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UNPLANNED READMISSIONS IN BELGIAN HOSPITALS

IMPORTANCE OF QUALITY OF IN-HOSPITAL CARE AND QUALITY OF CARE TRANSITIONS

Anja BRAET

Jury:

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Health care is more about love than about most other things

Donald Berwick

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Anja

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LIST OF ABBREVIATIONS

A

AE	adverse event
AMA	against medical advice
AMI	acute myocardial infarction
APN	advanced practice nurse
APR-DRG	All Patient Refined Diagnostic Related Group

B

Be-HDDS	Belgian hospital discharge dataset

C

CABG	coronary artery bypass grafting
CCI	Charlson comorbidity index
CHF	congestive heart failure
CHW	community health worker
CI	confidence interval
CMS	Centers for Medicare and Medicaid Services
CTM	Care Transitions Measure
CT-questionnaire	care transition questionnaire
CT-score	score on CT-questionnaire
COPD	chronic obstructive pulmonary disease

D

DA	discharge advocate
DALY	disability adjusted life year
DRG	Diagnostic Related Group

E

ED	emergency department

F

FCG	family caregiver

G

GP	general practitioner

H

HR	high readmission rate
HRRP	Hospital Readmission Reduction Program

I

ICD-9-CM	International Classification of Diseases, ninth revision, Clinical Modification
IHI	Institute of Healthcare Improvement
IQR	interquartile range

L

LR	low readmission rate

M

MDC	Major Diagnostic Category

O

OECD	Organization for Economic Co-operation and Development
OR	odds ratio

P

PCP	primary care physician

R

RN	registered nurse
RQ	research question
RR	relative risk
RSRR	risk standardized readmission ratio

S

SD	standard deviation
SRR	standardized readmission ratio

T

THA/TKA	total hip/knee arthroplasty

TABLE OF CONTENTS

Chapter 1 - INTRODUCTION

Outline

This chapter outlines the importance of readmissions and how they can be the result of a substandard quality of care. At the start of this thesis research, we hypothesized that hospital readmissions could be an important issue in Belgium, but we lacked data on this topic. On the other hand, it was not clear whether the association between readmission and quality of care – which has been studied primarily in US – could be extrapolated to the European, and specifically to the Belgian, context. Both reasons make this thesis about readmissions in Belgium relevant. The aim of this research is to study how to reduce hospital readmissions that are due to substandard quality of in-hospital care or to substandard quality of the care transition from hospital to home. The chapter ends with an overview of the thesis research and the different chapters of this manuscript.

Establishing the context

Readmissions are important

Hospital readmissions have a high impact on healthcare systems because they occur frequently, are costly and can lead to negative outcomes for patients. The *incidence* of readmissions depends on many variables, and numbers in the literature vary considerably. Jencks et al. and Chollet et al. [1, 2] drew attention to how *costly* readmissions are for community, calculating that expenditures for 30-day readmissions constitute 16-17% of total hospital payments in the US. Besides the high economic impact, readmissions induce *negative outcomes* in patients, because each hospital admission is associated with an increased risk of functional [3-5] and cognitive [6, 7] decline, especially in elderly patients.

A considerable proportion of readmissions is potentially preventable. According to literature reviews 5 to 79% (median=27.1%) [8] or 9 to 48% [9] of all readmissions could potentially be prevented. Preventable readmissions can be caused by suboptimal quality of care during the hospital stay, suboptimal quality of the transition from hospital to home or suboptimal quality of care after discharge.

Readmissions are related to quality of care

In this section we illustrate how readmissions can be the result of poor quality of care.

Readmissions resulting from adverse events

Adverse events (AEs) are defined by the Institute of Healthcare Improvement (IHI) as “noxious and unintended events occurring in association with medical care” [10]. AEs are associated with quality of care because half of them are preventable or the harm to the patient could at least partially be prevented [11, 12].

AEs occur frequently: globally, 42.7 million AEs occur each year, resulting in 23 million disability adjusted life years (DALYs) [13]. After discharge from hospital, one in five patients presents one or more AEs [11, 12]. Forster et al. [12] state that 23% of all readmissions is associated with an AE related to the hospital stay. Additionally, a large-scale Dutch study [14] reveals that one in four patients with an AE related to the hospital stay is readmitted.

Readmissions resulting from underuse of medical care

Underuse of medical care occurs when patients do not receive the care recommended by medical standards. This was studied by McGlynn et al. [15], who showed that 46.3% of patients do not receive the care recommended. In addition, several researchers have reported the association between underuse of medical care and readmissions. In 1997, Ashton et al. [16] described in a meta-analysis how the risk of early readmission increased by 55% when the quality of in-hospital care – defined as the degree to which the care processes were in line with accepted standards of routine hospital care – was substandard. Other studies reveal that suboptimal treatment (procedures not performed or suboptimal medical treatment), insufficient investigations and incomplete diagnoses are important causes of preventable readmissions [17-19].

Readmissions resulting from a gap in continuity of care

Because guaranteeing continuity of care is essential to preventing readmissions, this topic is discussed here more thoroughly. Continuity of care is threatened when patients are discharged from hospital to home; not only does the care setting change, but the care team at home consists of other professionals, working in another context with other responsibilities.

A good description of continuity of care is provided by Reid et al. [20]: “how one patient experiences care over time as coherent and linked; this is the result of good information flow, good interpersonal skills, and good coordination of care”. This definition incorporates three types of continuity: information, provider and management continuity.

Information continuity

Information continuity is related to the transfer of information about patients’ care, as well as information about preferences and values [20]. Hospital physicians communicate to their colleagues in primary care mainly by writing a discharge summary. The timeliness of receiving this discharge summary can be important for the primary care physician (PCP) to be able to guarantee continuity of care. The literature suggests that the availability of discharge summaries offers room for improvement, with 12-34% of the discharge summaries not available at the time of the first post-discharge visit to PCP or other physicians [21-23]. Horwitz et al. [24] showed that 38% of discharge summaries were not sent to any outpatient physician in a tertiary care hospital. However, no association can be found in the literature between readmissions and timeliness of the discharge summary. Van Walraven et al. published two studies on this topic and could not find evidence of an association between readmissions and timeliness of discharge summary. In the first study [22], discharge summaries were made for 71% of patients, but 10% of them were not sent to a physician and discharge summaries were only available in 12% of the outpatient visits. In the second

study [25], the availability of the discharge summary was not associated with a decreased risk of urgent readmissions for patients with two or more post-discharge physician visits.

Also the accuracy of the discharge summary offers room improvement. A comprehensive discharge summary can, for example, reduce the number of medication errors [27]. Different researchers have studied the relationship between the content of the discharge summary and readmissions [22, 28, 29], but no association has been found.

Provider continuity

Provider continuity (also called relational continuity) indicates the ongoing relationship between patients and health professionals [20]. Jencks et al. [1] described how half of the patients readmitted within 30 days after discharge to home had no outpatient physician visit. Jackson et al. [26] and Brooke et al. [27] demonstrated that timeliness of post-discharge follow-up in the outpatient setting is essential to prevent readmissions. They concluded that early primary care follow-up decreases the risk of readmission significantly, especially in patients with a high risk of readmission. Van Walraven et al. [25] argued that post-discharge continuity with the regular physician is associated with lower readmission rates compared to visits with any other physician. However, only patients with two or more post-discharge physician visits were included in this study.

Management continuity

Management continuity assures that care is offered in a timely and coherent manner by different care providers [20]. One example of a possible threat to management continuity is pending results at the moment of discharge. With 41% of patients having pending results at the moment of discharge and almost one in ten of the results classified as potentially actionable, Roy et al. [28] state that this is a common challenge for continuity. In the same study, 62% of the primary care physicians were not aware of the potentially actionable results. Inevitably, hospital physicians were dissatisfied with the follow-up of their colleagues in primary care. Not only is the follow-up of pending results a challenge for continuity of care, but the execution of the recommended work-up at the moment of discharge is as well; this was not completed in 36% of the cases in a retrospective cohort study [29].

Care transitions as a crossroads in healthcare

Care transitions are defined by Coleman et al. [30] as “the movement patients make between healthcare practitioners and settings (hospital, ambulatory care practices, home health, rehabilitation facilities, hospices, long-term care facilities…) as their condition and care needs change during the course of a chronic or acute illness”. In the context of this research, we use the term “care transition” to indicate a patient’s movement from hospital to primary care.

The notion that care transitions are important has grown since the early 2000s, when the Institute of Medicine, in its report “Crossing the quality chasm” [31], promoted better coordination of healthcare delivery across different settings to achieve seamless care. Later, Maureen Bisognano [32], the former IHI president, and her colleagues indicated substandard quality of care transitions as the main cause of readmissions. Care transitions are important since, at the moment of transition, continuity of care can be threatened, AEs often occur and patients and their caregivers are often unprepared for discharge. The association of both continuity of care and AEs with unplanned hospital readmissions is discussed in the previous section. The unpreparedness of patients and caregivers is illustrated by Horwitz et al. [24], who interviewed patients admitted for acute coronary syndrome, heart failure or pneumonia. They reported that only 60% of the patients were able to accurately describe their diagnosis. In the same study, 30% of the patients were noticed of the discharge date less than one day in advance and only 66% of them were asked by staff whether they had enough support at home.

Researchers have found an association between substandard quality of care transitions and readmissions. Shalchi et al. [18] found that 11% of avoidable readmissions were due to inadequate discharge preparation, including ineffective handover to primary care and insufficient patient education. Coleman et al. [33, 34] developed a questionnaire to evaluate patients’ perspectives of the care transition, called the Care Transitions Measure (CTM). They showed that the result of this questionnaire, and thus the patient’s perception of the care transition, is related to subsequent emergency department (ED) visits and hospital readmissions for the same condition.

It is obvious that care transitions are moments prone to quality problems. In addition, at the moment of care transitions, patients are more vulnerable to quality problems. Vulnerability increases due to so-called “post-hospital syndrome” [35]. This term is used to indicate patients’ weak condition after discharge due to stress and physical deconditioning. Stress is induced during the hospital stay by pain, malnutrition, disturbed sleep patterns, anxiety, insecurity, information overload or medication use.

Why study readmissions in Belgium?

Although readmissions occur frequently, are costly and are, at least partially, related to suboptimal quality of care, until 2010 no systematic research was conducted on this topic in Belgium. There are, however, plenty of reasons to presume that readmissions could be an important health issue in Belgium now and in the future. In this section, important risk factors for readmissions and their prevalence in Belgium are discussed.

Ageing

Age is a well-known and important risk factor for readmission. In 2014 Belgian inhabitants had a life expectancy of 78.6y for males and 83.5y for females, and this is expected to increase to 84.6y and 88.9y respectively by 2060 [36, 37]. Because of the high life expectancy and low fertility rate, the top of the population pyramid has become wider, with the percentage of very elderly (80 years and older) reaching 5.4% in 2015 in Belgium, with an expected increase to 8.9% in 2060 [36].

Chronic diseases

Chronic diseases that increase the risk of hospital admissions (e.g. COPD or heart failure) are particularly associated with high readmission rates. The prevalence of chronic diseases is high in Belgium: in a large-scale Belgian health questionnaire in 2013, 28.5% of the population reported suffering from one or more chronic diseases [38].

Multimorbidity

The risk of readmission increases with the number of comorbidities [39]. The Belgian health questionnaire mentioned above also studied the prevalence of multimorbidity, defining multimorbidity as the presence of at least two of six chronic diseases (heart diseases, chronic lung diseases, diabetes, cancer, arthritis or arthrosis and hypertension). Multimorbidity increases with age and is present in 13.5% of the Belgian population [38, 40].

Socio-economic risk factors

Many studies confirm that patients with low incomes [1, 41-43], low education levels [44], low health literacy [45] or deficient social support [44, 46], or those belonging to an ethnic minority [1, 43, 47-50], have a higher risk of readmission. Data show that socio-economic risk factors are omnipresent in Belgium: in 2014, 5.9% of the population suffered from severe material deprivation [51] and almost one in ten young adults between 18 and 24 had not finished secondary school [37], and in 2008 13% of the total population was born outside Belgium [37]. Furthermore, inequality in care also exists in Belgium. This is illustrated

by Anson et al. [52], who found that native Belgians had better access to preventive healthcare than immigrants.

Social deprivation and loneliness of the elderly population

Loneliness and social deprivation are associated with a higher risk of readmission [53], and these are well-known problems in Belgium. Almost half of Belgian inhabitants 65 years and older state they feel lonely, and almost one in three is socially deprived [54].

Length of hospital stay

According to some authors, short lengths of stays are related to higher risks for readmission, especially among the elderly [55, 56]. Length of in-hospital stay is influenced by the hospital financial system. Since 2002 Belgian hospital payments have originated partially from a prospective hospital payment system based on All Patient Refined Diagnostic Related Groups (APR-DRGs) [57]. Because, in this system, hospitals are financed based on their casemix, independent of the costs, the length of hospital stay decreased in the years after implementation [58]. Length of stay for surgical, medical and geriatric patients in 2012 was 4.5, 6.0 and 19.2 days, respectively. This is a reduction in length of stay compared to 2001 of 26.4% for surgical, 28.6% for medical and 32.5% for geriatric stays [59]. If this decrease in length of stay is associated with premature hospital discharge before stabilizing the acute health problem, without sufficiently preparing patients and caregivers or without essential communication with primary care, then readmissions will be an important health issue in Belgium.

Care fragmentation

Care fragmentation is the result of care that is not coordinated; patients are treated by different healthcare providers with fragmentation of care within or between different healthcare settings. This fragmentation induces ineffective and inefficient care with high costs, medical errors and risks for discontinuity of care [60, 61].

Care fragmentation is also present in Belgium. Patients are free to choose their physician: more than 50% of Belgian inhabitants have at least one visit with a specialist each year, and most of them (63%) decide to consult the specialist directly, without consulting their general physician [62].

Based on patient characteristics, the hospital payment system and care fragmentation, we can argue that readmissions have an important impact on Belgian healthcare. Furthermore, the association between quality of care and readmissions, as described previously, is mostly based on US research. It is not clear whether this association, so apparent in the US, can be extrapolated to European countries. Fischer et al. [63]

reviewed European literature to examine the validity of readmission rates as a quality indicator in Europe and concluded that careful interpretation of readmission rates as a quality indicator is necessary. Both findings form the rationale for this study. The relevance of studying readmissions in Belgium increased recently with the introduction of a readmission penalty in 2014 and with the planned Belgian healthcare reform that focusses on care coordination and introduces integrated care programs.

Aim of the study

The overall aim of this thesis is to study how to reduce hospital readmissions that are due to substandard quality of in-hospital care or due to substandard quality of the care transition from hospital to home.

The contribution of this thesis is to create new knowledge about unplanned readmissions and to present practical solutions for reducing readmissions. To achieve the overall aim, four operational aims are formulated and seven research questions addressed.

The **first aim** is to explore the incidence of unplanned hospital readmissions in Belgium.

RQ1: What is the incidence of unplanned hospital readmissions in Belgium?

RQ2: Which patient groups are most frequently readmitted?

RQ3: What are risk factors for unplanned readmission in Belgian acute hospitals?

The **second aim** is to identify discharge interventions from hospital to home that have been demonstrated to be effective in reducing hospital readmissions within three months in medical/surgical adult patients and to understand the effect of discharge interventions on secondary outcome measures.

RQ4: Which discharge interventions are effective in reducing readmissions within three months after discharge from hospital?

RQ5: What is the effect of discharge interventions on mortality, use of emergency department and patient satisfaction?

The **third aim** is to understand the causes of readmissions related to suboptimal quality of care.

RQ6: How are readmissions related to the quality of in-hospital care processes for three patient groups?

Finally, the **fourth aim** is to understand the causes of readmissions related to suboptimal quality of care transition.

RQ7: How are readmissions related to the quality of care transitions from hospital to home for three patient groups?

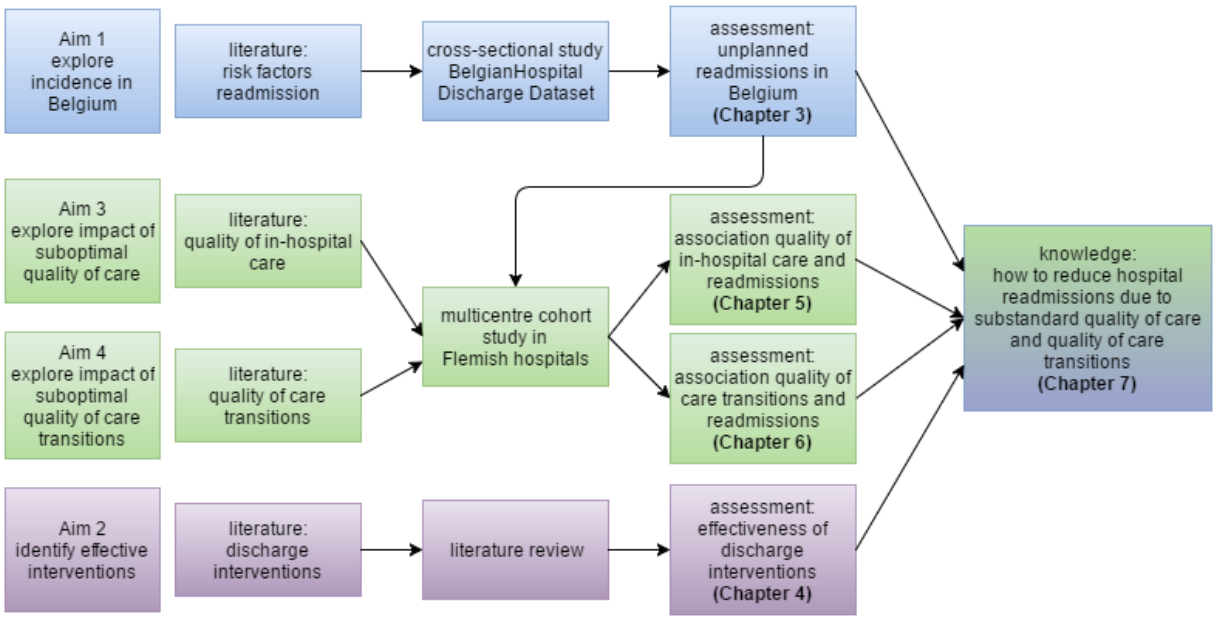
Focusing the scope of the study

After formulating the overall aim, we are able to focus and narrow the scope of the study. Because we are especially interested in readmissions linked to the quality of in-hospital care and the quality of the care transition from hospital to home, planned readmissions and care transitions to other care facilities are excluded. The aim also implies that we focus on the processes in the hospital and during the transition from hospital to home. Quality of care at home and care coordination between primary care professionals are therefore not included. We further limited this study to readmissions to general and university hospitals in Belgium, excluding psychiatric, geriatric and specialized hospitals. The study is limited to readmissions after a previous inpatient stay; one-day clinics were therefore excluded. Furthermore, specific populations are excluded, such as psychiatric and obstetric patients. Finally, the study is limited to adult patients 18 years or older.

Overview of the study

The four operational aims and their contributions to the overall aim are illustrated in Figure 2.1.

Figure 2.1: Outline of thesis research and chapters in thesis manuscript



After this **introduction** to the topic and to the doctoral research, **chapter two** adds essential background information. In this chapter different options for measuring readmission rates are discussed and illustrated by governmental incentives in different countries.

To be able to understand readmissions in Belgium, we first need to describe the phenomenon of readmissions in Belgian hospitals. This is done through a cross-sectional study based on the Belgian hospital discharge dataset (Be-HDDS). Medical and surgical adult inpatients discharged in 2008 from all 110 acute hospitals in Belgium were included in this study. The results are presented in **chapter three**.

The effectiveness of discharge interventions is studied by conducting a systematic literature review. This review, conducted according to the methodology of the Joanna Briggs Institute, is presented in **chapter four**.

In the **fifth chapter** the association between readmissions and quality of in-hospital care is addressed. To study this association we conducted a multicentre prospective cohort study in 12 Flemish hospitals. To measure quality of care, AEs were analysed through the information available in patient records.

The association between readmissions and quality of care transitions is described in **chapter six**. To describe quality of care transitions, five care transitions elements were measured: patient readiness for discharge, patient and caregiver education, contribution of general practitioner (GP) to the discharge process and timeliness and content of discharge summaries.

Finally, in the **discussion chapter** of the thesis manuscript the findings of the different studies are integrated and discussed. Practical recommendations for care professionals, hospital managers, policymakers and future research are formulated in this chapter.

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Chapter 2 - BACKGROUND

Outline

Because the aim of this thesis is to study how to reduce preventable hospital readmissions, it is fundamental to understand how readmission rates can measure relevant readmissions and how they can be used to reduce readmissions. In the first section, "Measuring readmissions", the process of identifying relevant readmissions is discussed. In the second section, "Governmental programs", the use of readmission rates in different governmental programs is illustrated. Finally, we formulate reflections on public reporting and penalizing readmissions.

Measuring readmissions

No guidelines exist for measuring and reporting readmissions. Nevertheless, many choices must be made that influence the validity of the readmission rate as an indicator of quality of care [1]. Thus, in reporting and benchmarking readmission rates, a clear description of the methodology is necessary. The most important measures for readmissions are readmission rate, standardized readmission ratio and risk-standardized readmission ratio.

The *readmission rate* is the number of readmissions within a specific time interval divided by the number of index admissions, and is expressed as a percentage. Admissions that can be followed by a readmission are called index admissions, or candidate admissions. The admission preceding a readmission is called the initial admission. The level at which the readmission rate is calculated (national, regional, hospital, department, medical speciality) depends on the target audience and the purpose of the indicator.

Readmissions can also be expressed as the ratio of observed readmissions to expected readmissions. This ratio, which corrects for risk factors, is called the *standardized readmission ratio* (SRR) [2]. An SRR greater than 1 expresses an excess of readmissions. The risk factors that are taken into account are often patient-related factors (e.g. age, comorbidities) or hospital-related factors (e.g. teaching status) and are mostly based on national statistics.

A third measure is the risk-standardized readmission ratio (RSRR). This measure is the ratio of predicted to expected readmissions multiplied by the national unadjusted readmission rate. The measure is specifically used in the US for public reporting and financial penalties (p. 27) and uses hierarchical generalized linear models. The number of predicted readmissions is the number readmissions predicted based on the hospital performance given the observed casemix. In the model hospital specific intercepts are used. The number of expected readmissions is the number of predicted readmissions based on the national performance given the specific casemix.

Defining relevant readmissions

Measuring readmissions requires good definitions of what will be considered a relevant readmission. It is therefore necessary to define the time interval between discharge of the initial admission and the readmission, the type of readmission (exclusion of planned admissions, only emergency admissions, etc.) and the reason for readmission (all-cause readmission, readmission related to initial stay, preventable readmission, etc.).

Defining the time interval

Readmissions are defined as hospital admissions within a specific time interval after previous discharge from hospital. The time interval is the maximum number of days between the discharge date of the initial admission and the admission date of the readmission. In exceptional cases, the time interval is not measured from the discharge date from the initial admission, but from the date of admission.

The choice of the time interval is important, because it determines the number of related readmissions that will be missed (false negatives) and the number of unrelated readmissions (false positives). When the time interval is too long, many unrelated readmissions will be counted. On the other hand, when the time interval is too short, relevant readmissions will be missed. Heggestad et al. [3] stated that after 30 days, 50% of readmissions had occurred and that 70% of the readmissions were related to the first admission. With a longer interval more readmissions will be counted, but the proportion of unrelated readmissions will increase. In particular, when readmissions are measured as an indicator of quality of care it is important that the proportion of unrelated readmissions is at a minimum, and thus the choice of a short time interval is pertinent. The 30-day interval is generally accepted as the interval with a minimum number of readmissions missed and a minimum number of unrelated readmissions [3-5]. Hence, this interval is the most often used in studies and benchmarks, making comparisons possible.

Defining the type of readmission

When readmissions are measured as a quality indicator, planned readmissions are not relevant, and therefore they must be excluded. The proportion of planned readmissions varies according to the patient population studied. To avoid measuring planned readmissions, oftentimes only emergency readmissions are counted.

Defining the reason for readmission

There are three situations concerning the reason for readmission: all-cause readmissions, related readmissions and preventable readmissions.
Studies using administrative databases frequently define *all-cause readmissions* within a specific time interval as relevant readmissions. However, this method has been criticised because using all-cause readmissions leads to overestimation. Not all readmissions are indeed related to the index admission and thus are relevant readmissions. To understand the impact of the choice of all-cause readmissions, we must first discuss why patients are readmitted. Different researchers have studied the reasons for readmission in large populations. Jencks et al. [6] studied readmissions of Medicare patients and found that most patients are readmitted for medical conditions (84.4% of the readmissions after an initial medical stay and 72.6% of the readmissions after a surgical stay). In that study, the most frequent reasons for readmission are potentially related to the initial admission. This is

confirmed by other studies [4, 7]. In Table 2.1 reasons for readmission and the rate of unrelated readmissions for two medical and two surgical examples are presented.

Table 2.1: Most frequent reasons for readmission and rate of unrelated readmissions for two medical and two surgical conditions

Patient groups		Description	Measure	Result
Medical conditions				
Heart failure	Medicare patients [6]	heart failure	2 most important reasons for readmission within 30 days	- heart failure (37.0%) - pneumonia (5.1%)
	Canadian population [7]	heart failure without coronary angiogram	2 most important reasons for readmission within 30 days	- heart failure without coronary angiogram (42.2%) - COPD (5.2%)
	US hospitals (Florida) [4]	congestive heart failure	unrelated readmissions within 15 days	14.4%
COPD	Medicare patients [6]	COPD	2 most important reasons for readmission within 30 days	- COPD (36.2%) - pneumonia (11.4%)
	Canadian population [7]	COPD	2 most important reasons for readmission within 30 days	- COPD (56.3%) - heart failure without coronary angiogram (5.2%)
	US hospitals (Florida) [4]	COPD	unrelated readmissions within 15 days	10.7%
Surgical conditions				
Major bowel surgery	Medicare patients [6]	major bowel surgery	2 most important reasons for readmission within 30 days	- GI problems (15.9%) - postoperative infection (6.4%)
	Canadian population [7]	colostomy/ enterostomy	2 most important reasons for readmission within 30 days	- postoperative complications except hemorrhage (14.9%) - other gastro-intestinal disorders (12.3%)
	US hospitals (Florida) [4]	major small & large bowel procedures	unrelated readmissions within 15 days	7.8%

Major hip or knee surgery	Medicare patients [6]	major hip or knee surgery	2 most important reasons for readmission within 30 days	- aftercare (10.3%) - pneumonia (5.1%)
	Canadian population [7]	knee replacement	2 most important reasons for readmission within 30 days	- aftercare (9.5%) - complications except hemorrhage (7.5%)
	US hospitals (Florida) [4]	hip joint replacement	unrelated readmissions within 15 days	12.0%

As an alternative to all-cause readmissions, only *related readmissions* could be counted. Related readmissions are readmissions for the same APR-DRG or MDC. Reporting only readmissions in the same APR-DRG induces high specificity but low sensitivity, and many relevant readmissions will be missed (Table 2.1).

A second alternative for all-cause readmissions is *preventable readmissions*. There are two kinds of preventable readmissions: potentially preventable readmissions that are identified using models based on administrative databases and clearly preventable readmissions that are identified by patient record review. We will discuss three examples of models used to identify potentially preventable readmissions.

Readmissions flagged by Goldfield et al. [4] as potentially preventable are:

- readmissions for reasons that are the same or closely related to the initial admission,
- acute exacerbations of chronic conditions that could be influenced by the initial admission, and
- complications that could be related to the initial admission.

This model uses APR-DRG classification to identify readmissions as potentially preventable. The software (Potentially Preventable Readmission Grouping Software) was developed and commercialized by 3M. The percentage of readmissions 15 days after discharge that are classified by Goldfield et al. as unrelated to the initial stay can be found in Table 2.1. They did not test the association of potentially preventable readmissions (based on the model) with clearly preventable readmissions (based on patient record review). This was done later by Jackson et al. [8], who compared the results of this software with manual patient record review and patient interviews to identify clearly preventable readmissions. With a sensitivity of 85% and a specificity of 28%, the authors argued that the software cannot replace manual patient record review to identify preventable readmissions.

Halfon et al. [2] defined potentially preventable readmissions as readmissions within 30 days that were related to the initial stay and were not expected to occur as part of a program of care. Potentially preventable readmissions were identified through a

computerized program. The correlation between the rate of clearly preventable readmissions (identified through patient record review) and potentially preventable readmissions was moderate (correlation coefficient 0.56) and the authors concluded that potentially preventable readmissions in this model can be used as an indicator to measure clearly avoidable readmissions.

Van Walraven et al. [9] defined potentially preventable readmissions as all urgent readmissions. Clearly preventable readmissions were defined as readmissions due to an avoidable adverse event. No correlation was found between potentially preventable readmissions and clearly preventable readmissions. This is not surprising, because the definitions of potentially and clearly preventable readmissions are debatable: many urgent readmissions will not be related to the initial readmission (e.g. traffic accidents), and limiting clearly preventable readmissions to avoidable AEs excludes other preventable readmissions due to suboptimal quality of care or quality of care transitions.

The problem with measuring preventable readmissions can be reduced to a problem with defining what is judged as preventable or unpreventable. When the judgment starts from the question “what can be prevented by me?”, other readmissions will be identified as unpreventable from the hospital’s point of view rather than from the primary physician’s, patient’s or payer’s point of view.

Reporting how readmissions are measured

In the previous section we discussed different options for identifying relevant readmissions. In this section we describe implications of other methodological issues that must also be taken into account when reporting readmission rates.

Same-hospital readmission rates versus all-hospital readmission rates

No substantial variation in the incidence of readmissions to another hospital is reported in different studies: Jencks et al. [6] , Goldfield et al. [4], Kind et al. [10] and Halfon et al. [2] found, respectively, percentages readmitted to other hospitals within 30 days after discharge to be 24.4%, 24.6%, 22% and 17%. The risk of readmission to another hospital is higher for low-volume, for-profit and teaching hospitals [6, 10]. Nasir et al. [11] analysed whether same-hospital readmissions could be used as a surrogate for all-hospital readmissions for Medicare patients admitted for heart failure. They ranked hospitals for same-hospital readmissions rates and for all-hospital readmission rates and found that 13% of the hospitals differed more than one quintile between both rankings. The authors concluded that same-hospital readmission rates cannot be used as a surrogate for all-hospital readmission rates.

Measuring readmissions or readmission chains

Most often, readmission rates are expressed as the percentage of index admissions that is followed by a readmission within a specific time interval. Thus, each index stay can be followed by one readmission, which can be a new index admission.

The Potentially Preventable Readmission Grouping Software (3M) [4, 12], discussed previously, considers readmission chains instead of individual readmissions. A readmission chain is a sequence of one or more readmissions that are clinically related to the initial readmission. The time interval between readmission and previous admission is limited to the chosen time interval, but the total interval between initial admission and last readmission can be longer in the case of chains with more than one readmission.

Defining relevant index admissions

Defining index stays depends on the purpose of measuring readmissions, and inclusion and exclusion criteria need to be specified. The inclusion (or exclusion) criteria can be based on many factors, including but not limited to the following:

- Demographic characteristics
    - inclusion: e.g. elderly patients
    - exclusion: e.g. patients living not within a geographic area, children
- Diagnosis or other clinical features
    - inclusion: e.g. patients admitted for a specific condition, patients admitted for the medical/surgical department
    - exclusion: e.g. death expected within a short time, patient groups with specific readmissions (psychiatric or obstetric patients)
- Risk factors for readmission
    - inclusion: e.g. patients with minimal level of activity, number of medicines
    - exclusion: e.g. patients with inevitable high readmissions (metastatic malignancies, multiple trauma)
- Destination after discharge
    - inclusion: e.g. patients discharged towards home
    - exclusion: e.g. patients transferred to another acute hospital, patients who die during hospital stay
- Type of admission
    - inclusion: e.g. planned admissions
- Type of discharge
    - exclusion: e.g. patients discharged against medical advice (AMA)

The criteria to select index stays can be different from the criteria to identify readmissions. For example, we could measure emergency readmissions following elective

surgical stays. To minimize bias due to differences in patient mix, the index population is often restricted to one or a few clinical conditions [13].

Inclusion and exclusion criteria for index stays must be chosen considering the aim of the indicator. Some admissions are never relevant as an index stay and therefore must be excluded from analysis: admissions that end with the patient's death (because it cannot be followed by a readmission) and patients that are transferred to another acute hospital (because this is in fact not a discharge).

Governmental programs

In the previous section we discussed theoretically several options to define readmission rates. These will be illustrated in this section by means of examples from four countries that use public reporting or financial penalties in order to reduce readmission rates. We will show that the definition of readmission rate as an indicator differs in each example and depends on the purpose. The indicators used for financial incentives in the four countries are presented in Table 2.2.

United States

Public reporting

Public reporting began in the US in 2010 in order to reduce readmission rates. Disease-specific and hospital-wide 30-day readmission rates for Medicare patients 65 years or older are published on the Hospital Compare website (Medicare) [14]. Diseases that are reported for are: COPD, heart attack (AMI), heart failure, pneumonia, coronary bypass graft (CABG) and hip or knee replacement.

The reported readmission rate is based on all-cause readmissions. Planned readmissions such as admissions for chemotherapy or rehabilitation are excluded. All of a patient's readmissions during the 30-day interval after discharge are counted as one readmission. Readmissions during the 30-day interval are not eligible to count as index admissions. Patients discharged against medical advice are excluded as index stays as well as patients transferred to another acute hospital and patients who die during hospital stay. For AMI, patients who are admitted and discharged on the same day are also excluded as index stays.

Financial penalties

With the Hospital Readmission Reduction Program (HRRP) as a part of the Affordable Care Act, hospitals with higher-than-expected readmission rates are financially penalized. The intent of the program is to provide an incentive for hospitals to improve the quality of care by focusing on care transitions and to reduce the number of preventable readmissions. Readmissions are defined as admissions to the same or another hospital within 30 days after discharge. Excess readmissions are the readmissions exceeding the hospital's expected readmission rate. A hospital's expected readmission rate is the national mean readmission rate for the specific condition adjusted for demographic factors and severity of illness. The penalty is an adjustment of the total annual inpatient payments. The maximum rate of penalty was gradually increased in the first three years of the HRRP, starting with 1% in 2013 to a maximum rate of 3% in 2015. The penalty is based on the number of the excess readmissions. The Centers for Medicare and Medicaid Services (CMS) estimate of total penalties was $290 million in the first year and increased to $428 million in

2015, with 78% of the US hospitals that are penalized and an average hospital penalty of 0.63% of total inpatient payments in 2015 [15].

Not all index admissions are subject to this program: only patients admitted for acute myocardial infarction, pneumonia, heart failure, COPD and elective hip or knee replacement are included. The last two conditions were added in 2015. In 2017 coronary artery bypass graft (CABG) surgery will be added as the sixth condition. Readmission rates for financial reimbursement are measured in the same way as the readmission rates for public reporting.

Impact

Readmission rates began to decline from the moment the US Congress enacted the HRRP in 2012 and have continued to decline since [15]. The hospital-wide readmission rate for Medicare patients declined from 19.5% before 2012 to 18.5% in 2012 and 17.5% in 2013 [16]. CMS calculated that 150,000 fewer patients were readmitted between January 2012 and December 2013 compared to the previous years. This observed reduction in readmissions is probably not only the result of improved quality of care and care transitions, but can also reflect unintended effects, such as: postponing readmissions until after 30 days, tightening admission criteria, refusing high-risk patients and avoiding admitting patients by ED or observation substitution [17, 18]. How important the escape mechanisms are is not yet known.

England

In England public reporting for readmission rates and financial incentives have existed since 2011 [19].

Public reporting

A time interval of 28 days is used for public reporting and both all-condition readmission rates and specific readmission rates are reported [20]. The specific readmission rates are calculated for fractured proximal femur, hip replacement, hysterectomy and stroke. Raw and risk-adjusted readmission rates are published.

Financial incentives

Financial incentives for reducing readmissions were introduced in 2011 as part of the program Payment by Results [21]. In contrast to the public reporting system, for financial incentives a time interval of 30 days is used and only emergency readmissions are considered. Exclusions are formulated for: maternity and childbirth, children age four or younger, emergency transfers from other hospitals, discharge against medical advice, cancer, renal dialysis and readmission after transplant. Hospitals are not reimbursed for

readmissions above the locally set threshold readmission rate of unavoidable readmissions. The local level of unavoidable readmissions is determined each year through patient record review. In contrast to public reporting, no risk-adjustment is done for reimbursement. The savings are reinvested in post-discharge prevention of readmissions.

Impact

The data published on the website cover the period from 2002/2003 to 2011/2011. Recent data are expected in August 2016. The impact of the national incentives on readmission rates is yet unknown.

Germany

No public reporting exists in Germany. Financial incentives were introduced in 2004 together with the Diagnosis Related Groups (DRG)-based hospital payment to prevent unintended consequences of this payment system [19]. The primary aim was therefore not quality improvement. In Germany, relevant readmissions are identified at the level of individual patients. Readmissions are relevant in one of three conditions: readmissions within the same DRG, readmissions within the same Major Diagnostic Category (MDC) when the first admission was a medical admission and in the second admission surgery was performed, and readmissions for complications of treatment performed during the initial admission. The time interval of relevant readmissions depends on the type of readmission. For readmissions with surgery after an initial medical admission, the time interval between discharge and readmission is 30 days. For readmissions within the same DRG or readmissions for complications, the time interval depends on the initial DRG and lies between four days (for ophthalmological surgeries) and 70 days (for craniotomy with radiotherapy). When a second admission is identified as readmission, the two admissions are merged into a single admission for reimbursement. Many exceptions are defined at the DRG level, resulting in 23% of all DRGs being excluded from this policy. No documentation could be found about the impact of the national initiative on readmission rates.

Belgium

In Belgium, readmissions have been penalized since 2014 [22]. Same-hospital all-condition and all-cause readmissions within 10 days after discharge are penalized by reducing the fixed amount per admission by 18%. This regulation is perceived more as a saving measure than as a measure to improve quality of care and quality of care transitions. Objections can be formulated because all readmissions are penalized, including planned readmissions and readmissions that are in fact transfers back to the initial hospital. As a possible mechanism to avoid penalties, planned readmissions and transfers can be delayed. However, this will only affect patients and will not add quality.

Table 2.2: Use of readmission rates for financial incentives in four countries

	US	England	Germany	Belgium
Risk adjustment?	YES: for age, comorbidities, patient frailty	NO	NO	NO
Selection of relevant readmissions				
Time interval	30 days after discharge	30 days after discharge	Dependent on situation: - same MDC: 30 days after discharge - same DRG or complication: DRG-specific limits (from admission date of initial stay)	10 days after discharge
Exclusion of planned readmissions?	YES	YES	NO	NO
All-cause readmissions?	YES	YES	NO - same DRG or; - same MDC or; - complication	YES
Preventable readmissions?	NO	YES (to set target)	NO	NO
How readmissions are measured				
Same- or all-hospital readmissions?	all-hospital	all-hospital	same-hospital	same-hospital
Individual readmissions or readmission chains	readmissions are dichotomous variables (present/not present)	individual readmission	individual readmission	individual readmission
Selection of relevant index admissions				
Demographic characteristics	inclusion: - 65y or older - Medicare patients	exclusion: - children younger than 4y	NO	NO

	US	England	Germany	Belgium
Diagnosis or other clinical features	inclusion: - COPD - AMI - heart failure - pneumonia - CABG - hip or knee replacement	exclusion: - cancer, chemotherapy or radiotherapy - obstetrics and childbirth - renal dialysis - transplant	exclusion: - obstetrics and childbirth - stays in ICU - some cancer DRGs - pain therapy - renal dialysis - pre-MDC DRGs (e.g. transplants) - error DRGs (surgery not related to the main diagnosis)	NO
Risk factors for readmission	NO	NO	NO	NO
Destination after discharge	exclusion: - transfer to other acute hospital - death during hospital stay	NO	NO	NO
Type of admission	NO	exclusion: emergency transfers from another hospital	NO	NO
Type of discharge	exclusion: discharge AMA for AMI: discharge on day of admission	exclusion: discharge AMA	NO	NO
Incentive				
Target	expected readmission rate based on national data	percentage avoidable emergency readmissions	individually set	no readmissions
Financial repercussion	adjustment of the total annual inpatient payments (max. 3%)	no reimbursement of readmission	merge of readmission stay with initial stay for reimbursement (1 DRG)	reduction of fixed amount per admission by 18%

AMA=against medical advice; AMI=acute myocardial infarction; CABG=coronary artery bypass grafting; COPD=chronic obstructive pulmonary disease; DRG=Diagnostic Related Group; MDC=Major Diagnostic Category

Reflections

There are many objections to using readmission rates for public reporting and penalizing readmissions, the most important of which are discussed briefly in this section.

Risk adjustment

Many factors can influence readmissions, including the patient's behavior and the availability and quality of post-discharge care. Herrin et al. [19] argued that 58% of the variation between hospitals in the US can be explained by the county in which the hospital is located. They found county characteristics to be independently associated with readmissions. The most important characteristic was accessibility of care: a higher number of general physicians and a higher number of nursing homes were associated with lower readmission rates. In addition to socio-economic factors other patient-related factors influence readmissions. Barnett et al. [33] tested the impact of a large set of patient characteristics on readmissions. Of the 29 patient characteristics tested, 22 were significantly associated with readmissions and 17 patient characteristics were differently distributed between hospitals with high and hospitals with low readmission rates. Patient behavior and accessibility of care are difficult to correct for. Thus, when hospitals are penalized for readmission rates, they are partially penalized for factors that cannot be controlled at the hospital level.

In the US there are many objections to the absence of risk adjustment for race or socioeconomic factors. Many studies confirm that patients with low incomes [6, 20-22], low education levels [23], low health literacy [24] or deficient social support [23, 25], or those belonging to an ethnic minority [6, 22, 26-29] have a higher risk of readmission [6, 22, 23, 28, 30]. Shih et al. [23] reported that the risk of being penalized is twice as high in minority-serving hospitals compared to non-minority-serving hospitals (61% to 32%) and the amount of readmission penalties for minority-serving hospitals is three times as high as for non-minority-serving hospitals ($112 million to $41 million) [34]. As a consequence, hospitals that need the money the most, because they must overcome more barriers to achieve high-quality transitions, suffer the most from this program. CMS is concerned that lowering the targets for hospitals with more low-income patients will slow down the improvements within this type of hospital:

> "…Notably, there were many public comments on risk adjustment for sociodemographic status at the patient-level and hospital-level. While we appreciate the commenters' feedback, we consider these topics to be out of scope of the proposed rule…because we do not want to mask potential disparities or minimize incentives to improve the outcomes of disadvantaged populations…." (Cited from the Federal Register, 2015) [37].

Small numbers

By measuring disease-specific readmission rates, the random variation is high for hospitals with small numbers of observations, making it impossible to distinguish between random variation and true performance. Possible solutions are to take into account all conditions or to publish readmission rates not annually but biennially or triennially [38].

Inverse association between readmissions and mortality

Various authors [39-42] have noticed a negative association between readmission rates and mortality rates for patients admitted for heart failure. This effect is present in hospitals with low mortality rates. A first possible explanation is the competing risk between death and readmission: patients who die in the hospital cannot be readmitted. Thus, hospitals with low mortality rates have more patients who can be readmitted. Another possible explanation is that in hospitals with low mortality rates more patients with a higher severity of illness are "saved" and discharged from hospital. These patients are, because of the higher severity of their illness, at a higher risk of readmission. A third explanation is that hospitals with low admission thresholds (patients are more likely to be admitted) have lower mortality rates because they have more low-severity patients and higher readmission rates resulting from the low admission criteria. This problem can be solved by using all-conditions readmission rates, because at this level the association between mortality and readmissions is absent [38].

Accepting the penalty

Hospitals can also accept the penalty instead of implementing expensive strategies to improve patients' transitions. Reducing readmissions is indeed often expensive, because extra nurses, pharmacists or other hospital employees have to be hired to implement discharge interventions. Leppin et al. [43] found that interventions delivered by two or more individuals were more effective in reducing readmissions compared to interventions delivered by one person. In the US, the risk of penalization when all hospitals improve remains the same, which means that hospitals can decide that trying to avoid penalties is not cost-efficient. Safety-net hospitals in particular, which serve the most vulnerable people, often have no budget to pay penalties for high readmission rates together with extra costs to reduce readmissions [36]. Other factors that do not encourage hospitals to implement improvement strategies are penalties that are low or when hospitals feel little accountability for the penalized readmissions. Both factors apply in Belgium.

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Chapter 3 - RISK FACTORS FOR UNPLANNED HOSPITAL READMISSIONS: A SECONDARY DATA ANALYSIS OF HOSPITAL DISCHARGE SUMMARIES

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Braet A, Weltens C, Sermeus W ,Vleugels A. 2015. Risk factors for unplanned hospital re-admissions: a secondary data analysis of hospital discharge summaries. *Journal of Evaluation in Clinical Practice,* 21(4)**,** 560-6.

Abstract

Objective: to identify patient groups at risk for unplanned hospital readmissions and risk factors for readmission.

Method: We analysed the Belgian Hospital Discharge Dataset (Be-HDDS) including data from 1,130,491 patients discharged in 2008. Patient and hospital factors contributing to readmission rate were analysed using a multivariable model for logistic regression.

Results: The overall unplanned readmission rate was 5.2%. Cardiovascular and pulmonary diagnoses were the most common reasons for readmission. We found that 10.4% of all readmissions were due to complications. A high number of previous emergency department (ED) visits proved to be a predictor for readmission (odds ratio (OR) for patients with at least 4 ED visits in the past 6 months 4.65; 95% confidence interval (CI) 4.25-5.08). Patients discharged on Friday (OR 1.05; 95%CI 1.01-1.08) and patients with a long length of stay (OR 1.19; 95%CI 1.15-1.23) also had a higher risk for readmission. Patients with short lengths of stay were not at risk for readmission (OR 0.99; 95%CI 0.95-1.02).

Conclusions: Actions to reduce readmissions can be targeted to patient groups at risk, and should be aimed at the caring for chronic cardiovascular or pulmonary diseases, preventing complications and multiple ED visits, and ensuring continuity of care after discharge, especially for patients discharged on Friday.

Introduction

Unplanned hospital readmissions occur frequently and are expensive. In 2004, almost one fifth of US Medicare patients were readmitted within 30 days of discharge [1]. The cost of these readmissions was $17.4 billion, out of $102.6 billion in total hospital payments. To reduce hospital readmissions national programs are introduced in many countries. The best known example is the Medicare Hospital Readmission Reduction Program (HRRP) as part of the Affordable Care Act, penalizing US hospitals with high readmission rates. In 2013 two thirds of the US hospitals were affected and $280 million was charged in readmission penalties [2].

A shorter length of stay might be associated with a higher probability for readmission because patients tend to be sicker when they leave the hospital, and the time available to prepare patients and caregivers for discharge becomes shorter. However the effect of length of stay on readmission rates is not yet clear. Some studies have shown that readmission rates rise with length of stay [3-6]. In other studies an association is found between short lengths of stay and readmission rates [7, 8] and one study had to conclude that there was no association with length of stay and readmissions [9]. Severity of illness might be a mediator effect, which is rarely corrected for in these studies.

The day of discharge is another important factor that may affect readmission rates. The risk of a lapse in continuity is assumed to be greater for patients discharged on Friday [10]. Studies searching for associations between readmission rate and day of discharge show inconclusive results [11, 12]. Since discharges on Friday are common, this parameter as it relates to readmissions will be studied.

The research questions of this study are (i) which patient groups are most frequently readmitted; (ii) what patient characteristics are determining the risk for readmission; (iii) is length of in-hospital stay associated with readmission; (iv) is discharge on Friday associated with a higher risk for readmission?

Methods

Study type and data source

We conducted a cross-sectional study using the 2008 Belgian Hospital Discharge Dataset (Be-HDDS) which is similar to international administrative data and includes data for all in-patients in acute hospitals. The 110 acute hospitals consist of 83 general hospitals, 7 university hospitals and 14 general hospitals with a university character. In Belgium no patient groups are excluded from admission to an acute hospital.

The collection of hospital discharge data has been compulsory in Belgium since 1990 for all in-patients in all acute hospitals. The Be-HDDS was commissioned by the Belgian Ministry of Public Health via the Royal Decree of 6 December 1994. The quality of the data is audited by the Ministry of Public Health in two ways. Firstly, a software program checks the data for missings, outliers and inconsistent data. Secondly, by regular hospital audits, a random selection of patient records is reviewed to evaluate the accuracy of the records [13]. The Be-HDDS contains patient demographics, data about the hospital stay (date and type of admission and discharge, referral data, admitting department, and destination after discharge) and clinical data (primary and secondary diagnoses as described in the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), diagnostic and therapeutic procedures as described in the ICD-9-CM). The Be-HDDS is used for hospital financing, epidemiology, and surveys of national quality. Patient conditions are categorized into 25 Major Diagnosis Categories (MDCs), and patients are further classified into All Patient Refined Diagnostic Related Groups (APR-DRGs) (2008: version 15). APR-DRGs are the subgroups of patients with similar clinical conditions and utilization patterns [14]. Next to APR-DRGs four classes (minor, moderate, major and extreme) of severity of illness and risk of mortality are calculated. The Be-HDDS does contain a unique hospital patient identifier which allows calculating readmissions in the same hospitals, but not between hospitals.

Data selection and definitions

We analysed patients readmitted to the same hospital within 30 days after discharge. The 30-day interval is generally accepted as the optimal balance between a high rate of readmissions and a low rate of unrelated or ‘false positive’ readmissions [1,15-17].

A readmission was classified as “unplanned” when it was coded as an urgent admission in the Be-HDDS. An initial admission was defined as the admission preceding a readmission. An index admission was defined as any admission that can be followed by a readmission. By this definition, an admission ending with the patient's death was not considered an index admission. Patients discharged to another hospital were also excluded from analysis because these discharges are transfers between hospitals and cannot be seen

as a patient discharge from hospital. Patients could have more than one index admission and more than one readmission, but an initial admission could only be followed by one readmission. We defined the readmission rate as the number of patients discharged from an acute hospital and urgently readmitted to the same hospital within 30 days, divided by the number of index admissions.

For this study, we sampled all medical and surgical patients > 17 years of age discharged in 2008 from all 110 acute general hospitals in Belgium. Two hospitals were excluded from the analysis, because of too small numbers for adult admissions. Outpatients, one day clinics and patients staying in the hospital for more than 6 months were excluded. Because of the chronic nature of certain conditions with expected or unavoidable readmissions, patients with burns (MDC 022), multiple significant trauma (MDC 025), myeloproliferative diseases (MDC 017), HIV (MDC 024), obstetric patients (MDC 014), and psychiatric ward patients were excluded from analysis. The number of hospitals and selected stays for each step in the selection process is presented in Table 3.1.

Table 3.1: Different steps in the selection of admissions

Actions		Number of hospitals	Number of admissions
1. Selection of all stays		139	6,104,474
2. Selection of type of stays	exclusion of outpatient emergency stays exclusion of one-day stays exclusion of newborns exclusion of psychiatric stays exclusion of in-hospital stays of more than 6 months	139	1,737,985
3. Selection of pathology	exclusion of MDC's 14, 17, 22, 24 and 25	139	1,543,113
4. Selection of age	exclusion of patients with birth year > 1990	139	1,363,876
5. Selection of hospitals	exclusion of non-acute hospitals exclusion of one hospital for children exclusion of one hospital with < 1,000 admissions	110	1,341,337
6. Selection of stays with no 30 day follow-up	exclusion of stays with discharge date > December 1, 2008	110	1,230,616
7. Selection of index stays	- exclusion of stays ending with patient's decease - exclusion of stays with discharge to another hospital	110	1,130,491

MDC=major diagnostic category

Analysis

To determine the factors that influence risk for readmission, we constructed a model consisting of two levels: patient and hospital. The patient variables included gender, age, discharge with or against medical advice, severity of illness, Charlson comorbidity index, length of stay, previous visits to the emergency department (ED), acuity at admission and discharge destination. For length of stay we did not use the absolute number of days spent in hospital, because this is strongly linked to the reason for admission, severity of illness and age. Instead, we classified each hospital stay as a short, intermediate or long stay by comparing the observed length of stay to the expected length of stay for patients with the same APR-DRG, age category (< 75 or ≥ 75 years) and severity of illness. The expected length of stay was based on the national database. Lengths of stay shorter than the first quartile of the expected length of stay were classified as short and those longer than the third quartile as long. Patients with rare conditions (less than 10 patients for a specific APR-DRG, age category and severity of illness per year for the whole country) were excluded from the analysis.

We used the Charlson comorbidity index as described by D'Hoore [18.19] which uses only the first 3 digits of the ICD-9-CM code. This makes the index less influenced by coding optimization. Patient acuity at admission was operationalized by noting the type of admission. Urgent admissions, whether to the ED or not, were classified as acute admissions. Planned admissions were classified as non-acute. For the multivariable model, we calculated the number of all previous visits to the ED for 180 days preceding the index admission. Therefore, only patients admitted after 01 July 2008 were selected for analysis in the multivariable model. Within the model, the variable of patient MDC was withheld as confounding variable.

To analyse the effect of discharge home versus discharge to a nursing facility destination after discharge was used as variable in the multivariable model. The hospital variables in the model were the number of discharges on Friday, the quartile hospital length of stay, the average hospital mortality percentage, and hospital size as indicated by total yearly number of admissions. To classify hospitals according to the hospital length of stay, we calculated first for each patient the difference between the observed length of stay and the median expected length of stay. Next, we calculated for each hospital the mean difference between the observed length of stays and the expected length of stays. These differences were distributed normally and could be divided into four quartiles. In this way hospitals could be classified as hospitals with a long length of stay (differences of observed length of stays and expected length of stays in fourth quartile), a short length of stay (differences in first quartile) and an intermediate length of stay (second and third quartiles). The number of deaths among patients with minor or moderate risk of mortality was used to determine the hospital mortality rate, calculated as the number of patients with mortality risks 1 and 2 divided by the total number of patients who died in the hospital. In the

multivariable model, hospital length of stay, hospital mortality, and number of admissions were categorized as low (or short), intermediate, or high (or long), with the second and third quartiles forming the intermediate category. In this way we compared readmission rates between hospitals with short versus long lengths of stay, low versus high hospital mortality, and low versus high number of admissions.

For multivariable analysis, logistic regression was used with unplanned readmission as dependent variable and the independent variables described above. SAS Enterprise Guide 4.2. was used for all statistical analysis.

Results

After exclusions of those patients with conditions having high or unavoidable readmissions, 1,130,491 index admissions among 110 acute Belgian hospitals were included in the analysis (Table 3.1). Of these, 116,288 admissions (10.3%) were followed by a readmission within 30 days and 58,819 of the readmissions were unplanned (50,5%). The overall unplanned readmission rate among patients in this data set was 5.2% of the index admissions.

Patient groups and reasons for readmission

15 APR-DRGs accounted for 30% of all readmissions (Table 3.2). The APR-DRGs with the highest number of readmissions were: COPD (140), heart failure (194) and pneumonia (139). Patients admitted in these APR-DRGs were often readmitted for the same reasons: COPD (26.7%), heart disease (16.7%) and pneumonia (11.6%).

In the top-15 of APR-DRGs we identified four surgical APR-DRGs. Readmissions for the surgical APR-DRGs were often due to complications of care. Overall among all readmissions, cardiovascular diagnoses were cited in 16.8% of readmissions, pulmonary diagnoses were cited in 13.3%, and complications of surgical and medical care were the reason for readmission in 10.4%.

Table 3.2: APR-DRGs with greatest number of readmissions and the three most frequent reasons for readmission

APR-DRG initial admission (code)	Total		Readmissions			Primary readmission diagnosis			Secondary readmission diagnosis			Tertiary readmission diagnosis		
	N	%	N	Rate (%)	% *	Description	N	% **	Description	N	% **	Description	N	% **
Chronic obstructive pulmonary disease, chronic bronchitis, emphysema (140)	20,924	1.85	3,077	14.7	5.2	Chronic obstructive pulmonary disease and allied conditions	1635	53.1	Pneumonia and influenza	291	9.5	Other forms of heart disease	132	4.3
Heart failure, congestive heart failure (194)	14,938	1.32	2,091	14.0	3.5	Other forms of heart disease	873	41.8	Pneumonia and influenza	112	5.4	Hypertensive disease	91	4.4
Simple pneumonia (139)	18,194	1.61	1,704	9.4	2.9	Pneumonia and influenza	392	23.0	Chronic obstructive pulmonary disease and allied conditions	202	11.9	Other forms of heart disease	140	8.2
Other digestive system diagnoses, food poisoning, benign tumour (250)	20,960	1.85	1,329	6.3	2.3	Other diseases of intestines and peritoneum	195	14.7	Symptoms	88	6.6	Complications of surgical and medical care, not elsewhere classified	87	6.5

APR-DRG initial admission (code)	Total		Readmissions			Primary readmission diagnosis			Secondary readmission diagnosis			Tertiary readmission diagnosis		
	N	%	N	Rate (%)	% *	Description	N	% **	Description	N	% **	Description	N	% **
Cardiac arrhythmia & conduction disorders, irregular heartbeat (201)	16,480	1.46	1,139	6.9	1.9	Other forms of heart disease	511	44.9	Pneumonia and influenza	58	5.1	Symptoms	55	4.8
Other vascular procedures, clipping aneurysm (173)	16,776	1.48	999	6.0	1.7	Complications of surgical and medical care, not elsewhere classified	269	26.9	Diseases of arteries, arterioles, and capillaries	164	16.4	Other forms of heart disease	68	6.8
Medical back problems, spondylosis, disc degeneration, back pain (347)	18,867	1.67	931	4.9	1.6	Dorsopathies	372	40.0	Symptoms	42	4.5	Other Forms Of Heart Disease	35	3.8
Major small & large bowel procedures, colostomy, ileostomy (221)	12,491	1.10	930	7.4	1.6	Complications of surgical and medical care, not elsewhere classified	265	28.5	Other diseases of intestines and peritoneum	160	17.2	Symptoms	56	6.0
Respiratory system signs, symptoms & other diagnoses, bronchitis, pleurisy (144)	15,190	1.34	929	6.1	1.6	Other forms of heart disease	86	9.3	Pneumonia and influenza	71	7.6	Symptoms	70	7.5

APR-DRG initial admission (code)	Total		Readmissions			Primary readmission diagnosis			Secondary readmission diagnosis			Tertiary readmission diagnosis		
	N	%	N	Rate (%)	% *	Description	N	% **	Description	N	% **	Description	N	% **
Urethral & transurethral procedures, repair, incision (446)	14,011	1.24	878	6.3	1.5	Other diseases of urinary system	278	31.7	Complications of surgical and medical care, not elsewhere classified	188	21.4	Symptoms	95	10.8
Respiratory malignancy (136)	6,144	0.54	845	13.8	1.4	Malignant neoplasm of respiratory and intrathoracic organs	276	32.7	Malignant neoplasm of other and unspecified sites	112	13.3	Diseases Of The Blood and Blood-forming Organs	64	7.6
Major joint & limb reattachment procedure of lower extremity without trauma (302)	32,030	2.83	798	2.5	1.4	Complications of surgical and medical care, not elsewhere classified	313	39.2	Other forms of heart disease	39	4.9	Fracture of Lower Limb	38	4.8
Nonbacterial gastroenteritis & abdominal pain, viral enteritis (249)	13,803	1.22	791	5.7	1.3	Symptoms	118	14.9	Other diseases of intestines and peritoneum	63	8.0	Intestinal infectious diseases	47	5.9
Urinary stones w/o ESWL without removal (465)	9,372	0.83	754	8.0	1.3	Other diseases of urinary system	545	72.3	Symptoms	64	8.5	Complications of surgical and medical care, not elsewhere classified	39	5.2

APR-DRG initial admission (code)	Total		Readmissions			Primary readmission diagnosis			Secondary readmission diagnosis			Tertiary readmission diagnosis		
	N	%	N	Rate (%)	% *	Description	N	% **	Description	N	% **	Description	N	% **
Degenerative nervous system disorders, Alzheimers, Parkinsons (42)	9,693	0.86	716	7.4	1.2	Hereditary and degenerative diseases of the central nervous system	243	33.9	Pneumonia and influenza	34	4.8	Fracture of Lower Limb	31	4.3

APR-DRG=All Patient Refined Diagnostic Related Groups; N=number

The APR-DRGs of the initial admissions are listed in order of decreasing total number of readmissions within 30 days of discharge.

Total number of index admissions was 1,130,491. Total number of unplanned readmissions was 58,819.

* Percentage of total unplanned readmissions for all APR-DRGs

** Percentage of unplanned readmissions for the specific APR-DRG

In the multivariable model we analysed 454,429 admissions, resulting in 23,815 readmissions. Multivariable logistic regression analysis produced a model predictive of hospital readmissions with a c-statistic of 0.733. The factors found to influence risk of readmission grouped are presented in Table 3.3.

Patient related factors that increased risk for readmission included male gender, age, discharge against medical advice, severity of illness, number of comorbidities, multiple previous ED visits, and acuity at admission. The highest odds of readmission were found in patients with ≥ 4 previous ED visits (4.65; 95% confidence interval (CI) 4.25-5.08) and in patients with the most severe illness (2.10; 95%CI 1.97-2.24). Studying the effect of destination after discharge we found a higher proportion of patients readmitted when discharged to a nursing home (8.95%) than when discharged home (5.08%). In the multivariable model, however, patients discharged home had higher odds for readmission compared to those discharged to a nursing facility (1.22; 95%CI 1.16-1.29).

Table 3.3: Odds of readmission based on multivariable analysis of patient- and hospital factors affecting readmission rate

Characteristic		Readmission		Odds ratio	
		Number	%	Estimate	95%CI
Patient					
Gender	Male	12,474	5.70	1.11	1.08-1.13
	Female	11,341	4.81	Reference	
Age	≥85	2,894	9.01	1.59	1.51-1.69
	75-84	6,730	7.81	1.55	1.48-1.61
	65-74	4,710	5.85	1.32	1.26-1.38
	50-64	5,019	4.34	1.13	1.09-1.19
	18-49	4,462	3.18	Reference	
Discharge mode	against medical advice	311	8.56	1.34	1.20-1.54
	on medical advice	23,504	5.21	Reference	
Severity of illness[§]	4	1,708	12.84	2.10	1.97-2.24
	3	6,258	10.66	1.87	1.78-1.96
	2	9,933	6.07	1.46	1.41-1.52
	1	5,915	2.70	Reference	
Charlson	≥3	7,142	11.84	1.84	1.77-1.92
comorbidity index	2	3,483	6.95	1.30	1.24-1.35
	1	3,173	6.73	1.27	1.21-1.32
	0	10,017	3.37	Reference	
Length of stay[§§]	Short stay	3,652	5.70	0.99	0.95-1.02
	Long stay	5,908	6.68	1.19	1.15-1.23
	Intermediate stay	14,241	4.72	Reference	
Previous visits to	≥4	702	21.84	4.65	4.25-5.08
emergency	2-3	2,977	13.00	2.54	2.43-2.66
department	1	5,645	7.97	1.68	1.62-1.73
	0	14,491	4.05	Reference	
Acuity	Acute	15,628	7.74	1.71	1.66-1.76
	Not acute	8,187	3.24	Reference	
Destination	to home	22,103	5.08	1.22	1.16-1.29
	to nursing home	1,712	8.95	Reference	
Hospital					
Weekday of	Friday	6,043	5.65	1.05	1.01-1.08
discharge	Other day	17,772	5.11	Reference	
Hospital length of	Short (≤ 1.1*)	7,036	5.27	1.02	0.99-1.06
stay	Long (≥ 2.7*)	5,332	5.41	1.00	0.96-1.03
	Intermediate (1.1 - 2.7*)	11,447	5.14	Reference	
Hospital mortality	High (≥ 28.5**)	3,649	5.19	1.09	1.04-1.14
	Intermediate (15.39 - 28.5**)	14,330	5.29	1.07	1.04-1.11
	Low (≤ 15.4**)	5,836	5.15	Reference	

Characteristic		Readmission		Odds ratio	
		Number	%	Estimate	95%CI
Number of admissions	Low (≤ 6,0)	2,086	5.72	1.03	0.98-1.09
	Intermediate (6,0 – 12,9)	10,484	5.37	1.01	0.98-1.04
	High (≥13,0)	11,245	5.04	Reference	

*Hospital length of stay expressed as the mean difference between observed length of stay and expected length of stay

**Hospital mortality rate expressed as percentage of total mortality in patients with low risk of mortality

§ Severity of illness: 23 admissions with severity 0 missing (1 readmission)

§§ Length of stay: 160 admissions with expected length of stay missing (14 readmissions)

The rate of unplanned readmissions in individual hospitals ranged from 2.4 to 7.6 (mean 5.2, standard deviation 1.0). Hospitals with high or intermediate mortality rates in patients with low risk of mortality had slightly greater odds for readmission than hospitals with a low mortality rate (1.09; 95%CI 1.04-1.14 for high mortality rates; 1.07; 95%CI 1.04-1.11 for intermediate mortality rates). We did not observe an association between the size of the hospital (number of total admissions) and readmission rates (odds 1.03; 95%CI 0.98-1.09 for hospitals with a small number of admissions; 1.01; 95%CI 0.98-1.04 for hospitals with an intermediate number of admissions compared to hospitals with a high number of admissions).

Length of in-hospital stay

Patients with a long length of stay had higher odds for readmission compared to patients with an intermediate length of stay (1.19; 95%CI 1.15-1.23). Patients with short lengths of stay did not have higher odds of readmission compared to those with intermediate stays (0.99; 95%CI 0.95-1.02).

Hospitals characterized as having long lengths of stay or short lengths of stay did not have higher odds for readmission than those with intermediate lengths of stay (1.00; 95%CI 0.96-1.03 for hospitals with long length of stay; 1.02; 95%CI 0.99-1.06 for hospitals with short length of stay).

Discharge on Friday

Odds for readmission were higher in patients discharged on Friday compared to those discharged any other day (1.05; 95%CI 1.01-1.08). In this data set, 23.7% of all patients were discharged on Friday. The weekday of discharge was also related to severity of illness. A higher proportion of patients with severe illness (severity 3 or 4) were discharged on Monday (22.5%) or Friday (19.2%) compared to 7.9% of patients with severe illness discharged on Sunday. Readmission rates in weekend-days were below the national average of 5.2% (4.4% on Saturday and 4.0% on Sunday).

Discussion

The average hospital readmission rate in Belgium is 5.2%, which is below the rate reported in other studies [20]. One explanation can be found in sample specifications. We included also young patients with low readmission rates that are frequently excluded in other studies. On the other hand, we excluded patient groups with expected or unavoidable readmission, patients discharged to other hospitals and we lacked data from readmissions into other hospitals.

Using the Be-HDDS had several limitations. One limitation was the absence of a unique patient identifier to follow individual patients across the various hospitals. The study was therefore limited to readmissions into the same hospital. Readmissions into other hospitals, however, are not trivial. Studies have shown that 19-24% of the readmissions occur in other hospitals than the index hospital [1, 21]. This makes that the real readmission rate in Belgium can be estimated between 6.4% and 6.8%. A second limitation was the lack of information about health care consumption or outcomes once the patient had left the hospital. One previous study demonstrated that half of readmitted patients had no visit with a physician between discharge and readmission [1]. Also, known social risk factors such as ethnicity, education, employment, and social support were absent in the Be-HDDS.

In this study we did not identify possible preventable readmissions. For this, we could not make the difference between “real” readmissions – linked to the initial admission – and multiple admissions – which are unlinked to the previous admission. Also, to better understand the hospital factor, further research by using multilevel analysis would be needed.

Despite these limitations, this study revealed several notable findings. The first one is that almost one third of all readmissions was previously admitted for an APR-DRG out of a list of only 15 APR-DRGs. Combined with the fact that 40% of all readmissions were due to cardiovascular or pulmonary diseases or due to complications, we can conclude that actions to reduce readmissions can be targeted to patient groups at risk.

Another important finding is the absence of a relation between short lengths of stay and high readmission rates. In fact, we found that longer patient stays were linked to higher readmission rates, despite correction for age, severity of illness, and comorbidity. This finding is in line with previous studies [3-6]. One possible explanation is a higher risk for adverse events after discharge in patients with long hospital stays [22]. Another explanation is the hypothesis that frail patients with a limited social network stay longer in the hospital, but have a higher risk for readmission. The practical implication of this finding is that health professionals need to be convinced that for a patient that is medically and socially ready for discharge delay of discharge need to be avoided. In patients with a long length of hospital stay, this long stay must be seen as a risk factor for readmission. For these patients

smoothing the care transition from hospital to home in cooperation with primary care physicians and home care nurses will be very important. A strength of this study is the correction of length of stay for APR-DRG, severity of illness and age. This correction is necessary to classify lengths of stay as short or long.

The high discharge rate on Friday is partially explained by the Belgian hospitals financing system which provides support based on the national average length of stay, and partially by the fact that hospitals are minimally staffed on the weekends. Thus, delaying a discharge until Monday is in neither the hospital's nor the patient's best interest. Discharging the patient on Friday will reduce the length of stay, and relieve the burden of the reduced weekend staff. The high readmission rate of patients discharged on Friday discloses the need for a patient screening system to identify those patients at risk for readmission so that, if care continuity cannot be ensured, the discharge can be postponed. This finding need to be considered when discussing the discharge date so that for frail patients discharge on Friday can be avoided or that other action can be taken such as contacting the primary care physician before discharge.

Another important finding is the highly positive relation between the number of previous ED visits and the readmission rate. This observation is congruent with the results of the LACE study in which the LACE index (Acuity, Comorbidity and the number of Emergency visits in the past 180 days) was identified as screening tool for patients with a high risk for readmission [6]. It is clear that multiple visits to the ED must trigger actions to coordinate the care around patient and caregivers. This requires collaboration and coordination between different groups of care providers and different levels of care and is at this moment focus of research [23-25].

Since 2014 in Belgium all readmissions to the same hospital within 10 days after discharge are penalized. The penalty includes a reduction of 18% in fixed amounts per admission. For several reasons this regulation is more a saving measure than a measure to improve coordination of care. Firstly, because all hospitals and all readmissions are penalized without any risk adjustment and secondly, because the interval is limited to 10 days. For a middle-sized acute hospital we found that 36% of readmissions within 10 days were planned and 2.5% involved patients that were transferred back after admission in another hospital. The negative implication of penalizing readmissions in this way could be that readmissions will be avoided by delaying admissions. Because only hospital stays of minimal one night are counted in this Belgian model, recurrent readmissions to ED are no trigger at this moment. Compared to the Belgian situation the Hospital Readmission Reduction Program (HRRP) within the Affordable Care Act in the US stimulates hospitals much more to improve coordination of care. Because only hospitals with excessive readmission rates for specific conditions are penalized for 30-days readmissions. In this case readmission rates are risk adjusted and readmissions for certain unrelated conditions or – for acute myocardial infarction – readmissions for related procedures are excluded.

Actions to reduce readmissions can be targeted to patient groups at risk, and should be aimed at the caring for chronic cardiovascular or pulmonary diseases, preventing complications and multiple ED visits, and ensuring continuity of care after discharge, especially for patients discharged on Friday.

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Chapter 4 - EFFECTIVENESS OF DISCHARGE INTERVENTIONS FROM HOSPITAL TO HOME ON HOSPITAL READMISSIONS: A SYSTEMATIC REVIEW

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Braet A, Weltens C ,Sermeus W. 2016. Effectiveness of discharge interventions from hospital to home on hospital readmissions: a systematic review. *JBI Database of Systematic Reviews & Implementation Reports,* 14(2)**,** 106-73.

Executive summary

Background

Many discharge interventions are developed to reduce unplanned hospital readmissions, but it is unclear which interventions are superior.

Objectives

The objective of this review was to identify discharge interventions from hospital to home that reduce hospital readmissions within three months and to understand their effect on secondary outcome measures.

Inclusion criteria

Types of participants

Participants were adults (18 years or older) discharged from a medical or surgical ward.

Types of intervention(s)/phenomena of interest

The included interventions had to be designed to ease the care transition from hospital to home or to prevent problems after hospital discharge.

Types of studies

This review considered only randomized controlled trials.

Types of outcomes

Primary outcome measure was hospital readmission within three months after discharge. Secondary outcomes included patient satisfaction, return to emergency department and mortality.

Search strategy

Studies in English between January 1990 and July 2014 were considered for inclusion. The databases searched were PubMed, Web of Science, Embase and CINAHL.

Methodological quality

Methodological validity was assessed by two reviewers prior to inclusion using the standardized critical appraisal instruments from the Joanna Briggs Institute.

Data extraction

Quantitative data were independently extracted by the two reviewers using the standardized data extraction tool from the Joanna Briggs Institute.

Data synthesis

Meta-analysis was performed by using a random effect model; data were pooled using Mantel-Haenszel methods. For subgroups analysis only papers with critical appraisal score of seven or more were selected.

Results

Meta-analysis was performed on 47 studies. The overall relative risk for hospital readmission was 0.77 [95%CI, 0.70-0.84] ($p<0.001$). The relative risk for return to the emergency department was 0.75 [95%CI, 0.55-1.01] ($p=0.06$) and for mortality 0.70 [95%CI, 0.48-1.01] ($p=0.06$). Patient satisfaction improved in favor of the intervention group in five out of the six studies evaluating patient satisfaction.

Exploratory subgroup analysis found that interventions starting during hospital stay and continuing after discharge were more effective in reducing readmissions compared to interventions starting after discharge (between subgroup difference $p=0.01$). Multi-component interventions were not superior compared to single-component interventions (between subgroup difference $p=0.54$). Interventions oriented on patient empowerment were more effective compared to all other interventions (between subgroup difference $p=0.02$).

Conclusions

Interventions designed to improve the care transition from hospital to home are effective in reducing hospital readmission. These interventions preferably start in the hospital and continue after discharge rather than starting after discharge. Enhancing patient empowerment is a key-factor in reducing hospital readmissions.

Recommendations for practice

Interventions to reduce hospital readmissions should start during hospital stay and continue in the community (grade A recommendation). This requires financial systems that support and facilitate collaboration between hospitals and home care.

Interventions that support patient empowerment are more effective in reducing hospital readmissions (grade B recommendation). To promote patient empowerment health professionals must be trained to increase patients' capacity to self-care.

Recommendations for research

Future research should focus on interventions that improve patient empowerment and on the effects of discharge interventions after more than three months.

Background

Unplanned hospital readmissions after discharge occur frequently and are very costly. In 2004, almost one fifth of the US Medicare patients were readmitted within 30 days and the cost of these readmissions was $17.4 billion, out of $102.6 billion in total hospital payments [1]. Early unplanned readmissions can be seen as a quality indicator associated with the process of inpatient care [2-5]. Not only defects in the quality of care during hospitalization but also during the care transition from hospital to home can lead to readmissions [6, 7]. Care transition is defined by Coleman [8] as 'a set of actions designed to ensure the coordination and continuity of healthcare as patients transfer between different locations or different levels of care within the same location'.

To improve care transitions and diminish hospital readmissions, multiple discharge interventions have been developed and tested. Discharge interventions in this paper are defined as interventions performed, at least partly, by hospital professionals, explicitly targeted to smooth the transition from hospital to home or to prevent or diminish problems after hospital discharge [9]. Discharge interventions can be one single action like a telephone call after discharge, but also complex interventions have been developed. Some examples of complex interventions are:

- Care Transitions Intervention, developed by Dr Eric Coleman [10-12]. This model, based on four pillars (medication self-management, patient centered record, follow-up and use of red flags), starts during hospitalization and is followed by a home visit and follow-up telephone calls.

- Advanced nurse practitioner care coordination [13].

- Ideal Transition Home Model [6, 14]. This model was created as a part of the 'Transforming Care at the Bedside' project for patients with congestive heart failure (Institute for Healthcare Improvement and Robert Wood Johnson Foundation). The four core elements of the Ideal Transition Home Model are: enhanced admission assessment of post-discharge needs, enhanced teaching and learning, enhanced communication at discharge and timely post-acute care follow-up.

- BOOST (Better Outcomes for Older adults through Safe Transitions): a program in Michigan [15]. The program consists of identifying high-risk patients, educating patients, scheduling follow-up appointments and medication reconciliation at discharge.

To choose the most efficient intervention for reducing hospital readmissions is difficult for managers or clinicians. The aim of this systematic review will be to facilitate this choice by synthesizing the best available evidence.

Before starting the research we performed a preliminary search of the Joanna Briggs Library of Systematic Reviews, Cochrane Library, Medline and CINAHL databases for systematic reviews published in the last five years and review protocols studying discharge interventions. We identified four JBI systematic reviews [16-19], one Cochrane systematic review [20] and also three other recent systematic meta-reviews [9, 21, 22].

Lee and Slyer studied the effectiveness of discharge interventions for patients with heart failure and found a positive effect with telephone based post-discharge nurse care [16] and nurse coordinated transitioning of care [18]. Domingo and her colleagues [19] evaluated the impact of discharge interventions on hospital readmissions for patients admitted with community acquired pneumonia and found an effect with medication reconciliation combined with follow-up telephone calls. The effect of caregiver education on readmissions for patients admitted with community acquired pneumonia was the focus of the study by McLeod-Sordjan and her colleagues [17], but they were unable to identify an effect due to problems of isolating caregiver education as a direct intervention. Shepperd and her colleagues [20] conducted a systematic review to determine the effectiveness of discharge planning. They concluded that hospital length of stay and readmissions to hospital were significantly reduced for patients allocated to discharge planning. The meta-review conducted by Mistiaen [9] examined the effectiveness of discharge interventions in reducing post-discharge problems. They found limited evidence that some interventions can reduce readmissions especially interventions that combine discharge planning and discharge support (aftercare). In a meta-review conducted by Scott [21] the efficacy of peridischarge interventions was investigated. The author found that mostly multi-component interventions with pre- and post-discharge elements were beneficial. This study, however, was carried out by only one reviewer and the primary outcome measure (readmission) was not specified. Hansen [22] published a systematic review examining interventions aimed at reducing readmissions. The authors concluded that no single intervention was associated with reduced risk of readmission. The only meta-analysis on discharge interventions was published by Leppin and colleagues [23]. They confirmed that complex interventions consisting of five or more different intervention components were more effective than interventions consisting of less than five components in reducing hospital readmissions within 30 days after discharge, and confirmed the hypothesis that interventions supporting patient capacity for self-care were more effective compared to interventions that did not increase patient capacity. Both Hansen and Leppin limited the search to readmissions within an interval of 30 days after discharge.

Although a recent systematic review and meta-analysis were available, the reviewers wanted to broaden the time span to three months based on the observation that in most studies the intervention lasted more than a month. The second reason to widen the time span is the expectation that effective discharge interventions reduce hospital utilization over a longer time instead of inducing only a short-term effect.

This review was conducted according to an *a priori* published protocol [24].

Objectives

The objective of this review was to identify discharge interventions from hospital to home that have been demonstrated to be effective in reducing hospital readmissions within three months in medical/surgical adult patients and to understand their effect on secondary outcome measures. The specific review questions are:

a. Which discharge interventions can reduce hospital readmissions within three months after discharge from the hospital?

b. In addition to reducing readmissions, what is the effect of these discharge interventions on mortality, use of emergency departments (EDs) and patient satisfaction?

Inclusion criteria

Types of participants

This review considered studies that include adult patients discharged from a medical or surgical ward of an acute hospital. Studies with participants aged 18 years or older, male and female were included. Studies with discharges from EDs or intensive care units and patients receiving palliative care, psychiatric care or obstetrical stays were excluded.

Types of intervention(s)/phenomena of interest

This review considered studies that evaluated discharge interventions. The included interventions must have been performed – at least partly – by hospital professionals with the intention of easing the care transition out of the hospital to home or to prevent or alleviate problems after hospital discharge. Disease specific approaches were not considered.

Types of studies

This review considered only randomized controlled trials.

Types of outcomes

Primary outcome measure was hospital readmission within three months after discharge from hospital. Hospital readmissions were defined as hospitalizations to the same

or another hospital for any reason within three months after discharge. Longer discharge intervals were excluded because the more time that passes between discharge and readmission, the less likely that the readmission is linked with the first admission, inducing false positive or unlinked readmissions [25]. Studies that did not measure hospital readmission rate were excluded. Secondary outcomes included patient satisfaction, return to EDs and mortality.

Search strategy

The search strategy aimed to find both published and unpublished studies. A three-step search strategy was used. First an initial limited search of MEDLINE and CINAHL was undertaken followed by an analysis of text words in titles and abstracts and of index terms used to describe the papers. A second search used all identified keywords and index terms, and was done across all included databases. Thirdly, the reference lists of all full text papers were searched for additional studies. Studies published in English between January 1990 and July 2014 were considered for inclusion. Before 1990 practically no studies were published on discharge interventions [22].

The databases searched were PubMed, Web of Science, Embase and CINAHL. The search strategy is documented in Appendix 4.I. Unpublished studies were retrieved by searching proceedings and meeting abstracts in Web of Science. To manage the references EndNote was used. Records were retrieved and added to the library by the primary reviewer. Two reviewers screened titles and abstracts independently. Conflicts were resolved by discussion. To assess the screening procedure compliance interrater reliability was measured by categorizing each study as “included” or “excluded” for a specific reason. Reasons for exclusion were listed in descending order: population, intervention, study characteristics, and outcome. For each excluded study the first listed reason for exclusion was registered. For papers with missing primary outcomes or primary outcomes that were not clearly described, the authors were contacted in November 2014 to provide additional information. All decisions about rejecting or obtaining documents were recorded by the same person, responsible for the library of references. Most full text articles were available from the internet; otherwise documents were ordered by the KU Leuven - University of Leuven Library. To be able to replicate the search process, all searches, decisions and steps were documented. A list of the papers that were retrieved is given in Appendix 4.II.

Assessment of methodological quality

Quantitative papers selected for retrieval were assessed by two independent reviewers for methodological validity prior to inclusion in the review using a standardized critical appraisal instrument from the Joanna Briggs Institute (Meta Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI)) (Appendix 4.III). Before starting critical appraisal the two reviewers agreed on the criteria for a positive or negative appraisal:

negative evaluation (answer=”no”) on questions 1, 7, 8, 9 and 10 needed to be clarified in the comments section, questions 3 and 5 were evaluated as “unclear” unless clearly described in the paper, and finally, question 6 was only answered negatively when this was mentioned by the author or evaluated as a possible source of bias. Disagreements between the reviewers were resolved through discussion.

Data extraction

Quantitative data independently extracted by the two reviewers were included in the review using the standardized data extraction tool from JBI-MAStARI (Appendix 4.IV). The data included specific details about the interventions, populations, study methods and outcomes of significance to the review question and specific objectives. Any disagreement was resolved by discussion.

Data synthesis

To estimate the effect size of discharge interventions on hospital readmission rates a meta-analysis was conducted. Between-trial heterogeneity was explored using I^2 and expressed as low when I^2 was smaller than 25% and high for I^2 greater than 75% [26]. Because patient characteristics varied between the different studies, weighted mean effect sizes were computed using a random effects model. The number of hospital readmissions in the comparison groups of each study was used to calculate relative risks using the Mantel-Haenszel method. Relative risks were preferred over odds ratios to eliminate the risk for misinterpretation. The possibility of publication bias was minimized by also including proceeding papers and meeting abstracts and by identifying meticulously duplicated reports.

To explore the effect of specific intervention characteristics, a post hoc subgroup analysis on studies of the highest quality (critical appraisal score of seven or more) was conducted. Because previous systematic reviews showed evidence of beneficial effect of the moment of execution of the intervention components (pre-discharge, post-discharge or both), the number of components, implementation of patient empowerment, and discharge planning we decided to analyse these interventions as subgroups in a meta-analysis. For subgroup analysis we used a random effect model to calculate within- and between subgroup effects [27]. Analysis - combined and on subgroups - was conducted with Review Manager 5.3 and 95% confidence intervals were used.

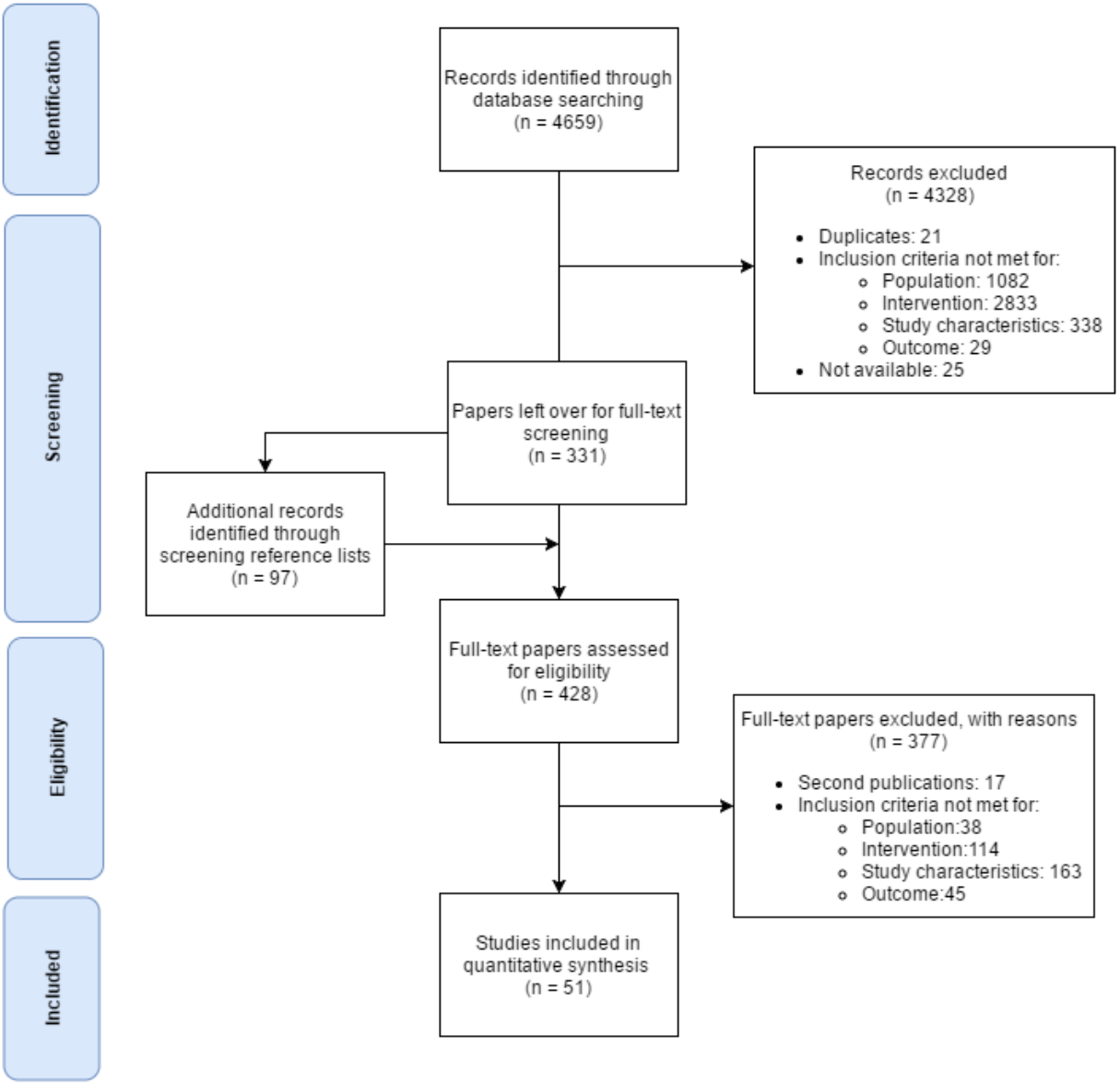
Results

Description of studies

Search of keywords in databases identified 4659 papers. Screening of titles and abstracts resulted in exclusion of 4328 papers and inclusion of 331 papers. The interrater reliability of this first screening was moderate, but statistically significant (Kappa 0.417, p=0.000) [28].

The review of the reference lists of the 331 papers identified 97 additional papers for full-text screening. Hence a total of 428 papers were retrieved for full text screening and comprehensive evaluation against the eligibility criteria. Because the primary outcome (readmission within three months) was not or not unambiguously recorded in some papers, 37 authors were contacted by email, resulting in nine useful answers [29-37] and additional inclusion of seven papers [29, 31, 32, 34-37]. Following this step (full text screening and contacting authors), 377 papers were excluded because the studies did not meet the inclusion criteria (Figure 4.1). Methodological quality of the 51 papers was assessed and no studies were excluded based on quality. To understand how readmissions were measured 16 authors were contacted, resulting in two useful answers [38, 39]. One of the 51 included papers was a conference proceeding [40]. Details of included and excluded studies are summarized in Appendix 4.VI and Appendix 4.VII.

Figure 4.1: Flowchart for inclusion of papers



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

Study Characteristics

The selected papers were published between 1990 and 2014, with 86% of them after 2000. Thirty-four out of the 51 included papers were published after 2004, hence this review proved to be complementary to the meta-analysis of Mistiaen (1994-2004) [9]. All papers described unique studies. Most of the studies were conducted in North America and Canada (55%), followed by Europe (25%) and Asia (10%). Sample sizes varied between 10 and 3,988 patients (median=175 patients).

Patient Characteristics

Studies included patients with cardiac diseases (n=21), patients admitted for an orthopedic problem (n=3), patients with pulmonary diseases (n=3), patients with stroke (n=1) and mixed groups (n=23). Often, only a population at risk was studied: in 17 papers only elderly or older adults were included, for Riegel the population at risk was a minority population [41] and in other papers chronically ill or other patients with high risk for readmission were studied. Study and patient characteristics are presented in Table 4.1 and in Appendix 4.VI.

Intervention Characteristics

In this review we compared a wide variety of interventions. To handle this, we categorized the different interventions based on a taxonomy introduced by Hansen [22] and adapted by Leppin [23] (Table 4.2 and Appendix 4.V). This taxonomy makes it possible to describe interventions based on their different components. Interventions were classified in three domains as interventions that took place in the hospital before discharge (pre-discharge), outside the hospital after discharge (post-discharge) or both (pre&post-discharge).

Table 4.1: Study and patient characteristics for the 51 included studies

Author, year	Setting	Intervention	Patient groups	Number of patients (intervention / usual care)	Quality criteria satisfied (N=10),n	Domains	Number of intervention components	Number of different disciplines
Balaban RB, 2008 [42]	community teaching hospital, US	discharge-transfer intervention	medical or surgical patients	96 (47/49)	6	pre & post	4	3
Basoor A, 2013 [43]	community teaching hospital, US	checklist	heart failure	96 (48/48)	6	pre	2	2
Braun E, 2009 [44]	teaching hospital, Israel	telephone follow-up	general medicine	309 (153/156)	4	post	1	NA
Burns ME, 2014 [45]	academic medical center safety-net hospital and 10 affiliated adult primary care practices	community health worker-intervention	patients at risk	423 (110 / 313)	5	pre & post	6	1
Chiantera A, 2005 [40]	public hospital, Italy	telecardiology	acute coronary syndrome	200 (99/101)	2	post	1	2
Coleman EA, 2006 [10]	integrated delivery system, US	care transitions intervention	chronically ill older patients	750 (379/371)	8	pre & post	8	1
Courtney M, 2009 [29]	tertiary referral hospital, Australia	exercise and telephone follow-up program	older medical patients at risk	168 (64/64)	7	pre & post	7	2
Dendale P, 2012 [31]	seven large hospitals, Belgium	telemonitoring facilitated collaboration	heart failure	160 (80/80)	7	post	2	2

Domingues FB, 2011 [39]	tertiary university hospital, Brazil	education and telephone monitoring	heart failure	120 (57/63)	5	post	1	1
Dowsey MM,1999 [38]	tertiary university hospital, US	clinical pathway	hip and knee arthroplasty	175 (94/81)	6	pre	2	2
Dudas V, 2001 [46]	academic teaching hospital and referral center, US	telephone follow-up	general medicine	221 (110/111)	6	post	1	1
Eaton T, 2009 [47]	public hospital, New Zealand	early pulmonary rehabilitation	COPD	97 (47/50)	9	pre & post	2	3
Evans RL, 1993 [48]	department of Veterans Affairs, US	discharge planning	patients at risk	835 (417/418)	3	pre	1	3
Forster AJ, 2005 [49]	tertiary care teaching hospital, Canada	nurse team coordinator	medicine patients	361 (175/186)	6	pre & post	4	1
Gonzalez-Guerrero JL, 2014 [32]	general hospital, Spain	disease management program in a geriatric daycare hospital	heart failure	117 (59/58)	10	post	3	3
Gurwitz JH, 2014 [50]	large multispecialty group practice, US	electronic health record–based intervention	medical-surgical	3661 (1870/1791)	8	post	2	NA
Harrison MB, 2002 [51]	teaching hospital, Canada	transitional care	heart failure	192 (92/100)	7	pre & post	6	2
Huang T, 2005 [52]	medical center, Taiwan	discharge planning	hip fracture	122 (63/59)	5	pre & post	8	1
Jaarsma T, 1999 [53]	University hospital, the Netherlands	education and support	heart failure	179 (84/95)	7	pre & post	5	1

Jack BW, 2009 [54]	safety-net hospital, US	reengineered discharge intervention	general medicine	738 (370/368)	9	pre & post	7	2
Kangovi S, 2014 [55]	two academically affiliated hospitals, US	intervention with community health workers	general medicine	446 (222/224)	8	pre & post	6	1
Koehler BE, 2009 [56]	university medical center, US	care bundle	high-risk elderly medical patients	41 (20/21)	8	pre & post	8	1
Lannin NA, 2007 [57]	rehabilitation unit, Australia	pre-discharge home visits	rehabilitation unit, older adults	10 (5/5)	7	pre	1	1
Laramee AS, 2003 [58]	academic medical center, US	case management	heart failure	256 (131/125)	5	pre & post	7	1
Legrain S, 2011 [59]	five university-affiliated hospitals and one private clinic, France	discharge-planning intervention	older adults	665 (317/348)	8	pre & post	4	1
Leventhal ME, 2011 [60]	university hospital, Switzerland	interdisciplinary management program	heart failure	42 (22/20)	7	post	7	1
Li H, 2012 [35]	regional hospital, US	CARE (Creating Avenues for Relative Empowerment)	older adults	407 (202/205)	7	pre	1	1
Lopez Cabezas C, 2006 [34]	general hospital and municipal hospital, Spain	active information program	heart failure	134 (70/64)	8	pre & post	3	1
Man WD, 2004 [61]	teaching hospital, UK	rehabilitation program	COPD	34 (18/16)	5	post	2	3

Marusic S, 2013 [62]	university hospital, Croatia	pharmacotherapeutic counseling	older medical patients	160 (80/80)	7	pre	1	1
Mayo NE, 2008 [63]	five acute-care hospitals within an university hospital network, Canada	case management	stroke	186 (93/93)	8	post	4	1
McDonald K, 2002 [64]	university hospital, Ireland	multidisciplinary care	heart failure	98 (51/47)	4	pre & post	4	2
Melton LD, 2012 [65]	hospitals in 50 states of US	prioritized post-discharge telephonic outreach	patients at risk	3,988 (1,994/1,994)	8	post	1	1
Naylor MD, 1990 [66]	medical center, US	comprehensive discharge planning	elderly patients, medical/surgical unit	40 (20/20)	6	pre & post	6	1
Naylor MD, 1994 [67]	university hospital, US	comprehensive discharge planning	elderly patients/4 cardial DRGs	142 (72/70)	4	pre & post	6	1
Nazareth I, 2001 [68]	three acute general and one long-stay hospital, UK	pharmacy discharge plan	elderly patients	340 (164/176)	7	pre & post	6	1
Osman LM, 2002 [69]	acute teaching hospital, UK	self-management program	acute asthma	280 (135/145)	7	pre	2	1
Parry C, 2009 [12]	two community based hospitals, US	care transitions intervention	elderly patients	98 (49/49)	7	pre & post	6	1
Rich MW, 1993 [70]	university hospital, US	comprehensive multidisciplinary treatment	elderly patients, heart failure	98 (63/35)	4	pre & post	6	1
Rich MW, 1995 [71]	university hospital, US	comprehensive multidisciplinary	elderly patients, heart failure	274 (136/138)	5	pre & post	6	1

		treatment						
Riegel B, 2006 [41]	two community hospitals, US	telephone case management	Hispanics of Mexican origin with heart failure	134 (69/65)	8	post	2	1
Saleh S, 2012 [72]	general hospital, US	comprehensive post-discharge care transition program	elderly patients	333 (160/173)	3	pre & post	6	1
Sales VL, 2013 [73]	teaching hospital, US	trained volunteers	heart failure	137 (70/67)	4	pre & post	5	1
Sethares KA, 2004 [74]	community hospital, US	tailored message intervention	heart failure	70 (33/37)	7	pre & post	1	1
Shyu Y, 2005 [75]	one hospital, Taiwan	interdisciplinary intervention program	elderly patients, hip fracture	137 (69,68)	5	pre & post	4	2
Strömberg A, 2003 [76]	one university hospital and two county hospitals, Sweden	nurse-led heart failure clinic	heart failure	106 (52/54)	8	post	3	1
Weaver LA, 2001 [77]	community hospital, US	telephone follow-up	cardiac surgery	90 (44/46)	3	post	1	1
Wong FK, 2011 [36]	acute regional hospital, China	health-social partnership transitional program	patients admitted to medical units	555 (272/283)	8	pre & post	5	2
Wong FK, 2014 [37]	acute general hospital, China	transitional care program: home visit group + call group	patients admitted to medical units	610 (196 (home visit)/204 (call)/210)	9	pre & post	5	2

Woodend AK, 2008 [78]	university hospital, Canada	telehome monitoring	cardiac disease	249 (124/125)	3	post	1	1
Zhao Y, 2009 [79]	comprehensive hospital, China	post-discharge transitional care program	coronary heart disease	200 (100/100)	5	pre & post	4	2

COPD=chronic obstructive pulmonary disease; DRG=diagnosis related group; NA=not available; post=post-discharge intervention; pre=pre-discharge intervention; pre & post=pre & post-discharge intervention

Table 4.2: Taxonomy to categorize discharge interventions

Intervention components	Description of the component
education	education of patient about diagnosis or treatment, not focused on self-management
discharge planning	development of an individualized discharge plan for a patient prior to leaving hospital for home [20]
medication intervention	medication reconciliation (creating the most accurate list possible of all medications) or medication review (evaluating critically all medications to optimize therapy)
appointment scheduled	follow-up appointment scheduled or patient is stimulated to schedule an appointment
rehabilitation	rehabilitation aimed at improving functional status
streamlining	streamlining of services or logistical coordination
home visit	visit to patient's home or place of residence
patient empowerment	interventions with the intention to increase patients control over his illness or stimulate the participation in the medical decision making process or reinforce psychosocial skills
transition coach	health worker who interacts with patient before and after discharge bridging inpatient and outpatient settings
patient-centered documents	adapted and individualized discharge materials or care plan to be used by patients
timely communication	arrangement to communicate or to communicate earlier with primary care provider, this can be physicians or nurses
timely follow-up	follow-up visit after discharge with physician or nurse as a part of the intervention
telephone call	patients or caregivers are contacted by telephone after discharge
patient hotline	presence of a direct telephone line for patient initiated communication
telemonitoring	an automated process for the transmission of data on a patient's health status from home to the respective health care setting [80]

Methodological quality

The quality of the selected studies varied widely, ranging from two to 10 on the critical appraisal scale for randomized controlled trials (Table 4.3). A critical appraisal score of 7 corresponded with the 75th percentile of all critical appraisal scores. We defined studies with a critical appraisal score of 7 or more as high-quality studies. Blinding of patients (Q2 in Table 4.3) and assessors (Q5) was clearly described in 10% and 31% of the included papers, respectively. In most papers (63%) blinding of the assessors was not mentioned, leaving it unclear as to whether this was done or not. Studies with ill-defined or weak randomization processes were not excluded.

Readmission rate measurement was assessed as reliable in 63% of the papers (Q9). Measurement of readmissions only based on patient or caregiver self-report was not assumed as reliable [35, 44, 51, 52, 62, 75, 77-79]. In one paper the readmission interval was not fixed; this outcome measurement was also evaluated as not reliable [49]. We had no description of how readmission rate was measured for nine papers [39, 40, 48, 57, 64, 67, 70-72]. Although assessed as reliable, in some papers only medical records or administrative data were used to evaluate the number of readmissions, possibly resulting in underestimation of the outcome measure [10, 36, 37, 42, 43, 46, 56, 68]. In four papers only disease specific readmissions were counted [43, 47, 64, 73]. In some studies only readmissions to the same hospital were studied [36-38, 42, 43, 60, 69, 72, 73, 76] contributing to a risk of underestimation. In other studies it was not clear whether readmissions to all hospitals or only to the primary hospital were counted [40, 44, 46, 47, 53, 56, 57, 64, 68, 75].

Riegel and colleagues [41] studied the effect of a discharge intervention on a specific population; Hispanics living on the US-Mexico border. Because of the specific socio-economic and cultural characteristics of this ethnic minority, such as language and education, the external validity of this research is questionable. Also in the study of Lopez Cabezas [34] the low educational level of the study population could be a problem for external validity. The high degree of illiteracy in that study (22% of patients in intervention group and 9% of patients in control group) will probably have an impact on education of patients. In some studies only small percentages of the total population were included inducing the risk of selection bias by inducing sampling bias [12, 44, 46].

Table 4.3: Critical appraisal of included studies using the MAStARI Appraisal instrument (Appendix 4.III)

Citation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Balaban RB, 2008 [42]	U	N	U	Y	U	Y	Y	Y	Y	Y
Basoor A, 2013 [43]	U	N	U	Y	U	Y	Y	Y	Y	Y
Braun E, 2009 [44]	N	N	U	N	U	Y	Y	Y	N	Y
Burns ME, 2014 [45]	U	N	U	U	U	Y	Y	Y	Y	Y
Chiantera A, 2005 [40]	U	N	U	U	U	U	Y	Y	U	N
Coleman EA, 2006 [10]	Y	N	U	Y	Y	Y	Y	Y	Y	Y
Courtney M, 2009 [29]	Y	N	Y	N	Y	N	Y	Y	Y	Y
Dendale P, 2012 [31]	U	N	Y	Y	U	Y	Y	Y	Y	Y
Domingues FB, 2011 [39]	Y	N	U	N	U	Y	Y	Y	U	Y
Dowsey MM, 1999 [38]	U	N	Y	U	U	Y	Y	Y	Y	Y
Dudas V, 2001 [46]	U	N	U	Y	U	Y	Y	Y	Y	Y
Eaton T, 2009 [47]	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Evans RL, 1993 [48]	U	N	U	Y	U	Y	N	U	U	Y
Forster AJ, 2005 [49]	Y	Y	Y	N	Y	N	U	Y	N	Y
Gonzalez-Guerrero JL, 2014 [32]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Citation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Gurwitz JH, 2014 [50]	Y	N	Y	N	Y	Y	Y	Y	Y	Y
Harrison MB, 2002 [51]	Y	N	Y	Y	U	Y	Y	Y	N	Y
Huang T, 2005 [52]	Y	N	U	N	N	Y	Y	Y	N	Y
Jaarsma T, 1999 [53]	Y	N	U	Y	N	Y	Y	Y	Y	Y
Jack BW, 2009 [54]	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Kangovi S, 2014 [55]	Y	N	Y	Y	Y	N	Y	Y	Y	Y
Koehler BE, 2009 [56]	Y	N	Y	Y	U	Y	Y	Y	Y	Y
Lannin NA, 2007 [57]	Y	N	Y	N	Y	Y	Y	Y	U	Y
Laramee AS, 2003 [58]	U	N	U	Y	U	N	Y	Y	Y	Y
Legrain S, 2011 [59]	Y	N	Y	Y	Y	N	Y	Y	Y	Y
Leventhal ME, 2011 [60]	Y	N	Y	N	Y	Y	Y	Y	Y	N
Li H, 2012 [35]	Y	Y	Y	Y	U	U	Y	Y	N	Y
Lopez Cabezas C, 2006 [34]	Y	N	Y	Y	U	Y	Y	Y	Y	Y
Man WD, 2004 [61]	Y	N	U	N	N	U	Y	Y	Y	Y
Marusic S, 2013 [62]	Y	N	Y	Y	Y	N	Y	Y	N	Y
Mayo NE, 2008 [63]	U	N	Y	Y	Y	Y	Y	Y	Y	Y
McDonald K, 2002 [64]	U	N	U	Y	U	Y	Y	U	U	Y

Citation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Melton LD, 2012 [65]	U	Y	Y	Y	U	Y	Y	Y	Y	Y
Naylor MD, 1990 [66]	Y	N	Y	N	U	N	Y	Y	Y	Y
Naylor MD, 1994 [67]	U	N	U	N	U	Y	Y	Y	U	Y
Nazareth I, 2001 [68]	Y	N	Y	N	U	Y	Y	Y	Y	Y
Osman LM, 2002 [69]	U	N	Y	Y	Y	N	Y	Y	Y	Y
Parry C, 2009 [12]	Y	N	U	Y	U	Y	Y	Y	Y	Y
Rich MW, 1993 [70]	U	N	U	Y	U	Y	U	Y	U	Y
Rich MW, 1995 [71]	Y	N	Y	Y	U	N	U	Y	U	Y
Riegel B, 2006 [41]	Y	N	Y	Y	U	Y	Y	Y	Y	Y
Saleh S, 2012 [72]	Y	N	U	N	U	N	Y	U	U	Y
Sales VL, 2013 [73]	U	N	U	U	U	Y	N	Y	Y	Y
Sethares KA, 2004 [74]	U	N	Y	Y	U	Y	Y	Y	Y	Y
Shyu Y, 2005 [75]	Y	U	N	N	U	Y	Y	Y	N	Y
Strömberg A, 2003 [76]	Y	N	Y	Y	Y	N	Y	Y	Y	Y
Weaver LA, 2001 [77]	U	N	U	Y	U	U	Y	Y	N	U
Wong FK, 2011 [36]	Y	N	Y	Y	U	Y	Y	Y	Y	Y
Wong FK, 2014 [37]	Y	Y	Y	Y	U	Y	Y	Y	Y	Y
Woodend AK, 2008 [78]	U	N	U	N	U	U	Y	Y	N	Y

Citation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Zhao Y, 2009 [79]	Y	N	U	N	Y	U	Y	Y	N	Y
%	**60.8**	**9.8**	**54.9**	**60.8**	**31.4**	**66.7**	**90.2**	**94.1**	**62.7**	**94.1**

Q1=was the assignment to treatment groups truly random?; Q2=were participants blinded to treatment allocation?; Q3=was allocation to treatment groups concealed from the allocator? Q4=were the outcomes of people who withdrew described and included in the analysis?; Q5=were those assessing outcomes blind to treatment allocation?; Q6=were the control and treatment groups comparable at entry?; Q7=were groups treated identically other than for the named interventions?; Q8=were outcomes measured in the same way for all groups?; Q9=were outcomes measured in a reliable way?; Q10=was appropriate statistical analysis used? Y=yes; U=unclear; N=no

Readmission rate

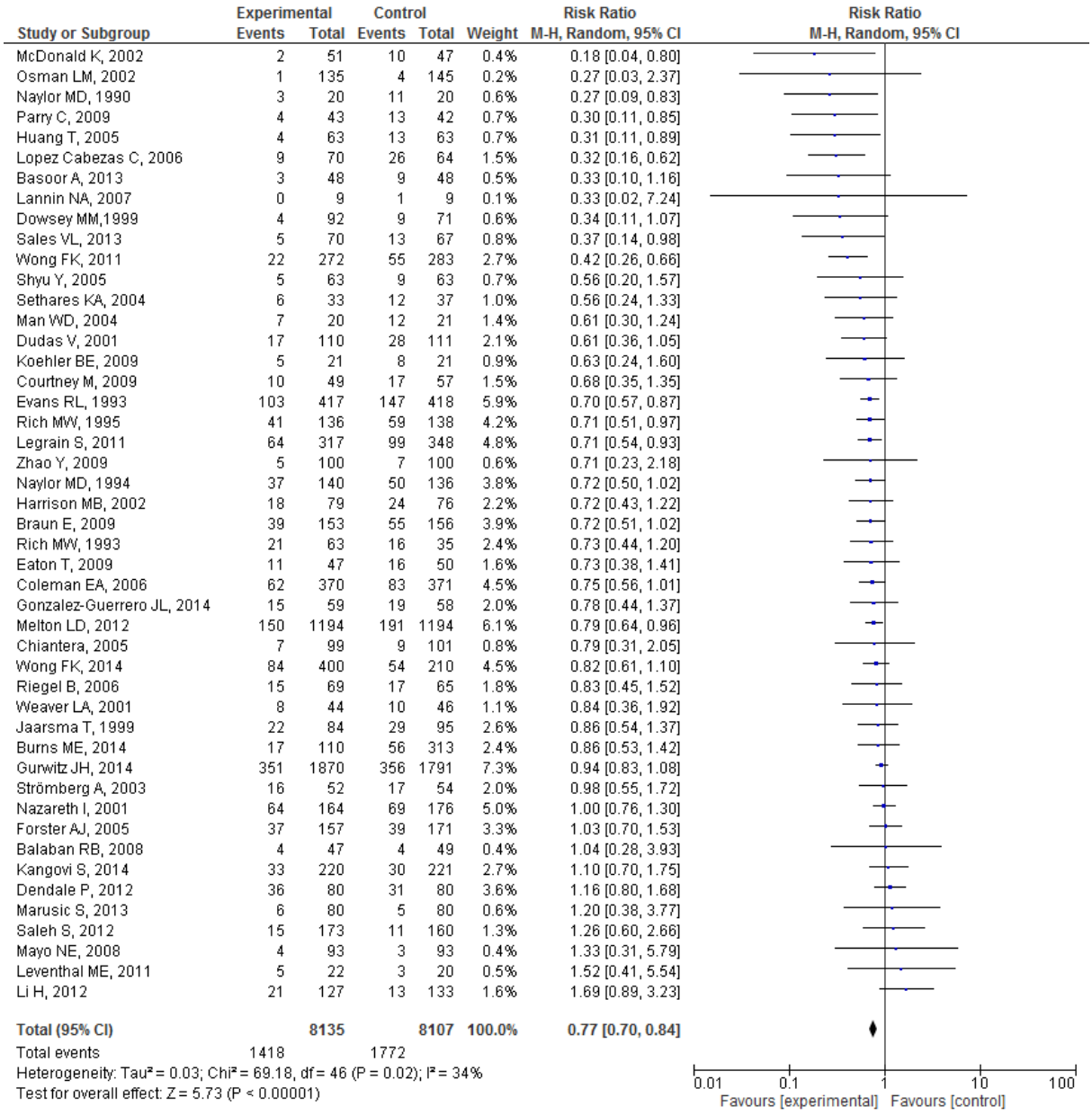
In two studies readmission rate was expressed as a compound result: Forster [49] included any post-discharge event (ED visit, death or readmission) and Weaver [77] the number of readmissions together with the number of ED visits. For meta-analysis the composite results were used.

In four studies [39, 54, 58, 78] only the total number of readmissions was mentioned but not the number of patients readmitted at least once within the readmission interval. The pooled relative risk for hospital readmission in these studies was 0.84 [95%CI, 0.66-1.06]. We decided to exclude the four papers for meta-analysis although the subgroup difference with papers using readmission rates was not statistically significant (Chi^2=0.46, p=0.50), leaving 47 studies for further meta-analysis.

In 12 studies hospital readmission was measured both after one and after three months. No difference in risk for readmission could be detected between both groups (RR, 0.64 [95%CI, 0.52-0.79] after one month and RR, 0.71 [95%CI, 0.62-0.82] after three months; p=0.39). For meta-analysis the longest available readmission interval (maximum three months) was used.

The overall relative risk for hospital readmission in the 47 papers was 0.77 [95%CI, 0.70-0.84] (p<0.001) (Figure 4.2). Although heterogeneity was not absent (p=0.02), inconsistency between trials was moderate (I^2=34%). Heterogeneity in the included studies was present in the populations (different ages, pathology groups, risk factors), in the interventions (different discharge interventions were tested, but also the usual care differed between studies) and in the context of the studies (different healthcare and financial systems).

Figure 4.2: Meta-analysis for hospital readmission rate comparing discharge interventions (experimental) to usual care (control)



M-H=Mantel-Haenszel; CI=confidence interval

Analysing subgroups

Post hoc subgroup analysis was used to evaluate if interventions in specific domains were more effective, if multi-component interventions were more effective than single-component interventions and if specific interventions were more effective in reducing hospital readmissions.

By exploring the subgroups, we observed a high discrepancy in the amount of high-quality studies (critical appraisal score of 7 or more) in the different subgroups. This was especially found in subgroups comparing interventions testing patient empowerment to

interventions without patient empowerment (10 out of 11 studies testing patient empowerment were high-quality studies compared to 16 out of 36 studies without patient empowerment). To eliminate the possibility of bias due to low study quality, only studies of the highest quality (critical appraisal score of seven or more) were selected for subgroup analysis, leaving 26 high-quality papers to analyse (

Table 4.4). To compare single-component interventions to multi-component interventions, there was a need to define a cut-off to identify these multi-component interventions. Similar to a previous meta-analysis on this topic [23], the cut-off according to the 75th percentile was defined, in this case, at six components. Readmission intervals of one and three months were analysed separately. Subgroups with less than three studies were not analysed.

Interventions with only components before discharge (pre-discharge interventions) and interventions with only components after discharge (post-discharge interventions) were compared to interventions with components both before and after discharge (pre&post-discharge interventions). This identified a statistically significant difference after three months of pre&post-discharge interventions compared to post-discharge interventions (between subgroup difference p=0.01).

No difference in risk reduction could be identified after one month for multi-component interventions compared to single-component interventions (between subgroup difference p=0.54).

We also tested the effects of two intervention components: patient empowerment and discharge planning. The group of interventions testing patient empowerment was both after one and after three months more effective in reducing hospital readmissions compared to the group of interventions not testing patient empowerment (between subgroup difference p=0.008 after one month and p=0.02 after three months).

The group of interventions testing discharge planning was more effective in reducing hospital readmissions in the first month after discharge than the group of interventions not testing discharge planning (between subgroup difference p=0.0004). This positive effect of discharge planning, however, disappeared three months after discharge (between subgroup difference p=0.57).

Table 4.4: Meta-analysis of subgroups in 26 papers with high critical appraisal score

Description of subgroup	Description of comparison	Interval	Number of studies (subgroup/ comparison)	Relative risk for hospital readmission [95%CI]		P†
				Subgroup	Comparison	
Domains						
Pre-discharge	Pre&post-discharge	1 mo	3/9	0.79 [0.30-2.07]	0.67 [0.51-0.88]	0.75
Post-discharge	Pre&post-discharge	1 mo	4/9	0.83 [0.66-1.02]	0.67 [0.51-0.88]	0.07
		3 mo	5/10	1.00 [0.78-1.28]	0.70 [0.61-0.81]	0.01
Pre-discharge	Post-discharge	1 mo	3/4	0.79 [0.30-2.07]	0.83 [0.66-1.02]	0.93
Interventions						
Multi-component interventions‡	Single-component interventions	1 mo	5/3	0.67 [0.42-1.07]	0.79 [0.63-0.99]	0.54
Patient empowerment	No patient empowerment	1 mo	7/9	0.59 [0.46-0.76]	0.87 [0.56-1.18]	0.008
		3 mo	8/9	0.70 [0.57-0.84]	0.93 [0.79-1.09]	0.02
Discharge planning	All other papers	1 mo	4/12	0.53 [0.38-0.73]	0.88 [0.79-0.97]	0.004
		3 mo	5/12	0.73 [0.54-0.98]	0.80 [0.70-0.92]	0.57

† between subgroup difference

‡: interventions with 6 or more components

mo=months

Secondary outcomes: return to emergency department, mortality and satisfaction

In addition to the effect on readmission rates, the effects of discharge interventions on ED visits and mortality were assessed. Table 4.5 presents the risk ratios of ED visits and mortality. The effect of discharge interventions on admissions to the ED was assessed in 10 papers. In three papers a statistically significant reduction in ED visits was observed after discharge. The overall effect was not statistically significant (RR, 0.75 [95%CI, 0.55-1.01]; p=0.06). The effect on mortality was tested in 14 papers. The discharge interventions had no overall effect on mortality (RR, 0.70 [95%CI, 0.48-1.01]; p=0.06).

Patient satisfaction was measured in six studies, using six different sets of questions. Because of the lack of a standard questionnaire, meta-analysis was not

performed. In five studies statistically significant results were reported in favor of the intervention group based on the individual questions or on the questionnaire; this is presented in Table 4.6.

Table 4.5: Risk ratio for emergency department-visits and mortality

First author, year	Intervention	ED visits Risk ratio [95%CI] (n=10)	Mortality Risk ratio [95%CI] (n=14)
Balaban RB, 2008 [42]	discharge-transfer intervention	1.04 [0.07-16.19]	-
Burns ME, 2014 [45]	community health worker - intervention	1.35 [0.83-2.20]	-
Courtney M, 2009 [29]	exercise and telephone follow-up program	-	0.67 [0.12-3.86]
Dudas V, 2011 [46]	telephone follow-up	0.41 [0.21-0.79]	-
Forster AJ, 2005 [49]	nurse team coordinator	-	0.82 [0.19-3.59]
Harrison MB, 2002 [51]	transitional care	0.63 [0.41-0.96]	-
Huang T, 2005 [52]	discharge planning	-	0.11 [0.01-2.02]
Jaarsma T,1999 [53]	education and support	0.85 [0.41-1.75]	-
Legrain S, 2011 [59]	discharge planning intervention	1.01 [0.45-2.25]	0.91 [0.61-1.36]
Lopez Cabezas C, 2006 [34]	active information program	-	0.15 [0.02-1.23]
Man WD, 2004 [61]	rehabilitation program	0.23 [0.06-0.95]	0.53 [0.05-5.35]
Marusic S, 2013 [62]	pharmacotherapeutic counseling	0.64 [0.35-1.15]	0.20 [0.01-4.10]
Mayo NE, 2008 [63]	case management	1.15 [0.58-2.29]	1.00 [0.06-15.75]
Nazareth I, 2001 [68]	pharmacy discharge plan	-	2.15 [0.75-6.15]
Rich MW, 1995 [71]	comprehensive multidisciplinary treatment	-	0.46 [0.19-1.09]
Sales VL, 2013 [73]	trained volunteers	-	0.96 [0.29-3.16]
Shyu Y, 2005 [75]	interdisciplinary intervention program	0.50 [0.16-1.58]	0.33 [0.01-8.03]
Strömberg A, 2003 [76]	nurse-led heart failure clinic	-	0.24 [0.07-0.79]
Wong FK, 2014 [37]	transitional care program: home visit group + call group	-	1.03 [0.06-16.35]
Total:		**0.75 [0.55-1.01]**	**0.70 [0.48-1.01]**

Table 4.6: Results of patient satisfaction questionnaires

First author, year	Questionnaire	Interval†	Result
Braun E, 2009 [44]	survey to evaluate satisfaction with: - information how to take medication - medical and nursing treatment - information at discharge	3 months	Statistically significant better scores for intervention group compared to usual care for satisfaction with information how to take medication (p<0.001) and satisfaction with medical treatment (p<0.001). No difference was found for the other questions.
Dudas V, 2011 [46]	survey to evaluate satisfaction with: - care - discharge information - length of hospital stay	2 or 6 weeks	Statistically significant better scores for intervention group compared to usual care for satisfaction with medication instructions (p=0.007). No difference was found for the other questions.
Forster AJ, 2005 [49]	survey based on a locally used survey; to measure perception of hospitalization processes and satisfaction of care	30 days	Statistically significant better scores for intervention group compared to usual care for physician having sufficient information about medical history (p=0.03). More patients recalled being contacted by hospital personnel after discharge (p<0.001). No statistically significant difference for questions about medication, written list of appointments, preparation for transition and quality of care.
Lopez Cabezas C, 2006 [34]	satisfaction survey used by the Catalan Health Department	2 months	Intervention group had statistically significant better scores on satisfaction with information compared to usual care (p=0.026).
Nazareth I, 2001 [68]	validated 7-item questionnaire to measure satisfaction with health services	3 months	No statistical significant difference between intervention and control groups (mean difference=0).
Wong FK, 2014 [37]	validated 15-item questionnaire	4 weeks	Intervention groups had statistical significant better total scores compared to control group (p<0.001) - not specified on what items the difference was noted.

†: interval between discharge and patient satisfaction questionnaire

Discussion

In this systematic review we searched for evidence to determine which discharge interventions reduce hospital readmissions within three months after discharge. We included 51 randomized controlled trials. Meta-analysis indicates that interventions developed to smooth the transition from hospital to home are effective in reducing readmissions. Subgroup analysis confirms that discharge interventions that start before discharge and continue after discharge are more effective in reducing hospital readmissions than interventions that only start after hospital discharge. Also interventions that support patient empowerment are more effective in reducing hospital readmissions compared to interventions that did not include patient empowerment.

When interpreting the results of the subgroup meta-analysis, it is important to consider that the tested component was mostly not the sole component. Furthermore, these results need to be interpreted as exploratory, keeping in mind that the differences found were not always related to the effects of the intervention characteristic being assessed.

Another factor influencing the data was heterogeneity. Heterogeneity was present in the studied populations, discharge interventions, interventions in the usual care group and context of the studies. Discharge interventions as well as interventions in the usual care group differed between the studies. A factor influencing the classification was that not all interventions were described clearly. Also the way hospital readmissions were measured and counted differed and was not always described well.

We can conclude that interventions to enhance discharge from hospital to home need to start in the hospital and continue after discharge rather than stopping at the moment of discharge or starting after discharge. This was already mentioned in previous reviews, emphasizing the importance of combining elements from the pre- and post-discharge phases [9, 21].

Based on this study we can't conclude that multi-component interventions are more effective in reducing hospital readmissions compared to single-component interventions. This is contrary to the conclusion of the meta-analysis conducted by Leppin [23]. One possible explanation for this difference is that the classification of the different components was not the same. It is difficult to define the components of an intervention and one can argue that even single-component interventions were not truly single-component ones. An example is the single-component intervention in Braun's study [44]. Participants in the intervention group were communicated by telephone one week and one month after discharge. During the telephone call the patient was asked how the recommendations at discharge were followed and about medication compliance. Even though there were two intentions behind the call, the intervention was classified as single-

component. The finding that multi-component interventions are not always more effective is also applicable for other knowledge translation interventions [81]. Wensing and colleagues suggested that multi-component interventions are not always superior to single-component interventions, but are more effective when they address different types of barriers.

Another important finding is that interventions that facilitate patient's capacity for self-care (patient empowerment) are superior in preventing hospital readmissions. This finding was also showed by Leppin [23]. Confirming the effect of facilitating patient's self-capacity is important as it reinforces the need for health professionals to evolve from a traditional model of patient education to one that is centered on empowering patients [82]. In the first traditional model, health professionals educating the patient about his/her condition is the most important goal. In the second model, the goal of patient education is to enable patients to make informed choices.

Conclusion

Meta-analysis indicates that discharge interventions reduce hospital readmission rates. Discharge interventions that start before discharge and continue after discharge are more effective in reducing hospital readmissions than interventions that only start after hospital discharge.

Recommendations for practice

Interventions to reduce hospital readmissions should start during the hospital stay, bridge the transition and continue in the community (grade A recommendation). Financial systems must support and facilitate collaboration between hospitals and home care.

Interventions that support patient empowerment are more effective in reducing hospital readmissions (grade B recommendation). Training caregivers and introducing processes to raise patients' capacity to self-care are important in order to reduce hospital readmissions.

Recommendations for research

As hospital readmissions are an important burden to the community, hospitals and individual patients, it is important to intensify the research to identify effective discharge interventions. Focusing on interventions to improve patient empowerment will be important in the future. Also more research is needed to assess the effects of discharge interventions after more than three months.

Conflicts of Interest

The authors declare that there were no conflicts of interest.

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Appendices

Appendix 4.I: Search strategy

Search ID	Search terms	Search limits	Database
S1	patient readmission AND (patient discharge OR continuity of patient care OR communication)	all adult>19 years published between 1/1/1990 and 07/31/2014 English language MeSH terms	PubMed
S2	(readmission OR rehospitalization OR rehospitalization) AND (discharge OR continuity OR transition OR "case management") NOT psychiatry	all adult>19 years published between 1/1/1990 and 07/31/2014 English language free text	PubMed
S3	(readmission OR rehospitali?ation$) AND (discharge OR continuity OR transition OR "case management")	published between 1990 and 2014 English language excluding subject areas: psychiatry, pediatrics, emergency medicine, psychology, anesthesiology, reproductive biology, rehabilitation, substance abuse, criminology, dermatology, dentistry, rheumatology, immunology, primary health care, law, pathology, biology, biophysics, genetics and heredity, cell biology, microbiology, critical care medicine, allergy, medicine legal, physiology and biochemistry molecular biology	Web of Science
S4	hospital readmission AND (hospital discharge OR continuity of care OR transition OR case management)	English language humans publications from 1990 to 2014 age groups: adults 18-64 years, aged +65 years areas of focus: NOT anatomy and development, biochemistry, genetics, medical instrumentation, microbiology, pathology and forensic science, paediatrics, pharmacology and pharmacy, radiology and nuclear medicine, toxicology and drug dependence	Embase
S5	(readmission OR rehospitali?ation$) AND (hospital discharge OR continuity of patient care OR case management)	English language human all adult publication date from January 1990 to July 2014	CINAHL

Appendix 4.II: Studies selected for retrieval

Balaban, RB. Redefining and redesigning hospital discharge to enhance patient care: A randomized controlled study. Journal of General Internal Medicine.2008; 23(8): 1228-1233.

Basoor, A. Decreased readmissions and improved quality of care with the use of an inexpensive checklist in heart failure. Congestive Heart Failure.2013; 19(4): 200-206.

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Appendix 4.III: MAStARI Appraisal instrument

JBI Critical Appraisal Checklist for Randomised Control / Pseudo-randomised Trial

Reviewer _____ Date _____

Author _____ Year _____ Record Number _____

	Yes	No	Unclear	Not Applicable
1. Was the assignment to treatment groups truly random?	☐	☐	☐	☐
2. Were participants blinded to treatment allocation?	☐	☐	☐	☐
3. Was allocation to treatment groups concealed from the allocator?	☐	☐	☐	☐
4. Were the outcomes of people who withdrew described and included in the analysis?	☐	☐	☐	☐
5. Were those assessing outcomes blind to the treatment allocation?	☐	☐	☐	☐
6. Were the control and treatment groups comparable at entry?	☐	☐	☐	☐
7. Were groups treated identically other than for the named interventions	☐	☐	☐	☐
8. Were outcomes measured in the same way for all groups?	☐	☐	☐	☐
9. Were outcomes measured in a reliable way?	☐	☐	☐	☐
10. Was appropriate statistical analysis used?	☐	☐	☐	☐
	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info. ☐

Comments (Including reason for exclusion)

Appendix 4.IV: MAStARI data extraction instrument

JBI Data Extraction Form for Experimental / Observational Studies

Reviewer _____ Date _____

Author _____ Year _____

Journal _____ Record Number _____

Study Method

RCT ☐ Quasi-RCT ☐ Longitudinal ☐

Retrospective ☐ Observational ☐ Other ☐

Participants

Setting

Population

Sample size

Group A _____ Group B _____

Interventions

Intervention A

Intervention B

Authors Conclusions:

Reviewers Conclusions:

Appendix 4.V: Classification of the interventions

	education	discharge planning	medication intervention	appointment scheduled	rehabilitation	streamlining	home visit	patient empowerment	transition coach	patient-centered documents	timely communication	timely follow-up	telephone call	patient hotline	telemonitoring	other
PRE-DISCHARGE INTERVENTIONS																
Basoor A, 2013 [43]	x					x										
Dowsey MM, 1999 [38]		x				x										
Evans RL, 1993 [48]		x														
Lannin NA, 2007 [57]							x									
Li H, 2012 [35]																FCG training
Marusic S, 2013 [62]	x															
Osman LM, 2002 [69]	x							x								
POST-DISCHARGE INTERVENTIONS																
Braun E, 2009 [44]													x			
Chiantera A, 2005 [40]															x	
Dendale P, 2012 [31]												x			x	
Domingues FB, 2011 [39]													x			
Dudas V, 2001 [46]													x			
Gonzalez-Guerrero JL, 2014 [32]												x	x	x		
Gurwitz JH, 2014 [50]				x							x					
Leventhal ME, 2011 [60]	x						x	x		x	x		x			care plan

	education	discharge planning	medication intervention	appointment scheduled	rehabilitation	streamlining	home visit	patient empowerment	transition coach	patient-centered documents	timely communication	timely follow-up	telephone call	patient hotline	telemonitoring	other
Man WD, 2004 [61]	x				x											
Mayo NE, 2008 [63]							x				x		x	x		
Melton LD, 2012 [65]													x			
Riegel B, 2006 [41]								x					x			
Strömberg A, 2003 [76]	x											x		x		
Weaver LA, 2001 [77]													x			
Woodend AK, 2008 [78]															x	
PRE-& POST-DISCHARGE INTERVENTIONS																
Balaban RB, 2008 [42]		x								x	x		x			
Burns ME, 2014 [45]	x	x		x					x		x		x			
Coleman EA, 2006 [10]	x		x				x	x	x	x			x			
Courtney M,2009 [29]		x			x		x		x	x			x	x		
Eaton T, 2009 [47]	x				x											
Forster AJ, 2005 [49]	x			x		x							x			
Harrison MB, 2002 [51]	x	x						x		x	x		x			
Huang T, 2005 [52]	x	x					x		x	x	x		x	x		
Jaarsma T, 1999 [53]	x						x		x				x	x		
Jack BW, 2009 [54]	x	x	x	x						x	x		x			
Kangovi S, 2014 [55]				x			x		x	x	x		x			
Koehler BE, 2009 [56]	x	x	x	x				x		x	x		x			
Laramee AS, 2003 [58]	x	x		x				x	x				x	x		
Legrain S, 2011 [59]	x		x					x			x					

	education	discharge planning	medication intervention	appointment scheduled	rehabilitation	streamlining	home visit	patient empowerment	transition coach	patient-centered documents	timely communication	timely follow-up	telephone call	patient hotline	telemonitoring	other
Lopez Cabezas C, 2006 [34]	x												x	x		
McDonald K, 2002 [64]	x					x						x	x			
Naylor MD, 1990 [66]	x	x							x		x		x	x		
Naylor MD, 1994 [67]	x	x							x		x		x	x		
Nazareth I, 2001 [68]	x	x	x				x			x	x					
Parry C, 2009 [12]	x		x					x	x	x			x			
Rich MW, 1993 [70]	x	x	x				x				x		x			
Rich MW, 1995 [71]	x	x	x				x				x		x			
Saleh S, 2012 [72]	x		x	x			x	x		x						
Sales VL, 2013 [73]	x		x	x						x			x			
Sethares KA, 2004 [74]	x															
Shyu Y, 2005 [75]		x			x		x					x				
Wong FK, 2011 [36]		x					x	x	x				x			
Wong FK, 2014 [37]		x					x	x	x				x			
Zhao Y, 2009 [79]	x						x				x		x			

FCG=family caregiver

Appendix 4.VI: Included studies

Study	Participants	Intervention A	Intervention B	Notes
Balaban RB, 2008 [42]	inclusion: - admission to medical-surgical department - medical home at one of the two primary care sites - discharge to home exclusion: - elective admissions	discharge-transfer intervention: - comprehensive, user-friendly patient discharge form - electronic transfer of the Patient Discharge Form to the primary care RNs - telephone contact by a primary care RN to the patient - PCP review and modification of the discharge-transfer plan	usual care: - discharge instructions handwritten in English - communication between the discharging physician and the PCP when needed - no communication between inpatient and outpatient RNs	- small study population (47 intervention, 49 usual care) - readmission to 1 of the 3 hospitals of an alliance - readmission abstracted from the EMR or progress notes
Basoor A, 2013 [43]	inclusion : - primary diagnosis of acute decompensated heart failure exclusion: - age (<18 years) - pregnancy	- use of a checklist with various evidence-based pharmacologic and nonpharmacologic therapeutic measures - counseling of patients about the interventions in the checklist	usual care: no checklist used	- small study population (48 intervention, 48 usual care) - patients in intervention group were not at random selected. Patients in the usual care group were at random selected out of all patients that did not receive the checklist intervention - readmission measured via hospital records; risk for underestimation - only disease specific readmissions
Braun E, 2009 [44]	inclusion: - admission to department of medicine exclusion: - no telephone access - language: not speaking	telephone calls one week and one month after discharge	usual care: discharge report for PCP given with patients	- large study population (200 intervention, 200 usual care) - patient satisfaction not measured by a validated questionnaire

Study	Participants	Intervention A	Intervention B	Notes
	Hebrew, Arabic, Russian or English - discharge within two days - cognitive impairment - patients were excluded after inclusion when they failed to answer at least one of the telephone calls			- only 400 patients out of 1878 patients were included; after inclusion patients who did not had full contact were excluded from analysis; risk for selection bias - low qualitative appraisal - readmission was measured by telephone interview; risk of underestimation
Burns ME, 2014 [45]	inclusion: - One or more risk factors: pathology (chronic heart failure, COPD or pneumonia), age (60 years or older), length of stay >3 days, weekend discharge, hospitalization within the previous 6 months, discharge to home - PCP in affiliated primary care practice	community health worker (CHW) intervention: - introductory visits during hospital stay - CHW participation in the hospital discharge process - weekly telephone calls to elicit patient concerns - liaison calls to primary care nurses as needed	usual care: - comprehensive, individualized home care plan reviewed with the patient - electronic transmission of the plan to primary care nursing staff - telephone call from a primary care nurse within 72 h of discharge to address medical questions or needs	- large study population (110 intervention, 313 usual care) - weekly phone calls only in 38% of intervention patients - readmission measured via medical records of health alliance (2 hospitals); risk of underestimation
Chiantera A, 2005 [40]	inclusion: - acute coronary syndrome exclusion: - bundle branch block and permanent pacemaker	telecardiology: ECG send spontaneously for symptoms and weekly as scheduled	usual care: follow-up visit after discharge	- critical appraisal: low methodological quality of paper - not mentioned how readmission was measured - no statistical analysis on readmission rates

Study	Participants	Intervention A	Intervention B	Notes
Coleman E A, 2006 [10]	inclusion: - age (65 years or older) - discharge to home - no documentation of dementia - no plans to enter a hospice - at least one of 11 predefined diagnoses is documented exclusion: - no telephone access - language: not English speaking - not within geographic area - admission for a psychiatric condition	care transitions intervention - assistance with medication self-management - patient-centered record owned and maintained by the patient to facilitate cross-site information transfer - timely follow-up with primary or specialty care - a list of “red flags” - transition coach met with the patient in the hospital, conducted a home visit and telephoned 3 times during a 28-day discharge period.	usual care: not described	- large study population (379 intervention, 371 usual care) - intervention based on patient empowerment - readmission abstracted from administrative records of contracted and non-contracted hospitals
Courtney M, 2009 [29]	inclusion: - age (65 years or older) - admitted with a medical diagnosis - at least one risk factor for readmission exclusion: - not able to participate in the intervention	- exercise and telephone follow-up program: - individualized care plan - individualized exercise intervention - pre-discharge: transitional care plan, assistance with the exercise program, written guidelines - post-discharge: home visit within 48 hours, follow-up telephone calls, availability of nurse for contact	usual care: not described	- intervention lasted longer than 3 months after discharge (6 months)
Dendale P, 2012 [31]	inclusion: - admission for heart failure exclusion - reversible heart failure and some other specified types - major cognitive dysfunction	telemonitoring facilitated collaboration: - telemonitoring of a set of parameters with actions of PCPs and heart failure clinic in case of deterioration - patients were followed in the heart-failure clinic at 3 and 6 months	usual care: - no telemonitoring - patients followed by PCP	

Study	Participants	Intervention A	Intervention B	Notes
	- previous residency in nursing home - cardiac rehabilitation program - severe kidney insufficiency or pulmonary obstructive disease - planned pacemaker or cardiac surgery - compromised survival			
Domingues FB, 2011 [39]	inclusion: - heart failure - age (18 years or older) exclusion: - no telephone access	telephone calls after discharge	usual care: - inpatients: educational nursing intervention (3-5 visits), educational manual, self-monitoring charts for weight - after discharge: follow-up visits	- not mentioned how readmission was measured - not used in meta-analysis because number of readmissions counted and not readmission rate
Dowsey MM, 1999 [38]	inclusion: - hip or knee joint arthroplasty exclusion: - revision arthroplasty - simultaneous bilateral joint arthroplasty - arthroplasty for acute trauma or complex tumor surgery	clinical pathway: daily goals, daily evaluation of discharge plan	usual care: absence of clinical pathway	- readmission only to primary hospital
Dudas V, 2001 [46]	inclusion: - general medicine patients - pharmacy-facilitated discharge	follow-up phone call by a pharmacist 2 days after discharge for patients with pharmacy facilitated discharge	pharmacy facilitated discharge without follow-up telephone call	- approximately 70% of the patients did not receive pharmacy-facilitated discharge and were not

Study	Participants	Intervention A	Intervention B	Notes
	- discharge to home exclusion: - language: not English speaking - unable to participate in a telephone conversation or complete a written satisfaction survey			eligible for inclusion; risk for selection bias - only 79 of the 110 patients in the telephone group were contacted by telephone; risk for underestimation of the effect - intervention lasted until 2 days after discharge - readmission measured via hospital records; risk for underestimation
Eaton T, 2009 [47]	inclusion: - COPD - exertional dyspnea interfering with daily activity exclusion: - not able to complete questionnaire - major cognitive dysfunction - comorbidities precluding the ability to participate in rehabilitation	inpatient and outpatient rehabilitation program with exercises and educational sessions	usual care: standardized care and education in accordance with the COPD guidelines	- small study population (47 intervention, 50 usual care) - only 40% attended ≥ 75% of the rehabilitation sessions (a priori definition of adherence) - in results only attendees in the intervention group were mentioned - unscheduled emergency visits (not only ED, but also primary care) were recorded, but results were not mentioned - only COPD related readmissions
Evans RL,	inclusion:	early discharge planning that starts on third day	usual care: no assessment by	- large study population (417

Study	Participants	Intervention A	Intervention B	Notes
1993 [48]	- patients at risk for long length of stay - readmission or discharge to nursing home: risk-screening index ≥ 3	of admission	social worker or only upon referral	intervention, 418 usual care) - control group could also receive discharge planning at request of the physician - not mentioned how readmissions were measured
Forster AJ, 2005 [49]	inclusion: - Patients admitted to one of the four general medicine teams	Clinical nurse specialists retrieved prehospital information, arranged in-hospital consultations and tests, arranged follow-up visits, provided patient education, telephoned patients after discharge	usual care: not described	- large study population (157 intervention, 151 usual care) - intervention lasted until 3 days after discharge - composite outcome (readmission + ED visits +/- death) - readmission interval approximately 30 days, but it could be longer
Gonzalez-Guerrero JL, 2014 [32]	inclusion: - acute heart failure - admission to geriatric service - hospital stay more than 2 days exclusion: - discharge to retirement home - bedridden patients - cognitive impairment - psychiatric condition	disease management program in a geriatric daycare hospital (GDCH): - pre-discharge: evaluation by team - post-discharge: telephone call within 48h, evaluation in GDCH after 10 days, 1 month and 6 months, geriatrician available by telephone (9-14h) and telephone follow-up by geriatrician after 3 months	usual care: manual with HF education follow-up by PCP	- high critical appraisal score (8/10) - intervention lasted longer than 3 months after discharge (6 months)

Study	Participants	Intervention A	Intervention B	Notes
	- compromised survival - impossibility to follow-up			
Gurwitz JH, 2014 [50]	inclusion: - PCP within medical group - age (65 years or older) - discharge to community exclusion: - psychiatric condition - discharge to hospice	electronic health record (EHR)–based intervention: - facilitate the information flow to PCPs about dates, medication - alerts to schedule follow-up visits within 1 week after discharge	usual care: no EHR	- large study population (1870 intervention, 1791 usual care) - intervention not focused on patients - intervention organized by a primary care medical group, but hospital is also involved
Harrison MB, 2002 [51]	inclusion: - congestive heart failure - home nursing care - stay > 24hours exclusion: - language: not English or French speaking - not within geographic area - cognitive impairment	- supportive care for self-management: evidence-based education program, education map - linkages between hospital and home nurses and patients: nursing transfer letter, telephone call within 24 hours of discharge, telephone advice from hospital RN, education booklet used at home, community RN consult with hospital RN - balance of care between the patient and family and professional healthcare workers	usual care: - in-hospital: o early assessment and discharge plan o weekly discharge planning meetings o consult of a regional home care co-coordinator as required o referral for home care, and necessary services - after discharge: usual home nursing care with assessment and monitoring, health teaching, direct care	- no additional providers: collaboration of hospital and home RN - outcomes measured by patient self-report; risk of underestimation
Huang T, 2005 [52]	inclusion: - hip fracture - age (60 years or older)	- pre-discharge: discharge plan, education, summaries of discharge plan are provided to patients and caregivers	usual care: patients received no brochures nor written discharge summaries	- outcomes measured by patient self-report; risk of underestimation

Study	Participants	Intervention A	Intervention B	Notes
	exclusion: - not within geographic area - too ill - cognitive impairment	- post-discharge: home visit, available by telephone, nurse initiated contacts		
Jaarsma T, 1999 [53]	inclusion: - heart failure NYHA class III and IV - diagnosis at least 3 months before - age (50 years or older) exclusion: - language: not Dutch speaking. - co-existing, severe chronic disease - discharge towards nursing home - psychiatric diagnosis - CABG/PTCA or valve surgery in last 6 months or expected within 3 months	supportive-educative intervention: - intensive, systematic and planned education during hospital stay and after discharge - study nurse telephoned patients, did home visit and was available by telephone	usual care: information for patients dependent on insight of individual nurses or physicians	- intervention lasted until 10 days after discharge
Jack BW, 2009 [54]	inclusion: - admission to medical department - discharge to community exclusion: - no telephone access - language: not English speaking - admission from skilled nursing facility/other hospital	RED intervention (Reengineered discharge): - during hospital stay: a nurse discharge advocate (DA) arranged follow-up appointments, confirmed medication reconciliation, and conducted patient education with an individualized instruction booklet that was sent to their primary care provider. - the DA created an after-hospital care plan (AHCP)	usual care: not described	- high critical appraisal score (8/10) - large study population (370 intervention, 368 usual care) - not used in meta-analysis because number of readmissions counted and not readmission rate

Study	Participants	Intervention A	Intervention B	Notes
	- planned hospitalization	- after discharge: a clinical pharmacist called patients 2 to 4 days after discharge to reinforce the discharge plan and review medications		
Kangovi S, 2014 [55]	inclusion: - general medicine service - age (18-64 years) - discharge towards home - low socio-economic status exclusion: - language: not English speaking	individualized management for patient-centered targets (IMPaCT) by CHW: - during hospital stay: set goals, create a plan, liaison between patients and care team - after discharge: support by home visits, telephone calls, coach patients to schedule and attend appointments	usual care: - discharge needs discussed in daily multidisciplinary rounds - reconciliation of medication changes by nurses - written discharge instructions for patients - discharge summary within 30 days to PCP	- large study population (222 intervention, 224 usual care) - protocol for CHWs recruitment and training - well-established usual care
Koehler BE, 2009 [56]	inclusion: - one of 20 selected DRGs - ≥3 chronic comorbidity conditions - age (70 years or older) - use of ≥5 medications - assistance for ≥1 ADL - discharge towards home exclusion: - no telephone access - language: not English speaking - primarily surgical admission - compromised survival	intervention group care bundle: - medication counseling/reconciliation - condition specific education/enhanced discharge planning - phone follow-up - personal health record to engage patients and promote information transfer to outpatient settings	usual care: not described	- small study population (20 intervention, 21 usual care) - intervention lasted until 1 week after discharge - composite outcome (readmission + ED visits) - outcome measurement via the hospital's electronic reporting system; risk of underestimation - effect on outcome greatest after 1 month and smaller after 2 months
Lannin NA, 2007 [57]	inclusion: - admission to rehabilitation	pre-discharge home visit: a single home-based occupational therapy session	usual care: single functional assessment and educational	- small study population (5 intervention, 5 usual care)

Study	Participants	Intervention A	Intervention B	Notes
	unit - referred to occupational therapy - discharge towards home - age (65 years or older) exclusion: - cognitive impairment - medical contraindication		session during hospital stay	- pilot study - intervention lasted until discharge
Laramee AS, 2003 [58]	inclusion: - congestive heart failure (CHF) - at risk for readmission - discharge towards home exclusion: - planned cardiac surgery - cognitive impairment - compromised survival - hemodialysis	case management intervention: - early discharge planning and coordination of care - individualized and comprehensive patient and family education - 12 weeks of enhanced telephone follow-up and surveillance - promotion of optimal CHF medications and medication doses	usual care: inpatient: - standard care - ancillary services provided on request - medication and CHF education by staff nurses post-discharge care: - follow-up by PCP	- large study population (131 intervention, 125 usual care) - not used in meta-analysis because number of readmissions counted and not readmission rate
Legrain S, 2011 [59]	inclusion: - admission to geriatric unit in an emergency - age (70 years or older) exclusion: - expected length of stay<5 days - compromised survival - language: not French speaking	discharge-planning intervention: - comprehensive chronic medication review - education on self-management of disease - detailed transition-of-care communication with outpatient health professionals	usual care: - standard care plan from acute geriatric unit team - comprehensive geriatric assessment - usually also a rehabilitation component	- large study population (317 intervention, 348 usual care) - multicentric study - not stated how long intervention lasted
Leventhal M E, 2011 [60]	inclusion: - heart failure - age (adult)	interdisciplinary management program: post-discharge: - home visit	usual care: - normal medical and nursing care	- small study population (22 intervention, 20 usual care) - study stopped due to

Study	Participants	Intervention A	Intervention B	Notes
	- discharge to home exclusion: - severe concurrent cardial diseases - cognitive impairment - not able to comprehend a telephone conversation - compromised survival - language: not German speaking	- telephone calls - educational kit - care plan with patient and nurse identified goals; discussed with PCP	- lifestyle recommendations - communication with PCP - educational booklet - follow up by PCP	prolonged recruiting time - protocol changed during study: inclusion criteria and time of randomization - only readmissions to same hospital: risk for underestimation
Li H, 2012 [35]	inclusion patients: - age (65 years or older) - expected hospital stay of more than 4 days inclusion family care givers (FCG): - age (21 years or older) - strongly related to patient - primary FCG exclusion patients: - admission from a long-term care facility - diagnosis of dementia - hospice care exclusion FCG: - language: cannot read and speak English - not within geographic area - mental or physical impairment - paid care providers	CARE (Creating Avenues for Relative Empowerment): Two informational and educational sessions for FCG to empower, educate and inform them. FCG's are assisted to develop a health care plan	attention control intervention: two sessions with informational and educational materials about hospital and hospital services	- readmission measured only by self-report of FCG

Study	Participants	Intervention A	Intervention B	Notes
Lopez Cabezas C, 2006 [34]	inclusion: - heart failure exclusion: - not within geographic area - nursing home - cognitive impairment	active information program: patients received information about the disease, drug therapy, diet education, and active telephone follow-up	usual care: not described	- low educational level of study population could be a problem for external validity - not mentioned how readmission was measured
Man WD, 2004 [61]	inclusion: - admission for an acute exacerbation of COPD exclusion: - comorbidity that could limit exercise training - attendance of a pulmonary rehabilitation program in the preceding year	outpatient rehabilitation program with exercises and education	usual care: no rehabilitation program	- small study population (18 intervention, 16 usual care) - one third of the patients included in the rehabilitation program did not attend 50% of the sessions; risk for selection bias
Marusic S, 2013 [62]	inclusion: - admission to medical clinic - age (65 years or older) - discharge to community - prescription of at least 2 medications for chronic diseases exclusion: - cognitive impairment - compromised survival - discharge to long-term care facility - inability to be followed-up	pharmacotherapeutic counseling during hospital stay	usual care: - discharge letter given with patient for PCP - information of medications by physician	- post-discharge outcomes measured by patient self-report; risk of underestimation - external validity: can we extrapolate this result to western European countries?
Mayo NE, 2008 [63]	inclusion: - stroke patients returning	case management: - home visits	usual care: patients were instructed to make an	

Study	Participants	Intervention A	Intervention B	Notes
	home directly - one of the criteria indicating specific need for health care supervision post-discharge exclusion: - discharge to inpatient rehabilitation facility or long-term care	- telephone contact - contact with personal physician: give information and make appointment - patient hotline	appointment with the PCP	
McDonald K, 2002 [64]	inclusion: - congestive heart failure (CHF) - age (18 years or older) exclusion: - CHF in setting of myocardial infarction or unstable angina - compromised survival	multidisciplinary care - inpatient: nurse led education, dietician consults - after discharge: telephone follow-up, follow-up in heart failure clinic	usual care: - ancillary services when requested - clinical criteria to be fulfilled before discharge - optimal medical therapy - follow-up by PCP	- small study population (51 intervention, 47 usual care) - methodology poorly described; patient selection not clear - control group could also receive some interventions at request of the physician - not mentioned how readmission was measured - readmissions only for heart failure
Melton LD, 2012 [65]	inclusion: - patients with active private health insurance coverage - length of stay ≥ 3 days - ICD-9-CM major diagnosis of Heart/Circulatory, Lower Respiratory or Gastrointestinal	prioritized group: - 2 post-discharge phone calls by a case manager (CM) within 24 hours of discharge - calls were made in descending health risk order	unprioritized group: call by a CM 3 days after discharge calls were not made in any health risk order	- large study population (1994 intervention, 1994 usual care) - not stated how long intervention lasted - number of days to post-discharge contact varied widely - mean number of phone calls was 1.8 in both groups

Study	Participants	Intervention A	Intervention B	Notes
Naylor MD, 1990 [66]	inclusion: - admission to medical and surgical units - alert and oriented at admission - from home - telephone access availability exclusion: - no telephone access - language: not English speaking - not able to respond questions	comprehensive discharge planning by gerontological nurse specialist: - general discharge planning expanded with: o assessment of needs o assessment of knowledge and teaching, o telephone contact within first two weeks after discharge	usual care: general discharge planning coordinated by primary or associate nurse	- small study population (20 intervention, 20 usual care) - difference in race between both groups with in experimental group 90% white people and in control group 40%
Naylor MD, 1994 [67]	inclusion: - 2 medical DRGs (congestive heart failure or AMI) or 2 surgical DRGs (coronary artery bypass graft or cardiac valve replacement) - age (70 years or older) - from home - alert and oriented at moment of admission exclusion: - no telephone access - language: not English speaking	comprehensive discharge planning: - comprehensive assessment of discharge planning needs - development of a discharge plan - validation of patient and caregiver education - coordination of discharge plan (until 2 weeks after discharge) - interdisciplinary communication regarding discharge status - evaluation of effectiveness of discharge plan	routine discharge planning: complicated discharge planning coordinated by the social worker and community nursing coordinator	- not mentioned how readmission was measured
Nazareth I, 2001 [68]	inclusion: - age (75 years or older) - four or more medicines at	integrated discharge plan of hospital and community pharmacists: - hospital pharmacists: assessment of	usual care: discharge summary to PCP	- large study population (164 intervention, 176 usual care)

Study	Participants	Intervention A	Intervention B	Notes
	discharge exclusion: - language: not English speaking - too ill	medication, rationalization of drug treatment, assessment of patients' ability to manage medication, information, liaison with carers, copy of discharge plan to patient, community pharmacist and PCP. - community pharmacists: visit at home		- readmission data based on hospital's administrative system: risk for underestimation
Osman LM, 2002 [69]	inclusion: - admission with acute asthma - age (14–60 years)	self-management program: - education: pathophysiology, symptoms, risk factors, medicines - development of written self-management plan (symptom and peak flow based) with patients	usual care: not described	- large study population (280) - more women in intervention group: risk for underestimation readmission rate in intervention group (women traditionally have lower readmission rates)
Parry C, 2009 [12]	inclusion: - fee-for-service Medicare patients - age (65 years or older) - community-dwelling - have at least one of 11 diagnoses exclusion: - no telephone access - language: not English speaking - not within geographic area - admission for a psychiatric condition - cognitive impairment	care transitions intervention: - reliable medication self-management system - patient-centered record - timely follow-up with primary or specialty care - a list of "red flags" and instructions on how to respond to them	usual care: standard discharge planning	- small study population (49 intervention, 49 usual care) - high refuse rate to participate (27%) could have induced selection bias
Rich MW,	inclusion:	comprehensive multidisciplinary treatment:	usual care: ancillary services at	- small study population (63

Study	Participants	Intervention A	Intervention B	Notes
1993 [70]	- age (70 years or older) - admission to medical ward - discharge towards home - high risk for readmission exclusion: - not within geographic area - risk for unpreventable readmission - cognitive impairment	- teaching - medication review - early discharge planning - discharge summary form transmitted to home-care nurse - enhanced follow-up through home care and telephone contacts	request of physician	intervention, 35 usual care) - control group could also receive elements of intervention group - not stated how long intervention lasted - not mentioned how readmission was measured
Rich MW, 1995 [71]	inclusion: - admission to medical unit - heart failure - four or more hospitalizations in preceding five years exclusion: - not within geographic area - discharge to long-term-care facility - cognitive impairment - compromised survival	comprehensive multidisciplinary treatment: - teaching - medication review - early discharge planning - discharge summary form transmitted to home-care nurse - enhanced follow-up through home care and telephone contacts	usual care: eligible for standard treatments and services ordered by physician	- usual care is not standardized - not stated how long intervention lasted - not mentioned how readmission was measured
Riegel B, 2006 [41]	inclusion: - heart failure - Hispanics - living in community	telephone follow-up by bilingual nurse case managers	usual care: education before discharge and discharge instructions, often only written information	- specific population (Hispanics on US-Mexico border) -> external validity?
Saleh S, 2012 [72]	inclusion: - elderly Medicare patients exclusion: - dementia without a caregiver - severe psychiatric conditions - planned readmission	comprehensive post-discharge care transition program: - patient-centered health record - structured discharge preparation - patient self-activation and management sessions	regular discharge process: not described	- large study population (160 intervention, 173 usual care) - not mentioned how readmission was measured

Study	Participants	Intervention A	Intervention B	Notes
	- end-stage renal disease or primary diagnosis of tumors - assisted living with a coached caregiver - residence in a nursing home	- follow-up appointment with a physician provider within 7 days - coordination of data flow		
Sales VL, 2013 [73]	inclusion: - heart failure - age (18 years or older) exclusion: - dementia - severe psychiatric conditions - transfer to other hospital	- during hospital stay: o education o review of medication o review of discharge instructions o personalized discharge sheet - after discharge o encourage follow-up o weekly phone calls	usual care: - standardized discharge sheet - appointment with PCP scheduled	- low critical appraisal score (4/10) - patients discharged towards home with or without visiting nurse home care, inpatient rehabilitation facility or skilled nursing facility - only disease specific readmissions in same hospital measured: risk for underestimation
Sethares KA, 2004 [74]	inclusion: - heart failure - discharge to home exclusion: - language: not English speaking - cognitive impairment	tailored message intervention based on results on Health Belief Scales	usual care: - discharge instructions by nurse - educational sheets	- randomization process not described - small study population (33 intervention, 37 usual care)
Shyu Y, 2005 [75]	inclusion: - age (60 years or older) - hip fracture (arthroplasty or fixation) - minimal level of activity - within geographic area	interdisciplinary intervention program: - geriatric consultation service: geriatric assessment, development of postoperative plan, postoperative follow-up - rehabilitation program: early	usual care: without well-organized, interdisciplinary care protocols	- low critical appraisal score (5/10) - post-discharge outcomes measured by patient self-report; risk of underestimation

Study	Participants	Intervention A	Intervention B	Notes
	exclusion: - severe cognitive impairment - compromised survival	postoperative rehabilitation, home visits - discharge planning		
Strömberg A, 2003 [76]	inclusion: - heart failure exclusion: - severe chronic pulmonary disease - cognitive impairment - compromised survival - discharge to geriatric clinic or home care - already patient at the nurse-led failure clinic	nurse-led heart failure clinic: - evaluation of status - standardized education - structured follow-up - telephone availability during weekdays	usual care: follow up in primary care	
Weaver LA, 2001 [77]	inclusion: - cardiac surgery - age (21 years or older) - discharge to home 3-7 days after surgery exclusion: - language: not English speaking	telephone follow-up	usual care: routine postoperative care without telephone follow-up	- small study population (44 intervention, 46 usual care) - outcome measured by patient self-report; risk for underestimation
Wong FK, 2011 [36]	inclusion: - admission to medical unit - age (60 years or older) - telephone access availability - discharge to home exclusion: - no telephone access - language: not Cantonese	health-social partnership transitional care management program (HSTCMP): - pre-discharge assessment - post-discharge: home visits and telephone calls by nurse and volunteers during 4 weeks after discharge	usual care: - health advice - medication instructions - arrangements for follow-up - support services if needed	- large study population (272 intervention, 283 usual care) - outcome measured by hospital's administrative system; risk for underestimation

Study	Participants	Intervention A	Intervention B	Notes
	speaking - not within geographic area - inability to communicate - compromised survival - MMSE≤20			
Wong FK, 2014 [37]	inclusion: - admission for respiratory, diabetic, cardiac or renal conditions exclusion: - no telephone access - discharge to assisted care facilities - language: not Cantonese speaking - not within geographic area - inability to communicate - compromised survival - MMSE≤20	pre-discharge assessment - home visit group: post-discharge 2 telephone calls and 2 home visits addressing patients' needs on different domains - call group: post-discharge 4 telephone calls	usual care: - health advice - medication instructions - arrangements for follow-up - 2 placebo calls	- large study population (196 home visit group, 204 call group, 210 usual care) - control group received placebo calls - intervention group with 2 arms - outcome measured by hospital's administrative system; risk for underestimation
Woodend AK, 2008 [78]	inclusion: - symptomatic heart failure - or angina - discharge to home exclusion: - language: not capable of reading and writing English or French - not within geographic area	telehome monitoring: video conferencing and daily transmission of data	usual care: - patients were referred to community practitioner or cardiologist - all patients received telephone number of APN	- no clinical data other than cardiologic data - outcome measured by patient report; risk for underestimation - not used in meta-analysis because number of readmissions counted and not readmission rate
Zhao Y, 2009 [79]	inclusion: - age (60 years or older)	transitional care program (TCP): - pre-discharge: health advice (diet,	usual care: - discharge instructions by	- results not generalizable to Western context

Study	Participants	Intervention A	Intervention B	Notes
	- angor or myocardial infarction - discharge to home exclusion: - no telephone access - language: not Mandarin speaking - not able to communicate - cognitive impairment - transferred to another unit during stay in hospital - not within geographic area	medication, exercise, life-style), document advice and sent to community nurse - post-discharge: home visits, telephone follow-up	physician - educational pamphlets available	- outcome measured by patient self-report; risk for underestimation

APN=advanced practice nurse; CHF=congestive heart failure; CHW=community health worker; DA=discharge advocate; ED=emergency department RN=registered nurse; PCP=primary care physician

Appendix 4.VII: Excluded studies

Deschodt, M., Effect of an inpatient geriatric consultation team on functional outcome, mortality, institutionalization, and readmission rate in older adults with hip fracture: A controlled trial

Reason for exclusion: not randomized

Kulshreshtha, A., Use of remote monitoring to improve outcomes in patients with heart failure: A pilot trial

Reason for exclusion: not truly random (week on – week off)

Chapter 5 - ADVERSE EVENTS DURING HOSPITAL STAY: A COHORT STUDY OF HOSPITALS WITH DIVERGENT READMISSION RATES

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Braet A, Weltens C, Laenen A, Sermeus W. Adverse events during hospital stay: a cohort study of hospitals with divergent readmission rates

Abstract

Introduction: Because the association between quality of care and preventable readmissions is not clear, we explore hospital-acquired adverse events (AEs) across hospitals with strong divergent readmission rates. We also explore the association of AEs with post-discharge events (readmission, emergency department visits, and mortality).

Methods: In a prospective cohort study, outcomes of patients in hospitals with high and low readmission rates (HR and LR hospitals) were compared for three patient groups (heart failure, pneumonia and total hip/knee arthroplasty). Hospital-acquired AEs were identified using the Global Trigger Tool methodology.

Results: A total of 100 AEs were detected in the 296 patient records reviewed (30.1% of the patients with AEs). Patients with heart failure in HR hospitals had a higher risk of AEs compared to LR hospitals (OR 3.185; 95%CI 1.137-8.923; p=0.028). No difference was found between HR and LR hospitals for harmfulness and preventability of AEs. Patients with AEs stayed longer in the hospital (9.8; SD 6.8) compared to patients without AEs (6.9; SD 3.8) (p<0.001) and had more comorbidities (median 1.0; interquartile rate (ICR) 0.0; 3.0) compared to patients without AEs (median 0.0; ICR 0.0; 2.0) (p=0.027). The presence of AEs is not related to post-discharge events, but more harmful AEs were associated with a higher risk of post-discharge events compared to AEs with minor levels of harm (OR 3.879; 95%CI 1.198-12.562; p=0.024).

Discussion: Hospital readmission rates were not associated with hospital-acquired AEs, nor were AEs associated with post-discharge events.

Introduction

Unplanned hospital readmissions occur frequently after discharge and represent a high burden on healthcare expenditures. Readmission rates 30 days after discharge are estimated at 15-20% and represent 17% of total hospital payments for Medicare patients [1, 2].

The association between quality of care transitions and preventable hospital readmissions has been comprehensively demonstrated [3-6]. We can presume that, besides the quality of care transitions, quality of in-hospital care is also an important factor in preventable readmissions. However, the association between the quality of in-hospital care and preventable readmissions is not yet clear. Quality of in-hospital care can be assessed by measuring patient safety by means of monitoring hospital-acquired adverse events (AEs) [7]. AEs are injuries caused by medical care [8]. Jha et al. [9] showed that 42.7 million AEs occur each year globally. These AEs result in 23 million disability-adjusted life years (DALYs) lost annually due to medical care.

Different studies have demonstrated that one in four patients with an AE related to the hospital stay is readmitted [10, 11]. Complications of medical care – which are one type of AE – are also frequent reasons for readmission. In a previous study [12], we showed that one out of ten readmissions is due to complications of care, and Morris et al. [13] showed that in a surgical population 56% of readmissions are associated with a newly diagnosed complication. However, when using AEs as a proxy for quality of care, only *preventable* AEs are of interest. Van Walraven et al. [14] could not demonstrate a correlation between hospital-specific readmission rates due to preventable AEs (2.2% of all discharges, 95%CI 1.8%-2.6%) and all-cause readmission rates (13.5%, 95%CI 12.5%-14.5%).

Several methodologies have been developed to identify AEs [15]. In this study the Global Trigger Tool (GTT) is used, because the methodology has been well documented [16], has been demonstrated to be superior to voluntary reporting or patient safety indicators [15, 17], and is widely used, thus making comparison possible.

The first aim of this study is to explore whether quality of in-hospital care is associated with unplanned readmissions. Therefore, we studied whether quality of in-hospital care differs between hospitals with a strong divergence in readmission rates. Differences between hospitals with high readmission rates (HR hospitals) and hospitals with low readmission rates (LR hospitals) are analysed for the incidence, harmfulness and preventability of AEs.

The second aim of this study is to explore the association between AEs and post-discharge events (as a composite indicator of readmissions, emergency department (ED) visits and mortality).

Methods

Selection of hospitals and patients

The multicentre cohort study took place between June 2013 and July 2014in 12 Flemish hospitals. Selection of the hospitals was based on rankings of 30-day standardized readmission ratios for three patient groups (heart failure, pneumonia and planned total hip or knee arthroplasty (THA/TKA)), based on discharge data from 2008. Readmission rates were risk-adjusted for age, gender, Charlson comorbidity index (CCI) [18] and severity of illness. For each patient group, two hospitals listed in the top 40 (HR hospitals) and two hospitals listed in the bottom 40 (LR hospitals) were selected. HR and LR hospitals were selected in such a way that readmission rates differed significantly for each patient group between HR and LR hospitals. Hospitals were invited to include 30 patients. Hospitals were eligible for participation when they were located in the Flemish region of Belgium, they admitted at least 100 patients a year for the selected patient groups and no hospital merger had taken place since 2008. For HR hospitals, a minimum of ten readmissions a year was required to be eligible. Only the principal investigator was aware of the hospital allocation status. Two hospitals failed to begin the study. The other ten hospitals consisted of one university hospital, one general hospital with university beds and seven general hospitals. The research was approved locally by the Ethic Committees of each of the ten hospitals.

Consecutive patients were informed and invited to participate in the study. Inclusion criteria were: ability to give consent; 18 years or older; admitted for heart failure, pneumonia or THA/TKA; inpatient stay in acute wards only; discharge to home; telephone access available; and Dutch speaking. Patients with diagnosed dementia were excluded from the study.

Global Trigger Tool

Adverse events (AEs) are defined as “noxious and unintended events occurring in association with medical care” and are always associated with patient harm [16]. To assess the number of AEs, the Global Trigger tool was used; patient records were screened searching for predefined triggers, which were used to identify AEs [16]. The review team consisted of seven people: five master’s students with a relevant diploma in healthcare and two physicians (AB and CW) with clinical experience. The principal investigator (AB) had more than one year of experience with the GTT methodology, and the other six researchers participated in a one-day training in using GTT.

The methodology as described by the IHI was rigorously followed [16]. Medical records were reviewed a minimum of six weeks after patients’ discharge. The record review was carried out in two stages. First, two researchers independently reviewed each record, looking for triggers and possibly related AEs. Afterwards, each record was discussed by the

research team, including the physicians. If no triggers and no AEs were found, the record was closed. When triggers were found, each trigger and its potential association with an AE was discussed. Kappa scores were measured to assess the inter-rater reliability of trigger finding. With a Cohen's kappa of 0.66, we can state that the reliability was substantial [19].

For each identified AE we determined the degree of patient-related harm, the related clinical process and preventability (Box 1). Patient-related harm was categorized using the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) Index [20]. A classification for the clinical process was found in the Dutch national report of adverse events of 2008 [21]. The score for preventability was derived from the score used by Wilson [22]. The 6-point scale was grouped into three categories: scores of 4 or more were classified as high preventability, scores of 2 and 3 as low preventability, and score 1 as not preventable [21-23]. In cases of disagreement, the final decision was made by the physicians.

Box 1: Categories to classify patient-related harm, clinical process and preventability

Category	Description or examples
Patient-related harm according to the NCC MERP index	
Category E	Temporary harm to the patient and required intervention
Category F	Temporary harm to the patient and required initial or prolonged hospitalization
Category G	Permanent patient harm
Category H	Intervention required to sustain life
Category I	Patient death
Clinical process	
Diagnostic	E.g. missed, too late or inadequate diagnosis
Surgical	E.g. surgical interventions
Non-surgical interventions	E.g. central catheters, endoscopy, pacemakers, radiological procedures
Drugs	E.g. side effects, allergic reactions, anaphylactic shock
Other clinical activities	Nursing and paramedical care
Discharge	E.g. inadequate discharge
Other	E.g. patient fall
Preventability	
No preventability	
Score 1	Virtually no evidence for preventability
Low preventability	
Score 2	Slight to modest evidence for preventability
Score 3	Preventability not likely, less than 50–50 but close call
High preventability	
Score 4	Preventability more likely than not, more than 50–50 but close call
Score 5	Strong evidence for preventability
Score 6	Virtually certain evidence for preventability

For each AE, we determined the moment of occurrence and detection. AEs can occur before the index admission (studied admission) and be detected during the index admission; these AEs are referred to as AEs present at admission. AEs can also occur during the index admission with detection during the same admission or after discharge; these AEs are referred to as hospital-acquired AEs. In this study we excluded AEs present on admission and thus analysed only hospital-acquired AEs.

Variables and outcome

Adverse events are presented as the percentage of patients with a minimum of one AE, the number of AEs for 100 admissions and the number of AEs per 1,000 patient days. The modified Charlson Comorbidity Index, as described by Quan [24], was assigned to each patient based on information available in the patient records. Five to six weeks after discharge, patients or caregivers were contacted by phone to assess whether a readmission or a visit to the ED had occurred. Readmission, visit to the ED and mortality were classified as post-discharge events. The information about post-discharge events obtained from patients or caregivers was checked and eventually completed during patient record review.

Statistical analysis

The comparison of two groups was performed using the Chi-square test for categorical variables and the Mann-Whitney U test for continuous variables. Binary outcome variables (AE, harm, post-discharge events) were analysed using logistic regression models, and ordinal outcome variables (preventability) were analysed using proportional odds models. Multivariable models were used to correct for possible confounders. Results are presented by odds ratios (OR) with 95% confidence intervals (CI). All tests are two-sided, and a 5% significance level is assumed for all tests. Analyses were performed using SAS software (version 9.4 of the SAS System for Windows).

Results

Demographics

In ten hospitals, 291 patients were invited to participate; 15 of them refused to participate and five were excluded after initial inclusion (four patients were not discharged towards home and one patient was transferred to geriatric subacute care). Of the 271 patients included, two records could not be retrieved, leaving 269 records for analysis. In Table 5.1 HR and LR hospitals are compared for patient and hospitals characteristics. HR hospitals included more male patients compared to LR hospitals (54.8% compared to 41.5%; p=0.029). Because two hospitals failed to include patients, distribution of patient groups differed between HR and LR hospitals: HR hospitals included more patients with pneumonia compared to LR hospitals (41.1% compared to 15.4%), and LR hospitals included more patients with heart failure (39.0% compared to 17.8%). LR- compared to HR hospitals included more patients in small hospitals (61.0% compared to 41.1%; p=0.001) and in general hospitals (100.0% compared to 61.6%; p<0.005).

Table 5.1: Comparison of patient and hospital characteristics across HR and LR hospitals

Characteristic		Statistic	HR hospital N=146	LR hospital N=123	Total N=269	p-value
Patient characteristics						
Gender	**male**	n (%)	80 (54.8)	51 (41.5)	131 (48.7)	0.029
Age (years)		Mean (Std)	69.5 (13.02)	68.9 (14.2)	69.2 (13.6)	0.824
Length of stay (days)		Mean (Std)	7.9 (5.4)	7.5 (4.7)	7.8 (5.1)	0.260
CCI		Median (IQR)	0.0 (0.0; 2.0)	0.0 (0.0; 2.0)	0.0 (0.0; 2.0)	0.544
Patient group	**THA/TKA**	n (%)	60 (41.1)	56 (45.5)	116 (43.1)	<0.005
	heart failure	n (%)	26 (17.8)	48 (39.0)	74 (27.5)	
	pneumonia	n (%)	60 (41.1)	19 (15.4)	79 (29.4)	
Hospital characteristic						
Hospital size	**<300 beds$**	n (%)	60 (41.1)	75 (61.0)	135 (50.2)	0.001
Teaching status	**general hospital**	n (%)	90 (61.6)	123 (100.0)	213 (79.2)	<0.005

CCI=Charlson Comorbidity Index; HR/LR=high/low readmission; IQR=interquartile range; Std=standard deviation; THA/TKA=total hip/total knee arthroplasty

$=number of surgical and medical beds

Description of AEs

Eighty-one patients (30.1% of all patients) had a combined 100 AEs (37.2 AEs/100 admissions; 48.0 AEs for 1,000 patient days). All AEs resulted in temporary patient-related harm: 81% category E and 19% category F. A plurality of AEs were caused by nursing or paramedic care (category 'other clinical activities') (39%), followed by drugs (33%) and surgical processes (17%). We classified 12% of the AEs as high preventability, 78% as low preventability and 10% as not preventable.

Patients with AEs did not differ significantly from patients without AEs with regard to gender and age (Table 5.2). Patients with AEs stayed longer in the hospital (mean length of stay 9.8 days; SD 6.8) compared to patients without AEs (6.9 days; SD 3.8) (p<0.001), but no difference in length of stay was detected in patients with harm category E (9.7 days, SD 7.28) compared to category F (10.4 days, SD 5.06) (p=0.701). Patients with AEs had more comorbidities (median 1.0; interquartile rate (ICR) 0.0; 3.0) compared to patients without AEs (median 0.0; ICR 0.0; 2.0) (p=0.027). Patient groups were not equally distributed between patients with and patients without AEs, and more patients with THA/TKA had no AE (p=0.023).

Table 5.2: Comparison of patient- and hospital characteristics for patients with and without AEs

Characteristic		Statistic	No AE present	AE present	p-value
Patient characteristics					
Gender	**male**	n/131 (%)	92/131 (70.2)	39/131 (29.8)	0.906
	female	n/138 (%)	96/138 (69.6)	42/138 (30.4)	
Age (years)		Mean (Std)	68.4 (13.4)	71.2 (13.8)	0.053
Length of stay (days)		Mean (Std)	6.9 (3.8)	9.8 (6.8)	<0.001
CCI		Median (IQR)	0.0 (0.0; 2.0)	1.0 (0.0; 3.0)	0.027
Patient group	**THA/TKA**	n/116 (%)	91/116 (78.4)	25/116 (21.6)	0.023
	heart failure	n/74 (%)	45/74 (60.8)	29/74 (39.2)	
	pneumonia	n/79 (%)	52/79 (65.8)	27/79 (34.2)	
Hospital characteristics					
Hospital size	**<300 beds[$]**	n/135 (%)	100/135 (74.1)	35/135 (25.9)	0.133

	≥300 beds$	n/134	88/134	46/134	
		(%)	(65.7)	(34.3)	
Teaching status	**general hospital**	n/213	152/213	61/213	0.304
		(%)	(71.4)	(28.6)	
	university hospital	n/56	36/56	20/56	
		(%)	(64.3)	(35.7)	

AE=adverse event; CCI=Charlson Comorbidity Index; IQR=interquartile range; Std=standard deviation; THA/TKA=total hip/total knee arthroplasty
$=number of surgical and medical beds

Adverse events across hospitals with low and high readmission rates

In Table 5.3 descriptive statistics are compared between high readmission and low readmission hospitals for each of the three patient groups for presence of AEs (for 269 patients), harm of AEs and preventability of AEs (for 100 AEs).

Table 5.3: Comparison of outcomes across HR and LR hospitals

Outcome	**HR hospital n/N (%)**	**LR hospital n/N (%)**	**Total n/N (%)**
Adverse event present	48/146 (32.9)	33/123 (26.8)	81/269 (30.1)
THA/TKA	16/60 (26.7)	9/56 (16.1)	25/116 (21.6)
heart failure	15/26 (57.7)	14/48 (29.2)	29/74 (39.2)
pneumonia	17/60 (28.3)	10/19 (52.2)	27/79 (34.2)
Patient-related harm: category E$	48/58 (82.8)	33/42 (78.6)	81/100 (81.0)
THA/TKA	14/18 (77.8)	6/10 (60.0)	20/28 (71.4)
heart failure	15/19 (78.9)	14/17 (82.4)	29/36 (80.6)
pneumonia	19/21 (90.5)	13/15 (86.7)	32/36 (88.9)
High preventability$	7/58 (12.1)	5/42 (11.9)	12/100 (12.0)
THA/TKA	4/18 (22.2)	0/10 (0.0)	4/28 (14.3)
heart failure	2/19 (10.5)	3/17 (17.6)	5/36 (13.9)
pneumonia	1/21 (4.8)	2/15 (13.3)	3/36 (8.3)

THA/TKA=total hip/total knee arthroplasty; HR/LR=high/low readmission rate hospitals
$=based on number of AEs (N=100)

We evaluated the association between the presence of AEs and readmission rates (HR/LR hospitals). Analysing the effect of readmission rates over all patients (with corrections for gender, comorbidity level and patient group), no evidence was found for an association between high or low readmission rates and the presence of AEs (OR 1.418; 95%CI 0.796-2.529; p= 0.235). An interaction effect was found between readmission rate and patient group (p=0.010). Patients admitted for heart failure to an HR hospital had a higher risk of AEs compared to patients admitted to an LR hospital (OR 3.185; 95%CI 1.137-8.923; p=0.028). For patients admitted for THA/TKA, no difference was found between HR and LR hospitals (OR 1.969; 95%CI 0.781-4.962; p=0.150), nor was a significant difference

between HR and LR hospitals found for patients admitted for pneumonia (OR 0.356; 95%CI 0.122-1.035; p=0.058).

The same analysis was performed to compare harmfulness of AEs in HR hospitals to LR hospitals. No evidence was found for an association between readmission rate and harmfulness of AEs (OR 0.628; 95%CI 0.211-1.864; p=0.397), and no evidence was found for an interaction with patient group (p=0.604).

Comparing HR to LR hospitals for preventability of AEs showed no evidence of an association (OR 0.793; 95%CI 0.294-2.137; p=0.643), and no evidence was found for an interaction with patient group (p=0.537).

Association of adverse events with post-discharge events

Post-discharge outcomes could not be retrieved for 20 patients, resulting in post-discharge evaluations for 249 patients. For five of the 20 patients with missing post-discharge data, hospital-acquired AEs took place; four patients had AEs with harm category E and one patient had an AE with harm category F. Post-discharge events were present in 56 of the 249 patients (22.5%): 35 patients visited the ED, 45 were readmitted and eight patients died in the six weeks after discharge.

One quarter (25.0%) of patients with hospital-acquired AEs presented a post-discharge event, compared to 21.4% of patients without AEs (Table 5.4). Analysing the effect of AEs over all patients (with corrections for comorbidity level, length of stay and patient group), no evidence was found for an association between AEs and an increased risk of post-discharge events (OR 0.826; 95%CI 0.397-1.720; p=0.608).

Patients with AEs with minor harm (category E) presented in 19.0% post-discharge events, compared to 44.4% for patients with more severe harm (category F). No different distribution in patient characteristics was found for harmfulness of adverse events. Statistical analysis showed evidence of a higher risk of post-discharge events in patients with AEs with harm level F compared to harm level E (OR 3.879; 95%CI 1.198-12.562; p=0.024).

Table 5.4: Association of adverse events with post-discharge events

Outcome		Post-discharge event present n/N (%)	Odds ratio		p-value
			Estimate	95% CI	
Adverse event	**Present**	19/76 (25.0)	0.826	0.397-1.720	0.608
	Not present	37/173 (21.4)	Reference		
Harm	**Category F**	8/18 (44.4)	3.879	1.198-12.562	0.024
	Category E	11/58 (19.0)	Reference		

In five of the 19 patients with post-discharge events (26.3%) the event was due to an hospital-acquired AE. All five AEs were low preventable (Table 5.5).

Table 5.5: Post-discharge events due to hospital-acquired AEs

Patient group	Clinical process	Description of adverse event	Post-discharge event
THA/TKA	Surgical	Hip luxation shortly after discharge	Readmission
	Drugs	Large ecchymosis under LMWH	ED visit
	Other clinical activities	Urosepsis shortly after discharge	Readmission
Heart failure	Drugs	Fall with rib fracture due to hypovolemia	Readmission
	Drugs	Hypokalemia with metabolic alkalosis due to diuretics shortly after discharge	Readmission

AE=adverse event; ED=emergency department; LMWH=low molecular weight heparin; THA/TKA=total hip/total knee arthroplasty

Discussion

We compared the quality of in-hospital care between hospitals with high disease-specific readmission rates and low readmission rates for patients with heart failure, pneumonia and THA/TKA.

The first aim of this paper was to evaluate whether differences in readmission rates between hospitals can be explained by differences in the quality of in-hospital care. Therefore, we assessed the in-hospital quality of care by measuring the occurrence and severity of adverse events. Adverse events were traced using the Global Trigger Tool. We explored whether quality of in-hospital care differs between hospitals with a strong divergence in readmission rates. We found that for patients with heart failure admission to hospitals with high readmission rates (HR hospitals) was associated with a higher risk of AEs compared to admission to hospitals with low readmission rates (LR hospitals). No difference in harmfulness and preventability of AEs was found between HR and LR hospitals. These findings imply that quality of in-hospital care in this study cannot be associated with readmission rates, which is in line with the results of a large multicentre study [14].

The second aim of this study was to explore the association between AEs and post-discharge events (readmission, emergency department (ED) visits and mortality). We found that, in general, hospital-acquired AEs are not associated with a higher risk of post-discharge events. Only more harmful AEs are associated with a higher risk of post-discharge events.

In the patient population studied, the presence of AEs was related to length of stay, the number of comorbidities and the reason for admission. The incidence of AEs in our study was higher compared to two studies that reported on hospital-acquired AEs using GTT: we found that 30.1% of the patients had AEs (37.2 AEs/100 admissions), compared to 25.0% of the patients (31.1 AEs/100 admissions) in the study of Good et al. [25] and 21.3% of the patients (24.6 AEs/100 admissions) in the study of Kennerly et al. [26]. Several hypotheses can be formulated to explain this difference. First, it is possible that AEs occur more frequently in Belgian hospitals. Belgian hospitals have little experience in analysing AEs and only a few hospitals have implemented the GTT methodology. A second and more obvious explanation is the fact that we selected three patient groups with a high risk of AEs [27]. A third hypothesis is that we found many AEs because all hospitals had comprehensive electronic patient records available. A low threshold for detecting AEs could partially explain why we found more AEs with minor harm (81%) compared to previous research (63.3% in the study of Kennerly et al. [26]). On the other hand, the absence of patients who died in hospital will also have influenced the degree of harm, because severe AEs that caused mortality were excluded from analysis. We cannot compare the current results to research reporting on all AEs (hospital-acquired AEs and AEs present at admission), because AEs present at admission are more harmful and more preventable compared to hospital-acquired AEs. Our finding that the presence of AEs is related to length of hospital stay, but

not to age and gender, is in line with previous research [15, 17, 23, 28]. The effect of age, however, is not clear in the literature, because some researchers have identified a higher risk of AEs for older patients [15, 23, 29].

An important strength of this study is the use of a well-accepted protocol to detect AEs. A recognizable weakness of the GTT is that records are analysed retrospectively and AEs can only be detected when written down in patient records. The number of detected AEs is therefore an underestimation, but is more comprehensive than voluntary reporting [15]. Underestimation of the occurrence of AEs can also be assumed because we reviewed only patient records of the index hospitals and therefore missed information from other hospitals. By using the GTT-methodology, we lacked information of primary care physicians according to adverse events that did not reach the hospital physician. Because we included only patients discharged from hospital to home, we potentially excluded important AEs from our study. Our results are also only related to three patient groups, which limits the external validity of the study. Another limitation is that classifying hospitals by high or low readmission rates was based on discharge data from 2008, while the study took place between 2013 and 2014. We have no information on whether hospital classification was the same during the study period. Furthermore, quality of care was made measurable by monitoring patient safety; however, other parameters could be chosen, such as underuse or overuse of clinical care (effective care) or timeliness of care [30]. Finally, the study population was too small to perform analysis on hospital characteristics.

Based on this study we can conclude that there is no association between hospital readmission rates and quality of in-hospital care, as measured by the number of hospital-acquired adverse events. Furthermore, no association was found between hospital-acquired adverse events and post-discharge events. If hospitals want to reduce their readmission rates, focusing on patient preparation for discharge and continuity of care after discharge will likely be more efficient compared to focusing on preventing hospital-acquired adverse events.

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Chapter 6 - THE QUALITY OF TRANSITIONS FROM HOSPITAL TO HOME: A HOSPITAL-BASED COHORT STUDY OF PATIENT GROUPS WITH HIGH AND LOW READMISSION RATES

This chapter is submitted for publication to International Journal of Care Coordination (March 2016):

Braet A, Weltens C, Bruyneel L, Sermeus W. The quality of transitions from hospital to home: a hospital-based cohort study of patient groups with high and low readmission rates

Abstract

Introduction: The quality of transitions from the hospital to home are critical for preventing readmissions. The aims of this study were to evaluate variations in the quality of transitions across groups of patients and across hospitals with high and low readmission rates and to study the impact of transitions on postdischarge outcomes.

Methods: A multicentre cohort study was conducted at twelve Flemish hospitals between June 2013 and September 2015 to examine transitions for patients with heart failure, pneumonia, or total hip/knee arthroplasty (THA/TKA). Hospitals with high (HR) and low (LR) readmission rates were selected based on readmission rates in 2008. The quality of the transitions was assessed based on readiness for discharge, patient education, general practitioner (GP) contributions to the discharge process, and timeliness and completeness of discharge summaries.

Results: A total of 233 patients were included in the study. Readiness for discharge was better in patients with THA/TKA than in those with heart failure or pneumonia (mean differences 11.1 (95%CI 5.3-16.9) (p=0.001) and 5.8 (95%CI 1.2-10.5) (p=0.016), respectively). Heart failure patients had better readiness scores in LR- than in HR hospitals (mean difference 13.5 (95%CI 2.5-24.5)) (p=0.017). Insufficient timeliness of discharge summaries was a risk factor for postdischarge events (OR 10.564; 95%CI 1.476-75.603; p=0.019).

Discussion: To improve the quality of transitions from hospital to home, communication with GPs must occur in a timely manner and with a focus on the continuity of care. Particularly in patients with complex postdischarge needs, preparing patients for discharge is essential to prevent readmissions.

Introduction

Hospital readmissions place a significant burden on patient and healthcare expenditures. Depending on how they are defined, readmission rates can vary widely. A systematic review showed that the median readmission rate was 15.3% (interquartile range (IQR) 9.2%-33.7%), and the median proportion preventable readmission rate was 27.1% (IQR 14.9%–45.6%) [1].

Suboptimal transitions of care from hospital to home are a significant cause of preventable readmissions and can result from the inadequate preparation of patients and their caregivers for discharge to home or from a discontinuity in care after discharge [2]. Five variables associated with the quality of transitions are described in the literature: patient readiness for discharge, patient and caregiver education, contributions of the general practitioner (GP) to the discharge process, and timeliness and completeness of the discharge summary. Although all five transition elements are described as important for improving the quality of transitions, their associations with postdischarge outcomes have not been demonstrated. The relative importance of the five elements is not yet known, and it is likely that some elements are more closely associated with postdischarge outcomes than others.

Patient readiness for discharge reflects how patients are prepared for hospital discharge and addresses questions such as: Are patients sufficiently informed about their ongoing care plan? Is there an organized system for their care at home? Do they have clearly designated follow-up appointments [3]. Patient readiness can be measured by the Care Transitions Measure (CTM). The CTM is a validated instrument that tests the quality of transitions from the patient's perspective. The CTM has been used in studies in the US to evaluate readmissions and postdischarge ED visits [4, 5]. Coleman et al. [4] showed that the CTM score was significantly lower in patients readmitted to the hospital (63.0) than it was for patients who were not readmitted (68.1). Therefore, readmission rates can be expected to improve with the establishment of strategies to prepare patients for discharge. Other questionnaires exist to evaluate the transition of care, such as the "Problems after discharge questionnaire" [6], but they focus less on the degree to which patients feel prepared for discharge.

The importance of *patient education* has been repeatedly demonstrated. Errors and adverse events after discharge frequently result from poor patient understanding of the postdischarge care instructions [7, 8]. Patient education is often a component of discharge interventions used to improve the transition from hospital to home. However, it is not clear how much the patient education component contributes to the total effect of these interventions.

The contributions of the GP to the discharge process have been described in various studies as a key determinant of the hospital discharge process [9-11]. However, many GPs

experience a lack of collaboration from hospital physicians [12]. In a meta-analysis, Foy et al. [13] showed that communication between GPs and medical specialists improved patient outcomes compared with standard care procedures for patients with diabetes. To our knowledge, there is no evidence that GP contributions to the discharge process are associated with better postdischarge outcomes.

To guarantee continuity of care after discharge, it is essential that GPs be informed in a timely manner about their patients' hospital stays [14, 15]. Hospital specialists communicate with GPs through written discharge summaries. The timeliness of this discharge summary has often been described as suboptimal [3, 16-20]. However, an association between the timeliness of the summary and postdischarge outcomes has not yet been demonstrated [17, 18, 21]. In a case-control study, Hansen et al. [21] showed that the availability of a discharge summary in the patient record within one week after discharge did not differ between readmitted and non-readmitted patients. One explanation for this lack of evidence could be a suboptimal methodology for evaluating timeliness, such as the use of absolute cut-offs without considering individual needs [18]. In addition, the completeness of the discharge summary is often described as suboptimal, but as with timeliness, an association between the completeness of the discharge summary and postdischarge outcomes has not been demonstrated [16, 19, 21]. In a study by Hansen et al. [21], the presence of six elements in discharge summaries did not differ between readmitted and non-readmitted patients. This absence of evidence could also be explained by the applied methodology, which utilized the presence or absence of specific content in the discharge summary that was unrelated to the clinical context.

Research on transitions has been hampered by the absence of a gold standard for measuring this complex, multidimensional construct. In addition, the absence of one element is only relevant when patient preparedness or continuity of care is endangered. No previous studies have assessed all five elements simultaneously. Here, we propose a systematic and integrated study of the five transition elements and their associations with patient outcomes.

The first aim of this hospital-based cohort study was to describe variations in the quality of transitions among three patient groups (heart failure, pneumonia, and total hip/knee arthroplasty (THA/TKA)) and across hospitals with statistically significant differences in readmission rates for these groups. The patient groups were chosen because they represent acute and chronic patients, medical and surgical disciplines, and planned and unplanned admissions. These groups also have high volumes and the APR-DRGs (All Patient Refined Diagnosis Related Groups) represent clinically homogeneous patient groups. Our examination of the quality of transitions included the five transition elements described above: readiness of patients for discharge, education of patients and caregivers, contributions of GPs to the discharge process, and timeliness and completeness of postdischarge communication.

The second aim was to explore the association between the quality of transitions and postdischarge outcomes (readmissions, emergency department visits, and mortality). Our hypothesis was that the quality of transitions of care differed between hospitals with high and low readmission rates and that the risk for postdischarge events was influenced by the score on the care transition elements.

Methods

Study design

A multicentre cohort study was conducted at twelve Flemish hospitals between June 2013 and September 2015. The study hospitals included two university hospitals and ten general hospitals. The sample size was calculated to identify a 5% difference in the Care Transitions (CT)-questionnaire between the two cohorts at a significance level of 0.05 and a power of 80%. Hospitals were selected based on their 30-day readmission rates in 2008 for one of three patient groups: heart failure, pneumonia or planned THA/TKA. All Belgian hospitals (n=110) were ranked for each of the three patient groups based on standardized readmission ratios with risk adjustments for age, gender, the Charlson comorbidity index (CCI) [22] and severity of illness. For each patient group, two hospitals with high readmission rates (listed in the top 40), hereafter referred to as HR hospitals, and two hospitals with low readmission rates (listed in the bottom 40), hereafter referred to as LR hospitals, were invited to contribute 30 patients each to the study. The selection of HR and LR hospitals was conducted in such way that readmission rates for each patient group differed significantly between the HR and LR hospitals. The inclusion criteria for hospitals were as follows: located in the Flemish region of Belgium; admission of at least 100 patients per year for the selected patient group; no hospital mergers since 2008; and a minimum of 10 observed readmissions per year for HR hospitals. The designation of hospitals as HR or LR was concealed from the assessor, who was in contact with both patients and GPs. This research was approved by the Ethics Committees of each of the twelve hospitals.

Patients had to meet the following inclusion criteria: ability to provide consent; 18 years of age or older; admitted for heart failure, pneumonia or THA/TKA; an inpatient stay in an acute ward only; discharged to home; access to a telephone; and the ability to speak Dutch. Patients were excluded from the study if they had a known diagnosis of dementia or if they refused to participate. Consecutive patients were included. The eligibility of each patient for inclusion was verified by the head nurse, who was informed of and educated on these criteria. Informed consent was obtained at a maximum of 24 hours prior to the planned discharge. The inclusion of patients stopped when a hospital had included 30 patients or six months after the first patient was included.

Data collection

The quality of the transition from hospital to home was assessed by surveying patients and GPs. Patients received the questionnaire at discharge and were asked to return it within one week. Patients who did not respond were contacted once by phone. Patients who declined to complete the questionnaire at that time were offered the option of a short telephone interview. In addition to the assessment of patient readiness for discharge, other elements evaluated in the patient questionnaire included family structure, level of education and self-rated health status.

GPs were invited to complete an electronic questionnaire three weeks after their patient was discharged from the hospital. Non-respondents were contacted by phone. If a response was still not obtained seven weeks after discharge, the GP was classified as non-respondent for that patient.

Five to six weeks after discharge, an independent assessor contacted the patients by phone. At that time, hospital readmissions and visits to the ED were evaluated. A maximum of five attempts were made to contact each patient at different times. The 'postdischarge event' outcome was a composite indicator of hospital readmissions, visits to the ED and mortality. A postdischarge event was recorded if one or more events took place within six weeks after discharge.

The CCI was evaluated by a review of patient records a minimum of six weeks after discharge. Additional information regarding readmissions, visits to the ED and mortality was obtained at that time.

Questionnaires

Patient survey

The CTM was used to measure patient readiness for discharge. The CTM is a validated questionnaire developed by Coleman et al. to measure the quality of transitions from hospital to home [4, 5]. We translated the survey into Dutch and validated it according to the guidelines developed by the Translation and Cultural Adaptation group [23]. The comprehensibility and relevance of the questions were evaluated by interviewing 52 patients. The questionnaire was adapted slightly to the Belgian context as the CT-questionnaire: two questions were dropped because they were considered redundant, and one question was added. The original and revised questionnaires are provided in Appendix 6.1. The internal consistency of the CT-questionnaire was evaluated using Cronbach's alpha (Cronbach's alpha=0.96). Factor analysis was not appropriate because the measure of sampling adequacy was too low (Kaiser-Meyer-Olkin=0.559). The CT-questionnaire scores (CT-scores) were linearly transformed to convert individual scores to a 0-100 scale.

Survey for general practitioners

GPs were asked about their contributions to the discharge process, the education of patients and caregivers, and the timeliness and completeness of the discharge summaries. Because there is a discrepancy between patient self-rated understanding and objective knowledge, the level of education in this study was judged by the GPs [24]. Contributions to the discharge process were considered insufficient when GPs replied that they had not been consulted to help prepare patient discharge papers, and they perceived this as a shortcoming. The education of patients and caregivers was considered insufficient when GPs indicated that knowledge was insufficient (3-point Likert scale: very good, sufficient, insufficient) for any of three educational topics: illness, warning signs and medication [11]. To assess the timeliness of the discharge communications, GPs were asked whether they received the discharge summaries in a timely manner to ensure continuity of care. If the answer was no, this variable was considered insufficient. To assess the completeness of the discharge summary, GPs were asked whether the information for four elements (diagnosis, medication, follow-up appointments and pending results [11, 14, 15]) of the discharge summaries was sufficient to ensure continuity of care. If the answer was no for one or more elements, this variable was considered insufficient.

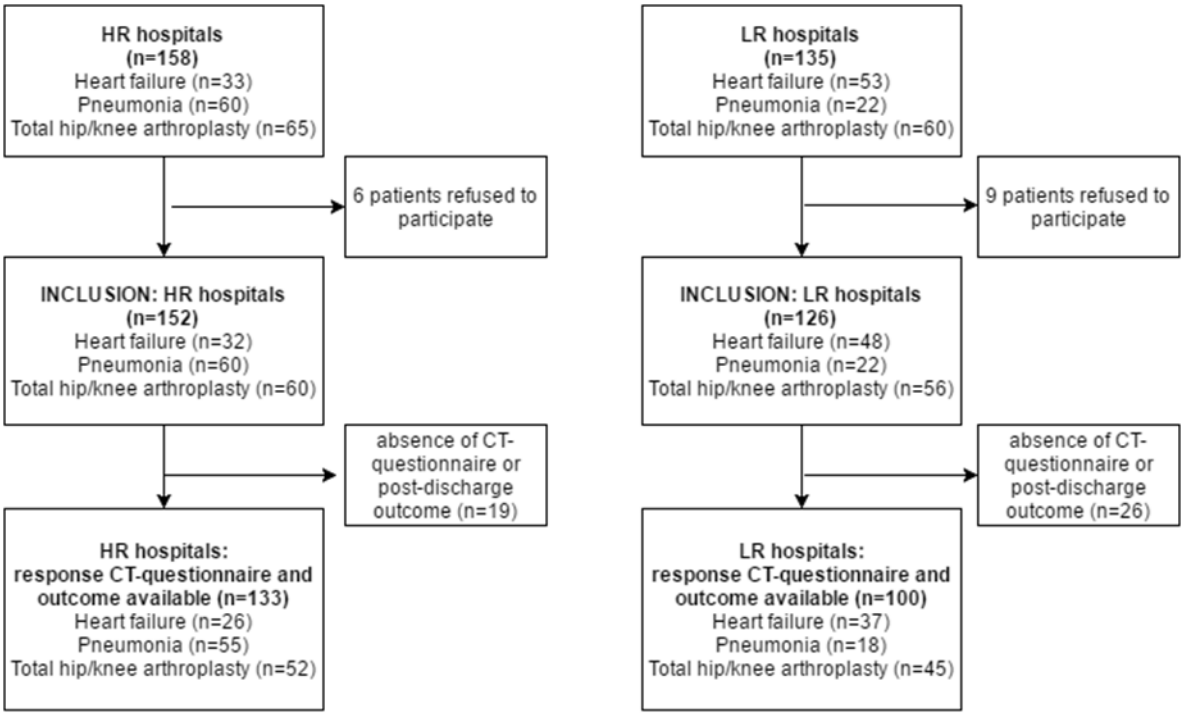
Statistical analysis

To determine whether the patient and hospital variables were equally distributed, chi-square goodness-of-fit tests were conducted for categorical variables. In cases with fewer than five expected cases in one group of categorical variables, Fisher's exact test was used. One-way ANOVA was used to determine whether the patient and hospital variables were equally distributed for the CT-scores. Logistic regressions were performed to assess the relationship between postdischarge events and transition elements. Patient and hospital variables related to postdischarge events used to construct the model for logistic regression included patient group, length of stay and hospital size. All analyses were performed using SPSS Statistics 23.

Results

A total of 293 patients from the 12 selected hospitals were invited to participate in the study. Fifteen patients refused to participate. Of the 278 patients included, 233 completed the CT-questionnaire and were contacted six weeks after discharge to obtain postdischarge outcome data. These 233 patients were included in the analysis. Figure 6.1 illustrates the selection of patients for each patient group in the HR and LR hospitals. The median number of patients included from each hospital was 28 (IQR 19-30). The six HR hospitals included 133 patients, and the six LR hospitals included 100. The education of patients and caregivers, the contributions of GPs to the discharge process, and the timeliness and completeness of the discharge summaries were evaluated for 101 of the 233 included patients by 94 GPs (43.3% response rate).

Figure 6.1: Flow diagram of the selection of patients



HR/LR=high/low readmission rate; CT-questionnaire=Care Transition questionnaire

Table 6.1 shows statistically significant differences between HR and LR hospitals for patient groups ($p<0.005$), length of stay ($p=0.010$), teaching status ($p<0.005$) and hospital size ($p<0.005$). Compared with LR hospitals, HR hospitals had more patients with pneumonia (41.4% vs 18.0%); fewer patients with short lengths of stay (<five days) (15.8% vs 32.0%); more patients from university hospitals (38.3% vs 5.0%) (two university hospitals in the HR group and one in the LR group); and more patients admitted to large hospitals (41.4% vs 5.0%) (two large hospitals in the HR group and one in the LR group).

Table 6.1: Comparison of patient and hospital characteristics across HR and LR hospitals

Characteristic	Category	HR hospitals n (%)	LR hospitals n (%)	Overall n (%)	p-value
Patient characteristics					
Age	18-60	27 (20.3)	22 (22.0)	49 (21.0)	0.657
	61-80	82 (61.7)	56 (56.0)	138 (59.2)	
	>80	24 (18.0)	22 (22.0)	46 (19.7)	
Gender	male	75 (56.4)	44 (44.0)	119 (51.1)	0.061
	female	58 (43.6)	56 (56.0)	114 (48.9)	
Family structure	living alone	21 (18.4)	23 (27.4)	44 (22.2)	0.134
	living with others	93 (81.6)	61 (72.6)	154 (77.8)	
	missing data	19	16	35	
Diploma	no secondary school diploma	67 (58.8)	51 (63.7)	118 (60.8)	0.484
	secondary school diploma or higher	47 (41.2)	29 (36.3)	76 (39.2)	
	missing data	19	20	39	
Self-rated health status	moderate to very good	105 (91.3)	75 (89.3)	180 (90.5)	0.632
	poor or very poor	10 (8.7)	9 (10.7)	19 (9.5)	
	missing data	18	16	34	
Patient group	heart failure	26 (19.5)	37 (37.0)	63 (27.0)	<0.005
	pneumonia	55 (41.4)	18 (18.0)	73 (31.3)	
	THA/TKA	52 (39.1)	45 (45.0)	97 (41.6)	
Charlson comorbidity index	0 (118)	69 (53.9)	49 (51.6)	118 (52.9)	0.904
	1 or 2	35 (27.3)	26 (27.4)	61 (27.4)	
	>2	24 (18.8)	20 (21.1)	44 (19.7)	
	missing data	5	5	10	
Length of stay	<5 days (53)	21 (15.8)	32 (32.0)	53 (22.7)	0.010
	5-9 days (123)	79 (59.4)	44 (44.0)	123 (52.8)	
	>9 days (57)	33 (24.8)	24 (24.0)	57 (24.5)	
Hospital variables					
Teaching status	general hospital	82 (61.7)	95 (95.0)	177 (76.0)	<0.005
	university hospital*	51 (38.3)	5 (5.0)	56 (24.0)	
Hospital size**	<150 beds	3 (2.3)	24 (24.0)	27 (11.6)	<0.005
	150-500 beds	75 (56.4)	71 (71.0)	146 (62.7)	
	>500 beds	55 (41.4)	5 (5.0)	60 (25.8)	

HR/LR=high/low readmission rate; THA/TKA=total hip/knee arthroplasty
*two university hospitals and one hospital affiliated with a university
**number of medical/surgical beds

Overall quality of transitions from hospital to home across patient groups

We first present the overall quality of transitions and quality of transitions across patient groups, as shown in Table 6.2.

For *patient readiness for discharge*, the mean CT-score was 82.5 (standard deviation (SD) 18.0). Patient readiness for discharge was higher for patients who underwent THA/TKA than for those with heart failure (mean difference 11.1 (95% confidence interval (CI) 5.3-16.9)) (p=0.001) and for patients with THA/TKA than for those with pneumonia (mean difference 5.8 (95%CI 1.2-10.5)) (p=0.016).

Nearly one in five (18.8%) GPs expressed concerns about one or more topics regarding *patient and caregiver education*. Education was most frequently evaluated as insufficient for patients admitted for heart failure (26.1% insufficient). For these patients, the greatest problem was that of warning sings (21.7% insufficient).

The *contributions of GPs to the discharge process* were limited: 90 of 101 GPs (89.1%) indicated that they were not involved in the discharge process. Of these, 19 (21.1%) believed that their input was necessary for the discharge process, thus 18.8% of all GPs evaluated this item as insufficient. The absence of GP involvement was most pronounced in the heart failure patient group, in which 21.7% of GPs evaluated this item as insufficient.

The *timeliness of the discharge summaries* was considered insufficient by 6.9% of GPs. GPs considered the receipt of discharge letters within 2 days of a patient's discharge as sufficiently timely in 97.6% of cases and 3 or more days after discharge as sufficiently timely in 70% of cases. Discharge summaries for patients with heart failure were all considered sufficiently timely.

Slightly more than one in ten (12.9%) GPs noted that the *completeness of the discharge summaries* was insufficient to guarantee continuity of care for one or more topics. Most concerns were addressed at follow-up appointments, with 8.3% of GPs indicating that they had not been adequately informed.

Table 6.2: Quality of care transitions across patient groups and HR and LR hospitals

Care transition element	Patient group	HR hospitals	LR hospitals	Overall	p-value
Readiness for discharge	heart failure	68.3 (26.1)	81.8 (17.7)	76.2 (22.4)	0.017
(mean CT-score (SD))	pneumonia	80.7 (16.0)	84.1 (16.0)	81.5 (16.0)	0.425
	THA/TKA	88.4 (11.3)	86.1 (17.8)	87.3 (14.6)	0.460
	overall	**81.2 (18.4)**	**84.2 (17.4)**	**82.5 (18.0)**	**0.219**
Education	heart failure	22.2	28.6	26.1	1.000
(% insufficient)	pneumonia	20.8	12.5	18.8	1.000
	THA/TKA	16.7	13.6	15.2	1.000
	overall	**19.3**	**18.2**	**18.8**	**0.887**
GP contribution	heart failure	11.1	28.6	21.7	0.611
(% insufficient)	pneumonia	16.7	12.5	15.6	1.000
	THA/TKA	20.8	18.2	19.6	1.000
	overall	**17.5**	**20.5**	**18.8**	**0.711**
Timeliness of discharge	heart failure	0.0	0.0	0.0	1.000
summary	pneumonia	12.5	12.5	12.5	1.000
(% insufficient)	THA/TKA	8.3	4.5	6.5	1.000
	overall	**8.8**	**4.5**	**6.9**	**0.465**
Completeness of	heart failure	11.1	21.4	17.4	1.000
discharge summary	pneumonia	16.7	0.0	12.5	0.550
(% insufficient)	THA/TKA	8.3	13.6	10.9	0.659
	overall	**12.3**	**13.6**	**12.9**	**0.840**

CT-score=score on the Care Transitions questionnaire; HR/LR=high/low readmission rate; PCP=primary care physician; SD=standard deviation; THA/TKA=total hip/knee arthroplasty

Table 6.3 represents patient and hospital characteristics for the five transition elements. Patients with moderate to very good self-rated health status had significantly higher CT-scores compared with patients with poor to very poor self-rated health status (mean difference 27.4; 95%CI 16.5-38.4) ($p<0.005$). No other statistically significant differences were identified. Both patient education and GP contribution to the discharge process were evaluated as insufficient in patients with poor to very poor self-rated health status by one in three GPs. Discharge summaries for patients with poor to very poor self-rated health status were all considered sufficiently timely.

Table 6.3: Patient and hospital characteristics for the five transition elements (N=101)

Characteristic	Category (N)	Readiness for discharge mean CT-score (SD)	Education % insufficient	GP contribution % insufficient	Timeliness of discharge summary % insufficient	Content of discharge summary % insufficient
Patient characteristics						
Age	18-60 years (24)	81.4 (19.3)	8.3	20.8	12.5	16.7
	61-80 years (56)	86.4 (16.8)	19.6	19.6	7.1	10.7
	>80 years (21)	72.6 (22.4)	28.6	14.3	0.0	14.3
Gender	male (45)	81.7 (16.4)	13.3	15.6	8.9	13.3
	female (56)	82.9 (21.4)	23.2	21.4	5.4	12.5
Family structure	living alone (22)	87.4 (11.1)	13.6	18.2	9.1	9.1
	living with others (62)	81.6 (19.4)	17.7	21.0	4.8	12.9
	unknown (17)					
Diploma	no secondary school diploma (48)	80.6 (18.4)	16.7	18.7	6.2	12.5
	secondary school diploma or higher (34)	85.9 (16.8)	17.6	23.5	5.9	11.8
	unknown (19)					
Self-rated health status	moderate to very good (75)	86.1 (14.5)	14.7	18.7	6.7	10.7
	poor or very poor (9)	58.6 (23.6)	33.3	33.3	0.0	22.2
	unknown (17)					
Charlson comorbidity index	0 (51)	87.3 (12.5)	11.8	21.6	9.8	13.7
	1 or 2 (26)	80.7 (16.4)	26.9	15.4	3.8	11.5
	>2 (18)	73.0 (31.7)	22.2	16.7	0.0	16.7
	unknown (6)					
Length of stay	<5 days (18)	84.7 (16.1)	16.7	0.0	5.6	5.6
	5-9 days (60)	84.4 (18.2)	21.7	23.3	6.7	15.0
	>9 days (23)	75.2 (23.0)	13.0	21.7	8.7	13.0

Hospital variables						
Teaching status	general hospital (77)	85.2 (14.6)	18.2	20.8	6.5	14.3
	university hospital* (24)	73.2 (28.3)	20.8	12.5	8.3	8.3
Hospital size**	<150 beds (10)	89.3 (11.7)	10.0	0.0	0.0	10.0
	150-500 beds (63)	81.3 (21.2)	19.0	22.2	4.8	12.8
	>500 beds (28)	82.3 (15.6)	21.4	17.9	14.3	14.3

CT-score=score on the Care Transitions questionnaire; GP=general practitioner; SD=standard deviation; THA/TKA=total hip/knee arthroplasty

*two university hospitals and one hospital affiliated with a university

**number of medical/surgical beds

Quality of transitions from hospital to home across hospitals with low and high readmission rates

We will now discuss the quality of transitions from hospital to home across hospitals with high and low readmission rates, as shown in Table 6.2. No difference was observed between *patient readiness* scores between LR and HR hospitals (mean difference 2.9; 95%CI -1.8-7.6) (p=0.219). A significant difference in the CT-score was identified between LR and HR hospitals for patients admitted for heart failure (mean difference 13.5; 95%CI 2.5-24.5) (p=0.017). No significant difference in *patient education* was identified between HR (19.3% insufficient) and LR hospitals (18.2% insufficient) (p=0.887) either overall or for specific patient groups. GPs of patients admitted to HR and LR hospitals evaluated their *contributions to the discharge process* as insufficient for 17.5% and 20.5% of their patients, respectively (p=0.711). The GPs of patients admitted to HR and LR hospitals did not receive *discharge summaries in a timely manner* for 8.8% and 4.5% of their patients, respectively (p=0.465). GPs of patients in HR hospitals experienced problems with the *completeness of discharge summaries* for 12.3% of discharged patients compared with 13.6% of GPs of patients in LR hospitals (p=0.840).

Associations between quality of transitions and post-discharge events

In the six weeks after hospital discharge, 24 of the 101 patients had one or more postdischarge events: 16 visited the ED (three without readmission), 21 were readmitted and one patient died in the hospital. More postdischarge events occurred in patients with pneumonia (43.8% had postdischarge events, compared with 17.4% of patients with heart failure and 13.0% of patients who underwent THA/TKA) (p=0.005); patients with long hospital stays (43.5% had postdischarge events, compared with 11.1% of patients with short hospital stays) (p=0.030); patients in large hospitals (46.4% had postdischarge events, compared with 10.0% of patients admitted to small hospitals) (p=0.004); and patients in HR hospitals (31.6% had postdischarge events, compared with 13.6% of patients in LR hospitals) (p=0.036) (Table 6.4). This last observation confirms that the patients in HR hospitals had a higher risk of postdischarge events than did those in LR hospitals.

Table 6.4: Comparison of incidences of post-discharge events by patient and hospital variables and readmission classification (N=101)

Variable	Group (n)	Post-discharge events n (%)	p-value
Patient variables			
Age	18-60 (24)	4 (16.7)	0.200
	61-80 (56)	12 (21.4)	
	>80 (21)	8 (38.1)	
Gender	male (45)	14 (31.1)	0.120
	female (56)	10 (17.9)	
Patient group	heart failure (23)	4 (17.4)	0.005
	pneumonia (32)	14 (43.8)	
	hip or knee arthroplasty (46)	6 (13.0)	
Family structure	living alone (22)	3 (13.6)	0.543
	living with others (62)	13 (21.0)	
	missing data (17)		
Diploma	no secondary school diploma (48)	12 (25.0)	0.136
	secondary school diploma or higher (34)	4 (11.8)	
	missing data (19)		
Self-rated health status	poor or very poor (9)	2 (22.2)	0.679
	moderate to very good (75)	14 (18.7)	
	missing data (17)		
Charlson comorbidity index	0 (51)	9 (17.6)	0.380
	1 or 2 (26)	8 (30.8)	
	>2 (18)	5 (27.8)	
	missing data (6)		
Length of stay	<5 days (18)	2 (11.1)	0.030
	5-9 days (60)	12 (20.0)	
	>9 days (23)	10 (43.5)	
Hospital variables			
Teaching status	general hospital (77)	18 (23.4)	0.870
	university hospital* (24)	6 (25.0)	
Hospital size**	<150 beds (10)	1 (10.0)	0.004
	150-500 beds (63)	10 (15.9)	
	>500 beds (28)	13 (46.4)	
Readmission classification			
HR or LR hospitals	HR hospitals (57)	18 (31.6)	0.036
	LR hospitals (44)	6 (13.6)	

CT-score=Care Transitions questionnaire score, HR/LR=high/low readmission rate; PCP=primary care physician

*two university hospitals and one hospital affiliated with a university

**number of medical/surgical beds

To assess the association between transitions and postdischarge events, five logistic regression models, one for each transition element, were analysed (Table 6.5). To dichotomize the CT-scores, those below the 25th percentile (CT-score: 70) were defined as

low compared with scores greater than 70. Hosmer-Lemeshow tests indicated a good model fit for the five models (p>0.05). The logistic regression analysis showed that only the timeliness of the discharge summary was associated with a higher risk of postdischarge events. The odds of experiencing a postdischarge event among patients without a timely discharge summary compared with those with a timely discharge summary were 10.564 (95%CI 1.476-75.603) (p=0.019).

Table 6.5: Association between quality of care transitions and post-discharge events

Care transition element	**Comparison**	**Odds ratio**		**p-value**
		estimate	95%CI	
Readiness for discharge	CT-score <25th percentile	1.298	0.382-4.412	0.677
	CT-score ≥25th percentile	Reference		
Education	insufficient	1.357	0.380-4.843	0.638
	sufficient	Reference		
PCP contribution	insufficient	1.555	0.434-5.566	0.498
	sufficient	Reference		
Timeliness of discharge summary	insufficient	10.564	1.476-75.603	0.019
	sufficient	Reference		
Completeness of discharge summary	insufficient	0.817	0.179-3.738	0.817
	sufficient	Reference		

CT-score=Care Transitions questionnaire score; PCP=primary care physician

Discussion

We evaluated five transition elements (readiness for discharge, education of patients and caregivers, contributions of GPs to the discharge process, and timeliness and completeness of discharge summaries) for three patient groups (heart failure, pneumonia and THA/TKA) using a prospective cohort design.

A difference in the quality of transitions from hospital to home between patient groups was observed for patients admitted for heart failure or pneumonia, who felt less prepared for discharge than patients admitted for a planned THA/TKA. This observed difference can be explained by the planned nature of the surgical procedure, indicating that patients are well-informed before admission to the hospital. There was also a difference in the quality of transitions between hospitals with high and low readmission rates for patient readiness for discharge among those with heart failure, who are less prepared in hospitals with high readmission rates. This result indicates that preparing patients for discharge is essential to prevent readmissions, particularly in patients with complex postdischarge needs. Of the five transition elements that were studied, only the timeliness of the discharge summary was associated with postdischarge events. This finding reinforces the importance of timely postdischarge communication.

The mean CT-score in our study (82.5, SD 17.9) is much better than the CTM reported in the literature in the US (67.3, SD 13.7 [4] or 71.2, SD 16.5 [5]). However, the study populations cannot be compared because the current study also included young patients and elective surgery cases. In addition, the CT-questionnaire is not completely comparable with the CTM because some questions were different. The finding that patient readiness for discharge was lower in patients with poor to very poor self-rated health status compared with those with moderate to good self-rated health status is congruent with previous studies. Parry et al. showed that CTM scores for patients with poor self-rated health status (66.9, SD 17.9) were significantly lower than those for patients with good to excellent self-rated health status (75.6, SD 16.1) ($p=0.003$) [5]. The timeliness of the discharge summaries was much better in our study than in previously published studies: 93.1% of GPs reported having received discharge summaries on time compared with 22.5% of GPs in the Netherlands in 2006 [20]. One explanation for this discrepancy is that the hospitals in the present study, as well as many other hospitals in Flanders, use electronic patient records that facilitate writing and sending discharge letters. Another explanation is that the presence and content of discharge summaries as a compulsory part of patient records has been regulated by Belgian law since 1999. The desire of GPs to contribute more to the discharge process has also been observed in previous studies. Hesselink et al. reported that GPs and hospital physicians agreed that hospital physicians are not sufficiently aware of patients' living situations [12]. In the same study, GPs expressed a need to be consulted by hospital physicians more quickly and more frequently.

Although Belgium comprises three communities, we selected only hospitals in Dutch-speaking Flanders for this study. However, we have no reason to expect that variations across hospitals in terms of readmission rates or between the quality of transitions and postdischarge outcomes differ among communities. We believe that the implications of this study can be extrapolated not only to the two other Belgian communities but also to other countries.

The absence of additional differences in the quality of transitions among the cohorts may be due to a regression to the mean. We classified hospitals as having high or low disease-specific readmissions based on their readmission rates over one year. Because a considerable proportion of readmissions cannot be prevented, hospitals with a high readmission ranking (increasing the chance of being selected for our study) may have a lower ranking during another year (and therefore would not have been selected).

In interpreting the results, we also must take into account that the timespan between the readmission rate scores in 2008 and the start of the study was five years. This could not be prevented because we used the most recent available data. To minimize the impact of this delay, we excluded hospitals that went through a merger after 2008. In 2014 a financial penalty was introduced for readmissions within 10 days after discharge. This penalty does not correlate to quality of care, because also planned readmissions or patient transfers are penalized. For this reason and because the penalty is relatively small, we believe that the penalty has no influence on the quality of transitions after 2014. The sample size was calculated based on the primary aim of the study to identify variations in five transition elements across hospitals with large differences in readmission rates. Unfortunately, the response rate to the questionnaire distributed to GPs was too low to detect differences at a significance level of 0.05 and a power of 0.80.

We chose to use a subjective evaluation of education level judged by GPs rather than by patients because research shows a discrepancy between high self-rated understanding and observed understanding [24]. In the present study, we relied on the evaluation by GPs and not on patient surveys because of the increased clinical relevance of the obtained score. GPs rate not only the knowledge of the patient but also whether this knowledge is sufficient to ensure an optimal transition from hospital to home. For example, the GP may consider a patient whose medication is administered twice daily by a dedicated nurse at home but who has limited knowledge about his medication schedule to be sufficiently informed. Evaluating the clinical relevance of transition elements (GPs were asked whether they were able to guarantee continuity of care) rather than solely evaluating the presence or absence of these elements is a methodological strength of this study.

A number of clinical implications can be formulated. Good patient readiness for discharge in patients with complex postdischarge needs is associated with lower readmission rates. To prevent postdischarge events, we suggest that all GPs receive the discharge

summary of each patient within two days after discharge. Missing elements in the discharge summary can be prevented by using a template that includes all relevant topics. To ensure continuity of care, primary care professionals must be contacted as part of the discharge process. To make this possible, new communication technologies should be explored. It is clear that the contributions of GPs to the discharge process, which is a two-way exchange of information, cannot be replaced by a good discharge summary. The current findings can serve as base from which to adapt existing regulations. The results of this study indicate that the quality of transition from hospital to home is influenced by communication among the different caregivers. Therefore, policymakers should stimulate communication between secondary/tertiary care and primary care facilities. The introduction of Accountable Care Organisations and Integrated Care Models are examples of a more patient-centred health care organization with an emphasis on mutual communication.

Future research should focus on other transition elements that could be important for the quality of transition from hospital to home. This can be based on the results of recent meta-analyses investigating discharge interventions [25, 26]. Further investigation of the association between CT-scores and postdischarge outcomes for different patient groups is necessary before this tool can be widely implemented. In addition, expanding the target audience to other health care professionals at home is essential to fully understand the clinical relevance of transition elements.

These findings emphasize the importance of approaching vulnerable patients in a systematic way to better prepare them for leaving the hospital. To guarantee continuity of care, primary care professionals need to be involved in the discharge process, particularly for patients with complex care needs. Communication with primary care professionals must be timely and focused on the continuity of care.

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Appendix

Appendix 6.I: Care Transitions questionnaire

Care Transitions Measure: original questionnaire	Care Transitions questionnaire (Dutch version)	Care Transitions questionnaire (English translation)
Q1 Before I left the hospital, the staff and I agreed about clear health goals for me and how these would be reached.	Q3 Had u, op het moment dat u het ziekenhuis verliet afspraken gemaakt met uw arts, verpleegkundige of kinesist over wat u wanneer zou willen bereiken op het gebied van uw gezondheid?	Q3 When you left the hospital, did you have agreements with your physician, nurse or physiotherapist about your health goals?
Q2 The hospital staff took my preferences and those of my family or caregiver into account in deciding what my health care needs would be when I left the hospital.	Q1 Hield men in het ziekenhuis echt rekening met uw wensen bij het bepalen welke zorgen u na uw ontslag nodig zou hebben?	Q1 Did the hospital's staff take your preferences into account in decisions regarding your health care needs after discharge?
Q3 The hospital staff took my preferences and those of my family or caregiver into account in deciding where my health care needs would be met when I left the hospital.	Q2 Hield men in het ziekenhuis echt rekening met uw wensen bij het bepalen waar u na uw ontslag zou verzorgd worden (bv thuis, rusthuis, hersteloord,…)?	Q2 Did the hospital staff take your preferences into account in decisions regarding where your health care needs would be met after discharge (e.g., home, rest home, nursing home)?
Q4 When I left the hospital, I had all the information I needed to be able to take care of myself.	Q5 Had u, op het moment dat u het ziekenhuis verliet alle noodzakelijke informatie om thuis verder te kunnen?	Q5 When you left the hospital, did you have all the information you needed to be able to take care of yourself?
Q5 When I left the hospital, I clearly understood how to manage my health.		
Q6 When I left the hospital, I clearly understood the warning signs and symptoms I should watch for to monitor my health condition.	Q9 Begreep u, eens terug thuis, waar u moest op letten om te weten dat er niets verkeerd aan het lopen was met uw gezondheid?	Q9 When you were at home, did you understand the signs you should watch for to determine if something was wrong with your health?
Q7 When I left the hospital, I had a readable and easily understood written plan that described how all of my health care needs were going to be met.	Q7 Had u, op het moment dat u het ziekenhuis verliet een voor u geschreven plan waarin duidelijk stond wat er diende te gebeuren om uw gezondheid te verbeteren?	Q7 When you left the hospital, did you have a written plan that described what was necessary to improve your health?

Q8 When I left the hospital, I had a good understanding of my health condition and what makes it better or worse.	Q10 Begreep u, eens terug thuis, hoe uw gezondheidstoestand was en waardoor hij kon verbeteren of verslechteren?	Q10, When you were at home, did you understand the condition of your health and the factors that would make it better or worse?
Q9 When I left the hospital, I had a good understanding of the things I was responsible for in managing my health.	Q11 Begreep u, eens terug thuis, welke zaken u zelf kon en moest doen om zo gezond mogelijk te blijven?	Q11 When you were at home, did you understand what you needed to do to remain as healthy as possible?
Q10 When I left the hospital, I was confident that I knew what to do to manage my health.		
Q11 When I left the hospital, I was confident I could actually do the things I needed to do to take care of my health.	Q6 Had u, op het moment dat u het ziekenhuis verliet er vertrouwen in dat u ook werkelijk zou kunnen doen wat nodig was om voor uw gezondheid te zorgen?	Q6 When you left the hospital, did you feel confident that you could do the things you needed to do to take care of your health?
Q12 When I left the hospital, I had a readable and easily understood written list of the appointments or tests I needed to complete within the next several weeks.	Q8 Had u, op het moment dat u het ziekenhuis verliet een leesbare en gemakkelijk te begrijpen lijst met afspraken of onderzoeken die u in de daaropvolgende weken moest ondergaan?	Q8 When you left the hospital, did you have a readable and easily understood written list of the appointments or tests you needed to complete within the next several weeks?
Q13 When I left the hospital, I clearly understood the purpose for taking each of my medications.	Q12 Begreep u, na uw ontslag uit het ziekenhuis, van elk geneesmiddel waarom u het moest innemen?	Q12 After discharge from the hospital, did you understand the purpose of each of your medications?
Q14 When I left the hospital, I clearly understood how to take each of my medications, including how much I should take and when.	Q13 Begreep u, na uw ontslag uit het ziekenhuis, van elk geneesmiddel hoe u het moest innemen, hoeveel u ervan moest nemen en wanneer?	Q13 After discharge from the hospital, did you understand how to take each of your medications, how much to take and when?
Q15 When I left the hospital, I clearly understood the possible side effects of each of my medications.	Q14 Begreep u, na uw ontslag uit het ziekenhuis, van elk geneesmiddel wat de mogelijke nevenwerkingen konden zijn?	Q14 After discharge from the hospital, did you understand the possible side effects of each of your medications?
	Q4 Had u, op het moment dat u het ziekenhuis verliet het gevoel dat u voldoende voorbereid was om het ziekenhuis te verlaten?	Q4 When you left the hospital, did you feel well prepared to leave?

Qx=xth question in questionnaire

Answer categories: “Strongly Agree”, “Agree”, “Disagree”, “Strongly Disagree”, “Not Applicable

Chapter 7 - DISCUSSION

Outline

This chapter begins by summarizing the answers to the formulated research questions. These answers are also interpreted based on current literature. We then reflect on the sense or nonsense of measuring readmission rates as an indicator for quality of care. Subsequently the overall methodological strengths and weaknesses are discussed. Finally, we formulate overall conclusions for different groups of stakeholders and translate the conclusions into concrete recommendations.

Findings with respect to the formulated research questions

In this section the answers to the seven research questions, formulated in the introduction chapter, are summarized and interpreted based on the current literature.

RQ1. What is the incidence of unplanned hospital readmissions in Belgium?

Overall incidence

In the **third chapter** we reported that the Belgian overall readmission rate within 30 days after discharge in 2008 was 10.3% and the unplanned readmission rate 5.2%. Because only readmissions to the same hospital were monitored, the all-hospital readmission rate in the studied population is between 17% [1] and 25% [2] higher. This results in an estimated all-hospital unplanned readmission rate within 30 days after discharge of about 7%.

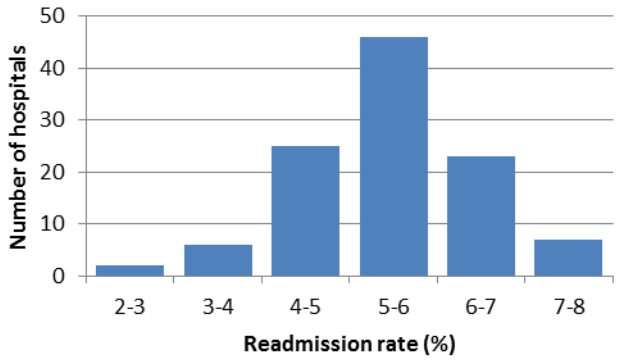
The unplanned readmission rate in Belgium is low compared to other studies. In a literature review by van Walraven et al. [3], the median unplanned readmission rate of the 34 studies included was 15.3%. The explanation of the low readmission rate in this study might be found in sample specifications: we included young adults, excluded patient groups with expected or unavoidable readmission and excluded planned readmissions, and we lacked data on readmissions to other hospitals. The readmission rate, found in our study, cannot be compared to that from another Belgian study by Trybou et al. [4]. In that study, hospital discharge data from the same year (2008) from 45 hospitals were used. They found a readmission rate of 1.5% within one month after discharge. In contrast to our study, they included also one-day clinics as index stay and only readmissions to the same APR-DRG were counted.

Although sampling specification can partly explain the low readmission rate, we can conclude that the overall incidence of readmissions is low in Belgium.

Hospital incidence

The readmission rate in Belgian hospitals within 30 days after discharge varies widely and ranges from 2.4% to 7.8% across hospitals (median 5.3, IQR 1.5) (Figure 7.1).

Figure 7.1: Hospital readmission rates for unplanned, same-hospital readmissions in Belgium (2008)



A wide variation in readmission rates between hospitals has been described in literature. Jencks et al. [5] and Herrin et al. [6] described differences in readmission rates between US states and US counties respectively, indicating that local factors influence readmission rates. However, differences between hospitals cannot only be explained by local factors and reflect also differences in quality of care. Halfon et al. [1] described that the standardized readmission ratio (SRR), which is the ratio of observed to expected number of readmissions, varies between hospitals from 0.07 to 2.8. They found a correlation between the number of clearly preventable readmissions and SRR (correlation coefficient 0.66).

RQ2. Which patient groups are most frequently readmitted?

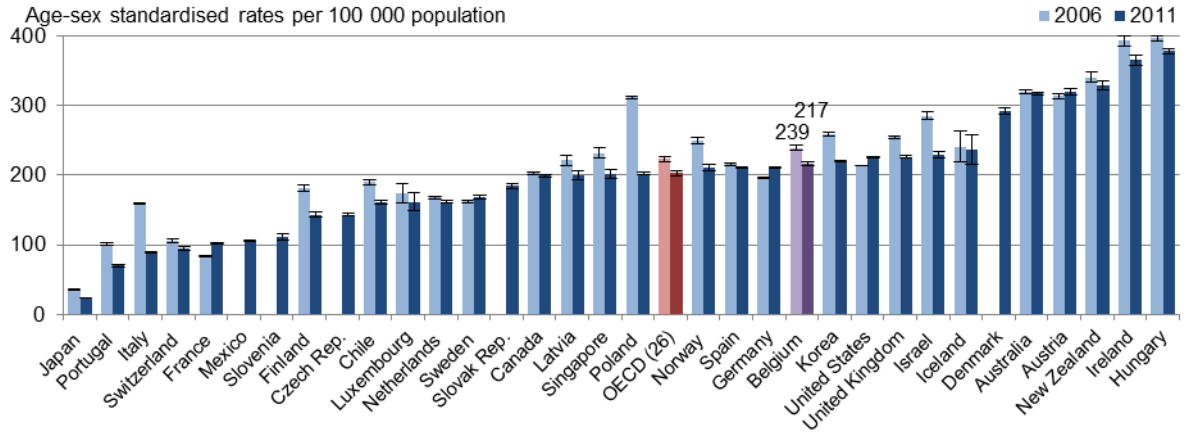
Patient groups readmitted

The 15 APR-DRGs with the most readmissions account for 21.2% of the index admissions and 30.9% of all readmissions, as reported in **chapter three**. The APR-DRGs with the highest number of unplanned readmissions within 30 days after discharge are: COPD (14.7% readmission rate), heart failure (14.0% readmission rate) and pneumonia (9.4% readmission rate). In the top 15 of APR-DRGs we identified four surgical APR-DRGs: “Other vascular procedures, clipping aneurysm” (6.0% readmission rate), “Major small & large bowel procedures, colostomy, ileostomy” (7.4% readmission rate), “Urethral & transurethral procedures, repair, incision” (6.3% readmission rate) and “Major joint & limb reattachment procedure of lower extremity without trauma” (2.5% readmission rate).

Because readmission rates differ substantially between different APR-DRGs, implementing interventions to effectively reduce readmissions will have the most impact on high-volume APR-DRGs with high readmission rates, provided that the high readmission rate reflects a high rate of preventable readmissions. COPD and heart failure are therefore possible first-choice patient groups. Because of the chronic and evolutionary aspect of these diseases, it could be argued that the rate of preventable admissions is probably low. This

point of view is contradicted by the Organization for Economic Co-operation and Development (OECD) [7], which states that COPD admissions are highly preventable through proper primary care management. For this reason, the OECD reports COPD admission rates as a proxy for primary care quality, with high rates indicating poor coordination, poor continuity or structural problems. The COPD admission rates for different European countries are presented in Figure 7.2. Belgium scores above the average, indicating that many admissions (and therefore also readmissions) for COPD might be avoidable.

Figure 7.2: COPD hospital admission rate for 2006 and 2011



Source: OECD, Healthcare quality indicators primary care [8]

Reason for readmission

Table 7.1 based on Be-HDDS of patients discharged in 2008, illustrates that in the 13 most important MDCs, most patients were readmitted into the same MDC as the initial admission. This is also illustrated in **chapter three** (Table 3.2), which lists the most frequent reasons for readmission for the top 15 APR-DRGs.

The finding that readmissions are often related to the initial admissions is not new. This was discussed previously in **chapter two**.

Table 7.1: Number and percentage of unplanned readmissions within 30 days after discharge for 13 most important MDCs

Initial MDC	MDC of readmission N (%)												
	001	**004**	**005**	**006**	**007**	**008**	**009**	**010**	**011**	**016**	**018**	**019**	**021**
001	**1837 (41)**	477	467	238	67	297	111	157	174	37	130	160	83
004	388	**4932 (56)**	861	569	131	400	137	231	272	165	223	123	88
005	537	1130	**4859 (50)**	667	126	455	177	263	345	121	292	149	285
006	300	607	530	**3290 (44)**	265	309	99	217	309	131	503	122	406
007	80	149	121	407	**1512 (50)**	85	43	60	85	38	179	21	110
008	460	625	534	563	86	**2509 (38)**	191	156	210	78	394	116	287
009	94	178	139	116	24	125	**334 (21)**	40	70	44	159	40	131
010	127	240	222	273	52	115	40	**441 (22)**	84	24	123	50	132
011	143	321	330	372	65	155	60	115	**2236 (50)**	50	194	47	197
016	70	162	112	156	37	59	20	31	36	**348 (30)**	61	15	14
018	56	148	95	117	55	55	40	29	73	36	**256 (24)**	10	25
019	134	126	92	73	17	85	29	37	38	4	17	**448 (35)**	74
021	54	84	74	125	44	49	36	29	47	8	59	64	**345 (31)**

The Major Diagnostic Categories (MDCs) listed are: MDC 001=Nervous System, MDC 004=Respiratory System, MDC 005=Circulatory System, MDC 006=Digestive System, MDC 007=Hepatobiliary System and Pancreas, MDC 008=Musculoskeletal System And Connective Tissue, MDC 009=Skin, Subcutaneous Tissue And Breast, MDC 010=Endocrine, Nutritional And Metabolic System, MDC 011=Kidney And Urinary Tract, MDC 016=Blood and Blood Forming Organs and Immunological Disorders, MDC 018=Infectious and Parasitic Diseases, MDC 019=Mental Diseases and Disorders, MDC 021=Injuries, Poison And Toxic Effect of Drugs
Only MDCs with a minimum of 1,000 admissions in initial admission and readmission stay are represented.

In **chapter three** we described how one out of ten readmissions is due to complications of care, with a higher proportion of surgical patients readmitted for complications compared to medical patients.

Morris et al. [9] also showed that readmissions are often associated with a high incidence of complications. They studied a large surgical population and found that 56.0% of readmissions were associated with a newly assessed complication.

This implies that actions to reduce complications, such as better adherence to guidelines, will reduce the number of preventable readmissions.

RQ3. What are risk factors for unplanned readmission in Belgian acute hospitals?

Risk factors for readmissions were discussed in **chapter three**. Patient-related factors that increase the risk of readmission are: male gender, age, discharge against medical advice, severity of illness, number of comorbidities and acuity at admission. These risk factors are thoroughly discussed in literature. In this section we highlight risk factors that should be taken into account when implementing interventions to reduce readmissions.

Previous visits to emergency department

An important risk factor for readmission is the number of previous emergency department (ED) visits in the past six months.

Also Van Walraven et al. [10] described previous visits to the ED as a risk factor for readmission. Interventions to improve transitions of elderly persons visiting the ED, called "ED-community transition strategies", are the subject of recent research. A common aspect of the interventions is geriatric assessment and referral for assistance after discharge. The effect of ED-community transition strategies is studied by Lowthian et al. [11] in a systematic review, but did not identify any positive impact on the studied outcomes (unplanned ED visits, hospital admission, institutionalization, functional decline and mortality).

In this context, previous ED visits are regarded as a risk factor for readmission, but they are, in fact, a pre-existing status – present before the index admission. Therefore, multiple ED visits can also be seen as a predictor for admission and thus, after discharge, for readmission.

The knowledge that frequent ED visits are associated with repeated admissions implies that we must adapt the care offered to patients who visit the ED frequently. For these patients, the focus must not only be on their medical condition, but also on the coordination of care between health professionals together with patients and their caregivers. This requires collaboration between different groups of care providers across the different levels of care.

Length of hospital stay

We found that patients with a long length of stay have a higher risk of readmission compared to patients with an average length of stay. This finding is in line with earlier studies that showed an increased risk of readmission after long lengths of stay for different patient groups: elderly patients [12], surgical patients [13, 14], medical patients [15, 16] and

a general case mix [10, 17]. One possible explanation for the increased risk is that patients with a long length of stay are more at risk of presenting adverse events (leading to a readmission) after discharge, as described by Forster et al. [18]. Another possible explanation is that patients with a limited social network stay longer in the hospital, but have a higher risk of readmission. Furthermore, long hospital stays can also be related to the post-hospital syndrome described in the introduction chapter, inducing increased vulnerability after discharge in patients with longer hospital stays.

In contrast to a long length of stay, we found that the risk of readmission for patients with a short length of stay is not higher compared to patients with an average length of stay. This absence is an important finding, because this confirms that it is unlikely that patients with a short length of stay are sent home unprepared for discharge.

Based on these findings, we conclude that hospital stays should be as short as clinically necessary. Informing patients and caregivers about the expected discharge date as soon as possible and early discharge planning are therefore important interventions. Moreover, all hospital processes need to be designed to ensure timely discharge.

Discharge on Friday

Patients discharged on Friday have a slightly higher risk of readmission compared to patients discharged any other day. This is an important finding, because almost one in four patients (23.7%) in Belgium is discharged on Friday.

This high frequency of discharges on Friday can also be found in the literature. Van Walraven et al. [19] showed a higher risk of unplanned readmission or mortality for patients discharged on Friday compared to discharges on all other days. In contrast, Graham et al. [20] observed no difference in outcomes for older patients discharged on Friday compared to discharges on all other days. These conflicting results can possibly be explained by the fact that the risk of readmission increases only slightly with discharge on Friday.

The consequence of this finding is that for patients at risk of readmission who are discharged on Friday, supplementary actions must be undertaken to ensure continuity of care. Otherwise, postponing discharge until Monday should be considered.

Other risk factors

No association was found between the hospital's size and readmission rates. In our research we used the mortality rate in patients with a low risk of mortality as a general indicator for quality of care. Hospitals in the lowest quartile were identified as hospitals with low mortality rates, and hospitals in the highest quartile as hospitals with high mortality rates. We found that hospitals with high or intermediate mortality rates have slightly greater odds for readmission compared to hospitals with a low mortality rate.

Screening based on risk factors

In our cross-sectional study we showed that in addition to length of hospital stay and previous visits to the ED, acuity at admission (admission through ED) and the number of comorbidities are also risk factors for unplanned hospital readmissions. These four elements have been previously described as the LACE index (Length of stay, Acuity, Comorbidity, ED visits), which is discriminative at predicting risk of unplanned readmissions or death, as studied by van Walraven et al. [10]. Because the four elements of the LACE index can easily be scored during hospital stay, this index could be useful to identify patients at risk of readmission. Further research is necessary to assess predictive value and the feasibility of broadly implementing this index.

RQ4. Which discharge interventions are effective in reducing readmissions within three months after discharge from the hospital?

In **chapter four** we presented the results of a systematic review and were able to conclude that discharge interventions are effective in reducing readmissions. Exploratory subgroup analysis was executed to investigate which interventions are potentially superior in reducing readmissions. We summarize the results in this section.

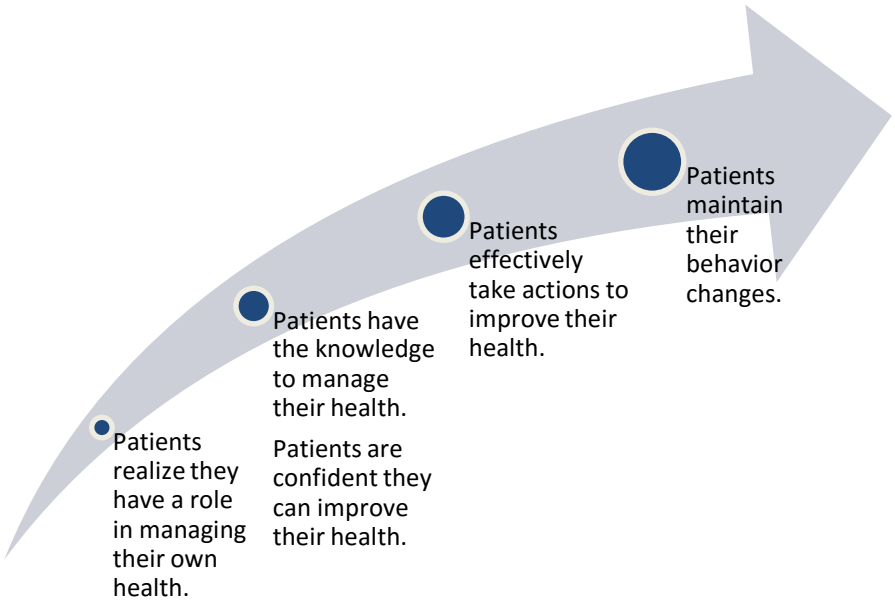
Patient empowerment and patient self-management

Our systematic review demonstrated that interventions for patient empowerment were more effective compared to all other interventions [21]. Interventions stimulating patient empowerment were defined as "interventions with the intention to increase patients' control over his illness or stimulate the participation in the medical decision making process or reinforce psychosocial skills" (based on Ouschan et al. [22] and Aujoulat et al. [23]).

A previous meta-analysis by Leppin et al. [24] supports this finding. They described how interventions supporting patients' capacity for self-care are 30% more effective in reducing readmissions compared to interventions that do not improve self-care. Spehar et al. [25] showed in a qualitative study that patients also perceive that readmissions could be prevented with enhanced education, involvement in the decision-making process and increased medication knowledge.
Christina Pavetto Bond and Eric Coleman [26] describe how self-management can be achieved, defining four levels of activation (Figure 7.3). The first essential level is to make patients understand that they can and must play a role in restoring or maintaining health. The second level is to build knowledge and confidence before patients, in the third level, effectively take actions to improve their health. The fourth – and probably the most difficult – level is to maintain these behavioral changes. Because almost one in five general practitioners (GPs) in the cohort study evaluated patient education (level 2) as insufficient,

as described in **chapter six**, implementing self-management and patient empowerment will be a substantial challenge.

Figure 7.3: Four levels of activation in patient self-management



Source: Bond and Coleman, Reducing readmissions [26]

In recent years patient empowerment has gained attention in Belgian healthcare: patient empowerment and approaching patients as active partners in their healthcare are key concepts in the current plan for the restructuring of Belgian healthcare and in the initiatives for integrated care [27-29].

Discharge planning

Our systematic review demonstrated that discharge planning reduced readmissions up to three months after discharge. Discharge planning is a methodology to prepare patients during their hospital stay prior to leaving the hospital. It starts with screening patients shortly after admission; afterwards an assessment takes place and, together with patients and caregivers, a discharge plan is developed. After implementing the discharge plan, the execution of the plan is monitored [30, 31]. Discharge planning is described in the literature as an in-hospital process that is limited to the length of patients' stays [32].

In the literature, the effect of discharge planning on readmissions is not clear. A previous Belgian study in six general hospitals showed that discharge planning reduced institutionalization at the moment of discharge and up to 90 days after discharge (OR 0.47; 95%CI 0.31–0.70), but had no impact on readmissions after 15 and 90 days (OR 0.58; 95%CI 0.26–1.25 and OR 0.90; 95%CI 0.58–1.40, respectively) [33]. Shepperd et al. [31] concluded in a systematic review that there is evidence for small reductions in readmission rates for elderly patients admitted with medical conditions.

In Belgium, “discharge management” was introduced by Moons et al. [34, 35] as a tool to ensure a seamless transition from hospital to home and is comparable to discharge planning, as described above. During the cohort study, we interviewed social workers in ten out of the twelve hospitals. In two hospitals all patients were screened for increased need for discharge planning, in five hospitals screening was implemented for selected patient groups, and in three hospitals no tool was present. Additionally, the timing of screening varied between the hospitals: only four out of the seven hospitals responded that screening took place within 24 hours after admission.

Start in hospital and continue at home

We reported that interventions starting during the hospital stay and continuing after discharge were effective in reducing readmissions, in contrast to interventions that were limited to the hospital stay or started only after discharge. This was also found in reviews by Mistiaen et al. [36] and Scott [37]. This finding implies that discharge interventions need to bridge the transition from hospital to home and cannot be limited to the hospital context.

At this point we would like to discuss the etymologic origin of the word “discharge”. The origin can be found in the Old French word “deschargier”, which meant “to exempt, release”; later on the meaning “to release from work or duty” arose [38]. In this context, discharge from hospital can also be interpreted as a release of physicians from their duty to care for their patients. This meaning is at present no longer suitable, because the duty of physicians or other care professionals does not end at the hospital’s door.

Single-component interventions

Based on our research, multi-component interventions (interventions consisting of a minimum of six components) seem not to be superior compared to single-component interventions.

This finding is contrary to a previous review performed by Leppin et al. [24], who described how multi-component interventions (interventions consisting of a minimum of five components) were more effective compared to interventions composed of fewer than five components. A possible explanation for the difference is that the set of studied components was different in both studies. Another possible explanation is that, more than the number of intervention components, the number of barriers to change that are addressed must be counted. Wensing et al. [39] illustrated that, in knowledge translation, multi-component interventions are not always superior, but they are more effective when they address different types of barriers. These barriers or obstacles to change can be present at each level of healthcare: patients, individual professionals, teams, healthcare organisations,…[40].

The practical implication of this finding is that discharge interventions do not need to be complex, but should preferably address different types of barriers to change.

RQ5. What is the effect of discharge interventions on mortality, use of the emergency department and patient satisfaction?

The systematic review (**chapter four**) showed that there is no effect of discharge interventions on return to the ED and mortality. In contrast, patient satisfaction improves in favor of the discharge intervention group.

The positive effect of discharge interventions on patient satisfaction could be expected, because patients are often unsatisfied concerning hospital discharge. Berendsen et al. [41] showed in a qualitative research study that patients are often disappointed about the hospital discharge procedure: they mention a lack in information given by their specialist, their individual needs were not enough taken into account and it took too long before their GP was informed about the hospital stay. Discharge interventions that improve these topics, can be expected to improve patients' satisfaction.

RQ6. How are readmissions related to the quality of in-hospital care processes for three patient groups?

In **chapter five** we studied the quality of in-hospital care for three patient groups (heart failure, pneumonia and THA/TKA). Quality of in-hospital care was assessed by monitoring hospital-acquired AEs, identified using the Global Trigger Tool methodology. We explored hospital-acquired AEs across hospitals with strong divergent readmission rates. Only for patients with heart failure, we found more AEs in hospitals with high readmission rates compared to hospitals with low readmission rates. However, no difference could be found between HR and LR hospitals for harmfulness and preventability of AEs.

This finding is in accordance with a large multicentre cohort study conducted by van Walraven et al. [42] who couldn't find a correlation between hospital-specific readmission rates due to preventable AEs and all-cause readmission rates.

RQ7. How are readmissions related to the quality of care transitions from hospital to home for three patient groups?

In **chapter six** we studied the quality of transitional care by analysing five care transition elements for three patient groups (heart failure, pneumonia and THA/TKA): patient and caregiver education, contribution of the general practitioners (GPs) to the discharge process, timeliness and content of the discharge summary, and patient readiness for discharge. We found that 18.8% of the GPs evaluated *education* of patients and caregivers negatively, that 18.8% of the GPs wanted to contribute actively to the *discharge*

process, that for 6.9% of the patients the *discharge summary* arrived *too late* to ensure continuity of care and that the *completeness* of the discharge summary was insufficient for 12.9% of the patients. Furthermore, we found an overall score for *readiness for discharge* of 82.5 (SD 17.9).

To assess the effect of the quality of the care transitions, differences in the five care transition elements between hospitals with high disease-specific readmission rates and hospitals with low disease-specific readmission rates were studied. We also studied the association between post-discharge events (ED visits, hospital readmission or mortality) and the five care transition elements.

We found lower readiness scores for patients admitted for heart failure when admitted to hospitals with high disease-specific readmission rates. This finding is supported by previous research that demonstrated the association between readiness for discharge and readmission [43].

We also demonstrated that more post-discharge events were present in patients of GPs who did not receive the discharge summary on time. This finding emphasizes the importance of timely communication after hospital discharge. Most GPs evaluated discharge summaries that arrived within two days after discharge as timely. In our study, timeliness of discharge summaries was better compared to other studies. This can be explained by the legal obligation to have a discharge summary available in the patient's record [44] or the high proportion of hospitals using electronic patient records. Difficulties in communication between secondary and primary care (and vice versa) have been reported previously by different researchers. Two studies in the Netherlands confirm the difficulties in communication. Hesselink et al. [45] described how GPs and community nurses want to be involved more quickly and more frequently. GPs and community nurses mentioned the underestimation of their knowledge and skills as a reason for the absence of collaboration from hospital professionals. Berendsen et al. [46] showed a discrepancy in the mutual evaluation of effectiveness of communication between GPs and specialists, with 22% of GPs evaluating the discharge summary as timely compared to 62% of the specialists who thought that their summaries arrived on time.

Sense or nonsense of readmission rate as quality indicator

Discussions in the literature about using the readmission rate as a quality indicator seem endless. In this thesis we provide some recommendations based on the literature on this topic, which was previously described in **chapter two**.

When using readmissions to evaluate and monitor the quality of care, the definition and calculation of the readmission rate has to be performed with adequate consideration and should be based on following rules:

1. The calculation of the readmission rate depends on the projected application of the indicator. A readmission rate definition intended to improve quality of care (e.g. England) will differ from a readmission rate definition intended to penalize malpractices with the APR-DRG-based hospital payment (e.g. Germany) [47].

2. When hospitals are compared to each other, correction for risk factors such as age and comorbidities is relevant. Although we see differences in readmission rates according to race, gender or socio-economic status, correcting for these items is contra-indicated, because quality of care may not depend on demographic factors. Indeed, we must strive for high-quality care and care transitions for all patients.

3. Because patients' diseases determine the risk of readmission, it is relevant to compare disease-specific readmission rates. It is also meaningful to compare readmission rates for populations at risk, such as elderly patients.

4. Because planned readmissions are not related to suboptimal quality of care, they should be excluded. To measure relevant readmissions, selecting potentially preventable readmissions by using software is a good option (e.g. Potentially Preventable Readmission Grouping Software, developed and commercialized by 3M), provided that this selection is broad and that readmissions to other APR-DRGs and MDCs are also taken into account.

5. To avoid counting unrelated readmissions, it is important that the readmission interval is not too long. We suggest that the readmission interval is a maximum of 30 days. Including readmissions to other hospitals is preferable. We recognize, however, that the combination of disease-specific readmissions and readmissions to all hospitals is not currently possible in Belgium.

Methodological strengths and limitations

The strengths and limitations of the study are discussed in their respective chapters. In this section we outline overall methodological issues and how they should be interpreted in the broader context of this research.

Reflections related to the study population

External validity in the cohort study was increased by studying three different patient groups: one group with a chronic disease (heart failure), one with an acute illness (community acquired pneumonia) and one admitted for planned surgery (THA/TKA). Because this doctoral research is limited to the Belgian – and, even more specifically, to the Flemish – context, some descriptive results cannot be extrapolated to other countries. We believe, however, that the overall conclusions transcend the local healthcare organization.

In the cohort study we were not able to get enough answers from other **primary care professionals** besides GPs to formulate conclusions. This is a weakness in this study that offers room for further research.

Reflections related to the study design

A strength of this study is its **mixed methods design**, using a cross-sectional and a prospective cohort design. These study designs were chosen because this is the first study conducted on the topic in Belgium, and the research was primarily exploratory and observational. In addition to the chosen study designs, qualitative research could also offer important information about patients' and primary care physicians' expectations and the reasons for readmission. It is recommended to explore this further in future research.

The trial allocation sequence was not concealed, because consecutive patients were assessed for eligibility in the cohort study. The risk exists that in times of high workload (many patients admitted or understaffing) commitment to the study was not a priority for hospital staff. This could induce **selection bias** and endangers the **internal validity** because patients are at that moment more at risk of substandard quality of care or care transitions. We attempted to reduce this bias through day-by-day follow-up.

In only five of the 51 papers included in our systematic review, patients were **blind** to their allocation, which potentially introduces bias. No statistically significant subgroup difference was present between the interventions with blinding of patients and the interventions without blinding (Chi^2=0.28, p=0.60).

In interpreting the results we must keep in mind that these results must be considered **exploratory** and **observational**, and therefore conclusions about causal relations cannot be made.

Reflections related to interventions

This doctoral research is designed from a hospital perspective, using the **hospital** and hospital professionals **as a starting point**. In reality, however, healthcare is a continuum, and hospital care is only a limited part of this continuum. As a result of this initial limitation, we have no information about the impact of the quality and coordination of primary care, which needs further research.

In the literature review we did not include **pre-admission interventions** that are designed to improve discharge from hospital to home. Searching PubMed for the effect of pre-admission interventions on readmissions showed that published evidence is scarce and often concerns pre-admission orthopedic clinics. Further research on pre-admission discharge interventions is therefore recommended.

Reflections related to outcomes and variables

A notable strength of the cross-sectional study, described in **chapter three**, is the availability of a **national dataset** containing demographic and clinical information for all patients discharged from Belgian hospitals.

In this thesis research we took into account **clinical information***,* which was an important strength of this study and was considered essential from the beginning. The availability of clinical information made it possible to identify patient groups at risk of readmission and the clinical reasons for readmission. Due to clinical information we were able to correct length of hospital stay in the cross-sectional study for APR-DRG, severity of illness and age, which was necessary to classify length of stay as short or long.

In both the cross-sectional and the cohort study we did not make a distinction between related or unrelated readmissions, and thus **all-cause readmissions** were measured. This choice is tenable, because for an individual patient each unplanned readmission is experienced as an undesirable outcome.

Because of the absence of a unique patient identifier, we were not able to follow individual patients across the various hospitals in the cross-sectional study. For this reason we could only report **readmissions to the same hospital**. In the literature, the readmission rate to other hospitals is assessed at 17% [1] to 25% [2]. Of the 253 patients with whom we could follow up after discharge in the cohort study, 43 patients were readmitted within 6 weeks. Of them, 9.3% were readmitted to another hospital. This suggests that readmission to other hospitals in Flanders is probably less than one out of four readmissions.

A weakness of the cross-sectional Be-HDDS study was the absence of information about **healthcare consumption** after discharge from hospital. This was collected in the post-discharge follow-up of patients discharged from 12 Flemish hospitals: six weeks after

discharge, 11.2% of patients without readmission and 17.5% of patients with readmission had had no visits with their PCP (p=0.292).

We formulated the absence of **socioeconomic risk factors** such as ethnicity, education and marital status in the Be-HDDS as a weakness. Later, in the cohort study, we found no association between educational level or family structure and post-discharge events.

Recommendations

Based on the results of this doctoral research in relation to previous studies, we can formulate recommendations for different stakeholders. These recommendations are in line with the aim, formulated in the introduction, “to study how to reduce hospital readmissions that are due to substandard quality of in-hospital care or due to substandard quality of the care transition from hospital to home.”

Recommendations for health professionals

Recommendations for care professionals are subdivided into recommendations for in-hospital health professionals and primary care physicians. To see patients as active partners in their own healthcare and to encourage and educate them to take up this role is an important message for every care professional.

In-hospital

To prevent unplanned readmissions, patients at risk of readmission must be identified early in their hospital stay. In the absence of a specific screening tool for readmission, the screening tool used in the hospital to detect patients eligible for discharge planning can be used. Additionally, patients frequenting the ED must be identified and regarded as patients at risk of admission or readmission. For patients at risk, smoothing the care transition from hospital to home in cooperation with caregivers, primary care physicians and home care nurses is essential. Interaction with primary care before discharge is preferable for these patients. To minimize variability and prevent errors or adverse events, it is important that best-practice guidelines or evidence-based care pathways, whenever available, are used. To prevent adverse events, the delay of discharge for patients who are medically and socially ready for discharge must be avoided. Timely and accurate communication with primary care professionals is essential for all patients to make continuity of care after discharge possible.

Primary care physicians

Guaranteeing continuity of care when patients move from secondary to primary care is essential. As described previously, hospital physicians can do much to promote continuity of care, but PCPs need to be organized to comply with therapeutic advice, medication changes and pending results.

Recommendations for hospital managers

When hospital managers are confronted with high readmission rates, it is essential to understand which patient groups are affected and why patients are readmitted. Based on our findings we can identify four critical domains to prevent readmissions: patient

empowerment, communication between secondary and primary care, discharge planning, and coordination of care. The domain 'quality and safety' was added from a theoretical point of view, but was not apparent in our study. The assessment of the five domains is illustrated in Table 7.2, with a distinction between basic and high levels of performance. Basic-level interventions are interventions that need to be first in place, before implementing more complex, high-level interventions.

Table 7.2: Illustration of the assessment of the five critical domains in preventing readmissions for basic and high levels of performance

Critical domains	Basic level	High level

Patient empowerment	**education:**
	- procedure exists
	- assessment of needs
	- evaluation of effectiveness
	- documented in patient record
	- health professionals are trained
	- procedure adherence is monitored and feedback is provided
	- before discharge, patients are educated about:
	  o diagnosis and impact on life at home
	  o medication
	  o warning signs
	  o follow-up appointments
		patients are active partners in their healthcare:
		- health professionals are trained to increase patients' capacity for self-management
		- patients receive patient-oriented discharge instructions
		- patient record is available for patients

Primary care communication	**timely and relevant discharge communication**:
	- procedures for discharge communication exist, describing:
	  o minimal relevant content
	  o timeliness
	- discharge summary is part of patient record
	- junior doctors and new physicians are trained in writing discharge letters
	- discharge communication is electronically transferred
	- procedure adherence is monitored and feedback is given
		active interaction with primary care professionals:
		- PCPs are, whenever relevant, consulted to give input for hospitalized patients
		- community nurses are involved with in-hospital care

Discharge planning	**individualized discharge plan:** - screening for patients with increased discharge needs starts	**specific actions to promote coordination of discharge:** - discharge manager/transition

	shortly after admission to hospital - needs are assessed for all patients identified by screening - goals are defined based on needs - primary care, patient and family are involved in formulating the interdisciplinary discharge plan - execution of plan is monitored - plan is adapted if necessary	coach to help patients bridge the transition - ED-community transition strategies are implemented
Quality and safety	**best-practice guidelines and care pathways:** - guidelines or evidence-based care pathways are available - care professionals are educated on using the guidelines/care pathways - adherence is monitored and feedback is given	**specific actions to enhance quality of care and minimize adverse events:** - pharmaceutical counseling - medication reconciliation - telemedicine
Coordination of care	**responsible practitioner:** - patient and health professionals know at each moment who they can contact in case of questions or health problems **follow-up:** - timely follow-up by primary care is ensured - follow-up instructions are acted upon by patients and professionals	**specific actions to promote coordination:** - one patient record for all health professionals - patients are contacted after discharge by phone - a hotline exists for patients and caregivers

Recommendations for policymakers in healthcare

To optimize care transitions and stimulate continuity of care, healthcare organization and financing in Belgium must be redesigned. To achieve this reorganization, the current Minister of Social Affairs and Public Health, already proposed a detailed plan [28, 48]. Some key elements in this plan to promote coordination and continuity of care are:

- to develop a multidisciplinary record, accessible for every care professional;
- to regard patients as active partners in their healthcare, and to support self-management
  - this will be facilitated by giving patients access to their electronic health records
  - initiatives promoting health literacy will be stimulated;

- to ensure seamless transitions from and to hospital;
- to encourage patients to choose one general practitioner as a reference physician; and
- to finance low-variable care based on bundled payments.

To make these changes possible, not only hospital organization and financing but also other healthcare pillars need to be modified. To allow patient-centered multidisciplinary teamwork and to ensure that knowledge and expertise are optimally used, Royal Decree N° 78 concerning the practice of the healthcare professions [49] is being rewritten. Furthermore, to stimulate multidisciplinary consultations, coordination of care, telemedicine, etc., nomenclatures need to be adapted. These changes are planned, together with an eHealth-roadmap and new initiatives concerning integrated care for chronic patients.

At the same time, the restructuring of primary care in Flanders is taking place to evolve from acute and more fragmented care to integrated care [50]. Since 2014 the Belgian and Flemish governments have taken the first steps on this long journey. Stimulating patients to become active partners will be a great challenge. However, changing the behavior of physicians, nurses and other health professionals in empowering patients and in multidisciplinary teamwork will probably be the most difficult job. If the reform of healthcare organization and financing really promotes coordination and continuity of care, with patients taking up their role as active partners, we expect that, based on this study, this reform will help in reducing unnecessary admissions.

When financial penalties are introduced to stimulate hospitals to reduce readmission rates, we emphasize that the chosen indicator reflects substandard quality of care or quality of care transitions. Furthermore, the rewards should be re-invested in prevention of readmissions by improving health literacy, coordination of care, multidisciplinary health records, etc. These re-investments are preferably prioritized for communities with more barriers, such as neighborhoods with a low socio-economic status.

Recommendations for future research

This doctoral research points to many opportunities for further research. *First*, research is needed to describe how transitions of the elderly from the emergency department to the community can be improved. *Second*, the effect of pre-admission interventions on readmissions needs to be assessed. *Third*, further insight into coordination and quality of primary care in Belgium and the association with readmissions will be useful for healthcare reform. *Fourth*, research on a feasible screening tool to detect patients at risk of readmission can help in focusing on patient groups most at risk of readmission. *Fifth*, further research on the usefulness of the care transition questionnaire for different patient groups is needed. After further validation, this questionnaire can be a useful tool to evaluate

the quality of care transitions. *Sixth*, although family caregivers play an important role in chronic care and in preventing readmissions [51], their impact on readmissions is rarely studied. Additionally, discharge interventions specifically focused on family caregivers are scare: only one of the 51 interventions studied in the systematic review was focused on them [52]. To better understand how to support caregivers in their role and prevent readmissions, further research is necessary. *Finally*, further research to assess the effect of patient empowerment on the outcomes of discharge interventions, such as discharge planning, will help us to better understand the impact of patient empowerment.

Overall conclusion

One in twenty patients discharged from a Belgian hospital has an unplanned readmission within 30 day after discharge. Many factors influence the risk of readmission, and the incidence of readmissions in some patient groups is more than one in ten patients. As a result of this PhD research and based on the current literature, we conclude that opportunities to reduce readmissions are situated in five critical domains: patient empowerment, communication, discharge planning, quality and safety, and coordination of care. Interventions to reduce readmissions cannot be limited to the hospital stay and must continue after discharge.

Take home messages

For patients

- Be aware that you can do much to manage your own health.
- Make sure that, before you leave the hospital, you really understand
    - what your health problem is;
    - what you need to do at home to recover from your illness or to prevent complications;
    - how you can know if something goes wrong and what you should do in that case;
    - what medication you need to take, why, when, how, and for how long; and
    - what follow-up appointments you have or need to make.
- Make sure that you are able to follow advice or the suggested therapy at home.
- Hospital stays should be as short as needed. When possible, organize yourself so you can go home as soon as clinically appropriate.

For health professionals

- Make sure patients are well educated; stimulate patients to ask questions.
- Empower and encourage patients to manage their own health.
- Make sure patients know at each moment who can be contacted in case of problems after discharge.

<u>Health professionals in hospitals</u>

- Start with informing and educating patients at hospital admission.
- Implement early discharge planning and stimulate patients and caregivers to think about discharge as soon as they are admitted.
- Do not hesitate to consult the PCP or community nurse to better understand the patient's psychosocial context and therefore better understand the patient's needs.
- Ensure that your primary care colleagues have, in a timely manner, all information necessary to guarantee continuity of care.

<u>Primary care professionals</u>

- Do not hesitate to contact your colleagues in the hospital before or during the hospital stay when you have concerns about the patient's discharge to home.
- Contact your colleagues in the hospital if you have questions or are missing essential information to ensure continuity of care.
- Make sure you are organized to coordinate the post-discharge follow-up.

For hospital managers

- Assess improvement opportunities to prevent readmissions in one of the five critical domains: patient empowerment, communication, quality and safety, discharge planning and coordination of care.

For policymakers

- Accomplish the planned healthcare reform, respecting all stakeholders.
- Ensure communication between the different levels of care.
- When financial penalties are used as a way to engage hospitals in reducing hospital readmissions, make sure that the chosen indicator is related as much as possible to substandard quality of care or quality of care transitions.

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SUMMARY / SAMENVATTING

Summary

Hospital readmissions – defined as new admissions to the hospital after hospital discharge within a specific time interval – occur frequently, are costly and can lead to negative outcomes for patients. Because a considerable proportion of unplanned readmissions are caused by suboptimal quality of care and are therefore potentially preventable, unplanned hospital readmissions are used as an indicator of quality of care.

The overall aim of this research was to study how to reduce hospital readmissions that are due to substandard quality of in-hospital care or to substandard quality of the care transition from hospital to home. We used a mixed-methods approach to address four operational aims. The first aim was to explore unplanned hospital readmissions in Belgium, addressing the incidence of unplanned hospital readmissions, the identification of patient groups that are most frequently readmitted and the identification of risk factors for unplanned readmissions. The second aim was to identify discharge interventions that have been demonstrated to be effective in reducing hospital readmissions within three months of discharge, and to understand their effect on mortality, use of emergency departments (EDs) and patient satisfaction. The third aim was to understand the causes of readmissions related to suboptimal quality of in-hospital care. Finally, the fourth aim was to understand the causes of readmissions related to suboptimal quality of care transition from hospital to home.

An exploratory cross-sectional study was conducted to understand the phenomenon of hospital readmissions in Belgium (first aim). We analysed the Belgian Hospital Discharge Dataset including data from 1,130,491 patients discharged in 2008. The overall unplanned readmission rate 30 days after discharge was 5.2%. The highest numbers of readmissions were found for patients admitted for COPD (14.7% readmission rate), heart failure (14.0%) and pneumonia (9.4%). Overall, the most common reasons for readmission were cardiovascular and pulmonary diagnoses (in 16.8% and 13.3% of all readmissions, respectively) and 10.4% of all readmissions were due to complications. We identified multiple factors that increase the risk of readmission: male gender, age, discharge against medical advice, severity of illness, number of comorbidities, multiple previous ED visits, discharge destination, discharge on Friday, length of stay and acuity at admission. Because multiple ED visits are an important risk factor for readmissions, these ED visits must trigger actions to coordinate care between health professionals together with patients and their family caregivers. Another important finding is that the risk of readmission increases with length of stay; thus delaying discharge for a patient who is ready for discharge should be avoided.

We performed a systematic literature review to study the effectiveness of discharge interventions in reducing hospital readmissions (second aim) and included 51 studies. Discharge interventions were defined as interventions designed to ease the care transition

from hospital to home or to prevent problems after hospital discharge and were performed – at least partly – by hospital professionals. We found that discharge interventions significantly reduced the risk of hospital readmission (by 23%) and improved patient satisfaction. However, they did not reduce the risk of ED visits nor mortality. Interventions starting during hospital stay and continuing after discharge and interventions that support patient-empowerment were most effective in reducing readmissions. Additionally, discharge planning – an intervention to prepare patients for discharge during their hospital stay – reduced readmissions up to three months after discharge. Complex, multi-component interventions were not superior in comparison to single-component interventions.

We conducted a prospective cohort study to understand the causes of readmissions related to suboptimal in-hospital quality of care (third aim) and suboptimal quality of the care transitions from hospital to home (fourth aim) for three patient groups (patients with heart failure, pneumonia and total hip/knee arthroplasty). For each patient group, hospitals with high and low readmission rates were selected.

To assess the impact of in-hospital quality of care we explored hospital-acquired adverse events (AEs) (injuries caused by medical care) across hospitals with strong divergent readmission rates. A total of 100 AEs were detected in the 296 patient records reviewed (30.1% of the patients had AEs). We found no association between hospital-acquired AEs and hospital readmissions. Additionally, no association was found between AEs and the presence of post-discharge events (mortality, visit to ED or readmission).

The impact of quality of care transitions was assessed by evaluating five care transition elements: readiness for discharge, patient and caregiver education, general practitioner (GP) contributions to the discharge process, and timeliness and completeness of discharge summaries. Overall, the quality of care transitions offers room for improvement. We found that patients with heart failure in hospitals with high readmission rates were less prepared for discharge compared to patients in hospitals with low readmission rates. We also found that more post-discharge events occurred in patients of GPs who did not receive the discharge summaries in a timely manner.

We conclude that unplanned hospital readmissions occur frequently for specific patient groups. The risk of readmission is affected by patient- and disease related factors, as well as by the number of previous ED visits and the length of hospital stay, with increasing risk for longer stays. Based on this study, we identify patient empowerment, communication with primary care and timely preparing patients for discharge as important domains to prevent unplanned hospital readmissions.

Samenvatting

Ziekenhuisheropnames kunnen worden gedefinieerd als nieuwe opnames in het ziekenhuis binnen een specifiek tijdsinterval na een voorafgaandelijk ontslag uit het ziekenhuis. Ze komen frequent voor, zijn duur voor de maatschappij en kunnen voor patiënten negatieve gevolgen hebben. Omdat een belangrijk aandeel van de ongeplande heropnames mogelijk voortvloeit uit suboptimale kwaliteit van zorg en dus vermijdbaar is, worden ongeplande ziekenhuisheropnames gebruikt als indicator voor kwaliteit van zorg.

De doelstelling van dit onderzoek was om na te gaan hoe heropnames ten gevolge van een suboptimale kwaliteit van zorg in het ziekenhuis of ten gevolge van een suboptimale zorgtransitie van ziekenhuis naar huis vermeden kunnen worden. Door gebruik te maken van verschillende onderzoeksmethoden werden vier operationele doelstellingen uitgewerkt. Het eerste doel was om ongeplande ziekenhuisheropnames in België te onderzoeken en had betrekking op: incidentie van ongeplande ziekenhuisheropnames, identificatie van patiëntengroepen die het meest frequent worden heropgenomen en identificatie van risicofactoren voor heropname. Het tweede doel was om ontslaginterventies te identificeren die effectief te zijn in het reduceren van ziekenhuisheropnames binnen de drie maanden na het ontslag en om inzicht te krijgen in hun effect op mortaliteit, gebruik van de dienst spoedopname (SO) en patiëntentevredenheid. Het derde en vierde doel was om de oorzaken te kennen van heropnames die verband houden met suboptimale kwaliteit van zorg in het ziekenhuis en met suboptimale kwaliteit van de zorgtransitie van ziekenhuis naar huis.

Een exploratief cross-sectioneel onderzoek werd uitgevoerd om inzicht te krijgen in het fenomeen van ziekenhuisheropnames in België (eerste doel). We analyseerden de Belgische MZG-data (minimale ziekenhuisgegevens) en beschikten over gegevens van 1.130.491 patiënten ontslagen in 2008. Het percentage ongeplande heropnames 30 dagen na ontslag was 5.2%. Het grootste aantal heropnames werd gevonden voor patiënten opgenomen voor COPD (14.7% heropnames), hartfalen (14.0%) en pneumonie (9.4%). De belangrijkste redenen voor heropnames waren cardiovasculaire en pulmonaire aandoeningen (respectievelijk bij 16.8% en 13.3% van de heropnames) en 10.4% van alle heropnames was het gevolg van een complicatie. We identificeerden verschillende factoren die het risico op heropname doen toenemen: mannelijk geslacht, leeftijd, ontslag tegen medisch advies, ziekte-ernst, aantal co-morbiditeiten, voorafgaande bezoeken aan de dienst SO, ontslagbestemming, ontslag op vrijdag, ligduur en het niet gepland-zijn van de opname. Omdat meerdere voorafgaande bezoeken aan de dienst SO een belangrijke risicofactor voor heropnames zijn, moeten deze bezoeken aanleiding geven tot acties om de zorg te coördineren tussen zorgprofessionals en dit samen met patiënten en hun mantelzorgers. Een andere belangrijke bevinding is dat het risico op heropname toeneemt met de ligduur in het ziekenhuis. Daarom moet het uitstellen van het ontslag van patiënten die klaar zijn voor ontslag vermeden worden.

We voerden een gesystematiseerd literatuuronderzoek uit om de effectiviteit van ontslaginterventies in het vermijden van ziekenhuisheropnames te onderzoeken (tweede doel) en onderzochten 51 studies. Ontslaginterventies werden gedefinieerd als interventies ontwikkeld om de zorgtransitie van ziekenhuis naar huis te vergemakkelijken of om problemen na het ontslag te voorkomen en werden – minstens gedeeltelijk – uitgevoerd door ziekenhuis professionals. We toonden aan dat ontslaginterventies het risico op heropname significant verminderden (met 23%) en patiëntentevredenheid verbeterden. Deze interventies verminderden echter noch het risico op bezoek aan de dienst SO, noch het risico op mortaliteit. De meest effectieve ontslaginterventies waren interventies die werden opgestart tijdens het ziekenhuisverblijf en verder liepen na het ontslag uit het ziekenhuis en interventies gericht op 'patient empowerment'. Ook ontslag planning – een interventie om patiënten gedurende hun verblijf in het ziekenhuis voor te bereiden op hun ontslag – verminderde het aantal heropnames tot drie maanden na het ontslag. Complexe interventies die uit veel verschillende componenten bestaan, waren niet superieur in vergelijking met interventies die uit één enkele component bestaan.

We voerden een prospectief cohort onderzoek uit om inzicht te krijgen in de oorzaken van heropnames gerelateerd aan suboptimale kwaliteit van ziekenhuiszorg (derde doel) en suboptimale kwaliteit van zorgtransitie van ziekenhuis naar huis (vierde doel). Dit gebeurde voor drie patiëntengroepen: patiënten met hartfalen, pneumonie en totale heup/knieprothese. Voor elke patiëntengroep werden ziekenhuizen met hoge en lage heropnameratio's geselecteerd.

Om de impact van kwaliteit van ziekenhuiszorg te bepalen, onderzochten we adverse events (AEs) (schade ten gevolge van medische zorg) ontstaan in het ziekenhuis in ziekenhuizen met sterk uiteenlopende heropnameratio's. In totaal werden 100 AEs gevonden in de 296 onderzochte dossiers (30.1% van de patiënten had AEs). We konden geen associatie vinden tussen AEs ontstaan in het ziekenhuis en heropnames. Evenmin konden we een associatie vinden tussen AEs en negatieve uitkomsten na het ontslag (mortaliteit, bezoek aan de dienst SO of heropname).

De impact van kwaliteit van zorgtransities werd onderzocht door het evalueren van vijf elementen: voorbereid zijn op het ontslag, educatie van patiënten en mantelzorgers, betrokkenheid van huisartsen bij het ontslagproces en tijdigheid en volledigheid van de ontslagbrief. In het algemeen vonden we veel ruimte voor verbetering op het gebied van zorgtransities. We stelden vast dat patiënten met hartfalen in ziekenhuizen met hoge heropnameratio's minder voorbereid waren in vergelijking met patiënten in ziekenhuizen met lage heropnameratio's. We konden ook aantonen dat meer negatieve gebeurtenissen na het ontslag plaatsvonden bij patiënten van wie de huisarts de ontslagbrief niet tijdig ontving.

Om te besluiten kunnen we stellen dat ongeplande ziekenhuisheropnames frequent voorkomen voor bepaalde patiëntengroepen. Het risico op heropname wordt beïnvloed door patiënt- en ziekte gerelateerde factoren, evenals door het ziektebeeld van de patiënt, het aantal voorafgaande bezoeken aan de dienst SO en de verblijfsduur in het ziekenhuis met een toename van het risico bij langere verblijfsduren. Op basis van dit onderzoek kunnen we 'patient empowerment', communicatie met eerste lijn en het tijdig voorbereiden van patiënten voor ontslag identificeren als belangrijke domeinen om ongeplande ziekenhuisheropnames te voorkomen.

CURRICULUM VITAE & LIST OF PUBLICATIONS

Curriculum vitae

Anja Braet was born in 1973 in Borgerhout (Belgium). She graduated as a medical doctor from the University of Antwerp (Belgium) in 1998 and worked as a primary care physician in the north of the province of Antwerp until 2004. At this moment she works as policy advisor for the medical department at az Sint-Blasius (Dendermonde). Specific topics of interest are: improvement of care processes (e.g. care pathways, measurement of quality of care) and continuity of care. She is one of the two patient safety coordinators in the hospital and has implemented the Global Trigger Tool methodology for evaluation of adverse events.

In 2005, she obtained the title of master in clinical data management (University of Antwerp, Brussels and Ghent). In 2010 she started as a doctoral student at the KU Leuven, Department of Public Health & Primary Care. With hospital readmissions as research topic, she could combine her experience as primary care physician and hospital professional.

She lives with Peter Van Puyvelde and their children at Sint-Pauwels.

List of publications

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