Readmission to hospital within 30 days of discharge - in older adults

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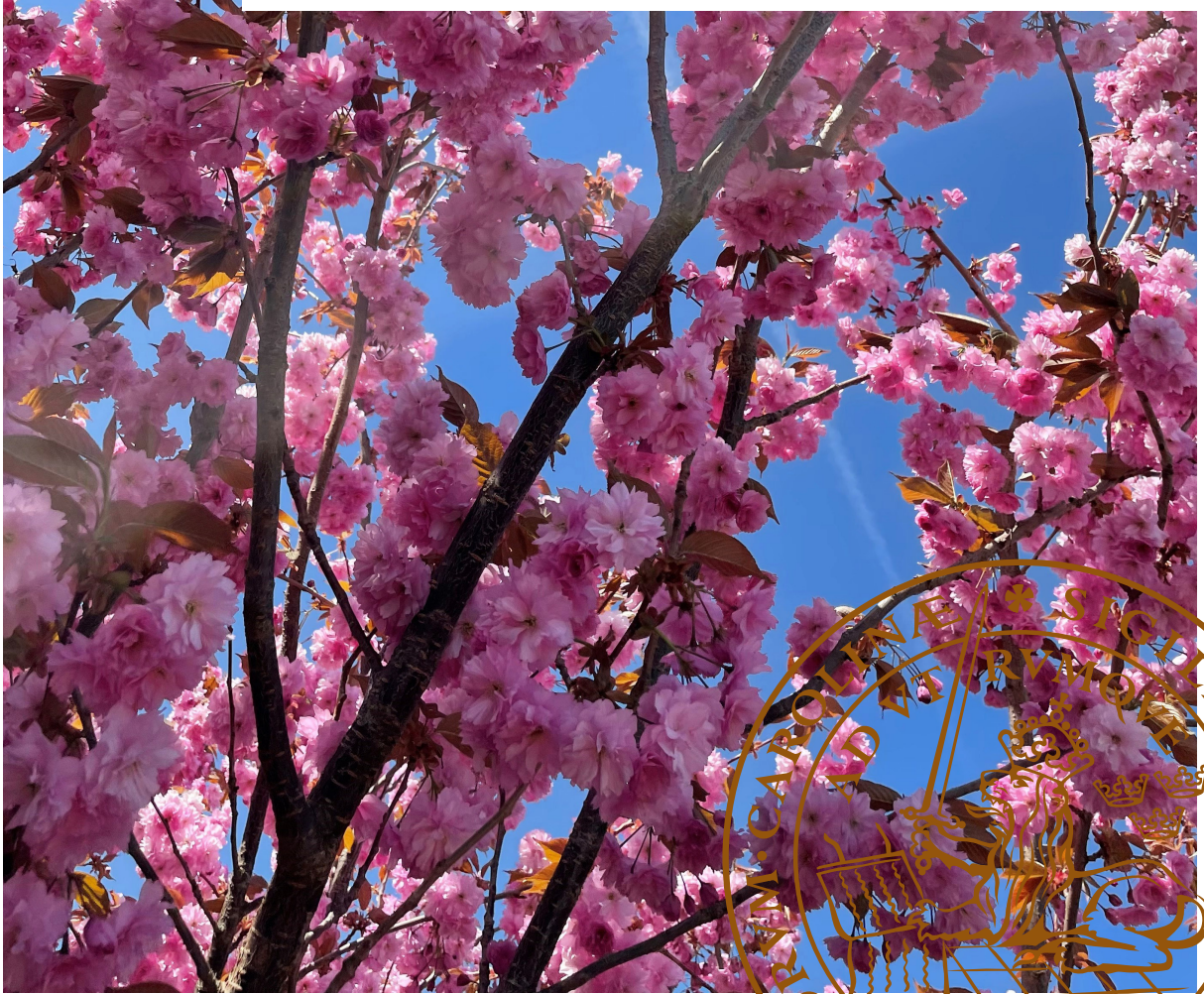

Readmission to hospital within 30 days of discharge – in older adults

Maria Glans has a background as a clinical pharmacist working mainly with medication reconciliation and medication review in older adults in hospital care. Over the years she has developed a keen interest in patient safety issues in general and a willingness to work towards improving the care of older adults in particular.

In her thesis, she has identified individual and organisational risk factors for readmission to hospital within 30 days of discharge, in older adults. Furthermore, she has developed a risk assessment tool - the HOME Score - aiming to identify older adults at increased risk of medication-related readmission.

Using the findings of this thesis to improve processes and implement preventive measures can help improve the care of older adults and, hopefully, decrease the risk of hospital readmission within 30 days of discharge in this population. This would be beneficial to patient safety as well as the health economy.

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LUND
UNIVERSITY

DOCTORAL DISSERTATION

By due permission of the Faculty of Medicine, Lund University, Sweden.

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Title Readmission to hospital within 30 days of discharge – in older adults

Abstract

Introduction

Readmission to hospital within 30 days of discharge is common, even more so in older adults. Studies show that almost 30% of all-cause readmissions and close to 70% of medication-related readmissions can be prevented.

As unnecessary hospitalisations pose a risk to both patients and the health economy, many countries, including Sweden, have set goals to decrease the frequency of early readmissions. To achieve these goals, a better understanding of the underlying causes and risk factors for readmissions within 30 days of discharge is needed, as well as insight into what can be done to prevent them.

Aims

The specific aims of this thesis were to identify individual and organisational risk factors for unplanned readmission to hospital within 30 days of discharge and to develop a risk assessment tool that can be used to identify older adults at increased risk of medication-related readmission.

Methods

Data used to identify individual and organisational risk factors for readmission in Papers I and II were retrospectively collected from electronic medical records. In Paper II the readmissions were further assessed as being unlikely or possibly medication-related using the Assessment Tool for identifying Hospital Admissions Related to Medications (AT-HARM10). In Paper III the views and perceptions of hospital physicians regarding the discharging process, focusing on documentation and information transfer of medications and medication changes in transitions of care, were investigated by focus group discussions and analysed by using qualitative content analysis. The data from Papers I and II as well as the knowledge gained in Paper III were further used in Paper IV to develop a risk assessment tool that was externally validated.

Results

As shown in Papers I and II, comorbid older adults using many medications, frequently using healthcare, and living alone and/or dependent on home care were at increased risk of readmission to hospital within 30 days of discharge. The odds of a possibly medication-related readmission also increased in patients with an emergency admission and if dosages had been adjusted at discharge. The odds of an unlikely medication-related readmission also increased if the length of stay was five days or longer and if the patient was discharged on a Friday or from the general surgery department.

The hospital physicians in Paper III identified several obstacles in transferring information regarding medications at discharge, some of which, such as implementing routines aiming to improve information continuity and involving clinical pharmacists in transitions of care, are possible to act upon.

The 1–6-point risk score developed in Paper IV was named the HOME Score. It had a c-index of 0.69 (95%CI 0.64-0.74) and good calibration. A score of ≥4 points was identified as the optimal cut-off value and showed a sensitivity of 76%, specificity of 54%, positive predictive value of 29%, and a negative predictive value of 90%. In the external validation, the model remained predictive of medication-related readmission with a c-index of 0.65 (CI95% 0.57-0.72, p-value < 0.001).

Conclusions

Individual and organisational risk factors for unplanned readmission to hospital within 30 days of discharge have been identified and a risk assessment tool aiming to identify older adults at increased risk of medication-related readmission has been developed. Using the findings of this thesis to improve processes and implement preventive actions can help improve the care of older adults and, hopefully, decrease the risk of hospital readmission within 30 days of discharge in this population. This would be beneficial to patient safety as well as the health economy. Further studies are needed to test these hypotheses.

Keywords Older adults, Patient discharge, Transitions of care, Patient readmission, Medication-related problems, Potentially inappropriate medications, Polypharmacy, Risk factors, Risk assessment

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To my beautiful family, with love

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Preface

Working as a clinical pharmacist I have often come across patients returning to hospital shortly after discharge. On many occasions, I have thought to myself that "this readmission could have been avoided if we had just…been better at informing the patient, reconciled the medication list, seen to it that the patient had help with his/her medications after discharge" and so on and so forth.

My interest in the subject grew and since December 2017 I have been a part-time PhD student at the Department of Clinical Sciences in Malmö, where my studies have revolved around readmission to hospital within 30 days of discharge – in older adults.

This is the result of my endeavours…

Abstract

Introduction

Readmission to hospital within 30 days of discharge is common, even more so in older adults. Studies show that almost 30% of all-cause readmissions and close to 70% of medication-related readmissions can be prevented.

As unnecessary hospitalisations pose a risk to both patients and the health economy, many countries, including Sweden, have set goals to decrease the frequency of early readmissions. To achieve these goals, a better understanding of the underlying causes and risk factors for readmissions within 30 days of discharge is needed, as well as insight into what can be done to prevent them.

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Individual and organisational risk factors for unplanned readmission to hospital within 30 days of discharge have been identified and a risk assessment tool aiming to identify older adults at increased risk of medication-related readmission has been developed.

Using the findings of this thesis to improve processes and implement preventive actions can help improve the care of older adults and, hopefully, decrease the risk of hospital readmission within 30 days of discharge in this population. This would be beneficial to patient safety as well as the health economy. Further studies are needed to test these hypotheses.

Abbreviations

ADE	Adverse Drug Event
ADR	Adverse Drug Reaction
AT-HARM10	Assessment Tool for identifying Hospital Admissions Related to Medications
CRP	C-Reactive Protein
FRID	Fall-Risk Increasing Drug
GP	General Practitioner
ME	Medication Error
MedBridge trial	Medication Reviews Bridging Healthcare trial
MRP	Medication-Related Problem
PIM	Potentially Inappropriate Medication
RCT	Randomised Clinical Trial
ROC curve	Receiver Operating Characteristic curve
STOPP & START	Screening Tool of Older Person's Prescriptions and the Screening Tool to Alert doctors to Right Treatment
The HOME Score	The Hospitalisations, Own home, Medications and Emergency admission Score
WHO	World Health Organization

Definitions

The first hospital admission is called the **index admission** (1).

A **readmission** is an admission occurring within a specified period of time after discharge from the index admission (1). This thesis focuses on emergency (unplanned) readmissions within 30 days of discharge.

A **medication-related readmission** is a readmission "of which a medication-related problem (MRP) is either the main cause for admission or a significantly contributing cause for admission (i.e. without the MRP, the patient would not have been readmitted)" (2).

A **medication-related problem** (MRP) is an "undesirable patient experience that involves medication therapy and that actually or potentially interferes with desired patient outcomes" (3). Medication-related problems include adverse drug events, adverse drug reactions, and medication errors (1, 2).

An **adverse drug event** (ADE) is "any injury resulting from medication use, including physical harm, mental harm, or loss of function. ADEs can result from adverse drug reactions (non-preventable) or medication errors (preventable)" (1).

An **adverse drug reaction** (ADR) is "a response to a drug which is noxious and unintended, and which occurs at doses normally used in man for the prophylaxis, diagnosis, or therapy of disease, or for the modifications of physiological function" (1).

A **medication error** (ME) is an "error in the process of prescribing, dispensing, or administering the medications that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer" (1).

Transitions of care is "a set of actions designed to ensure the co-ordination and continuity of healthcare as patients transfer between different locations or different levels of care within the same location" (4).

Polypharmacy is, in this study, defined as the use of five medications or more in total (regularly and as needed), whereas **Excessive polypharmacy** is defined as the use of 10 medications or more in total (regularly and as needed).

List of papers

This thesis is based on the following papers, referred to in the text by their Roman numerals:

I. **Glans M**, Kragh Ekstam A, Jakobsson U, Bondesson Å, Midlöv P. Risk factors for hospital readmission in older adults within 30 days of discharge - a comparative retrospective study. *BMC Geriatrics*. 2020 Nov 11;20(1):467.

II. **Glans M**, Kragh Ekstam A, Jakobsson U, Bondesson Å, Midlöv P. Medication-related hospital readmissions within 30 days of discharge - A retrospective study of risk factors in older adults. *PLoS One*. 2021 Jun 10;16(6):e0253024.

III. **Glans M**, Midlöv P, Kragh Ekstam A, Bondesson Å, Brorsson A. Obstacles and Opportunities in Information Transfer Regarding Medications at Discharge - A Focus Group Study with Hospital Physicians. *Drug Healthc Patient Saf*. 2022 May 17;14:61-73.

IV. **Glans M,** Kempen TGH, Jakobsson U, Kragh Ekstam A, Bondesson Å, Midlöv P. Identifying older adults at increased risk of medication-related readmission to hospital within 30 days of discharge – development and validation of a risk assessment tool. *Submitted.*

Introduction

Readmission to hospital within 30 days of discharge is common, even more so in older adults (5, 6). In Sweden, as in several other western countries, about 20% of older adults discharged from hospital are readmitted within 30 days (5-7). Almost 30% of these readmissions are medication-related (1).

Even though not all readmissions can be avoided, previous studies show that nearly 30% of all-cause readmissions (8) and approximately 70% of medication-related readmissions (1) may be possible to prevent. Preventability of readmissions is more common in older adults (≥ 65 years) (9).

With readmission, patients, especially older adults, risk being affected by hospital associated complications such as exposure to infections, episodes of confusion and accidental injury through falls (10, 11). However, readmissions are a risk for the health economy as well as for the individual patient (5). Therefore, many countries, including Sweden, have set goals to decrease the frequency of readmissions within 30 days of discharge (5, 12, 13).

To implement effective interventions and achieve these goals a better understanding of the underlying causes of readmissions within 30 days of discharge is needed, as well as insight into what can be done to prevent them.

Underlying causes and risk factors for readmission

Identifying risk factors for readmission to hospital within 30 days of discharge is a big issue in the research community and previous studies have specified several such risk factors.

Some of these risk factors are related to patient characteristics such as comorbidities (14, 15), gender (16), age (16), previous hospitalisations (14, 17), or living arrangements (15, 16, 18). Others are related to the hospitalisation itself, such as type of admission (14, 17), procedures performed (17), length of stay (14, 17), or specific lab results (15-17).

Other areas indicated as risk factors include polypharmacy, high-risk medications, and transitions of care (1, 9, 19). Interestingly, these three areas are also considered as the primarily targeted areas in the World Health Organization's (WHO) third global patient safety challenge, Medication Without Harm (20), where the goal is to reduce the level of severe, avoidable harm related to medication.

Multimorbidity, polypharmacy and high-risk medications

Life expectancy in Sweden and worldwide is steadily increasing (21-23) and this is causing challenges to the healthcare system as well as to social care. With age, the number of morbidities and the proportion of people with multimorbidity increases. Most older adults (65 years and older) are multimorbid, as seen in Figure 1 (24). With multimorbidity comes increased healthcare use (25, 26) and increased risk of readmission (27).

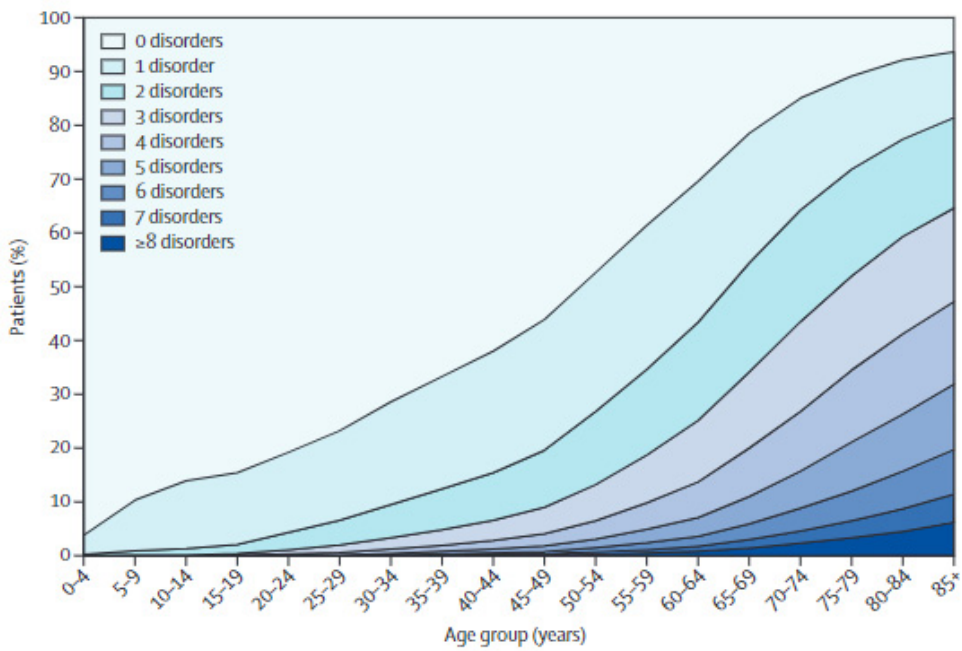


Figure 1. The number of chronic disorders increases with age, as shown by Barnett et al in this Scottish study from 2012 (24, 28). By the age of 65 most people are diagnosed with two or more chronic disorders and are, by definition, multimorbid.

As the number of morbidities increase, so does the need for further medications to treat these disorders. Taking five medications or more, also known as polypharmacy (29), is

common among older adults. Approximately 30% of patients aged 65 years and older, in developed countries, take five medications or more regularly (30) and studies show that Swedish older adults spend a considerable proportion of their lives living with polypharmacy (31, 32).

Even though polypharmacy is not necessarily inappropriate in itself, physiological changes that arise with age can affect the pharmacokinetics and pharmacodynamics of medications (30, 33), thus leading to an increased sensitivity and an increased risk of medication-related problems (MRPs) (30). In fact, polypharmacy (16, 34, 35) and the presence of, or past, MRPs (1, 16, 36) are both factors found to increase the risk of readmission to hospital within 30 days of discharge. Hence, it is important to identify patients with inappropriate polypharmacy that may lead to such adverse clinical outcomes.

The use of potentially inappropriate medications (PIMs) has also been indicated to increase the risk of readmissions to hospital (37). Such medications include medications that often lead to side effects and adverse events, such as fall-risk-increasing drugs (FRIDs) or other high-risk medications (38).

Approximately 20% of patients aged 65 years and older use medications which can be classified as high-risk (39) and several studies report on specific medication groups involved in hospital readmission (1, 16, 19). The highest prevalence for medication-related readmission has been seen for antibiotics, diuretics, vitamin K antagonists, and opioids. Other medications have also been indicated, such as antidiabetics, antihypertensives, corticosteroids, antiplatelet drugs, and psychotropic drugs (1, 16, 19).

Transitions of care

Several researchers have identified factors related to transitions of care, especially hospital discharge, as being important in early hospital readmission (40). To ensure continuity of care it is important that information on events occurring during hospitalisation, and plans for follow-up, are transferred to primary and municipal care as well as to the patient. Unfortunately, studies show that such information is often incomplete, unclear, delayed, or even missing (41-44).

Medication discrepancies and medication errors are common in care transitions (44) and almost 60% of potentially preventable readmissions are caused by problems concerning either medications or transitions of care (9). Furthermore, about 30% of potentially preventable medication-related readmissions are caused by transition errors, including failure to communicate medication changes to the patient and/or the next

caregiver (19, 45). Deficient communication in combination with older adults having trouble understanding medication instructions (46) can lead to poor adherence, which can increase the risk of 30-day readmission (47).

It has been further indicated that living arrangements before admission as well as discharge destination (6, 48) can affect the risk of readmission, especially in patients using high-risk medication regimens (39). Older adults living in their own home are at increased risk of medication-related readmission (18). In addition, older adults living alone have been found to be more prone to medication errors (46), which can be most likely attributed to the lack of having someone to monitor, assist or remind them to take their medications. Living alone has also been associated with elevated mortality in older adults (49).

Preventing readmission

The best way to prevent readmission to hospital within 30 days of discharge is to combine several minor activities into concepts (19, 50). These activities should aim to improve medication use as well as transitions of care, especially if aiming to reduce the frequency of medication-related readmissions (19, 45).

Improving medication use

The basis of good medication use should be that the expected benefit of the treatment exceeds the expected risk (38). Thus, the goal is to ensure that there is an indication for the treatment, that the diseases or symptoms are alleviated, and that the treatment causes as few side effects, or other nuisances, as possible (38).

By regularly analysing and reassessing an individual's medication use in a systematic way, the quality of medication use in older adults can be improved (19, 51, 52). Medication reviews of this kind, which are carried out in multi-professional teams consisting of doctors, pharmacists, and nurses, have been shown to reduce the number of ADEs as well as the use of PIMs in older patients (53, 54). Furthermore, they have been shown to reduce the risk of all-cause readmission as well as medication-related readmissions in older adults (55).

Several lists of potentially inappropriate medications (PIMs) have been developed with the aim of helping healthcare professionals discover, identify, and prevent medication-induced morbidity in older adults (56). The lists most widely used are the Beers criteria

(57) and the Screening Tool of Older Person's Prescriptions and the Screening Tool to Alert doctors to Right Treatment (STOPP & START) criteria (58).

Since many of the tools developed follow country-specific guidelines and prescribing habits, as well as national drug markets, they are not always transferrable to other countries (59). Hence, in order to enable the analysis of potentially inappropriate prescription patterns in and across European countries, the EU(7)-PIM list has been developed (60).

In Sweden, the Swedish indicators of good medication therapy in the elderly, developed by the Swedish National Board of Health and Welfare (38), are commonly used. Included are drug-specific indicators such as lists of PIMs and FRIDs as well as support to prescribers in medication choices within specific diagnoses. The indicators further recommend avoiding inappropriate polypharmacy, especially the use of three or more psychoactive medications.

Improving transitions of care

To come to terms with medication discrepancies and medication errors in care transitions, it is essential that medication lists are reconciled and updated. Furthermore, information on medications and medication changes, as well as a follow-up plan, must be handed to the patient, as well as transferred to the next caregiver, at discharge (19, 51). Communication interventions at discharge can help increase medication adherence to treatment after discharge as well as decrease the risk of readmission within 30 days of discharge, as shown in a large multinational systematic review with a meta-analysis by Becker et al (61).

In Skåne county, medication reconciliation should be performed in all patients upon admission to hospital and a discharge summary, including a medication report and an updated medication list, should be handed to the patient upon discharge as well as transferred to the next caregiver (52, 62). The discharge summary should be comprehensible to the patient and include information on events occurring during the hospital stay as well as changes made to medications, reasons for these changes, and the plan for follow-up (52). The discharging physician should also go through the information in the discharge summary with the patient, and preferably also next of kin, before discharge (52).

It has been shown that the number of medication errors and ADEs experienced after discharge can decrease when such a discharge summary is provided to the patient, their general practitioner, and, when needed, the municipal care nurse (50).

Identifying patients at increased risk of readmission

To ensure that interventions aiming to reduce the frequency of readmission within 30 days of discharge are implemented where they are most likely to have an effect, it is important to be able to identify patients at increased risk of such readmissions. This may be done by assessing the vulnerability and frailty of the older adult by using a comprehensive geriatric assessment tool (63, 64). However, more specific risk assessment tools may be preferable.

Before developing such a risk assessment tool, it is important to define its purpose. If the aim of identifying patients at increased risk of readmission is to implement interventions during the hospital stay, such as medication reconciliation and medication review, the tool needs to only include variables known at admission. Such variables could include age, gender, living arrangements before admission, or medications used at admission. If the purpose, on the other hand, is to implement activities at or after discharge, the tool can also include variables known only at the time of discharge, such as length of stay, lab results, or number of changes made to medications.

Over the years, several risk assessment tools specified for identifying patients at increased risk of 30-day readmission have been developed (14, 17, 65, 66). Most of these, such as the HOSPITAL Score (17) and LACE Index (14), assess the risk of all-cause readmission. There are also risk assessment tools looking at increased risk of medication-related healthcare use after discharge (16) or the risk of readmission if using high-risk medication regimens (67). However, to our knowledge, there is no risk assessment tool available that specifically aims to identify older adults at increased risk of medication-related readmission to hospital within 30 days of discharge.

Aims of the thesis

The overall aim of this thesis was to gain a better understanding of the underlying causes and risk factors for readmissions to hospital within 30 days of discharge, in older adults, as well as to gain insight into what can be done to prevent them.

Specific aims

I. The aim of the first study was to identify risk factors associated with readmission to hospital within 30 days of discharge, in older adults. The study focused not only on risk factors related to patient characteristics prior to and events during the initial hospital stay, but also on the processes of discharge, transition of care and follow-up.

II. The aim of the second study was to identify risk factors associated with medication-related readmission to hospital within 30 days of discharge, in older adults.

III. The aim of the third study was to explore and understand the experiences and perceptions of hospital physicians regarding the discharging process, focusing on documentation and information transfer of medications and medication changes in transitions of care.

IV. The aim of the fourth study was to develop and validate a risk assessment tool that can be easily used by healthcare professionals to identify older adults at increased risk of medication-related readmission to hospital within 30 days of discharge.

The goal, in the long run, is to use the results of this thesis to implement interventions aiming to improve the care of older adults and, hence, reduce the frequency of readmission to hospital within 30 days of discharge, in this population.

The aims of the thesis are further depicted in Figure 2.

Figure 2. A schematic showing the overall and specific aims of the thesis as well as the long-term goal.

Methods

Overview of methods used

This thesis consists of three quantitative studies and one qualitative study. An overview of the studies is presented in Table 1.

Table 1
Overview of Papers I-IV

Paper	I	II	III	IV
Study design	Cross-sectional	Cross-sectional	Qualitative	Cross-sectional
Participants	In total 720 patients aged 65 years and older. The study group (n=360) were readmitted within 30 days of discharge whereas the comparison group (n=360) were not.	In total 720 patients aged 65 years and older. The study group (n=360) were readmitted within 30 days of discharge whereas the comparison group (n=360) were not.	15 hospital physicians in internal medicine	Development cohort: In total 720 patients aged 65 years and older. A total of 143 patients had a possibly medication-related readmission within 30 days of discharge whereas 577 did not. Validation cohort: In total 892 patients aged 65 years or older. A total of 54 patients had a possibly medication-related readmission within 30 days of discharge whereas 838 did not.
Data collection method	Data collected from electronic medical records	Data collected from electronic medical records	Data collected through focus group discussions	Data collected from electronic medical records
Data analysis	Student's *t*-test χ2-test or Fisher's exact test Multiple logistic regression analysis (manual backward)	Student's *t*-test χ2-test or Fisher's exact test Multiple logistic regression analysis (manual backward)	Qualitative content analysis	Multiple logistic regression analysis ROC-curve analysis Youden's index Cross-tabulation Sensitivity and specificity, positive and negative predictive value

Study settings

The studies were conducted in Skåne county, a region in the south of Sweden where 1.4 million (13%) of the Swedish population live and about 20% of the population are aged 65 years and older (22).

Papers I, II, and IV included patients admitted to the hospital in Kristianstad in the north-eastern part of Skåne county. Kristianstad hospital is a medium-sized hospital that provides elective and emergency care to the population in Kristianstad and surrounding municipalities. In Paper III, participating physicians worked at the hospital in Kristianstad and the smaller, local, hospital in Hässleholm.

Division of Swedish healthcare

In Sweden, the regions are responsible for primary and hospital care whereas nursing care, in nursing homes or the home setting, is provided by the municipality in collaboration with physicians from primary care. Hospital, primary, and municipal care are expected to collaborate when it comes to planning patient care after discharge from hospital (68).

Information transfer in transitions of care

In Skåne county the hospitals, primary care units, and municipalities all have separate electronic medical records, which can complicate information transfer in transitions of care. To ensure that the medication list is correct upon admission to hospital the attending physician should perform medication reconciliation and update the medication list in the hospital's electronic medical record (52). Clinical pharmacists are available to help if needed. Clinical pharmacists can also perform medication reviews during the hospital stay, primarily focusing on patients 75 years and older using five medications or more (52, 69).

On the day of discharge from hospital a discharge summary, including a medication list and a medication report summarising medication changes during the hospital stay, should be compiled and printed from the electronic medical record. The discharge summary should be handed to, and reviewed with, the patient at discharge. It should also be sent, by post, to the general practitioner in primary care (52) where it should be scanned to their electronic medical record. The medical case history - a more detailed document on the hospital stay - should also be sent to the next caregiver, accompanied

by a referral if follow-up is needed. Finally, the municipal care nurse should get a copy of the discharge summary and medical case history, when applicable.

Identifying risk factors for all-cause readmission (Paper I)

The first step towards understanding the underlying causes and risk factors for readmission to hospital within 30 days of discharge was to identify individual and organisational risk factors for all-cause readmission.

Participants

Data were retrospectively retrieved from the electronic medical records of 720 randomly selected older adults (≥65 years) admitted to the hospital in Kristianstad for at least 24 hours in 2017. Patients were admitted to one of the following departments: Internal medicine, General surgery, Infectious disease, Orthopaedics, Gynaecology, or Ear/Nose/Throat. Following discharge, the patients in the study group (n=360) were readmitted within 30 days while the patients in the comparison group (n=360) were not.

Patients could only occur once in the study, either in the study group or in the comparison group. If patients had multiple unplanned 30-day readmissions only the first was included. Patients were excluded if the readmission was planned, the patient died during the initial hospital stay, the patient was readmitted on the same day as being discharged, or if the patient went home against medical advice.

Procedure

A series of variables were collected aiming to cover the whole chain of events, from patient characteristics prior to and events during the initial hospital stay to factors concerning the processes of discharge, transition of care, and follow-up. These events are depicted in Figure 3.

Statistical analysis

Descriptive statistics for each collected variable were calculated and compared between the study group and the comparison group. An unpaired Student's *t*-test was used for

comparison of continuous data while categorical data were compared between groups using a χ^2-test or Fisher's exact test.

To identify variables independently associated with 30-day readmission a multiple logistic regression analysis (manual backward), controlled for the variables gender, age, and type of admission, was conducted. The variable with the highest p-value was withdrawn in each step of the analysis until all remaining variables had a p-value of < 0.05. To check the models' calibration a Hosmer and Lemeshow goodness-of-fit test (70) and Nagelkerke R^2 were used.

Data were analysed using IBM SPSS version 26. A significance level (α) of 0.05 was used. The analyses used are listed in Table 1.

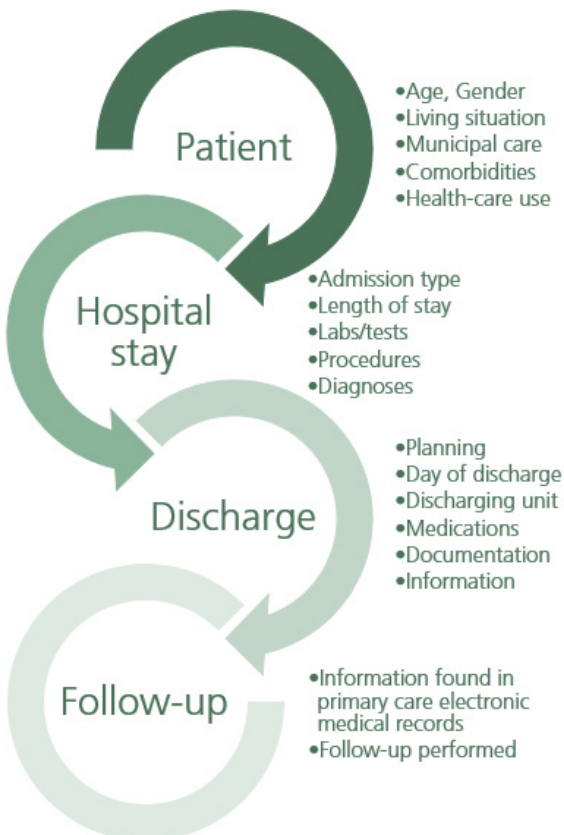


Figure 3. The chain of events covered in the data collection included patient characteristics prior to and events during the initial hospital stay as well as factors concerning the processes of discharge, transition of care, and follow-up.

Identifying risk factors for medication-related readmission (Paper II)

The next step was to assess the proportion of possibly medication-related readmissions within 30 days of discharge and to identify risk factors for such readmissions.

Participants

Data collected in Paper I were used for further analyses.

Procedure

Proportion of possibly medication-related readmissions

Readmissions were assessed as possibly or unlikely to be medication-related using the Assessment Tool for identifying Hospital Admissions Related to Medications (AT-HARM10) (2). This assessment tool, developed within the Medication Reviews Bridging Healthcare (MedBridge) trial (71, 72), can be used to identify (re-)admissions where a medication-related problem is either the main cause of admission or a significantly contributing factor.

The tool was developed to be used by two final-year undergraduate and postgraduate pharmacy students (2) while our assessments were made by an experienced clinical pharmacist (MG) after which they were reviewed and finalised by an experienced geriatrician (AKE). For more information about AT-HARM10 (2), see Appendix 1.

Risk factors for possibly medication-related readmission

The variables chosen to be included in the analysis were those previously known, according to research and/or clinical experience, to play a role in possibly medication-related readmission.

Hence, factors of primary interest were the following: potentially inappropriate medication therapy, polypharmacy, living arrangements prior to index admission, dependency on municipal care prior to index admission, and changes made to medication regimens at initial discharge. Potentially inappropriate medication therapy was defined as the use of PIMs, FRIDs, and/or the use of three or more psychoactive drugs according to the Swedish indicators of good medication therapy in the elderly (38).

Statistical analysis

Descriptive statistics were calculated for each variable and compared between groups. Comparisons were made between possibly medication-related readmissions and the comparison group as well as between unlikely medication-related readmissions and the comparison group. Possibly medication-related readmissions were further analysed, within the group, to compare variables related to living arrangements between sub-groups. Comparisons of continuous data were performed using an unpaired Student's *t*-test while categorical data were compared between groups using a χ^2-test or Fisher's exact test.

Two multiple logistic regression analyses (manual backward) were conducted in order to identify variables individually associated with possibly, and unlikely, medication-related readmissions, as compared to the comparison group.

Data were analysed using IBM SPSS version 26. A significance level (α) of 0.05 was used. The analyses used are listed in Table 1.

Identifying obstacles in the discharging process (Paper III)

To gain insight into how to, possibly, prevent readmission, the aim of this qualitative study was to explore the experiences and perceptions of hospital physicians regarding the discharging process, focusing on documentation and information transfer regarding medications and medication changes.

Participants

Intern and resident physicians from internal medicine departments at the hospitals in Kristianstad (Hospital 1) and Hässleholm (Hospital 2) were informed about the study and three focus groups were formed from those interested and available.

The first focus group (FG 1) included participants from Hospital 1 whereas participants from Hospital 2 were recruited to the second and third focus groups (FG 2 and FG 3).

The goal was to form focus groups with a mix of male and female interns and resident physicians. Furthermore, participants were to be familiar with each other and comfortable with sharing their experiences and perceptions in their group. The final distribution of participants is shown in Table 2.

Table 2
Distribution of participants in the focus group discussions (Paper III)

Focus Group	Hospital	Number of Participants	Number of Interns	Number of Residents
FG 1	1	4		2 male, 2 female
FG 2	2	5	1 male, 2 female	2 female
FG 3	2	6	2 male, 2 female	2 female

Procedure

Data were collected through focus group discussions that took place in the autumn of 2020. The first focus group discussion, which took place at the hospital in Kristianstad (Hospital 1), was held in a meeting room conveniently located for all participants. Unfortunately, due to the Covid-19 pandemic, the second and third focus group discussions had to be held as digital conferences with the participants at the hospital in Hässleholm (Hospital 2). All discussions were audio recorded and they lasted between 60-90 minutes.

To facilitate the discussions and maintain consistency a semi-structured interview guide in Swedish was used (Appendix 2). The interview guide was based on previous knowledge of problems in the discharging process and helped make sure that relevant issues were discussed. It included general areas of interest as well as specific points and probes to bring up as needed.

The focus group discussions started with the trigger question:

> Studies show that primary care physicians do not always trust the information in the discharge summary, especially the medication list. What are your perceptions of the discharging process in general and the documentation of medications and medication changes in particular? What are the obstacles and opportunities as you see it?

Qualitative content analysis

Focus group discussions were audio recorded, transcribed verbatim, and subjected to qualitative content analysis according to Malterud (73). The analysis started directly after finishing the first focus group discussion and was performed in several steps.

The first step included reading through the transcribed material and making sure it was accurate and reflected the totality of the discussions. The text was then read several times to get a sense of the whole. Subsequently, preliminary themes were identified and validated through an iterative process of reading, discussing, and rereading the material.

Self-standing meaning units related to the aim of the study were identified, coded, and organised into sub-categories and categories. Exemplar quotes illustrating each category were chosen. Finally, a theme covering the essence of the findings was defined and a confirmatory analysis was performed.

The analytical process is exemplified in Table 3.

Table 3
Examples of the analytical process in Paper IV

Meaning unit	Sub-category	Category
…and then it's just that we don't have the same medical record as primary care, so we don't know why the patient is prescribed ramipril instead of something else. (FG 1)	IT-systems	Infrastructure
…you want to do it right when you have the time and possibility, of course, but when the pressure is on, even if we know that we are supposed to do certain things, deviations increase as the pressure is rising. (FG 1)	Routines and work organisation	

Development and validation of a risk assessment tool (Paper IV)

The next step in the process was to use the knowledge gained in Papers I, II, and III to develop a risk assessment tool that aimed to identify older adults at increased risk of medication-related readmission within 30 days of discharge.

Participants

The risk assessment tool was developed using data collected in Paper I and external validation was performed using data from the Medication Reviews Bridging Healthcare (MedBridge) trial (71, 72).

MedBridge was a randomised clinical trial aiming to study the effects of hospital-based medication reviews, with or without post-discharge follow-up, compared to usual care, in older adults (≥65 years). The focus was the use of healthcare resources after discharge and outcomes measured included readmission to hospital within 30 days of discharge

and possibly medication-related readmission as assessed with AT-HARM10 (2). The trial was conducted at four hospitals (Uppsala, Gävle, Västerås, and Enköping) in the mid-eastern part of Sweden.

Included in the trial were participants admitted to a medical ward at one of the four hospitals, for at least 24 hours in 2017-2018. A total of 2637 patients were included of which 1745 were included in one of the two medication review groups and 892 in the group receiving usual care.

To make sure that the interventions studied in the MedBridge trial would not affect the result of the validation, only the 892 patients receiving usual care were used to validate the risk assessment tool. In this validation cohort (n=892), a total of 132 patients were readmitted within 30 days of discharge and 54 (41%) of these readmissions were assessed as being possibly medication-related.

Procedure

The results of Paper III suggested that to improve information transfer regarding medication and medication changes at discharge, interventions need to be implemented during the hospital stay as well as at discharge and in transitions of care. Hence, only variables known already at admission could be included in the risk assessment tool.

Variables included in the final model were chosen by comparing patients with a possibly medication-related readmission and those that were not readmitted or had a readmission unlikely to be related to medications. To control the predictive ability, precision, and usefulness of the risk assessment tool it was externally validated using data from the MedBridge trial (71, 72).

Statistical analysis

Data were analysed using IBM SPSS version 27. A significance level (α) of 0.05 was used. The analyses used are listed in Table 1.

Development of the risk assessment tool

A suitable scoring in the risk assessment tool was decided upon using the result of a multiple logistic regression analysis where patients with a possibly medication-related readmission were compared to those that were not readmitted or had a readmission unlikely to be related to medications.

The risk score was subsequently calculated for the development cohort and a new multiple logistic regression analysis was performed with possibly medication-related

readmission as the dependent variable and the risk score as the test variable. The quality of the model was estimated using the Hosmer and Lemeshow goodness-of-fit test and Negelkerke R^2. Using the saved probabilities from this logistic regression analysis, a receiver operating characteristics (ROC) curve was plotted and the area under the ROC-curve (c-index) was calculated, which gave a measure of the tools' predictive ability, i.e., how well the tool predicts medication-related readmission.

Youden's index was used to decide upon a suitable threshold score after which sensitivity, specificity, positive and negative predictive value, and the number of correctly predicted patients were calculated using cross-tabulation.

Validation of the risk assessment tool

A multiple logistic regression analysis, with the variables included in the risk assessment tool, was performed in the validation cohort as well, by comparing patients with a possibly medication-related readmission with those that were not readmitted and those with a readmission that was unlikely to be medication-related.

The risk score was calculated within the validation cohort and a new logistic regression analysis, with possibly medication-related readmission as the dependent variable and the risk score as the test variable, was performed. The Hosmer and Lemeshow goodness-of-fit test was performed and Negelkerke R^2 was calculated after which a ROC-curve was plotted, and a c-index was calculated. Cross-tabulation was used to calculate sensitivity, specificity, positive and negative predictive value, and the number of correctly predicted patients in the validation cohort.

Ethical considerations

Papers I and II

The studies were approved by the Regional Ethical Review Board in Lund and administrative permission to access data from medical records was acquired from Skåne county. Prospective participants were informed about the study via an ad in a newspaper covering the geographical area of the study population (Appendix 3). The ad explained the aim and approach of the study and included contact information of the first author, encouraging prospective participants to make contact if they did not want to participate or had further questions about the study.

There was no contact made from prospective participants and it could perhaps be argued that the ad was not visible enough or that older adults might not comprehend the information given. However, the study did not include any intervention and the participants were not in any danger of physical or psychological harm if included. Furthermore, their integrity was assured by the anonymisation and secure storing of data throughout and after the study.

Paper III

Ethical approval was applied for from the Swedish Ethical Review Authority, but they assessed that ethical approval was not required since the study did not include any intervention covered in the Swedish Ethical Review Act. The advisory remark from the Swedish Ethical Review Authority stated that there were no ethical objections to the study.

Even so, to ensure that participants were fully aware of what their participation entailed, they were asked to read an information letter describing these things (Appendix 4). Informed consent, including consent for publication, was obtained from all participants. After the data transcription, the recordings were deleted. Hence, the data used for analysis cannot be linked to individual participants nor can individual participants be identified by reading the material.

Paper IV

No further data were collected in this study and no interventions were made. Only anonymised data from studies previously approved by the Swedish Ethical Review Authority or by a Regional Ethical Review Board was used, thus indicating that there would be no risk for the included participants. Even so, ethical approval was applied for and approved by the Swedish Ethical Review Authority.

Results

Identifying risk factors for all-cause readmission (Paper I)

Patient characteristics related to readmission

Patients readmitted within 30 days of discharge were of poorer health overall, prior to index admission. They had a higher degree of healthcare utilisation (2.0±1.3 hospitalisations within 12 months prior to index admission vs 1.4±1.0, p-value <0.001), and a higher Charlson Comorbidity Index score (8±3 vs 6±3, p-value <0.001). Further, readmitted patients were, to a greater extent, living in their own home alone (44% vs 36%, p-value 0.028) and/or depending on home care (33% vs 16%, p-value <0.001).

Patients readmitted within 30 days of discharge used a significantly larger number of medications (11±5.3 vs 9.0±4.9, p-value <0.001). This included the use of FRIDs (3.6±2.1 vs 3.2±2.2, p-value 0.014) and some medications known to cause adverse drug events, e.g., diuretics (52% vs 41%, p-value 0.002) and anticoagulants (34% vs 27%, p-value 0.023). In addition, several comorbidities were more common in readmitted patients, such as chronic ischaemic heart disease (34% vs 24%, p-value 0.007) and chronic obstructive pulmonary disease (26% vs 13%, p-value <0.001).

Variables related to the initial hospital stay and discharge

The proportion of patients with a length of stay five days or longer was higher in the study group (66% vs 53%, p-value <0.001), and readmitted patients were in greater need of care planning before discharge than those not readmitted (29% vs 21%, p-value 0.017). There was also an increased risk of readmission if discharged on a Friday (27% vs 19%, p-value 0.012) or from the general surgery department (28% vs 21%, p-value 0.046).

Further, it was more common in patients readmitted to have had medications withdrawn (31% vs 23%, p-value 0.024) or dosages adjusted (34% vs 24%, p-value 0.003) at discharge. Only about 50% of these changes were documented in the

discharge summary or medical case history, with a slight, yet insignificant, indication towards poorer documentation in patients subsequently readmitted.

Variables individually associated with all-cause readmission

The final logistic regression model (Table 4) showed increased odds of readmission in patients of poor health, using 10 medications or more, and living in their own home with home care. The odds of 30-day readmission also increased if the length of the initial hospital stay was five days or longer and if the patient was discharged on a Friday or from the general surgery department.

Table 4
Final logistic regression model showing variables individually associated with all-cause readmission to hospital within 30 days of discharge, in older adults[a]

Variable	OR	95% CI	*p*-value
Gender	0.89	0.63-1.25	0.500
Emergency admission	1.43	0.73-2.77	0.297
Charlson Comorbidity Index score	1.12	1.04-1.20	**0.002**
Number of hospitalisations, 12 months	1.41	1.19-1.68	**<0.001**
Length of stay 5 days or longer	1.72	1.18-2.49	**0.005**
Day of discharge (reference: Monday-Thursday)			**0.007**
Friday/Day before weekend/public holiday	1.88	1.24-2.87	**0.003**
Weekend/Public holiday	0.83	0.44-1.54	0.551
Discharging unit (reference: Internal medicine)			**0.004**
General surgery	2.09	1.34-3.24	**0.001**
Infection	0.54	0.26-1.13	0.101
Orthopaedics	1.02	0.53-1.96	0.949
Gynaecology/Ear Nose Throat	1.47	0.55-3.93	0.442
Living in own home with home care	1.61	1.06-2.45	**0.025**
Excessive polypharmacy[b]	1.66	1.15-2.40	**0.007**
Major surgery performed during initial hospital stay	0.59	0.37-0.94	**0.027**

Abbreviations: CI – Confidence Interval. [a]Adjusted for gender, type of admission and age (within the age-adjusted Charlson Comorbidity Index score), [b]Defined as the daily use of 10 medications or more. Hosmer Lemeshow goodness of fit test p-value: 0.457. Nagelkerke R2: 0.228. Significant p-values are indicated in bold.

Identifying risk factors for medication-related readmission (Paper II)

Possibly medication-related readmission

Readmissions were assessed as possibly medication-related in 40% of the cases (143 of 360). In 43% of these readmissions (n=61) there was also an implication of this relation in the electronic medical record. Such notes were most common in patients discharged from, and readmitted to, departments of internal medicine.

The final logistic regression model (Table 5) showed that the odds of possibly medication-related readmission increased with an increase in Charlson Comorbidity Index score and the number of hospitalisations within 12 months prior to the index admission. Furthermore, patients living in their own home, alone, were at increased risk of possibly medication-related readmission as were patients with dosage adjustments made at initial discharge and those with an emergency admission at the initial hospital stay.

Table 5
Final logistic regression model showing variables individually associated with possibly medication-related readmission to hospital within 30 days of discharge, in older adults[a]

Variable	OR	95% CI	*p*-value
Gender	0.88	0.57-1.36	0.568
Emergency admission	5.13	1.70-15.43	**0.004**
Charlson Comorbidity Index score	1.15	1.05-1.25	**0.002**
Number of hospitalisations, 12 months	1.33	1.10-1.61	**0.003**
Excessive polypharmacy[b]	1.74	1.07-2.81	**0.024**
New medications started	0.54	0.33-0.88	**0.014**
Dosages adjusted	1.63	1.03-2.58	**0.038**
Living arrangements (reference: Own home, alone)			**0.025**
Own home, with spouse/other	0.59	0.37-0.94	**0.025**
Nursing home	0.45	0.21-0.95	**0.037**

Abbreviations: OR – Odds Ratio, CI – Confidence Interval. [a]Adjusted for gender, type of admission and age (within the age-adjusted Charlson Comorbidity Index score) [b]Defined as a regular intake of 10 medications or more. Hosmer Lemeshow goodness of fit test p-value: 0.565. Nagelkerke R2: 0.204. Significant p-values are indicated in bold.

Unlikely medication-related readmission

Patients with a readmission unlikely related to medications were also of poor health with, compared to patients not readmitted, a higher Charlson Comorbidity Index score and a higher number of hospitalisations in the past 12 months prior to index admission.

Further, the odds of unlikely medication-related readmission increased if the length of stay was five days or longer and if discharge occurred on a Friday or from the general surgery department.

Living arrangements

Patients living in their own home, alone, had an almost 70% increased risk of possibly medication-related readmission as compared to living with someone (OR 1.69, p-value 0.025). Compared to living in a nursing home the risk of possibly medication-related readmission was more than doubled if living alone (OR 2.22, p-value 0.037).

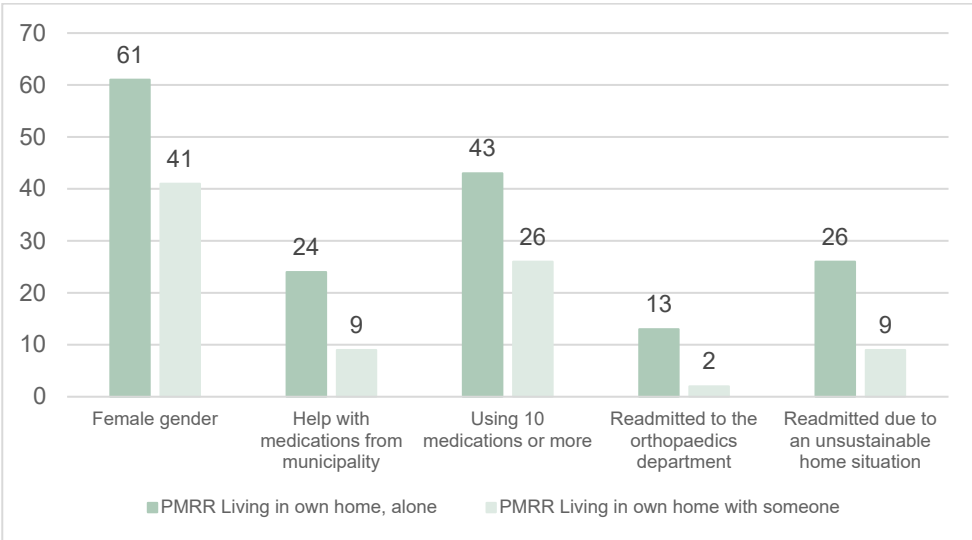


Figure 4. Differences between patients with a possibly medication-related readmission (PMRR) living in their own home alone and those living in their own home with someone.

As shown in Figure 4 patients with a possibly medication-related readmission who lived alone were, to a larger extent than those living with someone, women, dependent on help with medications from the municipality, and/or using 10 medications or more. Furthermore, patients living alone waited longer before readmission occurred (13±9 days as compared to 9±8 days, p-value 0.006) and it was more common that they were readmitted to the orthopaedics department or due to an unsustainable home situation.

Identifying obstacles in the discharging process (Paper III)

The qualitative content analysis of the focus group discussions yielded three categories with two sub-categories each, as depicted in Figure 5.

Based on these categories a theme emerged aiming to encompass how physicians do their best despite difficult conditions but, in the end, are humble to the fact that they are only human.

Figure 5. Three categories with two subcategories each were identified. A central theme aims to encompass how physicians do their best despite difficult conditions but find, in the end, that they are only human.

Obstacles identified

The physicians identified several obstacles in documenting and transferring information regarding medications at discharge as seen in Table 6. Some of these are harder for the individual to affect while some show opportunities for change.

One of the major problems identified by the participants was performing a medication reconciliation and updating the medication list at admission. The task of achieving an updated medication list was affected by several of the obstacles identified by the participants and listed in Table 6. The participating physicians expressed concern that this could lead to medication-related problems during, as well as after, the hospital stay.

The fact that hospital and primary care have different electronic medical records may be considered the biggest problem but adding to it is, among other things, a lack of time and continuity as well as a lack of routines and knowledge.

Further, some physicians tend to not take responsibility for the medication list, and they do not always follow routines, even if they are established.

Finally, even if physicians had all the time in the world, there is still the patient that is ill and has a hard time providing information on the medications used. Sometimes they do not want to reveal what medications they do or do not take, making it even harder to get straight answers.

Table 6
Categories, sub-categories and individual obstacles identified in the qualitative content analysis (Paper III)

Category	Sub-category	Obstacle
Infrastructure	IT-systems	Electronic medical records are different in hospital-, primary-, and municipal care
		IT-systems are complicated, time-consuming and user-unfriendly
		There is often a lack of functioning equipment
	Work organisation and routines	Time is often scarce leading to medication reconciliation being down prioritised and discharges being rushed
		There is a lack of doctor continuity making daily tasks even more time-consuming
		Routines regarding documentation and information transfer are not always in place and/or followed leading to a lack in information continuity
Physician	Knowledge and education	Education is not prioritised, especially in more experienced physicians
		Some physicians lack interest in learning the systems used
	Understanding and responsibility	Some physicians do not understand the consequences of not following routines
		Some physicians do not take responsibility regarding the medication list or documentation and information transfer regarding medications
Patient/Next of kin	Providing information	Patients cannot always provide the information needed due to not remembering, feeling ill, stressed, and/or having low cognitive margins
		Some patients do not want to admit to bad compliance or do not want to bother the staff even if they get the wrong medication while in the hospital
		Next of kin is not always available to ask or help
	Understanding information	Patients can have a hard time understanding the information given at discharge, especially if physicians use medical jargon or if the patients have other things on their mind
		Next of kin is not always available to help
		There is a limit to what the discharging physician can do to clarify the discharge summary, medication report, and medication list

Opportunities lifted

An electronic medical record, which is common for hospital and primary care, is under development in Skåne county. This was considered a good thing by the participating physicians who expressed hope that this will help in medication reconciliation as well as in the transfer of information in transitions of care.

Regardless of whether the IT-systems used are complicated or user-unfriendly or not, some of the problems identified regarding documentation and information transfer could, according to the participants, benefit from improving physicians' education in the systems used. Furthermore, participants believed that improving physicians' insight regarding the situation and routines of the next caregiver could help with understanding the consequences of not following routines or not taking responsibility regarding the medication list.

In some wards clinical pharmacists help with medication reconciliation. This was greatly appreciated by the participating physicians who expressed hope for this service to spread to other wards as well as to the emergency department.

Development and validation of a risk assessment tool (Paper IV)

Development of the risk assessment tool

The final multiple logistic regression model, as shown in Table 7, included variables known at admission and individually associated with possibly medication-related readmission within 30 days of discharge. Based on the odds ratios in the final model, points were assigned to each of the included variables. Hence, *Emergency admission* was assigned two points and the other four variables were assigned one point each.

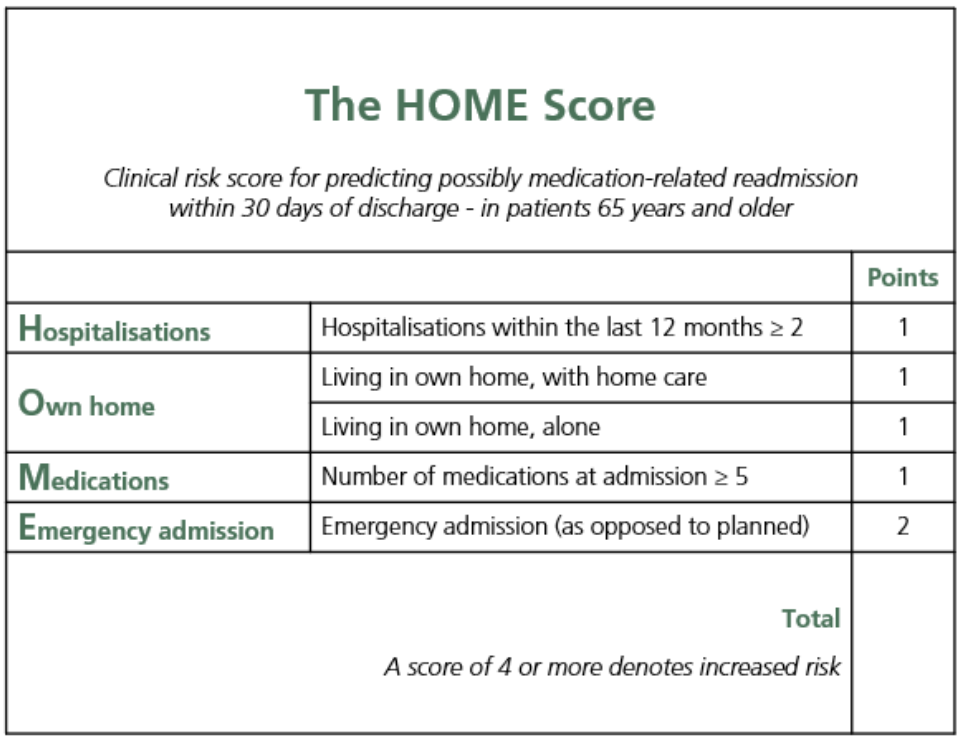
The resulting risk assessment tool, or risk score, was named the Hospitalisations, Own home, Medications, and Emergency admission (HOME) Score (Figure 6). Youden's index was calculated for each step in the risk score and a score of ≥4 was found to be a suitable threshold value.

At the threshold score sensitivity was 76%, specificity 54%, positive predictive value 29%, negative predictive value 90% and the number of correctly predicted patients was 108 (out of 143). The calculated c-index of the risk score was 0.69 (95% CI 0.64-0.74).

Table 7
Final multiple logistic regression model from the development dataset with possibly medication-related readmission within 30 days of discharge as the outcome variable[a]

Variable	OR	95% CI	p-value
Age	1.00	0.98-1.03	0.927
Gender	1.01	0.68-1.49	0.969
Emergency admission	3.98	1.40-11.33	**0.010**
Hospitalisations in the last 12 months ≥2	1.54	1.04-2.28	**0.032**
Medications at admission ≥5	2.20	1.27-3.80	**0.005**
Living in own home, with home care	1.85	1.18-2.91	**0.008**
Living in own home, alone	1.57	1.04-2.37	**0.030**

Abbreviations: OR – Odds Ratio, CI – Confidence Interval. [a]Adjusted for gender and age. Hosmer Lemeshow goodness of fit test p-value: 0.369. Nagelkerke R^2: 0.113. Significant p-values are indicated in bold.



The HOME Score

Clinical risk score for predicting possibly medication-related readmission within 30 days of discharge - in patients 65 years and older

		Points
Hospitalisations	Hospitalisations within the last 12 months ≥ 2	1
Own home	Living in own home, with home care	1
	Living in own home, alone	1
Medications	Number of medications at admission ≥ 5	1
Emergency admission	Emergency admission (as opposed to planned)	2
	Total	
	A score of 4 or more denotes increased risk	

Figure 6. The HOME Score - to be used at admission to hospital in order to identify older adults (≥65) at increased risk of medication-related readmission within 30 days of discharge. Hospitalisations within the last 12 months and living in own home, alone or with home care, refer to events and conditions prior to the admission in question.

Validation of the risk assessment tool

In the validation cohort, the model remained predictive of possibly medication-related readmission with a c-index of 0.65 (CI95% 0.57-0.72, p-value < 0.001) and good calibration. At the threshold score (≥4 points) sensitivity was 63%, specificity 51%, positive predictive value 8%, and negative predictive value 96% (Table 8). The number of correctly predicted patients was 34 (out of 54).

Table 8
Diagnostic testing of the Hospitalisations, Own home, Medications, and Emergency admission (HOME) Score

	Development cohort	Validation cohort
Sample size	720	892
Readmission within 30 days of discharge (%)	350 (50)	132 (15)
Possibly medication-related readmission (%)	143 (40)	54 (41)
Unlikely medication-related readmission (%)	217 (60)	78 (59)
Area under the ROC-curve (standard error)	0.69 (0.02)	0.65 (0.04)
95% confidence interval	0.64-0.74	0.57-0.72
At HOME Score ≥ 4 points		
Sensitivity, %	76	63
Specificity, %	54	51
Positive predictive value, %	29	8
Negative predictive value, %	90	96

Abbreviation: ROC – Receiver Operator Characteristic

Summary of results

Underlying causes and risk factors for readmission

To summarise the results of Papers I and II (Figure 7) it can be said that older adults of poor health, including multiple comorbidities, frequent healthcare use, and the use of many medications, were at increased risk of readmission to hospital within 30 days of discharge. Risk of readmission was further increased in patients living in their own home alone and/or with home care.

Additionally, the risk of possibly medication-related readmission was increased if the index admission was an emergency admission and if dosages were adjusted at initial discharge.

Further, the risk of unlikely medication-related readmission was increased if the length of stay at index admission was five days or longer and if the patient was discharged on a Friday or from the general surgery department.

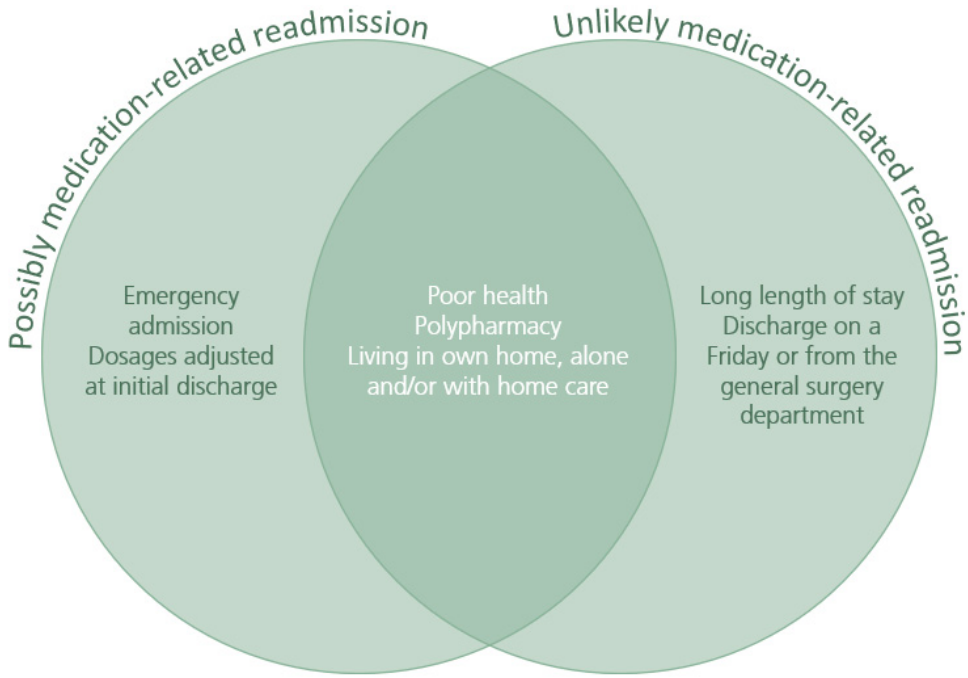


Figure 7. Summary of risk factors for readmission to hospital within 30 days of discharge, in older adults. Risks are divided into risk factors for possibly medication-related readmission, unlikely medication-related readmission, and those risk factors that are common to both types of readmission. Poor health includes having a higher Charlson Comorbidity Index score and a higher number of hospitalisations within 12 months prior to index admission. Polypharmacy is defined as the use of 10 medications or more.

Insights into how to prevent readmission

According to the physicians in Paper III activities aiming to improve the documentation and transfer of information regarding medications and medication changes are needed. These activities should aim to improve information continuity and medication use during the hospital stay as well as in transitions of care. To do so it is important that routines are in place and followed and that physicians are educated in and comfortable with the systems used. Involving clinical pharmacists and collaborating across disciplines could help with these activities.

The HOME score, developed in Paper IV can be used, upon admission to hospital, to identify older adults at increased risk of medication-related readmission. In doing so activities aiming to improve medication use and transitions of care may be implemented where they are most needed, and the risk of readmission may decrease.

Discussion

The overall aim of this thesis was to gain a better understanding of the underlying causes and risk factors for unplanned readmissions to hospital within 30 days of discharge, in older adults, as well as to gain insight into how to prevent them.

This was done by identifying individual and organisational risk factors for readmission (Papers I and II) as well as by exploring the experiences and perceptions of hospital physicians regarding the discharging process, focusing on the documentation and transfer of information regarding medications and medication changes in transitions of care (Paper III). Combining the knowledge gained in the first three studies the Hospitalisations, Own home, Medications, and Emergency admission (HOME) Score was developed, aiming to identify older adults at increased risk of medication-related readmission within 30 days of discharge.

The goal is to use the results of this thesis to implement interventions aiming to improve the care of older adults and, hopefully, reduce the frequency of readmission to hospital within 30 days of discharge, in this population.

Improving the care of older adults

According to Kirkwood (74), biological ageing results from an accumulation of unrepaired cellular and molecular damage caused by different life stressors. As these cellular deficits accumulate, the effects on the body, as a whole, are eventually revealed as health deficits that cause frailty, disability, and disease. Hence, when getting older, the risk of health deterioration and multimorbidity increases.

Multimorbidity, in turn, leads to increased healthcare consumption (25, 26), longer hospital stays (26), and an increased risk of readmission (27), which is in agreement with the results of Papers I and II. This increased disease burden in readmitted patients is further backed by the results of Zheng et al (75) showing that readmitted patients carry an approximately 50% higher one-year cost prior to index admission than those not readmitted. Furthermore, Naseer et al have shown that several variables indicating disease burden are associated with emergency department visits in older adults (76) and

that prior healthcare use, in older adults, is associated with emergency department revisits within 30 days (77). Prior healthcare use is also included as a risk factor in several risk assessment tools aiming to identify risk of all-cause readmission, e.g., the HOSPITAL Score (17) and the LACE Index (14).

Creating continuity in care transitions

In multimorbid older adults, it can be difficult to determine which illness is causing the specific problems at hand. The different illnesses influence each other and so do the different medications used to treat them (78). Polypharmacy is common (30-32) and, as shown in Papers I, II, and IV, as well as in several previous studies (1, 16, 34, 67), it increases the risk of readmission to hospital within 30 days of discharge.

To meet the complex needs of older adults with multimorbidity, and achieve safe and effective healthcare, it is important to integrate care across disciplines and to work together in teams to create continuity of care (19, 45, 78, 79). With such a holistic approach, many patients would feel better and the need for repeated, unplanned readmission could be minimised (78).

Improving medication use

To include a clinical pharmacist in the interdisciplinary team has been shown to contribute to a reduction in readmission rate, especially when it comes to readmissions related to medications (80-82). As mentioned by the physicians in Paper III, and previously shown (19, 51, 52), a clinical pharmacist can help improve medication use through medication reconciliation and medication review. Clinical pharmacists can also help improve transitions of care by providing information on medications at discharge (83), or performing follow-up after discharge (84). Such activities could, perhaps, decrease the risk of medication-related readmission following dosage adjustments at initial discharge, which was identified as a risk factor in Paper II.

Unfortunately, in the Medication Reviews Bridging Healthcare trial (MedBridge) (71) the clinical pharmacist intervention did not show an effect on readmission or possibly medication-related readmission. This could, however, be the result of not specifically targeting patients in most need of medication review and follow-up (85).

In Papers I and II we showed that polypharmacy is a risk factor for readmission and Naseer et al (76) have shown that polypharmacy is also a risk factor for seeking emergency care in the first place. Furthermore, it has been previously shown that polypharmacy is more common in multimorbid older adults living in their own home with home care (86), and that receiving home care is more common if living alone (49).

All these variables are included in the HOME Score developed in Paper IV. Hence, further studies, preferably using the HOME Score to identify patients at increased risk of medication-related readmission before implementing preventive measures, are needed.

Ensuring information continuity

Reconciling the medication list is important in multimorbid older adults using many medications. Such medication reconciliations should be performed upon admission to hospital according to Swedish regulations (51) but, as indicated by the physicians in Paper III, it is often hard to find the information needed and time is often scarce in the emergency room. Hence, medication reconciliation may need to continue in the ward, and, again, be updated at discharge (83).

However, since time is similarly scarce in the ward, as well as at discharge, it is important to make sure that routines aiming to ensure information continuity throughout the hospital stay are in place and followed by all, as indicated by the physicians in Paper III. If there was information continuity regarding medications and medication changes from admission to discharge, the risk of discrepancies after discharge would probably decrease. Unfortunately, according to the physicians in Paper III, such information continuity is not always in place. This observation is further supported by the results of Caleres et al (41, 42, 44), indicating patient safety issues due to the insufficient transfer and suboptimal quality of discharge summaries in Skåne county.

As shown by Caleres et al (42), general practitioners in Skåne county also report a lack of time and a need to down-prioritise updating the medication lists in the primary care electronic medical records, thus forming a vicious circle of suboptimal medication lists. The general practitioners indicated, similarly to the physicians in Paper III, that a common electronic medical record would help improve information transfer in care transitions (42), something that needs to be further investigated when such an electronic medical record is in place.

Improving the discharging process

Previously, van Galen et al (87, 88) have studied the opinions of readmitted patients, their carers, nurses, and physicians on the predictability and preventability of readmissions to hospital. They concluded that the majority of those interviewed deemed readmissions to be more predictable and preventable when patients had not felt ready to be discharged; an observation supported by the results of Auerbach et al (45). Further, the root cause of predictable readmissions was often healthcare worker

related, such as poor communication, not enough information given at discharge, and not making sure the patient had enough help after discharge (88). This observation is further supported by the results of a Swedish study by Ekdahl et al (89) where the views of patients and medical staff regarding the discharging process were investigated. In this study, healthcare workers expressed a constant lack of time and a need to discharge patients in order to free beds for incoming patients, even though many patients were not ready for discharge.

We showed, in Paper II, that the risk of readmission unlikely to be related to medications, e.g., due to an infection, surgical complication, or trauma, was increased if being discharged after a long hospital stay, on a Friday, or from the general surgery department (apart from being of poor health, using multiple medications, and living in the community alone and/or with home care). These results are supported by the physicians interviewed by van Galen et al (88), who assessed that predictable readmissions after being discharged from a surgical department were associated with a longer length of stay at index admission and that such readmissions were more preventable if the patient had been discharged on the weekend, or if C-reactive protein (CRP) had been elevated at discharge, among other factors.

It was not further investigated, in this thesis, which activities to implement in order to reduce the risk of unlikely medication-related readmissions. However, considering the above-mentioned results (45, 87-89), ensuring the absence of infection or other complications before discharging a patient after a long hospital stay would probably help, as would making sure that the patient is ready for discharge. Making sure the patient and the next caregiver are well informed could also help, as could planning discharge in collaboration with the municipality and primary care, as well as scheduling follow-up shortly after discharge (45). Further studies are needed to support these hypotheses.

Providing social support after discharge

Previous studies have, as we did in Papers I, II, and IV, identified living arrangements as risk factors for readmission. In the PRIME tool Parekh et al (16) identified living alone as a risk factor for medication-related harm needing healthcare within eight weeks of discharge, and Gruneir et al (48) have shown that the risk of readmission is increased if discharged to the community with home care. Similarly, it has been shown that older adults living in their own home with home care are at increased risk of emergency department revisits within 30 days (76), as well as of unplanned (emergency) admission to hospital (90). Further, SanFilippo et al (39) showed that patients with high-risk medications discharged to their own home have an 80% increased risk of readmission

within 30 days, and Olson et al (91) identified an increased risk of readmission in older men living in their own home with their adult children as caregivers. On this note, a considerable reduction in formal help has been taking place in Sweden over the years, predominately affecting women and those living alone (92).

All in all, living arrangements are an issue in older adults and, if aiming to prevent readmissions, hospital and municipal care must work together to identify the need for additional home care services or other municipal care activities before discharge (45). This collaboration between hospital and municipal care is regulated by law (68) and regional routines are in place in Skåne county (62). However, according to the participating physicians in Paper III, this collaboration needs to improve; an observation that is further supported by reports from other parts of Skåne county (93).

To evaluate the need for additional support, a comprehensive geriatric assessment tool, aiming to assess vulnerability and frailty, can be used (63, 64, 94). It should, however, be noted that the receipt of social support is not always positive as it can, in some cases, be associated with a drop in self-esteem or threat to one's autonomy and control (95). Receiving social support is more likely to be beneficial after individuals have, themselves, decided to seek support and are receptive to it. In this case the receipt of social support can instead lead to an increase in self-esteem and control as well as to healthier behaviours such as better compliance to medical regimens (95).

Hence, to avoid readmissions due to, for example, an unsustainable home situation (Paper II), the planning of discharge, as well as the evaluation of individual care needs after discharge, should include making sure that the older adult understands the situation at hand and their own limitations. To include older adults in such decision-making has, however, been shown to be hard, according to Swedish healthcare professionals (89). This, again, has been attributed to a lack of time and a need to free beds in the ward.

Conclusions and possible clinical implications

Individual and organisational risk factors for readmission to hospital within 30 days of discharge have been identified and a risk assessment tool, the HOME Score, aiming to identify older adults at increased risk of medication-related readmission has been developed.

Using the findings of this thesis to improve processes and implement preventive measures can help improve the care of older adults and, hopefully, decrease the risk of hospital readmission within 30 days of discharge in this population. This would be

beneficial to patient safety as well as the health economy. Further studies are needed to test these hypotheses.

Strengths and limitations

Papers I and II

Data used were collected from one hospital which limits the generalisability of the results. Also, the study sample was rather small (n=720) compared to many other studies looking at risk factors for readmission. This was, however, needed due to the design of the study where variables were collected from electronic medical records through manual review, which is rather time-consuming, especially considering the large number of variables collected.

The number of included patients in Paper I was determined based on the assumption that readmitted patients used a 10% larger amount of potentially inappropriate medication regimens (PIMs) than those not readmitted, which was later determined not to be the case. This could have affected the results, risking inadequate power, but seeing as the results are very similar to those of various other studies this is unlikely. In Paper II there was a similar limitation as this was a subgroup analysis.

The two groups examined were equal in size, hospital stays were evenly distributed over the year, patients were admitted to different departments, and patients did not occur more than once in the study, either in the study group or the comparison group. These factors all contributed to finding as many different risk factors as possible in the sample, which was a strength. However, the unblinded review of medical records and assessment of risk factors could, even though objectivity was sought, add to skewness.

There was a large number of variables collected and analysed in order to cover the whole chain of events from admission to follow-up as well as patient characteristics (Paper I). The data collection was structured, and standardised instruments were used, when possible, to increase robustness. Efforts were made to avoid problems of collinearity in the multiple logistic regression analyses but there is still a risk that they have affected the final result.

Paper III

The thoughts expressed in this study are those of the participating physicians. They are not generalisable per se but may be transferable to similar contexts and used to gain

insight into how to improve documentation and information transfer regarding medications in transitions of care.

Unfortunately, physicians from surgical specialities and the emergency department did not participate in the study, which is a limitation. Another limitation is that the second and third focus groups were conducted as digital conferences, due to Covid-19 restrictions, which may have been inhibiting for some of the participating physicians.

Trustworthiness was sought in several ways. Credibility was aspired by including physicians of different gender but with recent experience from working with admission and discharge, making them well suited to contribute to a rich material. The different perspectives and differing research backgrounds of the authors helped avoid preconceptions in the analysis process (investigator triangulation) and persistent observation was secured throughout the analysis process.

Paper IV

The HOME Score is, to our knowledge, the first risk assessment tool aiming to identify older adults at increased risk of medication-related readmission within 30 days of discharge. It solely includes variables available at admission thus making it possible to implement preventive measures during the hospital stay as well as at discharge and in transitions of care.

The HOME Score was developed using data from a single Swedish hospital and even though it was validated using data from four other hospitals in another part of Sweden, it needs to be further validated in order to establish its clinical usefulness in other hospitals, counties, and countries.

The study sample used when developing the HOME Score was tailored for the identification of risk factors for readmission, with 50% of the patients being readmitted within 30 days of discharge. In the validation cohort, the proportion of readmitted patients was 15%, which is closer to that reported in previous studies (5-7). This could, perhaps, be considered a weakness.

To assess whether 30-day readmissions were possibly or unlikely to be medication-related, the tool AT-HARM10 was used by clinical pharmacists in both the development and validation cohort. This tool has been validated (2) but the assessments are implicit, and results depend on the person conducting them, which could be considered a weakness. However, even though assessments were made within two different studies using data from different parts of Sweden, the amount of possibly medication-related readmissions was almost the same in the development and

validation cohort (40% in the development cohort and 41% in the validation cohort), which indicates that this may not be a big issue.

In general

A general strength of this thesis is that the studies are coherent. They follow up on each other, using the results of the previous study to design the next one (Figure 8).

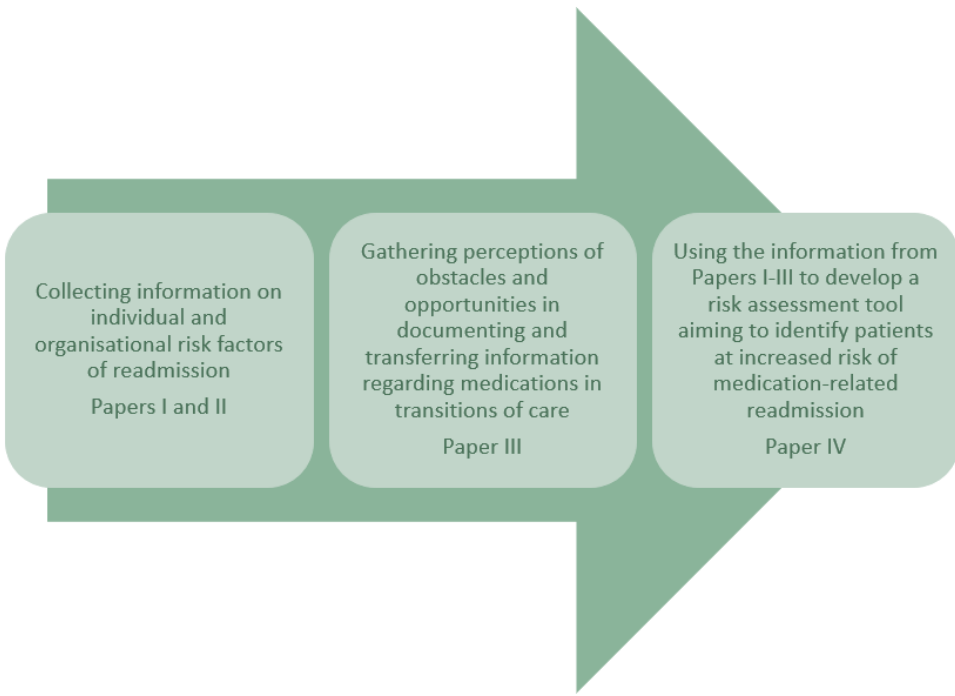


Figure 8. Showing how the studies included in this thesis form a straight line, from finding the underlying causes and risk factors for readmission to hospital within 30 days of discharge, including obstacles and opportunities in documenting and transferring information regarding medications in transitions of care, to finally developing a risk assessment tool aiming to identify older adults at increased risk of medication-related readmission to hospital within 30 days of discharge.

The next step would be to use the developed risk assessment tool - the HOME Score - to identify older adults at increased risk of medication-related readmission and implement suitable preventive measures, as theorised in the Discussion section. How this could be done is further discussed below.

Future research and practical suggestions

To test the risk assessment tool developed in Paper IV - the HOME Score - as well as the hypotheses put forward in the Discussion section, a randomised clinical trial (RCT) aiming to ensure information continuity and, preferably, including the inter- and transdisciplinary activities listed in Figure 9, would be of great value.

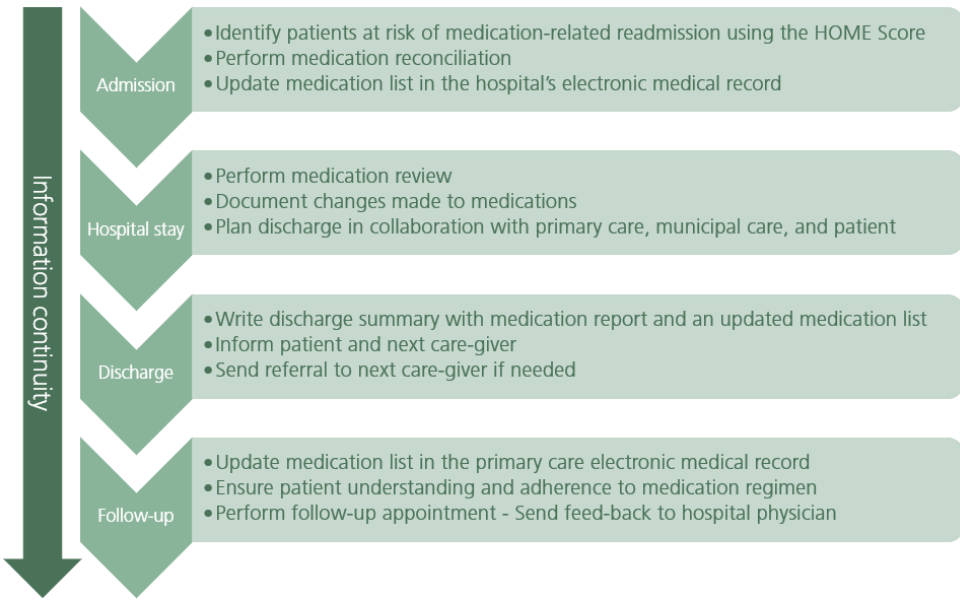


Figure 9. In order to prevent medication-related readmission information continuity in transitions of care need to improve. Further, medication use needs to improve, especially in patients identified as at increased risk. Including clinical pharmacists in patient care and collaborating across disciplines, with primary and municipal care, could help.

However, even if such an RCT was not to be performed, activities aiming to improve the care of multimorbid older adults and ensure information continuity regarding medications, still need to be implemented. To do so, hospital, primary, and municipal care need to find ways to improve collaboration as do different professions.

As indicated by the physicians in Paper III, an electronic medical record common for hospital and primary care could help improve information transfer in care transitions. This hypothesis needs to be further investigated when such an electronic medical record is in place in Skåne county.

User involvement

Older adults

Involving older adults in the work towards improving their care would be beneficial in order to make the activities, and/or the study, more relevant to them (96).

By involving older adults in planning and designing activities, as well as participating in them, their voices and needs of healthcare services can be taken into consideration which will, hopefully, help improve their future care.

Healthcare professionals

Involving healthcare professionals in the planning and design of activities and/or a study would be beneficial in order to choose interventions that are relevant, possible to implement, and that are sustainable over time (97).

Svensk sammanfattning

Bakgrund

Att bli återinlagd en kort tid efter utskrivning är vanligt hos äldre där ungefär 15-20 % av alla utskrivningar resulterar i en återinläggning inom 30 dagar. Att läggas in på sjukhus, vare sig det är en första inläggning eller en återinläggning, är riskfyllt, framför allt för äldre som riskerar att drabbas av sjukhusrelaterade komplikationer så som infektioner, konfusion och fallskador.

Forskning visar att en stor del av återinläggningar, och en än större del av läkemedelsrelaterade återinläggningar, kan undvikas. Med tanke på riskerna för patienter och kostnaderna för samhället har många länder, inklusive Sverige, som mål att minska frekvensen undvikbara återinläggningar inom 30 dagar. För att uppnå dessa mål, och sätta in förebyggande interventioner där de gör mest nytta, behövs en bättre förståelse för de underliggande orsakerna och riskerna bakom återinläggningar inom 30 dagar, liksom en inblick i vad som kan göras för att undvika dem.

Syftet med denna avhandling var att identifiera individuella och organisatoriska riskfaktorer för oplanerad återinläggning inom 30 dagar hos patienter 65 år och äldre, samt att utveckla ett riskanalysinstrument som kan användas för att identifiera äldre patienter med ökad risk för läkemedelsrelaterad återinläggning inom 30 dagar.

Metod och resultat

Delstudie I och II

I Delstudie I var syftet att identifiera patienter med störst risk för återinläggning samt processer i störst behov av förbättring. Variabler samlades in från totalt 720 patientjournaler från vårdtillfällen på Centralsjukhuset i Kristianstad under 2017. Hälften av patienterna hade återinlagts inom 30 dagar efter utskrivning och hälften hade inte återinlagts.

I Delstudie II analyserades de 360 återinläggningarna vidare för att ta reda på hur stor andel av dessa som kunde relateras till läkemedelsrelaterade problem samt identifiera riskfaktorer för läkemedelsrelaterad respektive icke läkemedelsrelaterad återinläggning.

Riskfaktorer för alla typer av återinläggningar

Återinlagda patienter hade en högre sjuklighet, det vill säga att de, jämfört med de som inte återinlades, hade fler diagnoser och hade varit inlagda på sjukhus fler gånger under de tolv månader som föregick den första inläggningen. Patienterna som återinlades använde också många läkemedel, tio eller fler, och bodde i större utsträckning i eget boende ensamma och/eller hade hemtjänst.

Riskfaktorer för potentiellt läkemedelsrelaterade återinläggningar

Totalt klassificerades 40 % av återinläggningarna som potentiellt läkemedelsorsakade. Risken att återinläggas på grund av läkemedelsrelaterade orsaker ökade om den första inläggningen var akut, i motsats till planerad, och om läkemedelsdoser hade justerats vid utskrivning.

De patienter som bodde ensamma i eget boende hade en nästan 70 % högre risk för potentiellt läkemedelsorsakad återinläggning jämfört med de som bodde tillsammans med någon. Jämfört med att bo på särskilt boende var risken för läkemedelsrelaterad återinläggning mer än dubbelt så hög för de som bodde ensamma.

Patienter med potentiellt läkemedelsorsakad återinläggning, som bodde ensamma, var i högre grad kvinnor som hade hjälp med sina läkemedel från kommunen och använde tio läkemedel eller fler. De som bodde ensamma väntade ofta längre innan de återkom till sjukhuset än de som bodde med någon, de blev oftare återinlagda på ortopeden och de blev oftare återinlagda på grund av en ohållbar hemsituation.

Riskfaktorer för icke läkemedelsrelaterade återinläggningar

Patienter som återinlades på grund av icke läkemedelsrelaterade orsaker, så som infektion eller kirurgiska komplikationer, hade ofta legat längre på sjukhuset än de som inte återinlades och det var vanligare att de hade skrivits ut en fredag eller dag före helgdag och/eller från kirurgen.

Delstudie III

Delstudie III var en kvalitativ studie där vi genom fokusgruppdiskussioner ville undersöka och förstå erfarenheter av och åsikter om utskrivningsprocessen hos läkare inom slutenvården. Fokus var dokumentation och informationsöverföring gällande

läkemedel. Totalt hölls tre fokusgruppsdiskussioner med fyra till sex deltagare i varje. Deltagarna var underläkare, AT-läkare eller ST-läkare inom internmedicinska specialiteter på sjukhusen i Kristianstad och Hässleholm.

Flera hinder som påverkar informationsöverföring gällande läkemedel vid utskrivning identifierades. Hinder gällande infrastruktur, så som brister i IT-system, tidsbrist och brist på läkarkontinuitet, är svåra att påverka som individ. Men om alla läkare lär sig de IT-system som används, och följer fastställda rutiner, kan man öka kontinuiteten i informationsflödet. Om alla läkare arbetar för förbättrad informationskontinuitet kan läkemedelsfelen i vårdens övergångar minska och läkemedelssäkerheten öka. Klinikapotekare kan vara till god hjälp i detta arbete.

Delstudie IV

Resultaten från delstudie I, II och III indikerar att åtgärder behövs för att förbättra processerna vid utskrivning men åtgärder behövs även under vårdtiden, för att förbättra informationskontinuiteten i vårdövergångar, mellan enheter på sjukhuset och vid utskrivning. Slutligen behövs åtgärder för att säkerställa läkemedelslistan och läkemedelsanvändningen i vårdens övergångar.

För att kunna sätta in förebyggande åtgärder där de gör mest nytta utvecklade och validerade vi, i Delstudie IV, ett riskanalysinstrument som fick namnet the HOME Score (HOME står för Hospitalisations, Own home, Medications, and Emergency admission). Med instrumentet, som är enkelt att använda vid inläggning på sjukhus, kan äldre patienter med ökad risk för läkemedelsrelaterad återinläggning inom 30 dagar identifieras och förebyggande interventioner kan sättas in.

Slutsats och patientnytta

Vi har identifierat individuella och organisatoriska riskfaktorer för återinläggning inom 30 dagar hos patienter 65 år och äldre, samt utvecklat ett riskanalysinstrument som kan användas för att identifiera äldre patienter med ökad risk för läkemedelsrelaterad återinläggning inom 30 dagar.

Resultaten i denna avhandling kan bidra till att förbättra processer och implementera förebyggande interventioner som syftar till att förbättra vården för våra multisjuka äldre. Detta kan i sin tur, förhoppningsvis, leda till minskad risk för återinläggningar inom 30 dagar i denna population vilket skulle leda till ökad patientsäkerhet såväl som besparingar för vården. Vidare studier krävs för att testa dessa teorier.

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References

1. El Morabet N, Uitvlugt EB, van den Bemt BJF, van den Bemt P, Janssen MJA, Karapinar-Çarkit F. Prevalence and Preventability of Drug-Related Hospital Readmissions: A Systematic Review. Journal of the American Geriatrics Society. 2018;66(3):602-8.
2. Kempen TGH, Hedstrom M, Olsson H, Johansson A, Ottosson S, Al-Sammak Y, et al. Assessment tool for hospital admissions related to medications: development and validation in older patients. International journal of clinical pharmacy. 2019;41(1):198-206.
3. Strand LM, Morley PC, Cipolle RJ, Ramsey R, Lamsam GD. Drug-related problems: their structure and function. Dicp. 1990;24(11):1093-7.
4. Coleman EA, Boult C. Improving the quality of transitional care for persons with complex care needs. Journal of the American Geriatrics Society. 2003;51(4):556-7.
5. Bailey MK, Weiss AJ, Barrett ML, Jiang HJ. Characteristics of 30-Day All-Cause Hospital Readmissions, 2010–2016. Healthcare Cost and Utilization Project (HCUP) Statistical Briefs. Rockville (MD): Agency for Healthcare Research and Quality (US); 2006.
6. Pedersen MK, Meyer G, Uhrenfeldt L. Risk factors for acute care hospital readmission in older persons in Western countries: a systematic review. JBI database of systematic reviews and implementation reports. 2017;15(2):454-85.
7. Swedish Association of Local Authorities and Regions. Health care in numbers [Internet]. Swedish Association of Local Authorities and Regions; 2022 [Available from: https://www.vardenisiffror.se.
8. van Walraven C, Bennett C, Jennings A, Austin PC, Forster AJ. Proportion of hospital readmissions deemed avoidable: a systematic review. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne. 2011;183(7):E391-402.
9. van der Does AMB, Kneepkens EL, Uitvlugt EB, Jansen SL, Schilder L, Tokmaji G, et al. Preventability of unplanned readmissions within 30 days of discharge. A cross-sectional, single-center study. PLoS One. 2020;15(4):e0229940.
10. Creditor MC. Hazards of hospitalization of the elderly. Annals of internal medicine. 1993;118(3):219-23.

11. Mudge AM, McRae P, Hubbard RE, Peel NM, Lim WK, Barnett AG, et al. Hospital-Associated Complications of Older People: A Proposed Multicomponent Outcome for Acute Care. Journal of the American Geriatrics Society. 2019;67(2):352-6.
12. Kristensen SR, Bech M, Quentin W. A roadmap for comparing readmission policies with application to Denmark, England, Germany and the United States. Health Policy. 2015;119(3):264-73.
13. Swedish Association of Local Authorities and Regions. Indicators for consistent health and social care. 2018.
14. van Walraven C, Dhalla IA, Bell C, Etchells E, Stiell IG, Zarnke K, et al. Derivation and validation of an index to predict early death or unplanned readmission after discharge from hospital to the community. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne. 2010;182(6):551-7.
15. Alassaad A, Melhus H, Hammarlund-Udenaes M, Bertilsson M, Gillespie U, Sundstrom J. A tool for prediction of risk of rehospitalisation and mortality in the hospitalised elderly: secondary analysis of clinical trial data. BMJ open. 2015;5(2):e007259.
16. Parekh N, Ali K, Davies JG, Stevenson JM, Banya W, Nyangoma S, et al. Medication-related harm in older adults following hospital discharge: development and validation of a prediction tool. BMJ Qual Saf. 2020;29(2):142-53.
17. Donze J, Aujesky D, Williams D, Schnipper JL. Potentially avoidable 30-day hospital readmissions in medical patients: derivation and validation of a prediction model. JAMA internal medicine. 2013;173(8):632-8.
18. Gustafsson M, Sjölander M, Pfister B, Schneede J, Lövheim H. Effects of Pharmacists' Interventions on Inappropriate Drug Use and Drug-Related Readmissions in People with Dementia-A Secondary Analysis of a Randomized Controlled Trial. Pharmacy (Basel). 2018;6(1).
19. Uitvlugt EB, Janssen MJA, Siegert CEH, Kneepkens EL, van den Bemt BJF, van den Bemt P, et al. Medication-Related Hospital Readmissions Within 30 Days of Discharge: Prevalence, Preventability, Type of Medication Errors and Risk Factors. Front Pharmacol. 2021;12:567424.
20. Donaldson LJ, Kelley ET, Dhingra-Kumar N, Kieny MP, Sheikh A. Medication Without Harm: WHO's Third Global Patient Safety Challenge. Lancet (London, England). 2017;389(10080):1680-1.
21. World Health Association. The Global Health Observatory 2022 [Available from: https://www.who.int/data/gho.
22. Statistics Sweden. Statistical database 2022 [updated 2022-07-22. Available from: https://www.scb.se/en/.
23. Mathers CD, Stevens GA, Boerma T, White RA, Tobias MI. Causes of international increases in older age life expectancy. Lancet (London, England). 2015;385(9967):540-8.

24. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. Lancet (London, England). 2012;380(9836):37-43.
25. Quinaz Romana G, Kislaya I, Cunha Gonçalves S, Salvador MR, Nunes B, Matias Dias C. Healthcare use in patients with multimorbidity. Eur J Public Health. 2020;30(1):16-22.
26. Bähler C, Huber CA, Brüngger B, Reich O. Multimorbidity, health care utilization and costs in an elderly community-dwelling population: a claims data based observational study. BMC Health Serv Res. 2015;15:23.
27. Pereira F, Verloo H, Zhivko T, Di Giovanni S, Meyer-Massetti C, von Gunten A, et al. Risk of 30-day hospital readmission associated with medical conditions and drug regimens of polymedicated, older inpatients discharged home: a registry-based cohort study. BMJ open. 2021;11(7):e052755.
28. The Lancet, Volume 380, Issue 9836, 2012, pages 37-43. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. Figure 1, Page 39. Copyright Elsevier (2012). Permission to print granted from Elsevier and Prof Guthrie, by e-mail, January 2023.
29. Masnoon N, Shakib S, Kalisch-Ellett L, Caughey GE. What is polypharmacy? A systematic review of definitions. BMC geriatrics. 2017;17(1):230.
30. Kim J, Parish AL. Polypharmacy and Medication Management in Older Adults. Nurs Clin North Am. 2017;52(3):457-68.
31. Wastesson JW, Canudas-Romo V, Lindahl-Jacobsen R, Johnell K. Remaining Life Expectancy With and Without Polypharmacy: A Register-Based Study of Swedes Aged 65 Years and Older. J Am Med Dir Assoc. 2016;17(1):31-5.
32. Wastesson JW, Morin L, Laroche ML, Johnell K. How Chronic Is Polypharmacy in Old Age? A Longitudinal Nationwide Cohort Study. Journal of the American Geriatrics Society. 2019;67(3):455-62.
33. Corsonello A, Pedone C, Incalzi RA. Age-related pharmacokinetic and pharmacodynamic changes and related risk of adverse drug reactions. Current medicinal chemistry. 2010;17(6):571-84.
34. Picker D, Heard K, Bailey TC, Martin NR, LaRossa GN, Kollef MH. The number of discharge medications predicts thirty-day hospital readmission: a cohort study. BMC Health Serv Res. 2015;15:282.
35. Basnet S, Zhang M, Lesser M, Wolf-Klein G, Qiu G, Williams M, et al. Thirty-day hospital readmission rate amongst older adults correlates with an increased number of medications, but not with Beers medications. Geriatrics & gerontology international. 2018;18(10):1513-8.

36. Ekerstad N, Bylin K, Karlson BW. Early rehospitalizations of frail elderly patients - the role of medications: a clinical, prospective, observational trial. Drug Healthc Patient Saf. 2017;9:77-88.
37. Wang P, Wang Q, Li F, Bian M, Yang K. Relationship Between Potentially Inappropriate Medications And The Risk Of Hospital Readmission And Death In Hospitalized Older Patients. Clin Interv Aging. 2019;14:1871-8.
38. Swedish National Board of Health and Welfare. Indicators of good medication therapy in the elderly. Stockholm: Swedish National Board of Health and Welfare; 2017.
39. SanFilippo S, Michaud V, Wei J, Bikmetov R, Turgeon J, Brunetti L. Classification and Assessment of Medication Risk in the Elderly (CARE): Use of a Medication Risk Score to Inform Patients' Readmission Likelihood after Hospital Discharge. J Clin Med. 2021;10(17).
40. Laugaland K, Aase K, Barach P. Interventions to improve patient safety in transitional care--a review of the evidence. Work. 2012;41 Suppl 1:2915-24.
41. Caleres G, Bondesson Å, Midlöv P, Modig S. Elderly at risk in care transitions When discharge summaries are poorly transferred and used –a descriptive study. BMC Health Services Research. 2018;18(1):770.
42. Caleres G, Strandberg EL, Bondesson A, Midlov P, Modig S. Drugs, distrust and dialogue -a focus group study with Swedish GPs on discharge summary use in primary care. BMC family practice. 2018;19(1):127.
43. Hesselink G, Schoonhoven L, Plas M, Wollersheim H, Vernooij-Dassen M. Quality and safety of hospital discharge: a study on experiences and perceptions of patients, relatives and care providers. Int J Qual Health Care. 2013;25(1):66-74.
44. Caleres G, Modig S, Midlöv P, Chalmers J, Bondesson Å. Medication Discrepancies in Discharge Summaries and Associated Risk Factors for Elderly Patients with Many Drugs. Drugs - real world outcomes. 2020;7(1):53-62.
45. Auerbach AD, Kripalani S, Vasilevskis EE, Sehgal N, Lindenauer PK, Metlay JP, et al. Preventability and Causes of Readmissions in a National Cohort of General Medicine Patients. JAMA internal medicine. 2016;176(4):484-93.
46. Marek KD, Antle L. Medication Management of the Community-Dwelling Older Adult. In: Hughes RG, editor. Patient Safety and Quality: An Evidence-Based Handbook for Nurses. Rockville (MD): Agency for Healthcare Research and Quality (US); 2008.
47. Rosen OZ, Fridman R, Rosen BT, Shane R, Pevnick JM. Medication adherence as a predictor of 30-day hospital readmissions. Patient Prefer Adherence. 2017;11:801-10.
48. Gruneir A, Fung K, Fischer HD, Bronskill SE, Panjwani D, Bell CM, et al. Care setting and 30-day hospital readmissions among older adults: a population-based cohort study. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne. 2018;190(38):E1124-e33.

49. Pimouguet C, Rizzuto D, Schön P, Shakersain B, Angleman S, Lagergren M, et al. Impact of living alone on institutionalization and mortality: a population-based longitudinal study. Eur J Public Health. 2016;26(1):182-7.
50. Hesselink G, Schoonhoven L, Barach P, Spijker A, Gademan P, Kalkman C, et al. Improving patient handovers from hospital to primary care: a systematic review. Annals of internal medicine. 2012;157(6):417-28.
51. Swedish National Board of Health and Welfare. Directives and general advice (HSLF-FS 2017:37) on prescription and handling of medicines in health care. Swedish National Board of Health and Welfare; 2017.
52. Department of medicines management and informatics in Skåne county. Directions for Medication Reconciliation and review in Skåne County. Region Skåne; 2014.
53. Bondesson A, Eriksson T, Kragh A, Holmdahl L, Midlov P, Hoglund P. In-hospital medication reviews reduce unidentified drug-related problems. European journal of clinical pharmacology. 2013;69(3):647-55.
54. Bergkvist A, Midlov P, Hoglund P, Larsson L, Eriksson T. A multi-intervention approach on drug therapy can lead to a more appropriate drug use in the elderly. LIMM-Landskrona Integrated Medicines Management. J Eval Clin Pract. 2009;15(4):660-7.
55. Bülow C, Clausen SS, Lundh A, Christensen M. Medication review in hospitalised patients to reduce morbidity and mortality. Cochrane Database Syst Rev. 2023;1(1):Cd008986.
56. Kaufmann CP, Tremp R, Hersberger KE, Lampert ML. Inappropriate prescribing: a systematic overview of published assessment tools. European journal of clinical pharmacology. 2014;70(1):1-11.
57. Fick DM, Semla TP, Steinman M, Beizer J, Brandt N, Dombrowski R, et al. American Geriatrics Society 2019 Updated AGS Beers Criteria® for Potentially Inappropriate Medication Use in Older Adults. Journal of the American Geriatrics Society. 2019;67(4):674-94.
58. O'Mahony D, O'Sullivan D, Byrne S, O'Connor MN, Ryan C, Gallagher P. STOPP/START criteria for potentially inappropriate prescribing in older people: version 2. Age and ageing. 2015;44(2):213-8.
59. Marshall MN, Shekelle PG, McGlynn EA, Campbell S, Brook RH, Roland MO. Can health care quality indicators be transferred between countries? Qual Saf Health Care. 2003;12(1):8-12.
60. Renom-Guiteras A, Meyer G, Thürmann PA. The EU(7)-PIM list: a list of potentially inappropriate medications for older people consented by experts from seven European countries. European journal of clinical pharmacology. 2015;71(7):861-75.
61. Becker C, Zumbrunn S, Beck K, Vincent A, Loretz N, Müller J, et al. Interventions to Improve Communication at Hospital Discharge and Rates of Readmission: A Systematic Review and Meta-analysis. JAMA Netw Open. 2021;4(8):e2119346.

62. Municipal administration and Skane County. Routine and guidance for collaboration at discharge from hospital care. In: Municipal administration and Skane County, editor. 2023.
63. Stillman GR, Stillman AN, Beecher MS. Frailty Is Associated With Early Hospital Readmission in Older Medical Patients. J Appl Gerontol. 2021;40(1):38-46.
64. Gregersen M, Hansen TK, Jørgensen BB, Damsgaard EM. Frailty is associated with hospital readmission in geriatric patients: a prognostic study. European geriatric medicine. 2020;11(5):783-92.
65. McCusker J, Bellavance F, Cardin S, Trepanier S, Verdon J, Ardman O. Detection of Older People at Increased Risk of Adverse Health Outcomes After an Emergency Visit: The ISAR Screening Tool. Journal of the American Geriatrics Society. 1999;47(10):1229-37.
66. Meldon SW, Mion LC, Palmer RM, Drew BL, Connor JT, Lewicki LJ, et al. A brief risk-stratification tool to predict repeat emergency department visits and hospitalizations in older patients discharged from the emergency department. Acad Emerg Med. 2003;10(3):224-32.
67. Olson CH, Dierich M, Adam T, Westra BL. Optimization of decision support tool using medication regimens to assess rehospitalization risks. Appl Clin Inform. 2014;5(3):773-88.
68. Swedish Government Offices. Law (2017:612) on collaboration at discharge from hospital healthcare. 2018.
69. Department of medicines management and informatics in Skåne county. The model of medication review (somatics) in Skåne county. Region Skåne, Hälso- och sjukvårdsnämnden; 2011.
70. Hosmer DW, Lemeshow S. Applied logistic regression. New York ;: Wiley; 2000.
71. Kempen TGH, Bertilsson M, Hadziosmanovic N, Lindner KJ, Melhus H, Nielsen EI, et al. Effects of Hospital-Based Comprehensive Medication Reviews Including Postdischarge Follow-up on Older Patients' Use of Health Care: A Cluster Randomized Clinical Trial. JAMA Netw Open. 2021;4(4):e216303.
72. Kempen TGH, Bertilsson M, Lindner KJ, Sulku J, Nielsen EI, Hogberg A, et al. Medication Reviews Bridging Healthcare (MedBridge): Study protocol for a pragmatic cluster-randomised crossover trial. Contemp Clin Trials. 2017;61:126-32.
73. Malterud K. Kvalitativa metoder i medicinsk forskning : en introduktion. 3., [uppdaterade] uppl. / översättning: Per Larson ed: Studentlitteratur; 2014.
74. Kirkwood TB. Understanding the odd science of aging. Cell. 2005;120(4):437-47.
75. Zheng S, Hanchate A, Shwartz M. One-year costs of medical admissions with and without a 30-day readmission and enhanced risk adjustment. BMC Health Serv Res. 2019;19(1):155.

76. Naseer M, K JM, Ehrenberg A, Schön P, Dahlberg L. Individual and contextual predictors of emergency department visits among community-living older adults: a register-based prospective cohort study. BMJ open. 2022;12(2):e055484.
77. Naseer M, Agerholm J, Fastbom J, Schön P, Ehrenberg A, Dahlberg L. Factors associated with emergency department revisits among older adults in two Swedish regions: A prospective cohort study. Arch Gerontol Geriatr. 2020;86:103960.
78. Ekdahl AW. How to promote better care of elderly patients with multi-morbidity in Europe: A Swedish example. European geriatric medicine. 2012;3(2):103-6.
79. Blachman NL, Blaum CS. Integrating Care Across Disciplines. Clin Geriatr Med. 2016;32(2):373-83.
80. Ravn-Nielsen LV, Duckert ML, Lund ML, Henriksen JP, Nielsen ML, Eriksen CS, et al. Effect of an In-Hospital Multifaceted Clinical Pharmacist Intervention on the Risk of Readmission: A Randomized Clinical Trial. JAMA internal medicine. 2018.
81. Phatak A, Prusi R, Ward B, Hansen LO, Williams MV, Vetter E, et al. Impact of pharmacist involvement in the transitional care of high-risk patients through medication reconciliation, medication education, and postdischarge call-backs (IPITCH Study). Journal of hospital medicine. 2016;11(1):39-44.
82. Gustafsson M, Sjolander M, Pfister B, Jonsson J, Schneede J, Lovheim H. Pharmacist participation in hospital ward teams and hospital readmission rates among people with dementia: a randomized controlled trial. European journal of clinical pharmacology. 2017;73(7):827-35.
83. Daliri S, Hugtenburg JG, Ter Riet G, van den Bemt BJF, Buurman BM, Scholte Op Reimer WJM, et al. The effect of a pharmacy-led transitional care program on medication-related problems post-discharge: A before-After prospective study. PLoS One. 2019;14(3):e0213593.
84. Kripalani S, Jackson AT, Schnipper JL, Coleman EA. Promoting effective transitions of care at hospital discharge: a review of key issues for hospitalists. Journal of hospital medicine. 2007;2(5):314-23.
85. Kempen TGH, Kälvemark A, Sawires M, Stewart D, Gillespie U. Facilitators and barriers for performing comprehensive medication reviews and follow-up by multiprofessional teams in older hospitalised patients. European journal of clinical pharmacology. 2020;76(6):775-84.
86. Doheny M, Schön P, Orsini N, Fastbom J, Burström B, Agerholm J. Socio-demographic differences in polypharmacy and potentially inappropriate drug use among older people with different care needs and in care settings in Stockholm, Sweden. Scand J Public Health. 2021:14034948211018384.
87. van Galen LS, Brabrand M, Cooksley T, van de Ven PM, Merten H, So RK, et al. Patients' and providers' perceptions of the preventability of hospital readmission: a prospective, observational study in four European countries. BMJ Qual Saf. 2017;26(12):958-69.

88. van Galen LS, Vedder D, Boeije T, Jansen W, Mullaart-Jansen NE, van der Peet DL, et al. Different Perspectives on Predictability and Preventability of Surgical Readmissions. J Surg Res. 2019;237:95-105.
89. Ekdahl AW, Linderholm M, Hellström I, Andersson L, Friedrichsen M. 'Are decisions about discharge of elderly hospital patients mainly about freeing blocked beds?' A qualitative observational study. BMJ open. 2012;2(6).
90. Dahlberg L, Agahi N, Schön P, Lennartsson C. Planned and Unplanned Hospital Admissions and Their Relationship with Social Factors: Findings from a National, Prospective Study of People Aged 76 Years or Older. Health Serv Res. 2018;53(6):4248-67.
91. Olson CH, Dey S, Kumar V, Monsen KA, Westra BL. Clustering of elderly patient subgroups to identify medication-related readmission risks. International journal of medical informatics. 2016;85(1):43-52.
92. Dahlberg L, Berndt H, Lennartsson C, Schön P. Receipt of Formal and Informal Help with Specific Care Tasks among Older People Living in their Own Home. National Trends over Two Decades. Social Policy & Administration. 2018;52(1):91-110.
93. Hem från sjukhuset [press release]. www.sverigesradio.se: Sveriges Radio2022.
94. Sternberg SA, Wershof Schwartz A, Karunananthan S, Bergman H, Mark Clarfield A. The identification of frailty: a systematic literature review. Journal of the American Geriatrics Society. 2011;59(11):2129-38.
95. Uchino BN. Understanding the Links Between Social Support and Physical Health: A Life-Span Perspective With Emphasis on the Separability of Perceived and Received Support. Perspect Psychol Sci. 2009;4(3):236-55.
96. Berge I, Barenfeld E, Dahlin-Ivanoff S, Haak M, Lood Q. Challenging oneself on the threshold to the world of research - frail older people's experiences of involvement in research. BMC geriatrics. 2020;20(1):410.
97. Laustsen CE, Westergren A, Petersson P, Haak M. Conceptualizing researchers' perspectives on involving professionals in research: a group concept mapping study. Health Res Policy Syst. 2021;19(1):39.

Appendix

Appendix 1. Assessment Tool for identifying Hospital Admissions Related to Medications (AT-HARM10) (Paper II)

Appendix 2. Semi-structured interview guide (Paper III) – in Swedish

Appendix 3. Ad in local newspaper informing prospective participants of data collection (Papers I and II)
- in Swedish

Appendix 4. Information letter to participants (Paper III) – in Swedish

Appendix 1. Assessment Tool for identifying Hospital Admissions Related to Medications (AT-HARM10) (Paper II)

AT-HARM10 – Instructions

Assessment Tool for identifying Hospital Admissions Related to Medications

The Assessment Tool for identifying Hospital Admissions Related to Medications (AT-HARM10) is a screening tool consisting of 10 questions used to determine whether a hospital admission is medication-related. A medication-related admission (MRA) is a hospital admission in which a medication-related problem (MRP) is either the main cause for admission or a significantly contributing cause for admission (i.e. without the MRP, the patient would not have been admitted). MRPs are defined here as "undesirable patient experiences that involve medication therapy and that actually or potentially interfere with desired patient outcomes". These not only involve adverse drug reactions to prescribed medication, but can also involve problems such as inappropriate prescribing and non-compliance, and problems related to over-the-counter (OTC) medications. It does not consider whether the admission was preventable (e.g. an admission caused by side effects of appropriate medication treatment is considered medication-related). AT-HARM10 was developed to measure the incidence of possibly medication-related admissions, MRAs.

The user of AT-HARM10 should not have to go through all patient data in the patient's medical record, because that would take too much time. The patient data from the medical records that will be provided for the assessment includes: admission notes from the current admission, medication list, laboratory data, pharmacists' notes and the discharge summary for the admission. All registered medications, including over-the-counter (OTC) medication, should be considered in the assessment. Non-registered complementary and alternative medicine (CAM) products and dietary supplements are not to be considered.

The tool comprises 10 questions which can only be answered "Yes" or "No". For further clarification of each question, please see the examples below. Questions 1-3 are used to identify admissions that are unlikely to be medication-related (U), while questions 4-10 are used to identify possibly medication-related (P) admissions. The assessment is finished as soon as the answer "Yes" is given for any question, resulting in the admission being either U or P. This means that it is not necessary to answer the remaining questions when a “Yes” answer has been given. If all the questions are answered "No", the assessment is still indecisive and needs to be examined by an expert panel.

Please note: While the reason for visiting the emergency department (ED) might be non-medication-related (e.g. chest pain, headache), in some cases the primary cause for admission might turn out to be medication-related (e.g. low potassium levels discovered while at the ED – worsened by a diuretic). In these cases, the admission should be classified as P.

AT-HARM10

Assessment Tool for identifying Hospital Admissions Related to Medications

Note: Questions 1-3 are used to identify admissions unlikely to be medication-related, while questions 4-10 are used to identify possibly medication-related admissions. The assessment is finished as soon as the answer "Yes" is given for any question → U (unlikely to be medication-related) or P (possibly medication-related). If all the questions are answered with "No", the admission should be classified as P (possibly medication-related).

1. Was the admission caused by an *infection* or a previously *undiagnosed* disease (e.g. diabetes or heart failure) that is *not medication-related*?
   Yes → U (unlikely to be medication-related)
   No → NQ (next question)

2. Was the admission caused by progression of a previously diagnosed disease that is *not medication-related* (with the progression of several chronic diseases, such as congestive heart failure or diabetes, a medication-related component can rarely be excluded)?
   Yes → U
   No → NQ
   NOTE: Appropriateness of medication treatment should only be considered in relation to this question to determine whether the admission is primarily caused by disease progression (*unlikely* MRA) or suboptimal medication treatment or use (*possible* MRA, question 4-10).

3. Was the admission caused by physical trauma, substance intoxication, social circumstances or allergies (e.g. car accident, wasp allergy, alcohol excess, mushroom poisoning) that are *not medication-related*?
   Yes → U
   No → NQ

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4. Is it hinted or stated in the medical record that the admission was *medication-related* (including non-compliance)?
   Yes → P (possibly medication-related)
   No → NQ

5. Might (side) effects of the medications the patient was taking (prescribed or non-prescribed) prior to hospitalisation have caused the admission (including over-treatment)?
   Yes → P
   No →NQ
   NOTE: An admission caused by side effects of appropriate medication treatment should be classified as *possibly* medication-related.

6. Are there abnormal laboratory results or vital signs that could be *medication-related* and might have caused the admission?
   Yes → P
   No → NQ

7. Was there any drug-drug interaction or drug-disease interaction (i.e. a contraindication) that might have caused the admission?
   Yes → P
   No → NQ

8. Did the patient have any *previously* diagnosed untreated or suboptimally treated (e.g. dose too low) indications that might have caused the admission?
   Yes → P
   No → NQ

9. Was the patient admitted because of a problem with the dosage form or pharmaceutical formulation (i.e. failure to receive the medication)?
   Yes → P
   No → NQ

10. Is the cause of the admission a response to cessation or withdrawal of medication therapy?
    Yes → P
    No → P (the tool has not been able to rule out that the admission is medication-related)

AT-HARM10 – Examples

Assessment Tool for identifying Hospital Admissions Related to Medications

Representative examples of when a question should be answered "Yes" or "No".

1. Was the admission caused by an *infection* or a previously *undiagnosed* disease (e.g. diabetes or heart failure) that is *not medication-related*?

   Yes: A patient admitted because of pneumonia that was *not related* to the patient's *medications*.

   Yes: A patient admitted because of rectal bleeding found, after investigation, to have been caused by a tumour.

   Yes: A patient admitted with an unclear diagnosis and new symptoms. The symptoms cannot be explained by the patient's current medications.

   No: A patient receiving immunosuppressive treatment admitted with infection.

   No: A patient admitted with new symptoms indicating heart failure (oedema, shortness of breath) and a history of excessive use of non-steroidal anti-inflammatory drugs (NSAIDs).

2. Was the admission caused by progression of a previously diagnosed disease that is *not medication-related*?

   NOTE: Appropriateness of medication treatment should only be considered in relation to this question to determine whether the admission is primarily caused by disease progression (*unlikely* MRA) or suboptimal medication treatment or use (*possible* MRA, question 4-10).

   Yes: A patient admitted because of progression of cancer that is not related to the patient's medications.

   Yes: A patient admitted because of exacerbation of congestive heart-failure, which worsened despite optimal treatment (the medication therapy seems

to follow the applicable treatment guidelines) and with no signs of non-compliance.

No: A diabetic patient admitted because of hyperglycaemia without other reason for admission (hyperglycaemia should never lead to admission in a patient that is optimally treated).

3. Was the admission caused by physical trauma, substance intoxication, social circumstances or allergies (e.g. car accident, wasp allergy, alcohol excess, mushroom poisoning) that are *not medication-related*?

   Yes: A patient admitted because of alcohol intoxication or a car accident that was *not related* to the use of the patient's *medications*.

   No: A patient admitted because of alcohol intoxication worsened by the concomitant use of sedatives.

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4. Is it hinted or stated in the medical record that the admission is *medication-related* (including non-compliance)?

   Yes: A physician states in the discharge note that the patient was admitted because of constipation caused by the lack of laxative therapy during treatment with a strong opioid.

   Yes: A patient admitted because of an epileptic seizure and a note in the medical records that the patient is known to be non-compliant.

5. Might (side) effects of the medications the patient was taking (prescribed or non-prescribed) prior to hospitalisation have caused the admission (including over-treatment)?

   NOTE: An admission caused by side effects of appropriate medication treatment should be classified as *possibly* medication-related.

Yes: A patient admitted with gastric bleeding who uses acetylsalicylic acid to prevent thrombotic events (regardless of the presence of a correct indication and the use of a proton pump inhibitor for gastric protection).

Yes: A patient admitted because of lactic acidosis after continuing medication with metformin while experiencing dehydrating stomach flu.

Yes: A patient who uses antihypertensive medication and was admitted due to a fall caused by orthostatic hypotension.

6. Are there abnormal laboratory results or vital signs that could be *medication-related* and might have caused the admission?

   Yes: A patient admitted with a serum digoxin concentration of 3.4 nmol/L (toxic concentration) which may have been the cause for admission.

   Yes: A patient admitted because of hypokalaemia (s-potassium < 3.5 mmol/L) and prescribed a diuretic.

   Yes: A patient with epilepsy admitted with seizures and prescribed a seemingly adequate dose of carbamazepine but with a measured plasma concentration that is too low.

7. Was there any *drug-drug interaction* or *drug-disease interaction* (i.e. a contraindication) that might have caused the admission?

   Yes: A patient admitted because of gastrointestinal bleeding who was taking diclofenac and warfarin in combination before admission.

   Yes: A patient admitted because of serotonin syndrome who was taking tramadol, citalopram and mirtazapine.

   Yes: A patient, previously diagnosed with bilateral renal artery stenosis, admitted because of acute renal failure after taking an ACE inhibitor.

   Yes: A patient with dementia, who has recently been prescribed an anticholinergic medication (e.g. hydroxyzine), admitted with confusion.

8. Did the patient have any, *previously* diagnosed, untreated or suboptimally treated (e.g. dose too low) indications that might have caused the admission?

   Yes: A patient diagnosed with congestive heart failure, who was taking only a starting dose of ACE-inhibitor (unjustifiably low dose), admitted because of fluid retention and dyspnoea.

   Yes: A patient admitted because of a hip fracture who had a prior diagnosis of osteoporosis but was not taking osteoporosis prophylaxis.

9. Was the patient admitted because of a problem with the dosage form or pharmaceutical formulation (i.e. failure to receive the medication)?

   Yes: A patient admitted with worsening asthma who was found to be unable to use the inhalers correctly.

   Yes: A patient admitted with palpitations who was found to be unable to swallow tablets and had been crushing slow-release antihypertensive tablets that should have been swallowed whole to retain their slow-release effects.

10. Is the cause of the admission a response to cessation or withdrawal of medication therapy?

    Yes: A patient whose prednisolone treatment has been discontinued too abruptly admitted with nausea, vomiting and diarrhoea.

Appendix 2.
Semi-structured interview guide (Paper III)
– in Swedish

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Bilaga 6 - Semi-strukturerad intervjuguide till studien:
Dokumentation och informationsöverföring vid utskrivning från slutenvård – en fokusgruppstudie om slutenvårdsläkares utmaningar och möjligheter

Övergripande ämnen

1. Studier visar att primärvårdsläkare inte alltid litar på informationen i utskrivningsinformationen, framför allt på läkemedelslistan. Hur ser du på **utskrivningsprocessen** i sin helhet och **dokumentationen gällande läkemedel** i synnerhet? Vilka utmaningar och möjligheter ser du?

   - Hur brukar en **läkemedelsavstämning** gå till? Vilka svårigheter ser du och hur skulle det kunna bli bättre? Erinra dig gärna några goda och mindre goda exempel.
   - Hur går du till väga när du skriver **utskrivningsinformation med läkemedelsberättelse**? Hur hittar du den information som behövs? Vilka svårigheter ser du och hur skulle det kunna bli bättre?
   - Vad är din uppfattning om **Pascal** och ordination vid hemgång när patienten har dosdispenserade läkemedel i hemmet?

2. Vid utskrivning behöver patient och nästa vårdgivare **information om uppföljning**. Hur ser rutinen ut gällande detta? Erinra dig gärna några exempel.

3. Epikris och utskrivningsinformation med läkemedelsberättelse ska **skickas till nästa vårdgivare** men enligt studier görs inte alltid detta. Fundera på vad som är orsaken till detta och hur det kan förbättras.

Checklista

Läkemedelsavstämning – Vem gör det? Hur görs det? Synpunkter på anteckning ”Läkemedelsavstämning slutförd”?

Dokumentation under vårdtiden – en förutsättning för lm-berättelse – Hur görs det?

Hur säkerställer man att andra kolleger på kliniken förstår vad som är gjort?

Hur säkerställs att patienten får rätt information i slutändan/vid hemgång?

Vad betyder det för patienten att få en korrekt Utskrivningsinformation med läkemedelsberättelse?

Kunskap i Melior Läkemedelsmodul – vilken utbildning har man fått?

Pascal – vilken utbildning har man fått? Vad händer om det blir fel?

Hur förs önskemål om uppföljning över till nästa vårdgivare - Skriver man om uppföljning enbart i epikrisen och/eller utskrivningsinformationen eller skickas remiss? Vems ansvar är det att göra detta? Skrivs journalanteckning?

Finns skriftlig rutin gällande utskrivningsinformation och överföring av informationen till nästa vårdgivare?

Vems ansvar är det att skriva utskrivningsinformationen och gå igenom med patient? Vems ansvar är det att skicka till nästa vårdgivare?

Vad betyder det för primärvårdsläkaren att få en korrekt Utskrivningsinformation m läkemedelsberättelse?

Appendix 3.
Ad in local newspaper informing prospective participants of data collection (Papers I and II) - in Swedish

Studie av återinläggningar inom 30 dagar för patienter 65 år och äldre

Återinläggningar av patienter inom 30 dagar är ett stort och kostsamt problem för sjukvården. Att förebygga återinläggningar kan potentiellt öka livskvaliteten för många patienter.

Med start 180601 planerar nu Lunds Universitet, i samarbete med Region Skåne, genomföra en journalgranskning i syfte att finna bakomliggande orsaker till, och riskfaktorer för, återinläggningar inom 30 dagar på Centralsjukhuset i Kristianstad. Ett urval av de patienter, 65 år och äldre, vilka varit inlagda på detta sjukhus under år 2017 kommer att inkluderas.

All bearbetning av data kommer att ske konfidentiellt; patientuppgifter ersätts med löpnummer. Såväl analyser som presentationer av resultat kommer att ske på gruppnivå. Enskilda individer kommer inte att kunna identifieras. Efter studiens avslutande kommer den att publiceras i vetenskaplig tidskrift.

Deltagande i studien är frivilligt. Om du inte vill delta i studien, vill ha ytterligare information eller efter studiens avslutande få ta del av resultat önskar vi att du skriftligen meddelar detta till undertecknad forskare, som är ansvarig för studiens uppföljning.

Maria Glans. Enheten för Farmaci, Centralsjukhuset Kristianstad, Region Skåne, 291 85 Kristianstad.
Tel: 044-309 29 71. E-post: maria.glans@skane.se

Appendix 4.
Information letter to participants (Paper III)
– in Swedish

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Information inför medverkan i forskningsstudie

Dokumentation och informationsöverföring vid utskrivning från slutenvård – en fokusgruppstudie om slutenvårdsläkares utmaningar och möjligheter

Härmed inbjuds du till att medverka i en forskningsstudie genom att delta i ett samtal om korrekt och effektiv dokumentation och informationsöverföring i utskrivningsprocessen.

Informationsöverföring kring läkemedel och uppföljning i vårdövergångar brister, vilket bland annat kan leda till att patienter, framför allt äldre, drabbas av läkemedelsrelaterade problem och i vissa fall även av återinläggning på sjukhus. Detta kan bland annat motverkas genom förbättrad dokumentation under vårdtiden och förbättrade rutiner i utskrivningsprocessen.

Enligt Region Skånes rutin ska utskrivningsinformation med läkemedelsberättelse och läkemedelslista skickas till nästa vårdgivare senast samma dag som patienten skrivs ut från sjukhuset. Tidigare studier har visat att primärvårdsläkarna i många fall inte får denna information. I en fokusgruppstudie med primärvårdsläkare uttrycktes dessutom att informationen i många fall upplevs som bristfällig.

Syftet med denna fokusgruppstudie är att utforska och förstå slutenvårdsläkares erfarenheter av och uppfattningar om utskrivningsprocessen, med fokus på dokumentation och informationsöverföring gällande läkemedel.

Nya insikter i slutenvårdsläkarnas uppfattningar om utskrivningsprocessen kan förhoppningsvis bidra till att hitta verktyg för att förbättra och förenkla denna. Detta möjliggör förbättrad kommunikation i vårdens övergångar och minskade risker för patienterna.

Studien genomförs i form av fokusgruppsdiskussioner där ST-läkare från olika specialiteter är inbjudna. Deltagare har valts ut i samråd med studierektorer inom respektive specialitet och du har ombetts att medverka då du har värdefull kunskap och erfarenhet inom området. Fokusgruppen träffas vid ett tillfälle under cirka två timmar och kommer att ledas av en moderator (Maria Glans, klinikapotekare) tillsammans med bisittare (Annika Brorsson, specialist och docent i allmänmedicin).

Diskussionerna spelas in och genomlyssnas samt transkriberas till text, varvid avidentifiering sker. Därefter förstörs ljudfilerna medan textmaterialet sparas i 15 år efter publicering, enbart åtkomligt för forskargruppen. Dina kommentarer kommer att behandlas så att inte obehöriga kan ta del av dem och kommentarer som kan knytas till specifik person redovisas inte. Ansvarig för dina personuppgifter är Lunds universitet som också är forskningshuvudman för studien. Du kommer kunna ta del av studiens resultat efter publicering i vetenskaplig tidskrift.

Det finns inga kända risker med att delta i projektet, och inte heller några personliga vinster. Ditt bidrag kan dock vara till stor hjälp för forskarna för att få mer kunskap om detta ämne. Ditt deltagande är frivilligt och medverkan kan när som helst avbrytas.

Forskare/kontaktperson som genomför studien och kan ge ytterligare information är klinikapotekare Maria Glans, maria.glans@med.lu.se, telefon: 044-309 29 71.

Inför gruppdiskussionen får du gärna reflektera över följande punkter:

1. Studier visar att primärvårdsläkare inte alltid litar på informationen i utskrivningsinformationen, framför allt på läkemedelslistan. Hur ser du på **utskrivningsprocessen** i sin helhet och **dokumentationen gällande läkemedel** i synnerhet? Vilka utmaningar och möjligheter ser du?
   - Hur brukar en **läkemedelsavstämning** gå till? Vilka svårigheter ser du och hur skulle det kunna bli bättre? Erinra dig gärna några goda och mindre goda exempel.
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2. Vid utskrivning behöver patient och nästa vårdgivare **information om uppföljning**. Hur ser rutinen ut gällande detta? Vad kan bli bättre? Erinra dig gärna några exempel.
3. Epikris och utskrivningsinformation med läkemedelsberättelse ska **skickas till nästa vårdgivare** men enligt studier görs inte alltid detta. Fundera på vad som är orsaken till detta och hur det kan förbättras.

Vänligen ta med underskriven blankett för informerat samtycke till fokusgruppen.

Varmt välkommen!

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Samtycke till deltagande i forskningsstudie

Dokumentation och informationsöverföring vid utskrivning från slutenvård – en fokusgruppstudie om slutenvårdsläkares utmaningar och möjligheter

Om du, efter att ha tagit del av bifogad information inför medverkan i forskningsstudie och efter att ha fått svar på eventuella frågor, samtycker till medverkan, var god skriv under nedan. Vänligen medtag underskriven samtyckesblankett till fokusgruppen.

_____

Ort och Datum

_____

Underskrift

_____

Namnförtydligande