ofta är förknippade med en högre biologisk ålder och skörhet. Skörhet (frailty på engelska) är ett geriatriskt syndrom, associerat med minskade fysiologiska reserver, ökad sårbarhet och ökad risk att drabbas av negativa hälsoutfall. Sköra äldre anses ha ett ofta återkommande behov av akutsjukvårdens resurser och fysisk försämring är vanligt. Kunskap om sköra äldre med betydande multisjuklighet är begränsat då de ofta är exkluderade från kliniska studier.

Fysisk kapacitet innefattar flera olika mätbara hälso- och skicklighetsrelaterade utfall, t.ex. kardiorespiratorisk kapacitet och muskelstyrka. Fysisk kapacitet påverkas negativt av skörhet och en minskning i fysisk kapacitet är associerat med en försämrad prognos. Tidigare forskning har visat att det är möjligt att förbättra fysisk kapacitet och därmed påverka graden av skörhet. Därför är det av största betydelse att identifiera sköra individer och att studera hur vården bäst bör utformas för att förebygga, minska och skjuta upp negativa hälsoutfall.

Det övergripande syftet med denna avhandling är att studera fysisk kapacitet i en grupp sköra äldre patienter inom akutmedicinsk sjukhusvård. Patienternas fysiska kapacitet utvärderas och jämförs i olika vårdformer, under och efter utskrivning från sjukhus. Syftet är också att studera långtidseffekterna av förändring i fysisk kapacitet avseende dödlighet. För att bättre förstå de underliggande faktorerna för deltagande i fysisk aktivitet och träning studeras patienternas egna uppfattningar av fenomenet.

Denna avhandling består av fyra artiklar som baseras på två studier innefattande sköra äldre patienter med betydande multisjuklighet, i anslutning till ett akutmedicinskt vårdtillfälle på sjukhus.

Artikel 1, baserades på en observationsstudie med tvärsnittsdesign (n=408). Olika komponenter av fysisk kapacitet mättes under ett index-vårdtillfälle och resultatet visade att sköra äldre patienter på sjukhus presterade under tidigare beskrivna åldersrelaterade referensvärden. Vidare, var fysisk kapacitet associerat med graden av skörhet snarare än kronologisk ålder.

Artikel 2, baserades på en prospektiv, kontrollerad studie med två parallella grupper. Patienterna som inkluderades i interventionsgruppen (n=206) fick akutmedicinsk sjukhusvård enligt Strukturerat Omhändertagande av Äldre (*på engelska förkortat CGA*). Kontrollgruppen (n=202) fick akutmedicinsk vård på en konventionell invärtesmedicinsk vårdavdelning. Det multiprofessionella omhändertagandet som kännetecknar CGA var fördelaktigt jämfört med konventionell vård och en större andel patienter bibehöll eller förbättrade sin fysiska kapacitet de första tre månaderna efter utskrivning från sjukhus.

Artikel 3, baserades på den kontrollerade studien och syftade till att prospektivt analysera associationen mellan fysisk kapacitet och 1-års mortalitet hos de 390 patienter som var i livet vid utskrivning från index-vårdtillfället. Resultaten visade att fysisk kapacitet under vårdtiden på sjukhus och förändringen i fysisk kapacitet de tre första månaderna efter utskrivning, båda var associerade med 1-års mortalitet, där låg fysisk kapacitet och försämring medförde högre dödlighet.

Artikel 4, baserades på en intervjustudie och utforskade patientperspektivet gällande fysisk aktivitet och träning. Analysen visade på temat "Meningsfullhet och risk för skada i en åldrande kropp", baserat på tre kategorier; "fysisk aktivitet som del av dagligt liv", "mål med fysisk aktivitet och träning" och "förutsättningar för fysisk aktivitet och träning".

Resultaten belyser vikten av att tydligt fokusera på fysisk kapacitet hos sköra äldre patienter som vårdas på sjukhus. En noggrann bedömning och ett multiprofessionellt omhändertagande tycks leda till fördelaktiga resultat, även hos sköra äldre patienter med en betydande multisjuklighet. Sjukvården behöver sannolikt förbättra kommunikationen angående fysisk aktivitet och träning, för att patienter bättre ska förstå fördelar och mål med träning och att de upplevda riskerna för skada ska minskas.

LIST OF PAPERS

- 1: Åhlund K, Ekerstad N, Öberg B, Bäck M. Physical performance impairments and limitations among hospitalized frail older adults. *J Geriatric Physical Therapy* 2018; 41:230-235
- 2: Åhlund K, Bäck M, Öberg B, Ekerstad N. Effects of comprehensive geriatric assessment on physical fitness in an acute medical setting for frail elderly patients. *Clinical Interventions in Ageing*. 2017; 12:1929–1939
- 3: Åhlund K, Ekerstad N, Bäck M, Karlson B.W , Öberg B. Preserved physical fitness is associated with lower 1-year mortality in frail elderly patients with a severe comorbidity burden. *Clinical Interventions in Ageing*. 2019; 14:577–586
- 4: Åhlund K, Öberg B, Ekerstad N, Bäck M. A balance between meaningfulness and risk of harm in an ageing body – frail elderly patients’ perceptions of physical activity and exercise – an interview study. In manuscript

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Some additional calculations are added in the result section of this thesis.

LIST OF CONTRIBUTIONS

Paper 1

Study design:	Kristina Åhlund , Niklas Ekerstad, Birgitta Öberg, Maria Bäck
Data collection:	Kristina Åhlund , Björn Karlson, Niklas Ekerstad
Data analysis:	Kristina Åhlund , Niklas Ekerstad, Birgitta Öberg, Maria Bäck, Henrik Hedevik
Manuscript writing:	Kristina Åhlund , Niklas Ekerstad, Birgitta Öberg, Maria Bäck
Manuscript revision:	Kristina Åhlund , Niklas Ekerstad, Birgitta Öberg, Maria Bäck

Paper 2

Study design:	Kristina Åhlund , Maria Bäck, Birgitta Öberg, Niklas Ekerstad
Data collection:	Kristina Åhlund , Björn Karlson, Niklas Ekerstad
Data analysis:	Kristina Åhlund , Niklas Ekerstad, Birgitta Öberg, Maria Bäck, Henrik Hedevik
Manuscript writing:	Kristina Åhlund , Maria Bäck, Birgitta Öberg, Niklas Ekerstad
Manuscript revision:	Kristina Åhlund , Maria Bäck, Birgitta Öberg, Niklas Ekerstad

Paper 3

Study design:	Kristina Åhlund , Maria Bäck, Niklas Ekerstad, Björn Karlsson, Birgitta Öberg
Data collection:	Kristina Åhlund , Niklas Ekerstad, Björn Karlson
Data analysis:	Kristina Åhlund , Maria Bäck, Niklas Ekerstad, Björn Karlson, Birgitta Öberg, Henrik Hedevik
Manuscript writing:	Kristina Åhlund , Niklas Ekerstad, Maria Bäck, Björn Karlson, Birgitta Öberg

Manuscript revision: **Kristina Åhlund**, Niklas Ekerstad, Maria Bäck,
Björn Karlson, Birgitta Öberg

Paper 4

Study design: **Kristina Åhlund**, Birgitta Öberg, Niklas Ekerstad,
Maria Bäck

Data collection: **Kristina Åhlund**

Data analysis: **Kristina Åhlund**, Birgitta Öberg, Niklas Ekerstad,
Maria Bäck

Manuscript writing: **Kristina Åhlund**, Birgitta Öberg, Niklas Ekerstad,
Maria Bäck

ABBREVIATIONS

ADL	Activities of Daily Living
CCI	Charlson's Comorbidity Index
CFS	Clinical Frailty Scale
CGA	Comprehensive Geriatric Assessment
CI	Confidence Interval
CONSORT	Consolidating Standards of Reporting Trials
COREQ	Consolidated Criteria for Reporting Qualitative Research
ED	Emergency Department
FI	Frailty Index
FRESH	FRail Elderly Support researchH group
HS	Handgrip Strength
HR	Hazard Ratio
IADL	Instrumental Activities of Daily Living
ICC	Intra Correlation Coefficient
METs	Metabolic Equivalents
MNA	Minimal Nutrition Assessment
MÄVA	Medicinsk Äldrevårdsavdelning (<i>In Swedish</i>)
NU	NÄL-Uddevalla Hospital Group
OR	Odds Ratio
Peak VO ₂	Maximal Oxygen Consumption
RM	Repetition Maximum
RPE	Rate of Perceived Exertion
SOC	Sense of Coherence
STROBE	Strengthening the Reporting of Observational studies in epidemiology
TREEE	Is the Treatment of Frail Elderly Patients Effective in an Elderly Care Unit
TUG	Timed Up-and-Go
WHO	World Health Organization
5-STST	Five-Times Sit-to-Stand Test
6-MWT	The Six-Minute Walk Test

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BACKGROUND

Demographics

For health care and research purposes, older adults are often sub-divided into three categories: young-old (65-74 years old), old-old (75-84 years old) and oldest-old (≥ 85 years old)¹. In statistical contexts where social economy is included, divisions with five-year groups for age are often used and the proportion over or under 80 is discussed^{2,3}.

Nowadays, elderly people are surviving longer than ever before and the number of elderly individuals in each category is increasing throughout the world. From an international perspective, older adults (≥ 80 years) will represent 12% of the European Union population by 2060³. In Sweden, the number of people 80 years or older is estimated to increase dramatically over the next 20 years. In 2040, there will be almost one million Swedes above 80 years of age².

Figure 1: Forecast of the number of people aged 65-79 years and 80+ in Sweden

The number of people in Sweden aged 65-79 and 80 years or older in 1960-2013 and a forecast for 2014-2060.
Source: Statistics in Sweden²

The heterogeneity of aging

The World Health Organization (WHO) uses the term “intrinsic capacity” to describe the composite of an individual’s total physical and mental capacity. This will change during the life course and is influenced by different aspects in life. There is a peak in intrinsic capacity during early adulthood and, from midlife onwards, decline is common. The trajectory tends to show great variability, where some components may decline to a greater extent, while others remain stable or even increase. This leads to great diversity in health and functional conditions in older people, only weakly associated with chronological age, which means that old people can have levels of both physical and mental capacity similar to those of a much younger person ^{4,5}, see Figure 2. In order to explain the heterogeneity of older people, the term “biologic age” is sometimes used ⁶. Also perceived quality of life was found to vary widely within groups of elderly people of the same age ⁷.

Figure 2: The diversity of intrinsic capacity increases with age (WHO)

WHO Clinical Consortium on Healthy Ageing. Report of consortium meeting 1–2 December 2016 in Geneva, Switzerland. Geneva: World Health Organization; 2017 (WHO/FWC/ALC/17.2). Licence: CC BY-NC-SA 3.0 IGO ⁴.

Aging is associated with a decline in physical fitness, such as decreased muscle strength, cardiovascular function, lung function and balance, and the presence of diseases and age-related disabilities becomes more common ⁸. A change in body composition occurs, leading to an increased fat mass and decreased muscle mass. After the age of 30, the muscle mass decreases by about 1-2% annually. After 60 years, the annual loss of muscle mass is estimated to be around 1.5-3% and, after age 75, the loss increases further ⁹. Cardiorespiratory fitness (peak VO₂) is found to decline with age, even after adjustments for physical activity habits. The loss accelerates with increasing age from approximately 3% per decade after 20 years, to > 20% after 70 years. Potential factors implicated in the decline include both central and peripheral aspects of aging. However, the rate by which maximum heart rate is reduced is fairly constant at 4-6% per decade. In older ages, probably impaired oxygen utilization intrinsic to the muscles has a large impact ¹⁰.

An accelerated loss of physical fitness may occur in relation to lifestyle, such as sedentary behavior and diseases ¹¹. Sarcopenia, or the progressive loss of skeletal muscle, is sometimes pathophysiologically regarded as an organ failure or “muscle insufficiency”, which can occur temporarily, e.g. during bedrest, or become a chronic condition ¹². Sarcopenia is thought to play an important etiological role in the frailty syndrome and has been found related to several adverse health outcomes, decreased strength and exercise tolerance, general weakness and fatigue and may affect the ability to perform activities in daily living ¹¹.

Multimorbidity, Disability and Frailty

Figure 3: Comorbidity, disability and frailty are all separate states, but they partially overlap

Prevalences—and overlaps—of comorbidity, disability, and frailty among community-dwelling men and women 65 years and older. Percents listed indicate the proportion among those who were frail ($n = 368$), who had comorbidity and/or disability, or neither. Total represented: 2762 participants who had comorbidity and/or disability and/or frailty. + $n = 368$ frail participants overall. * $n = 2576$ overall with 2 or more of the following 9 diseases: myocardial infarction, angina, congestive heart failure, claudication, arthritis, cancer, diabetes, hypertension, chronic obstructive pulmonary disease. Of these, 249 (total) were also frail. ** $n = 363$ overall with an activity of daily living disability; of these, 100 (total) were also frail.

This figure is reused with permission from Oxford University Press: Fried et al. *The Journals of Gerontology: Series A*, Volume 59, Issue 3, March 2004, Pages M255–M263 ¹³

Previously, when describing elderly individuals with increased vulnerability and a need for enhanced care, the terms multimorbidity/comorbidity, disability and frailty were often used interchangeably, probably because of their similarity and coexistence rate ¹³. They are now identified as three different, but partially overlapping conditions, see Figure 3. Each condition individually or in combination is associated with negative health consequences ^{12,13} and healthcare implications have to be adopted for the specific condition.

Multimorbidity is common, especially in people who are older. In Sweden, almost half the population live with a chronic disease and 25% are estimated to have two or more conditions¹⁴. Multimorbidity is defined as “*the co-occurrence of multiple chronic or acute diseases and medical conditions within one person*”¹⁵. Moreover, the term “comorbidity” is common in elderly research and means the occurrence of two or more chronic or acute diseases related to a specific index condition^{16,17}. The term “comorbidity burden” is sometimes used to describe the overall importance of the conditions and can be measured using validated instruments, such as Charlson’s Index¹⁸, which may provide an indication of future prognosis. A severe comorbidity burden is associated with mortality and can be seen as a risk factor for frailty^{19,20}.

The WHO defines *disability* as an “*impairment, activity limitation or participation restrictions*” that may affect different domains, such as cognition, mobility and self-care²¹. The physical components of disability are found to increase with age and are commonly diagnosed by self-reporting. Objectively, disability can be identified using instruments measuring activities of daily living (ADL) or instrumental activities of daily living (IADL)²². Disability can be seen as an outcome of frailty^{19,23}.

There is a growing understanding of *frailty* as a complex system²⁴. Most probably, frailty is a multifactorial consequence of cumulative decline in many bodily systems at the same time. Many components, such as inflammation, neuromuscular dysfunction, endocrine dysregulation, immune dysfunction, abnormalities in energy metabolism and failure of the central nervous system, are believed to play significant roles²⁵⁻²⁷.

Frailty reflects vulnerability and decreased physiologic reserves and is often used as a marker of biologic age^{19,28}. Frailty is assumed to herald physical decline and it often involves a downward spiral of worsening physical function and poorer prognosis, comprising dependence, reduced autonomy, risk of falling, hospitalization, institutionalization and death^{25,29-32}. A frail person runs the risk of rapid deterioration when exposed to external stressors, such as acute illness^{13,29}, which is illustrated in Figure 4. However, frailty is a dynamic syndrome where deterioration is common, but the individual course of frailty varies and the degree of frailty can be improved even in old age^{25,33}.

Figure 4: Fall to disability and death: comparison between normal aging, frailty and frailty associated with an acute event

This figure is reused with permission from J of Geriatric Cardiology. Tonet et al, 2019³⁴

Definition of frailty

According to the WHO, frailty is conceptually defined as “a clinically recognizable state in which the ability of older people to cope with everyday or acute stressors is compromised by an increased vulnerability brought by age-associated declines in physiological reserve and function across multiple organ systems”⁴. In research, there is no consensus definition of the frailty syndrome, but most researchers agree that it can be psychologic and physical, or a combination. The occurrence of sarcopenia and diminished muscle strength is a frequently mentioned and important discriminatory characteristic^{35,36}. In community-dwelling elderly individuals (≥ 65 years), a systematic review found an average prevalence of physical frailty of just under 10%, with a higher prevalence when psychosocial aspects were also included. More women than men were frail and the incidence increased significantly after 80 years of age and is estimated to be $> 25\%$ among those over 85 years of age^{37,38}.

Two main approaches are used to describe the syndrome. The first is the cumulative deficit model created by Rockwood²⁸, which encompasses an assortment of up to 70 symptoms, impairments, diseases and disabilities accumulated during the life course. The patient is evaluated clinically using a comprehensive assessment and a Frailty Index is created³⁹.

The frailty phenotype model by Fried ¹⁹ is based on five criteria related to the reduced physiologic reserve and focuses on weakness (e.g. low handgrip strength), exhaustion, slow walking speed, low physical activity and weight loss, which are signs of an underlying physiologic state of multisystem and energy dysregulation. If a person fulfills ≥ 3 of these criteria, he or she is considered frail. If 1-2 criteria are fulfilled, the patient is considered pre-frail.

Frailty instruments

To improve care for elderly patients, frailty screening should be better integrated in clinical practice. There is a discussion relating to how this screening should be conducted and what purpose should be achieved ⁴⁰. Many frailty instruments are validated as risk stratification instruments applicable in different settings and regarding different outcomes ⁴⁰. Some elderly patients describe outcomes, which they considered worse than death. Frailty screening can facilitate clinical decisions about treatment and outcome measurements and assist in care planning. To be able to fulfill the purpose of risk stratification, the instrument needs to capture degrees of frailty and measure adequate domains so that good generalizability and usefulness in clinical practice can be achieved ^{40,41}.

There is no screening instrument for frailty that can be regarded as the gold standard. Instead, there is an assortment of single- and multi-items tools that reflect one or more domains of the frailty syndrome ^{42,43}. The most used frailty instruments in the acute care setting are the Clinical Frailty Scale (CFS) ²⁸, Fried's phenotype frailty scale ¹⁹ and the Frailty Index (FI) ^{39,44}. In clinical practice, there is a need for a brief and accurate screening tool, which is also suitable for non-ambulatory patients. Screening instruments, such as the Clinical Frailty Scale ²⁸, based on the FI, or the FRAil Elderly Support research group (FRESH) screening instrument ^{45,46}, based on the frailty phenotype, are also useful.

In this thesis, the FRESH screening instrument was used to identify frailty.

Frailty and physical fitness

Physical function and physical fitness are closely related concepts, but it is important to realize that they are not interchangeable. Physical function is defined as "*The capacity of an individual to carry out the physical activities of daily living. Physical function reflects motor function and control, physical fitness, and habitual physical activity*" ⁴⁷. Physical function is usually evaluated with instruments measuring activities of daily living, but different instruments exist ^{48,49}. Impaired physical function may lead to disability, institutionalization, mortality and poor health-related quality of life ^{5,50}.

In frailty research, the term “physical performance” is commonly used. Physical performance measurements were previously used objectively to assess the performance of various activities in daily living (ADL) or physical tasks in the clinic, in contrast to self-reported ADL instruments. Only recently, a position paper formulated a clear definition: “*An objectively measured body function related to mobility*”⁵¹. Physical performance is a multidimensional concept, including several aspects involved in performance, such as bone, balance and other neurology, cardiovascular aspects and motivation.

Physical fitness is usually defined as “*A set of attributes that are either health or skill related. Physical fitness is operationalized as a set of measurable health- and skill related attributes that include cardiorespiratory fitness, muscular strength and endurance, body composition and flexibility, balance, agility, reaction time and power*”^{47,52}. The degree to which people have these attributes can be measured with specific tests. The health-related domain of physical fitness comprises five different components, cardiorespiratory endurance, muscle endurance, muscular strength, body composition and flexibility, which do not have to be consistent, meaning it is possible to be strong and have poorer flexibility at the same time. The skill-related components comprise agility, balance, coordination, speed, power and reaction time⁵².

People with different levels of physical fitness will react differently to physical activity that is fixed at an absolute intensity⁵³. The perceived rate of exertion and breathlessness for a given activity is determined by its oxygen cost relative to a person’s peak VO₂. Individuals who in their daily living are near the margin of their peak ability, e.g. aerobic capacity or muscle strength, are more vulnerable than those who have a greater margin between what they can best achieve and what they need to perform in their daily life¹⁰. When a task is perceived as strenuous, it tends to be avoided. Especially in elderly and deconditioned individuals, it may initiate a vicious cycle that further reduces aerobic capacity, causing further avoidance of physical activity and further loss of physical fitness^{10,54,55}.

As a result, accelerated loss of physical fitness components may lead to decreased muscle strength, low physical activity, slow walking speed and early fatigue, which describe four of the five criteria used to define the frailty phenotype¹⁹.

Physical activity and exercise

In the literature, the two concepts of physical activity and exercise are often confused and used interchangeably, but it is important to note that they are not synonymous⁴⁷.

Physical activity is usually defined as “*Any bodily movement produced by skeletal muscles that results in energy expenditure*”⁵². This is a complex behavior comprising more or less most of the things we do in life and can be divided into four sub-groups of activities; occupational, leisure, transport and household physical activity. Sedentary behavior is any waking behavior characterized by an energy expenditure of ≤ 1.5 metabolic equivalents (METs), while in a sitting, reclining or lying position⁵⁶.

Exercise is an activity people do with the intention of maintaining or improving fitness and is defined as “*A subset of physical activity that is planned, structured and repetitive and has a final or an intermediate objective, the improvement or maintenance of physical fitness*”⁵².

Both concepts include skeletal muscle activities resulting in energy expenditure, but they differ in terms of the ability to maintain or improve fitness. Sporting activities are usually performed with the aim of maintaining or improving physical fitness, while occupational, household activities and many daily tasks are usually performed in the most efficient way possible, i.e. the way that requires the least energy, and without the goal of maintaining or improving physical fitness⁵².

To maintain and improve health and physical fitness in adults, exercise needs to be of moderate or vigorous intensity or a combination and beyond daily physical activities⁴⁷. In older adults, exercise with moderate intensity, 20-30 min most days of the week, proved to be of greater benefit in relation to physical function, compared with those who were physically active every day but did not exercise⁵⁷.

OVERVIEW OF THE RESEARCH FIELD

The following overview is based on the topics representing two clinical studies that form the basis of the four papers included in this thesis; first, frail elderly individuals in relation to physical fitness and in-hospital care and, secondly, patients' perspective of physical activity and exercise.

Future challenges in hospital care

The demographic forecast, medical-technological developments and society's expectations in relation to care are thought greatly to influence the need for health care^{58,59}. The present population forecast shows that life expectancy will increase, while morbidity will not decrease⁶⁰. Medical improvements in the acute phase of diseases have led to better survival rates but also to an increasing number of people with disability and chronic conditions. These patients are stable during certain periods, but they may gradually or suddenly experience an exacerbation and acute hospital care may be necessary^{61,62}. Frail elderly individuals with multimorbidity and disability are frequent visitors to acute medical hospital departments⁶³. In this group of patients, admissions are often inevitable, they often require a longer length of stay compared with their younger counterparts and the re-admission rate is high⁶⁴⁻⁶⁶. In 2017, the proportion of people 65 years or older accounted for almost 20% of the Swedish population, but they accounted for half of all hospital admissions and 55% of all care given¹⁴. One challenge in future health care is to be prepared when it comes to managing an increasing number of frail elderly patients.

Studies of frail elderly individuals with disability and severe multimorbidity

Frail elderly individuals with disability and severe multimorbidity are often excluded from clinical trials. The reported reasons include difficulties due to recruitment, high drop-out rates and problems related to transportation⁶⁷. Excluding elderly people with substantial disability and multimorbidity, who are seen every day at acute medical hospitals, results in poor generalizability to a clinical population of frail elderly individuals^{61,68}.

Physical fitness and risk of decline in frail elderly individuals

Each component of physical fitness affects some aspect of health and it is well known that low cardiorespiratory fitness and muscle strength individually and in combination are associated with increased mortality in adults ⁶⁹⁻⁷¹. In addition to the risk of premature death, the accelerating decline in physical fitness with increasing age has consequences in daily life. To manage independent living, sufficient aerobic capacity and muscle strength are necessary ^{10,72}.

During hospitalization, low physical activity and bedrest are common. It has been found that, in connection with hospital care for acute medical conditions, elderly patients who prior to hospital admission walked independently spend about 83% of their hospital stay in bed and 12% of their time on a chair ⁷³. This has been found to be independently associated with adverse outcomes, such as longer length of stay, functional decline, disability, institutionalization and mortality ⁷⁴⁻⁷⁷. Frailty is a state of increased vulnerability which increases the risk of physical decline in connection with acute illness and in-hospital care and the recovery rate appears to be low ^{75,78-81}. To counteract this trajectory, early mobilization is suggested. Early mobilization was shown to improve physical function and has been described as feasible and safe to execute ⁸².

In frailty research, ADL questionnaires are the most common method used to evaluate physical function⁸³. Objectively measured components of physical fitness usually involve selected groups of elderly people with less frailty and multimorbidity and often include an exercise intervention^{84,85}. Patients with severe multimorbidity and those who are not able to walk are usually excluded ^{86,87}. The reference values for physical fitness tests are often divided into age strata and are described for community-dwelling older adults related to chronological age ⁸⁷⁻⁹⁰. However, there are examples of studies with a more clinical focus. Martin-Ponce et al. ⁹¹ studied the prognostic value of physical performance tests in hospitalized elderly patients, 60 years or older. The authors found that poor performance and the inability to perform walking tests and handgrip strength tests were associated with increased mortality.

Conventional in-hospital care

The form in which care is provided appears to be important. Today, limited healthcare resources may affect frail elderly patients adversely. The triaging system, where the most acute conditions are supposed to receive help first, may lead to long waiting times at the emergency room. This risks further deterioration in frail patients and the condition may both become more difficult and have greater consequences than in the first stage ^{44,92}. The conventional acute medical ward is usually a specialized, organ-specific unit with the goal of providing care according

to national and international evidence-based guidelines, adapted for specific diseases^{61,93}. On these wards, the rehabilitation varies a great deal, but regular assessments of physical function in all patients are not usually part of routine care. Organizationally, physical therapists and occupational therapists are linked to the wards, but they often use a consultative approach and, first after discussion with nurses and physicians, they meet those patients who are considered to have a pronounced need, usually prior to discharge. Team meetings involving all healthcare professionals are rare^{94,95}.

However, physical therapy interventions are considered beneficial in acute hospital care to prevent deterioration and re-admissions⁹⁶⁻⁹⁸. Specifically in connection with the transition process, contributions appear to be valuable in assessing, communicating and coordinating rehabilitation needs with other healthcare providers. They also play a role in prescribing assistive devices and exercise programs and providing information to both patients and their relatives⁹⁴.

Comprehensive Geriatric Assessment and Care

A Comprehensive Geriatric Assessment (CGA) is a process of assessment and care often referred to as “best practice” in relation to frail elderly patients^{61,99}. One common definition of a CGA is: “A *multidimensional interdisciplinary diagnostic process intended to determine a frail elderly person’s medical, psychological and functional capabilities and limitations, in order to develop an overall plan for treatment and long-term follow-up*”¹⁰⁰.

The CGA concept is characterized by the early identification of people running a large risk of complications and adverse health outcomes, followed by assessment, care and a follow-up plan. A CGA is made using a person-centered, holistic and multi-disciplinary approach, in addition to conventional evidence-based care, and it explicitly implies standardized instruments and an early rehabilitation perspective. The team commonly comprises physicians with both medical and geriatric competence, nurses, physical therapists, occupational therapists, social workers and dietitians who meet regularly, but all the players are sometimes not included^{83,101}.

To a varying extent, a CGA has proven to be beneficial, in terms of mortality, disability and cognitive functions in different settings¹⁰². During in-hospital care, a CGA at admission carried out on specialized acute ward units was found to be more effective than a CGA carried out by mobile teams¹⁰³. Baztan et al.⁹⁵ found that a CGA was effective compared with conventional care in reducing functional decline (ADL) at discharge and increasing the probability of living at home both at discharge and three months later, in elderly patients admitted to acute medical care.

Within a specialized CGA unit, physical therapists and occupational therapists work closely with other professions on the ward. These professionals implement a structured early rehabilitation strategy and, soon after admission, every patient is assessed regarding physical fitness and individualized treatments are provided. When needed, information is given to patients and their relatives to reduce the risk of concern and uncertainty related to physical activity. One goal is keeping the patient ambulatory and independent, to the greatest extent possible. The close collaboration between different healthcare professionals on the ward enables the sharing of information and experience, in order to use a more consistent, person-centered approach towards each patient ¹⁰⁴.

Physical activity and exercise in the treatment of frailty

An increased amount of physical activity, exercise, adequate protein intake and appropriate medication are thought to be the first-line therapies in the management of frailty ¹⁰⁵⁻¹⁰⁷ and comprehensive and individualized prescribed treatment interventions can improve or slow down the deterioration ¹⁰⁸.

Regarding exercise, several systematic reviews of frail elderly individuals conclude that structured and individually prescribed exercise is beneficial with regard to several different outcome measurements, e.g. frailty status, disability, muscle strength, balance and rate of falls ¹⁰⁹⁻¹¹². Studies of institutionalized frail elderly patients found that even those with cognitive and physical impairments gained from resistance, balance and functional exercise programs. The authors advocated moderate to high-intensity exercise, meaning that the participants were encouraged to exercise at an intensity of 40-80% of 1 repetition maximum (RM) and to increase the load progressively ^{84,113}.

However, there is no “golden standard” for exercise programs in frail elderly individuals, but it has been reported that multi-component exercise interventions, including resistance exercise, aerobic, balance and flexibility exercises, are effective in improving physical fitness in pre-frail and frail older adults ¹¹⁴. Individualized and specific exercise appears to be important and a prescription should first be implemented after an examination of the patients’ current health and fitness status and include progression and a follow-up plan ¹¹⁵.

Patients' perspective of physical activity and exercise

Older people are generally less physically active than younger adults ¹¹⁶. They spend more time sitting and have been shown to be mainly engaged in lower-intensity activities and rarely in activities of high intensity, compared with younger adults. Multimorbidity and disability are thought to further reduce the level of physical activity ^{117,118}.

Previous studies of elderly people described barriers to participating in exercise programs related to poor health, fear of falling and a perceived need for rest. Moreover, the expectations of the exercise intervention and problems related to transportation to the exercise facility were important aspects ¹¹⁹⁻¹²¹. A systematic review ¹²² of both quantitative and qualitative research highlighted problems related to lack of evidence in terms of barriers and motives for exercise in the oldest population and in frail elderly individuals with severe multimorbidity, as their perceptions may differ from those of less frail community-dwelling older people.

RATIONALE OF THE THESIS

According to the WHO, the maintenance of physical function is fundamental. It gives older adults an opportunity to be and do what they have reasons to value⁵. Old people constitute a heterogeneous group and age, multimorbidity and frailty are supposed to influence functioning.

Frail elderly individuals are frequent visitors to medical acute hospitals. Frailty means increased vulnerability, which may lead to adverse outcomes, such as physical deterioration, in connection with acute illness and hospitalization. Interventions to prevent or slow down the deterioration process, before leading to poorer physical function or disability, should therefore be important concerns for health care. It is unfortunate that frail elderly patients with severe multimorbidity are often excluded from clinical trials, which leads to an existing gap in knowledge, specifically regarding physical fitness in a hospital setting.

There are good examples of acute medical care units tailored to match the holistic needs of frail elderly patients. These units work on the basis of CGA and involve physical therapists to a greater extent, compared with conventional care. Previous evaluations show beneficial results in a hospital setting for different outcome measurements, such as return home, disability (ADL), mortality and readmission rates.

Physical fitness is closely related to physical function and, to improve in physical function, it is necessary to improve the components of physical fitness. Physical fitness has also been shown to be related to future prognosis. To our knowledge, there is no study that has thoroughly examined the effects of CGA on physical fitness or the impact of preservation/improvement in connection to hospital care from a longer perspective.

The effects of physical activity and exercise are compelling, even at older ages. However, there are still challenges when it comes to making frail elderly patients more physically active and few frail elderly patients participate in regular exercise. In order to better design rehabilitation programs for these patients, it is also important to explore the patients' perspective. Qualitative research can provide valuable knowledge and add patients' expertise to the way care may be improved.

AIMS

Overall aim

The overall aim of this thesis is to study physical fitness in a group of frail elderly patients, within clinical hospital health care. The patients' physical fitness will be evaluated and compared in different care settings during and after hospitalization. The aim is also to study the long-term consequences of changes in physical fitness on mortality. To better understand the underlying factors for participation in physical activity and exercise, patients' perceptions of the phenomena will be explored.

Specific aims

1. To, in a Swedish context, describe measurements of physical fitness in hospitalized frail older adults in relation to the degree of frailty.
2. To compare physical fitness during the acute care of frail elderly patients at a CGA unit versus conventional care and at a three-month follow-up.
3. To analyze 1) the association between physical fitness measurements and one-year mortality and 2) the association between preserved physical fitness during the first three months after discharge from emergency hospital care and one-year mortality.
4. To explore the perceptions of physical activity and exercise among frail elderly patients with a severe comorbidity burden after acute hospital care.

METHODS

Overview of the studies

This thesis contains four papers based on two studies comprising frail elderly patients with experience of an acute period in a hospital care setting. Papers 1-3 are from Study I and Paper 4 is based on Study II.

Table 1: An overview of the studies in the thesis

	Study I Prospective controlled trial, with two parallel groups			Study II Interview study
	Paper 1	Paper 2	Paper 3	Paper 4
Design	Observational study, cross-sectional design	Prospective analysis of two parallel groups	Prospective analysis	Content analysis
Participants	Frail elderly patients in an acute medical in-hospital setting, n=408	Frail elderly patients in an acute medical in-hospital setting. Intervention, n=206 Control, n=202	Frail elderly patients, who survived an acute medical hospital stay, n=390	Frail elderly patients three months after discharge from in-hospital care, n=18
Methods	Measurements of physical fitness in connection with a medical in-patient care episode (index)	Measurements of physical fitness at index and three months later, in patients at a CGA unit compared with patients in a conventional medical care unit	First, index values of physical fitness and, second, change in physical fitness during the first months after discharge were analyzed in relation to one-year mortality.	Interview study conducted three months after discharge from hospital
Physical fitness measurements	Handgrip strength Six-minute walk test Timed up-and-go Five times sit-to-stand	Handgrip strength Six-minute walk test Timed up-and-go	Handgrip strength Six-minute walk test	Not applicable
Data analysis	Descriptive statistics. Unpaired tests and post-hoc analysis	Descriptive statistics. Unpaired and paired tests. Multivariate regression analyses	Descriptive statistics, multivariate Cox proportional hazard regression analysis	Qualitative content analysis
Ethical approval	Dnr: 8883-12	Dnr: 8883-12	Dnr: 8883-12	Dnr: 8883-12 with additional approval: T784-13
Status	Published in J Geriatr Phys Therapy 2018;41:230-235	Published in Clin Interv in Ageing. 2017;12 1929–1939	Published in Clin Interv in Ageing. 2019;14 577–586	In manuscript

Designs and setting

Study I

This study was part of the prospective controlled clinical trial entitled “Is the Treatment of Frail Elderly Patients Effective in an Elderly Care Unit” (TREEE), carried out at the NÄL-Uddevalla (NU) Hospital Group, in western Sweden. Patients were recruited to the study between March 2013 and July 2015 in connection with a medical in-hospital care episode. For information on the design of each paper, see Table 1.

Study II

This study was derived from the TREEE research project and, during the ongoing recruitment process to the TREEE study, a qualitative interview study was also conducted. Content analysis with an inductive approach inspired by Krippendorff¹²³ was chosen. The method searches for patterns in the material and involves an unprejudiced analysis of texts, based on the informants’ experiences¹²⁴. For additional information on Paper 4, see Table 1.

Data collection and procedure

Study I (Papers 1-3)

A total of 408 patients were included for evaluation in the study. The inclusion criteria were age ≥ 75 years, assessed as being in acute need of in-hospital treatment and frail according to the FRESH screening instrument, comprising five questions related to tiredness, falls, endurance, needing support while shopping and three or more visits to the emergency department in the past 12 months. If two or more of these questions were answered with a yes, the patient was considered to be frail^{45,46}. Patients with a life-threatening acute illness suitable for specialized hospital units, e.g. acute myocardial infarction or sepsis, were excluded from the study, as were patients whose informed consent could not be obtained.

When the staff on the ambulance or at the primary healthcare center identified a patient who met the inclusion criteria, they phoned a senior physician at the CGA unit or, if it was at night, the on-call physician. If the physician agreed that the patient fulfilled the inclusion criteria of the study protocol and there was a bed available at the CGA unit, the patient was admitted there directly and allocated to the intervention group. If no bed was available at the CGA unit, the patient was admitted to a conventional acute medical ward via the emergency room and allocated to the control group. As soon as possible after admission, complete information about the study was given orally and in writing and, if necessary,

repeated, by healthcare professionals working within the study. Some of the frail older adults were cognitively impaired, especially in the acute stage of illness. In these cases, informed consent was given by next of kin.

All tests of physical fitness were performed during the index hospital stay and again in connection with the follow-up visit at the hospital or in the patients' home. It was not possible to standardize the day of testing, but the intention was to see the patient at the end of the hospital stay and the return visit was planned to be after three months ± 14 days. Physical therapists primarily performed the tests, but in some cases they were performed by trained physicians. The test procedure was well practiced in advance and the performance was repeated several times during the study, in order to make the procedure standardized, throughout the study.

Study II (Paper 4)

This was a qualitative interview study, where the participants were originally included in the TREEE study. For inclusion and exclusion criteria, please see Study I. Additional exclusion criteria in this study were moribund patients and patients whose cognitive or communicative ability made participation difficult, such as severe dementia, aphasia or difficulty participating in an interview in Swedish.

To capture representative perceptions of the phenomenon of physical activity and exercise, a strategic sampling procedure¹²³ was performed with the aim of including frail elderly patients, both men and women, with varying functional status, in both urban and rural living. The intention was to include 15-20 participants, as this was considered appropriate for capturing both common patterns and unique variations in relation to this context. In this population of frail elderly patients with severe multimorbidity, it was reasonable to calculate with a certain dropout rate. A total of 23 patients gave their informed consent to participate in the study, of which 18 finally conducted an interview.

The participants were enrolled to this interview study in connection with an acute hospital care episode. Three months after discharge from hospital, each patient was contacted by phone to decide the time and place of the interview. The participants were able to choose whether the interview would be at their homes or in a secluded room at the hospital in connection with a return visit. If the participant wanted to bring a relative, he or she was asked to remain silent during the interview.

A semi-structured interview guide was developed with the emphasis on the patients' perceptions of physical activity and exercise, their goals and needs, perceived barriers/facilitators, perceptions of exertion and information from health care. The interview began with the following entry question: "*How has your body functioned, since your discharge from hospital?*" After four interviews had been performed, the study group met and discussed the interview guide and

interview technique. No important changes were needed, apart from adding clearer follow-up questions such as “*How did you experience it*” and “*Can you tell me more*” to further deepen the dialogue and make the patients give a more elaborate narrative.

The interviews lasted for a median of 28 minutes (range 20 to 43) and they were all tape-recorded and transcribed verbatim.

For information on the population related to each of Papers 1-4, please see Table 1.

For a flowchart relating to the population and data collection, Papers 1-4, please see Figure 5.

Figure 5: Flowchart of population and data collection (Papers 1-4)

Measurements, Study I

Clinical and demographic characteristics were collected from medical records. All the participants performed tests of physical fitness during the index hospital stay. In connection with a follow-up visit at the hospital or in the patient's home three months later, the same variables were assessed. After one year, information on date of death was taken through the medical records or the National Cause of Death Register.

Frailty

The FRESH screening instrument is based on Fried's phenotype frailty scale ¹⁹. Originally, it comprised five questions related to endurance, tiredness, falls, needing support while shopping and ≥ 3 visits to the emergency department (ED) in the past 12 months. When two or more questions were answered with a yes, the person was considered frail ^{45,46}. The four physical questions (ED visits excluded) were later validated to identify frailty and were found to exhibit excellent clinical value in screening out frail older adults in an emergency care setting (sensitivity 84% and specificity 75%) compared with the phenotype frailty indicators. The fifth question relating to visits to the ED was of no additional value and may be omitted from the FRESH screening ⁴⁵. In Study I, we chose to assess the degree of frailty using the four-question version of the instrument.

The FRESH screening was performed by a physician or a nurse at the time of inclusion.

Multimorbidity

Charlson's Comorbidity Index (CCI) ¹⁸ is a commonly used instrument for assessing the comorbidity burden and predicting short- and long-term mortality. It consists of 19 conditions, each of which is given a severity weighting (1-6) depending on the risk of dying associated with this condition. From this, an index is produced, which may give an indication of the prognosis. A CCI of ≥ 5 is often interpreted as a severe condition consistent with a poor prognosis, but even a CCI of ≥ 3 may be regarded as a substantial comorbidity burden ^{18,125}. The CCI has been validated for use in elderly patients in an acute medical setting ¹²⁶.

In this study, the physician completed the CCI before discharge and again at the three-month follow-up visit.

Physical fitness

In Study I, physical fitness was measured with four different tests; Muscle strength: Handgrip strength test (HS) in the papers 1-3, Submaximal aerobic capacity: Six-minute walk test (6-MWT) in the papers 1-3, Functional mobility:

Timed up-and-go test (TUG) in the papers 1-2 and lower-limb strength: Five-times sit-to-stand test (5-STST) in paper 1.

Handgrip strength

Isodynamic handgrip strength (HS) is a validated measurement of muscle strength in the elderly¹²⁷.

The handgrip strength test was performed using a hand-held hydraulic dynamometer (SAEHAN, MVS In Motion, Willebroek, Belgium) with the option of an individually adapted grip position. The patient had to be in a sitting position with his/her arm next to his/her body, the elbow flexed at 90° and the wrist in a neutral position and he/she was then instructed to squeeze the dominant hand as hard as possible and then relax. The result was the peak value (kg) of three attempts, with a short rest (about one minute) between each attempt. A few patients did not manage to sit independently. They were allowed to lie in bed with their head end raised and their elbow supported.

The test of handgrip strength has been shown to have good test-retest reliability in community-dwelling elderly and in older persons with dementia (ICC = 0.97)^{127,128}.

Submaximal aerobic capacity

The six-minute walk test (6-MWT) was originally designed to measure submaximal aerobic capacity in patients with cardiorespiratory diseases¹²⁹ and it is also considered to be suitable for those with severe cardiovascular disease and severe multimorbidity¹³⁰.

The 6-MWT measures the total distance covered, during a six-minute walk. The test was performed indoors, in a long, flat, straight corridor with a hard surface. The walking course was 30 m in length, with marks on the floor every 5.0 m and the turnaround points were clearly marked. The patient was given an instruction to walk as far as possible during six minutes and choose his/her own intensity of walking. Encouragement was limited, but short information, such as “*well done*”, “*only one minute left*”, was accepted¹²⁹. In the present study, the patients were allowed to stop and continue during the test, but the test was interrupted if the patient was unable to continue, mostly due to dyspnea and strong dizziness. The walking distance was recorded in meters and calculated to the nearest full meter according to standardized mathematic rounding. In this study, no heart rate monitor was used, but, after finishing the test, all the patients rated their perceived exertion using the Borg rating of perceived exertion (RPE) scale¹³¹. Walking aids were allowed.

The 6-MWT has shown good test-retest reliability in community-dwelling elderly (ICC = 0.95) ⁸⁷.

Functional mobility

The timed up-and-go test has been shown to be a valid measurement of functional mobility in community-dwelling elderly adults and it correlates well with scores of gait speed (Pearson's $r=0.75$) and balance (Pearson's $r=-0.72$) but also with physical function (ADL) (Pearson's $r=-0.79$) ¹³².

The TUG measures the time spent, in seconds, when the patient rises from a standard armchair (approx. 46 cm), walks three meters, turns around and walks back to the chair again. The three-meter distance should be clearly marked with tape that deviates from the floor color ¹³². In the present study, the patients were instructed to walk as quickly and as safely as possible and walking aids were allowed.

The TUG has been shown to have good test-retest reliability (ICC = 0.99) for community-dwelling older adults ⁸⁷.

Lower-limb strength

Rising from a seated to a standing position requires lower-extremity muscle strength. If it is performed quickly, it can also be used as a test of lower-extremity function, such as muscle power ^{133,134}. The stand chair test was identified as an important predictor of falls in elderly individuals ¹³⁵.

There are several variants of stand chair tests. In this study, the five-times sit-to-stand test (5-STST) was used. The patient first attempts to stand up once from a standard armless chair (approx. 46 cm) with his/her arms folded across his/her chest. If the patient manages to do this, he/she rises and sits down five times in a row and the time is recorded. The test measures the time spent in seconds, from sitting position before first rising until the person stands up after the fifth rising ¹³³.

The 5-STST has been shown to have good test-retest reliability (ICC = 0.96) for older adults ¹³⁶.

Intervention and control group

In Study I (Paper 2), the outcome measurements were evaluated and compared between the groups to which the patients were allocated; intervention or control group. For comparisons between the intervention and control group, see Table 2.

Intervention group

The intervention was care in a CGA unit. Within the NU Hospital, there are two wards specializing in care for the elderly (in Swedish, Medicinsk ÄldreVårds-Avdelning, MÄVA). In addition to care according to illness-specific, evidence-based guidelines, they worked according to the principles of an interdisciplinary CGA with evidence-based procedures and an holistic approach, where patient-centered care was the focus. The MÄVA had the opportunity to enroll patients directly, without passing the emergency room. There were dedicated discharge nurses who, at an early stage during the hospital stay, planned the discharge and a good reception in primary and municipal health care.

At the CGA unit, the teamwork was well established. Physical therapists and occupational therapists were closely linked to the unit and the team met daily. The team worked together towards the goal of making the patient independent to the greatest degree possible. There was an explicit early rehabilitation strategy and almost all the patients were assessed for physical fitness, as soon as possible after admission. On the ward, the physical therapists worked with assessments, assistive device testing and prescribing information to patients and their relatives. The aim was that the patients and their relatives should feel safe in relation to performing physical activity. In-hospital training usually consisted of functional tasks, such as mobility strategies, walking and balance exercises. Although the patients did not receive a home-based exercise program, they received structured and individualized advice regarding physical activity and exercise, as part of the intervention.

Control group

The patients in the control group were admitted to a ward of conventional internal medicine, where medical procedures according to national and international evidence-based guidelines were followed. Patients were admitted to the ward via the emergency room and the central care planning unit at the hospital was contacted just prior to discharge. There was no pronounced interdisciplinary collaboration, with regular team meetings between health professionals. Occupational therapists and physical therapists were linked to each of these wards, but they worked on a consultative basis, which meant that they were only contacted after a doctor or nurse felt that there was a need for an assessment or rehabilitation.

Table 2: Comparison of the management in the intervention group (CGA) and the control group (conventional acute medical care)

	Comprehensive geriatric assessment and care	Conventional acute medical care
Department and facilities	Two MÄVA (acute elderly care CGA units) wards with a total of 48 beds; one, two, or four-bed rooms Division of Internal Medicine and Emergency Care	Wards of internal and emergency medicine; one, two, or four-bed rooms Division of Internal Medicine and Emergency Care
Team members		
Physicians	Yes. Specialists in internal medicine, family medicine and/or geriatrics	Yes. Specialists in internal medicine
Licensed practical nurses	Yes. Including specialized admission and discharge nurses	Yes
Occupational therapists	Yes	No. Only counseling
Physiotherapists	Yes	No. Only counseling
Nutritionists	No. Only counseling	No. Only counseling
Treatment	Systematic, structured interdisciplinary comprehensive geriatric assessment and care by validated instruments focusing on: somatic and mental health, medication review, functional and activity ability including early rehabilitation, social situation Early discharge planning	Following routines at departments of internal medicine and emergency care in accordance with guidelines
Admission route	Directly to the MÄVA ward via ambulance or primary care	Via the emergency ward

For both groups, standard management procedures in accordance with national and international evidence-based guidelines were followed.

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Analysis study I

The data were computerized and analyzed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY: IBM Corp). The tests used were two-sided and the statistical significance level was set at $p \leq 0.05$.

Sample size

A sample size calculation was made prior to inclusion in Study 1. It was based on change in ADL (Katz index), which was the primary outcome in the TREEE study. The effect size was based on the difference in ADL-change, between groups, from baseline to three months after discharge. No previous study with an identical primary variable was found, but one similar study which focused on ADL function during hospitalization in less frail patients provided a basis for the calculation¹³⁸. Using a two-sided test, 80% power and a significance level of $\alpha = 0.05$, it was necessary to include 150 patients in each study group. To compensate for the uncertainty, due to longer follow-up times which may affect the expected effect size, it was estimated that 200 patients in each study group, 400 in total, had to be included.

Cut-offs and previously used reference values

In Paper 1, cut-offs were chosen due to previously described cut-offs or age-related reference values in elderly research. For handgrip strength, cut-off values defining sarcopenia were chosen (<20 kg women and <30 kg men)¹¹. For the 6-MWT, the cut-off was set at 300m based on previous research on old patients with heart failure, where ≤ 300 m was considered poor aerobic capacity⁸⁶. A time to perform the TUG of >30 sec had previously indicated an increased risk of falling and dependence in ADL¹³² and, for the 5-STS, a time to perform of > 14.8 sec was interpreted as poorer than average in an old population (80-89 years)⁸⁸. In Paper 3, cut-offs were used to dichotomize physical fitness into normal vs. low handgrip strength and again the sarcopenia definition was used (<20 kg women and <30 kg men). In Paper 3, the cut-offs used were based on the results from Paper 1 and the groups were categorized as 0-100m, 101-200m and >200 m.

Change in physical fitness

To the best of our knowledge, there were no previously described definitions for the minimal detectable change, or the minimal clinically important change in relation to these measurements of physical fitness in hospitalized frail elderly patients with severe multimorbidity. In Papers 2 and 3, the 0- to three-month changes were trichotomized as *decline*, *stability* and *improvement*. Both improved and stable physical fitness were regarded as positive results in this population,

while a decline was an undesirable result. The values for change in each test were stipulated from a statistical viewpoint. As a result, the 0- to three-month change in the study population was used and, if it had decreased by one quartile or more, it was assumed to be a relevant decline. For HS, *decline* was defined as a change of -2 kg or more, *stable* as a change between the values -1 kg to +2 kg and *improved* as a change of +3 kg or more. In 6-MWT a *decline* was defined as a change of -50 m or more, *stable* as a change between the values -49 m to +23 m and *improved* as a change of +24 m or more. For the TUG a *decline* was defined as a change of +1.3 sec or more, *stable* as a change between the values +1.2 sec to -6.3 sec and *improved* as a change of -6.4 sec or more.

Confounders

There were several factors that could have influenced the results. From clinical experience, factors that may influence the outcome, such as age, gender and comorbidity burden, were regarded as important to consider and were included as confounders in the regression analysis (Paper 2) and in the Cox proportional hazard regression analysis (Paper 3). In the analysis of change, the index value of measurement (HS, 6-MWT or TUG) was included in the analysis as well.

Missing data

Many patients were unable to perform tests of physical fitness, due to an acute illness or a chronic condition. In addition, some patients were unavailable, e.g. early discharge, which meant that the results had to be separated into “unable to perform” and “missing”. In Papers 1 and 2, no imputation was made. In Paper 3, patients who were “unable to perform” were categorized in the lowest group, i.e. low handgrip strength and walking distance of < 100m. In the analysis of the 0- to three-month change in physical fitness in relation to mortality, an imputation was made, where patients who were unable to perform the tests were categorized with a value of 10 kg and 25 m respectively for the tests.

Overview of statistical methods used

Study I had a quantitative approach. An overview of the different outcome variables and statistical methods used is shown in Table 3.

Table 3: Overview of the variables and statistical methods used in Papers 1-3

	Dependent variable	Independent variable	Statistical method
Paper 1	Index measurements of physical fitness: HS, 6-MWT, TUG, 5-ST5	FRESH screening (categorized into three groups)	Descriptive statistics One-sample t-test (95% CI of the mean) Chi-square test between groups (categorical variables) One-way ANOVA between groups (continuous variables) Bonferroni post-hoc test
Paper 2	Change in physical fitness (0-3 months): HS, 6-MWT, TUG	Type of care given: 1) CGA unit 2) Conventional care	Descriptive statistics Chi-square test (categorical variables) Student's t-test between groups (continuous variables) Logistic regression models
Paper 3	Events within one year	1) Physical fitness at index (HS, 6-MWT) 2) Change in physical fitness 0-3 months (HS, 6-MWT)	Descriptive statistics Cox proportional hazard regression analysis 1) Hazard ratios in relation to index values of physical fitness 2) Hazard ratios in relation to 0- to three-month changes in physical fitness

Abbreviations:

HS: Handgrip Strength, 6-MWT: Six-Minute Walk Test, TUG: Timed Up-and-Go, 5-ST5: Five-times Sit-To-Stand, FRESH screening: FRail Elderly Support research group screening

Analysis, Study II (Paper 4)

The qualitative analysis was performed using content analysis inspired by Krippendorff ¹²³. It had an inductive approach and was performed in a manifest way, close to the text. The analysis process incorporated the following phases.

1) Text preparation: the first author (Kristina Åhlund) transcribed all the interviews and read the texts several times before starting to identify meaning units in each interview that related to the studied phenomenon. KÅ also began to code these units. A code is a label that briefly describes the meaning and is created with regard to the context and purpose of the study ¹²⁴.

2) Analysis process: all the other authors (Maria Bäck, Birgitta Öberg and Niklas Ekerstad) read the transcripts to obtain a sense of the whole. MB also identified meaning units and labeled them with codes. After this, KÅ and MB met, compared the codes and created preliminary categories and sub-categories, which were presented to BÖ and NE. A triangulation process was performed and the categories were abstracted to find the latent meaning of the phenomenon, after which a theme finally emerged. The process included an iterative procedure which was on going until consensus was reached.

3) Reporting data: writing a qualitative research article reflects the iterative nature of qualitative research and the analysis continues while writing. The results have to be described to ensure trustworthiness, which usually comprises credibility, transferability, dependability and confirmability ¹³⁹. The reporting of data in this study followed the consolidated criteria for reporting qualitative research (COREQ)¹⁴⁰.

ETHICS

Ethical approval

In Study I, ethical approval was required and given by the regional ethical review board in Gothenburg (December 12, 2012). The study was also registered at the Swedish National Database of Research and Development; identifier 113021. Nov 4, 2012. <http://www.researchweb.org/is/vgr/project/113021>

Study II was part of Study I and only additional approval was required.

Study I: Dnr: 8883-12

Study II: Dnr: 8883-12, with additional approval: T784-13

Ethical considerations

General ethical principles according to the Declaration of Helsinki were followed. All the study participants received study information both orally and in writing from trained professionals within the research group. In connection with acute illness, frail elderly patients often need to be given information repetitively and sometimes together with their next of kin. In cases where patients had dementia or difficulty signing informed consent, this study approved consent given by proxy.

According to the Swedish Ethical Review Act (2003: 460)¹⁴¹, informed consent must form the basis of research in humans. Four principles have been formulated to provide good research ethics; the principle of autonomy, the principle of non-maleficence, the principle of beneficence and the principle of fairness¹⁴². The principle of autonomy is considered decisive when it comes to conducting research in humans and highlights the importance of respecting the individual's right to decide for him/herself. However, there is a section in the Swedish Ethical Review Act¹⁴¹ that regulates the opportunity to conduct research where illness or any other condition prevents the patients from giving consent themselves. Certain conditions have to be met; the results are expected to be of benefit either to the patient or to others with similar illness and the patient's next of kin must be asked and give their permission.

In the long run, the case of no research in certain groups of patients may be disadvantageous for the group concerned. Frail elderly adults with multimorbidity, disability and cognitive impairments are unfortunately frequently excluded from scientific research⁶¹. According to the principle of fairness, all groups in society should be offered fair and equal care, which also means that research should include all groups in society¹⁴².

Assessments of physical fitness may have caused some discomfort to the patients. The tests were performed at self-selected speeds and the patients were allowed to interrupt them if necessary. No patients withdrew from the study due to adverse events related to the tests of physical fitness.

RESULTS

The overarching results from this thesis are that frail elderly patients in connection with acute medical in-hospital care had poor physical fitness, which was associated with their degree of frailty rather than their chronological age, but there is still rehabilitation potential. Assessment and care in a CGA unit is superior to conventional medical care when it comes to preserving and improving physical fitness, such as submaximal aerobic capacity, handgrip strength and functional mobility. Moreover, the preservation of or improvement in physical fitness during the first three months after discharge is independently associated with the one-year prognosis. From the patients' perspective, the perceptions of physical activity and exercise were described as a balance between what is perceived as meaningful to the individual and the risk of harm, in relation to an aging body.

Results, Study I (Papers 1-3)

Population

The population consisted of 408 older adults, 230 women (56%), with a mean age of 85.7 years (75 to 99 years). At index, all the participants were frail according to the FRESH screening and a total of 382 participants (94%) had a severe comorbidity burden, with a Charlson's Index of ≥ 5 . The most common diseases were renal failure (87%), hypertension (71%), heart failure (40%), ischemic heart disease (30%) and cerebrovascular disease (26%). The screening of nutritional status revealed that almost 64% of the population were malnourished or at risk of malnutrition. Women rated poorer health-related quality of life and lived alone to a greater extent, as compared to men. No other gender-related differences were reported. The average number of hospital days during the index care episode was $10.2 (\pm 6.6)$. Eighteen patients (4.4%) died during the index care episode. The post-hospitalization mortality was calculated for those 390 patients discharged alive. During the first three months after discharge, 11.5% of the patients died and, after one year, mortality was 37.9%.

In Paper 2, the patients were divided into two groups; the intervention group (CGA unit, $n=206$) and the control group (conventional care, $n=202$). There were no statistically significant differences between the groups, apart from a higher comorbidity burden (CCI 7.4 ± 2.1 vs 6.2 ± 1.5 , $p<0.001$) and a longer mean length of hospital stay at index (11.2 days vs. 9.2, $p=0.002$) in the intervention group as compared to the control group. After three months, there were no differences between the groups ($p=0.648$) related to the number of hospital days, due to fewer

re-admissions in the intervention group. Regarding physical fitness, an unadjusted analysis found no differences between groups at baseline, except for the TUG, with the control group performing less well, compared with the intervention group ($p < 0.05$). For study characteristics of the population, see Table 4.

Table 4: The study characteristics of the population

Variable	Total		Intervention group		Control group		P
	N		N		N		
Age, mean $\pm$ SD	408	85.7 $\pm$ 5.4	206	85.7 $\pm$ 5.3	202	85.6 $\pm$ 5.4	0.850
Female, n (%)	408	230 (56.4)	206	122 (59)	202	108 (53)	0.241
Frailty screening, median (min-max)	408	3 (2-5)	206	3.5 (0.9)	202	3.4 (0.9)	0.149
Charlson's Index (CCI), mean $\pm$ SD	408	6.8 $\pm$ 1.9	206	7.4 $\pm$ 2.1	202	6.2 $\pm$ 1.5	<0.001***
Dementia, n (%)	408	47 (11.5)	206	20 (9.7)	202	27 (13.4)	0.247
Nutrition (MNA), mean $\pm$ SD	391	10.2 $\pm$ 2.6	201	10.3 $\pm$ 2.6	190	10.1 $\pm$ 2.5	0.492
EQ-VAS, mean $\pm$ SD	373	48.9 $\pm$ 19.6	181	50.1 $\pm$ 19.9	192	47.8 $\pm$ 19.3	0.247
Lived alone, n (%)	408	271 (66.4)	206	139 (67)	202	132 (65)	0.649
Nursing homes, n (%)	408	52 (12.7)	206	28 (13.6)	202	24 (11.9)	0.604
Own living without home-help service, n (%)	408	137 (33.6)	206	60 (29)	202	77 (38)	0.055
Number of hospital days during index care episode, mean $\pm$ SD	408	10.2 $\pm$ 6.6	206	11.2 $\pm$ 6.1	202	9.2 $\pm$ 6.9	0.002**

*Nominal data are presented as n (%). Continuous data are presented as mean $\pm$ 1 SD or median with minimum to maximum. Abbreviations, SD: Standard deviation, MNA: Mini Nutritional Assessment, EQ-VAS: Euro QoL- Visual Analogue Scale. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

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Physical fitness

The main results (Papers 1-3) related to physical fitness are presented below.

Paper 1

The STROBE checklist¹⁴³ was followed, when reporting data in this paper.

In Paper 1, we found that the degree of frailty had an impact on physical fitness, while chronological age did not. Compared with previously used age-related reference values and cut-offs for the tests used, this population of frail elderly patients had poorer physical fitness, see Table 5.

Table 5: The association between frailty status and physical fitness measurements

Variable	FRESH ¹ screening 1 or 2 yes			FRESH screening 3 yes			FRESH screening 4 yes			p
	N	95% CI		N	95% CI		N	95% CI		
Age (years), mean ± SD	80	85.4 ± 5.7		161	85.3 ± 5.3		138	86.1 ± 5.3		
Hand grip (kg), mean ± SD	77	20.7 ± 8.6	18.8 to 22.7	142	18.5 ± 7.1	17.3 to 19.7	118	16.8 ± 7.0	15.5 to 18.1	0.001
Low hand-grip, n (%)	77	57 (74.0)		142	113 (79.6)		118	98 (83.1)		0.312
Unable to perform test of hand-grip strength, n (%)	80	3 (3.8)		161	19 (11.3)		138	20 (14.5)		0.048*
TUG (sec), mean ± SD	70	29.6 ± 30.1	22.4 to 36.7	119	32.6 ± 22.7	28.5 to 36.7	84	37.4 ± 26.2	31.7 to 43.1	0.164
TUG ≥ 30 sec, n (%)	70	18 (25.7)		119	51 (42.9)		84	42 (50.0)		0.008**
Unable to perform TUG, n (%)	81	11 (13.6)		159	40 (25.2)		135	51 (37.8)		<0.001***
6-MWT (m), mean ± SD	62	200 ± 114	170 to 229	103	144 ± 91	126 to 162	77	122 ± 93	101 to 143	<0.001
6-MWT ≤ 300 m, n (%)	62	46 (74.2)		103	96 (93.2)		77	73 (94.8)		<0.001***
Unable to perform 6-MWT, n (%)	77	15 (19.5)		153	50 (32.7)		136	59 (43.4)		0.002**
5-STs (sec), mean ± SD	43	23.8 ± 12.4	20.0 to 27.6	49	24.3 ± 8.4	21.9 to 26.8	30	30.2 ± 15.3	24.5 to 35.9	0.050*
5-STs > 14.8 sec, n (%)	43	33 (76.7)		49	46 (93.9)		30	29 (96.7)		0.010**
Unable to perform 5-STs, n (%)	81	38 (46.9)		158	109 (69.0)		139	109 (78.4)		<0.001***

Nominal data are presented as n (%). Continuous data are presented as mean $\pm$ 1 SD.

Abbreviations: SD: Standard Deviation, FRESH: FRail Elderly Support research group instrument, TUG: Timed Up-and-Go test, 6-MWT: Six-Minute Walk Test. 5-STST: Five-time Sit-To-stand test. Low handgrip strength: W <20 kg, M <30 kg. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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Many participants were not able to perform all the tests of physical fitness during the hospital stay, due to an inability to walk without the assistance of another person, unstable medical condition and exhaustion, for example. All the tests of physical fitness were associated with the degree of frailty, where the most frail patients had the poorest performance. ADL ability and poor nutritional status were significant factors for not being able to perform tests including ambulation, see Table 6.

Table 6: Characteristics of the patients who were unable to perform tests of physical fitness during the index care episode

Variable	Missing: n=28			Missing: n=33			Missing: n=42			Missing: n=30		
	Hand-grip strength, n=380			TUG, n=375			6-MWT, n=366			5-STS, n=378		
	Able to perform n=337	Unable to perform n=43	p-value	Able to perform n=273	Unable to perform n=102	p-value	Able to perform n=242	Unable to perform n=124	p-value	Able to perform n=122	Unable to perform n=256	p-value
Age, mean $\pm$ SD	85.7 $\pm$ 5.4	85.7 $\pm$ 4.5	0.99	85.5 $\pm$ 5.3	86.1 $\pm$ 5.6	0.35	85.4 $\pm$ 5.2	86.1 $\pm$ 5.7	0.20	84.6 $\pm$ 5.0	86.2 $\pm$ 5.4	<0.01*
Female, n (%)	147 (43.6)	19 (44.2)	0.45	159 (58.2)	52 (51.0)	0.21	143 (59.1)	66 (53.2)	0.28	71 (58.2)	142 (55.5)	0.28
FRESH median (min-max)	3.0 (2-4)	3.5 (2-4)	0.01*	3.1 (2-4)	3.5 (2-4)	<0.01*	3.0 (2-4)	3.0 (2-4)	<0.01*	3.0 (2-4)	3.0 (2-4)	<0.01*
1-2 Yes, n (%)	77 (98.7)	1 (1.3)		70 (25.6)	11 (10.8)		62 (25.6)	15 (12.1)		43 (35.2)	38 (14.8)	
3 Yes, n (%)	142 (88.8)	18 (11.3)		119 (43.6)	40 (39.2)		103 (42.6)	50 (40.3)		49 (40.2)	109 (42.6)	
4 Yes, n (%)	118 (86.1)	19 (13.9)		84 (30.8)	51 (50.0)		77 (31.8)	59 (47.6)		30 (24.6)	109 (42.6)	
CCI, mean $\pm$ SD	6.8 $\pm$ 1.9	7.0 $\pm$ 1.8	0.70	6.8 $\pm$ 1.9	6.9 $\pm$ 1.8	0.52	6.9 $\pm$ 1.9	6.7 $\pm$ 1.7	0.40	6.8 (1.8)	6.9 (1.9)	0.85
ADL, median (min-max)	4.0 (0-9)	6.0 (3-9)	<0.01*	4.0 (0-9)	8 (1-9)	<0.01*	4.0 (0-9)	7.0 (0-9)	<0.01*	3 (0-8)	5 (0-9)	<0.01*
MNA, mean $\pm$ SD	10.2 $\pm$ 3.0	8.5 $\pm$ 2.9	<0.01*	10.4 $\pm$ 2.9	8.7 $\pm$ 3.3	<0.01*	10.5 $\pm$ 2.8	8.7 $\pm$ 3.3	<0.01*	10.9 $\pm$ 2.6	9.5 $\pm$ 3.2	<0.01*

Nominal data are presented as n (%). Continuous data are presented as mean $\pm$ 1 SD or median with minimum to maximum.

Abbreviations: SD: Standard Deviation, TUG: Timed Up-and-Go test, 6-MWT: Six-Minute Walk Test. 5-STS: Five-time Sit-To-Stand test, ADL: Activities of Daily Living, MNA: Minimal Nutrition Assessment, FRESH: FRail Elderly Support research group instrument, CCI: Charlson's Comorbidity Index. * $p < 0.05$

Paper 2

The Consort checklist¹⁴⁵ was followed when reporting data in this paper.

The analysis was performed in two steps, first in continuous values and then dichotomized into the categories of decline and stable/improvement. The adjusted analysis found that the intervention group had improved significantly in all components of physical fitness. The patients in the control group improved in the TUG but declined in handgrip strength and the 6-MWT. Comparing groups, there were significant advantages for the intervention group in all components of physical fitness; handgrip strength, $p < 0.001$, 6-MWT, $p < 0.001$ and TUG, $p = 0.042$.

The dichotomized analysis revealed significant differences between groups for all three components of physical fitness. The intervention group declined to a lesser extent compared with the control group; handgrip strength, $p<0.001$, 6-MWT, $p<0.001$, TUG, $p=0.003$. For a visual picture of the results, see Figure 6.

Figure 6: Changes in physical fitness in the CGA unit and conventional care

Abbreviations: 6MWT: Six-Minute Walk Test, TUG: Timed Up-and-Go test, CGA: Comprehensive Geriatric Assessment

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In the regression analysis, the odds ratios (OR) showed the extent to which the outcome was influenced by the intervention. After adjustment, the ORs for decline were handgrip strength OR 4.4 (CI 95% 2.2 to 9.1), 6-MWT OR 13.9 (CI 95% 4.2 to 46.2) and TUG OR 2.5 (CI 95% 1.1 to 5.4) for the tests respectively, see Table 7.

Table 7: Decline in physical fitness 0-3 months

Variable		Intervention group		Control group		OR (CI 95%)	
		n	n (%)	n	n (%)	Unadjusted	Adjusted
Decline	Handgrip strength (- 2.0 kg or more)	133	23 (17.3)	108	46 (42.6)	3.2 (1.7 to 6.1)	4.4 (2.2 to 9.1)
	6-MWT (-50 m or more)	83	9 (10.8)	52	26 (50.0)	7.0 (2.8 to 17.7)	13.9 (4.2 to 46.2)
	TUG (+1.3 sec or more)	105	18 (17.1)	70	26 (37.1)	2.8 (1.3 to 5.9)	2.5 (1.1 to 5.4)

Abbreviations: 6-MWT: Six-Minute Walk Test, TUG: Timed Up-and-Go test

The 0- to 3-month change presented as dichotomized variables, decline versus non-decline, which denote preserved or improved physical fitness. Adjusted analyses were made with age, female gender, Charlson's Index and baseline value of measurement as covariates. The data are presented as the number (%), odds ratios and a 95% confidence interval.

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Paper 3

In Paper 3, it was found that both physical fitness (handgrip strength and the 6MWT) at index and the change during the first three months after discharge from hospital were associated with one-year mortality.

The adjusted hazard ratios for one-year mortality were HR_{6MWT} 3.3 (95% CI 1.9 to 5.8), $p < 0.001$, where those with a walking distance at index of $< 100m$ ran a higher risk of dying than those who walked $> 200m$. For handgrip strength, those with low handgrip strength at index ran a higher risk of dying than those with normal handgrip strength. $HR_{HS\ low}$ 2.4 (95% CI 1.3 to 4.3), $p = 0.003$, see Table 7.

Patients who declined in walking distance during the first three months ran a higher risk of a poorer one-year prognosis than those who improved in walking distance, $HR_{6MWT\ change\ decline}$ 3.8 (95% CI 1.4 to 10.1), $p = 0.007$. Patients who declined in handgrip strength during the first three months ran a higher risk of a poorer one-year prognosis than those who improved in handgrip strength, $HR_{HS\ decline}$ 2.2 (95% CI 1.1 to 4.6), $p = 0.032$, see Table 8 and Figure 7.

In addition, each adjusted analysis for both components of physical fitness showed that a high comorbidity burden at index ($CCI \geq 8$) and male gender were associated with higher mortality, but the degree of frailty and age did not have a significant influence.

Table 8: One-year mortality in relation to performance in HS and 6-MWT

Index	1-year mortality in relation to physical fitness at index					1-year mortality in relation to change in physical fitness during the first 3 months after discharge					
	Unadjusted		Adjusted		0-3 months change	Unadjusted		Adjusted			
	n	HR (95% CI)	p	HR (95% CI)		p	n	HR (95% CI)	p	HR (95% CI)	p
6-MWT						6-MWT					
>200m	76	1		1		Improved	40	1		1	
101-200m	81	1.47 (0.77 to 2.82)	0.243	1.60 (0.83 to 3.09)	0.165	Stable	161	2.36 (1.08 to 5.18)	0.032*	2.04 (0.91 to 4.56)	0.085
0-100 m	197	3.29 (1.91 to 5.66)	<0.001***	3.31 (1.89 to 5.78)	<0.001***	Decline	50	2.10 (0.86 to 5.11)	0.101	3.80 (1.42 to 10.06)	0.007**
HS						HS					
Normal	66	1		1		Improved	61	1		1	
						Stable	153	1.39 (0.78 to 2.48)	0.261	1.73 (0.94 to 3.19)	0.077
Low	301	2.57 (1.45 to 4.54)	0.001***	2.39 (1.33 to 4.27)	0.003**	Decline	62	1.34 (0.69 to 2.61)	0.394	2.21 (1.07 to 4.58)	0.032*

Abbreviations: 6-MWT: Six-Minute Walk Test, HS: Handgrip Strength, HR: Hazard Ratio, CI: Confidence Interval

*1-year mortality was adjusted for gender, age, CCI and frailty. 1-year mortality related to the 0-3 months change was adjusted for gender, age, CCI, frailty screening and the index value of measurement (HS or 6-MWT). The data are presented as hazard ratios and a 95% confidence interval. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

For HS, decline was defined as a change of -2 kg or more, stable as a change between the values -1 kg to +2 kg and improved as a change of +3 kg or more. In 6-MWT a decline was defined as a change of -50 m or more, stable as a change between the values -49 m to +23 m and improved as a change of +24 m or more. Normal HS was defined as >20 kg (women) and >30 kg (men). HS below these values was defined as low.

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Figure 7: One-year mortality in relation to 0- to three-month change in physical fitness

6-MWT: Six-Minute Walk Test, HS: Handgrip Strength

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In this group of patients, both improvements in and the preservation of physical fitness were defined as positive results and a decline or remaining with poor function was a non-desirable result. If the results for change were dichotomized into two categories; decline/stable with low fitness versus improved/stable instead of the previous three, a poorer prognosis was found for those patients who declined in function or retained low function, HR_{decline or ≤100m} 3.6 (95% CI 1.86 to 6.84), $p < 0.001$ and HR_{decline or stable low HS} 2.4 (95% CI 1.2 to 4.7), $p = 0.011$, see Table 9.

Table 9: One-year mortality in relation to dichotomized values for 0- to three-month change

1-year mortality related to change in physical fitness during the first 3 months					
0-3 months change	Unadjusted			Adjusted	
	n	HR (95% CI)	p	HR (95% CI)	p
6-MWT					
Declined or stable ≤100 m	168	2.90 (1.62 to 5.21)	<0.001***	3.57 (1.86 to 6.84)	<0.001***
Improved or stable >100m	83	1		1	
HS					
Declined or stable low	214	2.06 (1.14 to 3.75)	0.017*	2.41 (1.23 to 4.72)	0.011*
Improved or stable normal	62	1		1	

Abbreviations: 6-MWT: Six-Minute Walk Test, HS: Handgrip Strength, HR: Hazard Ratio, CI: Confidence Interval

1-year mortality related to the 0-3 months change was adjusted for gender, age, CCI, frailty screening and the index value of measurement (HS or 6-MWT). The category declined or stable ≤100 m included those patients who remained at the level of 100m or below in walking distance, at both index and 3-month follow-up. The category declined or stable low included those patients who had low HS at both index and at 3-month follow-up.

*Normal HS: >30 kg men, >20 kg women. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Results, Study 2 (Paper 4)

Eighteen interviews were conducted in Study II. The characteristics of the population are presented in Table 10.

Table 10: Characteristics of the study population (Paper 4) (N=18)

Age (years), median (min-max)	85.5 (75-94)
Female, n (%)	9 (50 %)
Frailty, FRESH screening, median (min-max)	3 (2-5)
CCI, median (min-max)	6 (5-11)
Living alone, n (%)	10 (56)
Home service, n (%)	6 (33 %)
Assistive device indoors n (%) (walker/crutches)	12 (67 %) (9/3)

Nominal data are presented as n (%). Continuous data are presented as the median (min-max).

Abbreviations: CCI: Charlson's Comorbidity Index, FRESH screening: Frail Elderly Support Research group screening

The results are presented in an overall theme, three main categories and eight sub-categories, see Figure 8.

Figure 8 – A summary of overall theme, categories and sub-categories

Abbreviations: PA: Physical Activity

In this group of frail elderly patients with substantial multimorbidity, the perceptions of physical activity and exercise were described as a balance between what they perceive as meaningful to themselves and the risk of harm in relation to their aging body. *Physical activity and exercise as part of daily life*, *goals of physical activity and exercise* and *prerequisites for physical activity and exercise* were separate categories that contributed to this theme. The results are described in detail in the manuscript of Paper 4 (pages 8-13).

DISCUSSION

Summary and discussion of main findings

This thesis provides a picture of the physical fitness status in frail elderly patients during an acute care event and reflects how different forms of care may affect physical fitness during the first months after discharge from hospital. Furthermore, the long-term consequences of both poor initial physical fitness status and deterioration in connection with an in-hospital stay were studied. To deepen this understanding, the patients' perceptions of physical activity and exercise were also explored.

We found that measurements of physical fitness were related to the degree of frailty rather than the chronological age. Greater focus should be placed on physical fitness within hospital care, including an individualized assessment of each patient to make tailored interventions to prevent deteriorations in physical function possible.

We also found that the organization of health care had an impact on outcomes related to physical fitness. An holistic care approach through a CGA was shown to have a positive effect on components of physical fitness, such as muscle strength, submaximal aerobic capacity and functional mobility. In Paper 3, we found that physical fitness was associated with the long-term prognosis. Greater physical fitness (submaximal aerobic capacity and muscle strength) in connection with an emergency medical in-hospital stay and the preservation of or improvement in physical fitness during the first months after discharge were both independently associated with one-year survival. As it is known that it is possible to affect the physical fitness status, even in frail and multimorbid elderly patients, preventing a deterioration in connection with emergency medical in-hospital care should be a top priority, in order to achieve a better prognosis.

The evidence relating to the benefits of physical activity and exercise is compelling, but few frail elderly patients are still sufficiently physically active and participation in exercise programs is low. In Study II, the findings describe a balance between what the patients perceive as meaningful and the risk of harm in an aging body. This includes aspects related to physical activity and exercise as part of daily life, goals for physical activity and exercise and the prerequisites needed to enable physical activity and exercise. In order to improve patients' understanding of the benefits of physical activity and exercise and to reduce the perception of risk, the healthcare system should develop routines for the way physical activity and exercise are best communicated to each patient.

Benefits of assessment of physical fitness in medical in-hospital care

In order to provide health care that takes account of the heterogeneous nature of elderly patients, we first have to identify those patients that risk a deterioration in connection with in-hospital care. It is recommended that frailty screening to identify frailty and facilitate risk stratification should be performed with instruments that capture multiple domains of the frailty syndrome ⁴⁰. Since frailty is strongly related to progressive disability ³², additional assessments focusing on components of physical fitness should also be made of patients identified as frail ¹⁰⁷. Greater attention to the physical domains, at an early stage during the hospital stay, would probably facilitate the tailoring of interventions adapted to suit each patient.

Based on clinical experience, today's acute emergency in-hospital care often involves a brief evaluation of physical function that determines further assessment, such as whether the patient is self-ambulatory on the ward, or whether the patient or relatives state a need for increased assistance in their home after discharge. The CGA was first developed as a diagnostic process ¹⁰⁰ to identify people who would benefit from enhanced treatment. In the care of cardiovascular diseases, different assessments of frailty screening, as well as single measurements of physical fitness, are discussed ^{34,41}. This information is thought to be helpful in clinical decision-making relating to invasive strategies based upon risk stratification, nutrition therapy and tailoring secondary prevention, including physical activity advice and exercise-based cardiac rehabilitation programs.

Questionnaires (e.g. the Katz ADL index ¹⁴⁸ or the Barthel ADL index ¹⁴⁹) are common when measuring self-reported physical function in hospitalized frail elderly patients. Self-reports are often used in large studies because they are easy to administer and capture the patient's own perspective of functioning. However, there is a risk of over- and underestimation, recall bias and social desirability ^{150,151}. Objective measurements of physical fitness are thought to be more precise. Although performance-based measurements for use in clinical settings are less accurate than laboratory-based tests, they have been shown to be applicable and valuable in detecting impairments at an early stage, before they affect overall physical function and become visible in an ADL index ¹⁵². Performance-based measurements have also been found to be able to discriminate across a larger spectrum of physical fitness and to be capable of measuring changes over time to a greater extent, compared with a self-reported ADL-index ¹⁵⁰.

Instruments for use in a clinical setting need to be feasible and without a need for advanced equipment, time efficient and easy to perform ¹⁵³. Previously, reference values for the 6-MWT, HS and TUG, for example, were established in different settings, but only in relation to chronological age ^{87,90,154}. To improve the interpretability and enable the identification of impairments related to different

components of physical fitness, clinical reference values are needed for physical fitness tests, to which the results can be compared¹⁵⁴. It could be claimed that age-related reference values are most beneficial during the period of healthy aging. To be valuable in tailoring exercise programs for use in a clinical in-hospital setting, in addition to chronological age, it is important to consider frailty.

Aspects of importance within CGA

In Paper 2, a CGA was found to be beneficial in preserving physical fitness, which is consistent with previous and more recent research that found that a CGA was beneficial for many outcomes, e.g. physical function and disability^{83,95,102,138}. In a multifactorial intervention, such as a CGA, there are many factors that may have an impact on the outcome. Exactly which components within a CGA that are actually beneficial is not clear, but there are some differences within the CGA unit compared with conventional care, such as the multi-professional team approach, structured early rehabilitation strategy, including assessment and careful care planning, and educational efforts, which may play an important role. It is likely that components other than those directly related to physical fitness also contribute to improved hospital outcomes. A CGA also includes more structured work in other aspects of care, such as pharmaceutical reviews and the use of direct admissions.

Studies have shown that frail and disabled elderly patients with substantial multimorbidity are likely to benefit from hospital care provided in a more holistic approach⁹³. The CGA is now the accepted “gold standard” in caring for frail elderly patients in hospitals¹⁵⁵. However, in the literature, there are discussions about who a CGA will benefit most^{102,155,156}. In Paper 2, elderly patients aged ≥ 75 years, considered frail according to the FRESH screening instrument and acutely admitted to hospital, were the target population. Patients in need of acute organ-specialized care were excluded and the intention-to-treat principle was followed. With few exclusion criteria, the study population was considered to be a good representation of clinical practice. Recently, Parker et al.¹⁵⁵ performed an umbrella review of CGA and found that the evidence of beneficial effects in terms of disability, institutionalization and death is specifically derived from hospitalized older people with acute illness. A CGA performed in other settings, such as a post-hospital discharge CGA, did not show the same beneficial results, with no effects on mortality or physical function¹⁰². These interventions were primarily based on assessments, discharge planning and in-home follow-ups by trained geriatric nurses and they were only eventually supplemented by visits by other professionals, including physical therapists. In hospital, a CGA may also be made in different ways. The two most common are within a dedicated ward, with direct responsibility for the patient, or by mobile teams, which provide a more consultative approach¹⁰².

A meta-analysis¹⁵⁷ found that mobile teams were beneficial in terms of short-term survival but less effective regarding physical function, re-admission rates and length of hospital stay. The included studies were considered to be lacking in their description of the composition of the team and the frequency of interdisciplinary meetings. Moreover, the frequency of patient visits varied greatly. Other factors of importance for the results may be related to the use of an advisory model, which may affect adherence to the recommendations given by the geriatric team. Having control of the care process is thought to be one of the key differences between the two CGA models and could be one reason why the CGA unit is effective and mobile teams are not.

A stroke unit is an example of a well-established complex multidisciplinary hospital intervention. Evaluations of stroke units have shown beneficial outcomes regarding survival, returning home and regaining independence¹⁵⁸. When evaluating components that make a stroke unit effective, the results are almost the same as those found for the CGA unit; structured assessment procedures for all team members, an early mobilization and rehabilitation strategy, regular multidisciplinary team meetings and early planning for discharge¹⁵⁹.

The role of the physical therapist

From the physical fitness perspective, physical therapists should probably play a more prominent role on the acute medical ward. In the CGA unit, physical therapists are part of the team, which enables an early rehabilitation strategy on the ward. Unpublished data from the TREEE project showed that the proportion of patients that received physical therapy was about 90% in the intervention group and about 47% in the control group. Just as with other conditions in emergency care, it is likely to be important to meet specialist health professionals, even in the area of physical function. Physical therapists are trained to identify functional impairments in geriatric patients, such as slowness in walking and muscle weakness¹⁶⁰, and are thought to be experts in prescribing exercise to optimize physical function⁹⁴.

A recent study found that frail elderly patients of advanced age have obvious benefits from participating in exercise, even if they begin late in life¹⁶¹. Moreover, exercise interventions during the in-hospital stay have been shown to increase the proportion of patients discharged to their homes and to reduce the length and cost of hospital stays for hospitalized older medical patients⁹⁸. Furthermore, physical therapy comprising ≥ 0.5 contacts/day was shown to be an independent predictor of functional improvement and shorter hospital stays, compared with those who had fewer contacts⁹⁷. In Paper 2, the patients did not attend exercise programs at the hospital, but assessments, careful planning and educational efforts probably meant that more focus was placed on patients' understanding of their situation regarding physical fitness/function. They also received assistance in

finding strategies for managing barriers, such as appropriate assistive devices and, when planned for discharge, patients may have found goals of interest to manage to return home.

Twenty years ago, Landi et al.¹⁶² evaluated the effects of introducing a structured rehabilitation program by physical and occupational therapists within the emergency medical ward. After having worked together and learning the skills and competence of each professional, in addition to better patient-related outcomes, they also found an increased interest in geriatric rehabilitation within the team. It is likely that wards with a more structured team approach are better at developing understanding and collaboration, which may lead to improved continuity for each patient regarding rehabilitation, information and goal setting¹⁰².

Needless to say, the availability of rehabilitation after hospital discharge may have influenced the results of the study. The work in both study groups reflected clinical practice in emergency health care. Both groups were similar in that physical therapists did not have the opportunity to follow patients after discharge regarding physical activity and exercise. When needed, information on the patient's physical function was reported to the rehabilitation professionals within municipal care and what was offered differed depending on the municipality. The patients in the study lived in many different municipalities and the representation was similar in both groups. The structured work within the CGA unit probably led to more information about physical function and physical fitness in the hospital epicrisis. Within Study I, no information on rehabilitation outside the hospital was available.

Meaningfulness in relation to physical activity and exercise in frail elderly patients

“Meaningfulness” is a concept that is often used as meaning “a meaningful life” and it is relevant to discuss this in relation to aging. Meaningfulness includes all the things that create or constitute meaning for a person¹⁶³. Subjectively, a person's life is meaningful if he/she feels that it is and it is not possible for anyone else to interpret what meaningfulness means to another person. There are many things that influence making life meaningful. Among others, the content of life, such as activities, experiences and relationships, that lead us forward to a specific and valuable goal is regarded as important¹⁶³.

What makes life meaningful may differ in frail elderly individuals compared with younger persons. A Canadian study by Hoover et al.¹⁶⁴ found that almost 50% of adults aged 85 years or older living at home rely on others to help them perform their daily activities. In the present study, patients described their goals for physical activity and exercise, in terms of being able to maintain independence in daily life. Many elderly people probably feel that they are on the verge of becoming more dependent. As dependency is related to life satisfaction¹⁶⁵, the

patients in the present study probably found their goal for physical activity and exercise meaningful. In frail elderly individuals, loneliness is a problem of great concern ¹⁶⁶. Sjöberg et al. ¹⁶⁷ studied the meaning of existential loneliness in frail elderly individuals in long-term care facilities. The results were presented in terms of “*being trapped in a frail and deteriorating body*”, “*being met with indifference*”, “*having nobody to share life with*” and “*lacking purpose and meaning*”. In our study (Paper 4), the patients also described goals for physical activity and exercise in terms of meeting friends by participating in activities with others. After studying the patients’ stories, it is likely that, in old age, sufficient physical function is a cornerstone of independence in daily life and an important facilitator when it comes to maintaining autonomy related to social interaction.

In Paper 4, physical activity and exercise were described as a balance between what the patients perceived as meaningful and the risk of harm in an aging body. The concept of “Sense of Coherence” (SOC)¹⁶⁸ has been shown to be an important determinant of life satisfaction and highlights three components related to perceived SOC and meaning; comprehensible, manageable and meaningful, which can be applied to the results of the study. Comprehensibility is related to an understanding of the purpose and knowing how to perform physical activity and exercise. It affects the benefits an individual sees and the valuable goals he/she sets. The individual also needs to perceive physical activity and exercise as manageable, which means being able to handle the demands related to the activity, e.g. risk of falls, illness or other symptoms related to the aging body. According to SOC, meaningfulness is something an individual personally values and it is related to motivation.

To enable participation in physical activity and exercise in frail elderly individuals, we have to clearly communicate the purpose of it and also give careful instructions on how they should actually perform it. A discussion about finding strategies for making participation possible is also necessary. Finally, they may need assistance in formulating valuable goals, which make physical activity and exercise meaningful for the individual.

Methodological considerations

Internal validity

The results of this thesis need to be considered in relation to the study limitations. In Study I, some systematic errors need to be addressed, as they might lead to an under- or overestimation of the results. To interpret the results properly, the large proportion of missing data may be important to consider, even though it is in line with previous research including physical fitness tests in hospitalized, frail, elderly patients ⁹¹. Prior to the inclusion of patients, a power calculation was performed. This primarily relied on other outcomes in the TREE study and was

described in detail in Paper 2. Compared with previously performed exercise interventions in frail elderly patients ^{169,170}, including evaluations of physical fitness, a fairly large number of participants completed the tests.

The opportunity to make an imputation of values in the analysis was discussed. In Paper 1, imputation was not appropriate, as the aim was to describe the physical fitness status in clinical in-hospital care. In Paper 2, the reason for no imputation was due to the probability that it was the most severely ill patients who did not manage to perform the tests. If they were excluded from the analysis, the potential to maintain fitness would probably be better and a difference between the two groups might be a little more difficult to detect. If there was still a difference, it probably reflected a “true” difference. In Paper 3, there were two separate analyses. In the first, all the patients who survived the index hospital stay were included. Those who were not able to perform the tests of physical fitness represented the lowest group of function. In the second analysis, imputations were made. Those who were unable to perform the tests were assigned values of 10 kg and 25 m, which were considered low and relevant, due to the varying status of acutely admitted frail elderly patients.

The patients were allocated to the intervention group or the control group based on the availability of hospital beds, which was assumed to be the most clinically feasible method for including and evaluating patients, representative of today’s emergency hospital care. To reduce the risk of selection bias, a computerized randomization procedure is recommended ¹⁷¹. However, it was considered too difficult to implement and it is known to be challenging when evaluating clinical practice in complex hospital health care ¹⁷². If the allocation procedure had been computerized, it would have been necessary to give informed consent in the ambulance, which appeared to be very difficult in this group of patients with severe multimorbidity. Additionally, due to the situation with a shortage of available beds within emergency care, many patients were excluded due to there being no available bed on the ward that the lottery procedure had chosen, which would in turn probably have made the inclusion procedure very lengthy. The allocation procedure might anyway be regarded as random to a satisfactory degree, as no one in the study group was able to influence the procedure. Different physicians were involved in the allocation; this also included on-call physicians if it was night time and the patients had been admitted to the same ward, even outside the study.

Cumulative comorbidities have been considered to be highly related to reduced exercise capacity in the elderly ¹⁷³. In Paper 2, both groups were highly affected by diseases, but the intervention group had a slightly higher comorbidity burden at index, which should mean poorer initial conditions for improvements in physical fitness. However, the patients in the intervention group managed to perform the tests to a greater extent at index, compared with the control group. This could perhaps be related to slightly longer hospital stays and also closer teamwork on the

ward, which made it easier to find opportunities to perform the tests. In turn, better initial results may lead to difficulty improving still further.

Another potential source of bias is that there was no opportunity to use blinding, as the intervention and control wards were situated in different hospital buildings. However, during the follow-up test procedure, the previous results for physical fitness were not available to the assessors.

In this specifically frail population, it would probably have been useful to have one more test accepted for non-ambulatory patients. In Paper 1, only 30% of the patients managed to perform a 5-STS test. It can be hypothesized that the 30s stand chair test¹⁷⁴ would have been more valuable, as the patients would then already have had a result after one rising.

Limitations due to the chosen study measurements are almost inevitable in clinical trials. The intention was to measure different components of physical fitness, although performance-related components are part of the evaluation. The tests were previously found to have good validity when measuring different components of physical fitness and were commonly used in elderly research. Moreover, the reliability of the tests was thought to be good. However, no data on measurement properties were found for this specific group of hospitalized frail elderly patients with severe multimorbidity. In the present study, the assessors were all trained to perform the tests as similarly as possible and there were training sessions both before the data collection started and repetitively during the study period.

The lack of studies of objectively measured physical fitness in hospitalized frail elderly patients sometimes made it difficult to decide on cut-offs and relevant clinically important changes in relation to the specific tests. The disadvantage of categorization due to cut-offs is that it only offers two options and makes small differences difficult to identify. Identifying meaningful changes is challenging and depends on the contexts, such as the baseline level of function and disease considerations¹⁷⁵. In this study, we had to stipulate relevant limits for change from a statistical viewpoint beyond the standard error of measurement. The minimal clinically important change can be defined as a change that has clinical or practical importance for the persons studied. For functional performance-based tests, it should be large enough for a person to perceive the change, in daily life or improved prognosis, for example¹⁷⁵. The changes used in Study I actually resulted in changes that were fairly similar or even greater than those previously reported in elderly populations^{176,177} and they could be considered clinically important, as they managed to identify change related to survival.

External validity

Generalizability is the extent to which the results can be transferred to other populations. In the TREEE study, patients who were in acute need of medical in-hospital care and fulfilled the criteria for inclusion were enrolled consecutively. As there were few exclusion criteria and the main purpose of TREEE was to evaluate existing hospital care, we feel that the population effectively represented clinical hospital care in Sweden. To be able to include even cognitively impaired patients, it was possible to give consent through proxy.

Paper 1 reflected the clinical picture related to physical fitness measurements. A substantial proportion of the patients were unable to perform the test during the hospital stay, but there were also patients who performed quite well in relation to previously described age-related reference values. The analysis found large standard deviations for all tests. The variation in physical fitness probably mirrors the heterogeneity in this group of patients and the degree of frailty appears to be important, with slightly larger variations in less frail patients. In Paper 2, all the patients who managed to perform two measurements of physical fitness were included in the analysis. The results appear to be generalizable to patients in clinical practice who are able to ambulate, at least short distances, and to those able to follow instructions to a satisfactory extent. Overall, in the clinical context of Swedish medical emergency hospital care, the generalizability is thought to be good.

Trustworthiness

In qualitative research, trustworthiness, including the terms credibility, transferability, dependability and confirmability, is a quality criterion and can be compared with the reliability and validity in quantitative studies. In addition, reflexivity is an integral part, ensuring the quality and transparency of the findings. Trustworthiness answers the question, is it true? ¹³⁹.

To explore the patients' perspectives of physical activity and exercise, Study II (Paper 4) had a qualitative approach. *Credibility* is concerned with the aspect of truth, which means the reliability of the data and the interpretations within the analysis process ¹³⁹. The patients in the study were admitted by strategic sampling with the aim of including both men and women with frailty, of varying ages and functional status and living in both urban and rural settings. This was considered appropriate in order to capture both common patterns and unique variations in relation to this context. In the analysis, an investigator triangulation was used, meaning that the data were coded, analyzed and interpreted step by step by all researchers until consensus was reached. The researchers' various past experiences enriched the analysis, as more perspectives were weighed up.

Transferability is the applicability of the research ¹³⁹. Writing a qualitative article mirrors the iterative process of continuous analysis and it also encompasses

questions of trustworthiness. There should be a broad description of the participants, the research process and the context in which the research was conducted. In our study, the characteristics of the study population are described, together with descriptions of the inclusion and exclusion criteria, the interview procedure and the interview guide. The description of the research has to be comprehensive enough for a reader to understand and decide whether the findings are transferable to his/her own setting.

Dependability includes the aspect of consistency, which means ensuring compliance with the particular method of analysis. *Confirmability* refers to neutrality and means that the interpretation should reflect the researchers' own viewpoints but should still be well grounded in the data ¹³⁹. Both dependability and confirmability are addressed by enabling transparency in the analysis process. The researchers should describe the process that produced their findings, such as coding schedule and quotations, on which their interpretations are based.

Krippendorff ¹²³ states that the text obtains its meaning through the reader and the interpretation of the informants' perceptions has to be carefully managed with consciousness of the context ¹²³. *Reflexivity* means examining the different assumptions and preconceptions and values that influence decisions in the research process. In Paper 4, all the interviews were performed by the same author (KÅ) who used a semi-structured interview guide to ensure that the interviews focused on the studied phenomenon. As a physical therapist, the preconception in relation to physical activity and exercise may be a positive experience beneficial to elderly people. The interview guide helped the interviewer to stay focused and neutral during the interviews and the fact that the triangulation process involved more perspectives was a strength.

CONCLUSIONS

This thesis highlighted the importance of considering physical fitness in clinical hospital health care, with special emphasis on hospitalized frail elderly patients with multimorbidity.

- The results showed that, among frail elderly patients in medical emergency in-hospital care, a substantial proportion of the patients were found to have poor physical fitness. Furthermore, physical fitness was associated with the degree of frailty, rather than the chronological age, which makes frailty important to consider when physical activity and exercise are discussed.
- A CGA was found to be beneficial in terms of the preservation of or improvement in physical fitness. It was hypothesized that the multi-professional approach and an early rehabilitation strategy, including an assessment of physical fitness and physical function and care tailored to suit each patient, were important components of the CGA, in relation to these outcomes.
- Physical fitness in connection with in-hospital care was associated with one-year mortality. Furthermore, preserved or improved submaximal aerobic capacity and muscle strength during the first months after an in-hospital episode were associated with an improved long-term prognosis. This means that frail elderly patients with a severe comorbidity burden can benefit from interventions aiming to preserve and/or improve physical fitness.
- Patients' perceptions of physical activity and exercise, as a balance between what is perceived as meaningful and the risk of harm, highlight the need for improved information and interventions with respect to the goals and prerequisites of each patient.

FUTURE IMPLICATIONS

- Greater focus on the systematic assessment of frail elderly patients in terms of frailty, physical function and physical fitness within hospital care is vital. It is important to identify patients at risk of functional decline in connection with in-patient hospital care. Assessments of physical fitness and physical function should be offered routinely as the basis of an individualized tailored intervention.
- To enhance the preservation of and/or improvement in physical fitness in hospitalized elderly patients, a multi-professional healthcare team, including physical therapists, who are trained to assess and prescribe exercise in elderly patients, is recommended.
- Hospital care according to a CGA is considered to be “best practice” care even for frail elderly patients with substantial multimorbidity and needs to be introduced to a greater extent in hospitals, to increase access to more available patients.
- Within a comprehensive intervention such as a CGA, it is difficult to pinpoint one factor of particular importance to the outcome, even though we believe that the role of physical therapists is important. In order to use the available resources in the best possible way, future research should be designed more specifically to analyze the importance of physical therapy within a CGA.
- There is a need for improved communication about physical activity and exercise to frail elderly patients with multimorbidity, within hospital health care. The team around the patient has to be consistent in communicating benefits, risks and guidance towards realistic and valuable goals. In order to succeed with this, future research should also explore how the team around the patients perceive the patients’ needs for physical activity and exercise.

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Linköping University
SE-581 83 Linköping, Sweden

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