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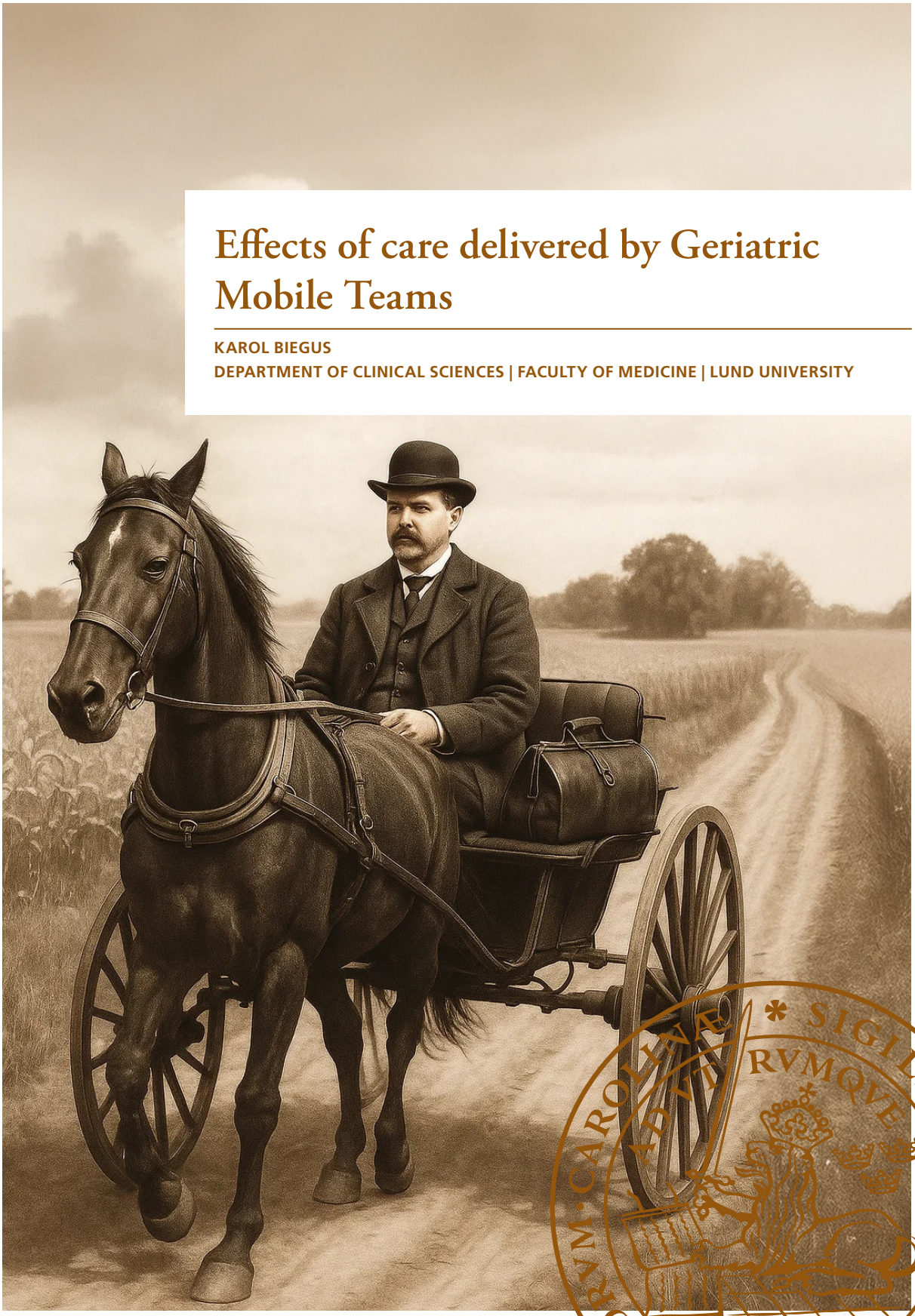

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LUND
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DOCTORAL DISSERTATION

Doctoral dissertation for the degree of Doctor of Philosophy (PhD) at the Faculty of Medicine at Lund University to be publicly defended on the 17th of September at 9.00 am at the Medicinhistoriska museet located in Gamla Barnsjukhuset, Bergaliden 20, 252 23 Helsingborg, Sweden

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Abstract: Geriatric mobile teams are becoming an increasingly common service offered to older patients, often with the aim of avoiding hospitalisation. As these services are implemented, rigorous evaluation is essential to ensure they deliver intended benefits. This thesis evaluates various models of geriatric mobile teams.

Paper I is a descriptive observational study using data from the recruitment phase of the trial in Paper III. It found a high consent rate among older adults with multimorbidity, though the oldest participants were harder to reach.

Paper II analysed baseline characteristics of participants from the same trial. It found that this cohort is relatively independent but particularly suffer from pain, anxiety, mobility issues, mild frailty —suggesting they may benefit from targeted interventions aimed at these problems.

Paper III presents results from GerMoT, a randomised, controlled, assessor-blinded trial. It showed that Comprehensive Geriatric Assessment (CGA)-based care delivered at home with a mobile team over 24 months had no significant effect on hospital days, mortality, quality of life, admissions, physical function, frailty, daily activities, or cognition compared to standard care.

Paper IV is a before-and-after study evaluating a reactive geriatric acute team. While no overall impact on hospitalisation was seen, subgroup analysis showed reduced hospital use among nursing home residents, ambulance referrals, and those receiving advanced treatments such as intravenous antibiotics or fluids.

Paper V assessed outcomes after a mobile team assumed medical responsibility for an Intermediate Care Facility (ICF). It showed a non-significant reduction in hospitalisations but a significant decrease in average length of stay at the ICF.

In conclusion proactive CGA-based mobile care does not appear to reduce hospitalisation over two years. However, reactive geriatric acute teams may reduce hospital use when they deliver hospital-level interventions.

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- To my family

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Biegus KR, Frobell RB, Wallin ÅK, Ekdahl AW. The challenge of recruiting multimorbid older patients identified in a hospital database to a randomised controlled trial. Aging Clin Exp Res. 2022 Dec;34(12):3115-3121. doi: 10.1007/s40520-022-02263-0.

Paper II

Biegus KR, Ekdahl AW. Baseline characteristics of the Geriatric Mobile Team trial (GerMoT) cohort - an alternative definition of multimorbidity *[Manuscript submitted for publication] 2024*

Paper III

Biegus KR, Jöud AS, Carlsson SK, Ekdahl AW. Is care based on Comprehensive Geriatric Assessment with mobile teams better than usual care? Results from a randomised controlled trial (The GerMoT trial). *[In manuscript] 2025*

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Arvidsson SA**, Biegus KR**, Ekdahl AW. The impact of a mobile geriatric acute team on healthcare consumption. Eur Geriatr Med. 2024 Dec;15(6):1859-1865. doi: 10.1007/s41999-024-01045-3.

Paper V

Biegus KR, Ekdahl N, Ekdahl AW. The effects of care delivered by a Geriatric Mobile Team at an intermediate care facility for older people: a pre- and post-interventional study. [In manuscript] 2025

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Campollo-Duquela ME, Castro-Vilela ME, Skoumal M, Hester-Hogebrug J, Ariën F, Wiig I, **Biegus KR**, Zerah L. Evaluating the evidence for sensor-based technologies and medical devices in fall prevention among hospitalized older adults: a systematic review. Spanish Journal of Geriatrics and Gerontology [manuscript accepted for publication] 2025

Author´s contributions to the papers

Paper I

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Karol Biegus and Anne Ekdahl. The first draft of the manuscript was written by Karol Biegus and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript. Karol Biegus is corresponding author.

Paper II

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Karol Biegus and Anne Ekdahl. The first draft of the manuscript was written by Karol Biegus and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript. Karol Biegus is corresponding author.

Paper III

Anne Ekdahl designed the trial. Karol Biegus participated in the intervention and drafted the manuscript. Anna Saxne Jöud and Katarina Steen Carlsson participated in designing the trial with a focus on statistics and health economics, respectively. Anna Saxne Jöud and Katarina Steen Carlsson and Karol Biegus performed parts of the analysis. All authors have reviewed the manuscript. Karol Biegus is corresponding author.

Paper IV

All authors contributed to the study conception and design. Karol Biegus designed the intervention and led the intervention. Data collections were performed by all authors and other staff working in GAT. Material preparation and analysis were performed by Sofie Arvidsson and Anne Ekdahl. The first draft of the manuscript was written by Sofie Arvidsson. Karol Biegus revised the manuscript. All authors read and approved the final manuscript. Karol Biegus is corresponding author.

Paper V

Anne Ekdahl designed the study. Anne Ekdahl and Karol Biegus wrote the first draft of the manuscript. Natascha Ekdahl did the data analysis. All authors have scrutinised and revised the manuscript. Karol Biegus is corresponding author.

Abbreviations

ADL	Activities of Daily Living
CFS	Clinical Frailty Scale
CG	Control Group
CGA	Comprehensive Geriatric Assessment
DoH	Declaration of Helsinki
ED	Emergency Department
EQ-5D-5L	EuroQol 5-Dimension 5-Level (a standardized measure of health status)
GAT	Geriatric Acute Team
GerMoT	Geriatric Mobile Team Trial
GMT	Geriatric Mobile Team
HaH	Hospital at Home
ICD-10	International Statistical Classification of Diseases and Related Health Problems, 10th Revision
ICF	Intermediate Care Facility
IG	Intervention Group
IPAQ	International Physical Activity Questionnaire
LOS	Length of Stay
LSS	Act Concerning Support and Service for Persons with Certain Functional Impairments
MDT	Multidisciplinary Team
MoCA	Montreal Cognitive Assessment
OPAT	Outpatient Parenteral Antibiotic Therapy
PASIS	Patient Administrative System in Skåne
PC	Primary Care
RCT	Randomized Controlled Trial
SD	Standard Deviation
SoL	Social Services Act
SPPB	Short Physical Performance Battery

Summary

Introduction

Over the past three centuries, Sweden's healthcare system has evolved extensively. In the 18th and early 19th centuries, healthcare in Sweden was primarily home-based, with "provinsialläkare" or provincial doctors playing a crucial role. These physicians travelled by horse and carriage to visit patients, providing essential medical care to both rural and urban populations. The provincial doctors were vital to the healthcare system, often managing a wide range of medical conditions with limited resources and tools[1]. Their home visits ensured that even the most remote and underserved communities received medical attention, maintaining a deeply personal doctor-patient relationship and a holistic approach to healthcare.

The late 19th and early 20th centuries saw significant changes due to industrialization and urbanization. Hospitals and clinics started to become more prevalent, and the healthcare system began to shift towards more specialized institutions, hospitals and primary healthcare centres that patient could come to[1].

In recent years, healthcare systems globally, and in Sweden, have embraced innovative models of care that deliver advanced services outside traditional hospital settings. Hospital at Home (HaH) services, virtual wards, and mobile teams have become prominent approaches in this evolution. HaH services provide acute hospital-level care to patients in their own homes, aiming to reduce hospital admissions and allowing patients to recover in familiar surroundings. Virtual wards extend this concept by utilizing telemedicine and remote monitoring technologies to manage patients with complex needs at home.

In international research, HaH has shown clear benefits on mortality, rates of delirium and reduced rate of admission to residential care[2]. No peer reviewed research of HaH exists in the Swedish context[3]. In Sweden various geriatric mobile teams, that are not part of a Hospital at Home scheme, have also been built to specifically address the needs of the older people, optimize resource utilization and alleviate the burden on overstretched hospitals[4,5]. These services, in Sweden, are heterogenous and have not been evaluated scientifically. Studies of similar services in other countries have shown uncertain effects on mortality, Emergency Department visits, hospitalisations, and length of stay in hospital[6]. This knowledge gap, especially in the Swedish context creates uncertainly around forming new mobile team services for older people. There is a political will, in Sweden to transition to more mobile services[4,7]. As we do this, it is important that these new models of healthcare are rigorously evaluated to ensure they deliver as intended.

Aims

The main aim of this thesis is to evaluate the effectiveness of different types of geriatric mobile teams used for avoiding hospital admissions.

Methods

The studies utilized various methodologies, including pre- and post-interventional analyses and a randomized controlled trial (RCT).

Paper I was an analysis of data collected during recruitment to the RCT GerMoT. The recruitment process was described at each step to better understand multimorbid older patient's willingness to participate in proactive interventions with a geriatric mobile team.

Paper II included baseline data analysis of patients recruited to the GerMoT trial. The inclusion criteria were: ≥ 75 years of age, ≥ 3 Emergency Department visits in the last 18 months, ≥ 3 diseases diagnosed according to different ICD-10 chapters and not living in a nursing home. Baseline characteristics of patients fulfilling the trial's inclusion criteria were compared to what is known about multimorbid patients from other studies.

Paper III presented the main results from the GerMoT study, a randomised, controlled, assessor blinded at baseline, single-centre trial. Participants were randomised to one of two groups: an intervention group (IG) receiving outpatient healthcare through a mobile team based on CGA in addition to usual healthcare and a control group (CG), with access to usual healthcare only. CGA is a detailed, interdisciplinary diagnostic and treatment process for older adults, looking at their health, mental well-being, daily activities, and support needs. Done by a team of experts, it creates a personalized care plan to help with patient's healthy, independence, wellbeing. The IG and CG were compared over 24-months follow-up with regards to number of days spend in hospital, mortality, quality of life, number of admissions, physical performance, frailty, ADL and cognition.

Paper IV was a before-and-after study of medical records to assess the effects of a Geriatric Acute Team (GAT) on healthcare utilisation. All patients referred to the team during the study period could participate in the study. The outcomes: emergency department (ED) visits, hospitalizations and length of stay in hospital were recorded for each participant during the three months prior to the first visit by GAT and compared to the same outcomes for each participant during the three months after the first visit.

Paper V was a retrospective before-and-after analysis of the electronic hospital medical notes and local records from an intermediate care facility (ICF). A baseline 1-year observation period, before the geriatric mobile team (GMT) took over the responsibility of a ICF, was followed by a 1-year post-intervention observational

period. During these periods all patients residing in the ICF were included in the study. The number of days spent in hospital and length of stay in the ICF were compared for the periods before and after the intervention.

Main results

Paper I

Out of 1212 patient identified in a database as meeting the inclusion criteria to GerMoT, 838 could be invited to participate. When recruiting to GerMoT, a new mobile team intervention, we achieved a 54% consent rate in older participants with multimorbidity. It is, however, more difficult to reach and invite the oldest old. Sex and disease burden do not seem to play a role in the ability to invite or willingness to participate.

Paper II

Patient recruited to GerMoT had high levels of multimorbidity and healthcare use. They had many features in common with patients meeting the traditional definitions of multimorbidity, that is two or more chronic diseases. They were however a much smaller and less heterogenous group who particularly suffered from pain, anxiety, mobility issues and had predominantly mild frailty, lived alone and were relatively independent.

Paper III

CGA based healthcare delivered in patient's homes by a mobile team had no effect at 12- and 24 months follow-up on the number of days spent in hospital, mortality, quality of life, number of hospital admissions, physical performance, frailty, activities of daily living and cognition compared to traditional healthcare.

Paper IV

There was no observed difference in ED visits, hospitalisations, and length of stay in hospital for all participants seen by a reactive geriatric acute team. However, for the participants living in nursing homes; ED-visits reduced on average by 0.5/participant ($p=0.002$), the number of hospitalisations reduced by 0.3/participant ($p=0.018$) and length of stay in hospital reduced by 4.3 days/participant ($p=0.045$). For the 13 participants referred by ambulance, the number of hospitalisations reduced by 0.7/participant ($p=0.044$) and length of stay in hospital reduced by 4.1 days/participant ($p=0.028$). The participants who got intravenous fluids or antibiotics also had less hospital care.

Paper V

A non-significant reduction in mean length of stay in hospital, from 2,60 (SD 6,93) days to 1.40 (SD4.09) days, p-value = 0.247, for inhabitants admitted from the ICF was observed in this study after a GMT took over the medical responsibility compared with the period when different PC-physicians had the medical responsibility. The length of stay in the ICF was significantly reduced from 54.6 (SD 42.4) days before the intervention to 40.1 (SD 29.0) afterwards, p-value = 0.028.

Discussion

The results of this thesis suggest that providing healthcare through a geriatric mobile team can have an effect on the need for hospital care in certain situations.

Paper I and II suggest that patients with multimorbidity can easily be identified in a database and are willing to participate in home-based healthcare interventions by a mobile team. By applying a few additional criteria to the traditional definition of multimorbidity (two or more chronic disease), it is possible to identify a more manageable subgroup of patients who require particular attention.

Paper III shows that proactive CGA-based mobile team interventions do not seem to reduce the need for hospitalisation when offered to patients in addition to usual healthcare. These results need to be interpreted with caution because our study had difficulties with maintaining staff continuity and a good quality of the intervention throughout the study. Our intervention, setting and team member constituents are unique to this study, limiting generalisability, even though the interventions adhered to the general principles of CGA. The principles of CGA have in recent years likely been incorporated into usual medical care, this may explain in part the lack of effect of our intervention compared to usual healthcare.

Paper IV studied the effects of a reactive mobile geriatric acute team treating ill patients in their homes. This team, originating from a hospital unit, offered more advanced diagnostic and treatment options than those typically available through primary care-led mobile teams. No significant reductions were observed in ED visits, hospitalisations, or hospital length of stay for the overall study population. This is likely attributable to the high levels of frailty and associated risk of clinical deterioration, which can lead to secondary illnesses, ED visits, and prolonged hospital stays. It is also possible that the team uncovered previously unrecognised medical conditions and unmet needs, which contributed to increased healthcare utilisation. In many cases, the team's interventions constituted routine care delivered at home because patients were unable to access primary care. However, a significant reduction in healthcare utilisation was observed in specific subgroups—namely, patients residing in nursing homes, those requiring advanced interventions such as intravenous antibiotics and fluids, and those referred by ambulance. Primary care

services typically do not provide intravenous antibiotics in nursing homes and do not respond to acute referrals from ambulance services. It is important to note that this subgroup analysis was not pre-specified and involved a limited number of participants. These findings should therefore be interpreted with caution and confirmed in studies focusing on these specific populations.

Paper V showed that for patients residing in a ICF the number of days they need to be in hospital might decrease if a GMT takes over the responsibility of the ICF. In our study the decrease was only a trend and not statistically significant. However, the time spent in the ICF decreased significantly after the GMT started working in the ICF. Improved coordination and cooperation between the GMT physician and ICF staff most likely facilitated faster care planning and decisions regarding where the patients should be moved after their ICF stay.

Conclusion

A reactive geriatric acute mobile team does not seem to reduce the need for hospital care among its patients. However, there was a modest indication that the intervention may decrease healthcare utilisation in patients requiring advanced treatments such as intravenous therapies. Similarly, patients residing in nursing homes, those referred to the team by ambulance, or those living in an intermediate care facility (ICF) also appeared to require less hospital care after being managed by the geriatric acute team. In contrast, a proactive CGA-based mobile team does not appear to be more effective than standard healthcare in reducing hospital service use. Further research is needed to confirm these findings.

Populärvetenskaplig sammanfattning på svenska

Introduktion

Under de senaste tre seklerna har Sveriges sjukvårdssystem genomgått omfattande förändringar. På 1700- och början av 1800-talet bedrevs vården i Sverige huvudsakligen i patienternas hem, där "provinsialläkare" spelade en avgörande roll. Dessa läkare reste med häst och vagn för att besöka patienter och erbjöd grundläggande medicinsk vård både på landsbygden och i städer. Provinsialläkarna var centrala i sjukvårdssystemet och hanterade ofta en rad olika medicinska tillstånd med begränsade resurser[1]. Genom sina hembesök säkerställde de att även patients boendes i avlägsna områden fick medicinsk vård, vilket bidrog till en nära relation mellan läkare och patient och ett mer helhetligt synsätt på vården.

Under senare delen av 1800-talet och tidigt 1900-tal förändrades mycket på grund av industrialisering och urbanisering. Sjukhus och kliniker blev vanligare, och vårdsystemet började övergå till institutioner som patienter kunde besöka[1].

På senare år har vården, både i Sverige och globalt, anammat nya vårdmodeller som erbjuder avancerad vård utanför sjukhusen. Sjukhus i hemmet, virtuella vårdavdelningar och mobila team har blivit viktiga delar av denna utveckling. Sjukhus i hemmet innebär att patienter får akutvård på sjukhusnivå i sina hem, vilket minskar behovet av sjukhusinläggningar och låter patienter återhämta sig i en bekant miljö. Virtuella vårdavdelningar bygger vidare på detta genom att använda telemedicin och fjärrövervakning för att hantera patienter med komplexa vårdbehov hemma. Sjukhus hemma har i många länder utvärderats noggrant. Dessa studier visar att denna vårdform kan öka överlevnad, minska förvirring and minska behovet av vårdboende[2]. Sjukhus hemma i Sverige, har inte utvärderats på ett vetenskapligt sätt[3].

Olika geriatriska mobila team, som inte är en del av sjukhus hemma, har skapats i Sverige för att specifikt möta äldres behov, och erbjuder omfattande medicinsk vård, inklusive avancerad diagnostik och behandlingar, direkt i patientens hem. Dessa team är inriktade på att hantera de unika utmaningar som äldre ställs inför, såsom multipla kroniska tillstånd och skörhet. Målet med dessa vårdmodeller är att förbättra patientnöjdheten, optimera resursanvändningen och minska trycket på sjukhusen[4]. Dessa team har inte utvärderats vetenskapligt. Denna kunskapslucka, särskilt i en svensk kontext, skapar osäkerhet kring hur nya mobila vårdteam för äldre bör utformas. I Sverige finns en politisk vilja att skapa mobila vårdlösningar[4]. När vi gör denna omställning är det viktigt att noggrant utvärdera de nya arbetssätten så att de verkligen fungerar som det är tänkt.

Syften

Huvudsyftet med denna avhandling är att undersöka hur effektiva geriatriska mobila team är i arbetet med att undvika sjukhusinläggningar.

Metoder

Studierna använde flera olika metoder, inklusive analyser före- och efter deltagare hade fått en viss behandling samt en studie där deltagare delas upp i två grupper, en med och ett utan behandling, så kallad randomiserad kontrollerad studie (RCT).

Artikel I var en analys av data som samlades in under rekryteringen till en RCT som heter GerMoT. Syftet var att bättre förstå äldre patienters vilja att delta i förebyggande insatser från ett geriatriskt mobilt team.

Artikel II analyserade grundläggande information om de patienter som rekryterades till GerMoT-studien, som kön, ålder, antal sjukdomar, deras livskvalitet o.s.v. För att få vara med skulle man vara 75 år eller äldre, ha besökt akutmottagningen minst tre gånger de senaste 18 månaderna, ha minst tre olika sjukdomar enligt olika diagnosgrupper och inte bo på särskilt boende. Patienternas egenskaper jämfördes med vad man sedan tidigare vet om äldre personer med flera sjukdomar från andra studier.

Artikel III redovisade huvudresultaten från GerMoT-studien. I denna studie fördelades deltagarna slumpmässigt till en av två grupper: en interventionsgrupp (IG) som fick vård genom ett mobilt team baserat på Comprehensive geriatric assessment (CGA) utöver vanlig vård, och en kontrollgrupp (CG) som endast hade tillgång till vanlig vård. CGA är en detaljerad, tvärvetenskaplig diagnostisk och behandlingsprocess för äldre, som undersöker deras hälsa, psykiska välbefinnande, dagliga aktiviteter och stödbehov. Ett team av vårdpersonal utförde CGA och skapade en personlig vårdplan för att stödja patientens hälsa, självständighet och välbefinnande. IG och CG jämfördes vid 12 och 24 månaders uppföljning.

Artikel IV var en studie där man analyserade medicinska journaler för att bedöma vårdutnyttjande och insatser från ett Geriatriskt Akut Team (GAT). Alla patienter som remitterades till teamet under studietiden kunde delta i studien. Resultaten: akutmottagningsbesök, sjukhusinläggningar och vårdtid på sjukhus registrerades för varje deltagare under de tre månaderna före det första besöket av GAT och jämfördes med samma utfall under de tre månaderna efter det första besöket.

Artikel V var en före- och efteranalys av elektroniska medicinjournaler och lokala register från ett korttidsboende. En baslinjeobservationsperiod på ett år, innan det geriatriska mobila teamet tog över ansvaret för en korttidsboendet, följdes av en ettårig observationsperiod efter interventionen. Alla som vårdades på korttidsboendet under perioderna deltog i studien. Antalet dagar som boenden på korttidsboendet tillbringat på sjukhus, antalet akutmottagningsbesök de haft och

deras vistelsetiden på korttidsboendet jämfördes för perioderna före och efter interventionen.

Huvudresultat

Artikel I

Av 1212 patienter som identifierades i en databas som uppfyllde kriterierna för att delta i GerMoT, kunde 838 bjudas in. När vi rekryterade till GerMoT tackade 54 procent av de tillfrågade äldre med flera sjukdomar ja till att vara med. Det visade sig dock vara svårare att nå de allra äldsta. Kön och hur många sjukdomar en person hade verkade inte påverka möjligheten att bli inbjuden eller viljan att delta.

Artikel II

Patienterna som rekryterades till GerMoT hade många sjukdomar samtidigt och använde vården mycket. De liknade på många sätt andra äldre som uppfyller den internationella definitionen av multisjuklighet där en person har två eller fler kroniska sjukdomar samtidigt. Men den här gruppen var mindre och mer likartad. De hade ofta problem med smärta, oro, nedsatt rörlighet och var i allmänhet bara lätt sköra. De bodde ofta ensamma men klarade sig ändå ganska bra i vardagen.

Artikel III

CGA-baserad vård som levererades i patientens hem av ett mobilt team visade ingen effekt vid 12 och 24 månaders uppföljning på antal dagar tillbringade på sjukhus, dödlighet, livskvalitet, antal sjukhusinläggningar, fysisk prestation, skörhet, aktiviteter i dagligt liv eller tankeförmågan, jämfört med vanlig vård.

Artikel IV

Under observationsperioden på tre månader, observerades det ingen skillnad i antal akutmottagningsbesök, sjukhusinläggningar eller vårdtid på sjukhus för alla deltagare som behandlades av vårt geriatriska akutteam. För de deltagare som bodde på särskild boende minskade dock antal akutmottagningsbesöken med i genomsnitt 0,5 per person, sjukhusinläggningarna minskade med 0,3 per person och vårdtiden på sjukhus minskade med 4,3 dagar per person under studietiden. För de 13 deltagare som remitterades till teamet av ambulans minskade antalet sjukhusinläggningar med 0,7 per person och vårdtiden på sjukhus minskade med 4,1 dagar per person. Deltagare som fick antibiotika i blodet behövde också mindre sjukhusvård.

Artikel V

Efter att det geriatriska mobila teamet tog över det medicinska ansvaret för ett korttidsboende kunde man se att vårdtiden på korttidsboende minskade från i

genomsnitt 54,6 dagar före interventionen till 40,1 dagar. Det observerades också en tendens till att medelvårdtiden på sjukhus för patienter inskickade från korttidsboende möjligen minskade

Diskussion

Resultaten av denna avhandling tyder på att vård genom geriatriska mobila team kan minska behovet av sjukhusvård i vissa situationer.

Artikel I och II visar att äldre med flera sjukdomar lätt kan identifieras i en databas och att många av dem är villiga att delta i vårdinsatser i hemmet med hjälp av ett mobilt team. Genom att lägga till några enkla kriterier till den vanliga definitionen av multisjuklighet (två eller fler kroniska sjukdomar) kan man hitta en mindre och mer hanterbar grupp som behöver extra stöd.

Artikel III visade att förebyggande CGA-baserade mobila team verkar inte minska behovet av sjukhusinläggningar. Dessa resultat måste tolkas med försiktighet eftersom vår studie stötte på svårigheter med att upprätthålla en stabil bemanning och en hög kvalitet på behandlingen genom hela studien. Teamets arbete, kontext och teammedlemmarnas sammansättning är unika för denna studie, vilket begränsar användningen av resultat i andra sammanhang. CGA principerna har troligen också blivit en del av den vanliga medicinska vården under de senaste åren, vilket delvis förklarar bristen på skillnader i effekten av vår behandling jämfört med den vanliga vården.

Artikel IV studerade effekterna av ett geriatriskt akutteam som behandlade akut sjuka patienter i deras hem. Detta team, tillhörande en sjukhusavdelning, erbjöd mer avancerade diagnostiska och behandlingsalternativ än vad som normalt erbjuds av primärvårdsledda mobila team. Det verkar inte minska antal akutmottagningsbesök, sjukhusinläggningar eller vårdtid på sjukhus för alla deltagare. Detta kan troligen delvis bero på den höga graden av skörhet hos patientgruppen och den därmed förknippade höga risken för sjukdomsförsämringar och funktionsnedsättning, vilket leder till nya sjukdomar, akutmottagningsbesök, sjukhusinläggningar och längre sjukhusvistelser. Teamet upptäckte också sannolikt tidigare oupptäckta sjukdomar och oidentifierade behov som ledde till högre vårdutnyttjande. Det fanns dock en mätbar minskning av vårdutnyttjandet när teamet tog hand om patienter som både på särskilt boende eller behövde mer avancerad behandling som antibiotika eller vätskor som gavs i blodet, eller när teamet kallades in av ambulans. Primärvården erbjuder normalt inte antibiotika i blodet på särskilda boende och svarar inte på akuta samtal från ambulansen. Analysen av dessa delar av arbetet var inte förutbestämd och berörde ett litet antal deltagare, varför dessa fynd behöver bekräftas av en specifik studie.

Artikel V visade att patienter som bor på ett korttidsboende kanske inte behöver läggas in på sjukhus lika ofta om ett geriatriskt mobilt team tar över ansvaret för korttidsboendet. I vår studie såg vi enbart en trend på detta och inte en säker effekt. Däremot minskade tiden som patienterna behövde vara kvar på korttidsboendet tydligt efter att teamet började arbeta där. Ett bättre samarbete och bättre kommunikation mellan team-läkaren och personalen på korttidsboendet gjorde troligen att vårdplaneringen gick snabbare och att beslut om nästa steg i vården kunde tas tidigare.

Konklusion

Ett geriatriskt akut mobilt team verkar inte minska behovet av sjukhusvård bland alla sina patienter. Det finns dock tecken på att denna mobila vård kan minska slutenvårdsutnyttjandet hos patienter som behöver avancerade behandlingar, som läkemedelsbehandling i blodet, och att detta kan vara hälsoekonomiskt fördelaktigt. På samma sätt verkade patienter som bor på särskild boende, remitterades till teamet av ambulans eller bor på ett korttidsboende också behöva mindre sjukhusvård efter att ha blivit behandlade av det geriatriska akutteamet. Förebyggande CGA-baserade mobila team verkar dock inte vara överlägsna vanlig vård när det gäller att minska behovet av sjukhusvård. Ytterligare forskning behövs för att bekräfta dessa resultat.

Overview of papers

	Paper I	Paper II	Paper III	Paper IV	Paper V
Aim	To investigate willingness to participate in proactive interventions.	To investigate if the GerMoT subgroup of multimorbid patients have complex needs	To investigate the effects of a proactive CGA based home team intervention	To investigate the effects of a reactive acute mobile geriatric team.	To investigate the effects of a geriatric mobile team in a ICF.
Outcomes	Ability to reach, Consent rate	No. diagnoses, Frailty, Grip strength,Cogniti on, Physical activity, ADL, QOL, Physical performance	No. admissions and hospital days, Mortality, QOL, Physical performance Frailty ADL, Cognition	No. ED visits, admissions and days in hospital	No. of days in hospital Length of stay in the ICF
Population	People living in their own home and in Helsingborg Hospital catchment area	People living in their own home and in Helsingborg Hospital catchment area	People living in their own home and in Helsingborg Hospital catchment area	Patients living in their own home and in Helsingborg Hospital catchment area	Patients staying in Helsingborg's ICF
Inclusion criteria	≥ 75 years of age, ≥ 3 visits to ED in the last 18months, ≥ 3 diagnoses indifferent ICD-10 chapters	≥ 75 years of age, ≥ 3 visits to ED in the last 18 months, ≥ 3 diagnoses indifferent ICD-10 chapters	≥ 75 years of age, ≥ 3 visits to ED in the last 18 months, ≥ 3 diagnoses indifferent ICD-10 chapters	Any referral to GAT	All patients at the ICF
Design	descriptive observational study	descriptive study	randomized, controlled, assessor-blinded (at baseline), single-centre trial	a before-and-after study	a before-and-after study
Study period	between 10/2018 and 6/2019	between 10/2018 and 6/2019	recruitment 10/2018 to 6/2019. Follow-up was at 24 months	recruited from 4/2022 to 10/2022. Follow-up was at 3-months	observation 9/2018 to 12/2019.Follow -up 2/2020 to 3/2012.
Included (n)	1212	450	450	102	Observation 113. Follow-up 126.
Statistical methods	independent sample t-test, chi-square test	independent sample t-test, chi-square test	independent sample t-test, chi-square test, Mann-Whitney U-test	paired sample t-test	Chi-square test, Mann-Whitney U-test
Results	Out of 1212 identified 838 could be invited. Consent rate 54%	High levels of multimorbidity, pain, anxiety, mobility issues, mild frailty, lived alone,independ ent	No difference compared to standard care	No overall effect. Decreased hospitalisation in some subgroups	Significant decrease in average length of stay at the ICF

CGA - Comprehensive geriatric assessment. ICF- Intermediate Care facility. ICD-10 - International Statistical Classification of Diseases and Related Health Problems, 10th revision. ADL - Activities of daily living. QOL- Quality of life. ED - Emergency department. GAT – geriatric acute team

Introduction

Historic perspective

Sweden's healthcare system has seen dramatic changes over the last three centuries. Initially, in the 18th and early 19th centuries, healthcare was predominantly home-based. People relied heavily on traditional remedies and the support of their community and family members. Medical knowledge was limited, and local healers and midwives often provided care using herbal treatments and folk medicine. This informal system varied widely across regions, reflecting local customs and available resources.

As Sweden moved into the 19th century, the role of provincial doctors, or "provinsialläkare," became increasingly important. These state-appointed physicians served both rural and urban areas, traveling by horse and carriage to visit patients in their homes. Provincial doctors offered essential medical services, often with limited resources. They were responsible for a broad range of healthcare needs, including delivering babies, treating infections, and performing minor surgeries [1].

The late 19th and early 20th centuries brought significant changes as Sweden industrialized and urbanized. Public health challenges such as poor living conditions and infectious diseases came into focus. This period saw the establishment of more formal healthcare institutions and the introduction of public health initiatives aimed at improving sanitation and controlling diseases. The healthcare system began to decentralize, with county councils ("landsting") taking over the responsibility and hospitals and healthcare centres becoming increasingly important.

By the mid-20th century, Sweden had developed a comprehensive welfare state, making healthcare more centralized and accessible. The introduction of universal healthcare ensured that all citizens had access to medical services, significantly improving public health outcomes. The healthcare system was organized into primary and secondary care levels. Primary care served as the first point of contact for patients, provided by general practitioners and municipal primary care ("kommunal primärvård"). Secondary care, provided by hospitals and specialists, handled more complex medical issues[8].

The Swedish healthcare system today

The governance of Sweden's healthcare system involved multiple layers, including the central state and county councils which are now renamed into 21 regions. The central state sets overarching health policies and provides some funding. The regions have their own political governance and are responsible for organizing and delivering healthcare services to people residing in the region and work towards a good health for the population. The region is responsible for specialist care, hospital care, and primary care through health centres and general practitioners. Regions finance their operations through taxes and state grants. There are 290 municipalities in Sweden and after the Swedish "ÄDEL" reform in 1992 they have taken on a central role in provide domiciliary health and social care. Today the municipalities are tasked with providing specific living arrangements and services, such as nursing homes and residences for people with disabilities. A municipality can offer home healthcare to people living in ordinary housing as well as those living in adapted accommodation or nursing homes. These services can include home care or personal assistance according to the Social Services Act (SoL)[9] or the Act Concerning Support and Service for Persons with Certain Functional Impairments (LSS)[10]. This responsibility does not include the healthcare provided by doctors, which is the region's responsibility[8]. This system requires close co-operation between the municipalities and the regions[11].

Today, Sweden's healthcare system is characterized by its high quality, accessibility, advanced medical technologies, and innovative care. However, long waiting times for specialist appointments and elective surgeries are becoming increasingly common, worsened by a shortage of medical staff, especially in rural areas. The growing population of older people increases the demand for chronic disease management, putting additional strain on resources. As the system is burdened by spiralling costs, policymakers have tried to decrease these costs by shortening hospital length of stay and diminishing the number of available hospital beds. Today, in Sweden, the total number of available hospital beds per capita is the lowest among countries in Western Europe and North America[12]. This has led to overcrowded hospitals, which further complicates effective service delivery.

Home healthcare services in Sweden

Services vary throughout Sweden but for the purposes of this thesis they can be summarised as follows. Patients can receive healthcare, social care and/or support under the LSS act at home in or other living arrangements. To qualify for home healthcare a person must not be able to physically come to their primary care centre. Home healthcare can include medical interventions, rehabilitation, and nursing care.

It can range from simple, infrequent care measures provided a few days apart to intensive healthcare with multiple visits and interventions per day for severely ill patients[13]. Most often the patient gets treated by a nurse and gets help with taking their medication, gets injections, blood tests, weight measurement, nutritional advice or simple procedures such as dressing or urinary catheter changes.

Whenever a doctor consultation is needed, the responsible home healthcare nurse, working for the municipality, contacts the primary care physician, who works for a region, in a primary care centre. The municipalities do not directly employ any doctors for the home healthcare services. This situation is often very challenging as primary care doctors rarely have allocated time for home healthcare and are usually already fully engaged in clinic activities in their primary care centres. In addition, patients with home healthcare are frequently the most ill with high levels of medical complexity. As a result, the physician time for rutin home healthcare is limited. It becomes even more scares for acute and unplanned consultations for patients with home health care[14].

Healthcare in nursing homes in Sweden

Patients living in nursing homes have slightly better access to home healthcare. All nursing homes have dedicated nursing staff that work in the nursing home and will most often have one or a few primary care physicians that attend the nursing home regularly. When patients move to a nursing home, they are asked to agree to change their primary care centre to the one responsible for that nursing home. This allows for the primary care physician attending that nursing home to take over their care[15]. The doctors responsible for a nursing home have scheduled time for consultations. This greatly increases availability and improves continuity of care. However, the possibility to make acute or unplanned visits is still often limited. Availability of physician consultations also varies greatly depending on which primary care centre is responsible for the nursing home and available resources, leading to large local and national variability.

Home visits without municipal home healthcare

Older patients who live in their own home and are temporarily unable to visit their primary care centre and have not been given home healthcare from the municipality can request a home visit by their primary care physician[16]. These visits are unusual and with poor availability for the same reasons as mentioned above. There is also no economic incentive for primary care centres to do these types of visits, adding to

the problem. Similarly, as above the availability varies greatly throughout the country.

To fill this care needs gap, of the multimorbid older person, a variety of mobile doctor services have been started throughout Sweden. Many of them are run by private companies working under contracts with the Regions[17]. They usually offer acute visits, with a physician consultation if needed, in patients own homes, nursing homes and intermediate care facilities (ICF). They can be called to patients who are unable to visit their primary care physician and do not have home healthcare services. They can also be called to any patient out of office hours. Visits consist of a physician assessment and simple treatment initiation when appropriate[17].

Home visits by hospital specialties

Many hospital specialties in Sweden, such as pulmonology, nephrology and infection diseases, have mobile teams and the possibility to do home visits for some of their patients. Home dialysis services, long term oxygen therapy delivery and home intravenous antibiotic treatment or outpatient parenteral antibiotic therapy (OPAT) are some examples of such services. These patients often also have municipal home healthcare, and the services co-operate closely. Hospital specialists remain medically responsible for their patients for the duration of follow-up but can also refer them to primary care when appropriate.

Role of ambulance services

Ambulance services in Sweden vary between different regions and locations. Their organisation is beyond the scope of this thesis, but they do play a role in assessing for and triaging patients for assessment by a physician at home. Ambulance staff are often well informed about availability of different mobile teams, home healthcare and mobile doctor services available locally that they can refer to. Ambulance staff are most often specially trained nurses and sometimes physicians, varying between first responder vehicles and transport ambulance. All staff will have access to an on-call physician for medical queries and decision making if necessary[18].

Advanced palliative care

Advanced palliative care or advanced healthcare at home has a prominent role in Swedish healthcare. All regions in Sweden have well developed services for patients that have chronic or malignant conditions and are nearing the end of their life. The services offer mostly advanced and complex palliative treatment to patients with malignancies[19] but are not limited to this and offer also curative treatments. The services are delivered by a team of nurses, doctors, healthcare assistants and counsellors. Treatments include blood transfusions, oxygen, antibiotics, parenteral nutrition, complex analgesia, infusions, pumps, monitoring and others. The teams often have strict criteria for selecting their patients, limiting availability and reserving the services to those with the most complex needs[20].

Hospital at Home and Virtual Wards

These models have been part of some healthcare systems for many years most notably in the United Kingdom, Canada, US, Italy, New Zealand, and Australia. Initial development of the model in these countries started in the 1990s[21,22]. They exist in multiple formats, adapting to the specific needs of different regions and healthcare providers[22,23].

Definitions

The terms "virtual ward" and "Hospital at Home" (HaH) are often used interchangeably to describe a coordinated approach to healthcare for acute conditions managed in a patient's home, rather than in a hospital. Originally, virtual wards focused on preventive care for individuals at risk of hospital admission[23]. There is considerable confusion around the differences between the two.

The consensus definition of Hospital at Home was presented at the World Hospital at Home Congress in Barcelona on 30th March 2023 and states that[24]:

> *"Hospital at Home is an acute clinical service that takes staff, equipment, technologies, medication, and skills usually provided in hospitals and delivers that hospital care to selected people in their homes or in nursing homes. It substitutes for acute inpatient hospital care.*
> *Hospital at Home is:*
> - *Subject to regulatory and governance obligations*
> - *Care is hospital-directed by specialist physicians*
> - *Fully responsible for the patient, providing all medical, nursing and allied healthcare*
> - *Diagnostics, therapeutics and observation are delivered at home during the episode of care*
> - *24 hours a day, 7 days a week*

Hospital at Home is NOT:

- *Outpatient care (thus, not self-administered intravenous treatment, and not OPAT)*
- *A hospital prevention programme*
- *A community-based chronic disease management programme*
- *Solely virtual care or remote telemonitoring*
- *Day facility-based treatment*
- *Primary home care*
- *Community nursing or standard skilled home healthcare"*

The term virtual ward is less established and initially referred to remote monitoring of patients with the help of various telemedicine technologies. Over time, the concept of the virtual ward has undergone evolution and change, and there are now various definitions of virtual wards. There is now a spectrum of models ranging from primarily using remote monitoring technology to achieve 'virtual' care (such as use of home pulse oximetry in COVID-19 patients) to models that rely on multidisciplinary teams to deliver high levels of in-home in-person care[2]. HaH is now often seen as a form of virtual ward. The British geriatrics society states that[25]:

> *"A Virtual Ward is a time-limited service enabling people who have an acute condition or exacerbation of a chronic condition requiring hospital-level care to receive this care in the place they call home… The Virtual Ward delivers a variable combination of remote monitoring and face-to-face treatment in the person's normal place of residence (at home or in their care home)."*

NHS England, UK states that[26]:

> *Virtual wards provide acute clinical care at home for a short duration (up to 14 days) as an alternative to care in hospital. Patients admitted to a virtual ward have their care reviewed daily by a consultant practitioner … via a digital platform… a virtual ward may also require in-person care, eg to deliver a care assessment or acute level interventions such as IV therapy… The model that blends in-person care at home with remote oversight and monitoring is often referred to as a Hospital at Home…"*

The Royal College of Physicians, UK explain that[23]:

> *"The term virtual ward refers to a specific group of patients managed at home by a clearly defined and consistent multiprofessional team working together for the patient, through the use of 'ward routines'."*

As there is considerable overlap between virtual wards and HaH (See Box 1). The evidence on HaH services is in most cases relevant to virtual wards providing the services are similar. The evidence for remote monitoring in isolation is not relevant to HaH.

Box 1. Services and terminology used in practice[2]

Virtual wards, hospital at home and remote monitoring

• **Hospital at home** services provide face-to-face care at home through a multidisciplinary team (MDT) based in the community. They are provided as an alternative to inpatient care.

• **Virtual wards** are a hospital-led and managed alternative to in-patient hospital care that is enabled by technology. They enable the delivery at home of acute care, monitoring and treatment to prevent admissions or support early discharge. They use a variable combination of remote monitoring and face-to-face care, and may incorporate remote monitoring, for example, through apps, technology platforms, wearables and devices such as pulse oximeters.

• **Remote monitoring** includes aspects of many virtual wards but is a broader term and is not always restricted to people who would otherwise require inpatient hospital care.

• **Step-up models** of care use virtual wards or hospital at home as an alternative to avoid inpatient admission to hospital.

• **Step-down models** of care use early discharge to virtual wards or hospital at home for a condition that would have otherwise required continuation of hospital inpatient care.

Hospital at Home in Sweden

Only a few functioning HaH schemes exist in Sweden. Examples include the newly started programs in Region Västra Götaland[27] and in Södertälje[28] two more established HaH services in Region Skåne at Skanes University Hospital[29] and in Region Stockholm at Capio S:t Görans Hospital[30]. The schemes in Skane and Stockholm both provide hospital level, somatic care to patients in their own homes, have strict inclusion criteria and no age limits. In Skane the hospital itself provides the service and is classified as outpatient care. I Stockholm the service is outsourced to a private healthcare provider but patients remain classified as inpatients at the hospitals internal medicine clinic[3]. In both schemes the service is fully responsible for the patients care during the treatment period which on average has been 5,3 and 4,4 days for Skane and Stockholm respectively. In Skane physical home visits can only be done in office hours, with other services needing to step in out of hours, whereas in Stockholm the service offers physical visits 24/7.

Effectiveness of Hospital at Home

When evaluating different endpoints presented in available research it is important to keep in mind that services are very heterogenous and evolving, varying in patient selection, interventions offered, intensity and context. For instance, some programs require that the patient does not live alone, while others do not. Similarly, the routine for the number of daily physical visits varies between programs. Some programs monitor vital signs continuously, while others do so only a few times per day. Many regional and local setups exist that are tailored to the specific needs of that region. The general principles of hospital at home and virtual wards delineated above are however followed in the evaluations presented here.

Clinical effectiveness

A recent evidence synthesis that included systematic reviews and meta-analysis concluded that HaH results are probably as good or better that inpatient care for most clinical outcomes[2]. Step-up models of admission avoidance showed a decreased mortality at 6-months (RR 0.77, 95% CI 0.60–0.99). Step-down models of early discharge showed no difference in 3- to 6-month mortality (RR 1.07, 95% CI 0.76–1.49) in patients with mixed medical conditions[2]. No difference[31-33] or decreased mortality[34] is well supported in the evidence.

Based on available data, HaH is not associated with an increased incidence of care-related injuries; if anything, there is a tendency towards a reduced rate of complications[31,32]. A lower incidence of delirium has been observed step-down[35] and step-up models[36].

A reduced rate of admission to residential care was observed following treatment at home in both step-up and step-down models (step-up RR 0.35, 95% CI 0.22–0.57; step-down RR 0.69, 95% CI 0.48–0.99)[2]. The evidence on re-admission after HaH was of low certainty in this evidence synthesis[2]. The short term re-admission (30 days) rate with HaH seems to be decreased by 36-70% compared with inpatient care [37-39] with less effect on more long term (3-12 months) re-admission[31-33].

A multisite randomised trial of admission avoidance HaH with CGA showed no difference in mortality, cognitive impairment or ADL at 6 months follow-up. There was a relative reduction in long term residential care for those allocated to HaH, and in delirium at one month[40].

The two established HaH programmes in Sweden have noted significantly lower (29% lower in Skane and 25% lower in Stockholm) re-admission rates compared to internal medicine inpatient care[3]. The incidence of care-related complications has also been low, and so far, only a few minor, less serious complications have been noted, specifically in the form of thrombophlebitis (inflammation of a vein due to a venous catheter), which does not appear to be directly related to the type of care

provided. None of these results have however undergone a rigorous peer review process.

Cost effectiveness

There is evidence that HaH leads to estimated cost-saving but these estimates vary widely and many studies evaluating costs may over-estimate savings[2]. For example, some studies used a generic calculated price for inpatient days, independent of disease, co-morbidity or duration of stay (as the cost of inpatient days usually decrease with longer stays). Some studies only look at costs of the provided care and not cost related to complications, readmission rate, staff education, potential effect on sick leave, etc. Many studies also disregarded cost to patients and carers. These factors should be taken into consideration when interpreting results such as the Cochrane review findings that step-up models may be less expensive than inpatient admission [2,32].

A randomised trial using CGA based HaH showed cost saving for health and social care (mean -£2,265, 95% CI: -4,279 to -252)[41]. Similarly, a RCT evaluating HaH care showed 38% (95% CI, 24% to 49%) cost savings compared to usual hospital care for the acute episode[37].

Both HaH schemes evaluated so far in Sweden have reported cost savings, compared to inpatient care; of 30-50% in the Skane and 20% in Stockholm[3]. These results have however not been published in peer reviewed journals.

Patient satisfaction

Patient satisfaction of HaH seems to be generally high in different evidence reviews [2,42,43]. The burden on caregivers and their experience however also needs to be taken into consideration when designing services.

Surveys, interviews and questionnaires also universally point towards high patient satisfaction with HaH services, in different countries [44-47].

HaHs schemes in Sweden have also reported high patient satisfaction. Based on survey responses, patients feel safer, more informed, and more satisfied with the care compared to those who received traditional inpatient care at hospitals[3].

Effectiveness proactive preventative geriatric mobile teams

Proactive preventative geriatric mobile teams that assess patient in their homes in order to prevent deterioration exist in many forms and have been evaluated extensively. Overall, most search shows inconsistent effect on mortality and

independence especially over longer follow-up[48,49]. Interventions often include CGA and other multidimensional preventative programs. These might have the potential to reduce mortality or improve function, in particularly in the non-frail [48-50]. The large variation in intervention components and reporting, means results should be interpreted with caution.

There have also been some preventative geriatric mobile team services piloted in different parts of Sweden. These have been pro-active, seeing a selected group of patients, in the community to prevent deterioration. They have been small scale initiatives or projects, often as part of a research project and we have not seen their permanent implementation[5].

In Sweden, CGA-based outpatient healthcare delivered by a mobile team, the Age-FIT trial, showed superior results of CGA-based healthcare compared to usual healthcare with respect to days in hospital, feeling of security, mortality and cost effectiveness[51-53].

Effectiveness of reactive acute geriatric mobile teams

Only a few geriatric mobile teams, that are not part of a HaH program, have been scientifically evaluated, and research in this area is scarce. Many programs have elements of HaH and it is therefore difficult to separate the evidence. Örebro University has during 2021 done a systematic review of clinical and health economic effects of mobile teams for community-dwelling geriatric patients [6], most of which were not part of a HaH program. In total fourteen studies were found, of which eight were randomized. Nine had high risk for bias and all but three had high risk for systematic errors. The studies reported uncertain results for the effects of mobile teams on mortality, ED visits, hospitalisations, and length of stay in hospital [6]. Therefore, many questions remain unresolved, highlighting the need for further scientific evaluations to better understand the effectiveness and utility of acute geriatric mobile teams.

In several regions of Sweden, mobile healthcare teams aim to bridge the gap between primary care and specialized care. These teams are operational in regions such as Västra Götaland, Uppsala, Skåne, and Östergötland. The teams can either originate from hospitals and specialized care facilities or from primary care.

Patient referrals are taken from various channels: primary care, prehospital services such as ambulance, specialized outpatient care, and inpatient care. The teams offer acute and reactive services, responding to acutely unwell patients. Depending on the commissioning entity, the objective of these services can either be to prevent hospitalization or to facilitate a quicker and safer discharge from hospitals while awaiting further follow-up care. The teams vary also in what they can offer. Those

focused on hospital avoidance can often offer more advanced diagnostic and treatment options (such as intravenous fluids and antibiotics, blood products or oxygen), while those focused on follow-up provide more primary care level services[3]. Those undergone rigorous scientific evaluation have shown uncertain results [54]. Others report anecdotal evidence, and their effects are therefore largely unknown [55-58]. Many services however have elements of classic hospital at home programmes showing a clear overlap of these services.

Future plans in Sweden

The Swedish National Board of Health and Welfare (Socialstyrelsen)[59] has been tasked by the government to develop a national plan for tackling the deficiency in hospital beds in Sweden. The main aim of this plan is to reach an equilibrium between demand and availability of beds providing capacity when needed[4]. This plan suggests certain areas of improvement. One such pivotal area is development of what is called "good and near healthcare," defined as healthcare delivered "closer to the patient." In practice this includes moving resources from the hospitals, into primary care and the community. Then, using these resources in a more effective away to delivered patient centred and needs focused care. The argument is that the healthcare many patients need, can be delivered in their own homes instead of admitting them to hospital[4]. The hope is that this will decrease the need for hospital beds and thus improve bed availability for those who need it. The assumption is that by better matching patient's needs with the care they receive, savings can be made whilst maintaining or improving quality of care. Unfortunately, Socialstyrelsen does not provide any references for their assumptions or any scientific basis for their recommendations. The board states that:

> *"the proposed plan has been created through an extensive iterative process, with broad involvement from relevant stakeholders from various parts of the healthcare system…(is)…based on dialogue with entities in regional and municipal healthcare, patient and family associations, professionals, and others. This has been done through interviews and dialogue with representatives …"*

The plan is therefore only a consensus plan with various stakeholders agreeing that this is the best way forward.

Alternatives to hospital beds are outlined in Socialstyrelsen's plan[4]. These include intermediate care beds, for care at a primary healthcare level only. These could be used to treat patients too sick to be at home but who do not need full access to hospital level care. Another alternative mentioned are mobile teams. These could provide primary or hospital level care in the patient's own home or nursing home[4].

Various small scale mobile team services and hospital at home or virtual ward projects have started appearing around the country[60,61].

Paucity of evidence

In summary, the international evidence for HaH is relatively robust however the implementation and evaluation of this service in a Swedish setting is still in its infancy. It is not clear if the international evidence on HaH is directly applicable to the Swedish context.

Internationally and in Sweden in particular, there is a paucity of evidence for services related to HaH such as proactive preventative geriatric mobile teams and reactive acute geriatric mobile teams. It is not known what parts of these services, in any, and for which patients they are effective in preventing hospital admission. Given that these mobile team-based services have started appearing in Sweden and given the plans to further invest in and implement such services, there is a great need to assess the effectiveness of various such geriatric mobile teams.

Aims

The main aim of this thesis was to evaluate the effectiveness of care delivered by geriatric mobile teams used for hospital avoidance. To reach this aim, the following sub-aims were set:

Paper I

To investigate multimorbid older patient's willingness to participate in proactive interventions with a geriatric mobile team.

Paper II

To describe the baselines characteristics of the GerMoT cohort and investigate if the GerMoT inclusion criteria, used as an alternative definition of multimorbidity, could help identify patients with complex needs.

Paper III

To investigate the effects of CGA based healthcare delivered in patient's homes by a mobile team on the number of days spent in hospital, mortality, quality of life, number of hospital admissions, physical performance, frailty, ADL and cognition compared to traditional healthcare.

Paper IV

To investigate if a mobile geriatric acute team emanating from a geriatric ward can decrease emergency department (ED) visits, hospitalizations and length of stay in hospital.

Paper V

To investigate the effects of a geriatric mobile team taking over the medical responsibility of an Intermediate Care facility (ICF), on the inhabitant's number of days spent in hospital, number of ED visits and length of stay in the ICF.

Methods

Study setting

All studies in this thesis have been conducted in Helsingborg. This is a city in the south of Sweden and has approximately 150.000 inhabitants [62]. The area contains both rural and urban parts. 9% of the inhabitants were 75 years or older [63]. The municipality is responsible for home health and social care including providing nursing home care if needed. Most healthcare in Helsingborg and the surrounding municipalities is provided by one hospital and around 25 primary care centres. Helsingborg Hospital is an acute hospital that admits emergencies 24 hours a day. It has approximately 250 available beds and a catchment area with 215,000 inhabitants. The hospital has a Geriatric Medicine Department with 25 acute geriatric beds. There is no specialist geriatric outpatient clinic and no private geriatric practitioners in the municipality.

Study populations

Papers I-III used data from the GerMoT study with the following inclusion criteria:

- ≥ 75 years of age
- ≥ 3 visits to the Emergency Department in the last 18 months
- ≥ 3 diseases diagnosed according to different ICD-10 (International Statistical Classification of Diseases and Related Health Problems, 10th revision) chapters
- Living in their own home and within the catchment area of Helsingborg Hospital

All people meeting the inclusion criteria were able to participate in the study and no exclusion criteria were applied. 450 participants consented to participate. 225 were allocated to the IG and 225 to the CG.

Paper IV considered all patients referred to GAT during the study period, between 28 April 2022 and 17 October 2022 eligible to participate. However, patients that had been in contact with GAT prior to 28 April 2022, the studies recruitment start, were excluded. 102 participants consented to participate.

There was no specific age cut-off used to select participate to the study. The mean age among the participants was 84.6 (51-100) years. Of all participants 56% were women. Only a few individuals were under 65 years of age, but all these participants had multimorbidity and were in need of a holistic geriatric assessment. The majority of all participants were frail. This can be inferred from that 27% lived in nursing homes and 78% of those living at home had help with ADL. Half of the participants living at home (51%) had home healthcare.

Paper V studied all inhabitants of a ICF during either of the two observational periods. The baseline observational period was from 2018-09-20 to 2019-12-23. The post-intervention observational period was from 2020-02-01 to 2021-03-31. Participants present at the ICF during both observational periods were excluded from the study. A total of 239 participants consented to participate. 113 participants in the baseline observational period and 126 participants in the post-intervention period. The mean age (range) was 82,1 (23-99) years and 79,9 (43-93) years, in the observation and post-interventions periods respectively. In the two groups there were 63% and 56% women, respectively.

Patient recruitment methods and consent

Paper I-III

The electronic Patient Administrative System in Skane (PASIS)[64] was used. This is an administrative database run by Region Skane, the county council of the southernmost region of Sweden, that registers healthcare usage including ED and other outpatient visits, admissions, diagnoses and demographic data. The recruitment process started with obtaining lists of patients, from PASIS, meeting the inclusion criteria for the studies. The research nurse then removed anyone from this list who had died, moved out of area or into a nursing or short stay home. Then all eligible patients were sent a letter with a description of the GerMoT intervention. A week later they were contacted by phone by the research nurse and given additional information if needed. Three attempts at contacting every person were made by phone before they were considered unreachable.

After preliminary consent on the phone an appointment for a home visit was made during which written consent was obtained, and baseline data collected. If a person

was unable to give informed consent because of their disability, informed consent was sought from a relative who could consent on their behalf.

Paper IV - V

All patient that had been in contact with the services were considered eligible to participate in the studies.

In the case of paper IV, all patients that have been referred to GAT during the studied period were considered eligible. Patients received both oral and written information about the study during the first home visit. They then had the opportunity to consent. Many patients had cognitive impairment, in which case a relative could give written informed consent.

In the case of paper V, all patients treated at the ICF during the observation and post-observation periods, were considered eligible to participate. Data was collected retrospectively from electronic medical records and from local ICF records. As all data was presented on an aggregate level, ensuring no possibility of identifying personal information, no informed consent was sought from individual participants. This was specified in the ethical approval for the study. It would in many cases not be possible to get informed consent as many patients had passed away at the time of study.

Study periods

Papers I-III used data from participants recruited to the GerMoT trail. The recruitment took place between October 2018 and June 2019. The follow-up was at 12 and 24 months after randomization.

Paper IV recruited patients between 28th April 2022 and 17th October 2022 and had a 3-month follow-up period for each participant from the day they were recruited.

Paper V The baseline observational period was from 20th September to 23rd December 2019. The post-intervention observational period was from 1st January 2020 to 31st March 2021.

Study designs

Papers I–III

Paper III is a randomized, controlled, assessor-blinded (at baseline), single-centre trial that has been described in a study protocol[65]. Paper I is a descriptive observational study based on data collected during the recruitment phase of the trial

reported in Paper III. Paper II is a descriptive observational study analysing the baseline characteristics of participants enrolled in the trial described in Paper III.

Papers IV

Paper IV is a before-and-after study examining outcomes in the same individuals following an intervention.

Paper V

Paper V is also a before-and-after study; however, unlike Paper IV, it compares outcomes between two different groups of inhabitants from the same intermediate care facility (ICF): one group that did not receive the intervention and another group that resided in the ICF at a later time and did receive the intervention.

Study interventions

Papers I-III

These papers are on the trial GerMoT. Participants randomised to the intervention arm in this trial received standard healthcare plus comprehensive geriatric assessment (CGA)-based healthcare delivered by an interdisciplinary team comprising a physician, nurse, physiotherapist, occupational therapist, and pharmacist. This was a proactive mobile team intervention and specifically included several parts.

Initially, a nurse conducted a holistic home interview, assessing the patient's life and health and collected venous blood for analysis (e.g., hemoglobin, glucose, creatinine, C-reactive protein). Then a clinical pharmacist performed a structured medication review via phone, accessing medical records and the Prescribed Drug Register. They compiled a current medication list, provided recommendations on doses, interactions, and side effects, and recorded these in the patient's medical records. After this the patients were asked to attend a hospital consultation with the physician, who reviewed medical records, confirmed health issues, conducted a physical, including neurological examination, and recorded an electrocardiogram. Medications were adjusted, and patients received a printed medication list. Patients reviewed contact number to the team members who they could contact in office hours (weekdays, 8:00 AM–4:30 PM). The participants remained under the team's care for 24 months, retaining access to usual healthcare, including primary care and emergency services. The team held weekly interdisciplinary meetings to discuss each patient's physical, psychological, social, and functional status, planning actions like dietitian assessments, home visits, or service adjustments to enhance quality of life. Follow-up varied from daily nurse contacts to 6-monthly checks.

Paper IV

This paper is on the GAT team. This was a reactive step-up service. GAT based in the Department of Geriatric Medicine, consisted of a geriatrician or internal medicine specialist and a nurse or healthcare assistant, provided holistic care to geriatric patients in their home environment. GAT collaborated with home healthcare, ambulance services, primary care, social care managers, and the geriatric ward, serving as a bridge between primary and secondary care. They coordinated with social-care managers to initiate or enhance care packages and with primary care to arrange home health services, referring patients to pharmacists, physiotherapists, or occupational therapists as needed.

Operating during office hours (weekdays, 8:00 AM–4:30 PM), GAT received referrals from home healthcare, nursing homes, ambulances, emergency departments (ED), geriatric wards, and primary care, prioritizing same-day visits when possible. Out-of-hours referrals from ambulances or ED were scheduled for the next day. Most referrals involved patients requiring acute medical assessments or interventions to prevent ED visits or hospitalizations. Patients could access ambulance or single-responder doctor services out of hours, available to all local residents.

GAT conducted medical assessments, medication reviews, blood tests (with results available within an hour), and used bladder scanners and arterial Doppler. Treatments included oxygen therapy, blood transfusions, and intravenous therapies (e.g., fluids, antibiotics, diuretics). The duration and frequency of interventions varied, typically lasting a few day until stabilization, after which patients were referred back to primary care.

Paper V

This paper is on the GMT working in a ICF. This was a mixed plan and reactive step-up service. The GMT, based in the Department of Geriatric Medicine, comprised a geriatrician or general internal medicine physician, supported by nurses and healthcare assistants from the geriatric department. There were also nurses and healthcare assistance at the ICF employed by the municipality. Five physicians participated, with one holding primary responsibility. When the GMT assumed medical responsibility, the physician visited the ICF 1–2 times weekly to address medical issues. The GMT was accessible by phone during office hours and could provide acute, unplanned weekday visits as needed. Services included blood sampling, intravenous fluids or medications, oxygen therapy, and bladder scans, which are typically unavailable in primary care settings. The GMT was involved in the medical management of all patients, could initiate end of life care and participated in the social planning. Patients were usually at the ICF for social reasons and social care managers authorized a two-week ICF stay, extendable in two-week increments based on factors such as the patient's healthcare and social needs,

rehabilitation potential, availability of permanent nursing home placements, and home adaptations for potential return.

Data collection

Paper I

For paper I, data were collected from the electronic Patient Administrative System in Skane (PASIS)[64] by a research nurse. PASIS is an administrative database maintained by Region Skåne—the county council of Sweden's southernmost region—that records healthcare utilisation, including emergency department (ED) visits, other outpatient encounters, hospital admissions, diagnoses, and demographic information.

Paper II

For paper II, data were collected, during the first home visit, by assessors not involved in the intervention and before randomisation. A protocol-guided interview was used by a registered nurse trained in using all the assessment tools. The assessment tools can be seen in table 1.

PASIS was used for patient demographic data and ICD-10 diagnoses. Only data from the last 4 years before inclusion was used as it was thought that any older diagnoses were less likely to contribute to the patient's current multimorbidity.

Table 1. Baseline measurements

Data collected	Method used	Explanation
Frailty	9 level Clinical Frailty Scale (CFS), version 1.2,[66] translated into Swedish by Niklas Ekerstad.	CFS is a validated screening tool for frailty that focuses on independence, mobility, balance, and cognition.
Grip strength	Jamar®dynamometer from Patterson Medical	The best of two attempts was recorded using a measured in the dominant hand.
Cognition	Swedish version of the Montreal Cognitive Assessment (MOCA) tool[67].	MOCA is a screening test of memory, orientation, concentration, attention, visuospatial and executive abilities.
Physical activity	Modified, short, 4 item version of the International Physical Activity Questionnaire (IPAQ) translated into Swedish[68].	IPAQ 4 item version includes time spent sitting, walking, in moderate and vigorous activity. This is used for self-reported physical activity and participants answered these questions with minimal support from the research nurse.
Activities of daily living (ADL)	Katz Extended ADL Index[69] was used which includes 6 personal and 4 instrumental ADL measurements	Personal ADL include bathing, feeding, dressing, toilet visits, continence and moving. Instrumental ADL include cleaning, shopping, transport and cooking.
Quality of life (QOL)	Swedish version[70] of the 2009 EuroQol Group five-dimension scale (EQ-5D-5L)[71], standard value sets, as produced by the EuroQol Group	The EQ-5D-5L value set for Denmark[72] was used as there is no value set for Sweden.
Physical performance	Short Physical Performance Battery (SPPB)[73] translated into Swedish[74].	

Paper III

For paper III, the same baseline data as for Paper II was used. Data on the primary outcome which was the number of days each participant spent in hospital during the first 24-months follow up, was obtained from the Patient Administrative Register of Care in Region Skane[75].

Secondary outcomes included:

- All-cause mortality, as registered in the Swedish cause of death register[76].

- Quality of life, as measured by the Swedish version[70] of the 2009 EuroQol Group five-dimension scale (EQ-5D-5L)[71] and a Swedish value set[77].
- Number of hospital admissions, as registered in the Patient Administrative Register of Care in Region Skane[75].
- Physical performance as assessed using the Short Physical Performance Battery (SPPB)[73] translated into Swedish[78], as in Paper II.
- Frailty according to the 9 level Clinical Frailty Scale (CFS), version 1.2, translated into Swedish [66], as in Paper II.
- Activities of daily living (ADL), as measured with Katz Extended ADL Index[69], as in Paper II.
- Cognition, as measured with the Swedish version of the Montreal Cognitive Assessment (MOCA) tool[67].

Paper IV

For paper IV, data were extracted from the patient's medical notes by the first author. Healthcare use was obtained from Patient Administrative Register of Care in Region Skane[75]. Data on municipal social care resource use were retrieved from the Social Service Register, Welfare[79].

Paper V

For paper IV, data were extracted from the patient's medical notes and local ICF records.

Statistical analysis

Papers I-II

Baseline characteristics were summarized using means with standard deviations (SD) for continuous variables and absolute numbers with percentages for categorical variables. Group differences were assessed using independent sample t-tests for continuous variables and chi-square tests for categorical variables.

Paper III

The participants were randomized 1:1 to the intervention or control group using a computer-package (IBM SPSS Statistics version 23.0).

To compare demographic data between the intervention and control groups, the chi-square test was employed. This test was also used to evaluate differences in SPPB, ADL, and MoCA measurements between the two groups. Mean EQ-5D-5L values were compared using an independent t-test. The Mann-Whitney U-test was applied

to assess differences in the mean number of hospital days, hospital admissions, and frailty levels between groups. Mortality was analysed using Kaplan-Meier survival curves for both groups, with the hazard ratio for the intervention group calculated using a univariate Cox proportional hazards model.

Paper IV
Interventions provided by the geriatric acute team are reported as the percentage of patients receiving each intervention. For the main outcomes, the number of ED visits,

number of hospitalizations and length of stay in hospital, a before- and after analysis with paired sample *t*-test was done.

Paper V
Baseline demographic data in the groups before and after interventions were compared using p-values calculated using Chi-square test. Statistical analysis of the main outcomes was conducted using the Mann-Whitney U test due to the highly skewed distribution of data on days spent in hospital and length of stay in the intermediate care facility (ICF).

Ethical considerations

The studies in this thesis included mostly frail older adults. This is a vulnerable population and any medical research involving this group of people requires particular ethical scrutiny. Several factors warrant consideration.

Firstly, this population is often in need of and dependent on access to medical care. This dependence makes them vulnerable and more likely to agree to research conducted by healthcare providers. There might be a believe that participation in research will improve their access to healthcare. Indeed, this is the case in the study in paper III but only for patients randomised to the intervention group. It is therefore important to clarify this during the consent process.

Secondly, this population often have physical and mobility impairment. This makes it difficult to come to research appointments, that can be a significant burden for the participants. The study in paper III included one visit to as hospital clinic. The remaining visits in this study and the other studies were home visits which limited the burden on participants.

Thirdly, minimizing risk to participants is central in any research. However, with studies involving frail older patients even simple diagnostic procedures or treatments can pose a health risk. Studies need to minimize this risk which could be physical, emotional or financial. In Sweden, most healthcare and transportation are either free or heavily subsidized. None of the studies in this thesis should have

contributed to unjustified physical, emotional or significant financial strains. Interventions aimed at hospital avoidance, risk decreasing access for participants to needed hospital care. In study III the intervention was provided in addition to ordinary healthcare. In studies IV and V hospital care was facilitated if the patient would benefit from it. The studies might also have identified unmet healthcare needs and thereby benefiting the participants.

Fourth, studies performed on frail older adults can be ethically justifiable if their aim is to improve the care of this group of people. This is the case will all the studies in this thesis, and we believe potential benefits justify involvement in the research.

Fifth, confidentiality and ensuring data protection, especially sensitive health information is central to any research. In this thesis, which partly also involves data of deceased individuals, data protection was ensured by the way it was collected, stored, processed and presented. We ensured that no data could be traceable to any individual.

Lasts, and importantly, many participants had cognitive impairment. This can make obtaining valid informed consent difficult and requires special safeguards. Informed consent is a cornerstone of ethical clinical research, ensuring participant voluntarily agree to take part after understanding the purpose, intervention, risks, benefits and their rights. The Declaration of Helsinki[80], first adopted in 1964 by the World Medical Association, provides ethical principles for medical research involving human subjects. The original 1964 version laid foundations and subsequent revisions (e.g., 1975, 2000, 2013) expanded protections for vulnerable populations, including those with cognitive impairment. The declaration states that:

> *"Each potential subject must be adequately informed of the aims, methods, anticipated benefits and potential hazards of the study and the discomfort it may entail. He or she should be informed that he or she is at liberty to abstain from participation…"*

In participants who lack capacity to comprehend and decide this might be difficult to apply. In later revisions, the declaration addresses vulnerable participants. Stating that:

> *"When the subject is incompetent… the physician must seek informed consent from the legally authorized representative."*

Also, that:

> *"These individuals must not be included in a research study that has no likelihood of benefit for them unless it is intended to promote the health of the group represented by the potential subject"*

The notion of assent is introduced:

> *"When a potential research subject who is deemed incapable of giving informed consent is able to give assent to decisions about participation in research, the physician must seek that assent in addition to the consent of the legally authorised representative. The potential subject's dissent should be respected."*

The studies in this thesis are conducted in a Swedish context. The Swedish Research Council (Vetenskapsrådet)[81] provides ethical guidelines for research, notably in publications like Good Research Practice[82] from 2017. These are built on the Helsinki Declaration and national legal framework such as the Patient Act (Patientlag 2014:821)[83]. They state that autonomy must be respected. For frail older adults with cognitive impairment, this means assessing their capacity to consent. Research-specific consent for incapacitated individuals is further regulated by The Act concerning Ethical Review of Research Involving Humans (Lag (2003:460) om etikprövning av forskning som avser människor)[84], which complements the Patient Act and clarifies that if capacity is lacking, participation should be discussed with, and consent must be sought from a proxy (eg. a close relative or legal guardian if this is included in their role). Additionally, researchers should seek assent from the participant to the extent possible, respecting their residual understanding or preferences. For example, explaining the study simply and observing for signs of distress or willingness.

In Sweden, research involving humans, human tissue or data requires approval from an Ethical Review Board (Etikprövningsmyndigheten)[85], ensuring compliance with ethical standards. The Swedish Research Council stresses that researchers must justify why the study includes cognitively impaired individuals and cannot be conducted on those with full capacity.

For papers I-IV written informed consent was sought according to the principles above. For paper V, written consent was not sought. In this and other retrospective studies informed consent might be waived if the Ethical Review Board deems it impractical (e.g., participants deceased or unreachable) and the risks are negligible. This was the case for paper V.

The studies in papers I-III were approved by the Regional Ethical Committee in Southern Sweden: 2016/630 and 2017/934. The study in paper IV was approved by The Swedish Ethical Review Authority No. 2022-01317-01. The study in paper V was approved by The Swedish Ethical Review Authority No. 2021-00245.

Results

Paper I

From October 2018 to June 2019, 1,212 individuals were identified in the regional database, PASIS as fitting the study's inclusion criteria. Before screening for eligibility, 86 passed away, 7 relocated outside the region, and 155 transitioned to care facilities, resulting in 964 potential participants. Of these, 113 were uncontactable, 8 lacked sufficient communication ability to participate, and 5 were enrolled in other studies. Ultimately, in total 374 people could not be invited, 838 were invited to participate, and 450 opted to join the trial. This process is outlined in Fig. 1.

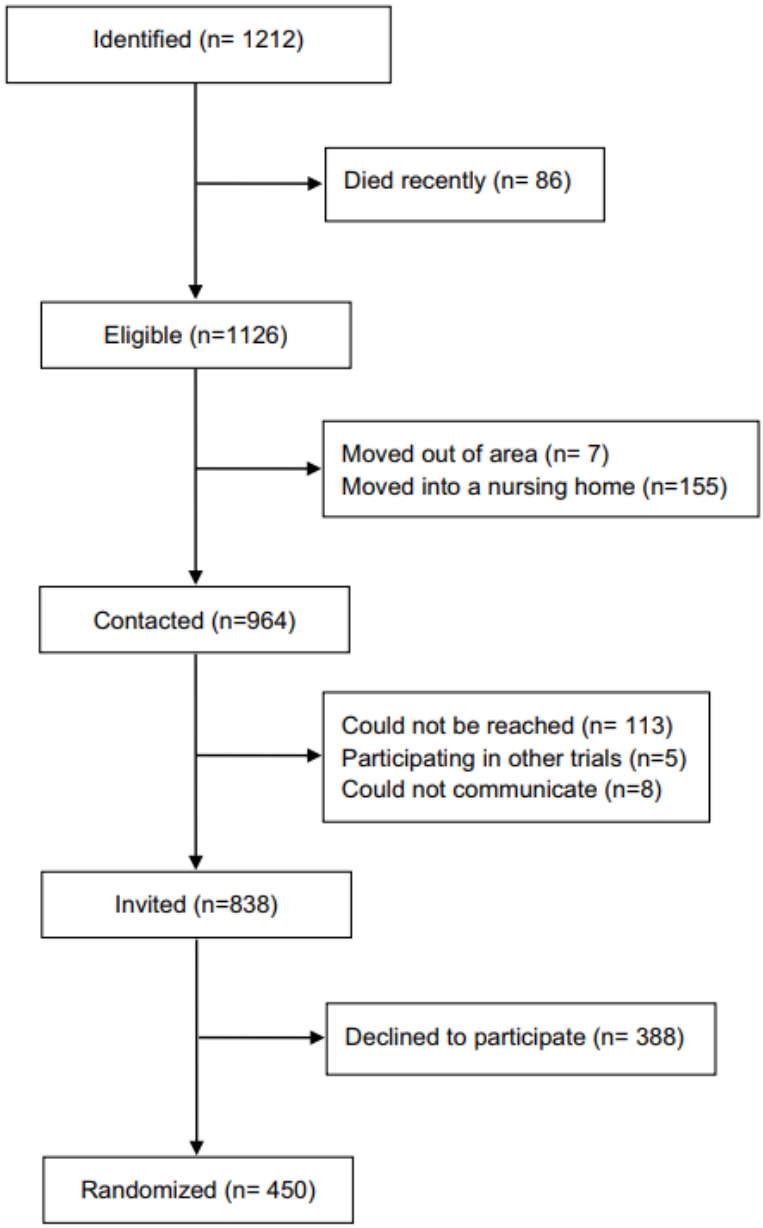

Figure 1. Recruitment flowchart (Paper I)

The chart in Figure 1 shows the recruitment process with fallout figures at each stage starting with 1212 patients identified in a database.

Table 2 shows a comparison based on age, gender and number of disease diagnoses (according to different ICD-10 chapters) between people who could be invited and those that could not, for any reason. Likewise, Table 3 compares people who consented to participate with those that did not.

Table 2. Comparison between the people who were invited and those that could not be invited (Paper I)

	Invited [total: 838 people]	Could not be invited [total: 374 people]	*p* value[b]
Age in years			
Mean (SD)	83.68 (5,64)	86.41 (5,77)	< 0.001
Sex			
Male (%)	390 (46.5%)	162 (43.3%)	0.298
Female (%)	448 (53.5%)	212 (56.7%)	
Number of disease categories[a,b]			
Mean (SD)	7.36 (2.51)	7.48 (2.47)	0.453

SD standard deviation

[a]Defined as diseases diagnosed according to different ICD-10 chapters

[b]p-value was calculated using the *t* test for continuous variables and the chi-squared test for categorical variables

Table 3. Comparison between the people who agreed to participate and those that declined (Paper I)

	Agreed to participate (total: 450 people)	Declined to participate (total: 388 people)	*p* value[b]
Age in years			
Mean (SD)	83.39 (5.50)	84.01 (5.78)	0.119
Sex			
Male (%)	205 (45.6%)	185 (47.7%)	0.539
Female (%)	245 (54.4%)	203 (52.3%)	
Number of disease categories[a]			
Mean (SD)	7.37 (2.48)	7.35 (2.55)	0.904

SD standard deviation

[a]Defined as diseases diagnosed according to different ICD-10 chapters

[b]p-value was calculated using the t-test for continuous variables and the chi-squared test for categorical variables

Consent rates by age, gender and number of diagnoses can be seen in figures 2, 3 and 4.

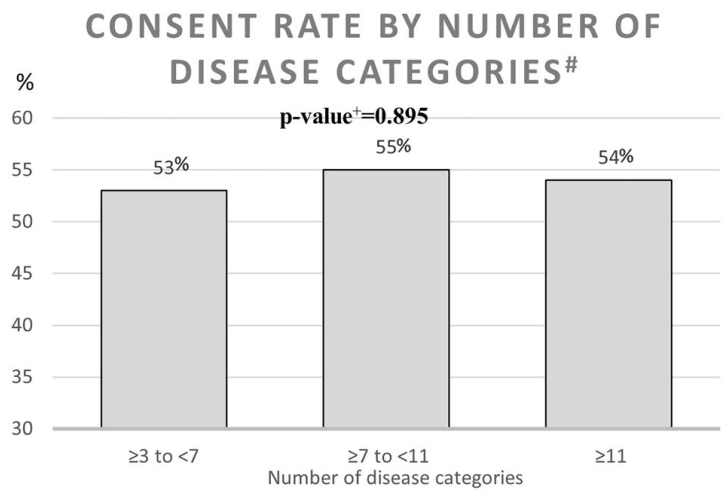

Figure 2. Consent rate by number of disease categories (Paper I)
#Defined as diseases diagnosed according to different ICD-10 chapters. +p value was calculated using the chi-squared test.

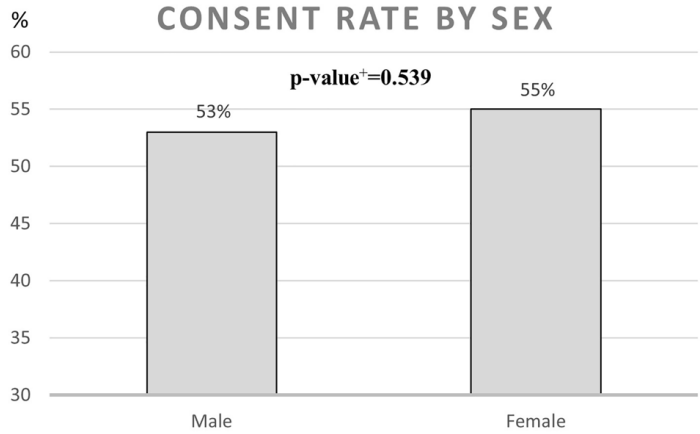

Figure 3. Consent rate by sex (Paper I)
+p value was calculated using the chi-squared test

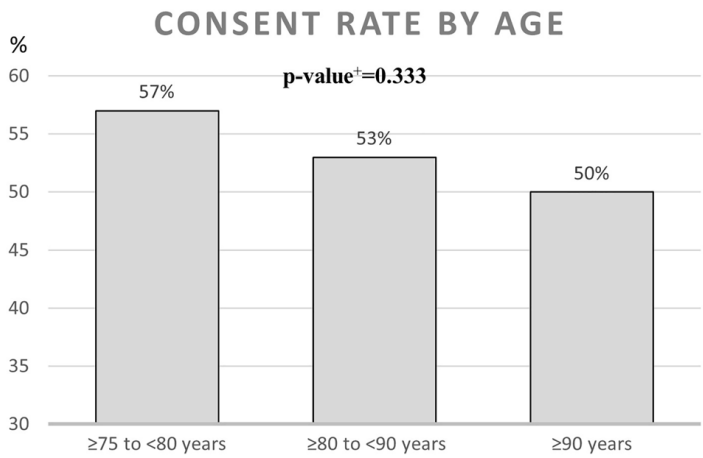

Figure 4. Consent rate by age (Paper I)
+p value was calculated using the chi-squared test

Paper II

At baseline, participants had a mean age of 83 years, with 245 (54%) being female. Over half lived alone, and 55% had not completed secondary education. 438 out of the 450 had a MOCA score recorded. The mean score was 22.2 (SD ± 5.74). Baseline characteristics of all 450 participants are displayed in table 4.

Table 4. Demographics (Paper II)

Variable	Result
Sex (n=450)	
Male	205 (46%)
Female	245 (54%)
Age [years] (n=450)	
Mean	82.6
Male (range)	82.5 (75-100)
Female (range)	82.6 (75-99)
Height [cm] (n=430)	
Mean	167.9
Male (range)	176 (160-197)
Female (range)	161 (146-181)
Weight [kg] (n=424)	
Mean	73.8
Male (range)	80.4 (42-130)
Female (range)	68.4 (36-118)
Marital status (n=450)	
married/living with partner	211 (46.9%)
widow/widower	148 (32.9%)
never married	15 (3.3%)
divorced, not remarried	69 (15.3%)
partner that lives separately	7 (21.6%)
Accommodation (n=447)	
rental	184 (41.2%)
own house	117 (26.2%)
own apartment	142 (321.8%)
other	4 (10.9%)
Aids/Adaptation in home* (n=450)	
yes, new adaptation done	140 (31%)
yes, adaptation already in place	63 (14%)
No	247 (55%)
Living (n=448)	
alone	243 (54%)
with partner/spouse	201 (45%)
with children or other	4 (1%)
Education (n=446)	
incomplete primary education	162 (36%)
complete primary education	84 (19%)
complete secondary education	29 (7%)

folk high school/vocational education	82 (18%)
university/higher education with diploma	84 (19%)
incomplete higher education or other	5 (1%)
MOCA (n=438)	
mean score ± SD	22.2 ± 5.74

Home adaptations are provided, if needed, by the municipality to improve independence and mobility at home. These are needs specific and examples include a special shower, ramps, automatic doors or lights.

Figure 5 shows the number of diagnoses in different ICD-10 chapters participants had. 19 had only the minimum 3 diagnosis recruited for inclusion. The mean was diagnoses in 7.3 different ICD-10 chapters.

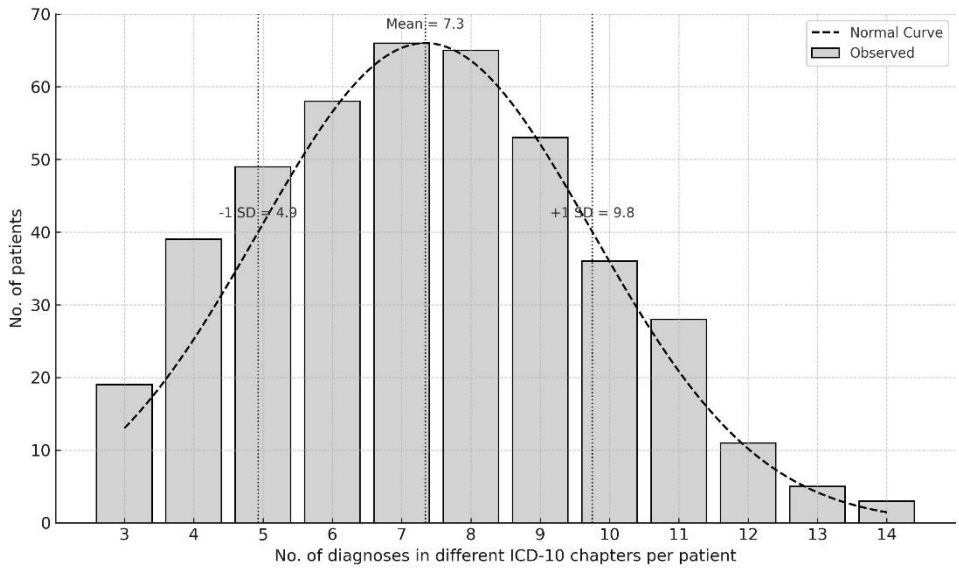

Figure 5. Number of diagnoses (Paper II)
ICD-10 - International Statistical Classification of Diseases and Related Health Problems, 10th revision

Nearly all participants (96%) had at least one diagnosis in the chapter on the circulatory system. Table 5 shows the distribution of diagnoses of the participants.

Table 5. Distribution of diagnoses of the participants (Paper II)

ICD-10 chapters	Number of people with at least one diagnosis in the ICD-10 chapter	Number of separate diagnoses made within each ICD-10 chapter
Certain infectious and parasitic diseases	243 (54%)	474
Neoplasms	234 (52%	466
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	142 (32%)	221
Endocrine, nutritional and metabolic diseases	360 (80%)	889
Mental and behavioural disorders	262 (58%)	509
Diseases of the nervous system	214 (48%)	313
Diseases of the eye and adnexa	331 (74%)	929
Disease of the ear and mastoid process	222 (49%)	371
Diseases of the circulatory system	433 (96%)	1987
Diseases of the respiratory system	309 (69%)	814
Diseases of the digestive system	323 (72%)	943
Diseases of the skin and subcutaneous tissue	321 (71%)	798
Diseases of the musculoskeletal system and connective tissue	391 (87%)	1722
Diseases of the genitourinary system	352 (78%)	897

According to the IPAQ, 52% of participants engaged in very strenuous activity over the past seven days, on averaging on 1.9 days and 34.5 minutes per day. Moderate strenuous activity was reported by 22% of participants, on average on 3.1 days and 79.0 minutes per day. Additionally, 65% of participants completed at least a 10-minute walk, on averaging on 4.3 days and 42.8 minutes per day. Of 372 respondents, the mean daily sitting time was 522.3 minutes (8.7 hours).

The SPPB was completed by 448 participants, yielding a mean balance score of 2.5, gait score of 2.4, chair rise score of 1.3, and total score of 6.3.

90% of participants were independent or partially independent with basic ADL such as feeding, continence, moving, toileting, dressing and bathing, as can be seen in Figure 6.

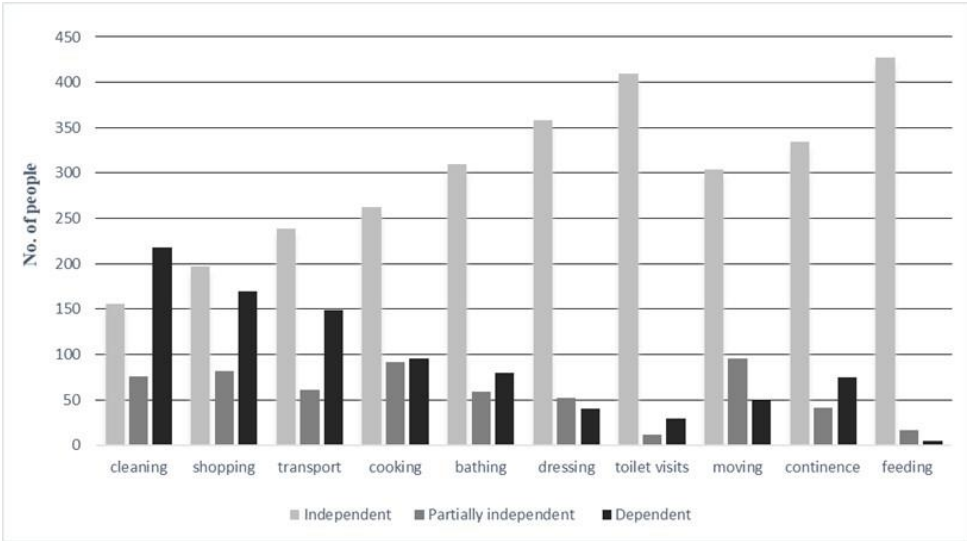

Figure 6. Activities of Daily Living (Paper II)

Hand grip strength was assessed in 443 participants, with an overall mean of 22.4 kg. Women had a mean grip strength of 17.5 kg, and men averaged 28.2 kg. Of the participants, 265 (60%) were classified as non-frail, with Clinical Frailty Scale (CFS) scores of 1–4, while 174 (40%) were frail, with scores of 5–9. Figure 7 presents the distribution of CFS scores.

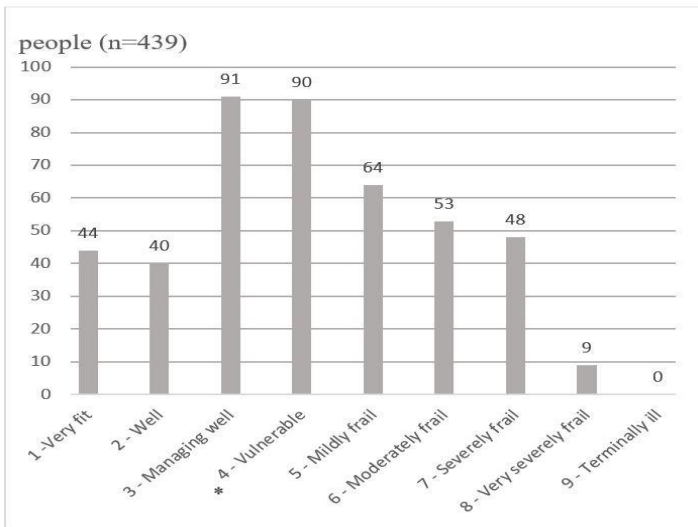

Figure 7. Clinical Frailty Scale (Paper II)
**People with score 1-4 are considered non-frail and with a score 5-9 as frail*

When using the EQ-5D-5L value set for Denmark our population has a mean value of 0.655 and a median of 0.700. Figure 8 shows a breakdown of the different domains.

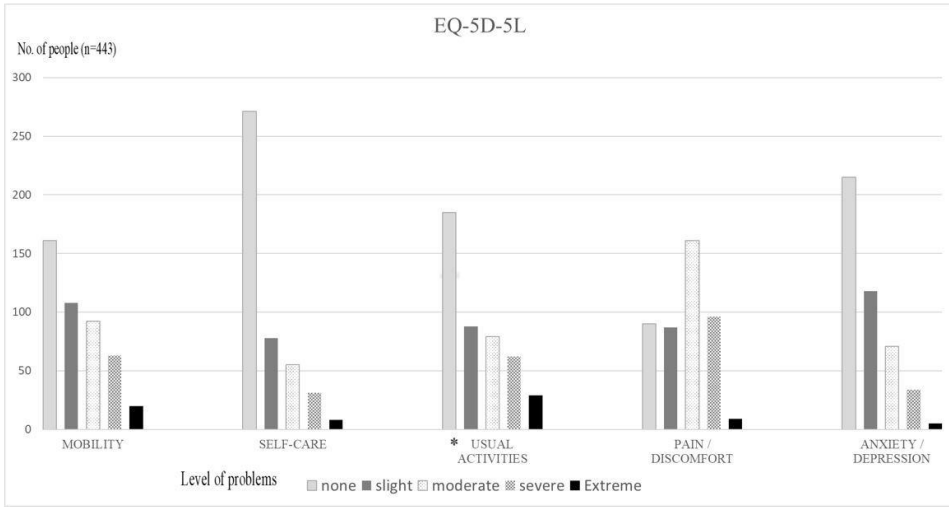

Figure 8. Quality of life measurements, EQ-5D-5L (Paper II)
**Usual activities include work, study, housework, family or leisure activities*

Paper III

A total of 450 participants were enrolled and randomized equally to the intervention group (n=225) or the control group (n=225). Follow-up assessments occurred at 12 and 24 months post-randomization. Figure 9 illustrates the number of participants in each group throughout the study. One participant relocated outside the study area within the first 12 months and was lost to follow-up. All other participants completed follow-up. Those who moved to a nursing home during the study remained included.

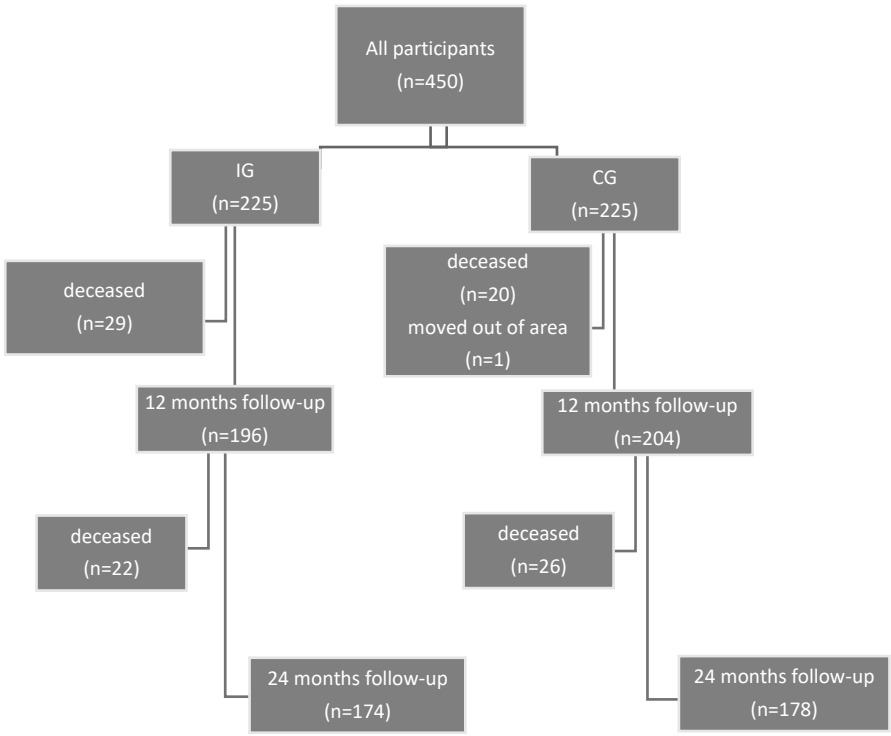

Figure 9. Participant flow (Paper III)

All baseline demographic data can be seen in Table 6. As shown in Table 8, participants at baseline were predominantly mildly frail and had a mean Montreal Cognitive Assessment (MoCA) score of 22. The mean SPPB score was 6 out of a maximum of 12, and mean quality of life (EQ-5D-5L) scores were comparable between groups: 0.75 for the intervention group (IG) and 0.76 for the control group (CG). Both groups were equal in size, with no significant differences in baseline characteristics between the intervention and control groups.

Table 6. Demographic data at baseline (Paper III)

Variable		CG n = 225	IG n = 225	*p*
Age	mean, years [SD]	82 [5.4]	83 [5.6]	*0.58*
Height	mean, cm [SD]	168 [10]	168 [11]	*0.42*
Weight	mean, kg [SD]	74 [17]	74 [15]	*0.98*
Sex, n (%)	Male	105 (47)	100 (44)	*0.52*
	Female	120 (53)	125 (56)	
Marital status, n (%)	married/living with partner	96 (43)	115 (51)	*0.09*
	widow/widower	82 (36)	66 (29)	*0.11*
	divorced, not remarried	38 (17)	31 (14)	*0.38*
	never married	9 (4)	13 (6)	*0.33*
Accommodation, n (%)	rental	100 (44)	84 (38)	*0.20*
	own apartment	71 (32)	71 (32)	*1.00*
	own house	52 (23)	65 (29)	*0.14*
	other	2 (1)	2 (1)	*1.00*
Living, n (%)	with partner/spouse	92 (41)	109 (49)	*0.09*
	alone	132 (59)	111 (50)	*0.06*
	with children or other	1 (0)	3 (1)	*0.13*
Education, n (%)	incomplete primary education	84 (38)	78 (35)	*0.44*
	complete primary education	40 (18)	44 (20)	*0.59*
	complete secondary education	10 (5)	19 (8)	*0.20*
	folk high school/vocational education	47 (21)	35 (16)	*0.17*
	university/higher education with diploma	38 (17)	46 (20)	*0.41*
	incomplete higher education or other	2 (1)	3 (1)	*1.00*

CG – control group. IG – intervention group. SD – standard deviation. p-value calculated using Chi square test

At 24-months follow-up the primary outcome recorded, mean cumulative number of days spent in hospital was not significantly different in the interventions and control groups (intention-to-treat analysis). The same was true after 12 months of follow-up. The comparison can be seen in Table 7.

Table 7. Number of days spent in hospital during first and second year of follow-up (Paper III)

Follow-up	Outcome	CG n = 166	IG n = 152	*p*
During month 1-12	Mean, days [SD]	9.6 [19.5]	8.7 [14.6]	*0.44*
	Median, day [range]	2 [0-211]	3 [0-116]	
During month 13-24	Mean, days [SD]	8.0[15.5]	7.4 [14.8]	*0.18*
	Median, day [range]	0 [0-120]	0 [0-101]	
Total during 24 months	Mean, days [SD]	17.6 [25.5]	16.2 [22.3]	*0.14*
	Median, day [range]	9 [0-211]	6 [0-116]	

CG – control group. IG – intervention group. p-value - calculated using Mann-Whitney U-test. SD – standard deviation

Mortality and all other secondary outcomes at 12 and 24 months were not different between the groups as presented in Figure 10 and Table 8.

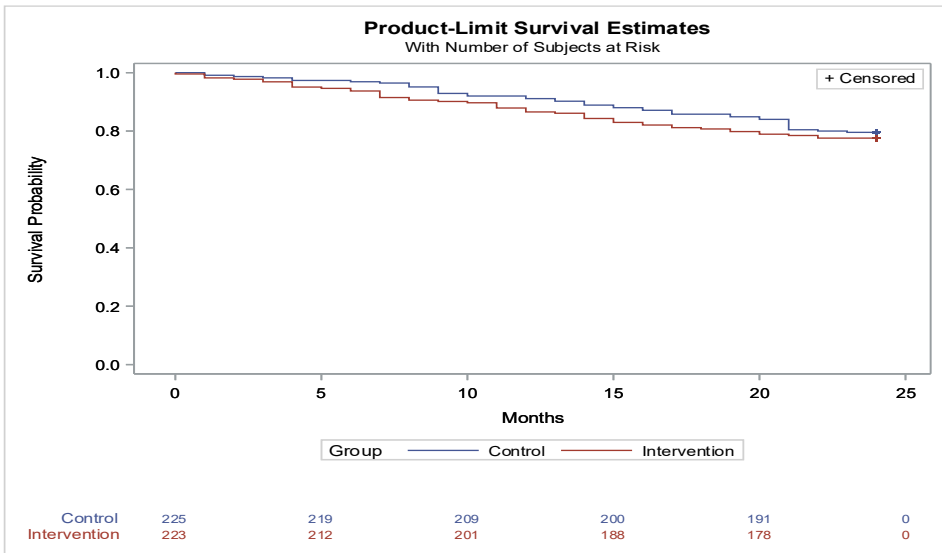

Figure 10. Kaplan-Meier survival plot, mortality 1-24 months post study inclusion (Paper III)

Table 8. Secondary outcomes presented by groups at bassline, within month 1-12 and month 13-24 (Paper III)

	Baseline			Month 1-12			Month 13-24		
Outcome	**IG**	**CG**	***p***	**IG**	**CG**	***p***	**IG**	**CG**	***p***
EQ-5D-5L									
n in group	221	220		181	197		160	161	
mean value[SD]	0.75[0.25]	0.76[0.25]	*0.81*[a]	0.74[0.25]	0.79[0.23]	*0.13*[a]	0.74[0.29]	0.80[0.21]	*0.24*[a]
No. of hospital admissions, deceased excluded									
mean, days[SD]	n/a	n/a		1.1[1.4]	1.4[2.2]	*0.29*[b]	1.1[1.7]	1.0[1.6]	*0.40*[b]
SPPB total score									
n in group	225	225		182	200		153	155	
mean score [SD]	6 [4]	6 [4]	*0.92*[c]	6 [4]	6 [4]	*0.93*[c]	6 [4]	5 [4]	*0.66*[c]
CFS									
n in group	219	219		182	199		164	169	
mean score	4.12	4.08	*0.74*[b]	4.39	4.50	*0.71*[b]	4.95	5.15	*0.34*[b]
ADL									
n in group	222	223		178	198		160	164	
mean score [SD]	5.3 [5]	5.5 [5]	*0.73*[c]	5.3 [5]	5.5 [5]	*0.55*[c]	6.0 [5]	6.5 [5]	*0.38*[c]
MOCA									
n in group	221	217		179	196		147	148	
mean score[SD]	22 [6]	22 [5]	*0.33*[c]	22 [6]	22 [6]	*0.77*[c]	22 [7]	22 [6]	*0.69*[c]

CG – control group. IG – intervention group. EQ-5D-5L – 5-level versions of EQ-5D (a standardised measure of health status developed by the EuroQol Group). [a]p-value calculated using two-sided T-test [b]p-value calculated using Mann-Whitney U-test. SD – standard deviation. n/a – not applicable. SPPB – Short Physical Performance Battery. [c]p-value calculated using Chi-Square test. CFS – 9 level Clinical Frailty Scale. ADL – activities of daily living measured with Katz Extended ADL Index. MOCA – Montreal Cognitive Assessment tool.

Of the participants randomized to the intervention group, 12 declined to participate in the intervention after baseline assessment but agreed to follow up visits. The per-protocol analysis, excluding these 12 participants, is presented in Table 4. This, like the intention-to-treat analysis, revealed no significant differences between the intervention and control groups in the number of hospital days.

Table 9. Number of days spent in hospital during first and second year of follow-up (a per protocol analysis, Paper III)

Follow-up	Outcome	CG n = 166	IG n = 152	*p*
During first 12 months	Mean, days [SD]	9.6 [19.5]	8.8 [14.9]	*0.48*
	Median, day [range]	2 [0-211]	2 [0-116]	
During second 12 months	Mean, days [SD]	8.0[15.5]	7.2 [14.7]	*0.13*
	Median, day [range]	0 [0-120]	0 [0-101]	
Total during 24 months	Mean, days [SD]	17.6 [25.5]	16.1 [22.1]	*0.14*
	Median, day [range]	9 [0-211]	6 [0-116]	

CG – control group. IG – intervention group. SD – standard deviation. P-value calculated using Mann-Whitney U-test.

Paper IV

The study enrolled 102 patients, averaging 84.6 years (range 51–100). Women comprised 56%, with 73% of all participants living at home and 27% in nursing homes. Among home-dwellers, 78% used care packages or social alarms (wearable devices alerting 24/7 home services, e.g., post-fall), and 51% had home healthcare. GAT administered i.v. treatments (fluids, antibiotics, infusions) 84 times to 38 patients and 28 blood transfusions to 16 patients. Nursing home residents received i.v. treatment more often (52%) than home-dwellers (34%). GAT enhanced home health care and social care packages in 37% of cases. See Table 10 for subgroup details.

Table 10. Interventions made by the geriatric acute team (Paper IV)

Participants (*n*)	Visits per patient (mean)	I.V. fluids (%)	I.V. antibiotics (%)	I.V. iron/diuretics (%)	I.V. blood (%)	GAT started HHC (%)	GAT increased HHC/POC (%)
All participants (102)	3.0	25	26	32	27	21	37
Lived at home (75)	3.4	17	20	35	17	29	51
Lived in nursing home (27)	2.3	44	41	37	56	0	0
Referred by primary care (38)	4.8	37	48	78	52	41	56
Referred by ambulance staff (13)	3.1	38	46	0	8	38	62
Referred by nursing home staff (15)	2.1	27	13	47	47	0	0
Referred by HHC nurse (22)	2.9	14	23	23	18	0	36
Referred from the ED (9)	1.9	0	0	22	0	44	33
Referred from GAW or another ward (5)	6.0	60	0	20	50	20	40
Deceased during follow-up (26)	3.3	31	50	69	31	35	35

I.V intravenous, *GAT* geriatric acute team, *HHC* home health care, *POC* package of care, *ED* emergency department, *GAW* geriatric acute ward

During follow-up, 26 participants (26%) deceased. Three participants were admitted to the geriatric ward. No differences were observed in emergency department (ED) visits, hospitalizations, or hospital length of stay across all participants. However, these outcomes decreased among participants residing in nursing homes and those whose Geriatric Assessment Team (GAT) intervention was initiated by ambulance (39% of participants). Additionally, all outcomes decreased for participants receiving intravenous (i.v.) antibiotics, and ED visits reduced for those receiving i.v. fluids. See Tables 11, 12, and 13.

Table 11. Mean number of visits to the emergency department 3 months before and 3 months after the first visit by the geriatric acute team (Paper IV)

Participants (*n*)	No of ED-visits before Mean (SD)	No of ED visits after Mean (SD)	*p* value
All participants (102)	0.7 (0.9)	0.5 (0.8)	0.323
Living in nursing homes (27)	0.6 (0.8)	0.07 (0.3)	0.002*
Living in nursing homes (deceased excluded) (20)	0.6 (0.8)	0 (0.0)	0.004*
Living at home (75)	0.7 (0.9)	0.7 (0.7)	0.78
Living at home (deceased excluded) (56)	0.7 (1.0)	0.6 (0.9)	0.59
Referred by ambulance staff (13) (living at home)	1.1 (0.8)	0.5 (1,0)	0.131
GAT-intervention with iv antibiotics (11)	1.0 (0.9)	0.09 (0.3)	0.01*
GAT-intervention with iv fluid (14)	0.9 (0.8)	0.07 (0.3)	0.001*
GAT-intervention with blood transfusion (16)	0.7 (0.7)	0.5 (0.8)	0.509
GAT initiating HHC(17)	0.8 (1.3)	0.7 (1.0)	0.778
GAT increasing HHC or POC(34)	0.7 (0.7)	0.9 (1.0)	0.362
Deceased (26)	0.7 (0.7)	0.8 (1.0)	0.557

ED emergency department, *SD* standard deviation, *GAT* geriatric acute team, *HHC* home health care, *POC* package of care

*$p \leq 0.05$

Table 12. Mean number of hospitalisations 3 months before and 3 months after the first visit by the geriatric acute team (Paper IV)

Participants (*n*)	Number of hospitalisations before, mean (SD)	Number of hospitalisations after, mean (SD)	*p* value
All participants (102)	0.4 (0.7)	0.4 (0.7)	0.621
Living in nursing homes (27)	0.4 (0.6)	0.07 (0.3)	0.018*
Living in nursing homes, deceased excluded (20)	0.3 (0.6)	0 (0.0)	0.030*
Living at home (75)	0.4 (0.8)	0.5 (0,7)	0.323
Living at home, deceased excluded (56)	0.5 (0.7)	0.3 (0.6)	0.36
Referred by ambulance staff, living at home (13)	1.0 (0.9)	0.3 (0.5)	0.044*
GAT-intervention with iv antibiotics (11)	0.7 (0.6)	0.09 (0.3)	0.011*
GAT-intervention with iv fluid (14)	0.6 (0.6)	0.1 (0.4)	0.054
GAT-intervention with blood transfusion (16)	0.4 (0.6)	0.4 (0.6)	1.00
Deceased (26)	0.5 (0.6)	0.8 (0.8)	0.175

SD standard deviation, *GAT* geriatric acute team, *iv* intravenous
*$p \leq 0.05$

Table 13. Mean number of days in hospital 3 months before and 3 months after the first visit by the geriatric acute team (Paper IV)

Participants (*n*)	Days in hospital before, mean (SD)	Days in hospital after, mean (SD)	*p* value
All participants (102)	3.4 (7.0)	3.5(7.1)	0.919
Living in nursing homes (27)	5.1 (11.0)	0.8 (3.0)	0.045*
Living in nursing homes, deceased excluded (20)	3.4 (7.7)	0 (0.0)	0.064
Living at home (75)	2.7 (4.6)	4.4 (7.8)	0.11
Living at home, deceased excluded (56)	2.6 (4.6)	3.3 (7.5)	0.55
Referred by ambulance staff, living at home (13)	6.2 (6.0)	2.1 (3.6)	0.028*
GAT-intervention with iv antibiotics (11)	5.9 (7.7)	0.4 (1.2)	0.045*
GAT-intervention with iv fluid (14)	4.7 (5.8)	1.1 (2.9)	0.062
GAT-intervention with blood transfusion (16)	5.4 (12.1)	2.5 (4.1)	0.323
Deceased (26)	4.8 (9.9)	6.3 (7.6)	0.553

SD standard deviation, *GAT* geriatric acute team, *iv* intravenous
*$p \leq 0.05$

Paper V

The were 239 participants in total. 113 participants in the baseline observational period and 126 participants in the post-intervention period. The GMT took over the medical responsibility of the ICF on the 1st of February 2020.

Data on the participants regarding gender, age and mortality did not differ between the two groups, see table 14.

Table 14. Baseline characteristics (Paper V)

	Before GMT*	After GMT*	p-value
Number of participants	113	126	
Days of observation	463	424	
Mean age (range)	82 (23-99)	80 (43-93)	0.117
Women (percent)	63	56	0.254
Deceased (percent)	13	15	0.690

**GMT= Geriatric Mobile Team*

Although the mean number of hospital admission days appeared to decrease before and after the intervention, no statistically significant difference was observed between groups. See Table 15. However, ICF LOS was significantly reduced in the post-intervention period.

Table 15. Mean number of days spent in hospital and mean length of stay in the ICF admitted from the ICF before and after the intervention (Paper V)

	Before GMT*	After GMT*	p-value****
Days spent in hospital, Mean per patient (SD)	2.60 (6.93)	1.40 (4.09)	0.247
LOS** in ICF***, Mean number of days per patient (SD)	54.6 (42.4)	40.1 (29.0)	0.028

**GMT= Geriatric Mobile Team*
***LOS = Length of stay*
****ICF = Intermediate care facility*
*****Mann-Whitney was chosen above independent t-test since the data was not normally distributed.*

Discussion

The Swedish National Board of Health and Welfare has recommended strategies to alleviate the increasing pressure on hospital beds in Sweden. One proposed approach involves reallocating hospital resources to establish mobile services capable of delivering primary and secondary healthcare in patients' homes[4]. These mobile teams aim to better address the needs of patients, particularly frail older adults, while enhancing healthcare quality and reducing hospital bed occupancy. To establish new services, we need to know what type of mobile services are both safe and effective in achieving their goal of decreasing the demand for hospital care. This thesis seeks to advance this evidence base on healthcare delivery to older adults via mobile teams.

This thesis focuses on the effects of geriatric mobile teams used for avoiding unnecessary hospital admissions. Both their impact on clinic outcomes and hospitalisation were studied. **Paper I** addressed multimorbid older patient's willingness to participate in research involving proactive interventions with a geriatric mobile team. **Paper II** described the characteristics of patients with one specific definition of multimorbidity. **Paper III** investigated the effects of one type of mobile team which provided proactive CGA based healthcare delivered in patient's homes. The studied population was the same as in Paper I and II. **Paper IV** looked at the effect a reactive mobile geriatric acute team can have on a broader cohort of older patients living at home. **Paper V** studied the effects of a geriatric mobile team taking over the medical responsibility of an intermediate care facility.

Research on geriatric mobile services encounters multiple challenges. First, the diverse definitions of these services pose a significant hurdle. Healthcare provided in patients' homes or care facilities varies widely in scope and complexity, with numerous services qualifying as mobile teams and delivering healthcare ranging from basic to highly specialized. Consequently, research requires detailed descriptions of the service and target population to address subtle intervention variations that may significantly influence outcomes, enabling comparisons across mobile services. Second, ethical considerations arise, as these services aim to partially or fully replace hospitalization, a well-established and extensively studied care model. Frail patients are also particularly vulnerable. Studies must therefore prioritize patient safety through rigorous ethical oversight. Third, methodological challenges complicate evaluations. Mobile team interventions require comparison with a control group, yet older frail adults constitute a heterogeneous population

with diverse needs and preferences[86,87], making it challenging to control for all variables or achieve adequate randomization.

Main findings

Papers I-III are studies involving a group of patients with a certain definition of multimorbidity. This definition of multimorbidity and inclusion criteria used in GerMoT has been adapted from the Swedish National Board of Health and Welfare's definition and used in several Swedish research and government publications [52,53,88-92].

Multimorbidity, commonly defined as the presence of two or more chronic conditions in an individual, encompasses a heterogeneous patient population with varying combinations of disorders, needs, functional level and frailty[93]. Moreover, this definition includes a large group, accounting for 66% - 98% of all adults aged ≥65 years[94,95], rendering it nearly as non-selective as an age-based cutoff. One could argue that the primary purpose of the multimorbidity label is to identify patients with complex needs who are underserved by fragmented, reactive healthcare systems yet consume a disproportionate share of secondary care resources, including inpatient and specialist care costs. Any costly intervention aimed at multimorbid older patients requires a narrow definition of multimorbidity that selects a smaller cohort, that would most benefit from an intervention. The Swedish National Board of Health and Welfare recommends focusing on a subgroup of multimorbid patients aged ≥75 years who, in the past 12 months, have had ≥3 hospital admissions and ≥3 distinct diagnoses. This group, representing 7% of Swedes aged ≥75 years or 0.7% of the total population, accounts for 19% of secondary care expenditure[89]. These patients can be identified using healthcare databases or electronic medical records, a practice increasingly feasible as more countries adopt such systems.

Paper II shows that patients meeting this definition exhibit high levels of multimorbidity and healthcare utilization, consistent with traditional definitions of multimorbidity (i.e., two or more chronic conditions). Specifically, this cohort is characterized by prevalent pain, anxiety, mobility limitations and cognitive impairment, yet have predominantly mild frailty. Notably, most participants lived alone and maintained relative independence with basic activities of daily living (ADLs), distinguishing them from more severely frail populations. This makes this cohort of particularly interest.

Over half of our cohort lived alone. Living alone is an independent risk factor for adverse health outcomes[96]. While not equivalent to loneliness, living alone increases the risk of loneliness[97]. Among older adults, loneliness is associated with functional and cognitive decline, depression[98-100] and increased healthcare utilisation[101]. As

modifiable risk factors, living alone and loneliness present opportunities for targeted interventions in this cohort to reduce morbidity and healthcare demands.

Our GerMoT trial cohort exhibited notable independence in basic ADLs, including self-feeding, continence, transfers, toileting, and personal hygiene. This independence may be attributed to the inclusion criterion of living at home (and not in a care facility), which typically requires proficiency in basic ADLs to maintain home-based living. Conversely, participants demonstrated reduced independence in instrumental ADLs, such as cleaning, shopping, transportation, and cooking. Community-dwelling older adults often access support for these tasks, enabling them to remain at home without transitioning to nursing homes. However, it should be noted that independence was assessed via self-report, which may differ from objective evaluations. The relative independence makes this cohort a good candidate for proactive healthcare interventions at home as they still have functional reserves they can rely on.

The GerMoT trial cohort exhibited low average MoCA scores of 22.2 (SD 5.7), suggesting potential undiagnosed dementia in some participants[102]. This can be compared to an age-matched cohort from the same Swedish region, which had a mean MoCA score of 25.3 (SD 2.5)[103]. These cognitive impairments likely hinder their ability to effectively seek healthcare. This could contribute to frequent emergency department visits and acute hospital admissions. Implementing strategies to diagnose and manage dementia could improve quality of life and avoid unnecessary admission.

The definition of multimorbidity, used in papers I-III, might be seen as excessively restrictive, with a high age cut-off and high number of diagnoses required and therefore excluding many multimorbid people with complex needs who have not required hospital care recently. Given that the probable interventions offered are likely to be multifaceted and costly we believe the inclusion criteria need to be this restrictive for optimal use of resources.

Paper I concluded that the GerMoT cohort is very willing to participate in research involving a home CGA-based intervention delivered though a mobile team. The consent rate was 54%. Literature reviews indicate that consent rates in clinical trials vary widely, influenced by trial design and target population, with an average rate of approximately 50%[104 105 106]. There are not many reports on consent rates among frail, multimorbid older adults with high healthcare utilization. The GerMoT trial's findings offer valuable guidance for future researchers studying this population. We attribute the observed consent rate to the trial's robust recruitment process and study design. However, these results are specific to the GerMoT trial's Swedish context. Consent rates in other countries may differ due to varying levels of reluctance to participate in research, limiting the generalizability of our findings to other recruitment settings.

The GerMoT trial employed a combination of an information/invitation letter followed by a phone call, a strategy previously shown to increase consent rates among older adults by 1.5 times in a physical activity study[107]. This approach likely contributed to the observed consent rates in our trial. Additionally, face-to-face recruitment in participants' homes, though more resource-intensive than indirect methods, proved effective[108 106]. The higher costs of in-home recruitment were offset by the low cost of screening processes in the GerMoT trial.

To foster trust, recruitment nurses allocated over one hour for initial home visits, a practice known to enhance recruitment success[106]. This relationship of trust was maintained throughout the study, supporting participant retention. To address potential barriers, such as perceived lack of benefit[109], research staff clearly explained the study's purpose, potential benefits, and risks to participants. Staff were trained in effective communication and care for older adults, further facilitating informed consent, as this training is recognized to positively influence consent rates[110 111].

Participants randomised to the intervention arm in GerMoT were offered extra medical attention in addition to usual healthcare. This incentive is appealing to most participants and therefore likely to increase the consent rate.

In paper I, initial screening identification of candidates for the intervention was done through databases. It was not possible to invite about 30% of the people meeting the inclusion criteria. This can serve as a guide for researchers conducting studies in the future but is likely to be very specific to this populations, inclusion criteria, databases used and geographic location, limiting the findings external validity.

Paper III reports on the GerMoT trials main findings. This randomized controlled trial evaluated the impact of comprehensive geriatric assessment (CGA)-based healthcare delivered in patients' homes by a mobile team, in addition to usual healthcare, over a two-year follow-up period. The study found no significant effects on hospital length of stay, mortality, quality of life, hospital admission rates, physical performance, frailty, activities of daily living (ADL), or cognition. Several factors may have contributed to the lack of observed effect, including limited staff continuity and insufficient team-building efforts, which may have undermined the consistency and cohesion required for effective implementation of CGA. In contrast, the Age-FIT trial, a similar but earlier Swedish study, demonstrated more favourable outcomes with CGA-based care, including reductions in hospital days and mortality[52,53]. A key difference between the two studies was Age-FIT's strong staff continuity and well-established team dynamics, which likely contributed to its greater effectiveness compared to GerMoT. Additionally, as GerMoT was conducted later than Age-FIT many CGA components may already be integrated into standard primary care[112], potentially diminishing the intervention's measurable impact.

Paper IV is a study on the effects of a geriatric acute team (GAT) treating acutely unwell geriatric patients at home on their subsequent need for hospitalisation. The study found no overall differences in emergency department visits, hospitalizations, or hospital length of stay among all participants. However, these outcomes were significantly reduced for patients residing in nursing homes and for those where GAT was initiated by ambulance services, representing 39% of the study cohort. Additionally, reductions in all outcomes were observed for participants receiving intravenous antibiotics. A decrease in ED visits was noted for those receiving i.v. fluids. The overall mortality rate was 26% (26 participants), with no difference between participants living at home or in nursing homes. GAT seems to be effective for patients in nursing homes with no increase in mortality noted.

We speculate that some of GAT's interventions were effective for a number of reasons. Firstly, the quick response time and ability for ambulance services to call on GAT likely made a difference to the outcome. Second, GAT was integrated with a geriatric hospital ward, enhancing their expertise in delivering advanced treatments and investigations. This likely contributed to the study outcomes and improved their understanding of hospital-based care options, enabling better decisions about when hospitalization was necessary or when conditions could be effectively managed at home, despite patients' poor vital signs or laboratory results. Third, the referral process was short, and cases assessed by the team before acceptance. This ensured that only relevant eligible patients were seen. The lack of positive outcomes overall for participants could be explained by other factors. The participants were frail with a high risk of disease exacerbations and subsequent ED visits. Additionally, the geriatric mobile team may have identified previously unrecognized conditions, leading to increased care utilization. Finally, some interventions were routine home-based care provided due to limited primary care access.

Paper V is a study on the effects of a geriatric medical team (GMT) assuming medical responsibility for an Intermediate Care Facility (ICF). A non-significant ($p=0.247$) reduction in hospital length of stay (LOS) of ICF patients was recorded when the GMT assumed medical responsibility compared to oversight by a primary care physician. However, ICF LOS decreased significantly ($p=0.028$). The GMT expertise, in particular, in diagnosing dementia and improved coordination with ICF staff likely facilitated nursing home placements. However, multiple factors may have contributed to this outcome, the GMT model demonstrates a promising approach to enhancing care delivery in ICF settings.

Strengths and limitations

Paper I-III

A key strength of paper I was the attempt to contact all patients meeting the criteria within a defined geographic area, minimizing selection bias. Population databases enabled comprehensive identification of eligible patients, but delays in contact meant some had died or moved to nursing homes, potentially reducing the number invited, particularly among older age groups. Contacting patients within a shorter timeframe could reduce such delays. Ethical approval allowed access to basic demographic data for all identified patients, enabling comparisons between those who consented and those who declined participation. This provided valuable insights into non-participants, strengthening the study. However, reasons for declining were not recorded, which could include patient characteristics, concerns, or study-specific factors. Such data could inform future trial designs. A limitation was the lack of socioeconomic status data for non-participants, leaving uncertainty about its influence on recruitment. Low education and income are often linked to reluctance to join clinical trials[113], potentially introducing bias to the sample.

The robust recruitment process is a clear strength of studies in papers I-III, achieving a high consent rate through broad inclusion criteria, no upper age limit, and inclusion of participants with cognitive disorders.

Another strength of GerMoT is its real-life setting as others designing this type of intervention are also likely to face staffing, competence, continuity, and resource shortages.

In paper III, effective randomization was achieved, as demonstrated by the intervention and control groups being comparable in size and baseline demographics.

In paper III, the GerMoT study assessed the intervention's impact on number of days in hospital. Reducing hospitalisation is only beneficial if it targets avoidable hospitalisations. The more relevant measure would have been the number of avoidable hospitalisations in the intervention and control groups. We assumed fewer hospital days reflect fewer avoidable hospitalisations, but this may not always be true. Preventing necessary hospitalisations could harm patients. Although outcomes in the intervention group were not worse than in the control group, there might have been harms we have not measured.

The other major limitation of GerMoT was the quality of the intervention. Limited staff continuity and competence together with a lack of team building might have contributed to a negative result.

The studies focused on a well-defined group within a single geographic area. While many findings may apply to similar populations elsewhere, geographic differences could lead to significant variations in outcomes.

Papers IV-V

Both studies' strengths included a real-world setting and high-quality medical record data.

Limitations include small samples sizes. These could have been increased by prolonging the duration of the studies. Extending the studies risked introducing confounders such as new staff, change in work routines and variable hospital bed availability.

In paper V all ICF residence were included in the study eliminating selection bias. In paper IV not all patients assessed by GAT were invited to participate, often due to the team forgetting to ask amid high workloads or physician turnover, with some physicians unaware of the study. This suggests no intentional patient selection occurred. To the authors' knowledge, no invited patients declined participation. However, patients in acute or emotionally challenging situations, such as decisions about palliative care or curative hospital treatment, were likely less frequently asked to join. This may have influenced outcomes related to mortality, emergency department visits, and hospitalisations.

In paper IV, to enhance the generalizability of the findings, a larger, preferably multi-centre study is required. The promising results of subgroup analysis, which were not pre-specified and included a small number of participants, require further validation through studies in these specific populations. Additionally, future research should differentiate between mobile teams originating from hospitals versus primary care settings and identify which patient groups benefit most from advanced home-based healthcare

Methodological considerations

Papers I-II

These are descriptive observational studies. This method was used as we had to rely on existing data and were seeking to identify patterns and associations. It was a simple, non-invasive and inexpensive way to do this without affecting the intervention in Paper III. Also, no additional ethical approval was necessary. This method, however, did not allow us to determine causality or draw strong conclusions about mechanisms in recruitment or interactions between participant characteristics. Given that patients in paper I-II all consented to participation in GerMoT they might not be a representative sample of the population that only fulfil the inclusion criteria. In addition, in Paper I, conclusions regarding patients' willingness to consent to

participation in the GerMoT trial may be influenced by unexamined variables. Without accounting for these potential confounding factors, the strength of the conclusions is diminished.

Paper III

GerMoT was a randomized, controlled, assessor-blinded (at baseline), single-centre trial. As such it offers strong internal validity and control over confounding. The intervention and control groups had very similar baseline characteristics and were also likely to have similar unknown confounders. However, its single-centre design and limited blinding beyond baseline may constrain the generalizability and introduce potential for bias. The blinding ensured objective assessments at baseline but not necessarily at follow up when there was no blinding of assessors, introducing potential measurement bias. Blinding of participants was not possible due to the nature of the intervention. The results of a single centre trial may be specific to that centre and not be generalisable to other settings or healthcare systems. The strict inclusion criteria in GerMoT further restricted generalisability. Finally, many patients eligible for participation in GerMoT had poor health and limited mobility and these are known barriers to recruitment to clinical trials[114]. Failing to recruit these patients would lead to a selection bias.

Paper IV-V

These are before-and-after studies. This method was used to show practical outcomes in a real-world setting. For paper IV the use of a control group would have been unethical as the team would have had to decline visiting some acutely unwell patients. For paper V having a control group would have been impossible as the team was responsible for all patients in the ICF. Measuring changes in the same group over time gives some insight into potential trends and effects such as hospitalisation or mortality. However, conclusions about causality are limited by potential effected of external factors and natural progression. In paper IV, the same patients were followed up post-intervention, while in paper V, outcomes were assessed in the same intermediate care facility (ICF) but in different patients, assuming stable patient characteristics over time. The natural progress of chronic diseases was not controlled for and could be mistaken for an intervention effect in paper IV. A patient that is given end of life care by their primary care physician, without the team's intervention, and thus requires less hospitalisation is one such example. External confounding factors could have affected outcomes in both papers. For paper V the concurrent COVID-19 pandemic and changes in staffing have likely affected outcome. In paper IV, seasonal effects, staff seniority and experience in the team also changed over time potentially effecting outcomes.

Paper IV was susceptible to selection bias as only some patients were included, as discussed earlier. Even though all patients residing in the ICF were included in paper V, the study period chosen might have caused a selection bias as the characteristics of patients admitted to the ICF likely vary over time.

The methods used in papers IV and V make the outcomes susceptible to other confounding factors. The lack of blinding and awareness of participating in the study could have affected the results. Patients recruited to studies are known to change their behaviours, this is called the Hawthorne effect[115]. Also, medical staff involved in clinical trials are known to alter their practices[116].

Finally, any extreme measurements recorded during the observation periods are likely to naturally revert to average, falsely suggesting an intervention effect. This phenomenon is called regression to the mean and could have affected the results in both papers.

Conclusions

We found that using GerMoT inclusion criteria selects a subgroup of multimorbid patients that could be of particular interest for interventions.

There exists a plethora of geriatric mobile team interventions for older multimorbid people. In our research proactive home based CGA healthcare does not seem to effect hospitalisation after 2 years follow-up. Proactive geriatric acute home team interventions seem to decrease the need for hospitalisation only if the team offers hospital level care such as intravenous treatments. A mobile geriatric team in an Intermediate Care Facility can decrease the length of stay at the facility and could decrease the need for hospitalisation.

Future perspectives

Hospital at home services have a good evidence base internationally. These services are still in their infancy in Sweden. There is a political ambition in Sweden to introduce more geriatric mobile home services, and these have started appearing around the country[4,7]. The evidence base for these is limited and this thesis makes a small contribution to this evidence. Before, we further implement a variety of mobile services is it paramount that we evaluate if they achieve their goals. Centrally, these goals need to be important for patients. Based on patient preferences further goals should focus on autonomy, quality of life, physical function, independence[117,118] and avoiding hospitalisations[119]. Only second, as with other taxpayer funded services, we have a duty to study the cost effectiveness of these interventions.

Regarding hospital avoidance, it is important to distinguish between decreasing needed or necessary hospitalisation and decreasing avoidable or unnecessary hospitalisation. HaH and other step-up services are a substitute for needed hospitalisation whereas proactive or preventative mobile teams are directed at avoidable admissions. This distinction should be made when designing these services. Governance and organisational affiliation should be different. Step-up (including HaH) services that provide hospital level care should be provided by hospital specialist in line with their competence whereas preventative models are more suited for primary care.

GerMoT was led by a team form the hospital and not integrated with social care. As discussed, lack of long term continuity of care and lack of social worker where likely reasons for absence of desired effect. Preventative mobile teams, as part of primary care and integrated with social care, should be compared to existing preventative primary care services. Interventions could simply consist of delivering available services at home and thus increasing access and availability. It is known that many frail patients find it difficult to access primary care[120].

Any plans for future healthcare, which services we develop and evaluate, need to be placed in a context of an aging population. According to Statistics Sweden the number of people above 80 years of age will increase by 38% by the year 2033 in Sweden[121].The group aged 20-66 years will increase by only 3,7%[121]. The proportion of vocationally capable people is thus decreasing. In addition, the number of nurses and healthcare assistants working within services for older people

had decreased in recent years. The number of geriatricians has remained constant at around 532 nationally[121]. Therefore, a crucial resource in healthcare is staffing and competence. Any team doing home visits can assess less patients than a team seeing patients in a hospital. Patient's home adaptation, available technology and geographic factors play a role. Small scale initiatives are often attractive workplaces and less sensitive to staffing shortages. Any future planning of large scale, system wide services need to take availability of trained staff into account.

Further research on geriatric mobile teams is crucial. As step-up services and HaH per definition replaces a needed hospitalisation, many studies on HaH have assumed that every patient interaction has replaced what would otherwise have been an admission. This assumption is not always true as some patients may choose to decline treatment if the only option is hospitalisation. Other patients may be hospitalised for social and not medical reasons and the actual intervention needed is increased social care. As available research points to a robust safety profile of HaH[2] performing further trials where patients are randomly allocated to treatment in hospital or to HaH might seem desirable or even necessary to study the effects of HaH on quality of life, physical function and independence. However, in a real-world setting patients will be given a choice of where they want to be treated. In addition, any HaH services will utilise hospital resources. In one acute episode a patient might get some investigations and treatments in hospital and some at home, moving freely between the two as needed. We will therefore need to compare outcomes of these new integrated services with known outcomes of established services over time.

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Use of generative AI models

This thesis has been produced with the assistance of the generative AI models ChatGPT 4o and Grok 3. They have been used for generating the front-page image, proofreading text, correcting syntax and spelling errors. The author of this thesis has processed any generated text and take full responsibility for the content.

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