

SHIFTING CARE FROM INPATIENT TOWARDS DAY-CARE AND AMBULATORY CARE: IMPACT ON READMISSION RATES & POST-DISCHARGE MORTALITY

PART I



NICOLAS BOUCKAERT, ISABELLE SAVOYE, RENATE ZEEVAERT, CARL DEVOS, LORENA SAN MIGUEL, KOEN VAN DEN HEEDÉ

Title:	Shifting care from inpatient towards day-care and ambulatory care: impact on readmission rates & post-discharge mortality
Authors:	Nicolas Bouckaert (KCE), Isabelle Savoye (KCE), Renate Zeevaert (KCE), Carl Devos (KCE), Lorena San Miguel (KCE), Koen Van den Heede (KCE)
Project manager:	Nathalie Swartenbroekx (KCE)
Information specialist:	Nicolas Fairon (KCE)
Data extraction, transformation and upload:	Stephan Devriese (KCE)
External experts and stakeholders:	Koen Beullens (Rijksinstituut voor ziekte- en invaliditeitsverzekering – Institut national d'assurance maladie-invalidité (RIZIV – INAMI), Luk Bruyneel (Former Onafhankelijke Ziekenfondsen (OZ)), Marc Coppens (Universitair Ziekenhuis Gent (UZ Gent)), Anja Crommelynck (Cliniques universitaires Saint-Luc), Bart Demyttenaere (Solidaris), Stephanie Devisscher (Zorgnet-Icuro), Kris Doggen (Former Vlaams Instituut voor Kwaliteit van Zorg (VIKZ)), Johan Pauwels (RIZIV – INAMI), (FOD Volksgezondheid, Veiligheid van de Voedselketen, Leefmilieu – SPF Santé publique, Sécurité de la Chaîne alimentaire, Environnement (FOD VVVL – SPF SSCE), (Federaal agentschap voor geneesmiddelen en gezondheidsproducten – Agence fédérale des médicaments et des produits de santé (FAGG – AFMPS)), Quentin Schoonvaere (Plateforme pour l'Amélioration continue de la Qualité des soins et de la Sécurité des patients (PAQS)), Gauthier Vandeleene (PAQS)
External validators:	Kristiina Kahur (HC Management Consulting Ltd, Estonia), Wilm Quentin (Universität Bayreuth, Germany), Astrid Van Wilder (Leuvens Instituut voor Gezondheidszorgbeleid, KU Leuven)
Acknowledgements:	We would like to thank the following KCE experts for their contribution during this study: Christophe de Meester, Carine Van de Voorde, France Vrijens. We would like to thank Statbel, the “Technische Cel – Cellule Technique (TCT)” – ad hoc team from Data and Management Information of the FOD VVVL – SPF SSCE and the Data Office of RIZIV – INAMI to deliver the data. In addition, we would like to thank Danielle Croisiaux and Tonio Di Zinno (Agence InterMutualiste (AIM)) for the data delivery of the second part of the study that will be published in a next report.
Reported interests KCE members:	KCE is a federal institution funded by INAMI/RIZIV, by the Federal Public Service of Health, Food Chain Safety and Environment, and by the Federal Public Service of Social Security. KCE's mission is to advise policymakers on decisions relating to health care and health insurance on the basis of scientific and objective research. It is expected to identify and shed light on the best possible solutions, in the context of an accessible, high-quality health care system with due regard for growing demand and budgetary constraints. , KCE has no interest in companies (commercial or non-commercial, i.e. hospitals and universities), associations (e.g. professional associations, unions), individuals or organisations (e.g. lobby groups) that could be positively or negatively affected (financially or in any other way) by the implementation of the recommendations. All experts involved in the writing of the report or the peer-review process completed a declaration of interest form. Information on potential conflicts of interest is published in the colophon of this report. All members of the KCE Expert Team make yearly declarations of interest and further details of these are available upon request.
Reported interests:	All experts and stakeholders consulted within this report were selected because of their involvement in the topic of Shifting care from inpatient towards day-care and ambulatory care: impact on readmission rates & post-discharge mortality.



Therefore, by definition, each of them might have a certain degree of conflict of interest to the main topic of this report.

Layout:

Ine Verhulst

Disclaimer:

- The external experts were consulted about a (preliminary) version of the scientific report. Their comments were discussed during meetings. They did not co-author the scientific report and did not necessarily agree with its content.
- Subsequently, a (final) version was submitted to the validators. The validation of the report results from a consensus or a voting process between the validators. The validators did not co-author the scientific report and did not necessarily all three agree with its content.
- Finally, this report has been approved by common assent by the Executive Board.
- Only the KCE is responsible for errors or omissions that could persist. The policy recommendations are also under the full responsibility of the KCE.

Publication date:

08 January 2026

Project number:

2018-15-HSR

Domain:

Health Services Research (HSR)

MeSH:

Patient Readmission; Length of Stay; Health Care Reform

NLM Classification:

WX 158

Language:

English

Format:

Adobe® PDF™ (A4)

Legal depot:

D/2025/10.273/54

ISSN:

2466-6459

Copyright:

KCE reports are published under a “by/nc/nd” Creative Commons Licence <http://kce.fgov.be/content/about-copyrights-for-kce-publications>.



How to refer to this document?

Bouckaert N, Savoye I, Zeevaert R, Devos C, San Miguel L, Van den Heede K. Shifting care from inpatient towards day-care and ambulatory care: impact on readmission rates & post-discharge mortality. Health Services Research (HSR) Brussels: Belgian Health Care Knowledge Centre (KCE). 2026. KCE Reports 412. <https://doi.org/10.57598/R412C>.

This document is available on the website of the Belgian Health Care Knowledge Centre.



■ TABLE OF CONTENTS

INTRODUCTION.....	7
1 SUBSTITUTION FROM INPATIENT TOWARDS DAY-CARE.....	9
1.1 INTRODUCTION AND RESEARCH OBJECTIVES	10
1.2 METHODS	13
1.2.1 Data sources	13
1.2.2 Data sample selection	16
1.2.3 Definition of main variables	17
1.2.4 Co-variates for risk-adjustment	20
1.2.5 Statistical analyses	21
1.3 RESULTS	23
1.3.1 Study population.....	24
1.3.2 Evolution of main outcomes	30
1.3.3 Association between day surgery rate and readmission rate	43
1.4 DISCUSSION.....	58
2 REDUCTION IN LENGTH OF STAY	59
2.1 INTRODUCTION AND RESEARCH OBJECTIVES	61
2.2 METHODS	62
2.2.1 Data sample selection	63
2.2.2 Statistical analyses	64
2.3 RESULTS	66
2.3.1 Study population.....	66
2.3.2 Evolution of main outcomes	72
2.3.3 Association between LoS rate and readmission, mortality and composite rates	90
2.4 DISCUSSION.....	108
3 THE ASSOCIATION BETWEEN LOS REDUCTIONS AND READMISSION RATES OR POST-DISCHARGE MORTALITY: A SYSTEMATIC REVIEW.....	109
3.1 RESEARCH QUESTION	109
3.2 METHODS	110
3.3 RESULTS	115
3.3.1 Literature search.....	115
3.3.2 Outpatient versus inpatient.....	116
3.3.3 LoS reduction	121
3.3.4 Temporal trend LoS and associated outcomes.....	124
3.3.5 Discussion	127



4	UMBRELLA REVIEW ON INTERVENTIONS FACILITATING SHORTER LENGTH OF STAY	128
4.1	INTRODUCTION	129
4.2	METHODS	129
4.2.1	Literature search and selection	131
4.3	QUALITY APPRAISAL AND DATA EXTRACTION	131
4.3.1	<i>Quality appraisal</i>	131
4.4	RESULTS	133
4.4.1	Literature search.....	133
4.4.2	Study characteristics	140
4.4.3	Study findings per intervention type	140
4.4.4	Quality of SRs.....	151
4.5	CONCLUSION AND DISCUSSION.....	164
5	DISCUSSION.....	167
5.1	GENERAL TRENDS IN DAY SURGERY AND OUTCOMES	167
5.2	GENERAL TRENDS IN LENGTH OF STAY REDUCTION AND OUTCOMES	167
5.3	INTERPRETATION AND POLICY IMPLICATIONS	168
5.4	LITERATURE CONTEXT AND COMPARATIVE EVIDENCE.....	168
5.5	LIMITATIONS AND FUTURE DIRECTIONS.....	169
5.5.1	Limitations of the Systematic and Umbrella Reviews	169
5.5.2	Unmeasured risk factors	169
5.5.3	Outpatient emergency department visits.....	169
5.5.4	Cost shifts.....	170
5.5.5	Patient experiences	170
6	REFERENCES	171

LIST OF FIGURES

Figure 1 – TCT data overview	14
Figure 2 – Linkage procedure of data from FPS Social security and Statbel	15
Figure 3 – Evolution of in-hospital mortality (observed rate)	25
Figure 4 – Evolution of the age-group distribution in the study population, by admission type	28
Figure 5 – Evolution of Elixhauser co-morbidity burden in the study population, by admission type	29
Figure 6 – Evolution of main outcomes (observed values).....	31
Figure 7 – Unplanned readmission per day after discharge	36
Figure 8 – Evolution of observed and risk-adjusted day surgery and readmission rates	38



Figure 9 – Relationship between day surgery rates and readmission rates (observed and risk-adjusted) in 2008-2014, by admission type	44
Figure 10 – Relationship between day surgery rates and readmission rates (observed and risk-adjusted) in 2016-2022, by admission type	45
Figure 11 – Relationship between risk-adjusted day surgery and risk-adjusted readmission rates, by period and age group	47
Figure 12 – Relationship between risk-adjusted day surgery and risk-adjusted readmission rates, by period and Elixhauser comorbidity burden	49
Figure 13 – Relationship between risk-adjusted day surgery and risk-adjusted readmission rates, by MDC, period and admission type (all admissions, day-care admissions and inpatient admissions)	51
Figure 14 – Evolution of in-hospital mortality (observed rate)	67
Figure 15 – Evolution of the age-group distribution in the study population	70
Figure 16 – Evolution of Elixhauser co-morbidity burden in the study population	71
Figure 17 – Unplanned readmissions per day after discharge	76
Figure 18 – Evolution of main outcomes (observed and risk-adjusted values)	82
Figure 19 – Relationship between LoS and readmission, mortality and composite rates (observed and risk-adjusted), by period	91
Figure 20 – Relationship between risk-adjusted LoS and risk-adjusted readmission, mortality and composite rates, by period and age group	93
Figure 21 – Relationship between risk-adjusted LoS and risk-adjusted readmission, mortality and composite rates, by period and Elixhauser comorbidity burden	94
Figure 22 – Relationship between risk-adjusted LoS and risk-adjusted readmission, mortality and composite rates, by MDC (medical/surgical) and period	96
Figure 23 – PRISMA flow diagram	115
Figure 24 – Flow chart for study selection	133

LIST OF TABLES

Table 1 – Data sample and exclusions	24
Table 2 – Descriptives of main population and admission characteristics in the study population [Number of admissions (% in group)]	25
Table 3 – Evolution of day surgery rate in the study population [Rate (difference end rate – start rate)]	32
Table 4 – Evolution of readmission rate in the study population [Rate (difference end rate – start rate)]	33
Table 5 – Descriptives of readmissions [Rate or days (difference end – start)]	37
Table 6 – Evolution of risk-adjusted day surgery rate in the study population [Rate (difference end rate – start rate)]	39
Table 7 – Evolution of risk-adjusted readmission rate in the study population [Rate (difference end rate – start rate)]	40



Table 8 – Data sample and exclusions	67
Table 9 – Descriptives of main population and admission characteristics in the study population [Number of admissions (Share in category)].....	68
Table 10 – Evolution of LoS in the study population [days (difference end – start)].....	73
Table 11 – Evolution of readmission, mortality rate and composite rate in the study population [Rate (difference end rate – start rate)]	78
Table 12 – Descriptives of readmissions [Rate or days (difference end – start)]	81
Table 13 – Evolution of risk-adjusted LoS in the study population [days (difference end – start)] .	84
Table 14 – Evolution of risk-adjusted readmission, mortality rate and composite rate in the study population [Rate (difference end rate – start rate)]	87
Table 15 – In- and exclusion criteria	112
Table 16 – Summary outpatient versus inpatient.....	120
Table 17 – Summary LoS reduction	123
Table 18 – Summary on time trend.....	126
Table 19 – PICOS framework for research question	130
Table 20 – Characteristics of included systematic reviews	134
Table 21 – Summary results from included SRs depending on the type of intervention	152
Table 22 – Results of interventions on length of stay and readmissions.....	153

LIST OF ABBREVIATIONS

ABBREVIATION	DEFINITION
ACS-NSQIP	American College of Surgeons National Surgical Quality Improvement Program
AEs	Adverse Events
AFIC-NIHD	Armed Forces Institute of Cardiology & National Institute of Heart Diseases
AKS	Attune Knee System
ASCEND-HF	Acute Study of Clinical Effectiveness of Nesiritide in Decompensated Heart Failure
aOR	adjusted odds ratio
BMI	body mass index
CA	Canada
CAD	coronary artery disease
CI	confidence interval
CIHI	Canadian Institute of Health Information
COPD	chronic obstructive pulmonary disease
CV	cardiovascular
d	day(s)
DAD	Discharge Abstract Database
DC	day-case
DNPR	Danish National Patient Register
DPC	diagnosis procedure combination
EAHFE	Epidemiology of Acute Heart Failure in Emergency departments
ED	emergency department
EMR	electronic medical records
ENT	ear, nose and throat
ERAS	Enhanced Recovery After Surgery
GFR	glomerular filtration rate
HF	heart failure
IC/ES	Institute for Clinical and Evaluative Sciences
IQR	interquartile range
m	month(s)
n	number
NCDR	National Cardiovascular Data Register
NSRI	non-randomized studies of interventions
NHLBI	National Heart Lung and Blood Institute



NSTEMI	non-ST-elevation myocardial infarction
NY	New York
NYHA	New York Heart Association
LMCAD	left main coronary artery disease
Ln	logarithm
LoS	length of stay
LV	left ventricular
OHIP	Ontario Health Insurance Plan
ON	overnight
OR	odds ratio
p	probability
PCI	percutaneous coronary intervention
POD	post-operative day
PROTECT	A placebo controlled randomized study of the selective A1 adenosine receptor antagonist rolofylline for patients hospitalized with acute decompensated heart failure and volume overload to assess treatment effect on congestion and renal function
RCT	randomized controlled trial
RD	risk difference
RoB	Risk of Bias
RR	risk ratio
SD	standard deviation
SDD	same day discharge
SR	systematic review
STEMI	ST-elevation myocardial infarction
SYNTAX	synergy between PCI with taxus and cardiac surgery scores
THA	total hip arthroplasty
TIMI	thrombolysis In myocardial infarction
TKA	total knee arthroplasty
TURP	transurethral prostatectomy
UAP	unstable angina pectoris
US	United States of America
VERITAS	Value of Endothelin Receptor Inhibition with Tezosentan in Acute heart failure Studies
vs	versus
WHF	worsening heart failure
Y	year

■ SCIENTIFIC REPORT

INTRODUCTION

LENGTH OF STAY REDUCTION DRIVEN BY INCENTIVES IN BELGIAN HOSPITAL FINANCING

As in most Western countries, Belgian hospitals face increasing pressure to improve efficiency, particularly by reducing the length of stay (LOS) for inpatient care and promoting substitution toward day-care admissions. Over the past decades, hospitals have implemented care pathways to streamline processes and shorten LOS.¹ A key driver of this evolution has been the introduction of a DRG-based financing system, which although not cost-based as in many other countries, allocates a closed national budget across hospitals using a point system. One of the most influential parameters in this system is the average LOS per DRG, calculated over the previous three years.² The nationally defined number of “justified days,” derived from this average, constitutes the basis for hospital financing. Hence, exceeding the average LOS results in no additional funding. Conversely, staying below the average allows hospitals (in theory^a) to earn more than they spend, creating a strong incentive to reduce LOS and increase admissions.²

ENCOURAGING DAY SURGERY THROUGH SYSTEM OF ‘JUSTIFIED DAYS: RECENT POLICY INITIATIVES FOR FURTHER EXPANSION

The incentive structure of justified days also applies to day surgery. For procedures on [the A-list](#), hospitals receive 0.95 justified days for day-care admissions (until 2022 it was only 0.81). The policy objective is to stimulate the performance of these procedures in day-care. For [B-list](#) procedures, day surgery is considered the default, and inpatient admissions are disincentivized as hospitals receive only 0.81 justified days also when the patient is admitted as an inpatient. In December 2022, the scope of these lists was expanded to further promote day surgery.³ However, these measures have raised concerns among home care organizations, who fear that care is being shifted to the home setting without adequate support, prompting calls to strengthen home nursing services.⁴

THE NEED TO BALANCE EFFICIENCY GAINS WITH QUALITY ASSURANCE

In parallel with efficiency efforts, hospitals have increasingly engaged in quality improvement initiatives.^{5, 6} Yet, reducing LOS and substituting inpatient care with day-care may also have unintended consequences, such as increased unplanned readmission rates or post-discharge mortality. Moreover, care may be shifted outside the hospital without sufficient alternatives in place.⁷ Since 2014, Belgian hospitals receive reduced payments for readmissions occurring within 10 days in the same hospital, further emphasizing the need to balance efficiency with quality.²

FOCUS OF CURRENT STUDY: IS THERE AN ASSOCIATION BETWEEN SHIFTING INPATIENT TOWARDS DAY- AND OUTPATIENT CARE WITH 30-DAY POST-DISCHARGE MORTALITY AND READMISSIONS?

This KCE study aims to explore whether there is an association between LOS reduction and substitution towards day-care on the one hand, and hospital readmissions and post-discharge mortality on the other. While this may seem straightforward, the analysis is complex due to numerous confounding factors such as changes in care pathways, medical therapies, case mix, and investments in post-acute care. Full adjustment for all these variables is not feasible.

^a The reality is more complex as there are problems of structural underfunding etc. We will not describe this in the current report but refer the interested reader to KCE reports 229; 392.



PART ONE OF A TWO-PART STUDY: EXPLORING BELGIAN ADMINISTRATIVE DATA AND PUBLISHED EVIDENCE ON TRADE-OFFS BETWEEN EFFICIENCY AND QUALITY

The study is structured into two separate reports due to delays in data delivery and the complexity of data linkage. The first report focuses on general trends and literature synthesis, while the second will provide more targeted analyses and stakeholder input. The division is somewhat artificial, as the literature review in the first report already covers procedures and conditions that will be analysed in detail in the second report. Nevertheless, it offers valuable insights into existing evidence.

Some topics are explicitly out of scope for this project, including the effectiveness of benchmarking or public reporting of readmission indicators, payment models that incentivize LOS reduction (e.g., bundled payments), inventories of outpatient services by region, and qualitative studies on patient experiences post-discharge.

THE STRUCTURE OF THE REPORTS

The first report (current report) includes four chapters:

- Chapter I: general analysis using Belgian administrative data to assess whether increased day-care use is associated with higher readmission rates or post-discharge mortality.
- Chapter II: general analysis of the association between LOS reduction for inpatient care and post-discharge readmission/mortality.
- Chapter III: literature review synthesizing evidence on the impact of LOS reduction and substitution towards day-care for selected procedures and conditions.
- Chapter IV: umbrella review evaluating the effectiveness of interventions aimed at promoting early discharge and preventing readmissions and post-discharge mortality.
- A concluding section will summarize findings, but no policy recommendations will be made at this stage.

The second report (scheduled for completion in the second half of 2026) will include:

- A chapter analyzing Belgian administrative data on the impact of substitution from inpatient to day-care for selected procedures, including effects on readmissions, emergency contacts, post-discharge mortality, and cost-shifting to ambulatory care.
- A chapter analyzing the impact of LOS reduction for selected procedures and conditions on the same outcome measures.
- A consultation with stakeholders (field experts, patient representatives) to evaluate conditions and interventions needed to ensure that efficiency gains do not compromise quality of care.

Policy recommendations will be formulated based on the findings of both reports.



1 SUBSTITUTION FROM INPATIENT TOWARDS DAY-CARE

KEY POINTS TABLE

(Inter-)national evolution: substitution of inpatient by day care admissions

- Internationally, the expansion of day surgery is driven by its potential to reduce healthcare costs and improve efficiency.
- In Belgium, hospital financing mechanisms actively incentivize day surgery through the Budget of Financial Means (BFM), which allocates funding based on 'justified days per DRG'.
 - Specific procedures on the 'A-list' receive 0.95 justified days when performed in day surgery, while those on the 'B-list' are always expected to be performed as day cases - disincentivizing inpatient admissions.
 - These lists were substantially updated in January 2023 to better reflect current medical practice and further stimulate the uptake of day surgery.

Analysis of nationwide administrative data

- This chapter evaluates if the shift from inpatient surgical care to day surgery is associated with 30-day post-discharge unplanned readmission and mortality rates using nationwide administrative data:
 - The linked data (Technical Cell - TCT and Statbel) covering a selection of elective surgical admissions with potential for day surgery included 11.5 million stays between 2008 and 2022;
 - To account for the transition from ICD-9-BE to ICD-10-BE coding in 2015, analyses were split into two periods: 2008-2014 and 2016-2022. Mortality data were only available for the second period due to linkage limitations.

Day surgery rates

- Day surgery rates increased from 57.6% in 2008 to 65.6% in 2022 (+8.0 pp).
- Risk-adjusted analyses showed an even stronger increase (+8.6 pp) in day surgery rates, particularly among older patients and those with higher comorbidity burdens.
- While increases were observed across all age groups, the largest relative gains were observed among adults aged 46-75 years (around +11 pp). Rates among children were already very high and changed only modestly.
 - By 2022, 19.6% of patients treated with three or more comorbidities were treated in day surgery, up from 14.9% in 2016.
 - Day surgery rates varied substantially across Major Diagnostic Categories (MDCs). The highest rates were observed in Eye (MDC 02, >90%), Ear, Nose, and Throat (MDC 03, ~80%), and Nervous System (MDC 01, ~88%), all showing further increases over time.

Post-discharge mortality

- Post-discharge mortality was stable across the years below <0.05%. Although such cases are unexpected in this patient population and each occurrence may indicate a potential quality issue, the numbers were too small to allow risk-adjusted analysis and were therefore not further examined..



Readmission rates

- Overall crude 30-day readmission rates remained stable or declined slightly (2.0% in 2008 to 1.8% in 2022). About 79% of readmissions took place in the hospital where the index stay took place. The average duration between discharge and unplanned readmission was 11 days, shortening slightly over time (-0.7 days). The readmission rates differed depending on patient and stay characteristics:
 - Day surgery consistently showed lower 30-day readmission rates (~1.2%) compared to inpatient stays (~3.0%).
 - Readmission risk increased with age and comorbidity: in 2022, rates ranged from 1.3% among adults aged 16-60 to 4.2% in those aged 85+. Patients with 3 or more comorbidities had a readmission rate of 4.9%, versus 1.3% in those without. These gradients were stable across both study periods.
 - Readmission rates varied markedly across MDC categories.
- Risk-adjusted readmission rates showed a slightly more pronounced decline (for all admissions combined from 2.0% in 2008 to 1.7% in 2022) than the unadjusted rates. This can be explained by a stronger decline among older and higher-risk patients.
 - For day surgery cases, adjusted levels were slightly lower (1.0% vs 1.2%) with a similar downward trend, whereas inpatient care showed higher adjusted levels (3.2% vs 3.0%) but a clearer decline over time (-0.3 pp risk-adjusted compared to 0.0 pp unadjusted)

Association between day surgery and readmission rates

- Increased day surgery rates were, in general, not associated with deteriorations in unplanned readmission rates. On the contrary, the increase in day surgery was accompanied by small improvements in readmission rates.
 - Improvements were most notable in older age groups (>45 years) where both a marked increase in day surgery rates and a reduction in readmission rates was observed. These groups, however, had greater potential for improvement, starting from lower day-surgery rates and higher readmission rates than younger age groups.
 - Furthermore, no evidence was found of increased readmission risks by performing relatively more day surgery in patients with several comorbidities.
 - While day surgery rates and readmission trends varied across Major Diagnostic Categories (MDCs), most showed either stable or improved outcomes.

1.1 Introduction and research objectives

In this chapter we describe the substitution of inpatient admissions by day surgery admissions based on a general analysis of the available administrative data. We focus on elective day surgery.

DAY SURGERY: HOSPITAL STAY WITHIN THE SPAN OF A SINGLE WORKING DAY FOR PLANNED SURGERY

Day surgery is characterised as: *‘a practice in which patients are admitted, undergo surgery, and are discharged within the span of a single working day, with no overnight stay’*. This definition can be further expanded by emphasizing that true day surgery encompasses *‘planned non-emergency surgical procedures performed on meticulously-selected and prepped patients who are intended to be managed within the day surgery environment’*.⁸ Alternative terms conveying the same meaning in different contexts are ‘same day surgery’, ‘ambulatory surgery’, ‘outpatient surgery’, ‘day-care

hospital', 'day only', or 'zero day hospital stay'.⁸ When appropriately applied, day surgery has been shown to deliver outcomes that are comparable to or better than those of inpatient procedures, while also contributing to improved hospital efficiency.⁹⁻¹¹

DAY SURGERY RATES HAVE INCREASED AS A RESULT OF MEDICAL AND ORGANISATIONAL ADVANCEMENTS

Over the past few decades, there has been a notable and consistent rise in the prevalence of day surgery across OECD countries.¹² This growth can be attributed to advancements in medical technologies, particularly the widespread adoption of minimally invasive surgical techniques, along with improvements in anaesthetic practices.¹² Additionally, the establishment of specialised day surgery facilities staffed by dedicated personnel and the implementation of clearly defined care pathways, along with financial incentives, have played instrumental roles in facilitating this development.^{10, 13}

AN INCREASE IN DAY-CARE RATES IS CONSIDERED TO HAVE MANY ADVANTAGES OF WHICH COST-SAVINGS IS THE MOST PROMINENT ONE

The rationale behind transitioning from inpatient to day surgery is multifaceted. Compared to inpatient procedures, day surgery is deemed to save costs as it reduces hospitalisation duration, eliminates the need for night and weekend staffing, decreases the hotel-like aspects of treatment, and optimizes the utilisation of infrastructure and staff. By relocating surgical procedures to specialised day surgery units, inpatient beds can be freed up for more complex surgical cases or other purposes, or even closed, resulting in consequential savings.^{13, 14} Other advantages that are attributed to day surgery are, for instance, reduced rates of nosocomial infections, expedited return to mobility, and heightened patient satisfaction in facilities where day surgery procedures have become standard practice.¹⁵

POLICY INCENTIVES TO FURTHER EXPAND DAY SURGERY

Shifting care from resource-intensive inpatient towards a day-care setting is a policy objective in most industrialised countries. Yet, the level of day surgery rates vary both between¹² and within^{9, 10, 14, 16} countries. The reasons for this variability are multifactorial (e.g. clinical culture of the surgical team, regional share of single households, hospital infrastructure, hospital service mix and case-mix differences).^{9, 17 18}

Incentivising day surgery through more favourable reimbursement mechanisms has been shown to effectively increase its uptake.^{9, 19, 20} As the scope of procedures suitable for day surgery continues to grow, many countries are actively exploring strategies to expand its use.^{19, 21} One commonly used measure is to allow providers to perform and bill procedures as day cases.¹⁹ Other incentives vary depending on the national payment system. In countries with activity-based payment models, using some form of DRGs, the financial incentives for day surgery rates differ.

Some countries use lower tariffs for the reimbursement of day surgery compared to inpatient surgery to better reflect the underlying cost structure (which is lower for day surgery), although these tariffs often remain above actual day-case costs. Policymakers face the challenge of finding a balance between a tariff that reflects actual costs and, at the same time, provides an incentive to favor the most efficient mode of admission (day case versus inpatient hospitalisation). After all, when the reimbursement gap is too wide between day-care and inpatient admissions it risks to discourage day surgery.

Other countries therefore apply the same tariff for day surgery and inpatient stays. This is mostly done for low-complexity, short-stay procedures to stimulate their use in day-care. In England, specific procedures receive even higher tariffs to promote day surgery.¹⁹ The significant observed cross-country variation in day surgery rates is largely influenced by these financial incentives.¹⁹ Other contributing factors include concerns about postoperative complications and the maturity of day surgery practices.^{12, 22}



In Belgium, the hospital budget of financial means (BFM) uses 'justified days per DRG (average length of stay (LOS) per DRG for the last three years)' as an important element in the distribution of the national closed budget across hospitals. This mechanism created a strong pressure on Belgian hospitals to reduce LOS for inpatient stays. Yet, it also has a payment mechanism that aims to stimulate day surgery.¹⁰ Indeed, for the procedures on the so-called 'A-list' (procedures for which the authorities want to stimulate a shift towards more day surgery), hospitals get 0.95 justified days when the admission concerns a day surgery admission. Procedures on the 'B-list' are considered as procedures where day surgery is always indicated. As a consequence, inpatient admissions are disincentivised: hospitals receive 0.95 justified days also when the patient is admitted as an inpatient (it was only 0.81 until end of 2022)^b. KCE report 282 demonstrated that these lists were insufficiently adapted to evolutions in medical practice. Therefore, in Belgium day surgery rates for several procedures (e.g. cholecystectomy) were lagging behind international practices.¹⁰ Since January 2023, these lists were substantially expanded to incentivise day surgery.³

A CAREFUL EVALUATION OF UNPLANNED READMISSIONS AND COST-SHIFTS TOWARDS AMBULATORY CARE ARE INDICATED

Nevertheless, the influence of the increase in day surgery on total healthcare expenditure may not be straightforward, as the decrease in unit costs (in contrast to inpatient surgery) could be counterbalanced by a general increase in the number of procedures performed.²³ After all, to make the shift from inpatient towards day care it is essential to adapt the clinical pathway and take supportive measures (e.g. additional ambulatory care follow-up). It is crucial to take into account any supplementary expenses associated with post-acute care and community health services following the interventions.¹²

In addition, postoperative complications stand out as a primary cause for unplanned readmissions.²⁴ Ensuring patient safety post-discharge and upholding the quality and safety of medical services necessitate precise preoperative assessment to select appropriate patients (i.e. avoid medical and social contra-indications), minimise perioperative complications, and lower the incidence of unplanned readmissions.²⁵

CHAPTER FOCUS: GENERAL ANALYSIS OF THE ASSOCIATION BETWEEN DAY SURGERY SHARE AND 30-DAY MORTALITY AND READMISSIONS

This chapter assesses the impact of shifting surgical care from inpatient hospitalisation to day surgery, focusing on 30-day readmission rates and 30-day mortality. Nationwide data covering a broad range of surgical procedures are used for this analysis (see Section 1.2). A second report will provide a more in-depth analysis of a selected subset of procedures. In addition to 30-day mortality and readmission rates, this follow-up study will include 30-day emergency department visits as an additional outcome indicator. The decision to split the study into two separate reports was driven by data availability. Specifically, the linked datasets required to evaluate outpatient emergency visits and potential cost-shifting towards ambulatory care –such as home nursing, general practitioners, and physiotherapy– were not available at KCE at the time of writing this report (data arrived mid-October 2025). These analyses will therefore be conducted and reported at a later stage.

The research questions addressed in this chapter are as follows:

- How did (risk-adjusted) day surgery rates evolve over time?
- How did (risk-adjusted) unplanned 30-day post-discharge readmission and mortality rates evolve over time per hospitalisation type (day-care versus inpatient) for elective surgical procedures?

^b

https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/2022.12.02_omzend_brief_dagziekenhuis_final_0.pdf

- Is there an association between the evolution in (risk-adjusted) day surgery rates and unplanned 30-day post-discharge readmission and mortality rates?

1.2 Methods

In the next sections we describe the databases (see section 1.2.1), study selection (see section 1.2.2), definition of measures (see section 1.2.3 and 1.2.4) and statistical analyses (see section 1.2.5).

1.2.1 Data sources

For the analyses we used the following databases:

- Subset of the “Technische Cel – Cellule Technique” (TCT) database, collected by the FPS Public Health and the RIZIV – INAMI on hospital stays in Belgian general hospitals, including a) Minimal Hospital Data (MZG – RHM) and b) Hospital Billing Data (AZV – SHA and ADH – HJA)
- Statbel data on mortality.

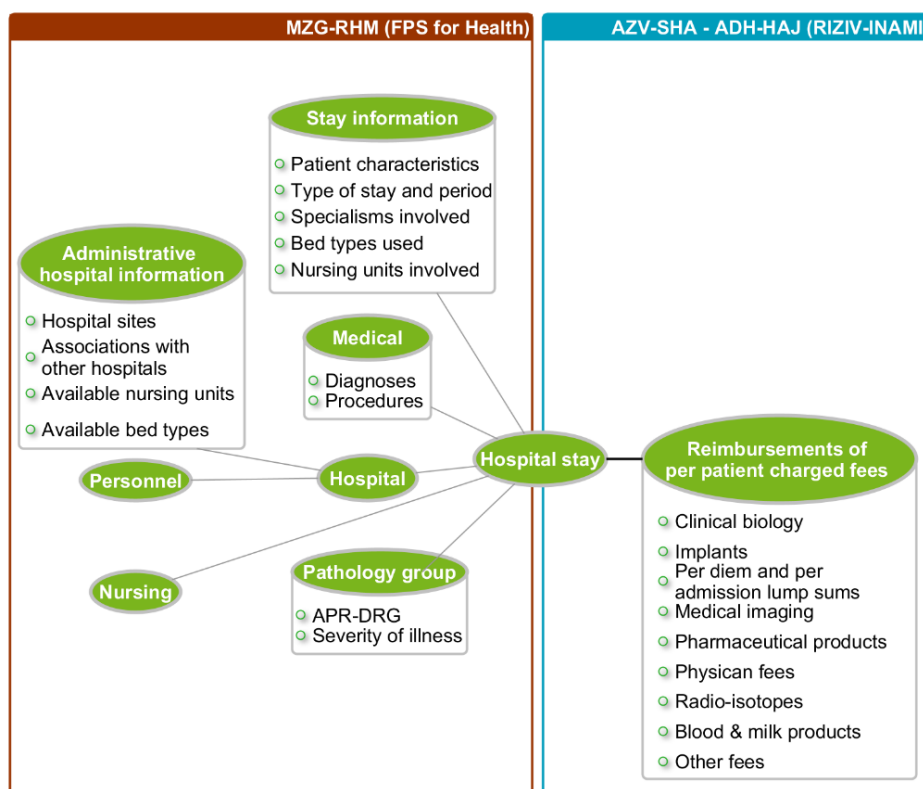
MZG – RHM AND AZV – SHA (TCT)

Established under the [Law of 29 April 1996](https://tct.fgov.be/), the “Technical Cell – Cellule Technique” (<https://tct.fgov.be/>) serves as a joint initiative of RIZIV – INAMI and FPS Public Health. Its primary objective is the collection, validation, anonymisation, and linking of hospital-related data. The Technical Cell, known as TCT, integrates Minimal Hospital Data (MZG – RHM) with reimbursement data from sickness funds, facilitating analyses linking healthcare insurance expenditures to treated conditions. These linked data are used in different policy applications (e.g. payment of low-variable care lump sum; lump sum payment hospital pharmaceuticals). The TCT database comprises the population of all hospital stays in Belgian acute hospitals for patients covered by the national health insurance system. Access to Technical Cell data by KCE is governed by the same legislation that established the Technical Cell.

The dataset derived from TCT is denoted as MZG – RHM (TCT). Belgian general hospitals are mandated to submit biannually a minimal dataset encompassing administrative, medical, and nursing attributes for both all inpatient and day-care stays, referred to as MZG – RHM (see Figure 1). As a consequence, the MZG – RHM is not a sample but includes the entire population of day- and inpatient hospitalisations. For the purposes of this study, the research team had access to a selection of variables from the MZG – RHM for the years 2008-2014 and 2016-2021. In 2015, the hospitals had to change the coding system (from ICD-9-BE towards ICD-10-BE) for diagnostic and procedure codes. Since 2015 was a ‘transitional period’, the data are not used for policy purposes.



Figure 1 – TCT data overview



The MZG – RHM (TCT) was used as a starting point and the core data for the analyses (e.g. selection of index stays). Since one of the main outcomes of interest is unplanned hospital readmission within 30 days after hospital discharge, it is necessary to follow patients across different hospitals. This is not possible via the MZG – RHM (only a unique patient identifier per hospital), while it is possible for the linked MZG – RHM – AZV – SHA data as the TCT uses a unique hospital independent patient identifier (the social security number) to perform the linkage. As a consequence, non-linked data (i.e. hospital stays not covered by the national health insurance like labour accidents, care for foreign patients) could not be used for the analyses. Patients with more than 12 admissions^c per year were not selected for data linkage.

LINKED TO STATBEL-DATA

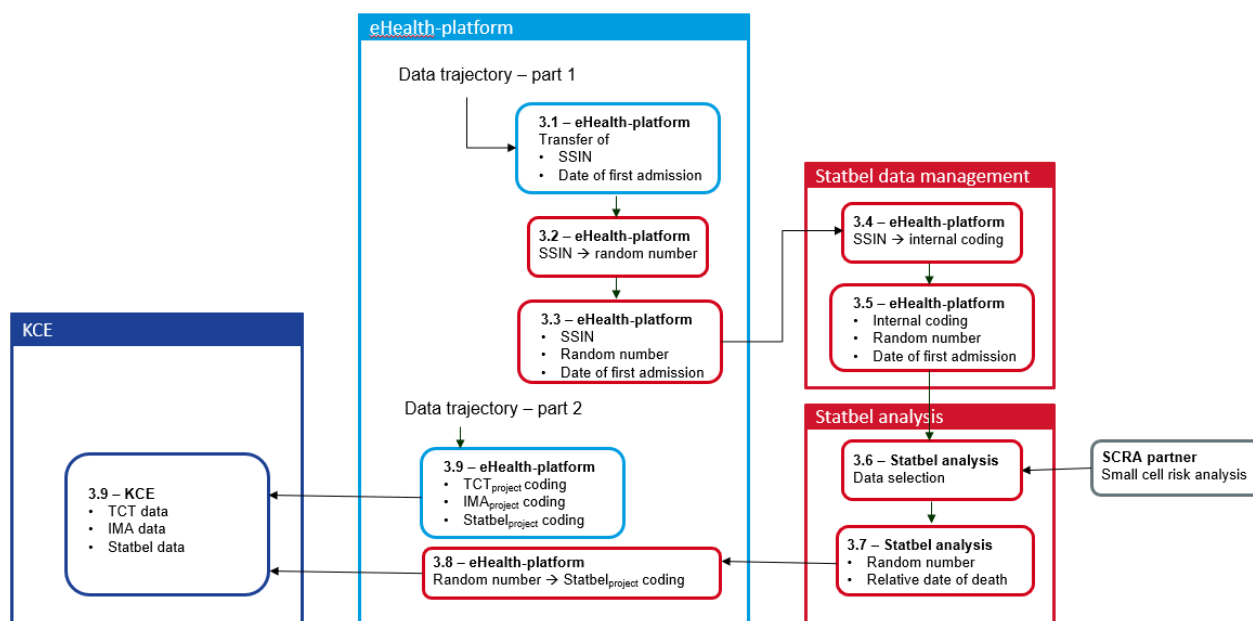
Statbel is the Belgian statistical office which collects data based on administrative data and surveys on several elements about the Belgian society, economy and territory.^d The Statbel data required for the current study was the date of death (converted into number of days relative to the date of first admission). As individual level data was requested, a deliberation of the Information Security Committee (IVC – CSI) was required, which assesses the appropriateness and security of the data process regarding admissibility, legal finality, proportionality and transparency. The demand was sent to the IVC – CSI for deliberation on September 5 2023, and was approved on December 5 2023. It was later modified so that data until 2022 could be included. The linkage of both databases (see Figure 2) was managed by a trusted third-party (eHealth) and sent to KCE data manager on May 13 2025, using a pseudonymised patient identifier. However, as the TCT no longer had access to the

^c The lack of outpatient emergency stays in 2021 and 2022 reduces the total count of stays per patient in these years thereby making the exclusion criterion less stringent.

^d <https://statbel.fgov.be/en/about-statbel>

reconversion tables for the pseudonymised patient identifiers and the social security numbers for the years 2008-2012, the Statbel data could not be linked for those years. As the time period with ICD-9-BE coding in MZG – RHM for which Statbel data could be linked (2012-2014) was too short, **only Statbel data for the second period (ICD-10-BE coding in MZG – RHM, 2016-2022) are reported in the current study**. Note that the authorisation of linkage also concerned data from the Intermutualistic Agency (IMA – AIM), but we did not receive the databases at the time of the writing of the present report (October 2025).

Figure 2 – Linkage procedure of data from FPS Social security and Statbel



SSIN: Social Security Identification Number.

TWO PERIODS: ICD-9 CODED DATA FROM 2008-2014 AND ICD-10 CODED DATA FROM 2016-2022

We used data from the years 2008-2014 and 2016-2022. The APR-DRG version 31 was used to select surgical procedures for the general approach. Although more recent versions of the grouper are available we have chosen version 31 as it is the only version of the grouper that can be based on ICD-9 and ICD-10 coding of diagnoses and procedures. As noted above, due to linkage problems at the level of the TCT, the mortality data could only be studied for the period 2016-2022. Patients with no billing data in the TCT were also not included in the study selection (i.e. these are stays without a unique patient identifier and for which it is not possible to calculate readmissions in another hospital nor to link the data to the mortality data of Statbel).

After applying the APR-DRG grouper (version 31) using the verified admission diagnosis as the primary diagnosis, we examined trends in admissions at the level of MDC and DRG^e. Within each period (Period 1: 2008–2014; Period 2: 2016–2022), no unexpected trends were observed at the population level. However, differences between the two periods were noted, likely attributable to changes in the coding system (ICD-9 versus ICD-10). Consequently, both periods were analysed separately.

^e This verification was done for both inpatient as day-care stays, for medical and surgical stays.



1.2.2 Data sample selection

In this chapter we focus on a wide range of surgical procedures. The aim of this 'general approach' is to demonstrate the evolution of (risk-adjusted) day-care surgery rates and (risk-adjusted) readmission and mortality rates over time in a descriptive way. Day-case admissions were identified using the variable A2_HOSPTYPE_FAC, which distinguishes day-hospital admissions (values "C" or "D") from inpatient admissions.

EXCLUSION RULES

Surgical APR-DRGs with sufficient volume and potential candidates for day surgery were retained for the analysis. The following general exclusion rules were used:

- Non-surgical stays. Surgical versus medical stays were classified based on the M/P indicator from the DRG output rather than procedure codes in M2_CODE_PROCEDURE
- Non-specific MDC's 'major diagnostic categories' or MDC's with very little APR-DRG's with day surgery, i.e. : 'MDC 10 Endocrine, Nutritional & Metabolic Diseases & Disorders', 'MDC 15 Newborns & Other Neonates with Conditions Originating in Perinatal Period'; 'MDC 17 Lymphatic, hematopoietic^f, other malignancies, chemotherapy and radiotherapy'; 'MDC 18 Infectious & Parasitic Diseases'; 'MDC 19 Mental Diseases & Disorders'; 'MDC 20 Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders'; 'MDC 21 Injuries, Poisonings & Toxic Effects of Drugs'; 'MDC 22 Burns'; 'MDC 23 Factors Influencing Health Status & Other Contacts with Health Services'; 'MDC 24 HIV Infections'; 'MDC 25 Multiple Significant Trauma'; 'Rest MDC's 'PP' and '00'.
- Stays with a severity of illness (SOI) category 3 or 4 (irrespective of the DRG) were excluded as they typically represent patients with a high number of co-morbidities which is often used as a contraindication for day surgery. For procedures eligible for day-case treatment, SOI 3 and 4 cases are rare and highly heterogeneous. Given the short time in hospital, complications are rarely captured in discharge data as most adverse events occur post-discharge, which is different compared to inpatient care. Including these cases would therefore introduce bias and reduce comparability with inpatient stays. Moreover, this approach aligns with policy practices for identifying low-variability procedures.
- Day surgery admissions with an overnight stay;
- Long-term stays (incl. administrative discharge or admission for long-term stay). These are stays that cover more than one coding period. Indeed, the data are transmitted every six months (i.e. twice a year) by hospitals to the federal authorities and contain information on the stays of patients who leave the hospital during the six months concerned.
- Non-index stays (readmissions, transfers, outpatient, stays within another stay);
- DRG's (v31) with less than 100 cases performed in day surgery in 2014 and 2022 were considered as too small to be considered as suitable candidates DRGs for the study purposes (see the Supplement to Chapter 1). The threshold of 100 cases per DRG was applied to ensure statistical stability and meaningful trend analysis. DRGs with very low volumes are more susceptible to random variation, which could distort overall patterns and lead to unreliable conclusions. This criterion also ensures that the analysis focuses on a population with genuine potential for day surgery, rather than on procedures that are currently rare in this setting. While

^f MDC 17 (Cancer) accounts for 4.6% of cases excluded because of MDC classification, and mainly consists of non-specific surgical DRGs. Cancer pathways typically involve multiple planned admissions, creating a risk that scheduled stays are misclassified as unplanned, which could distort readmission counts. Therefore, although relevant from a clinical point of view, this MDC was excluded in the analysis.

some interventions, such as total hip and knee replacements, are still uncommon in Belgian day-case practice, international evidence indicates that these procedures are increasingly shifting towards day admission (see Chapter 3).

- Unplanned hospital stays defined as A2_CODE_ADM= 'A' (urgent admission via emergency department without 112, with own transport), 'B' (urgent admission via emergency department without 112, with ambulance), 'C' (urgent admission via emergency department with 112 intervention, with ambulance), 'D' (urgent admission via emergency department with 112 intervention, with ambulance and MUG – SMUR or PIT), 'E' (urgent admission via emergency department with 112 intervention, with ambulance and MUG – SMUR or PIT from another hospital), 'G' (urgent admission but not via emergency department);
- Patients discharged from the index hospital against medical advice;
- Patients who had multiple transfers;
- Patients who died during the hospital stay of the index admission (or in the hospital where the patient was transferred). In-hospital mortality is attributed to a stay in three cases:
 - when in-hospital mortality is registered in MZG – RHM for that stay, even if not confirmed by Statbel data (MZG – RHM is considered the most reliable source as it is closest to the actual patient);
 - If not registered in MZG – RHM, but mortality is registered in Statbel 1 or 2 days before discharge and after admission;
 - For a transfer index stay, if MZG – RHM registers in-hospital mortality in the transfer stay or if Statbel registers mortality between discharge of the index stay and discharge of the transfer stay.

1.2.3 Definition of main variables

DEFINITION OF INDEX ADMISSIONS

- Every qualifying hospital stay was counted as a separate index admission, which is the starting point for follow-up to check for deaths or readmissions. Every eligible hospitalization was considered an index admission. So, there could be multiple index admissions per patient. Yet, readmissions, transfers, outpatient and stays within another stay were excluded as index admissions (see the exclusion rules above).

LENGTH OF STAY CALCULATION

- The length of stay is calculated as the number of days between the admission and discharge date. The following additional rules were applied:
- In case of inter-hospital transfer, the initial stay of the patient is considered the index stay and not the transfer stay(s) that occurred after the initial stay. However, the 30-day observation window starts at the discharge date of the final stay in the chain of transfers. In case the transfer stay(s) have a combined LOS of 30 days or more the group of stays will be excluded from the analysis. 30 day is an ad-hoc threshold, but in line with the post-discharge mortality window. In case of multiple transfers or in case the patient died after the transfer (in the second hospital), the patient was excluded.
- The days on psychiatric beds (beds labeled as 'A', 'K' or 'T') and rehabilitation beds (S1-S6 and Sp-beds) were not included in the LOS (see Supplement to Chapter 1). This decision is taken as some hospitals have these type of beds while others don't. Moreover, since the Sixth State Reform rehabilitation centres (including Sp, S1-Sbeds) are no longer the competency of the Federal authorities.



OVERALL DEFINITION OF 30-DAY POST-DISCHARGE UNPLANNED READMISSIONS

Hospital readmission refers to the situation where a patient, after being discharged, is admitted again within a defined period. Although various time frames are used in practice, the most commonly referenced are 30-day, 90-day, and 1-year intervals. The initial hospitalisation is referred to as the "index admission," while any subsequent admission within the specified timeframe is termed a "readmission". Readmissions present notable challenges for both healthcare systems and patients, often indicating issues in care continuity, discharge planning, or post-discharge support.²⁶

Previous research in Belgium has already explored hospital readmissions using administrative data. Due to limitations in the available datasets - specifically the use of MZG – RHM data, which includes hospital-specific patient identifiers rather than a unique national identifier - these studies were restricted to readmissions occurring within the same hospital. For example, an analysis of 2008 MZG/RHM data found an unplanned readmission rate of 5.2%, with cardiovascular and pulmonary conditions being the most frequent causes. Key risk factors included a high number of prior emergency department visits, discharge on a Friday, and prolonged length of stay, likely reflecting higher clinical severity. Interestingly, patients with shorter hospital stays were not found to be at increased risk of readmission.²⁷ Further research by Van Wilder et al.(2022)²⁸ using MZG/RHM data from 2008 to 2018 confirmed that hospital performance on readmission rates (same hospital only), prolonged LOS, and standardized mortality rates remained relatively stable over time, with low-performing hospitals consistently underperforming and high-performing hospitals maintaining strong results.²⁸

In this study, the primary outcome of interest is an unplanned readmission. Patients who had an eligible index admission were considered "readmitted" if they had one or more unplanned (i.e. patient admitted via emergency), all-cause admission(s) (day-care or inpatient) in an acute hospital within 30 days of discharge from the index admission, regardless of whether the readmission occurred at the same or a different hospital. Hence, except for a few specific exceptions (see next section), the analysis concerns all-cause 30-day post-discharge unplanned readmissions. For simplicity, the term **unplanned readmissions** will be used throughout the remainder of the text.

If a patient had more than one unplanned admission within 30 days of discharge from the index admission, only the first was considered a readmission (variable is dichotomous: yes/no). The readmission rate was calculated as the number of patients discharged from an acute hospital⁹ and readmitted within 30 days, divided by the number of index admissions.

Since the calculation of 30-days readmissions for December 2014 and December 2022 may be incomplete (as neither 2015 nor 2023 data are available), the rates reported for 2014 and 2022 may be slightly underestimated as it is a discharge database (i.e. admissions in 2014 and 2022 with discharges in 2015 and 2023, respectively). The same holds for 2011, as there was no continuity in patient identifiers between 2011 and 2012. This may explain differences observed compared with other reported years.

NOT CONSIDERED AS A READMISSION

In some specific situations, admissions occurring within 30 days were not considered as readmissions:

- Patients who were transferred, i.e. 'other hospital' reported as destination after discharge in hospital discharge data and second admission within 24 hours in a different or same hospital reported in the database; as explained above, for these patients, the two events were combined as a single stay and a combined duration of the stay was calculated (by adding the durations of the two stays). The second event was not counted as a readmission. However, if the combined duration did not exceed the maximum set in the inclusion criteria (see above), any readmission to

⁹ Admissions that occur within the eligible short-term period of 30 days after the index admission within an acute care hospitals but where the patient is admitted to a separate non-acute inpatient unit, such as rehabilitation, psychiatric care, or long-term care were included as readmissions.

the same or a different hospital occurring during the 30-day time period after the discharge from the second hospital was counted.

- Patients who were readmitted with a diagnosis of bone marrow transplant (DRG 003; 007; 008), of nervous system malignancies (DRG 041), ENT malignancies (DRG 110), respiratory malignancies (DRG 136), GI malignancies (DRG 240), hepatobiliary and pancreas malignancies (DRG 281), musculoskeletal malignancies (DRG 343), malignancies of the breast (DRG 382), renal and urinary tract malignancies (DRG 442 and 461), urological malignancies (DRG 500), malignancies of the female reproductive system (DRG 511, 512 and 530), for operating room procedures for lymphatic/hematopoietic/other neoplasma (DRG 680-681), lymphoma, myeloma and (non-)acute leukemia (DRG 690-691), radiotherapy (DRG 692), lymphatic and other malignant disorders and neoplasms with uncertain behaviour (DRG 694) or for chemotherapy (DRG 695 and 696), were not considered potential readmissions.
- Visits to the emergency department (=outpatient emergency stays) were not considered as potential readmissions. It should be noted that unplanned day-care admissions (i.e. hospitalisation without overnight stay) were considered as readmissions. Outpatient emergency contacts were calculated as admissions within 30-days of the index admission. Patients admitted via the emergency department with a same-day discharge and a DRG 'UUU' (i.e. ambulatory emergency contact) or DRG 'MMM' (day-admission with mini lump-sum) were labeled as outpatient emergency contacts. In 2021 and 2022 there were no outpatient emergency contacts in the data. The TCT data for outpatient emergency contacts is incomplete and can therefore not be used to calculate a reliable indicator on outpatient emergency contacts. This outcome will be further explored in the second report when studying a selection of procedures and conditions for which IMA – AMI data will be linked to the MZG – RHM.

DEFINITION OF 30-DAY POST-DISCHARGE MORTALITY

Mortality is defined as death occurring within 30 days after hospital discharge. This outcome variable is only available in period 2016-2022.

30-day mortality is attributed using the following rules:

- Each case of 30-day mortality can only be attributed to a single index stay. In case multiple index stays occurred within the 30-day window preceding death, the more recent index stay is used for attribution.
- Index stay vs readmission stay. A readmission stay is defined as an unplanned stay within 30 days of an index stay and that is not related to cancer treatment and nor an outpatient emergency stay. Readmission stays are not considered index stays; hence mortality cannot be attributed to these.
- Mortality not registered as in-hospital mortality and occurring on the day of discharge up to 30 days after discharge is considered as 30-day mortality. In-hospital mortality during a readmission stay will be considered as 30-day mortality in case it occurred within the 30-day window after discharge.

Given these calculation rules, the measure refers to all-cause 30-day post-discharge mortality. For simplicity, we will use the term **30-day mortality** throughout the report.

In-hospital mortality was excluded because the primary aim of this study is to examine population-level trends in day-surgery rates and its association with post-discharge outcomes - namely, mortality after discharge (and unplanned readmissions). In-hospital deaths are not directly related to policy decisions on early discharge and could confound interpretation, as they reflect different mechanisms. Shifts towards outpatient care is primarily driven by efficiency policies, medical innovation and clinical pathway optimisation, whereas in-hospital mortality is influenced by case severity and acute complications. Including in-hospital deaths would therefore obscure the real policy question: whether earlier discharge shifts risk to the post-discharge period. Nevertheless, in-hospital mortality in a low-



severity population is not expected and might signal quality concerns. Although a detailed analysis of in-hospital is beyond the scope of the current report, a brief description of in-hospital mortality trends is provided for context.

COMPOSITE INDICATOR

We created a composite indicator to measure the occurrence of an adverse event in the 30 days after discharge, combining both 30-day unplanned readmission or 30-day post-discharge mortality. This outcome variable is only available in period 2016-2022. The composite indicator was introduced as a pragmatic solution to address the fact that patients who die within 30 days cannot experience a readmission. By merging mortality and readmission into a single binary outcome (“mortality or readmission within 30 days”), we provide a simple robustness check of the main results. The indicator was constructed as an unweighted binary variable, and we also report the degree of overlap between the two components.

1.2.4 Co-variables for risk-adjustment

Since profound differences in patient characteristics can occur and impact both the day surgery rates and the outcomes, several covariates were included in the analyses. In this study, patient and hospital stay-related characteristics were selected in accordance to the published literature based on administrative data.²⁹ In addition, their associations with the exposure (inpatient versus day-care) and the outcomes were tested before including them in the models.

The factors that are included in the risk adjustment models for readmission and mortality outcomes include:

- Patient age in categories of 5 years up to age 90 or more. For the analysis of 30-day post-discharge mortality, broader age groupings were applied, reflecting the lower risk at younger ages and the overall lower event rate (0–50, 51–65, 66–80, and over 80 years). In the descriptive analyses, more aggregated age categories were used (0–15, 16–45, 46–65, 66–75, 76–85, and over 85 years);
- Gender;
- Condition or procedure of the hospital stay: all-patient refined diagnosis related group (APR-DRG)
- Place before admission (home, nursing home, other hospital, other)
- Discharge disposition (home, nursing home, other)
- Previous visits to the emergency department during the 180 days preceding the index admission were considered.
- Comorbidity is the presence of one or more medical conditions (physical or mental diseases), in addition to the primary diagnosis. They may affect the therapeutic decisions, but also have an impact on the patient outcomes such as length of stay, readmissions and mortality³⁰⁻³³. Thus, it is important to take into account comorbidities when measuring patients’ outcomes based on population-based data over time. To identify comorbid conditions we used the **AHRQ Elixhauser comorbidity index**, a validated instrument to measure comorbidities. The SAS macro code used to calculate the Elixhauser Comorbidities in this study was derived from the code developed as part of the Healthcare Cost and Utilization Project (HCUP), a Federal-State-Industry partnership sponsored by the Agency for Healthcare Research and Quality (AHRQ).^{34, 35} The Elixhauser Comorbidity Software (refined for ICD-10-CM) allows to identify 38 different pre-existing conditions based on secondary diagnoses (i.e., comorbidities) listed on hospital administrative data. The algorithm selects secondary diagnoses that are “present on admission” in case of acute conditions, which is the most common approach. Elixhauser comorbidity is considered as an effective method to incorporate the influence of comorbid conditions in models assessing the risk of readmission and mortality using administrative data.³⁶ In this study, we calculated the total

number of Elixhauser comorbidities identified for each patient (excluding those conditions arising after beginning of hospital observation or treatment). Patients with three or more comorbidities were grouped into a single category resulting in four categories: 0; 1; 2; 3 or more comorbidities. This categorisation was based on the observed distribution in our dataset and aligns with approaches used in similar population-level analyses. Aggregating all patients with three or more comorbidities into one group also helps mitigate potential effects of upcoding, as the impact of coding variations have less influence once cases are pooled into a higher-burden category.

1.2.5 Statistical analyses

The crude rate of the four measures of interest – (1) day surgery rates, (2) 30-day unplanned readmission rates, and (3) 30-day mortality rates and (4) 30-day composite rates (mortality or readmission) – can be calculated as the ratio of the number of observed events to the total number of eligible hospital admissions during a given period.

While this measure provides a straightforward description of the data, it is not suitable for comparing outcomes over time. Differences in patient case-mix, age structure, comorbidity and disease burden, as well as other factors have evolved considerably over the extensive study period (2008 to 2022). This can substantially influence these crude rates.

To enable meaningful comparison, adjustment for differences in case-mix is required. Risk adjustment was therefore applied to account for variations in patient characteristics that are beyond the control of hospitals and that may confound the observed outcomes.

Building on existing approaches, risk-adjusted rates were obtained using an indirect standardisation regression approach.^{28, 37-41} Indirect standardisation was preferred over direct standardisation, because in small samples (which is generally the case when subdividing by multiple factors such as age, sex, pathology groups, morbidity, etc.) direct standardisation may result in imprecise and unreliable mortality rates.⁴²⁻⁴⁶

1.2.5.1 Risk-adjusted rates

The same general modelling framework was applied to all outcome measures. However, given the low number of 30-day post-discharge mortality events in the study population (see section 1.2.3 on the definition of main variables and section 1.3.2.1 with descriptive results), no risk adjustment was performed for 30-day mortality, and only crude rates are reported. Consequently, the calculation of a risk-adjusted composite indicator was redundant. In the current Chapter, we therefore only calculated risk-adjusted readmission rates.

The described approach was therefore applied to estimate risk-adjusted rates for day surgery and 30-day readmissions.

Risk adjustment was stratified by time period and Major Diagnostic Category (MDC). For each period, a three-year baseline was used to calibrate the model: 2008-2010 for the first period (2008-2014) and 2016-2018 for the second period (2016-2022). This implies that separate models were estimated for each MDC and coding period. Within each MDC-specific model, DRG categories belonging to that MDC were included as covariates with their own coefficients (see section 1.2.4). This approach allows risk factors to vary across MDCs while preserving DRG-level granularity within each category.

The risk-adjusted rate (RAR)^{37, 39} of year t in period p is defined as

$$RAR_{t,p} = \frac{\text{Observed events}_{t,p}}{\text{Expected events}_{t,p}} \times BR_p = \frac{\sum_m \sum_i E_{t,p,m,i}}{\sum_m \sum_i \hat{p}_{t,p,m,i}} \times BR_p \quad (1)$$



The numerator is the sum of observed events ($\sum_m \sum_i E_{t,p,m,i}$) across all hospital admissions i and MDCs m in year t of period p . The variable $E_{t,p,m,i}$ takes the value 1 if the event occurred (i.e. day surgery procedure or readmission) and 0 otherwise.

The denominator represents the expected number of events, calculated as the sum of the estimated probabilities of the event ($\sum_m \sum_i \hat{p}_{t,p,m,i}$) across all hospital admissions i and MDCs m in year t of period p . Each $\hat{p}_{t,p,m,i}$ is a predicted probability between 0 and 1, with higher values indicating a greater expected likelihood of the event. The prediction model used to estimate the predicted probability for each admission is described in section 1.2.5.2 below.

The ratio is multiplied by the baseline rate of the event in period p (BR_p) to obtain the risk-adjusted rate.

Formally, this implies that when the observed rate exceeds the risk-adjusted rate in year t , this corresponds to the situation where the expected rate exceeds the baseline rate. In other words, given the case mix and baseline practice patterns, one would have expected more events than indicated by the baseline rate. Conversely, when the observed rate is below the risk-adjusted rate in year t , the expected rate is below the baseline level, meaning that, based on patient characteristics and baseline practice, one would have expected fewer events than indicated by the baseline rate.

$$RAR_{t,p} = \frac{\text{Observed events}_{t,p}}{\text{Expected events}_{t,p}} \times BR_p = \frac{\text{Observed rate}_{t,p}}{\text{Expected rate}_{t,p}} \times BR_p$$

$$\text{If } \text{Observed rate}_{t,p} > RAR_{t,p} \Leftrightarrow \text{Expected rate}_{t,p} > BR_p$$

$$\text{If } \text{Observed rate}_{t,p} < RAR_{t,p} \Leftrightarrow \text{Expected rate}_{t,p} < BR_p$$

1.2.5.2 Prediction model for probability of outcomes

Given the binary nature of the dependent variable, expected probabilities were estimated using logistic regression with Firth's bias-reduction method to mitigate small-sample bias and address potential separation issues.^{46, 47} Separate regression models were estimated for each period and each MDC (see section 1.2.5.1). Stratifying admissions by period and MDC increased homogeneity within each estimation group with respect to the underlying pathology, thereby enhancing the precision of the estimated probabilities.

For each period, a 3-year baseline period was used to examine the relationship between the outcome and a set of patient and admission characteristics (see section 1.2.4; discharge disposition was not included as an explanatory variable). The stratification allowed the regression coefficients of the explanatory variables to vary across periods and MDCs. The estimated coefficients were subsequently applied to all hospital admissions within the respective period and MDC to generate the expected probability of the outcome for each stay. This produced a counterfactual estimate of the probability of the event, conditional on the patient's characteristics and the baseline average relationship between risk factors and outcomes.

To limit the standard errors of the regression coefficients and improve model stability, the distribution of all categorical variables for each separate regression was examined to avoid excessively small cell counts. As far as possible, each category was defined to include at least 50 admissions, including at least one event. Where this threshold could not be met, the smallest or most similar categories were systematically combined, starting with the lowest category and merging sequentially with the next lowest. The procedure was repeated as necessary for subsequent categories. If the final category contained fewer than 50 admissions, it was merged with the second last category to meet the threshold.

The regression analysis was performed using the logistic procedure in SAS V9.4.

PREDICTION MODEL STATISTICS

For each regression model, the Wald statistic was calculated for every explanatory variable to assess its association with the outcome. A large Wald statistic indicates a strong association between the explanatory variable and the event, after adjustment for the other covariates in the model. This measure was used to identify the most influential explanatory variables in each regression model.⁴⁸

The overall fit and discriminatory ability of the logistic regression models were evaluated using the C-statistic, which is equivalent to the area under the receiver operating characteristic curve (AUC, AUC-ROC, or AUROC).^{40, 49} The C-statistic represents the probability that a randomly selected patient experiencing the event was assigned a higher predicted probability than a randomly selected patient without the event. A value of 0.5 suggests that the model performs no better than random chance, while a maximum value of 1 denotes perfect discrimination. Generally, a C-statistic above 0.7 indicates acceptable discriminatory ability, and values exceeding 0.8 denote excellent discriminatory performance.⁴⁰

1.2.5.3 Association readmission rates and day surgery rate

After risk adjustment of all outcome variables, the association between the evolution of risk-adjusted readmission rates and day surgery rates over time was examined. All analyses were performed separately for the periods 2008-2014 and 2016-2022.

The relationship was first assessed using a scatterplot illustrating the annual evolution of both indicators within each period. The plot area is divided into four quadrants according to the starting year of each period (2008 for the first period and 2016 for the second). The upper left quadrant, shown in green, represents increases in day surgery rates (indicating more efficient use of resources) combined with improvements in readmission rates. Movements within this area are therefore considered desirable. In contrast, the bottom right quadrant, coloured red, represents decreases in day surgery rates accompanied by higher readmission rates and is regarded as undesirable. The remaining two quadrants, which are not coloured, display opposite trends between readmission rates and day surgery rates. Second, to complement the descriptive analysis, simple period-specific ordinary least squares (OLS) regression models with robust standard errors to account for potential heteroskedasticity were estimated, using the annual risk-adjusted readmission rate as the dependent variable and the annual risk-adjusted day surgery rate as the explanatory variable.

The descriptive analysis was conducted on the full sample and on the subgroups of inpatient and day-care admissions. In each setting, day-surgery rates were linked to readmission risk. Subgroup analyses were also carried out to explore heterogeneity in this association across age groups, Elixhauser comorbidity categories, and MDCs.

1.3 Results

This chapter presents the results based on administrative data from MZG – RHM and Statbel. It begins with a description of the study selection and the evolution in the study population and hospital admissions. The subsequent section examines the overall trends in (risk-adjusted) day surgery rates and (risk-adjusted) 30-day readmission rates. Finally, we explore the association between the evolution in (risk-adjusted) day surgery activity and readmission rates, both at the population level and by type of admission, age group, Elixhauser comorbidity burden, and MDC.



1.3.1 Study population

1.3.1.1 Data sample selection

Table 1 summarises the data selection process and successive exclusion steps, as outlined in section 1.2. From an initial 53 513 974 hospital stays, 11 582 817 remained after applying the exclusion criteria. The largest reduction occurred after the exclusion of non-surgical stays, which reduced the dataset by more than two thirds. Other major exclusions related to pathological information (non-specific MDCs in step 2 and DRGs with limited day surgery activity in step 7), high severity of illness, unplanned admissions, and non-index stays. Among stays excluded based on SOI 3 or 4, only 1.6% were day cases and 98.4% inpatient stays.

Table 1 – Data sample and exclusions

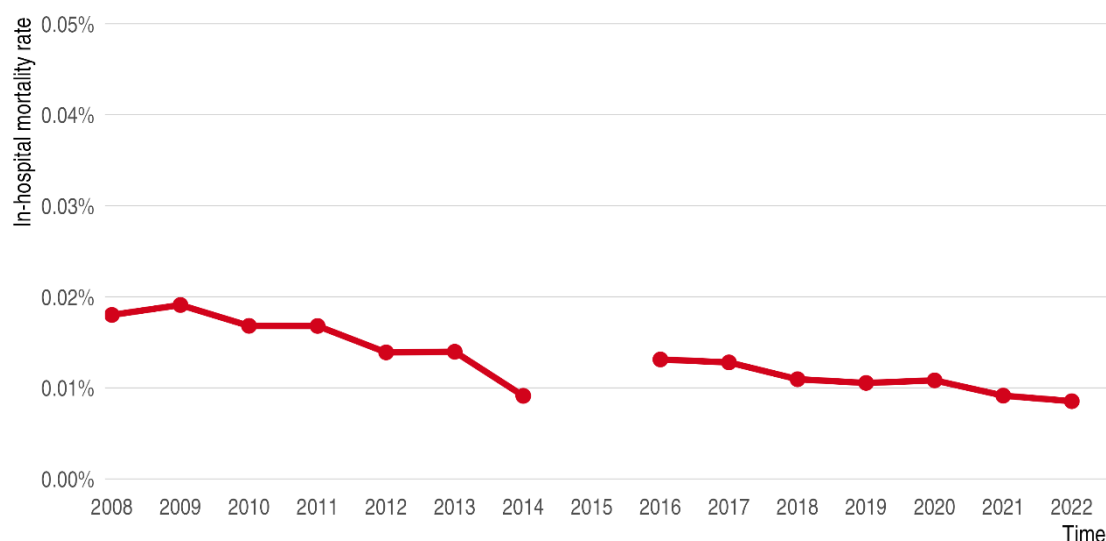
Criteria	Number of observations	Sample reduction
<i>All observations</i>	53 513 974	
<i>1. After excluding non-surgical stays</i>	16 420 768	37 093 206
<i>2. After excluding stays in non-specific MDCs and MDCs with limited day surgery activity</i>	15 121 229	1 299 539
<i>3. After excluding stays with severity of illness (SOI) 3 or 4</i>	14 356 347	764 882
<i>4. After excluding overnight stays</i>	14 350 140	6 207
<i>5. After excluding long-term stays</i>	14 349 796	344
<i>6. After excluding non-index stays</i>	14 081 146	268 650
<i>7. After excluding stays in DRGs with less than 100 cases performed in day surgery in 2014 and 2022</i>	12 544 959	1 536 187
<i>8. After excluding unplanned stays</i>	11 603 611	941 348
<i>9. After excluding discharges against medical advice</i>	11 586 621	16 990
<i>10. After excluding index stays followed by multiple transfers</i>	11 584 330	2 291
<i>11. After excluding stays ending in in-hospital death</i>	11 582 817	1 513

1.3.1.2 In-hospital mortality

Over the entire study period, and after applying all exclusions except the in-hospital mortality criterion, a total of 1 513 in-hospital deaths were recorded (see Table 1): 880 over the period 2008-2014 and 633 over the period 2016-2022. Only two deaths took place in the day-care setting. The small numbers reflect the fact that the study population consists of low-severity patients potentially eligible for day surgery.

Figure 3 shows that in-hospital mortality remained extremely low throughout the study period, fluctuating around 0.02% in 2008 and about 0.01% in 2022, without any visible increase over time. This rate was calculated on the study sample extended to include index stays resulting in in-hospital death.

Nearly half of all in-hospital deaths occurred in MDC 05 (Circulatory system, 26.6%), particularly within vascular procedure groups such as DRGs 173, 169, and 175, and MDC 06 (Digestive system, 23.9%), where major small and large bowel procedures (DRG 221) accounted for a substantial share.

Figure 3 – Evolution of in-hospital mortality (observed rate)

1.3.1.3 Study population and admission characteristics

Table 2 summarises the main descriptive characteristics of the study population for the full sample, for each period, and for the first and last year within each period. In the Supplement to Chapter 1, tables are included to present the same characteristics for inpatient stays and day care stays, respectively.

The study population comprised 11 582 817 surgical admissions – of which 7 130 829 in day care and 4 451 988 in inpatient care (see Supplement to Chapter 1) – almost evenly distributed between the first (2008-2014; 5 749 615 stays) and second (2016-2022; 5 833 202 stays) period. Across all years, 54.7% of admissions involved female patients. Nearly three quarters of patients were aged between 16 and 75 years.

Table 2 – Descriptives of main population and admission characteristics in the study population [Number of admissions (% in group)]

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
All admissions	11 582 817 (100.0%)	5 749 615 (100.0%)	765 894 (100.0%)	855 001 (100.0%)	5 833 202 (100.0%)	861 097 (100.0%)	867 026 (100.0%)
Sex							
Male	5 248 591 (45.3%)	2 559 899 (44.5%)	337 559 (44.1%)	384 233 (44.9%)	2 688 692 (46.1%)	391 446 (45.5%)	405 900 (46.8%)
Female	6 334 226 (54.7%)	3 189 716 (55.5%)	428 335 (55.9%)	470 768 (55.1%)	3 144 510 (53.9%)	469 651 (54.5%)	461 126 (53.2%)
Age							
Age group 0-15	991 906 (8.6%)	538 881 (9.4%)	72 252 (9.4%)	74 445 (8.7%)	453 025 (7.8%)	73 566 (8.5%)	64 892 (7.5%)
Age group 16-45	3 045 400 (26.3%)	1 612 549 (28.0%)	228 057 (29.8%)	229 750 (26.9%)	1 432 851 (24.6%)	216 136 (25.1%)	205 300 (23.7%)
Age group 46-60	2 840 763 (24.5%)	1 416 501 (24.6%)	185 292 (24.2%)	214 302 (25.1%)	1 424 262 (24.4%)	215 620 (25.0%)	201 213 (23.2%)
Age group 61-75	2 955 218 (25.5%)	1 337 173 (23.3%)	171 868 (22.4%)	207 823 (24.3%)	1 618 045 (27.7%)	222 863 (25.9%)	253 759 (29.3%)
Age group 76-85	1 446 771 (12.5%)	709 688 (12.3%)	92 540 (12.1%)	107 022 (12.5%)	737 083 (12.6%)	109 284 (12.7%)	115 642 (13.3%)
Age group over 85	302 759 (2.6%)	134 823 (2.3%)	15 885 (2.1%)	21 659 (2.5%)	167 936 (2.9%)	23 628 (2.7%)	26 220 (3.0%)
Elixhauser							

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
<i>No comorbidities</i>	8 804 876 (76.0%)	4 462 474 (77.6%)	588 519 (76.8%)	657 663 (76.9%)	4 342 402 (74.4%)	653 654 (75.9%)	636 481 (73.4%)
<i>1 comorbidity</i>	1 507 301 (13.0%)	726 864 (12.6%)	103 319 (13.5%)	106 953 (12.5%)	780 437 (13.4%)	111 777 (13.0%)	120 430 (13.9%)
<i>2 comorbidities</i>	733 430 (6.3%)	339 588 (5.9%)	46 625 (6.1%)	52 732 (6.2%)	393 842 (6.8%)	54 617 (6.3%)	59 908 (6.9%)
<i>3 or more comorbidities</i>	537 210 (4.6%)	220 689 (3.8%)	27 431 (3.6%)	37 653 (4.4%)	316 521 (5.4%)	41 049 (4.8%)	50 207 (5.8%)
Admission source							
<i>Home</i>	11 441 960 (98.8%)	5 689 478 (99.0%)	754 592 (98.5%)	845 703 (98.9%)	5 752 482 (98.6%)	851 379 (98.9%)	845 389 (97.5%)
<i>Nursing home</i>	10 380 (0.1%)	6 316 (0.1%)	974 (0.1%)	816 (0.1%)	4 064 (0.1%)	699 (0.1%)	590 (0.1%)
<i>Other hospital</i>	23 091 (0.2%)	13 789 (0.2%)	2 323 (0.3%)	1 673 (0.2%)	9 302 (0.2%)	3 239 (0.4%)	847 (0.1%)
<i>Other/unknown</i>	107 386 (0.9%)	40 032 (0.7%)	8 005 (1.0%)	6 809 (0.8%)	67 354 (1.2%)	5 780 (0.7%)	20 200 (2.3%)
Discharge disposition							
<i>Home</i>	11 476 755 (99.1%)	5 697 956 (99.1%)	754 761 (98.5%)	847 181 (99.1%)	5 778 799 (99.1%)	855 427 (99.3%)	857 633 (98.9%)
<i>Nursing home</i>	31 783 (0.3%)	15 497 (0.3%)	2 086 (0.3%)	2 271 (0.3%)	16 286 (0.3%)	2 263 (0.3%)	2 516 (0.3%)
<i>Other/unknown</i>	74 279 (0.6%)	36 162 (0.6%)	9 047 (1.2%)	5 549 (0.6%)	38 117 (0.7%)	3 407 (0.4%)	6 877 (0.8%)
Previous emergency contacts							
<i>Yes</i>	972 366 (8.4%)	459 144 (8.0%)	40 948 (5.3%)	75 748 (8.9%)	513 222 (8.8%)	64 108 (7.4%)	67 595 (7.8%)
<i>No</i>	10 610 451 (91.6%)	5 290 471 (92.0%)	724 946 (94.7%)	779 253 (91.1%)	5 319 980 (91.2%)	796 989 (92.6%)	799 431 (92.2%)
Palliative care patient							
<i>Yes</i>	1 091 (0.0%)	628 (0.0%)	108 (0.0%)	78 (0.0%)	463 (0.0%)	80 (0.0%)	76 (0.0%)
<i>No</i>	11 581 726 (100.0%)	5 748 987 (100.0%)	765 786 (100.0%)	854 923 (100.0%)	5 832 739 (100.0%)	861 017 (100.0%)	866 950 (100.0%)
MDCs - medical/surgical							
<i>MDC 01 (Surgical): Nervous System</i>	540 101 (4.7%)	258 782 (4.5%)	34 205 (4.5%)	38 277 (4.5%)	281 319 (4.8%)	42 078 (4.9%)	40 374 (4.7%)
<i>MDC 02 (Surgical): Eye</i>	1 952 100 (16.9%)	930 225 (16.2%)	116 373 (15.2%)	143 926 (16.8%)	1 021 875 (17.5%)	149 820 (17.4%)	157 309 (18.1%)
<i>MDC 03 (Surgical): Ear, Nose, Throat (ENT)</i>	1 988 553 (17.2%)	1 006 992 (17.5%)	129 272 (16.9%)	148 578 (17.4%)	981 561 (16.8%)	144 193 (16.7%)	149 027 (17.2%)
<i>MDC 04 (Surgical): Respiratory System</i>	50 761 (0.4%)	25 670 (0.4%)	3 248 (0.4%)	4 082 (0.5%)	25 091 (0.4%)	3 548 (0.4%)	3 572 (0.4%)
<i>MDC 05 (Surgical): Circulatory System</i>	954 938 (8.2%)	449 299 (7.8%)	59 614 (7.8%)	67 998 (8.0%)	505 639 (8.7%)	73 250 (8.5%)	76 665 (8.8%)
<i>MDC 06 (Surgical): Digestive System</i>	894 148 (7.7%)	423 282 (7.4%)	57 901 (7.6%)	63 674 (7.4%)	470 866 (8.1%)	67 830 (7.9%)	70 931 (8.2%)
<i>MDC 07 (Surgical): Hepatobiliary System</i>	242 776 (2.1%)	107 732 (1.9%)	13 852 (1.8%)	16 544 (1.9%)	135 044 (2.3%)	18 811 (2.2%)	21 000 (2.4%)
<i>MDC 08 (Surgical): Musculoskeletal System</i>	2 816 380 (24.3%)	1 465 352 (25.5%)	197 598 (25.8%)	218 900 (25.6%)	1 351 028 (23.2%)	206 550 (24.0%)	191 829 (22.1%)
<i>MDC 09 (Surgical): Skin/Breast</i>	629 498 (5.4%)	307 651 (5.4%)	41 755 (5.5%)	45 610 (5.3%)	321 847 (5.5%)	47 221 (5.5%)	47 130 (5.4%)
<i>MDC 11 (Surgical): Kidney/Urinary</i>	369 259 (3.2%)	156 345 (2.7%)	20 669 (2.7%)	23 251 (2.7%)	212 914 (3.7%)	27 480 (3.2%)	34 196 (3.9%)
<i>MDC 12 (Surgical): Male Reproductive</i>	266 442 (2.3%)	133 248 (2.3%)	19 272 (2.5%)	18 418 (2.2%)	133 194 (2.3%)	19 882 (2.3%)	20 127 (2.3%)

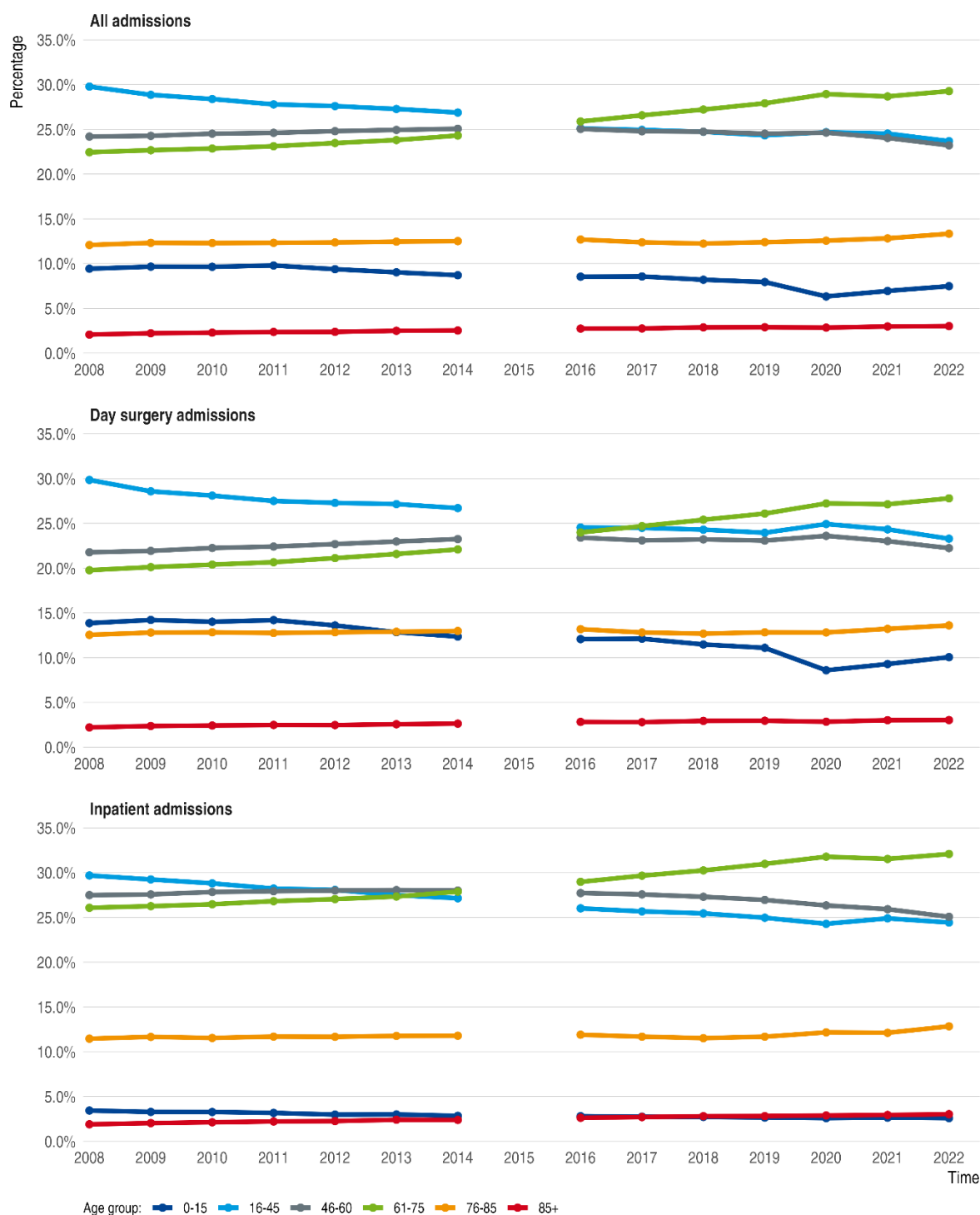
	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
<i>MDC 13 (Surgical): Female Reproductive</i>	697 963 (6.0%)	385 149 (6.7%)	57 147 (7.5%)	52 562 (6.1%)	312 814 (5.4%)	47 708 (5.5%)	44 980 (5.2%)
<i>MDC 14 (Surgical): Pregnancy/Childbirth</i>	161 832 (1.4%)	91 287 (1.6%)	13 804 (1.8%)	11 942 (1.4%)	70 545 (1.2%)	11 380 (1.3%)	8 578 (1.0%)
<i>MDC 16 (Surgical): Blood/Immunological</i>	18 066 (0.2%)	8 601 (0.1%)	1 184 (0.2%)	1 239 (0.1%)	9 465 (0.2%)	1 346 (0.2%)	1 308 (0.2%)

PERCENTAGE OF PATIENTS IN OLDER AGE GROUPS INCREASES OVER TIME

The age distribution, also illustrated in Figure 4, indicates a gradual shift towards older patients. In the full sample, the share of those aged 61-75 years increased markedly (from 22.4% in 2008 to 29.3% in 2022), and to a lesser extent among those aged 76-85 years (from 12.1% to 13.3%) and 85 years and over (from 2.1% to 3.0%). Conversely, declines were observed among younger adults (16-45 years; 29.8% to 23.7%), middle-aged patients (46-60 years; 24.2% to 23.2%), and children (0-15 years; 9.4% to 7.5%). Although the temporal age trends were similar in inpatient and day surgery settings, the age composition differed substantially. In day surgery, the share of children (0-15 years) was considerably higher (12.1% in day surgery versus 2.9% in inpatient care), while patients aged 46-75 years accounted for a larger proportion of inpatient admissions (see Figure 4)



Figure 4 – Evolution of the age-group distribution in the study population, by admission type

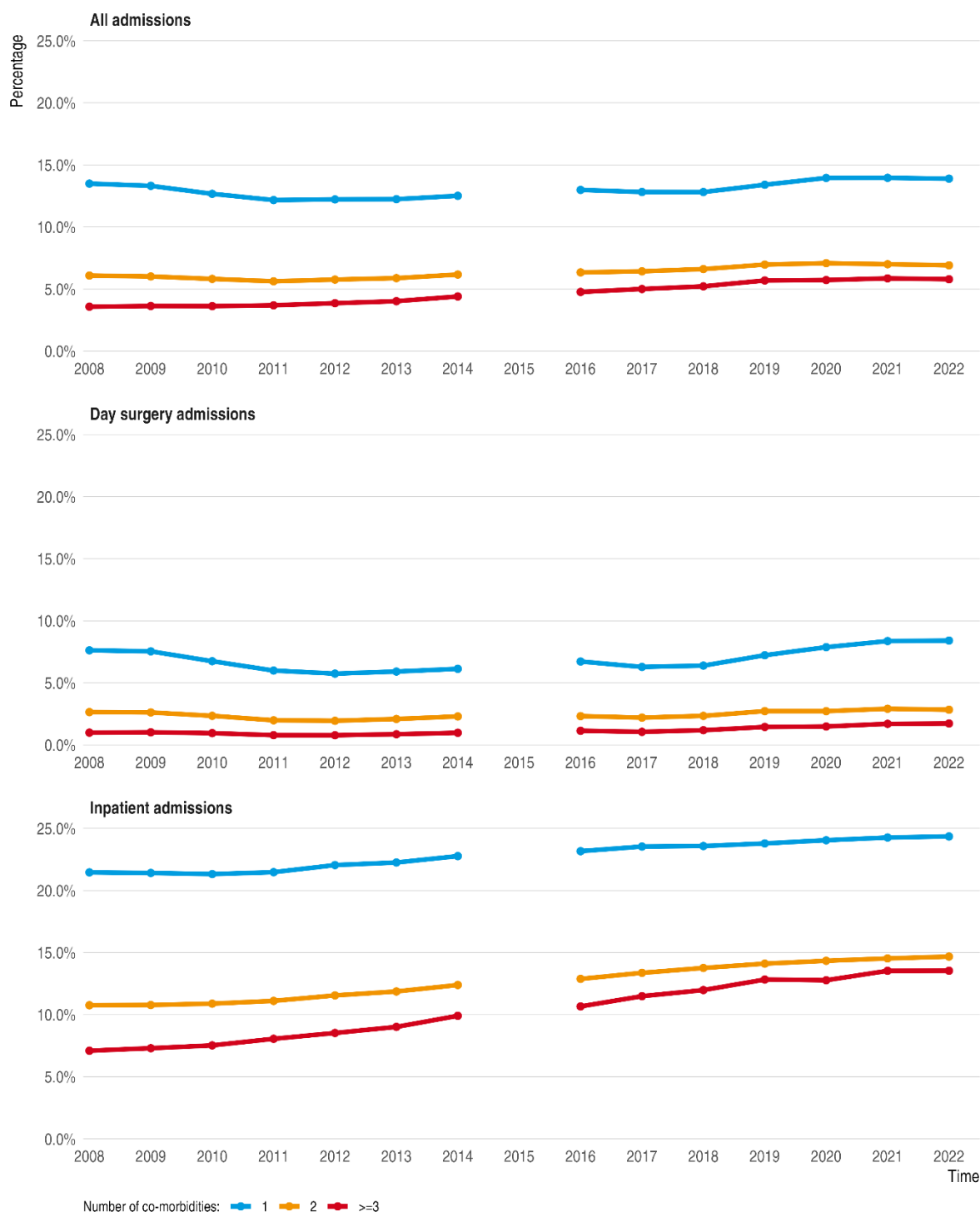


ALTHOUGH THE COMORBIDITY BURDEN FOR THE PATIENT SELECTION IS LOW, IT INCREASES OVER TIME, ESPECIALLY FOR INPATIENT STAYS

Consistent with the selection criteria, the comorbidity burden in the study sample was relatively low, with 76.0% of admissions involving patients without comorbidities. As shown in Figure 5, there was, however, a gradual increase in surgical procedures among patients with one or more Elixhauser comorbidities, rising from 23.2% in 2008 to 26.6% in 2022, particularly during the second period. The trend differed between day surgery and inpatient care, with a much steeper rise in comorbidity burden

among inpatients. This pattern likely reflects a shift from inpatient care to day surgery among patients with the lowest comorbidity burden. In 2022, patients without comorbidities represented 47.4% of inpatients, down from 60.7% in 2008, whereas in day surgery this group accounted for 88.7% of patients in 2008 and 87.0% in 2022. Palliative patients were extremely rare, as expected for this type of population.

Figure 5 – Evolution of Elixhauser co-morbidity burden in the study population, by admission type





MOST PATIENTS ARE ADMITTED FROM HOME AND DISCHARGED HOME

The vast majority of patients were admitted from home (98.8%) and discharged home again (99.1%). A modest increase in patients with a previous emergency contact (within 180 days prior to admission) was observed, particularly during the first period.

EYE, ENT AND ORTHOPEDIC SURGERY REPRESENT THE HIGHEST VOLUMES

Regarding the distribution of surgical activity, MDC 02 (Eye), MDC 03 (Ear, Nose and Throat), and MDC 08 (Musculoskeletal system) accounted for the largest shares of surgical stays, together representing nearly 60% of all admissions. Over time, relative increases were observed for MDC 02, MDC 05 (Circulatory system), MDC 06 (Digestive system), MDC 07 (Hepatobiliary system), and MDC 11 (Kidney/Urinary system), while MDC 08 (Musculoskeletal system), MDC 13 (Female reproductive system), and MDC 14 (Pregnancy/Childbirth) showed relative declines.

1.3.2 Evolution of main outcomes

1.3.2.1 Observed evolution

Figure 6 provides an overview of the evolution of the main outcome variables, i.e. day surgery rate, readmission rate, mortality rate, and the composite rate. Table 3 and Table 4 offer further detail on day surgery and readmission rates by age group, MDC, and admission type.

A BROAD AND SUSTAINED EXPANSION OF DAY SURGERY ACTIVITY

As shown in Table 3 and Figure 6, the overall day surgery rate increased substantially, from 57.6% in 2008 to 65.6% in 2022, representing an 8.0-percentage-point rise over the study period. Although a sharp temporary decline of nearly one quarter was observed in day surgery admissions in 2020, this had only a minor and short-lived impact on the overall trend. Overall, the results indicate a broad and sustained expansion of day surgery activity across multiple pathologies, progressively encompassing a wider and more clinically diverse patient population.

Increases were observed across all age groups, with the largest relative gains among adults aged 46-75 years (around +11 pp). Rates among children were already very high and changed only modestly. The expansion of day surgery was most pronounced among patients without comorbidities (from 66.5% to 77.8%), yet growth was also evident among those with one or more comorbidities, particularly during 2016-2022. By 2022, 19.6% of patients with three or more comorbidities were treated in day surgery, up from 14.9% in 2016, indicating that day surgery has progressively expanded to more complex cases.

Substantial differences were observed across MDCs. Day surgery was widespread in ophthalmology (MDC 02) and Ear, Nose, Throat (MDC 03), with rates exceeding 90% and around 80%, respectively, and both showed further increases over time. Rates were similarly high and stable in nervous system surgery (MDC 01). Marked growth, ranging from 10 to 25 percentage points, was observed in digestive (MDC 06), hepatobiliary (MDC 07), skin/breast (MDC 09), kidney/urinary (MDC 11), female reproductive (MDC 13), and blood/immunological (MDC 16) categories. In contrast, day surgery rates remained relatively stable in musculoskeletal surgery (MDC 08) and declined in pregnancy and childbirth (MDC 14).

Figure 6 – Evolution of main outcomes (observed values)

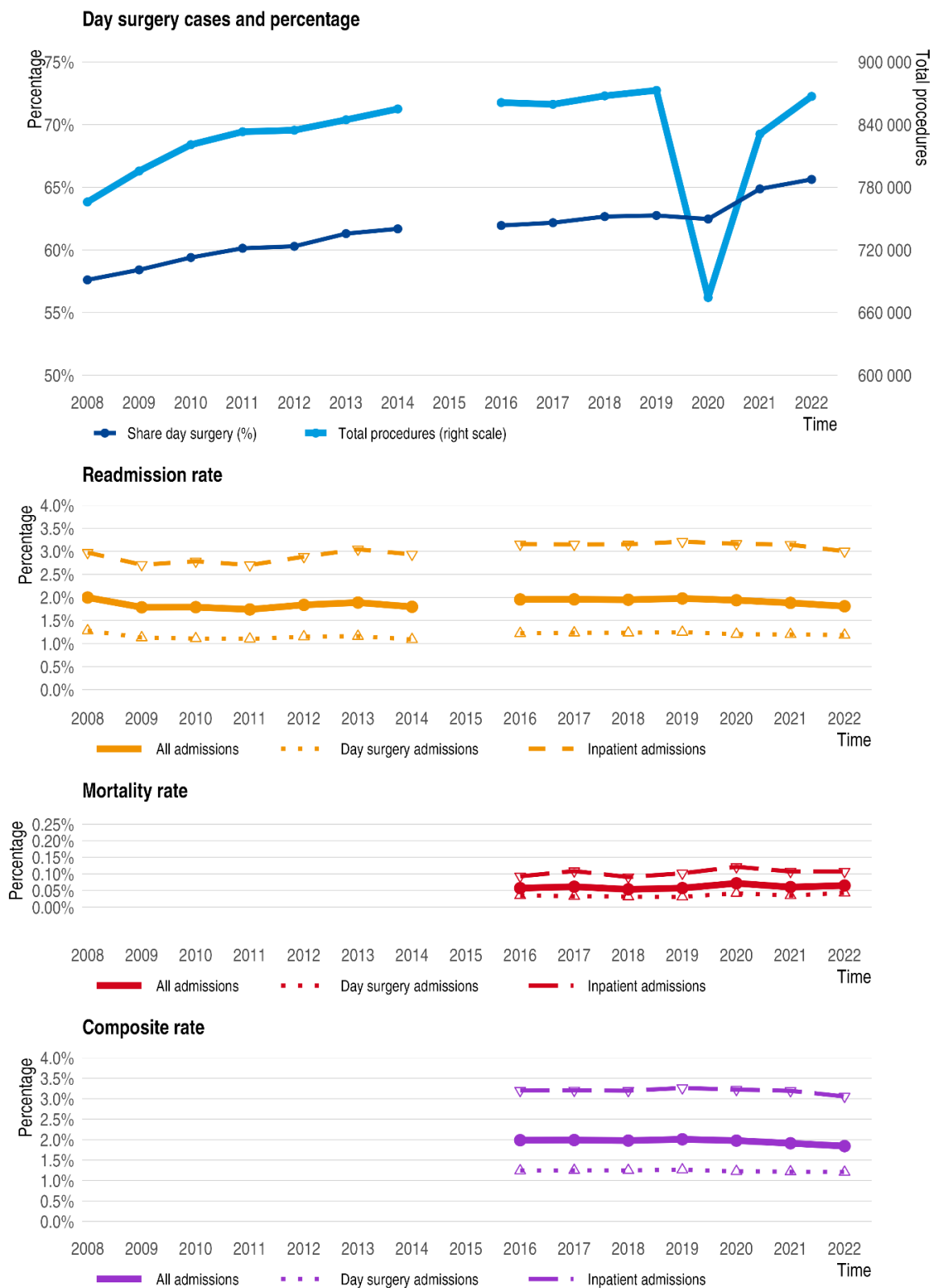




Table 3 – Evolution of day surgery rate in the study population [Rate (difference end rate – start rate)]

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
All admissions	61.6% (8.0 pp)	59.9% (4.1 pp)	57.6%	61.7%	63.2% (3.7 pp)	61.9%	65.6%
Age							
Age group 0-15	86.9% (3.5 pp)	86.6% (2.9 pp)	84.6%	87.5%	87.3% (0.6 pp)	87.5%	88.2%
Age group 16-45	60.8% (6.8 pp)	59.4% (3.6 pp)	57.7%	61.3%	62.4% (4.0 pp)	60.6%	64.5%
Age group 46-60	57.2% (11.0 pp)	54.7% (5.4 pp)	51.8%	57.2%	59.7% (5.0 pp)	57.9%	62.9%
Age group 61-75	56.8% (11.6 pp)	53.7% (5.3 pp)	50.7%	56.1%	59.3% (4.9 pp)	57.4%	62.3%
Age group 76-85	63.7% (7.1 pp)	62.1% (4.1 pp)	59.8%	63.9%	65.2% (2.6 pp)	64.3%	66.9%
Age group over 85	63.5% (4.3 pp)	62.7% (2.6 pp)	61.4%	64.0%	64.1% (2.0 pp)	63.7%	65.7%
Elixhauser							
No comorbidities	72.5% (11.3 pp)	69.7% (6.1 pp)	66.5%	72.6%	75.3% (4.5 pp)	73.3%	77.8%
1 comorbidity	32.7% (7.2 pp)	30.7% (-2.3 pp)	32.6%	30.2%	34.6% (7.6 pp)	32.1%	39.7%
2 comorbidities	23.6% (1.9 pp)	23.0% (-2.1 pp)	25.1%	23.0%	24.2% (4.3 pp)	22.7%	27.0%
3 or more comorbidities	15.4% (3.6 pp)	14.2% (-2.2 pp)	16.0%	13.8%	16.3% (4.8 pp)	14.9%	19.6%
MDCs							
MDC 01 (Surgical): Nervous System	87.9% (0.0 pp)	89.0% (2.5 pp)	87.5%	89.9%	86.9% (0.9 pp)	86.6%	87.5%
MDC 02 (Surgical): Eye	93.1% (4.4 pp)	92.0% (2.9 pp)	90.4%	93.3%	94.0% (1.5 pp)	93.3%	94.8%
MDC 03 (Surgical): ENT	78.7% (8.7 pp)	77.3% (5.0 pp)	73.9%	78.9%	80.3% (4.1 pp)	78.5%	82.5%
MDC 04 (Surgical): Respiratory	13.3% (6.4 pp)	10.5% (-1.2 pp)	11.2%	10.0%	16.3% (4.0 pp)	13.6%	17.6%
MDC 05 (Surgical): Circulatory	36.2% (4.9 pp)	36.0% (2.6 pp)	34.9%	37.4%	36.3% (3.6 pp)	36.1%	39.7%
MDC 06 (Surgical): Digestive	37.9% (22.5 pp)	31.2% (7.3 pp)	27.2%	34.5%	44.0% (10.6 pp)	39.2%	49.8%
MDC 07 (Surgical): Hepatobiliary	12.2% (18.4 pp)	6.1% (4.2 pp)	3.9%	8.1%	17.1% (10.4 pp)	11.9%	22.4%
MDC 08 (Surgical): Musculoskeletal	56.1% (2.7 pp)	55.7% (1.2 pp)	55.8%	57.1%	56.4% (2.9 pp)	55.7%	58.5%
MDC 09 (Surgical): Skin/Breast	42.4% (13.3 pp)	37.5% (4.4 pp)	35.9%	40.4%	47.2% (4.2 pp)	45.0%	49.2%
MDC 11 (Surgical): Kidney/Urinary	35.5% (25.2 pp)	24.2% (3.6 pp)	22.6%	26.2%	43.8% (8.6 pp)	39.1%	47.8%
MDC 12 (Surgical): Male Reproductive	39.9% (2.6 pp)	39.1% (4.7 pp)	36.3%	40.9%	40.6% (-3.8 pp)	42.6%	38.8%
MDC 13 (Surgical): Female Reproductive	46.6% (10.7 pp)	44.1% (4.9 pp)	41.4%	46.3%	49.7% (4.2 pp)	47.9%	52.1%
MDC 14 (Surgical): Pregnancy/birth	82.3% (-11.0 pp)	86.3% (0.1 pp)	86.3%	86.4%	77.2% (-4.8 pp)	80.1%	75.3%
MDC 16 (Surgical): Blood/Immunological	58.6% (12.4 pp)	56.3% (2.1 pp)	55.2%	57.2%	60.8% (9.1 pp)	58.5%	67.6%

STABLE 30-DAY READMISSION RATES WITH PERSISTENT GRADIENTS BY AGE, COMORBIDITY, AND ADMISSION TYPE

Table 4 and Figure 6 show that 30-day readmission rates remained broadly stable over the study period. Among all admissions combined, the readmission rate decreased marginally from 2.0% in 2008 to 1.8% in 2022. The trend was similar in both observation periods (2008-2014 and 2016-2022), with only minor year-to-year variation.

A clear gradient by age and comorbidity was observed readmission rates were higher among older age categories and patients with a higher comorbidity burden. In 2022, rates ranged from 1.3% among adults aged 16-60 years to 4.2% among those aged 85 years and over. Differences by comorbidity

burden were even more pronounced. Patients without comorbidities had a readmission rate of 1.3%, compared with 4.9% in those with three or more Elixhauser comorbidities. These age and morbidity patterns were consistent across both time periods

When disaggregated by admission type, day surgery admissions showed consistently lower readmission rates, on average around 1.2% throughout the study period. In contrast, inpatient admissions displayed substantially higher and more heterogeneous rates, averaging about 3.0% across the full period. The lower rates for day surgery relative to inpatient care were consistent across age groups, comorbidity categories, and MDCs, potentially capturing unmeasured differences in patient morbidity for patients admitted to day surgery. For both day surgery and inpatient care, rates remained stable over time and showed age and morbidity related gradients. Moreover, while in inpatient care readmission rates have increased in the top age groups, this is not the case in day surgery.

Substantial variation was also observed across MDCs. Readmission rates remained below 2% for MDC 01 (Nervous System), MDC 02 (Eye), MDC 03 (Ear, Nose and Throat), MDC 08 (Musculoskeletal System), MDC 09 (Skin and Breast), MDC 13 (Female Reproductive System), and MDC 14 (Pregnancy and Birth). In contrast, higher readmission rates were recorded for MDC 04 (Respiratory System), MDC 11 (Kidney and Urinary Tract), and MDC 12 (Male Reproductive System), consistently above 4 % across the full study period. In day surgery admissions, the largest increase in readmission rates was observed for MDC 04 (Respiratory System), whereas for inpatient care, the most pronounced increase occurred in MDC 12 (Male Reproductive System). Decreases over time were observed for MDC 01 (Nervous System), MDC 02 (Eye), MDC 09 (Skin and Breast), and MDC 14 (Pregnancy and Birth).

Table 4 – Evolution of readmission rate in the study population [Rate (difference end rate – start rate)]

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
All admissions							
<i>All admissions</i>	1.9% (-0.2 pp)	1.8% (-0.2 pp)	2.0%	1.8%	1.9% (-0.1 pp)	2.0%	1.8%
Age							
<i>Age group 0-15</i>	1.8% (0.4 pp)	1.6% (-0.0 pp)	1.7%	1.7%	1.9% (0.2 pp)	1.9%	2.1%
<i>Age group 16-45</i>	1.4% (-0.3 pp)	1.4% (-0.3 pp)	1.6%	1.4%	1.5% (-0.2 pp)	1.5%	1.3%
<i>Age group 46-60</i>	1.4% (-0.3 pp)	1.4% (-0.2 pp)	1.6%	1.4%	1.4% (-0.2 pp)	1.5%	1.3%
<i>Age group 61-75</i>	2.0% (-0.4 pp)	2.0% (-0.2 pp)	2.2%	2.0%	2.0% (-0.2 pp)	2.1%	1.9%
<i>Age group 76-85</i>	2.9% (-0.3 pp)	2.9% (-0.3 pp)	3.1%	2.8%	2.9% (-0.2 pp)	2.9%	2.7%
<i>Age group over 85</i>	4.3% (-0.2 pp)	4.2% (-0.3 pp)	4.4%	4.1%	4.4% (-0.3 pp)	4.5%	4.2%
Elixhauser							
<i>No comorbidities</i>	1.4% (-0.2 pp)	1.4% (-0.2 pp)	1.5%	1.3%	1.4% (-0.1 pp)	1.4%	1.3%
<i>1 comorbidity</i>	2.6% (-0.4 pp)	2.7% (-0.3 pp)	2.9%	2.6%	2.6% (-0.3 pp)	2.8%	2.4%
<i>2 comorbidities</i>	3.6% (-0.5 pp)	3.7% (-0.3 pp)	3.7%	3.5%	3.5% (-0.5 pp)	3.7%	3.2%
<i>3 or more comorbidities</i>	5.4% (-0.5 pp)	5.4% (-0.3 pp)	5.5%	5.1%	5.4% (-0.7 pp)	5.7%	4.9%
MDCs							
<i>MDC 01 (Surgical): Nervous System</i>	0.9% (-0.3 pp)	0.9% (-0.2 pp)	1.1%	0.8%	0.9% (-0.1 pp)	0.9%	0.8%
<i>MDC 02 (Surgical): Eye</i>	1.3% (-0.6 pp)	1.5% (-0.3 pp)	1.6%	1.3%	1.2% (-0.3 pp)	1.3%	1.1%
<i>MDC 03 (Surgical): ENT</i>	1.6% (0.1 pp)	1.5% (-0.1 pp)	1.7%	1.5%	1.7% (-0.0 pp)	1.7%	1.7%
<i>MDC 04 (Surgical): Respiratory</i>	5.5% (0.3 pp)	5.6% (1.2 pp)	4.9%	6.1%	5.5% (-0.1 pp)	5.3%	5.1%
<i>MDC 05 (Surgical): Circulatory</i>	3.1% (-0.5 pp)	3.0% (-0.3 pp)	3.3%	3.0%	3.1% (-0.5 pp)	3.3%	2.8%
<i>MDC 06 (Surgical): Digestive</i>	3.0% (-0.3 pp)	2.9% (-0.1 pp)	3.0%	3.0%	3.0% (-0.3 pp)	3.0%	2.7%

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
<i>MDC 07 (Surgical): Hepatobiliary</i>	3.4% (0.2 pp)	3.1% (-0.1 pp)	3.3%	3.3%	3.6% (-0.0 pp)	3.6%	3.5%
<i>MDC 08 (Surgical): Musculoskeletal</i>	1.1% (-0.3 pp)	1.1% (-0.2 pp)	1.3%	1.1%	1.1% (-0.1 pp)	1.2%	1.0%
<i>MDC 09 (Surgical): Skin/Breast</i>	1.7% (-0.7 pp)	1.8% (-0.3 pp)	2.0%	1.7%	1.6% (-0.4 pp)	1.7%	1.3%
<i>MDC 11 (Surgical): Kidney/Urinary</i>	5.3% (-0.3 pp)	5.3% (-0.1 pp)	5.4%	5.4%	5.3% (-0.3 pp)	5.4%	5.1%
<i>MDC 12 (Surgical): Male Reproductive</i>	4.2% (1.0 pp)	3.9% (0.5 pp)	3.6%	4.1%	4.6% (0.1 pp)	4.5%	4.6%
<i>MDC 13 (Surgical): Female Reproductive</i>	1.7% (-0.3 pp)	1.7% (-0.2 pp)	1.8%	1.7%	1.7% (-0.3 pp)	1.8%	1.5%
<i>MDC 14 (Surgical): Pregnancy/birth</i>	1.5% (-0.5 pp)	1.5% (-0.5 pp)	1.8%	1.4%	1.5% (-0.0 pp)	1.4%	1.3%
<i>MDC 16 (Surgical): Blood/Immunological</i>	3.1% (0.2 pp)	3.0% (0.7 pp)	2.7%	3.4%	3.2% (-0.3 pp)	3.2%	2.9%
Day surgery admissions							
All admissions	1.2% (-0.1 pp)	1.1% (-0.2 pp)	1.3%	1.1%	1.2% (-0.0 pp)	1.2%	1.2%
Age							
<i>Age group 0-15</i>	1.6% (0.4 pp)	1.5% (-0.0 pp)	1.5%	1.5%	1.8% (0.2 pp)	1.7%	1.9%
<i>Age group 16-45</i>	0.9% (-0.1 pp)	0.9% (-0.2 pp)	1.1%	0.8%	1.0% (-0.0 pp)	1.0%	1.0%
<i>Age group 46-60</i>	0.8% (-0.1 pp)	0.8% (-0.2 pp)	0.9%	0.7%	0.8% (-0.0 pp)	0.8%	0.8%
<i>Age group 61-75</i>	1.1% (-0.2 pp)	1.1% (-0.2 pp)	1.3%	1.0%	1.1% (-0.1 pp)	1.1%	1.0%
<i>Age group 76-85</i>	1.7% (-0.3 pp)	1.7% (-0.3 pp)	1.9%	1.6%	1.7% (-0.1 pp)	1.7%	1.6%
<i>Age group over 85</i>	2.8% (-0.4 pp)	2.8% (-0.5 pp)	3.1%	2.6%	2.9% (-0.3 pp)	3.0%	2.7%
Elixhauser							
<i>No comorbidities</i>	1.1% (-0.1 pp)	1.1% (-0.2 pp)	1.2%	1.0%	1.1% (-0.1 pp)	1.1%	1.1%
<i>1 comorbidity</i>	1.6% (0.0 pp)	1.5% (-0.4 pp)	1.7%	1.3%	1.7% (0.1 pp)	1.6%	1.7%
<i>2 comorbidities</i>	1.9% (-0.4 pp)	1.9% (-0.4 pp)	2.1%	1.7%	1.9% (-0.2 pp)	1.9%	1.7%
<i>3 or more comorbidities</i>	3.3% (-0.9 pp)	3.2% (-1.0 pp)	3.7%	2.7%	3.3% (-0.7 pp)	3.5%	2.8%
MDCs							
<i>MDC 01 (Surgical): Nervous System</i>	0.7% (-0.2 pp)	0.7% (-0.2 pp)	0.8%	0.6%	0.7% (-0.0 pp)	0.7%	0.6%
<i>MDC 02 (Surgical): Eye</i>	1.3% (-0.5 pp)	1.4% (-0.3 pp)	1.6%	1.2%	1.2% (-0.2 pp)	1.3%	1.1%
<i>MDC 03 (Surgical): ENT</i>	1.4% (0.2 pp)	1.3% (-0.1 pp)	1.4%	1.3%	1.5% (0.0 pp)	1.5%	1.5%
<i>MDC 04 (Surgical): Respiratory</i>	4.6% (1.5 pp)	5.2% (3.6 pp)	2.7%	6.4%	4.2% (0.6 pp)	3.7%	4.3%
<i>MDC 05 (Surgical): Circulatory</i>	1.1% (0.1 pp)	0.9% (-0.2 pp)	1.1%	0.9%	1.2% (0.1 pp)	1.1%	1.2%
<i>MDC 06 (Surgical): Digestive</i>	1.6% (-0.4 pp)	1.5% (-0.2 pp)	1.8%	1.6%	1.6% (-0.2 pp)	1.7%	1.5%
<i>MDC 07 (Surgical): Hepatobiliary</i>	3.3% (-0.1 pp)	3.1% (0.1 pp)	3.3%	3.4%	3.4% (-0.3 pp)	3.5%	3.2%
<i>MDC 08 (Surgical): Musculoskeletal</i>	0.7% (-0.2 pp)	0.7% (-0.2 pp)	0.9%	0.7%	0.7% (-0.1 pp)	0.7%	0.7%
<i>MDC 09 (Surgical): Skin/Breast</i>	1.0% (-0.4 pp)	1.0% (-0.4 pp)	1.3%	0.9%	1.0% (-0.1 pp)	1.0%	0.9%
<i>MDC 11 (Surgical): Kidney/Urinary</i>	3.8% (0.1 pp)	3.6% (-0.7 pp)	3.8%	3.1%	3.9% (-0.3 pp)	4.2%	3.9%
<i>MDC 12 (Surgical): Male Reproductive</i>	1.3% (0.3 pp)	1.2% (-0.0 pp)	1.1%	1.1%	1.3% (0.1 pp)	1.3%	1.4%
<i>MDC 13 (Surgical): Female Reproductive</i>	0.9% (-0.3 pp)	1.0% (-0.1 pp)	1.1%	1.0%	0.9% (-0.1 pp)	0.9%	0.8%
<i>MDC 14 (Surgical): Pregnancy/birth</i>	1.2% (-0.4 pp)	1.2% (-0.3 pp)	1.5%	1.2%	1.2% (-0.1 pp)	1.2%	1.1%

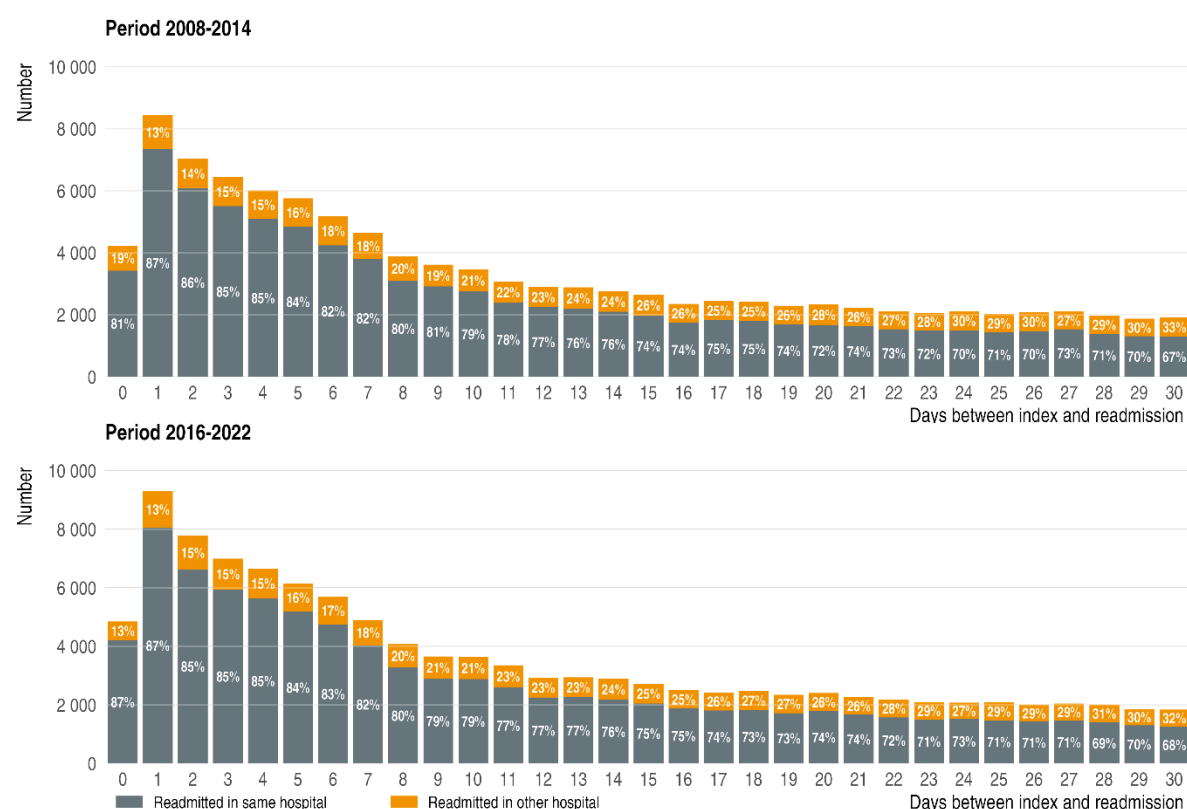
	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
<i>MDC 16 (Surgical): Blood/Immunological</i>	2.7% (0.3 pp)	2.6% (1.1 pp)	2.5%	3.5%	2.7% (-0.3 pp)	3.0%	2.7%
Inpatient admissions							
All admissions	3.0% (0.0 pp)	2.9% (-0.0 pp)	3.0%	2.9%	3.1% (-0.2 pp)	3.2%	3.0%
Age							
<i>Age group 0-15</i>	2.8% (0.5 pp)	2.6% (0.0 pp)	2.7%	2.7%	2.9% (0.6 pp)	2.7%	3.3%
<i>Age group 16-45</i>	2.2% (-0.4 pp)	2.1% (-0.2 pp)	2.4%	2.2%	2.3% (-0.3 pp)	2.3%	2.0%
<i>Age group 46-60</i>	2.3% (-0.3 pp)	2.2% (-0.1 pp)	2.4%	2.3%	2.3% (-0.3 pp)	2.4%	2.1%
<i>Age group 61-75</i>	3.2% (0.0 pp)	3.1% (-0.0 pp)	3.2%	3.2%	3.4% (-0.2 pp)	3.5%	3.3%
<i>Age group 76-85</i>	5.1% (0.3 pp)	4.9% (0.1 pp)	4.8%	4.9%	5.3% (-0.1 pp)	5.2%	5.1%
<i>Age group over 85</i>	6.9% (0.5 pp)	6.5% (0.3 pp)	6.4%	6.8%	7.2% (-0.2 pp)	7.1%	6.9%
Elixhauser							
<i>No comorbidities</i>	2.1% (-0.1 pp)	2.1% (-0.1 pp)	2.2%	2.1%	2.2% (-0.1 pp)	2.2%	2.1%
<i>1 comorbidity</i>	3.2% (-0.5 pp)	3.2% (-0.3 pp)	3.5%	3.1%	3.2% (-0.4 pp)	3.3%	2.9%
<i>2 comorbidities</i>	4.1% (-0.5 pp)	4.2% (-0.3 pp)	4.3%	4.0%	4.0% (-0.5 pp)	4.3%	3.7%
<i>3 or more comorbidities</i>	5.8% (-0.3 pp)	5.8% (-0.3 pp)	5.8%	5.5%	5.8% (-0.6 pp)	6.0%	5.5%
MDCs							
<i>MDC 01 (Surgical): Nervous System</i>	2.4% (-0.9 pp)	2.9% (0.2 pp)	2.7%	2.9%	2.1% (-0.5 pp)	2.2%	1.8%
<i>MDC 02 (Surgical): Eye</i>	2.2% (-0.8 pp)	2.4% (-0.3 pp)	2.5%	2.2%	1.8% (-0.3 pp)	2.0%	1.7%
<i>MDC 03 (Surgical): ENT</i>	2.5% (0.1 pp)	2.3% (0.0 pp)	2.5%	2.5%	2.6% (-0.1 pp)	2.6%	2.5%
<i>MDC 04 (Surgical): Respiratory</i>	5.7% (0.2 pp)	5.6% (0.9 pp)	5.1%	6.0%	5.7% (-0.2 pp)	5.5%	5.3%
<i>MDC 05 (Surgical): Circulatory</i>	4.2% (-0.5 pp)	4.2% (-0.3 pp)	4.5%	4.2%	4.2% (-0.7 pp)	4.6%	3.9%
<i>MDC 06 (Surgical): Digestive</i>	3.8% (0.4 pp)	3.5% (0.2 pp)	3.5%	3.7%	4.1% (0.0 pp)	3.9%	3.9%
<i>MDC 07 (Surgical): Hepatobiliary</i>	3.4% (0.3 pp)	3.1% (-0.1 pp)	3.3%	3.3%	3.6% (0.1 pp)	3.6%	3.6%
<i>MDC 08 (Surgical): Musculoskeletal</i>	1.6% (-0.3 pp)	1.6% (-0.3 pp)	1.8%	1.5%	1.6% (-0.2 pp)	1.7%	1.5%
<i>MDC 09 (Surgical): Skin/Breast</i>	2.2% (-0.6 pp)	2.2% (-0.2 pp)	2.4%	2.2%	2.1% (-0.6 pp)	2.3%	1.7%
<i>MDC 11 (Surgical): Kidney/Urinary</i>	6.1% (0.4 pp)	5.8% (0.3 pp)	5.9%	6.2%	6.4% (0.1 pp)	6.2%	6.3%
<i>MDC 12 (Surgical): Male Reproductive</i>	6.2% (1.5 pp)	5.5% (1.2 pp)	5.1%	6.2%	6.8% (-0.2 pp)	6.8%	6.6%
<i>MDC 13 (Surgical): Female Reproductive</i>	2.3% (-0.1 pp)	2.2% (-0.1 pp)	2.4%	2.3%	2.5% (-0.3 pp)	2.6%	2.3%
<i>MDC 14 (Surgical): Pregnancy/birth</i>	2.5% (-1.7 pp)	2.9% (-1.2 pp)	3.8%	2.5%	2.2% (0.0 pp)	2.0%	2.0%
<i>MDC 16 (Surgical): Blood/Immunological</i>	3.8% (0.3 pp)	3.6% (0.2 pp)	3.0%	3.2%	4.0% (-0.1 pp)	3.4%	3.3%

ONE IN FIVE READMISSIONS OCCUR IN ANOTHER HOSPITAL, TYPICALLY AFTER 11 DAYS

Table 5 presents descriptive information on readmission stays across the study period and Figure 7 presents the distribution of unplanned readmissions per day after discharge. The vast majority of readmissions (95.4%) were inpatient stays, with the share rising sharply between 2008 and 2009 (not shown) and stabilising above 95% thereafter. The low value in 2008 (86.4%) is an outlier, likely due to coding issues regarding the planned/unplanned status of day-care treatments in that year.

Roughly four in five readmissions (79%) occurred in the same hospital as the index admission, meaning that more than 20% took place in a different hospital – a non-negligible share that may reflect, among other factors, patient choice, referral patterns, or capacity constraints. This percentage appears to increase with time after discharge and fluctuates between 13% on day 1 after discharge and 33% on day 30 (period 1; comparable results in period 2). The mean number of days between discharge and readmission declined slightly from 11.3 to 10.6 days. Except on the day of discharge, the number of readmissions per day within the 30-day post-discharge window decreases progressively. While the average length of stay (LoS) during readmissions shortened by about one day (from 7.3 to 6.3 days). This reduction is consistent with the overall decrease in LoS observed over the study period (see Chapter 2).

Figure 7 – Unplanned readmission per day after discharge



Finally, about 23% of readmissions fell under the same MDC as the index stay, a share that remained stable over time. However, readmissions classified under a different MDC do not necessarily indicate unrelated conditions, as they may still be linked to complications or the continuation of care following the initial treatment.

30-DAY MORTALITY WAS LOW

As shown in Figure 6, 30-day mortality was low throughout the study period, with 466-565 deaths per year between 2016 and 2022, corresponding to less than 0.05% of all admissions. Mortality rates were slightly higher among inpatient admissions compared with day surgery admissions, but remained very low in both groups.

Given these minimal rates, no further analysis of 30-day mortality by patient or admission characteristics was performed, and the trend was not risk-adjusted (see also section 1.2.5.1). Consequently, constructing a composite indicator combining readmission and mortality was considered redundant in the subsequent analyses.

Table 5 – Descriptives of readmissions [Rate or days (difference end – start)]

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
<i>Share inpatient admissions</i>	95.4% (10.4 pp)	94.0% (9.8 pp)	86.4%	96.2%	96.7% (0.5 pp)	96.2%	96.7%
<i>Share admitted in same hospital as index</i>	79.3% (1.5 pp)	79.1% (2.3 pp)	77.4%	79.7%	79.5% (-0.8 pp)	79.7%	79.0%
<i>Days between index and readmission</i>	11.0 (-0.7)	11.1 (-0.4)	11.3	10.9	10.8 (-0.3)	10.9	10.6
<i>Acute length of stay (in days)</i>	7.2 (-1.0)	7.5 (-0.3)	7.3	7.0	6.9 (-0.8)	7.2	6.3
<i>Share with same MDC as index</i>	22.9% (1.3 pp)	22.5% (0.6 pp)	21.9%	22.5%	23.3% (-0.1 pp)	23.4%	23.2%

1.3.2.2 Risk-adjusted outcomes

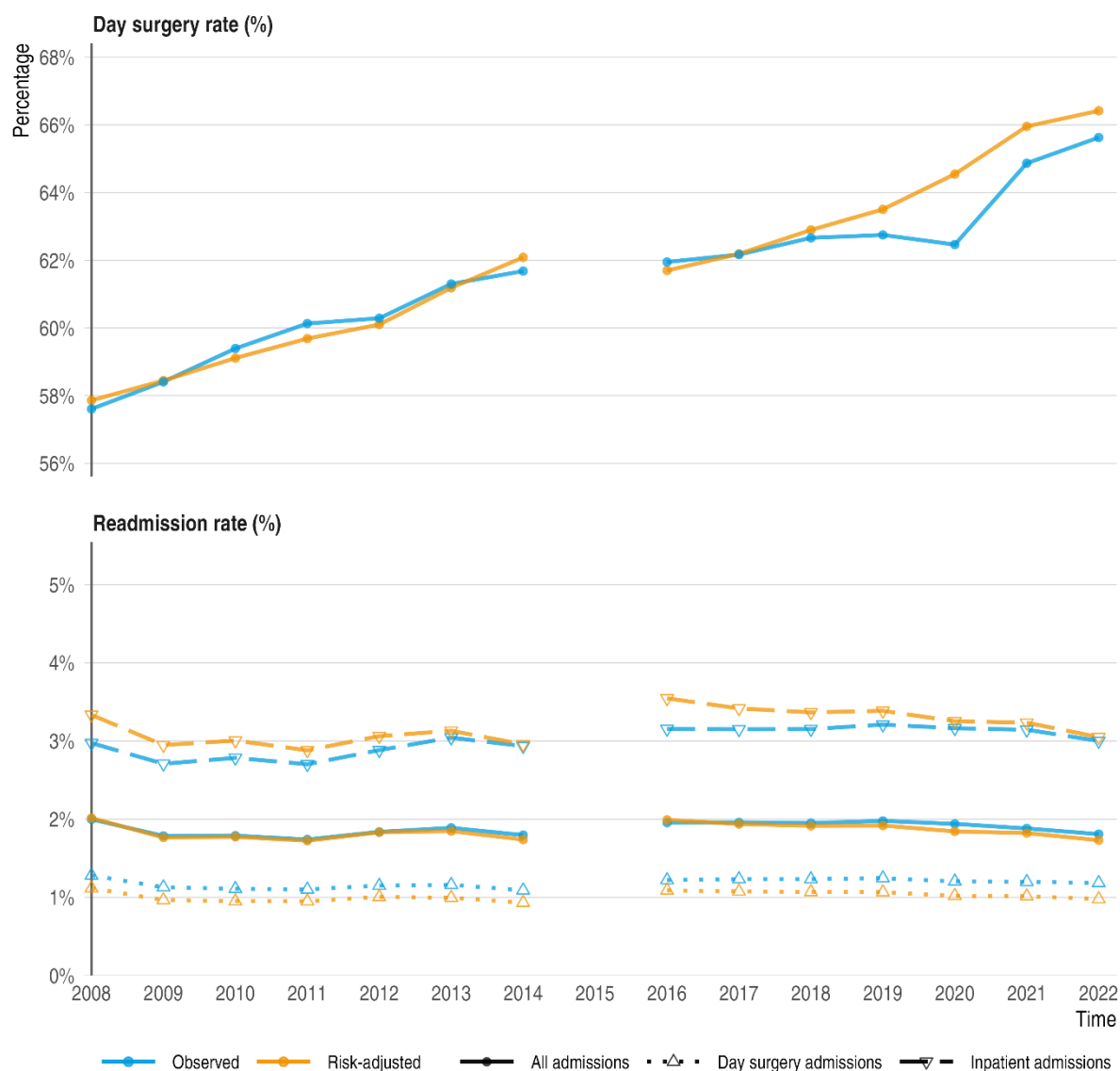
ESTIMATION MODELS

The C-statistics of the day surgery logistic regression models were high, ranging from 0.68 to 0.95, with a mean value of 0.81 (see Supplement to Chapter 1). The logistic models used to estimate the likelihood of readmission showed lower values, ranging from 0.61 to 0.73, with a mean value of 0.66, indicating only moderate discriminatory power (Supplement to Chapter 1).

In Supplement to Chapter 1 also information is provided on the most influential covariates included in the estimation of these models. Age group, Elixhauser comorbidity burden, DRG classification, and previous emergency contact (within 180 days prior to admission) were the explanatory variables accounting for the greatest proportion of variability in the outcomes.



Figure 8 – Evolution of observed and risk-adjusted day surgery and readmission rates



DAY SURGERY ADJUSTED UPWARDS FROM 2019 ONWARDS

Risk adjustment had little effect on the overall trend but led to a slight increase in the aggregate day surgery rate - from 61.6% to 61.9% - and in the estimated increase over time (+8.6 percentage points compared with +8.0 percentage points before adjustment). As shown in Figure 8 and can be seen in more detail when comparing Table 3 and Table 6, most of this upward adjustment occurred during 2016–2022, particularly from 2019 onwards. This suggests that, given the evolution in case mix, patient and admission characteristics – most notably the increasing age and comorbidity burden over time – fewer day surgery cases would have been expected. In other words, a larger proportion of day surgery procedures was performed among more complex patient groups in recent years.

Adjusted rates were marginally higher across most age groups, with more pronounced increases, both in absolute level and change over time, observed in the youngest and oldest groups. Regarding comorbidity, risk adjustment revealed a higher increase in day surgery rates over time among patients without comorbidities, while overall levels were revised upwards for those with comorbidities.

Across Major Diagnostic Categories (MDCs), several notable changes were observed following risk adjustment. The growth in day surgery rates became more pronounced for MDC 05 (Circulatory System), MDC 12 (Male Reproductive System), and MDC 14 (Pregnancy and Birth), each showing both an upward adjustment in overall level and in the rate of increase over time. A more modest upward adjustment of the increase in day surgery rates was also observed for MDC 01 (Nervous System), MDC 06 (Digestive System), MDC 09 (Skin and Breast), and MDC 13 (Female Reproductive System). Conversely, a downward adjustment was noted for MDC 11 (Kidney and Urinary Tract) and for the two large-volume categories MDC 02 (Eye) and MDC 03 (Ear, Nose and Throat).

Table 6 – Evolution of risk-adjusted day surgery rate in the study population [Rate (difference end rate – start rate)]

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
All admissions	61.9% (8.6 pp)	59.8% (4.2 pp)	57.9%	62.1%	63.9% (4.7 pp)	61.7%	66.4%
Age							
Age group 0-15	87.5% (3.9 pp)	86.8% (3.1 pp)	85.1%	88.2%	88.3% (1.3 pp)	87.7%	89.0%
Age group 16-45	61.1% (7.6 pp)	59.8% (5.4 pp)	57.5%	62.9%	62.6% (4.8 pp)	60.2%	65.0%
Age group 46-60	57.4% (11.4 pp)	54.5% (5.1 pp)	52.2%	57.4%	60.3% (6.1 pp)	57.6%	63.7%
Age group 61-75	56.9% (11.4 pp)	53.2% (4.2 pp)	51.4%	55.6%	59.9% (5.4 pp)	57.3%	62.7%
Age group 76-85	64.1% (8.3 pp)	61.8% (3.4 pp)	60.3%	63.7%	66.3% (4.7 pp)	63.9%	68.6%
Age group over 85	64.5% (6.7 pp)	63.1% (3.4 pp)	61.5%	64.9%	65.6% (5.3 pp)	62.9%	68.2%
Elixhauser							
No comorbidities	72.6% (12.2 pp)	69.1% (5.2 pp)	67.0%	72.2%	76.2% (6.0 pp)	73.2%	79.2%
1 comorbidity	33.4% (5.5 pp)	32.5% (1.5 pp)	32.2%	33.8%	34.2% (6.6 pp)	31.2%	37.7%
2 comorbidities	24.8% (3.4 pp)	24.9% (1.8 pp)	24.5%	26.3%	24.8% (5.9 pp)	22.0%	27.9%
3 or more comorbidities	16.1% (3.2 pp)	15.7% (0.6 pp)	15.7%	16.3%	16.3% (4.8 pp)	14.1%	19.0%
MDCs							
MDC 01 (Surgical): Nervous System	88.4% (1.4 pp)	88.4% (0.3 pp)	88.5%	88.8%	88.3% (3.7 pp)	86.2%	89.9%
MDC 02 (Surgical): Eye	92.7% (3.5 pp)	91.3% (1.0 pp)	91.1%	92.1%	94.0% (1.2 pp)	93.4%	94.6%
MDC 03 (Surgical): ENT	78.4% (6.8 pp)	76.7% (3.6 pp)	74.7%	78.3%	80.2% (3.0 pp)	78.4%	81.5%
MDC 04 (Surgical): Respiratory	13.3% (6.0 pp)	10.5% (-0.4 pp)	11.1%	10.7%	16.1% (3.4 pp)	13.7%	17.1%
MDC 05 (Surgical): Circulatory	38.3% (10.3 pp)	36.8% (5.5 pp)	34.6%	40.1%	39.6% (9.5 pp)	35.4%	44.9%
MDC 06 (Surgical): Digestive	38.7% (23.5 pp)	31.9% (9.8 pp)	27.3%	37.0%	44.7% (11.7 pp)	39.1%	50.8%
MDC 07 (Surgical): Hepatobiliary	12.1% (17.7 pp)	6.0% (4.1 pp)	4.0%	8.1%	17.0% (9.9 pp)	11.8%	21.7%
MDC 08 (Surgical): Musculoskeletal	56.3% (2.8 pp)	56.0% (2.3 pp)	55.7%	58.1%	56.7% (3.4 pp)	55.2%	58.6%
MDC 09 (Surgical): Skin/Breast	42.6% (14.2 pp)	37.2% (3.7 pp)	35.9%	39.6%	47.8% (5.3 pp)	44.8%	50.1%
MDC 11 (Surgical): Kidney/Urinary	35.1% (23.5 pp)	23.9% (3.4 pp)	22.4%	25.8%	43.3% (6.4 pp)	39.5%	45.9%
MDC 12 (Surgical): Male Reproductive	41.5% (11.3 pp)	38.9% (4.7 pp)	36.5%	41.3%	44.0% (6.2 pp)	41.6%	47.8%
MDC 13 (Surgical): Female Reproductive	47.5% (13.6 pp)	44.8% (6.9 pp)	41.4%	48.3%	50.8% (7.2 pp)	47.8%	55.0%
MDC 14 (Surgical): Pregnancy/birth	83.4% (-6.4 pp)	86.5% (0.8 pp)	86.4%	87.2%	79.4% (0.5 pp)	79.5%	80.0%
MDC 16 (Surgical): Blood/Immunological	59.1% (12.8 pp)	56.6% (3.4 pp)	54.8%	58.2%	61.3% (10.5 pp)	57.2%	67.7%



RISK ADJUSTED READMISSION RATES HAVE DECLINED SLIGHTLY As shown in Table 7 and Figure 8, risk adjustment had little effect on the overall trend in readmission rates, which remained broadly stable or slightly declined over time. For all admissions combined, the risk-adjusted rate fell from 2.0% in 2008 to 1.7% in 2022, compared with 2.0% to 1.8% in the unadjusted series. Despite the decreasing trend in the two study periods, it can be observed that the starting point in period 2 (both for risk-adjusted as unadjusted readmission rates) is higher compared to the final year of period 1. One possible explanation is the transition from ICD-9 to ICD-10 coding (see section 1.2), which may have altered DRG classification and thus the casemix of the study population, potentially affecting comparability between the two periods.

By age, adjusted rates were similar to or slightly lower than crude values, with larger declines among older patients (-0.5 percentage points for those aged 76-85 years and -0.7 percentage points for those aged 85 years and over). By comorbidity, declines became more pronounced with increasing morbidity (-0.8 pp compared to -0.5 pp unadjusted for patients with two and three or more comorbidities). This suggests that the apparent stability of readmission rates reflects two opposing effects:

- (1) an upward influence from the growing share of higher-risk patients with higher readmission rates,
- (2) a downward influence from falling readmission rates within these higher-risk groups.

Across MDCs, most categories displayed comparable or greater declines once adjusted, particularly in the following MDCs: MDC 05 (Circulatory System), MDC 06 (Digestive System), and MDC 11 (Kidney and Urinary Tract). Increases observed in some crude series, such as MDC 04 (Respiratory System) and MDC 12 (Male Reproductive System), were attenuated or reversed after adjustment.

Readmission risks remained higher for inpatient care than for day surgery admissions, and risk adjustment further widened this difference, in a way that risk-adjusted trends were above unadjusted trends for inpatient care and below for day care. This may be partly due to unmeasured morbidity differences, that are not entirely captured in the model that does not take up the hospital setting as risk factor. An alternative (partial) explanation is that quality of care is lower among late adopters of day surgery. For day surgery cases, adjusted levels were slightly lower (1.0% vs 1.2%, overall rate) with a similar downward trend, whereas inpatient care showed higher adjusted levels (3.2% vs 3.0%, overall rate) but a clearer decline over time (-0.3 pp risk-adjusted compared 0.0 pp unadjusted). The stronger downward trend in the risk-adjusted series for inpatient care suggest that, after accounting for measured patient characteristics, readmission rates declined more than would be expected based on the rising age and comorbidity burden of the patient population. Among inpatients, the upward revision was concentrated in the youngest age groups and among patients without comorbidities. Notably, upward revisions were also observed for MDC 01 (Nervous System), MDC 02 (Eye), MDC 04 (Respiratory System), MDC 13 (Female Reproductive System), and MDC 14 (Pregnancy and Birth).

Table 7 – Evolution of risk-adjusted readmission rate in the study population [Rate (difference end rate – start rate)]

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
All admissions							
<i>All admissions</i>	1.8% (-0.3 pp)	1.8% (-0.3 pp)	2.0%	1.7%	1.9% (-0.3 pp)	2.0%	1.7%
Age							
<i>Age group 0-15</i>	1.8% (0.3 pp)	1.6% (-0.0 pp)	1.7%	1.7%	1.9% (0.2 pp)	1.8%	2.0%
<i>Age group 16-45</i>	1.4% (-0.4 pp)	1.4% (-0.3 pp)	1.7%	1.3%	1.5% (-0.2 pp)	1.5%	1.3%
<i>Age group 46-60</i>	1.4% (-0.4 pp)	1.4% (-0.2 pp)	1.6%	1.4%	1.4% (-0.3 pp)	1.5%	1.2%
<i>Age group 61-75</i>	2.0% (-0.4 pp)	2.0% (-0.3 pp)	2.2%	1.9%	2.0% (-0.4 pp)	2.1%	1.8%
<i>Age group 76-85</i>	2.9% (-0.5 pp)	2.9% (-0.4 pp)	3.1%	2.7%	2.9% (-0.4 pp)	3.0%	2.6%
<i>Age group over 85</i>	4.2% (-0.7 pp)	4.1% (-0.7 pp)	4.6%	3.9%	4.3% (-0.8 pp)	4.8%	3.9%
<i>Elixhauser</i>							

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
<i>No comorbidities</i>	1.4% (-0.3 pp)	1.4% (-0.2 pp)	1.6%	1.3%	1.4% (-0.2 pp)	1.5%	1.3%
<i>1 comorbidity</i>	2.6% (-0.6 pp)	2.6% (-0.5 pp)	2.9%	2.5%	2.6% (-0.4 pp)	2.8%	2.4%
<i>2 comorbidities</i>	3.5% (-0.8 pp)	3.6% (-0.5 pp)	3.8%	3.3%	3.4% (-0.8 pp)	3.8%	3.0%
<i>3 or more comorbidities</i>	5.3% (-0.8 pp)	5.3% (-0.7 pp)	5.6%	4.9%	5.3% (-1.1 pp)	5.8%	4.7%
MDCs							
<i>MDC 01 (Surgical): Nervous System</i>	0.9% (-0.4 pp)	0.9% (-0.2 pp)	1.0%	0.8%	0.8% (-0.2 pp)	0.9%	0.7%
<i>MDC 02 (Surgical): Eye</i>	1.3% (-0.6 pp)	1.5% (-0.4 pp)	1.7%	1.3%	1.2% (-0.3 pp)	1.4%	1.1%
<i>MDC 03 (Surgical): ENT</i>	1.6% (0.1 pp)	1.5% (-0.1 pp)	1.7%	1.6%	1.8% (0.0 pp)	1.7%	1.8%
<i>MDC 04 (Surgical): Respiratory</i>	5.3% (-0.1 pp)	5.4% (0.8 pp)	4.8%	5.6%	5.2% (-0.5 pp)	5.3%	4.8%
<i>MDC 05 (Surgical): Circulatory</i>	3.0% (-0.7 pp)	3.0% (-0.6 pp)	3.3%	2.8%	3.0% (-0.8 pp)	3.4%	2.6%
<i>MDC 06 (Surgical): Digestive</i>	2.9% (-0.5 pp)	2.8% (-0.3 pp)	3.1%	2.8%	2.9% (-0.5 pp)	3.1%	2.6%
<i>MDC 07 (Surgical): Hepatobiliary</i>	3.3% (-0.0 pp)	3.0% (-0.2 pp)	3.3%	3.1%	3.5% (-0.4 pp)	3.7%	3.3%
<i>MDC 08 (Surgical): Musculoskeletal</i>	1.1% (-0.3 pp)	1.1% (-0.3 pp)	1.3%	1.0%	1.1% (-0.2 pp)	1.2%	1.0%
<i>MDC 09 (Surgical): Skin/Breast</i>	1.6% (-0.7 pp)	1.7% (-0.4 pp)	2.0%	1.6%	1.5% (-0.5 pp)	1.8%	1.3%
<i>MDC 11 (Surgical): Kidney/Urinary</i>	5.2% (-0.6 pp)	5.2% (-0.2 pp)	5.5%	5.3%	5.1% (-0.6 pp)	5.5%	4.9%
<i>MDC 12 (Surgical): Male Reproductive</i>	4.0% (0.3 pp)	3.8% (0.3 pp)	3.6%	3.9%	4.3% (-0.6 pp)	4.6%	4.0%
<i>MDC 13 (Surgical): Female Reproductive</i>	1.6% (-0.4 pp)	1.6% (-0.3 pp)	1.8%	1.6%	1.6% (-0.4 pp)	1.8%	1.4%
<i>MDC 14 (Surgical): Pregnancy/birth</i>	1.4% (-0.6 pp)	1.4% (-0.5 pp)	1.8%	1.3%	1.4% (-0.1 pp)	1.4%	1.2%
<i>MDC 16 (Surgical): Blood/Immunological</i>	2.8% (0.1 pp)	2.7% (0.4 pp)	2.5%	2.8%	2.9% (-0.4 pp)	3.0%	2.6%
Day surgery admissions							
All admissions	1.0% (-0.1 pp)	1.0% (-0.2 pp)	1.1%	0.9%	1.0% (-0.1 pp)	1.1%	1.0%
Age							
<i>Age group 0-15</i>	1.5% (0.4 pp)	1.3% (0.0 pp)	1.4%	1.4%	1.7% (0.2 pp)	1.6%	1.8%
<i>Age group 16-45</i>	0.7% (-0.1 pp)	0.7% (-0.2 pp)	0.8%	0.6%	0.7% (-0.1 pp)	0.8%	0.7%
<i>Age group 46-60</i>	0.6% (-0.1 pp)	0.6% (-0.1 pp)	0.7%	0.6%	0.7% (-0.1 pp)	0.7%	0.6%
<i>Age group 61-75</i>	0.9% (-0.3 pp)	1.0% (-0.2 pp)	1.1%	0.9%	0.9% (-0.1 pp)	1.0%	0.8%
<i>Age group 76-85</i>	1.6% (-0.4 pp)	1.7% (-0.4 pp)	1.8%	1.5%	1.6% (-0.3 pp)	1.7%	1.4%
<i>Age group over 85</i>	2.7% (-0.6 pp)	2.7% (-0.6 pp)	3.1%	2.5%	2.8% (-0.6 pp)	3.1%	2.5%
Elixhauser							
<i>No comorbidities</i>	1.0% (-0.1 pp)	0.9% (-0.1 pp)	1.0%	0.9%	1.0% (-0.1 pp)	1.0%	0.9%
<i>1 comorbidity</i>	1.3% (-0.1 pp)	1.2% (-0.3 pp)	1.4%	1.0%	1.3% (-0.1 pp)	1.4%	1.3%
<i>2 comorbidities</i>	1.5% (-0.5 pp)	1.6% (-0.4 pp)	1.8%	1.4%	1.5% (-0.3 pp)	1.6%	1.2%
<i>3 or more comorbidities</i>	3.0% (-1.3 pp)	3.1% (-1.2 pp)	3.7%	2.5%	2.9% (-0.9 pp)	3.3%	2.4%
MDCs							
<i>MDC 01 (Surgical): Nervous System</i>	0.6% (-0.2 pp)	0.6% (-0.2 pp)	0.7%	0.5%	0.6% (-0.1 pp)	0.6%	0.5%
<i>MDC 02 (Surgical): Eye</i>	1.2% (-0.5 pp)	1.3% (-0.3 pp)	1.5%	1.2%	1.1% (-0.3 pp)	1.3%	1.0%
<i>MDC 03 (Surgical): ENT</i>	1.3% (0.2 pp)	1.2% (-0.1 pp)	1.2%	1.2%	1.4% (0.0 pp)	1.4%	1.4%

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
MDC 04 (Surgical): Respiratory	4.4% (1.0 pp)	5.0% (3.2 pp)	2.7%	5.9%	3.9% (0.2 pp)	3.6%	3.8%
MDC 05 (Surgical): Circulatory	0.8% (-0.1 pp)	0.7% (-0.2 pp)	0.8%	0.6%	0.9% (-0.2 pp)	0.9%	0.7%
MDC 06 (Surgical): Digestive	1.2% (-0.4 pp)	1.2% (-0.2 pp)	1.4%	1.2%	1.2% (-0.2 pp)	1.3%	1.0%
MDC 07 (Surgical): Hepatobiliary	3.0% (-0.3 pp)	2.9% (0.1 pp)	3.2%	3.3%	3.0% (-0.1 pp)	3.0%	2.9%
MDC 08 (Surgical): Musculoskeletal	0.6% (-0.2 pp)	0.6% (-0.2 pp)	0.7%	0.6%	0.6% (-0.1 pp)	0.6%	0.5%
MDC 09 (Surgical): Skin/Breast	0.7% (-0.4 pp)	0.7% (-0.3 pp)	0.9%	0.6%	0.7% (-0.1 pp)	0.7%	0.6%
MDC 11 (Surgical): Kidney/Urinary	3.0% (-0.2 pp)	2.9% (-0.6 pp)	3.1%	2.6%	3.1% (-0.6 pp)	3.5%	2.9%
MDC 12 (Surgical): Male Reproductive	1.0% (-0.0 pp)	0.9% (-0.1 pp)	0.9%	0.8%	1.0% (-0.2 pp)	1.1%	0.8%
MDC 13 (Surgical): Female Reproductive	0.6% (-0.3 pp)	0.7% (-0.2 pp)	0.8%	0.6%	0.5% (-0.1 pp)	0.6%	0.5%
MDC 14 (Surgical): Pregnancy/birth	1.1% (-0.5 pp)	1.1% (-0.4 pp)	1.4%	1.1%	1.1% (-0.2 pp)	1.1%	0.9%
MDC 16 (Surgical): Blood/Immunological	2.0% (0.4 pp)	1.8% (0.6 pp)	1.8%	2.4%	2.2% (-0.4 pp)	2.6%	2.2%
Inpatient admissions							
All admissions	3.2% (-0.3 pp)	3.0% (-0.4 pp)	3.3%	3.0%	3.3% (-0.5 pp)	3.5%	3.0%
Age							
Age group 0-15	3.7% (-0.1 pp)	3.7% (-0.3 pp)	4.0%	3.7%	3.7% (0.3 pp)	3.6%	3.9%
Age group 16-45	2.6% (-0.5 pp)	2.5% (-0.5 pp)	2.9%	2.4%	2.8% (-0.4 pp)	2.9%	2.5%
Age group 46-60	2.5% (-0.5 pp)	2.4% (-0.3 pp)	2.7%	2.4%	2.5% (-0.6 pp)	2.7%	2.1%
Age group 61-75	3.3% (-0.3 pp)	3.2% (-0.4 pp)	3.4%	3.0%	3.4% (-0.6 pp)	3.8%	3.1%
Age group 76-85	5.0% (-0.3 pp)	4.9% (-0.5 pp)	5.1%	4.6%	5.2% (-0.6 pp)	5.4%	4.8%
Age group over 85	6.7% (-0.5 pp)	6.3% (-0.7 pp)	6.9%	6.2%	7.0% (-1.1 pp)	7.5%	6.4%
Elixhauser							
No comorbidities	2.5% (-0.3 pp)	2.4% (-0.4 pp)	2.7%	2.4%	2.6% (-0.4 pp)	2.8%	2.4%
1 comorbidity	3.2% (-0.8 pp)	3.2% (-0.6 pp)	3.7%	3.0%	3.2% (-0.6 pp)	3.5%	2.8%
2 comorbidities	4.1% (-0.9 pp)	4.2% (-0.7 pp)	4.4%	3.8%	4.0% (-0.9 pp)	4.5%	3.5%
3 or more comorbidities	5.6% (-0.8 pp)	5.6% (-0.8 pp)	5.9%	5.1%	5.7% (-1.2 pp)	6.3%	5.1%
MDCs							
MDC 01 (Surgical): Nervous System	3.2% (-1.7 pp)	3.9% (-0.2 pp)	3.9%	3.7%	2.7% (-0.9 pp)	3.0%	2.2%
MDC 02 (Surgical): Eye	2.9% (-1.5 pp)	3.4% (-0.5 pp)	3.6%	3.1%	2.3% (-0.6 pp)	2.7%	2.0%
MDC 03 (Surgical): ENT	3.0% (0.1 pp)	2.8% (-0.1 pp)	3.0%	2.9%	3.2% (0.0 pp)	3.1%	3.1%
MDC 04 (Surgical): Respiratory	5.4% (-0.2 pp)	5.4% (0.5 pp)	5.0%	5.5%	5.4% (-0.6 pp)	5.5%	4.9%
MDC 05 (Surgical): Circulatory	4.2% (-1.0 pp)	4.2% (-0.7 pp)	4.7%	4.0%	4.2% (-1.1 pp)	4.8%	3.7%
MDC 06 (Surgical): Digestive	3.9% (0.1 pp)	3.6% (-0.3 pp)	3.7%	3.4%	4.3% (-0.5 pp)	4.4%	3.9%
MDC 07 (Surgical): Hepatobiliary	3.3% (0.0 pp)	3.0% (-0.2 pp)	3.3%	3.1%	3.5% (-0.4 pp)	3.7%	3.3%
MDC 08 (Surgical): Musculoskeletal	1.8% (-0.6 pp)	1.8% (-0.5 pp)	2.1%	1.6%	1.8% (-0.4 pp)	2.0%	1.5%
MDC 09 (Surgical): Skin/Breast	2.4% (-0.8 pp)	2.4% (-0.5 pp)	2.7%	2.2%	2.4% (-0.8 pp)	2.8%	2.0%
MDC 11 (Surgical): Kidney/Urinary	6.3% (0.2 pp)	5.9% (-0.0 pp)	6.2%	6.2%	6.7% (-0.5 pp)	6.9%	6.4%

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
MDC 12 (Surgical): Male Reproductive	6.1% (0.9 pp)	5.5% (0.5 pp)	5.3%	5.9%	6.7% (-1.0 pp)	7.2%	6.2%
MDC 13 (Surgical): Female Reproductive	2.7% (-0.1 pp)	2.5% (-0.3 pp)	2.8%	2.5%	2.9% (-0.6 pp)	3.2%	2.6%
MDC 14 (Surgical): Pregnancy/birth	3.0% (-2.2 pp)	3.5% (-1.9 pp)	4.7%	2.8%	2.7% (0.1 pp)	2.3%	2.4%
MDC 16 (Surgical): Blood/Immunological	3.8% (-0.2 pp)	3.7% (-0.2 pp)	3.3%	3.0%	3.9% (-0.5 pp)	3.6%	3.1%

1.3.3 Association between day surgery rate and readmission rate

INCREASED DAY SURGERY RATES WERE NOT ASSOCIATED WITH DETERIORATIONS IN READMISSION RATES

Figure 9 and Figure 10 present a scatterplot of the relationship between the day surgery rate (y-axis) and the readmission rate (x-axis) for all admissions as well as subsets of inpatient and day surgery admissions. Both unadjusted and risk-adjusted evolutions are shown, with Figure 9 covering 2008-2014 and Figure 10 covering 2016-2022. Each trajectory represents the evolution over time within the respective period. Movements from the bottom right to the upper left indicate simultaneous improvement in both indicators (i.e. higher day surgery rates and lower readmission or adverse event rates). The green area corresponds to this desired direction of change, whereas movements into the red area indicate lower day surgery rates combined with higher readmission rates.

Across both periods, the observed and risk-adjusted trends show that, overall, increases in day surgery rates were not associated with deteriorations in readmission rates. On the contrary, the increase in day surgery was accompanied by small improvements in readmission rates, as reflected by the trajectories shifting away from the red zone towards the green area. While this improvement was not statistically significant in the first period, most effects were statistically significant in the second period. Trends are more favourable after risk adjustment, highlighting the importance of accounting for shifts in patient age, comorbidity burden, and overall case-mix composition across the study period.

For inpatient care, the unadjusted rates do not show a clear improvement in readmission rates over time in response to rising day-surgery rates. However, the risk-adjusted trends reveal a more favourable co-evolution, with a statistically significant association in the second period: a 1-percentage-point increase in day surgery rates was associated with a 0.08-percentage-point reduction in readmission rates. This means that the risk adjustment alters the significance of the association. In fact it could be considered as a positive finding. Despite an increase in day-surgery rates we observe a slight reduction in readmission rates after accounting for differences in patient and admission characteristics.

Finally, years associated with potential underestimation of readmissions (i.e. 2011, 2014, and 2022; see section 1.2.3) are indicated by red-outlined data points in the figures.



Figure 9 – Relationship between day surgery rates and readmission rates (observed and risk-adjusted) in 2008-2014, by admission type

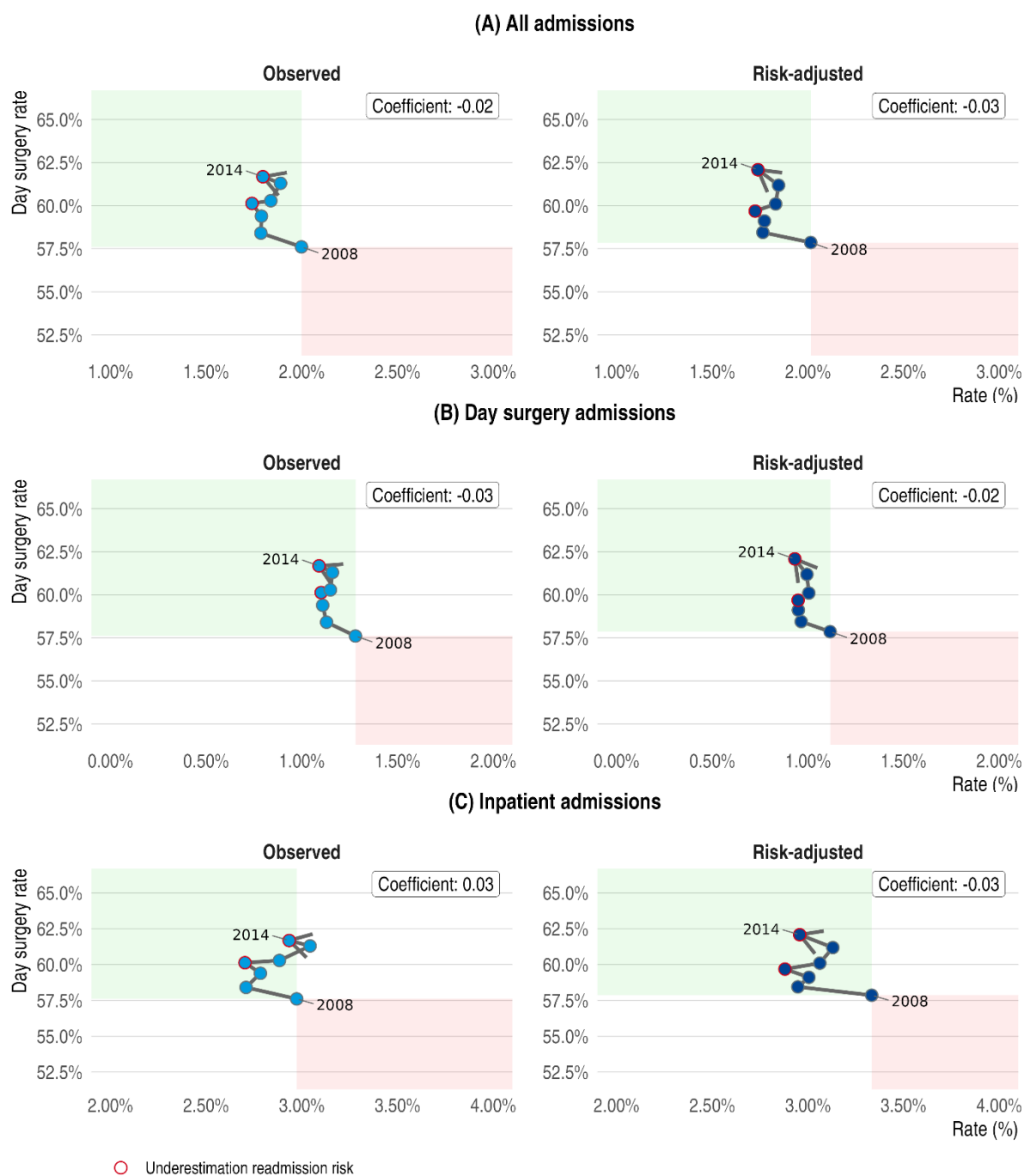
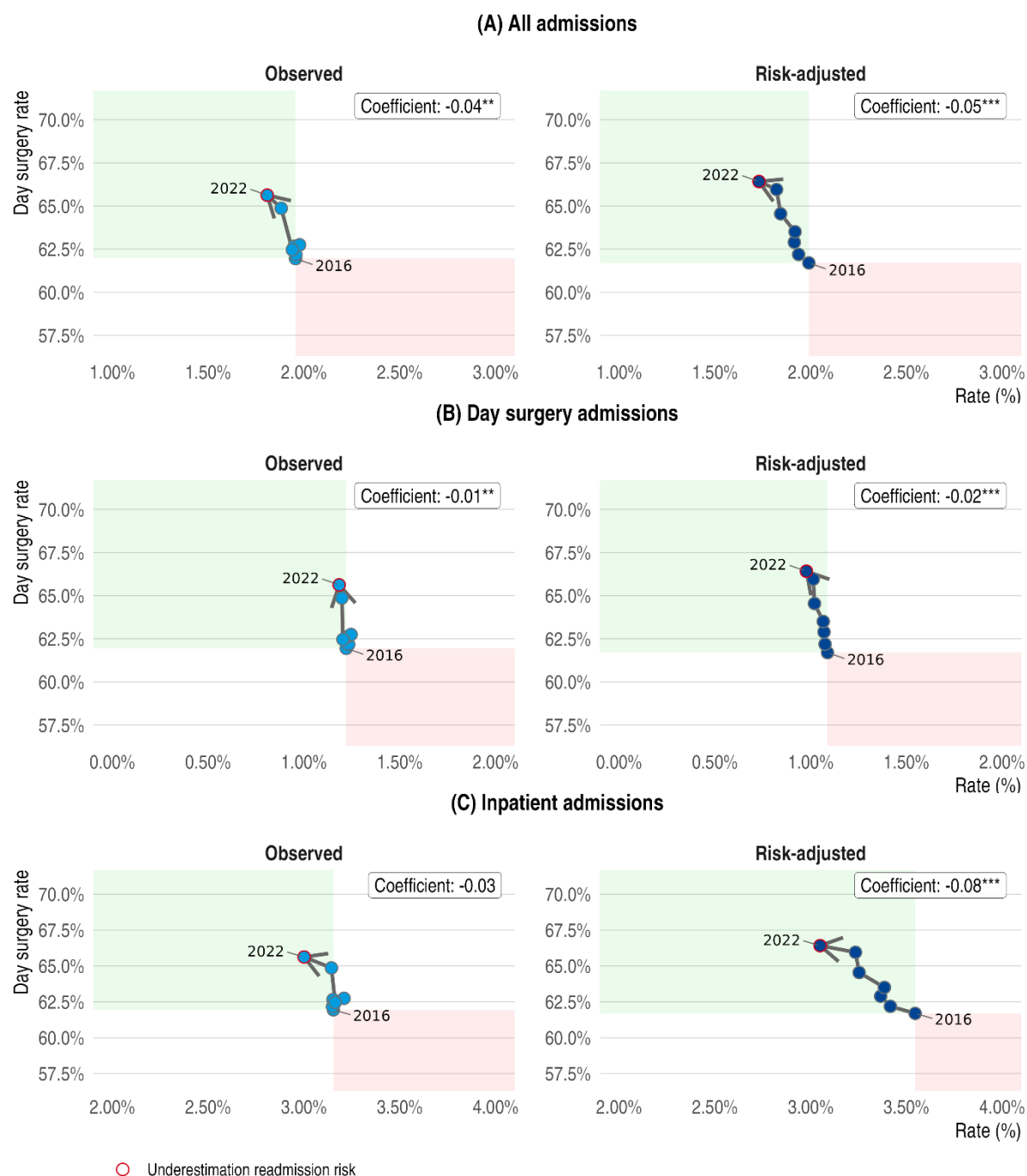


Figure 10 – Relationship between day surgery rates and readmission rates (observed and risk-adjusted) in 2016-2022, by admission type



Note: Significance level: ** = ≤ 0.01 , *** = ≤ 0.001 .

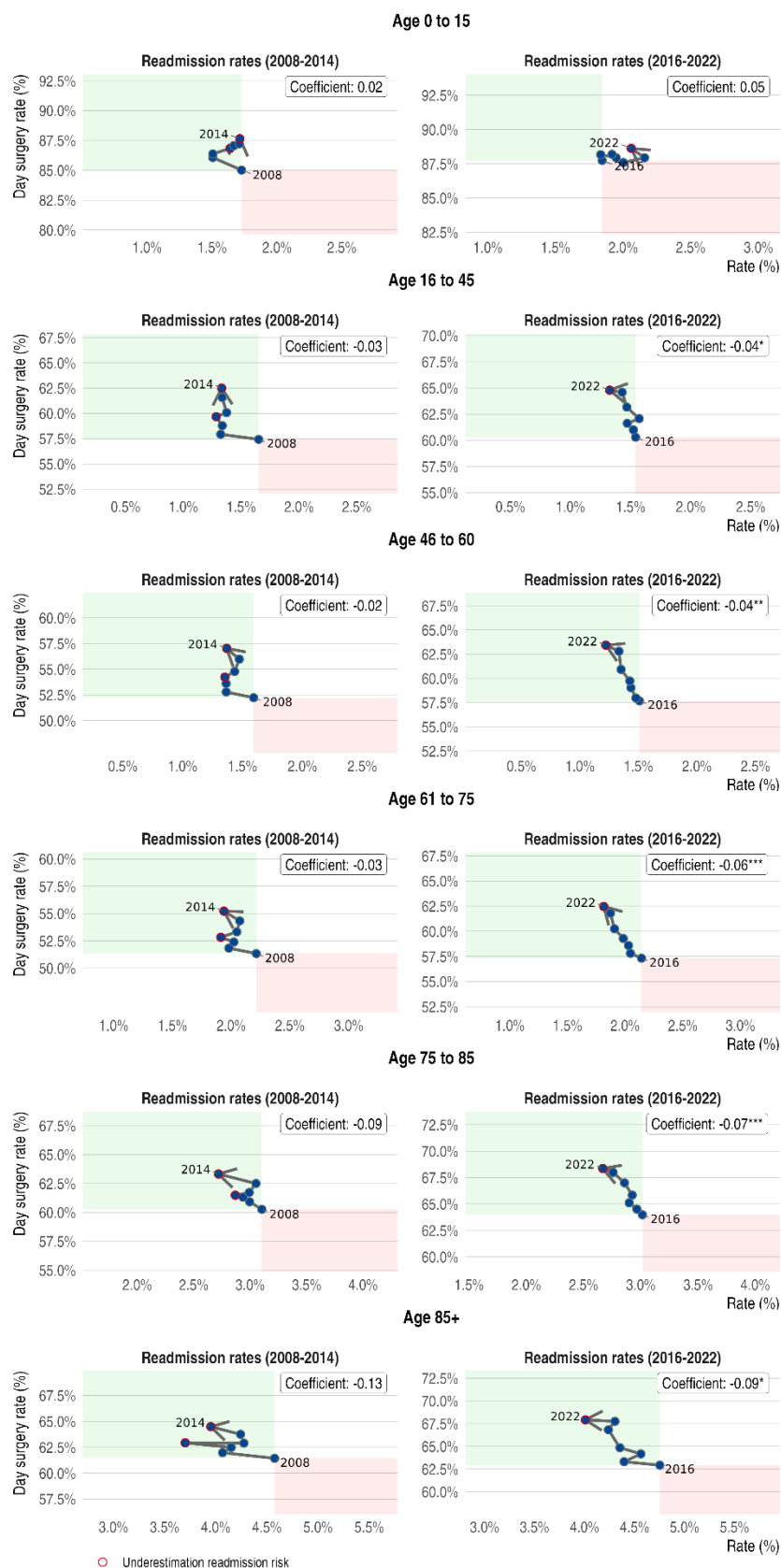


GREATER IMPROVEMENT IN OLDER AGE GROUPS

Figure 11 presents scatterplots showing the evolution of risk-adjusted day surgery and readmission rates across age groups for the two periods. As already described previously, day surgery rates are substantially higher among children aged 0-15 years (between 85% and 90%) compared with all other age groups. However, further increases in this youngest group appear limited, and even shifts slightly towards a less desirable direction. The upward pressure on readmissions is largely driven by DRG 097 (Tonsil and Adenoid Procedures), the highest-volume DRG in this age group, whereas other procedures, such as those related to the penis, testes, and scrotum (DRGs 481 and 483), show more favourable evolutions (data not shown).

In contrast, older age groups started from lower day surgery levels but exhibited more pronounced improvements, particularly from 45 years onwards. These cohorts demonstrated both a marked increase in day surgery rates and a reduction in readmission rates. This is also reflected in the magnitude and statistical significance of the association, especially during the second period.

Figure 11 – Relationship between risk-adjusted day surgery and risk-adjusted readmission rates, by period and age group



Note: Significance level: * = ≤ 0.05 ; ** = ≤ 0.01 ; *** = ≤ 0.001 .



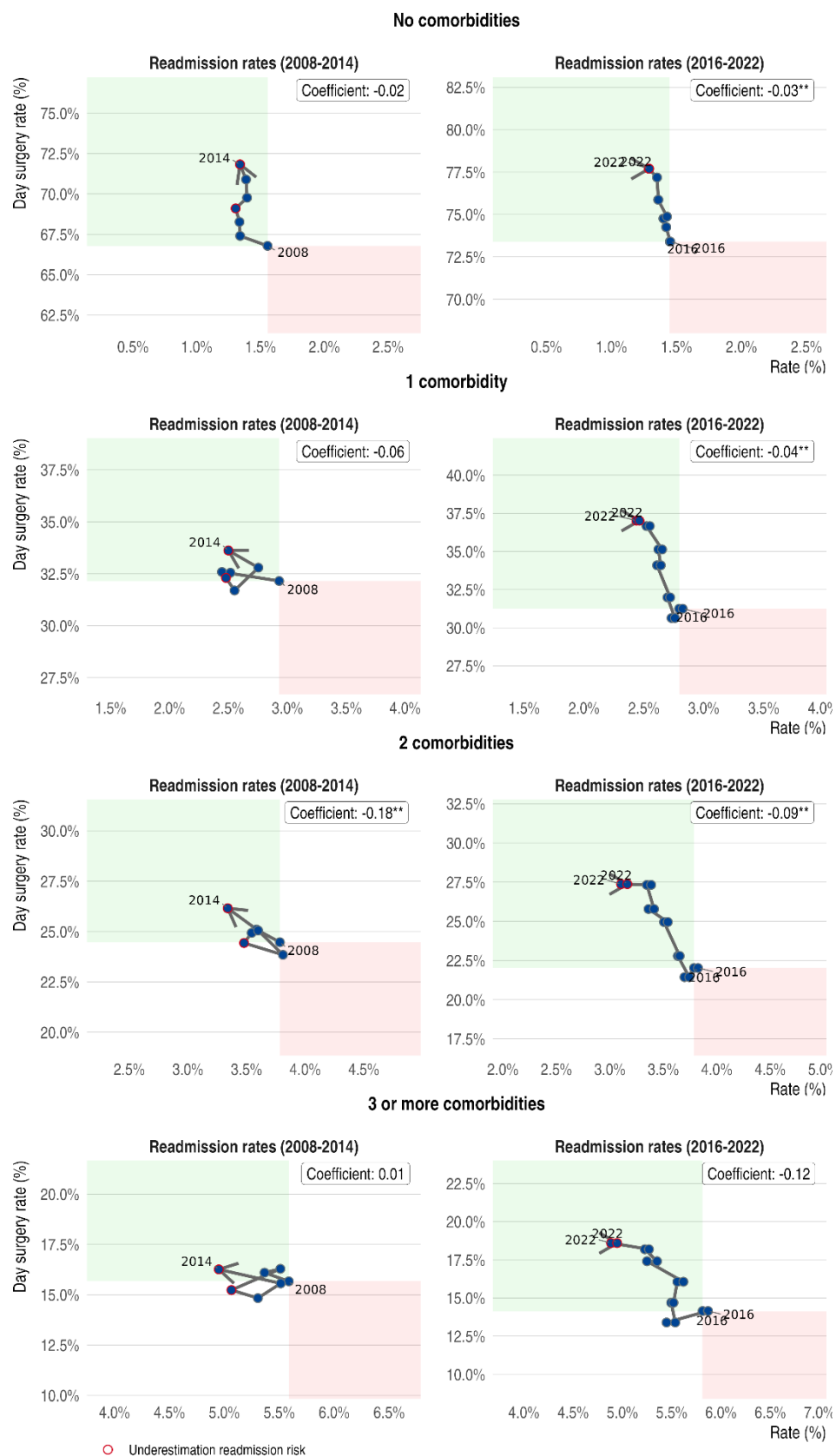
NO ADVERSE IMPACT OF INCREASED DAY SURGERY RATES ON HIGH-COMORBIDITY PATIENTS

Figure 12 illustrates the association between risk-adjusted day surgery rates and readmission rates according to patients' comorbidity burden. Overall, as also depicted in Table 6, day surgery rates declined substantially as the number of comorbidities increased.

Irrespective of comorbidity burden, there is no indication that higher levels of day surgery led to increased readmission rates. During 2016-2022, all subgroups showed a favourable evolution, with higher day surgery rates and lower readmission rates. These trends were statistically significant, except for patients with three or more comorbidities.

Hence, our results suggest that a more extensive implementation of day surgery did not lead to unintended adverse consequences for patients with a higher comorbidity burden.

Figure 12 – Relationship between risk-adjusted day surgery and risk-adjusted readmission rates, by period and Elixhauser comorbidity burden



Note: Significance level: * = ≤ 0.05 ; ** = ≤ 0.01 ; *** = ≤ 0.001 .



UNEVEN PROGRESS ACROSS PATHOLOGIES, BUT FEW CONCERNING SIGNALS

Figure 13 displays the relationship between risk-adjusted day surgery rates and readmission rates across MDCs, by study period and admission type. Overall, results for the second period (2016-2022) were more favourable, with higher day surgery rates generally accompanied by stable or lower readmission risks. Results were also more stable for high-volume MDCs, while greater noise in trends was observed for MDCs with smaller case volumes.

Statistically significant associations between increased day surgery rates and reduced readmission rates were found for MDC 02 (Eye) and MDC 05 (Circulatory system) in both study periods and across all admission types. Within MDC 05, however, several dynamics appear to interact. Some procedure groups began introducing day-surgery cases during the study period – such as cardiothoracic procedures (DRGs 167 and 169) and percutaneous cardiovascular procedures (DRGs 174 and 175) – resulting in varying effects on readmissions among early day-surgery cases. Others, such as pacemaker and defibrillator replacements (DRG 176), expanded day-surgery activity rapidly during the second period (2016-2022). In contrast, certain procedures, such as other circulatory system interventions (DRG 180), already had substantial day-surgery volumes at the start of the study period and continued to expand further. Across most DRGs within MDC 05, reductions in inpatient readmissions were observed despite the progressive transfer of lower-risk patients to the day-care setting.

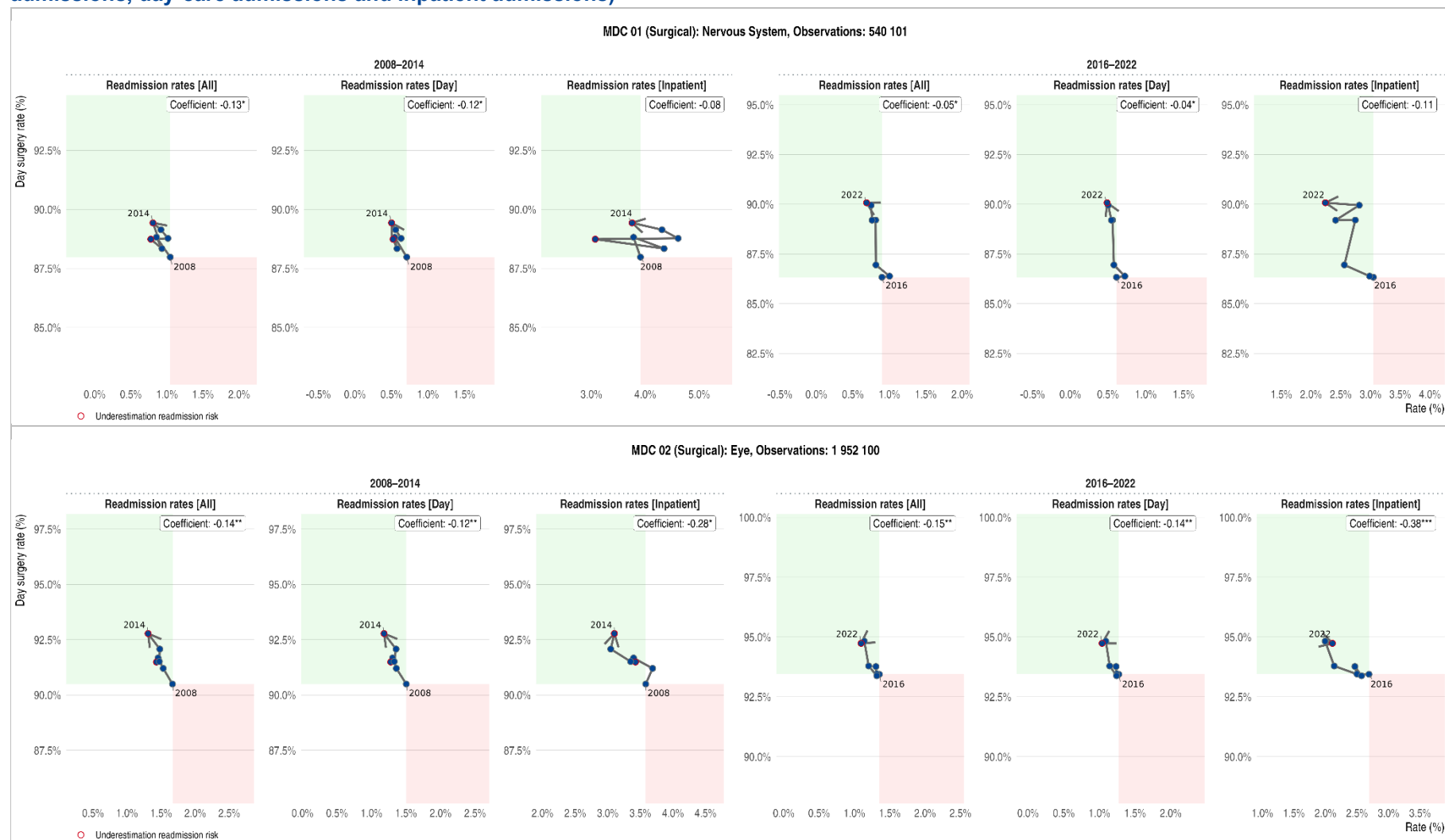
In addition, significant improvements were observed for MDC 09 (Skin and breast) during the second period (2016-2022), and for MDC 01 (Nervous system) in the first period (2008-2014).

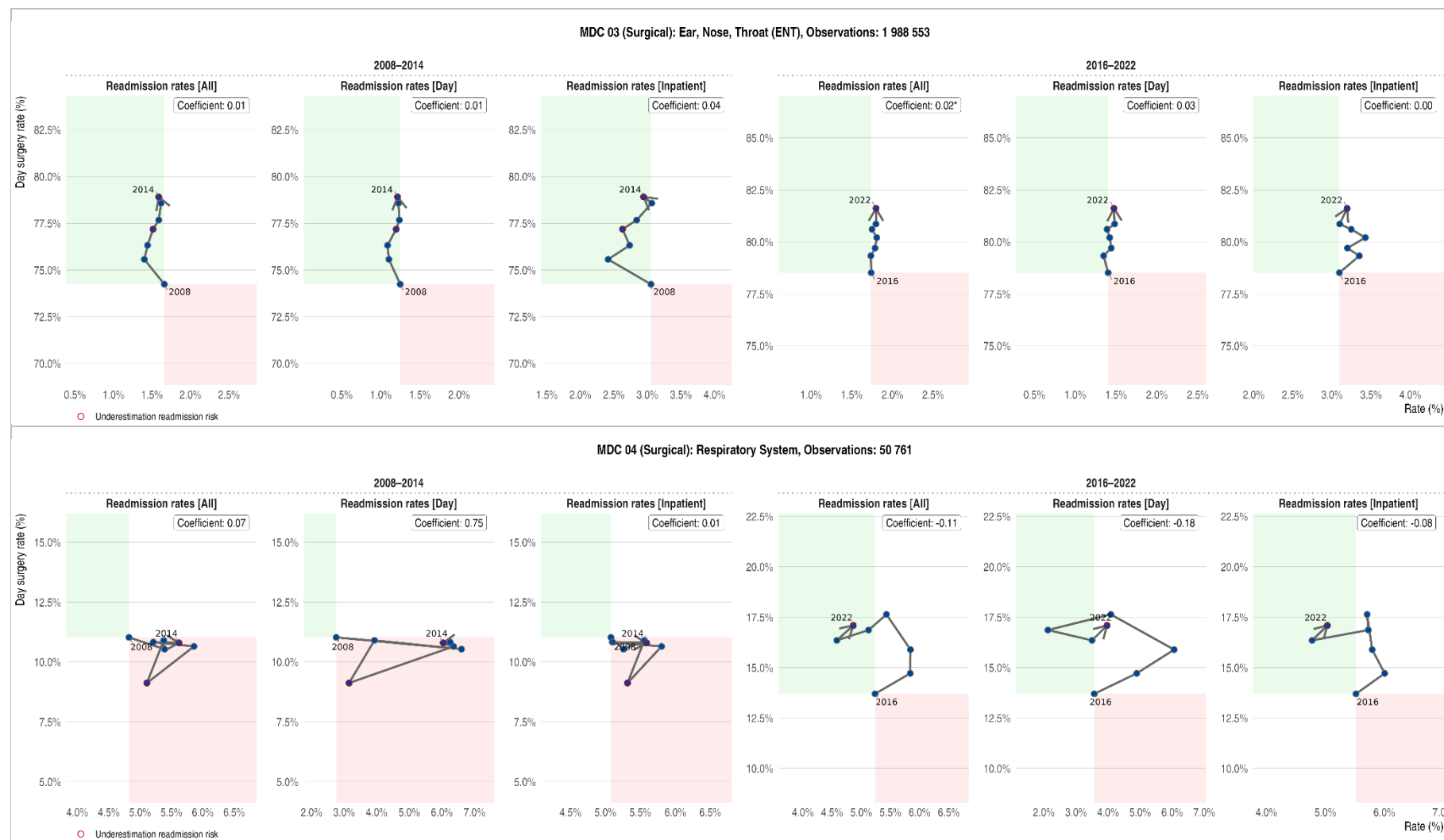
In contrast, MDC 04 (Respiratory system) showed a negative trajectory in the first period, characterised by lower day surgery rates and higher readmission rates, although this association did not reach statistical significance.

Mixed results were observed for MDC 12 (Male reproductive system). In the first period (2008-2014), higher day surgery rates were significantly associated with higher readmission rates in inpatient care. This pattern was mainly driven by transurethral prostatectomy (DRG 482), where a substantial increase in readmissions occurred without a corresponding rise in day-surgery cases. In the second period (2016–2022), however, a modest increase in day-surgery rates for this DRG (from about 1% to 6.5%) coincided with a decline in readmission rates. Consequently, during the second period, results for MDC 12, showed a statistically significant pattern of rising day surgery rates accompanied by lower readmission rates in both day and inpatient settings.

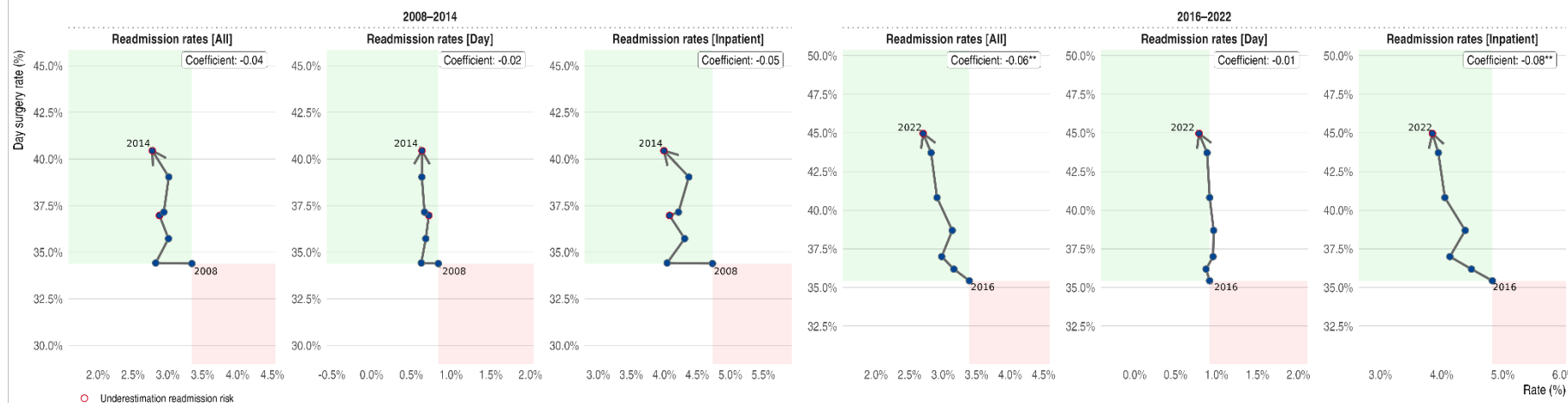
Finally, apart from MDC 02, other high-volume categories such as MDC 03 (Ear, nose, and throat) and MDC 08 (Musculoskeletal system) displayed continued increases in day surgery rates over time, without a corresponding impact on readmission rates, irrespective of admission type.

Figure 13 – Relationship between risk-adjusted day surgery and risk-adjusted readmission rates, by MDC, period and admission type (all admissions, day-care admissions and inpatient admissions)

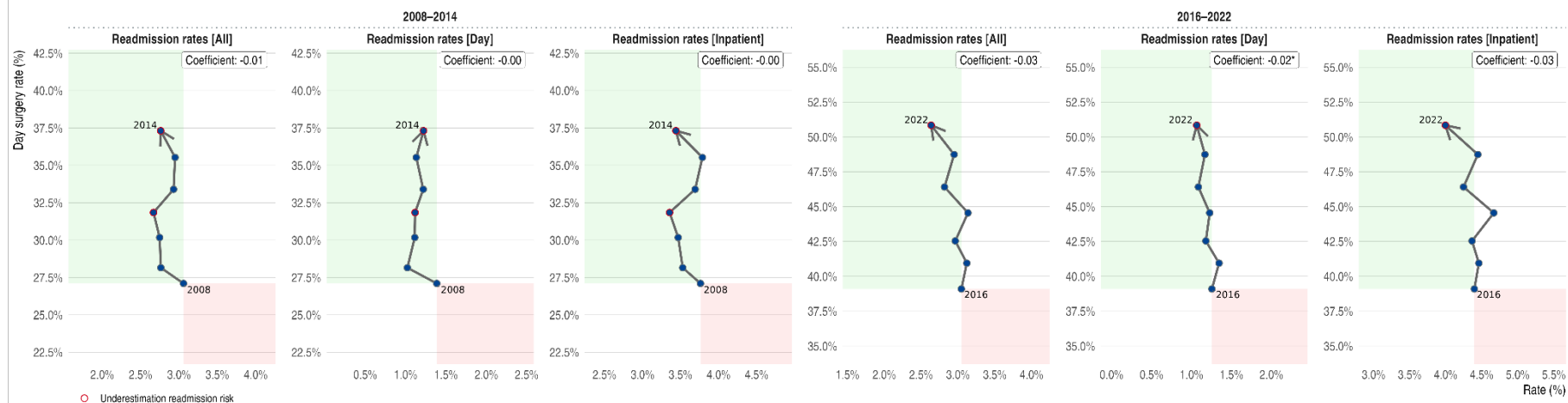


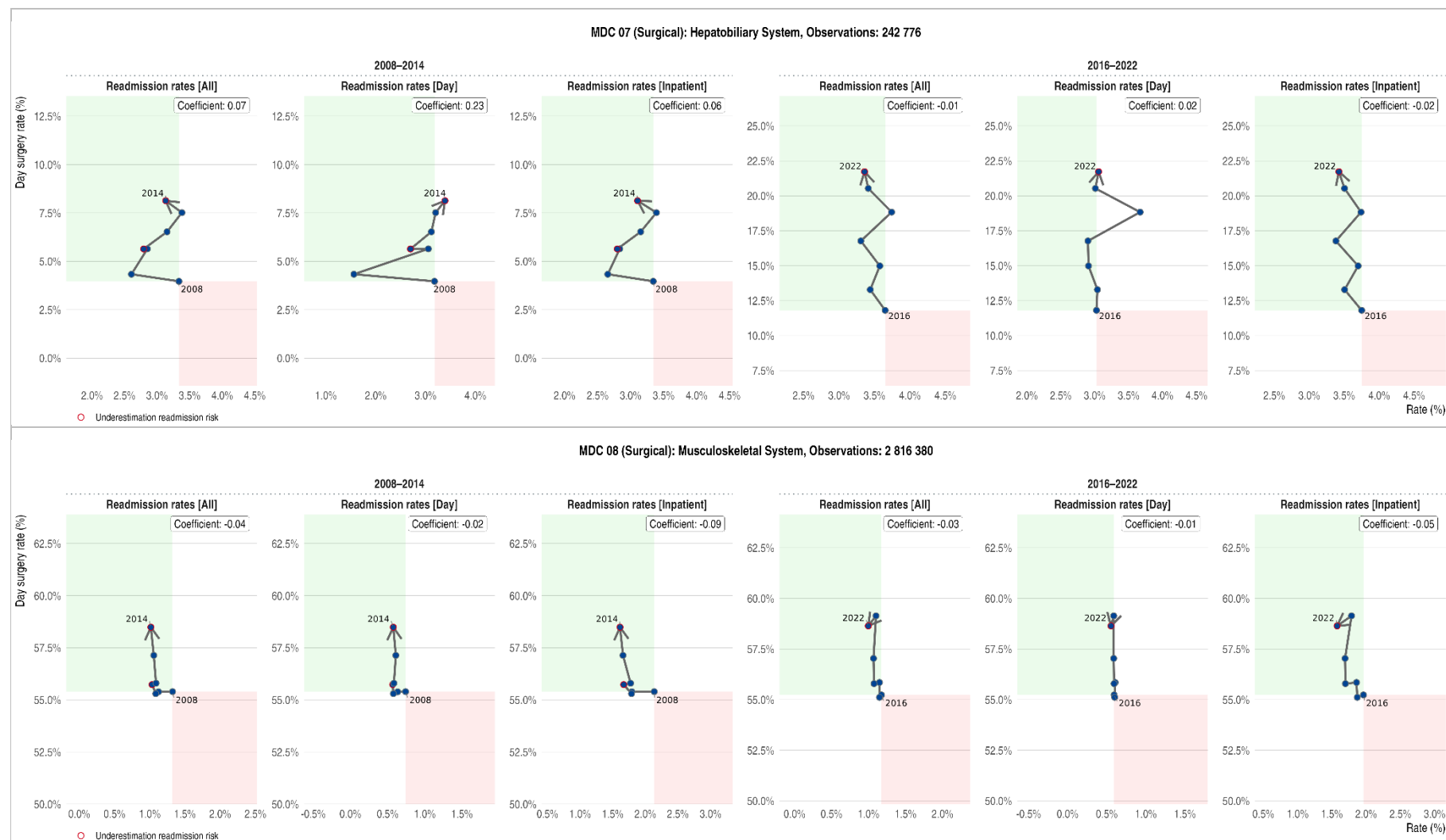


MDC 05 (Surgical): Circulatory System, Observations: 954 938

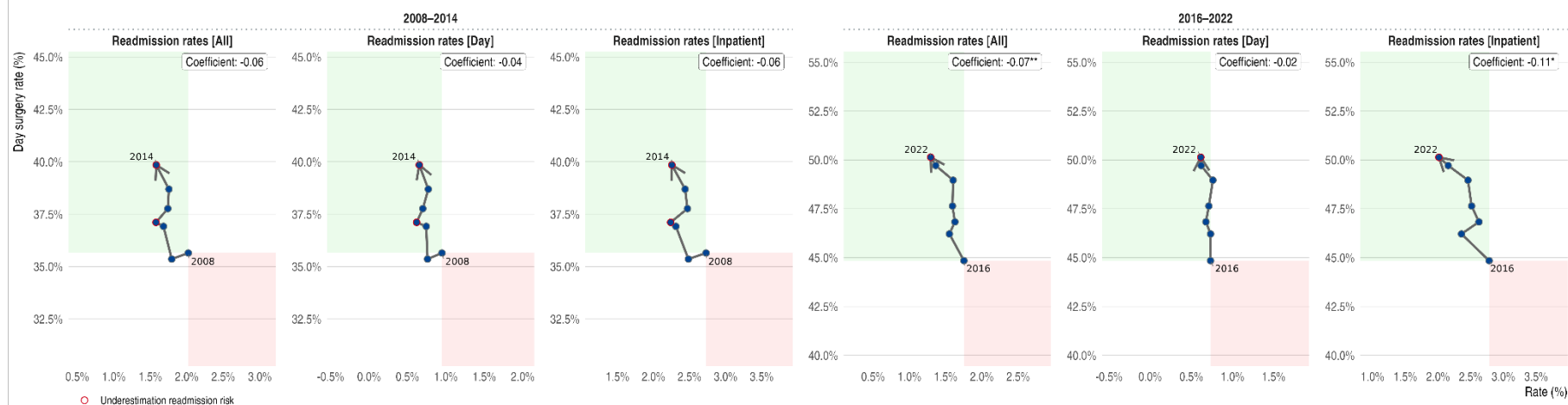


MDC 06 (Surgical): Digestive System, Observations: 894 148

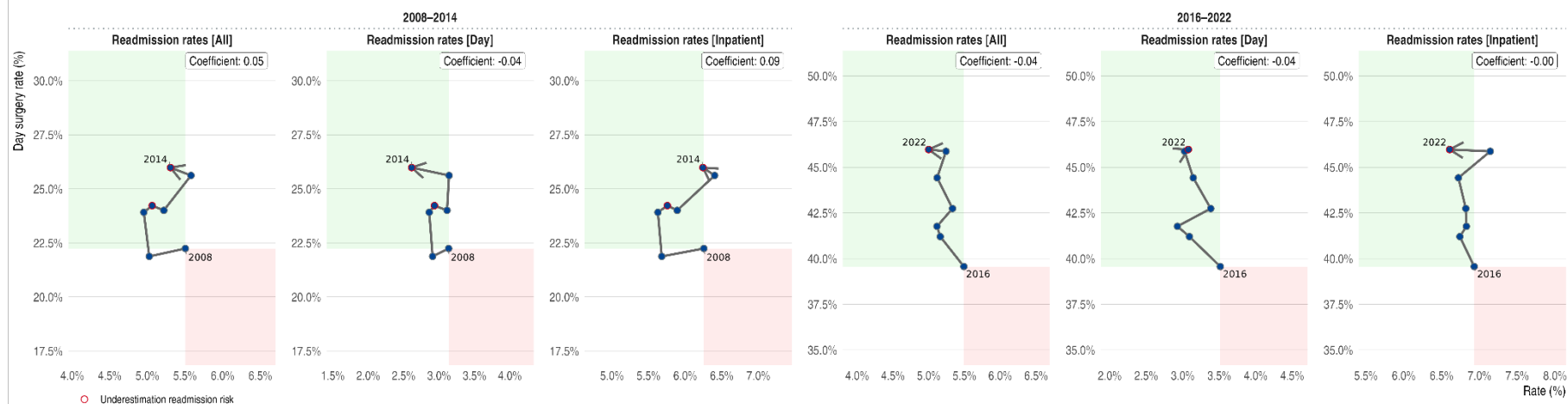


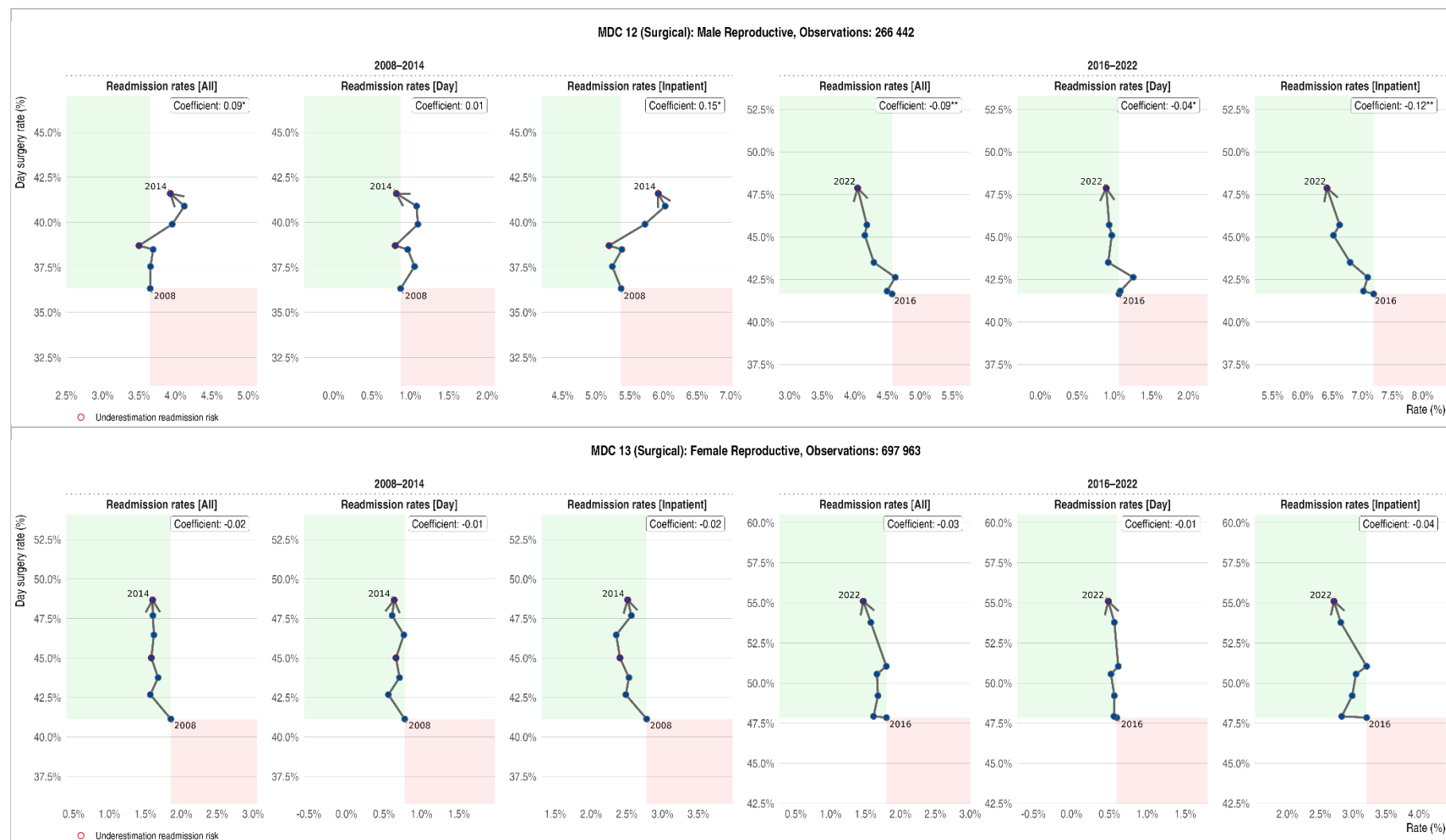


MDC 09 (Surgical): Skin/Breast, Observations: 629 498



MDC 11 (Surgical): Kidney/Urinary, Observations: 369 259







Note: Significance level: * = ≤ 0.05 ; ** = ≤ 0.01 ; *** = ≤ 0.001



1.4 Discussion

This chapter examined whether the increasing substitution of inpatient surgical care by day admissions in Belgium was associated with increases in unplanned hospital readmissions. The findings suggest that the expansion of day surgery over the study period (2008-2022) was not accompanied by a rise in readmission rates. On the contrary, readmission rates remained stable or declined slightly, even among the oldest patients (+85 years) and those with multiple comorbidities.

Post-discharge mortality was low (<0.05%) and therefore not subjected to further risk-adjusted analysis. This does not imply that the observed cases are negligible in terms of care quality. These events occur in a low-severity patient population where post-discharge mortality is not typically expected. Nevertheless, given the consistently low and stable numbers, there is no indication that the increase in day surgery over the years has been associated with higher 30-day post-discharge mortality.

Given that mortality was not risk-adjusted, the main focus of this chapter was 30-day unplanned readmissions. Day surgery consistently exhibited lower readmission rates compared to inpatient stays, and risk-adjusted analyses confirmed a modest but favourable trend over time. These findings support the notion that the shift towards day surgery has not compromised the safety of care as measured by hospital readmissions. It is however unclear why a temporary increase in readmission rates was observed during 2016–2017, as it interrupts the overall downward trend. Similar observations were made by Van Wilder et al. (2022)²⁸ and might potentially be explained by different coding practices.

Nevertheless, several limitations must be acknowledged. The study relied on administrative data, specifically the TCT database and the hospital discharge record in particular (MZG-RHM). This approach offers the advantage of population-level coverage across multiple years, enabling the analysis of long-term trends. However, it also entails inherent constraints. Coding-related issues such as upcoding or undercoding may occur, partly driven by the use of these data for hospital financing. Clinical detail is limited: while secondary diagnoses for comorbidities and complications are available, key clinical parameters (e.g., laboratory values, vital signs) are absent. Furthermore, changes in coding standards and practices over time - such as the use of 'present on admission' indicators may affect comparability. These limitations restrict the scope of risk adjustment and outcome measurement. Although adjustments were made for procedure type, age, and comorbidity burden, other influential factors such as socioeconomic status, availability of informal caregivers, and home support could not be accounted for. Moreover, important outcome measures such as outpatient emergency visits, patient-reported experiences, and quality of life were not available in the dataset. These dimensions are essential to fully assess the impact of care substitution on quality.

It is therefore important to interpret the findings with caution. The analyses are descriptive in nature and do not establish causal relationships. Both the increase in day surgery and the observed trends in readmissions may be influenced by a multitude of factors, including improved care organisation, the presence of dedicated day surgery infrastructure, advancements in surgical and anaesthetic techniques, and a broader culture of quality improvement within hospitals.

What can be concluded with confidence is that, over the study period, the proportion of elective surgical procedures performed in day care settings increased substantially, and this evolution was not associated with a deterioration in unplanned readmission rates. These findings suggest that efficiency gains through increased use of day surgery can be achieved without compromising short-term safety, although further research is needed to assess broader dimensions of care quality. Additionally, further research is needed to assess the cost implications of this shift, to ensure that efficiency gains within hospital settings do not result in a disproportionate burden on outpatient services.

2 REDUCTION IN LENGTH OF STAY

KEY POINTS TABLE

Reducing hospital length of stay as a core strategy for enhancing healthcare system efficiency

- Reducing hospital length of stay (LOS) is a central policy objective for many healthcare systems in attempt to increase efficiency. In Belgium, the Budget of Financial Means (BFM) incentivizes shorter LOS through reimbursement mechanisms that limit funding to nationally defined 'justified days' per DRG which are in fact based on the national average LOS. As a consequence, hospitals strive to perform at or below this average LOS.

Analysis of nationwide administrative data

- This chapter evaluates the association between reductions in LOS and 30-day post-discharge outcomes – unplanned readmission, mortality, and a composite indicator (readmission or mortality) – using nationwide administrative data.
 - The study population comprises over 18 million inpatient admissions in Belgian general hospitals between 2008 and 2022, excluding day-care stays, non-specific MDCs, long-term admissions, and in-hospital deaths.
 - Analyses are stratified into two periods (2008 - 2014 and 2016 - 2022) to account for coding transitions (from ICD-9 to ICD-10) and data availability, with mortality and composite outcomes analyzed only for the second period.
 - Risk adjustment was performed using zero-truncated negative binomial models for LOS and logistic regression for binary outcomes, controlling for age, gender, comorbidity burden (Elixhauser index), DRG classification, prior emergency contact, palliative care status, admission source, and discharge disposition.

Length of stay reduction

- Observed LOS declined from 6.1 days in 2008 to 5.1 days in 2022 (–1.0 day), with reductions across all age, comorbidity, and pathology groups.
- Risk-adjusted LOS showed an even stronger decline (–1.5 days: from 6.1 days in 2008 to 4.6 days in 2022), indicating that efficiency gains were greater than suggested by crude figures, particularly among older and more complex patients.
 - Among patients aged 85+, risk-adjusted LOS declined by 3.6 days from 13.6 days in 2008 to 10 days in 2022 (vs. –1.9 days unadjusted: from 13.3 days in 2008 to 11.3 days in 2022), and by 3.3 days (from 12.2 days in 2008 to 9.0 days in 2022) among those with ≥3 comorbidities (vs. –2.6 days unadjusted; from 12.2 days in 2008 to 9.6 days in 2022).
 - Surgical MDCs showed more pronounced reductions than medical ones.

Readmission rates

- Unadjusted 30-day readmission rates dropped from 5.5% in 2008 to 5.0% in 2022 (–0.5 pp). About 84% of readmissions took place in the same hospital as where the index admission took place. The average duration between discharge and readmission was 11.8 days (–0.4 days between 2008–2022). The mean LoS of readmissions over the study period was 10. Days and decreased over time (–1.9 days: from 10.9 days in 2008 to 9 days in 2022)).
- Risk-adjusted 30-day readmission rates declined from 5.6% in 2008 to 4.9% in 2022 (–0.7 pp), with steeper improvements among high-risk groups.



- Risk-adjusted readmission rates fell by 1.7 pp among patients aged 85+ (from 10.6 % in 2008 to 9.0 % in 2022). The unadjusted rates dropped by -0.9 pp (from 10.3% to 9.4% in the same period).
- Among those with ≥ 3 comorbidities, the risk-adjusted readmission rates dropped by 1.4 pp (from 10.3% to 8.9%) (while this was -1.1 pp for unadjusted rates: from 10.2% in 2008 to 9.1% in 2022)
- MDCs with greater LOS reductions generally showed stronger improvements in risk-adjusted readmission rates, although some MDCs showed upward trends.

Mortality rates

- Risk-adjusted 30-day mortality rates remained stable at 0.9% between 2016 and 2022. The observed slight increase (0.1 pp) in crude rates from 0.9 % in 2016 to 1.0% in 2022 were thus reversed after adjustment.
 - For patients aged 85+, risk-adjusted mortality declined by 0.5 pp after adjustment (from 6.3% to 5.8%), despite a crude increase of +0.3 pp (from 5.1% to 5.4%).
 - Similar reversals were observed for patients with ≥ 3 comorbidities (unadjusted: +0.2 pp from 2.9% to 3.1% versus -0.0 pp for risk-adjusted rates: 2.9% in both years) and in certain MDCs.

Composite outcome rates

- The risk-adjusted composite outcome (readmission or mortality) declined from 6.2% in 2016 to 5.5% in 2022 (-0.7 pp) after risk adjustment, with the largest improvements in high-risk groups.
 - Declines reached -1.5 pp among patients aged 85+ from 14.3% in 2016 to 12.8% in 2022 (compared to -0.2 pp for unadjusted rates: from 13.8% to 13.6%).
 - For those with ≥ 3 comorbidities the risk-adjusted composite outcome dropped with 1.3 pp from 12.2% in 2016 to 10.9% in 2022 (unadjusted: -0.6 pp, from 11.9% to 11.3%).
 - The evolution varied depending on MDC.
- Overlap between readmission and mortality events was limited (0.3% of admissions), but disproportionately affected older (85+: 1.23% of all admissions in this age group) and multimorbid patients (≥ 3 comorbidities: 0.87% of admissions in this group).

Association between length of stay reduction and outcome measures

- Efficiency gains in hospital care, resulting from reductions in risk-adjusted length of stay (LoS), were not associated with adverse patient outcomes:
 - Shorter hospital stays did not lead to increased risks of readmission. On the contrary, readmission rates showed consistent and favourable trends, particularly during the second period (2016–2022).
 - No systematic relationship was observed between LoS and 30-day mortality. The reductions in LoS were achieved without increases in post-discharge mortality.
 - Composite outcomes (readmission or mortality) largely mirrored the patterns observed for readmissions.
- Even among older and multimorbid patients, shorter hospital stays were associated with fewer readmissions. Disaggregated analyses by age and comorbidity burden revealed that the most substantial improvements occurred in groups with the highest baseline risks.

2.1 Introduction and research objectives

AVERAGE LENGTH OF STAY: INDICATOR OF EFFICIENCY

Hospitals are a cornerstone of healthcare systems, accounting for a substantial share of health expenditures - on average 38.2% among OECD countries.⁵⁰ As such, they are a frequent target of policy reforms aimed at improving efficiency and quality. One commonly used indicator of hospital efficiency is the average length of stay (ALOS), which reflects how long patients remain hospitalized before discharge. A reduction in ALOS, when not accompanied by increased resource use or cost-shifting to other sectors, can lead to significant cost savings.⁵¹

COMPLEX RELATIONSHIP BETWEEN LOS AND QUALITY OF CARE

Shorter hospital stays are often seen as beneficial from a system perspective, improving bed turnover and allowing hospitals to better manage demand for elective and emergency care.^{52, 53} However, the relationship between length of stay (LOS) and quality of care is complex. While prolonged stays may indicate poor care coordination or lack of post-acute options, premature discharge can lead to adverse outcomes such as readmissions or even mortality.⁵¹

Despite its widespread use, LOS is a multifactorial measure influenced by patient age, comorbidities, socioeconomic status, and hospital practices. Studies have shown that longer LOS is often associated with higher readmission rates, although this may reflect unmeasured severity rather than causality.⁵⁴

FINANCIAL INCENTIVES CAN INCREASE EFFICIENCY

Financial incentives play a key role in shaping hospital behavior. Since the 1980s, many countries have adopted activity-based funding, often through diagnosis-related groups (DRGs), which reward hospitals for increasing activity and reducing LOS.⁵⁵

International trends show a consistent decline in LOS over the past two decades, particularly in high-income European countries.⁵³ In the United States, LOS reductions began earlier and progressed rapidly, but have recently plateaued or even reversed slightly.⁵⁶ Differences in LOS across countries are influenced not only by financing models but also by demographic factors, disease burden, and the availability of post-acute care.⁵³

BELGIAN DRG SYSTEM PROVIDES INCENTIVES TO REDUCE LOS

Belgium employs a DRG-based hospital financing system for a substantial portion of its hospital budget, the Budget of Financial Means (BFM). Notably through subpart B2 of the BFM, which accounted for 36.3% of the total BFM for general hospitals in 2023, a strong incentive for LOS reduction is given. Unlike some international DRG systems that use DRG-based case payments to reimburse hospitals per admission, the Belgian model distributes a closed macro-budget across hospitals using a point-based system. Hospitals earn points based on the volume and type of care provided, and each point has a monetary value determined by dividing the national budget by the total number of points earned. A key parameter in this allocation is the average length of stay (LOS) per DRG, calculated over the past three years. Hospitals are only reimbursed for the nationally defined "justified days" per DRG, meaning that if a hospital exceeds the average LOS for a given DRG, it receives no additional funding (except for outliers) for the extra days.⁴ This system creates a strong financial incentive for hospitals to reduce LOS (and increase admissions) as hospitals attempt to stay below the national average LOS per DRG. Since the introduction of this model, Belgian hospitals have consistently sought to optimize throughput and shorten stays.⁴ Plans for future reforms continue to build on this logic, with proposals to move toward a more explicit cost-based DRG payment system. This would further reinforce the incentive structure while maintaining the core objective of promoting efficiency through reduced hospital stays.³ However, it is worth noting that countries with a long-standing tradition of cost-based DRG hospital payment systems are beginning to move away from this approach or introduce modifications (see KCE 392).⁴



CONCERNS ABOUT TRADE-OFFS: QUALITY AND COST ISSUES

While DRG systems have improved transparency and efficiency, they have also raised concerns about quality trade-offs and cost-shifting to post-acute care.¹⁴ In response, some countries have moved toward bundled payments that include readmissions, encouraging hospitals to ensure patients are truly ready for discharge^{57, 58}.

Reducing readmissions has become a policy priority in its own right, with various quality improvement programs targeting this issue⁵⁹. As hospitals face increasing pressures to optimize both efficiency and quality, understanding the balance between LOS and patient outcomes is essential.

In response to concerns about premature discharges and rising readmission rates under prospective payment systems health systems make the shift toward bundled payment models. Unlike traditional DRG-based payments that reimburse hospitals per admission, bundled payments provide a single, comprehensive reimbursement for an entire episode of care - including the initial hospitalization and any related readmissions within a defined period.^{57, 58} This approach realigns financial incentives by encouraging hospitals to optimize discharge planning and post-discharge support.⁵⁵ In Belgium hospitals only receive part of lump sums per admission (e.g. 67% of lump sums for medical imaging and clinical biology; 82% for pharmaceutical products) in case of readmissions within 10 days.

FOCUS OF THE CHAPTER: ARE TRENDS IN LOS ASSOCIATED WITH TRENDS IN READMISSION AND MORTALITY RATES

In this chapter, we investigate whether reductions in LOS in Belgian hospitals based on administrative data from the MZG-RHM are associated with increased 30-day readmission rates and mortality. While previous literature does not consistently show a direct link between shorter LOS and higher readmissions⁶⁰⁻⁶², concerns remain about potential quality trade-offs.

Beyond clinical outcomes, there is also a policy interest in understanding whether LOS reductions lead to cost-shifting toward post-acute or ambulatory care. Although this aspect will be addressed in a follow-up report, it remains an important consideration in evaluating the broader impact of hospital efficiency measures⁵⁸.

This chapter aims to analyse trends and associations in Belgian hospital data, with appropriate adjustments for patient characteristics and case mix. The research questions are:

- How did length of stay (LoS) evolve over time? How did unplanned 30-day post-discharge readmission and mortality rates evolve over time?
- Is there an association between the evolution in LoS and 30-day readmission and mortality rates?

2.2 Methods

We refer to the chapter day surgery (see Chapter 1) for an elaborate description of the data sources, the reason for subdividing the study period, analysis and results into two separate periods (2008-2014 and 2016-2022), the definition of index stays, outcome variables and covariates and calculation of length of stay.

In the chapter day surgery (Chapter 1, section 1.2.2), the definition of length of stay is discussed. In this study, we focus specifically on acute LoS, as rehabilitation and psychiatric care are not available in all hospitals and could therefore introduce inconsistencies between comparable stays across hospitals, for example, when rehabilitation days are included in one hospital but not in another. Throughout this chapter, LoS refers exclusively to time spent in acute care bed types.

In this section, we discuss the exclusion criteria specific for the analysis of LoS as well as the method of risk adjustment for LoS, which differs from the method used for the risk-adjustment of binary events as described in chapter day surgery.

2.2.1 Data sample selection

In this chapter we focus on a wide range of elective as well as unplanned inpatient admissions, both medical and surgical. The aim of this 'general approach' is to demonstrate the evolution of (risk-adjusted) LoS and (risk-adjusted) readmission and mortality rates over time in a descriptive way.

EXCLUSION RULES

The following general exclusion rules were used:

- Day-care stays and stays without time spent in acute beds;
- Non-specific MDC's 'major diagnostic categories':
 - 'MDC 19 Mental Diseases & Disorders'^h; 'MDC 20 Alcohol/Drug Use and Alcohol/Drug Induced Organic Mental Disorders'; 'MDC 21 Injuries, Poisonings & Toxic Effects of Drugs'; 'MDC 22 Burns'; 'MDC 23 Factors Influencing Health Status & Other Contacts with Health Services'; 'MDC 24 HIV Infections'; 'MDC 25 Multiple Significant Trauma'; 'Rest MDC's 'PP', 'SS' and '00'.
- Long-term stays (incl. administrative discharge or admission for long-term stay). These are stays that cover more than one coding period. Indeed, the data are transmitted every six months (i.e. twice a year) by hospitals to the federal authorities and contain information on the stays of patients who leave the hospital during the six months concerned.
- Non-index stays (readmissions (see section 1.2.3 in Chapter 1, day surgery on how readmissions are defined in this study), transfers, outpatient stays, day care stays taking place during a separately registered inpatient stay).
- Stays with LoS exceeding 90 days, in DRGs where such long stays represent 3 % or less of all admissions. This approach entails an arbitrary choice and alternative approaches, such as data-driven thresholds (e.g., mean + 3 standard deviations), could have been applied. Nevertheless, given the small number of outlier stays in the current specification (see section 2.3.1) or expected in alternative specifications, any reasonable alternative will not influence the main study results.
- Patients discharged from the index hospital against medical advice;
- Index stays followed by multiple transfers;
- Patients who died during the hospital stay of the index admission (or in the hospital where the patient was transferred). The linked data showed some differences in (time of) death between Statbel and MZG-RHM (part of TCT) data. In-hospital mortality is attributed to a stay in three cases:
 - when in-hospital mortality is registered in MZG-RHM for that stay, even if not confirmed by Statbel data (MZG-RHM is considered the most reliable source as the coding is closest to the actual patient care);
 - If not registered in MZG-RHM, but mortality is registered in Statbel 1 or 2 days before discharge and after admission;

^h Readmissions captured in acute-care hospitals provide only a partial picture for this patient group (MDC 19), as many subsequent admissions occur in psychiatric hospitals. These stays are recorded in the 'Minimal Psychiatric (MPG/RPM) dataset', which is not part of the TCT database used for the current analysis. Including MDC 19 would therefore introduce substantial incompleteness and misrepresentation of care pathways.



- For a transfer index stay, if MZG-RHM registers in-hospital mortality in the transfer stay or if Statbel registers mortality between discharge of the index stay and discharge of the transfer stay.

2.2.2 Statistical analyses

A broader argumentation for the need of risk-adjustment as well as the approach taken for risk adjustment of binary outcomes, namely (1) 30-day readmission, (2) 30-day mortality, and (3) the 30-day composite outcome of readmission or mortality, are described in detail in Chapter 1 on day surgery (see section 1.2.3).

2.2.2.1 Risk-adjusted LoS

While a proportional adjustment was applied for the binary outcomes, an absolute adjustment was preferred for the risk adjustment of LoS, or reasons of interpretability and in line with previous studies.^{39, 44, 63} Absolute changes, expressed in days, are more intuitive and facilitate direct comparison across procedures and patient groups.

Risk adjustment was stratified by time period and MDC further subdivided by medical and surgical treatment. For each period, a three-year baseline was used to calibrate the model: 2008-2010 for the first period (2008-2014) and 2016-2018 for the second period (2016-2022).

The risk-adjusted LoS (RAL)^{39, 44} for year t in period p is defined as

$$\begin{aligned}
 RAL_{t,p} &= (\text{Mean Observed } LoS_{t,p} - \text{Mean Expected } LoS_{t,p}) \\
 &\quad + \text{Mean Expected } LoS \text{ Baseline}_p \\
 &= \left(\frac{\sum_m \sum_i LoS_{t,p,m,i}}{N_{t,p}} - \frac{\sum_m \sum_i \widehat{LoS}_{t,p,m,i}}{N_{t,p}} \right) + \frac{\sum_{s \in \text{Baseline}} \sum_m \sum_i \widehat{LoS}_{s,p,m,i}}{\sum_{s \in \text{Baseline}} N_{s,p}}
 \end{aligned} \tag{2}$$

Risk-adjusted LoS is obtained by computing the difference between the mean observed LoS and the mean expected LoS, and then adding the mean expected LoS from the baseline period to calibrate results around that baseline.

The mean observed LoS ($\frac{\sum_m \sum_i LoS_{t,p,m,i}}{N_{t,p}}$) corresponds to the sum of observed LoS across all hospital admissions i and MDCs-medical/surgical m in year t of period p , divided by the total number of admissions in that year and period ($N_{t,p}$).

The mean expected LoS ($\frac{\sum_m \sum_i \widehat{LoS}_{t,p,m,i}}{N_{t,p}}$) is calculated as the sum of the predicted LoS values, obtained from the risk-adjustment model, across all hospital admissions i and MDCs-medical/surgical m in year t of period p also divided by the total number of admissions in that year and period ($N_{t,p}$).

The mean expected LoS in the baseline period ($\frac{\sum_{s \in \text{Baseline}} \sum_m \sum_i \widehat{LoS}_{s,p,m,i}}{\sum_{s \in \text{Baseline}} N_{s,p}}$) is computed in a similar way as mean expected LoS, but aggregated over all years s included in the baseline period for the corresponding period p .

Formally, this implies that when the observed mean LoS exceeds the risk-adjusted LoS in year t , this corresponds to a situation where the mean expected LoS in year t – based on the case mix of that year and the baseline practice patterns – is higher than the mean expected LoS at baseline. Put differently, given the characteristics of the patients treated in year t , one would have expected longer stays than what was expected on average at baseline. This indicates higher efficiency than expected. Conversely, when the observed mean LoS falls below the risk-adjusted LoS, the mean expected LoS in year t is lower than the expected baseline value. In other words, based on case mix and baseline practice, patients in year t would have been expected to have shorter stays than what was expected on average at baseline.

$$RAL_{t,p} = (\text{Mean Observed } LoS_{t,p} - \text{Mean Expected } LoS_{t,p}) + \text{Mean Expected } LoS \text{ Baseline}_p$$

If $\text{Mean Observed } LoS_{t,p} > RAL_{t,p} \Leftrightarrow \text{Mean Expected } LoS_{t,p} > \text{Mean Expected } LoS \text{ Baseline}_p$

If $\text{Mean Observed } LoS_{t,p} < RAL_{t,p} \Leftrightarrow \text{Mean Expected } LoS_{t,p} < \text{Mean Expected } LoS \text{ Baseline}_p$

2.2.2.2 Prediction model for length of stay

Given the count nature of the dependent variable (LoS, expressed in whole days) and the absence of zero-length stays, expected LoS were estimated using a zero-truncated negative binomial model.^{64, 65} This approach was preferred over a Poisson specification due to the right-skewness of the LoS distribution. Whereas the Poisson model assumes equality between the mean and the variance, the negative binomial model relaxes this assumption, allowing for overdispersion and thereby providing more robust estimates in the presence of long tails in the distribution of inpatient LoS. If the zero-truncated negative binomial model failed to converge, results from a zero-truncated Poisson model were used instead.

Separate regression models were estimated for each MDC-medical/surgical combination and each time period (2008-2014 and 2016–2022). Stratifying by period and MDC-medical/surgical increased homogeneity within each estimation group with respect to the underlying pathology, thereby enhancing the precision of the estimated expected values.

For each period, a 3-year baseline was used to calibrate the model (2008-2010 for the 2008-2014 period, and 2016-2018 for the 2016-2022 period). Within each estimation group, the model related the observed LoS to a set of patient and admission characteristics, including five-year age group, gender, number of Elixhauser comorbidities (0, 1, 2, 3+), previous emergency contact, palliative care status, APR-DRG, admission source (home, nursing home, other hospital, or other), and discharge disposition (home, nursing home, or other) (see also section 1.2.4 in Chapter 1, day surgery). The estimated coefficients from the baseline period were then applied to all inpatient admissions within the corresponding period and MDC-medical/surgical to generate the expected LoS for each stay. This produced a counterfactual estimate of LoS, conditional on the patient's characteristics and the average baseline relationship between risk factors and LoS.

The procedure used for the aggregation of categorical explanatory variables - designed to ensure, as far as possible, a minimum of 50 admissions per category to improve model stability in the binary risk-adjustment models - was maintained for the estimation of the LoS model (see also Section 1.2.5 in Chapter 1 on day surgery).

Model estimation was performed using the FMM procedure in SAS V9.4.

PREDICTION MODEL STATISTICS

For each regression model, a pseudo-Wald statistic⁶⁶ was computed for each explanatory variable to assess its overall association with the outcome. This statistic was calculated as the sum of squared z-values for all parameter estimates associated with a given variable (e.g. all age groups for the variable age). The pseudo-Wald statistic approximates a Wald chi-square test but does not account for correlations among parameter estimates. Larger pseudo-Wald values indicate a stronger association between the explanatory variable and the outcome, after adjustment for the other covariates in the model. This measure was used to identify the most influential explanatory variables in each model.⁴⁸

The overall model fit and predictive performance of the zero-truncated negative binomial models were assessed using the mean absolute error (MAE)⁷ between observed and predicted LoS. The MAE represents the average absolute difference, expressed in days, between the observed and the model-predicted LoS values across all admissions. Smaller MAE values indicate better predictive accuracy and should be interpreted in relation to the mean LoS.



2.2.2.3 Association (risk-adjusted) readmission, mortality and composite rates and LoS

After risk adjustment of all outcome variables, the association between the evolution of risk-adjusted LoS and the risk-adjusted 30-day readmission, mortality, and composite (readmission or mortality) rates over time was examined. All analyses were performed separately for the periods 2008-2014 and 2016-2022.

The relationship was first assessed visually using scatterplots illustrating the annual evolution of LoS and the event rates within each period. The plot area was divided into four quadrants, anchored at the starting year of each period (2008 for the first period and 2016 for the second). The bottom left quadrant, shaded in green, represents simultaneous reductions in LoS (indicating higher efficiency) and decreases in readmission, mortality or composite rates (hence an improvement in patient outcomes). Movements within this area are therefore considered favourable. In contrast, the upper right quadrant, shaded in red, indicates concurrent increases in LoS and deterioration of patient outcomes, and is considered unfavourable. The remaining two quadrants, which are not coloured, reflect mixed evolutions: either improved outcomes with longer stays or shorter stays accompanied by worsening outcomes.

To complement the descriptive analysis, simple period-specific ordinary least squares (OLS) regression models with robust standard errors (to account for potential heteroskedasticity) were estimated, using the annual risk-adjusted outcome rate (readmission, mortality, or composite) as the dependent variable and the annual risk-adjusted LoS as the explanatory variable. In addition, subgroup analyses explored heterogeneity in the association across age groups, Elixhauser comorbidity categories, and MDCs (split in surgical and medical part).

2.3 Results

This chapter presents the results based on administrative data from MZG-RHM and Statbel. It begins with a description of the study selection and the evolution in the study population and hospital admissions. The subsequent section examines the overall trends in (risk-adjusted) LoS and (risk-adjusted) 30-day readmission, mortality and composite rates. Finally, we explore the association between the evolution in (risk-adjusted) LoS and readmission, mortality and composite rates, both at the population level and by age group, Elixhauser comorbidity burden, and MDC.

2.3.1 Study population

2.3.1.1 Data sample selection

Table 1 summarises the data selection process and successive exclusion steps, as outlined in section 1.3.1.1. From an initial 53 513 974 hospital stays, 18 070 584 remained after applying the exclusion criteria. The largest reduction occurred following the exclusion of day-care stays and stays without any time spent in acute beds, which together reduced the dataset by almost 60%. Other major exclusion categories related to pathological information (non-specific MDCs) and non-index stays, each accounting for the removal of more than two million records.

Table 8 – Data sample and exclusions

Criteria	Number of observations	Sample reduction
<i>All observations</i>	53 513 974	
<i>1. After excluding day-care stays and stays without time spent in acute beds</i>	23 124 697	30 389 277
<i>2. After excluding stays in non-specific MDCs</i>	20 709 577	2 415 120
<i>3. After excluding long-term stays</i>	20 707 647	1 930
<i>4. After excluding non-index stays</i>	18 706 094	2 001 553
<i>5. After excluding stays with LoS exceeding 90 days, in DRGs where such long stays represent 3 % or less of all admissions</i>	18 656 703	49 391
<i>6. After excluding discharges against medical advice</i>	18 567 191	89 512
<i>7. After excluding index stays followed by multiple transfers</i>	18 491 909	75 282
<i>8. After excluding stays ending in in-hospital death</i>	18 070 584	421 325

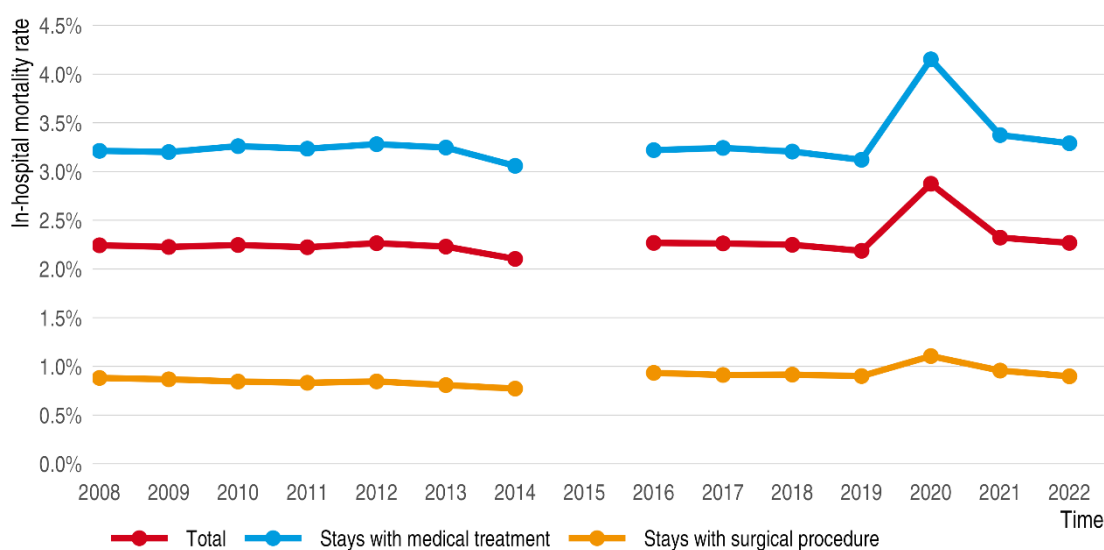
2.3.1.2 In-hospital mortality

Over the entire study period, and after applying all exclusions except the in-hospital mortality criterion, a total of 421 325 in-hospital deaths were recorded (see Table 8): 205 940 over the period 2008-2014 and 215 385 over the period 2016-2022.

Figure 14 shows that in-hospital mortality remained broadly stable at around 2.3% across both periods, with no clear upward or downward trend. A pronounced but temporary increase is visible in 2020, most likely associated with the COVID-19 pandemic, after which mortality returned to levels comparable to previous years. In-hospital mortality was higher, and the COVID-related peak more pronounced, in stays for medical treatment (about 3.3%) than in stays involving surgical procedures (around 1.0%).

In-hospital deaths were concentrated in a limited number of MDCs. Almost two thirds occurred in just four groups: MDC 04 respiratory system (25.5%), MDC 05 circulatory system (15.4%), MDC 01 nervous system (14.2%), and MDC 06 digestive system (9.7%). At the DRG level, the main contributors were DRG 139 (other pneumonia), DRG 194 (heart failure), DRG 136 (respiratory malignancy), DRG 045 (cerebrovascular accident with infarct), and DRG 720 (septicaemia), which together accounted for one in four in-hospital deaths.

Figure 14 – Evolution of in-hospital mortality (observed rate)





2.3.1.3 Study population and admission characteristics

Table 2 summarises the main descriptive characteristics of the study population for the full sample, for each period, and for the first and last year within each period. The study population comprised 18 070 584 admissions, with an almost even distribution between the two study periods (2008-2014 and 2016-2022). Women accounted for slightly more than half of all admissions (55.6%), with a small decline over time.

Table 9 – Descriptives of main population and admission characteristics in the study population [Number of admissions (Share in category)]

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
All admissions	18 070 584 (100.0%)	9 062 896 (100.0%)	1 259 151 (100.0%)	1 317 338 (100.0%)	9 007 688 (100.0%)	1 354 173 (100.0%)	1 274 406 (100.0%)
Sex							
Male	8 019 524 (44.4%)	3 977 601 (43.9%)	549 032 (43.6%)	580 744 (44.1%)	4 041 923 (44.9%)	603 497 (44.6%)	578 791 (45.4%)
Female	10 051 060 (55.6%)	5 085 295 (56.1%)	710 119 (56.4%)	736 594 (55.9%)	4 965 765 (55.1%)	750 676 (55.4%)	695 615 (54.6%)
Age							
Age group 0-15	1 779 934 (9.8%)	888 136 (9.8%)	125 000 (9.9%)	125 812 (9.6%)	891 798 (9.9%)	134 688 (9.9%)	134 793 (10.6%)
Age group 16-45	4 756 862 (26.3%)	2 498 779 (27.6%)	354 519 (28.2%)	352 679 (26.8%)	2 258 083 (25.1%)	347 615 (25.7%)	308 832 (24.2%)
Age group 46-60	3 377 641 (18.7%)	1 730 586 (19.1%)	236 836 (18.8%)	253 022 (19.2%)	1 647 055 (18.3%)	255 706 (18.9%)	218 560 (17.1%)
Age group 61-75	4 234 164 (23.4%)	2 033 294 (22.4%)	281 242 (22.3%)	301 305 (22.9%)	2 200 870 (24.4%)	316 699 (23.4%)	317 685 (24.9%)
Age group 76-85	2 690 167 (14.9%)	1 380 639 (15.2%)	196 751 (15.6%)	198 723 (15.1%)	1 309 528 (14.5%)	202 726 (15.0%)	188 191 (14.8%)
Age group over 85	1 231 816 (6.8%)	531 462 (5.9%)	64 803 (5.1%)	85 797 (6.5%)	700 354 (7.8%)	96 739 (7.1%)	106 345 (8.3%)
Elixhauser							
No comorbidities	7 808 351 (43.2%)	4 144 437 (45.7%)	600 244 (47.7%)	562 857 (42.7%)	3 663 914 (40.7%)	578 227 (42.7%)	502 026 (39.4%)
1 comorbidity	4 026 163 (22.3%)	2 065 956 (22.8%)	289 141 (23.0%)	302 358 (23.0%)	1 960 207 (21.8%)	298 590 (22.0%)	274 411 (21.5%)
2 comorbidities	2 589 070 (14.3%)	1 290 675 (14.2%)	177 452 (14.1%)	192 980 (14.6%)	1 298 395 (14.4%)	192 734 (14.2%)	183 969 (14.4%)
3 or more comorbidities	3 647 000 (20.2%)	1 561 828 (17.2%)	192 314 (15.3%)	259 143 (19.7%)	2 085 172 (23.1%)	284 622 (21.0%)	314 000 (24.6%)
Admission source							
Home	16 800 978 (93.0%)	8 434 854 (93.1%)	1 172 363 (93.1%)	1 227 544 (93.2%)	8 366 124 (92.9%)	1 258 630 (92.9%)	1 177 842 (92.4%)
Nursing home	434 199 (2.4%)	211 560 (2.3%)	29 738 (2.4%)	31 808 (2.4%)	222 639 (2.5%)	33 532 (2.5%)	31 814 (2.5%)
Other hospital	169 875 (0.9%)	86 873 (1.0%)	13 922 (1.1%)	11 896 (0.9%)	83 002 (0.9%)	13 359 (1.0%)	12 232 (1.0%)
Other/unknown	665 532 (3.7%)	329 609 (3.6%)	43 128 (3.4%)	46 090 (3.5%)	335 923 (3.7%)	48 652 (3.6%)	52 518 (4.1%)
Discharge disposition							
Home	16 948 734 (93.8%)	8 542 391 (94.3%)	1 188 898 (94.4%)	1 237 080 (93.9%)	8 406 343 (93.3%)	1 267 765 (93.6%)	1 186 025 (93.1%)
Nursing home	768 978 (4.3%)	349 750 (3.9%)	46 436 (3.7%)	54 851 (4.2%)	419 228 (4.7%)	59 708 (4.4%)	62 994 (4.9%)
Other/unknown	352 872 (2.0%)	170 755 (1.9%)	23 817 (1.9%)	25 407 (1.9%)	182 117 (2.0%)	26 700 (2.0%)	25 387 (2.0%)
Previous emergency contacts							

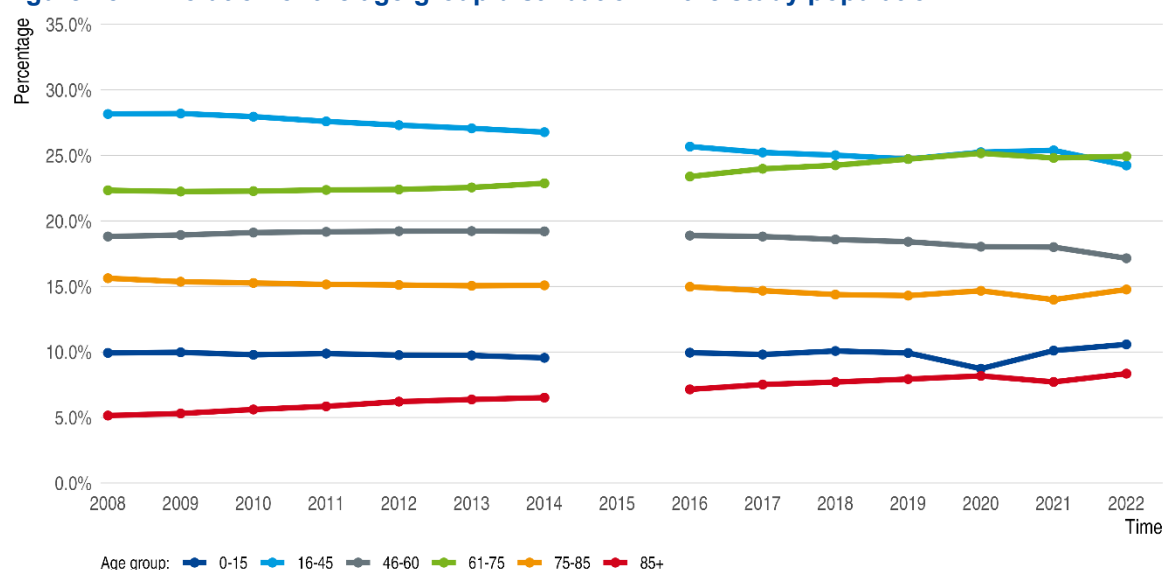
	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
Yes	2 092 040 (11.6%)	996 982 (11.0%)	101 887 (8.1%)	160 686 (12.2%)	1 095 058 (12.2%)	131 086 (9.7%)	153 241 (12.0%)
No	15 978 544 (88.4%)	8 065 914 (89.0%)	1 157 264 (91.9%)	1 156 652 (87.8%)	7 912 630 (87.8%)	1 223 087 (90.3%)	1 121 165 (88.0%)
Palliative care patient							
Yes	70 189 (0.4%)	29 704 (0.3%)	4 314 (0.3%)	4 369 (0.3%)	40 485 (0.4%)	5 018 (0.4%)	6 321 (0.5%)
No	18 000 395 (99.6%)	9 033 192 (99.7%)	1 254 837 (99.7%)	1 312 969 (99.7%)	8 967 203 (99.6%)	1 349 155 (99.6%)	1 268 085 (99.5%)
MDCs - medical/surgical							
MDC 01 (Medical): Nervous System	1 150 335 (6.4%)	566 795 (6.3%)	74 211 (5.9%)	84 946 (6.4%)	583 540 (6.5%)	90 618 (6.7%)	81 014 (6.4%)
MDC 02 (Medical): Eye	40 422 (0.2%)	20 796 (0.2%)	3 032 (0.2%)	2 996 (0.2%)	19 626 (0.2%)	3 110 (0.2%)	2 731 (0.2%)
MDC 03 (Medical): Ear, Nose, Throat (ENT)	1 017 257 (5.6%)	424 737 (4.7%)	51 300 (4.1%)	70 100 (5.3%)	592 520 (6.6%)	82 770 (6.1%)	92 030 (7.2%)
MDC 04 (Medical): Respiratory System	1 424 354 (7.9%)	702 440 (7.8%)	98 377 (7.8%)	100 417 (7.6%)	721 914 (8.0%)	103 261 (7.6%)	112 444 (8.8%)
MDC 05 (Medical): Circulatory System	1 212 669 (6.7%)	650 191 (7.2%)	94 140 (7.5%)	90 989 (6.9%)	562 478 (6.2%)	90 867 (6.7%)	72 204 (5.7%)
MDC 06 (Medical): Digestive System	1 186 402 (6.6%)	620 754 (6.8%)	90 498 (7.2%)	89 619 (6.8%)	565 648 (6.3%)	89 358 (6.6%)	75 197 (5.9%)
MDC 07 (Medical): Hepatobiliary System	282 870 (1.6%)	143 392 (1.6%)	19 913 (1.6%)	21 627 (1.6%)	139 478 (1.5%)	20 012 (1.5%)	20 024 (1.6%)
MDC 08 (Medical): Musculoskeletal System	610 945 (3.4%)	325 907 (3.6%)	49 899 (4.0%)	45 611 (3.5%)	285 038 (3.2%)	46 816 (3.5%)	36 923 (2.9%)
MDC 09 (Medical): Skin/Breast	312 081 (1.7%)	161 892 (1.8%)	23 065 (1.8%)	23 605 (1.8%)	150 189 (1.7%)	23 581 (1.7%)	20 521 (1.6%)
MDC 10 (Medical): Endocrine/Metabolic	318 877 (1.8%)	165 537 (1.8%)	23 553 (1.9%)	23 448 (1.8%)	153 340 (1.7%)	24 072 (1.8%)	21 328 (1.7%)
MDC 11 (Medical): Kidney/Urinary	537 153 (3.0%)	262 405 (2.9%)	35 690 (2.8%)	39 329 (3.0%)	274 748 (3.1%)	41 606 (3.1%)	37 389 (2.9%)
MDC 12 (Medical): Male Reproductive	62 736 (0.3%)	29 761 (0.3%)	4 299 (0.3%)	4 155 (0.3%)	32 975 (0.4%)	4 877 (0.4%)	4 577 (0.4%)
MDC 13 (Medical): Female Reproductive	46 438 (0.3%)	26 831 (0.3%)	4 205 (0.3%)	3 426 (0.3%)	19 607 (0.2%)	3 172 (0.2%)	2 559 (0.2%)
MDC 14 (Medical): Pregnancy/Childbirth	1 384 291 (7.7%)	736 119 (8.1%)	103 998 (8.3%)	102 745 (7.8%)	648 172 (7.2%)	97 828 (7.2%)	87 908 (6.9%)
MDC 15 (Medical): Newborn/Neonates	137 998 (0.8%)	54 206 (0.6%)	6 904 (0.5%)	8 293 (0.6%)	83 792 (0.9%)	11 503 (0.8%)	12 165 (1.0%)
MDC 16 (Medical): Blood/Immunological	136 962 (0.8%)	66 950 (0.7%)	9 860 (0.8%)	9 644 (0.7%)	70 012 (0.8%)	10 291 (0.8%)	10 289 (0.8%)
MDC 17 (Medical): Neoplasms	247 545 (1.4%)	143 039 (1.6%)	20 510 (1.6%)	19 829 (1.5%)	104 506 (1.2%)	17 855 (1.3%)	12 365 (1.0%)
MDC 18 (Medical): Infectious Diseases	254 900 (1.4%)	114 939 (1.3%)	14 168 (1.1%)	18 327 (1.4%)	139 961 (1.6%)	20 743 (1.5%)	20 208 (1.6%)
MDC 01 (Surgical): Nervous System	189 746 (1.1%)	89 230 (1.0%)	12 843 (1.0%)	12 491 (0.9%)	100 516 (1.1%)	14 891 (1.1%)	14 469 (1.1%)
MDC 02 (Surgical): Eye	149 535 (0.8%)	82 295 (0.9%)	12 340 (1.0%)	10 715 (0.8%)	67 240 (0.7%)	10 917 (0.8%)	8 969 (0.7%)
MDC 03 (Surgical): Ear, Nose, Throat (ENT)	454 687 (2.5%)	243 863 (2.7%)	35 806 (2.8%)	33 530 (2.5%)	210 824 (2.3%)	33 593 (2.5%)	28 672 (2.2%)
MDC 04 (Surgical): Respiratory System	70 786 (0.4%)	33 536 (0.4%)	4 113 (0.3%)	5 380 (0.4%)	37 250 (0.4%)	5 212 (0.4%)	5 369 (0.4%)
MDC 05 (Surgical): Circulatory System	1 037 148 (5.7%)	484 390 (5.3%)	65 365 (5.2%)	72 427 (5.5%)	552 758 (6.1%)	77 452 (5.7%)	82 234 (6.5%)
MDC 06 (Surgical): Digestive System	895 715 (5.0%)	456 471 (5.0%)	65 920 (5.2%)	65 202 (4.9%)	439 244 (4.9%)	66 874 (4.9%)	60 575 (4.8%)

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
MDC 07 (Surgical): Hepatobiliary System	303 733 (1.7%)	140 754 (1.6%)	18 853 (1.5%)	21 116 (1.6%)	162 979 (1.8%)	23 746 (1.8%)	23 661 (1.9%)
MDC 08 (Surgical): Musculoskeletal System	2 471 540 (13.7%)	1 233 768 (13.6%)	165 163 (13.1%)	182 868 (13.9%)	1 237 772 (13.7%)	183 341 (13.5%)	178 134 (14.0%)
MDC 09 (Surgical): Skin/Breast	394 687 (2.2%)	205 772 (2.3%)	28 437 (2.3%)	29 216 (2.2%)	188 915 (2.1%)	28 742 (2.1%)	26 670 (2.1%)
MDC 10 (Surgical): Endocrine/Metabolic	265 838 (1.5%)	123 729 (1.4%)	13 690 (1.1%)	20 521 (1.6%)	142 109 (1.6%)	21 950 (1.6%)	19 436 (1.5%)
MDC 11 (Surgical): Kidney/Urinary	344 622 (1.9%)	168 026 (1.9%)	22 709 (1.8%)	24 536 (1.9%)	176 596 (2.0%)	24 688 (1.8%)	26 189 (2.1%)
MDC 12 (Surgical): Male Reproductive	236 255 (1.3%)	119 707 (1.3%)	18 094 (1.4%)	15 981 (1.2%)	116 548 (1.3%)	16 475 (1.2%)	18 168 (1.4%)
MDC 12 (Surgical): Male Reproductive	236 255 (1.3%)	119 707 (1.3%)	18 094 (1.4%)	15 981 (1.2%)	116 548 (1.3%)	16 475 (1.2%)	18 168 (1.4%)
MDC 13 (Surgical): Female Reproductive	416 736 (2.3%)	242 260 (2.7%)	37 310 (3.0%)	31 967 (2.4%)	174 476 (1.9%)	27 657 (2.0%)	23 754 (1.9%)
MDC 14 (Surgical): Pregnancy/Childbirth	390 203 (2.2%)	185 988 (2.1%)	25 937 (2.1%)	26 800 (2.0%)	204 215 (2.3%)	29 348 (2.2%)	29 554 (2.3%)
MDC 15 (Surgical): Newborn/Neonates	4 038 (0.0%)	1 920 (0.0%)	277 (0.0%)	274 (0.0%)	2 118 (0.0%)	292 (0.0%)	282 (0.0%)
MDC 16 (Surgical): Blood/Immunological	11 294 (0.1%)	5 752 (0.1%)	835 (0.1%)	796 (0.1%)	5 542 (0.1%)	848 (0.1%)	657 (0.1%)
MDC 17 (Surgical): Neoplasms	40 410 (0.2%)	18 198 (0.2%)	2 407 (0.2%)	2 751 (0.2%)	22 212 (0.2%)	3 323 (0.2%)	2 836 (0.2%)

INPATIENT POPULATION IS GRADUALLY AGEING AND THE COMORBIDITY BURDEN INCREASES

The age distribution, also illustrated in Figure 4, indicates a gradual ageing of the hospitalised population. Admissions among patients aged 85 years and older increased from 5.1% in 2008 to 8.3% in 2022, while those aged 61–75 years rose from 22.3% to 24.9%. At the same time, the activity share of patients aged 15–60 years decreased, whereas the proportions of the youngest group (0–15 years) and those aged 76–85 years remained relatively stable.

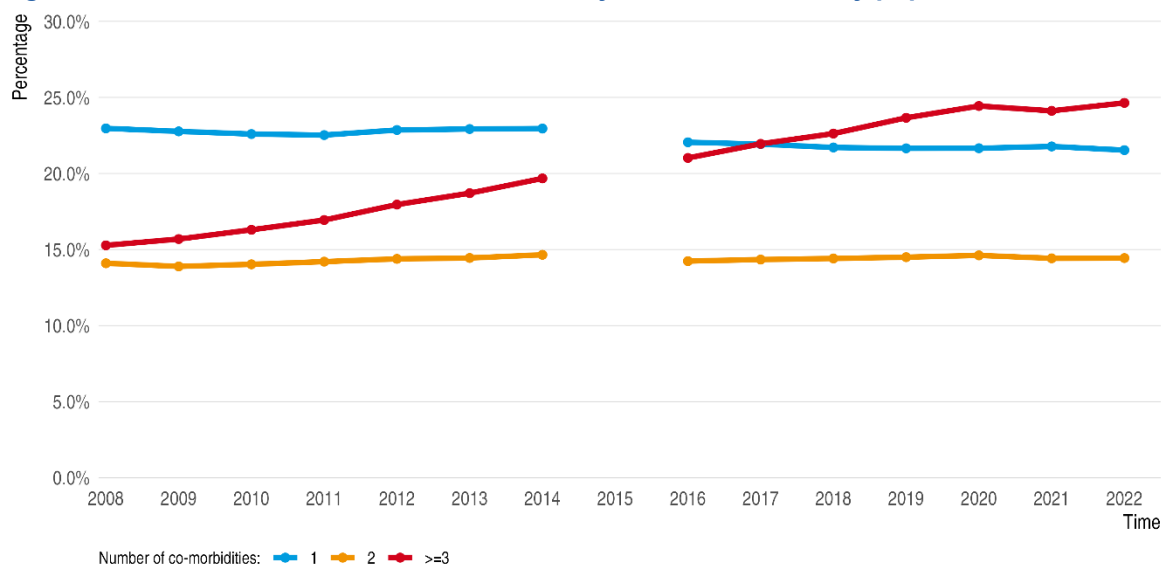
Figure 15 – Evolution of the age-group distribution in the study population



The comorbidity burden in the study population increased substantially over time. The share of patients without recorded comorbidities declined from 47.7% in 2008 to 39.4% in 2022, while the proportion with three or more Elixhauser comorbidities rose from 15.3% to 24.6%. As shown in Figure

5, this increase occurred more or less evenly across both periods. The proportions of patients with one or two comorbidities were relatively stable.

Figure 16 – Evolution of Elixhauser co-morbidity burden in the study population



MOST PATIENTS ARE ADMITTED FROM AND DISCHARGED HOME

Most patients were admitted from home (around 93%) and discharged home (around 94%) in both periods. Patients admitted from and discharged to a nursing home represented approximately 2.5% and 4.3% of the study population, respectively, with discharges to nursing homes becoming slightly more frequent over time. Approximately 12% of admissions were preceded by an emergency contact, with a marked increase during the first period, from 8.1% in 2008 to 12.2% in 2014, after which the rate remained stable. About 0.4% of patients had a recorded palliative care status.

VOLUMES PER MDC VARY BUT THE RELATIVE CONTRIBUTION PER MDC REMAINS RELATIVELY STABLE OVER TIME

The distribution across MDCs highlights the predominance of high-volume surgical domains such as the musculoskeletal system (MDC 08, 13.7%), circulatory system (MDC 05, 5.7%), and digestive system (MDC 06, 5.0%), which together accounted for over a quarter of all hospital stays. Among medical MDCs, several exceeded the 5% threshold, including the nervous system (MDC 01, 6.4%), ear, nose and throat (MDC 03, 5.6%), respiratory system (MDC 04, 7.9%), circulatory system (MDC 05, 6.7%), digestive system (MDC 06, 6.6%), and pregnancy and childbirth (MDC 14, 7.7%). The relative contribution of most MDCs remained relatively stable across periods, although a proportional increase was observed in surgical MDC 13 (female reproductive system), consistent with shifts towards day surgery. In contrast, pregnancy-related (MDC 14) and medical circulatory (MDC 05) admissions showed modest declines, while surgical circulatory (MDC 05) procedures increased slightly, reflecting demographic changes and evolving clinical practice.



2.3.2 Evolution of main outcomes

2.3.2.1 Observed evolution

Table 3 shows the evolution of LoS and Table 4 provides a detailed overview of the evolution of the main outcome variables, i.e. LoS, readmission rate, mortality rate, and the composite rate by age group, comorbidity burden, and MDC. Figure 6 visualizes the trend of the main outcomes, both unadjusted and risk-adjusted.

LENGTH OF STAY DECLINED STEADILY ACROSS AGE, COMORBIDITY, AND PATHOLOGY GROUPS

As shown in Table 3, mean LoS decreased from 6.1 days in 2008 to 5.1 days in 2022, corresponding to a reduction of approximately one day over the study period. This consistent decline was observed in both subperiods and across all demographic subgroups and pathologies, reflecting substantial gains in hospital efficiency despite the ageing of the patient population and the rising comorbidity burden (see section 2.3.1.3).

A clear gradient in LoS by both age and comorbidity was evident, with LoS increasing steadily with age and comorbidity burden. The only deviation from this pattern was seen in the youngest age group, where average LoS was relatively high compared with adolescents and young adults, mainly due to the long stays of newborn and neonatal patients (MDC 15).

Reductions in LoS were observed across all age groups, with the magnitude of change increasing with age. The average stay fell from 4.2 to 3.7 days among children (0-15 years) and from 3.8 to 2.8 days among adults aged 16-45 years. The most substantial absolute reductions occurred among older patients: from 10.0 to 8.0 days in the 76-85 age group and from 13.3 to 11.3 days among those aged 85 years and older.

The largest absolute reductions in LoS were observed in patients with multiple comorbidities (-2.5 days for patients with two comorbidities and -2.6 days for those with three or more), compared with -0.9 days among patients without comorbidities. Patients with multiple comorbidities had greater potential for reductions, starting from higher levels of LoS. Nonetheless, this pattern indicates that efficiency improvements were not limited to low-risk groups.

REDUCTIONS IN LOS MORE PRONOUNCED IN SURGICAL COMPARED TO MEDICAL PATHOLOGY GROUPS

Among medical MDCs, reductions of more than one day were observed in MDC 15 (Newborn/Neonates, -4.7 days), MDC 01 (Nervous system, -1.6 days), MDC 07 (Hepatobiliary system, -1.4 days), MDC 14 (Pregnancy/Childbirth, -1.3 days), and MDC 04 (Respiratory system, -1.3 days). MDC 08 (Musculoskeletal system) was the only medical MDC showing a divergent trend, with an increase of 1.2 days, as a result of a disruptive increase in LoS between both periods, potentially related to a shift in the grouping of pathologies following the transition from ICD-9 to ICD-10 coding. Similar disruptive changes between the two periods were also observed for MDC 01 (Nervous system) and MDC 15 (Newborn/Neonates).

For surgical MDCs, reductions in LoS were generally larger, exceeding two days over the study period in MDC 15 (Newborn/Neonates, -11.5 days), MDC 12 (Male reproductive system, -2.3 days), MDC 10 (Endocrine/Metabolic system, -2.1 days), and MDC 05 (Circulatory system, -2.1 days). For MDC 15, this reduction was mainly driven by a disruptive change between both periods. Other discontinuities were found in MDC 04 (Respiratory system), MDC 08 (Musculoskeletal system), and MDC 18 (Infectious diseases), the latter being the only surgical MDC showing an overall increase in LoS (+2.2 days) across the study period.

Table 10 – Evolution of LoS in the study population [days (difference end – start)]

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
All admissions	5.5 (-1.0)	5.7 (-0.7)	6.1	5.3	5.3 (-0.6)	5.6	5.1
Age							
Age group 0-15	4.0 (-0.5)	4.1 (-0.2)	4.2	4.0	3.9 (-0.2)	4.0	3.7
Age group 16-45	3.3 (-1.0)	3.6 (-0.4)	3.8	3.4	3.0 (-0.3)	3.1	2.8
Age group 46-60	4.0 (-1.2)	4.2 (-0.8)	4.6	3.9	3.7 (-0.5)	3.9	3.4
Age group 61-75	5.7 (-1.4)	5.9 (-1.1)	6.5	5.4	5.4 (-0.7)	5.8	5.1
Age group 76-85	8.9 (-2.0)	9.2 (-1.5)	10.0	8.5	8.7 (-1.4)	9.3	8.0
Age group over 85	12.2 (-1.9)	12.5 (-1.4)	13.3	11.9	12.0 (-1.5)	12.8	11.3
Elixhauser							
No comorbidities	3.3 (-0.9)	3.5 (-0.6)	3.7	3.2	3.0 (-0.4)	3.2	2.8
1 comorbidity	4.6 (-1.9)	5.0 (-1.2)	5.7	4.4	4.1 (-0.8)	4.6	3.8
2 comorbidities	6.5 (-2.5)	7.0 (-1.8)	7.9	6.1	6.0 (-1.2)	6.6	5.4
3 or more comorbidities	10.6 (-2.6)	11.2 (-1.8)	12.2	10.4	10.2 (-1.4)	11.0	9.6
MDCs							
MDC 01 (Medical): Nervous System	7.4 (-1.6)	7.3 (-2.0)	8.6	6.6	7.5 (-1.1)	8.1	7.0
MDC 02 (Medical): Eye	5.3 (-0.5)	5.3 (-0.6)	5.7	5.1	5.3 (-0.2)	5.3	5.2
MDC 03 (Medical): Ear, Nose, Throat (ENT)	2.0 (-0.7)	2.2 (-0.5)	2.5	2.0	1.9 (-0.2)	2.0	1.7
MDC 04 (Medical): Respiratory System	7.8 (-1.3)	8.0 (-0.8)	8.5	7.7	7.6 (-0.6)	7.8	7.2
MDC 05 (Medical): Circulatory System	5.6 (-0.3)	5.6 (-0.5)	5.9	5.4	5.6 (0.0)	5.7	5.7
MDC 06 (Medical): Digestive System	4.6 (-0.9)	4.8 (-0.5)	5.0	4.6	4.3 (-0.3)	4.5	4.2
MDC 07 (Medical): Hepatobiliary System	7.2 (-1.4)	7.5 (-0.8)	7.9	7.1	6.8 (-0.6)	7.1	6.6
MDC 08 (Medical): Musculoskeletal System	9.2 (1.2)	8.7 (-0.1)	8.7	8.6	9.7 (0.1)	9.8	9.8
MDC 09 (Medical): Skin/Breast	7.1 (-0.5)	7.2 (-0.4)	7.5	7.1	7.0 (-0.2)	7.2	6.9
MDC 10 (Medical): Endocrine/Metabolic	6.7 (-0.6)	6.9 (-0.5)	7.2	6.6	6.6 (-0.1)	6.7	6.5
MDC 11 (Medical): Kidney/Urinary	5.8 (-0.0)	5.7 (-0.3)	5.9	5.6	5.8 (-0.1)	5.9	5.9
MDC 12 (Medical): Male Reproductive	5.1 (0.1)	4.9 (0.1)	4.9	5.0	5.2 (0.0)	5.0	5.0
MDC 13 (Medical): Female Reproductive	3.8 (-0.1)	3.8 (-0.0)	3.7	3.7	3.8 (-0.3)	3.9	3.7
MDC 14 (Medical): Pregnancy/Childbirth	3.7 (-1.3)	4.2 (-0.5)	4.4	3.9	3.2 (-0.3)	3.4	3.1
MDC 15 (Medical): Newborn/Neonates	15.8 (-4.7)	18.4 (-0.5)	18.4	17.8	14.1 (-1.3)	14.9	13.6
MDC 16 (Medical): Blood/Immunological	6.5 (-0.8)	6.7 (-0.4)	6.9	6.5	6.4 (-0.4)	6.6	6.2
MDC 17 (Medical): Neoplasms	4.6 (0.1)	4.5 (-0.2)	4.6	4.5	4.7 (0.2)	4.6	4.7
MDC 18 (Medical): Infectious Diseases	7.2 (-0.2)	7.1 (-0.3)	7.2	6.8	7.2 (-0.1)	7.1	7.0
MDC 01 (Surgical): Nervous System	7.7 (-0.9)	7.9 (-0.5)	8.1	7.7	7.6 (-0.7)	7.9	7.2
MDC 02 (Surgical): Eye	1.5 (-0.4)	1.6 (-0.2)	1.7	1.5	1.4 (-0.2)	1.5	1.3
MDC 03 (Surgical): Ear, Nose, Throat (ENT)	2.0 (-0.2)	2.1 (-0.1)	2.1	2.0	2.0 (-0.1)	2.0	1.9
MDC 04 (Surgical): Respiratory System	10.9 (-1.7)	11.1 (-1.7)	11.7	10.1	10.8 (-1.3)	11.4	10.1



	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
MDC 05 (Surgical): Circulatory System	5.3 (-2.1)	5.9 (-1.0)	6.5	5.5	4.8 (-0.9)	5.3	4.4
MDC 06 (Surgical): Digestive System	5.1 (-1.5)	5.5 (-0.6)	5.8	5.2	4.7 (-0.8)	5.2	4.3
MDC 07 (Surgical): Hepatobiliary System	4.0 (-1.6)	4.3 (-1.3)	5.0	3.7	3.8 (-0.5)	4.0	3.5
MDC 08 (Surgical): Musculoskeletal System	5.9 (-0.8)	5.8 (-1.3)	6.5	5.2	6.0 (-0.9)	6.5	5.6
MDC 09 (Surgical): Skin/Breast	3.7 (-1.4)	4.0 (-0.7)	4.4	3.7	3.4 (-0.8)	3.8	3.0
MDC 10 (Surgical): Endocrine/Metabolic	3.2 (-2.1)	3.8 (-0.9)	4.2	3.3	2.6 (-0.9)	3.1	2.1
MDC 11 (Surgical): Kidney/Urinary	4.2 (-1.9)	4.8 (-0.8)	5.2	4.4	3.8 (-1.0)	4.3	3.3
MDC 12 (Surgical): Male Reproductive	4.1 (-2.3)	4.8 (-0.7)	5.1	4.4	3.5 (-1.2)	4.1	2.8
MDC 13 (Surgical): Female Reproductive	3.2 (-1.6)	3.6 (-0.7)	3.9	3.2	2.7 (-0.8)	3.1	2.3
MDC 14 (Surgical): Pregnancy/Childbirth	5.0 (-1.8)	5.7 (-0.6)	6.0	5.4	4.4 (-0.4)	4.6	4.2
MDC 15 (Surgical): Newborn/Neonates	44.4 (-11.5)	48.0 (-0.7)	52.0	51.3	41.1 (-2.6)	43.2	40.6
MDC 16 (Surgical): Blood/Immunological	5.0 (-0.6)	5.2 (-0.8)	5.5	4.7	4.8 (0.1)	4.8	4.9
MDC 17 (Surgical): Neoplasms	8.1 (-0.9)	8.4 (-0.6)	8.9	8.3	7.9 (0.2)	7.8	8.0
MDC 18 (Surgical): Infectious Diseases	17.6 (2.2)	16.6 (0.3)	16.1	16.4	18.3 (-0.9)	19.2	18.3

MODEST IMPROVEMENTS IN 30-DAY READMISSIONS ACROSS AGE AND COMORBIDITY GROUPS

As shown in Table 4, readmission rates declined moderately over the study period, from 5.5% in 2008 to 5.0% in 2022, a decrease of 0.5 percentage points (pp). Reductions were observed in both subperiods and across all age groups and comorbidity levels. Trends by MDC were more heterogeneous, although the large majority of MDCs showed a stable or slightly declining evolution over time.

A clear gradient in readmission risk by age was evident, with rates increasing progressively with age, ranging from 3.5% among patients aged 16–45 years to 9.8% among those aged 85 years and older. The exception was the youngest age group (0–15 years), where newborns and neonates in MDC 15 (Surgical) exhibited the highest readmission rates across all MDCs. The relative decline in readmission rates was visible across all age groups except the youngest, where rates remained stable.

Readmission risk also rose with comorbidity burden. In 2008, rates ranged from 3.7% among patients without comorbidities to 10.2% among those with three or more Elixhauser conditions. By 2022, these rates had declined to 3.0% and 9.1%, respectively, indicating improvements across all risk strata. The strongest reductions were observed among patients with one or two comorbidities (-1.4 pp and -1.7 pp, respectively).

SOME MDC'S HAVE MUCH HIGHER READMISSION RATES THAN OTHERS

Modest declines in readmission rates were observed across most MDCs between 2008 and 2022, though the magnitude and direction of change varied considerably by pathology and admission type. Among medical MDCs, readmission rates were highest in MDC 04 (Respiratory system, 8.3%), MDC 05 (Circulatory system, 7.3%), MDC 07 (Hepatobiliary system, 10.1%), MDC 11 (Kidney/Urinary system, 8.5%), MDC 16 (Blood/Immunological, 8.3%), and MDC 17 (Neoplasms, 10.6%), and lowest in MDC 03 (Ear, Nose, Throat, 2.4%). Reductions over time were most pronounced in MDC 03 (Ear,

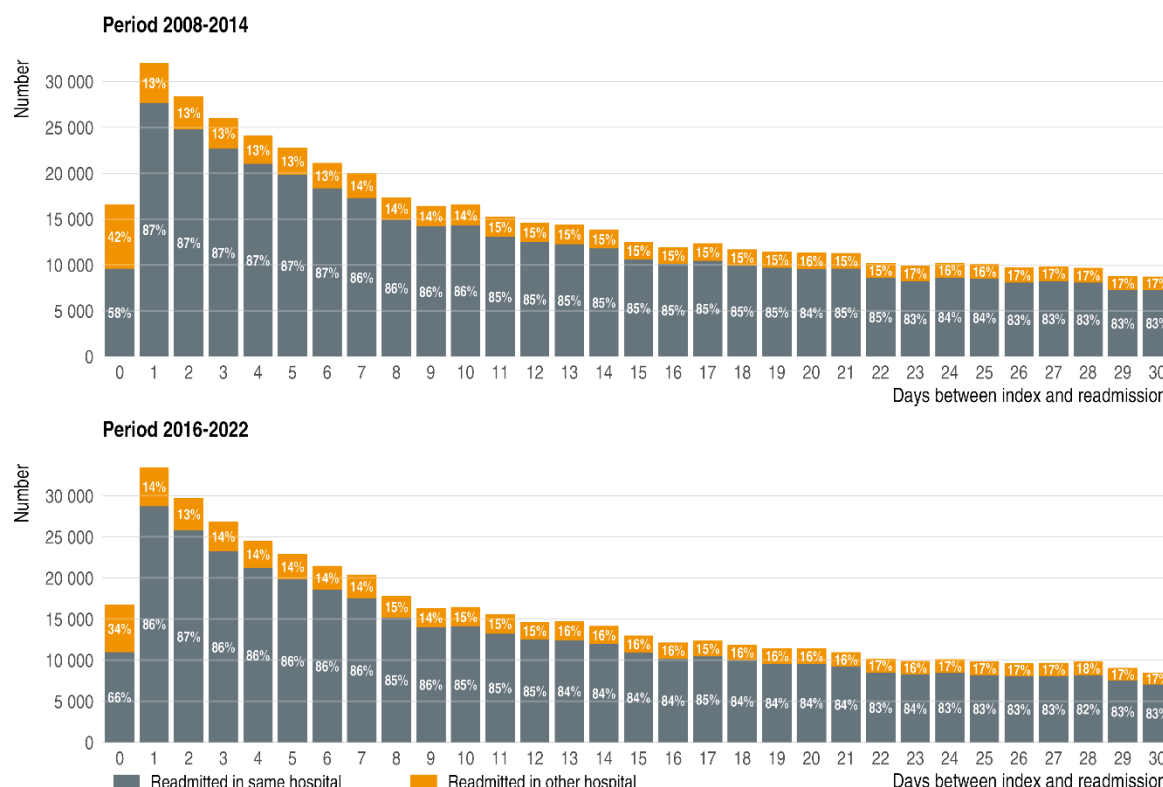
Nose, Throat, -1.2 pp), MDC 04 (Respiratory system, -1.3 pp), MDC 01 (Nervous system, -1.3 pp), MDC 12 (Male reproductive system, -1.3 pp), and MDC 14 (Pregnancy/Childbirth, -1.0 pp). In contrast, a few categories displayed stable or slightly rising trends, notably MDC 02 (Eye, +0.5 pp), MDC 10 (Endocrine/Metabolic system, +0.4 pp), and MDC 15 (Newborn/Neonates, +0.6 pp).

In surgical MDCs, the overall picture was similarly heterogeneous. Readmission rates were highest in MDC 04 (Respiratory system, 7.2%), MDC 11 (Kidney/Urinary system, 7.3%), MDC 15 (Newborn/Neonates, 12.2%), MDC 16 (Blood/Immunological, 7.4%), and MDC 17 (Neoplasms, 8.7%) and lowest in MDC 14 (Pregnancy/Childbirth, 1.6%), MDC 02 (Eye, 2.6%). The most notable decline was recorded in MDC 15 (-2.7 pp), followed by smaller reductions in MDC 05 (Circulatory system, -0.9 pp), MDC 02 (Eye, -0.9 pp), and MDC 09 (Skin/Breast, -0.4 pp). Increases were seen in a limited number of surgical MDCs, including MDC 07 (Hepatobiliary system, +0.7 pp), MDC 16 (Blood/Immunological, +1.1 pp), and MDC 17 (Neoplasms, +1.3 pp).

ONE IN SIX READMISSIONS OCCUR IN A DIFFERENT HOSPITAL, APPROXIMATELY 12 DAYS AFTER DISCHARGE

Table 12 summarises the characteristics of readmission stays over the study period. The vast majority of readmissions were inpatient admissions (97.6%), with a marked increase between 2008 and 2009 and stable rates above 95% thereafter. The low value observed in 2008 (92.2%) represents an outlier, likely linked to coding issues concerning the classification of planned versus unplanned day-care treatments in that year.

Approximately 84% of readmissions occurred in the same hospital as the index admission, meaning that around 16% of patients were readmitted elsewhere, which may reflect amongst other factors patient preferences or referral patterns. Figure 17 shows that the proportion of readmissions occurring in another hospital remains fairly stable across the days between discharge of the index stay and the unplanned readmission. The one notable exception is readmissions on day of discharge, where the percentage of readmissions to another hospital is much higher (period 1: 42%; period 2: 34%) and potentially include unrecorded hospital transfers.

Figure 17 – Unplanned readmissions per day after discharge

The average interval between discharge and readmission was 11.8 days, showing a modest reduction of 0.4 days over the study period. There is a clear declining number of readmissions during the 30-day window. (Figure 17) The mean LoS during readmissions decreased substantially, from 10.9 days in 2008 to 9.0 days in 2022 (-1.9 days), a trend consistent with the overall reduction in hospital LoS in the inpatient population (-1.0 days over the same period; see Table 3).

Finally, about 40% of readmissions were classified under the same MDC as the index stay, a proportion that remained broadly stable over time. Readmissions assigned to a different MDC do not necessarily reflect unrelated conditions, as they may still be associated with complications or ongoing care following the initial hospitalisation.

OVERALL MORTALITY RATES ARE UNCHANGED OVER TIME

The evolution of mortality rates in period 2, shown in Table 4, indicates that 30-day mortality remained around 1% and stable over time (0.9% in 2016 to 1.0% in 2022), with – as expected – strong gradients by age and comorbidity burden. There was a slight increase related to COVID as shown in Figure 6.

Mortality rates rose sharply with advancing age, from 0.2% among patients aged 46–60 years to 5.3% among those aged 85 years and older. Mortality also increased with comorbidity burden, ranging from 0.1% among patients without comorbidities to 2.9% among those with three or more Elixhauser conditions. More concerning is that in the highest age group (+0.3 pp) and comorbidity group (+0.2 pp), mortality rates showed slight increases, whereas mortality among low- and moderate-risk patients remained stable or declined marginally.

Across pathologies, mortality rates varied widely. Among medical MDCs, the highest values were observed in MDC 07 (Hepatobiliary system, 2.8%), MDC 04 (Respiratory system, 2.5%), and MDC 17 (Neoplasms, 2.6%), while rates were nearly zero in MDC 02 (Eye), MDC 14 (Pregnancy/Childbirth), and MDC 15 (Newborn/Neonates). Increases of 0.5 pp or more in 30-day mortality were seen in MDC

05 (Circulatory system, +0.5 pp), MDC 08 (Musculoskeletal system, +0.7 pp), MDC 13 (Female reproductive system, +0.7 pp), and MDC 17 (Neoplasms, +0.6 pp). No substantial decreases were observed.

Among surgical MDCs, mortality rates were considerably lower, remaining below 1% for nearly all groups except for MDC 04 (Respiratory system, 1.6%), MDC 16 (Blood/Immunological, 1.6%), and MDC 17 (Neoplasms, 2.0%). Increases of 0.5 pp or more were observed in MDC 16 (Blood/Immunological, +0.5 pp) and MDC 17 (Neoplasms, +0.6 pp). No substantial decreases were observed.

COMPOSITE RATES GENERALLY MIRROR READMISSION TRENDS, BUT MORTALITY REVERSES GAINS IN SELECTED PATHOLOGIES

Overall, composite rates combining 30-day readmission and mortality remained stable at around 6% in period 2, showing a slight decline from 6.1% in 2016 to 5.7% in 2022 (-0.3 pp). The pattern mirrors that observed for the separate outcomes: gradual improvement overall, but persistent gradients by age and comorbidity burden, and substantial heterogeneity across pathologies.

A clear age gradient was observed. Composite rates ranged from 3.4% among patients aged 16-45 years to 13.8% among those aged 85 years and older. Reductions were visible in all age groups except the oldest, where rates remained high and almost unchanged (-0.2 pp). Similarly, outcomes deteriorated progressively with comorbidity burden: from 3.2% in patients without comorbidities to 11.6% among those with three or more Elixhauser conditions. Absolute improvements were largest among patients with one or two comorbidities (-0.8 pp and -1.0 pp), suggesting that moderate-risk groups benefited most from advances in hospital and discharge care.

Across MDCs, composite rates varied widely. Overall, the trends largely mirrored those observed for readmission rates, which represent the dominant component of the composite measure. However, in some MDCs where mortality increased – particularly medical MDC 05 (Circulatory system), MDC 08 (Musculoskeletal system), MDC 09 (Skin/Breast), and MDC 13 (Female reproductive system) – stable or declining readmission rates in the 2016-2022 period were offset by modest rises in mortality.

LIMITED OVERLAP BETWEEN OUTCOMES, YET HIGHER RISK PATIENTS ARE DISPROPORTIONATELY AFFECTED

In addition, we examined the overlap between both components of the composite indicator. This can be easily inferred from Table 4 by summing the individual rates for readmission and mortality and comparing the result with the composite rate. This exercise shows an overall overlap of 0.28% of the total population, meaning that 0.28% of index admissions in the study sample experienced both a 30-day readmission and a 30-day mortality.

As with the individual outcomes, the overlap displayed a marked age and comorbidity gradient. The overlap was 0.10% in the 46–60 age group, compared with 1.23% among those aged 85 years and older. Similarly, the overlap was 0.02% of patients without comorbidities and 0.87% among those with three or more Elixhauser comorbidities.

Substantial heterogeneity was also observed across MDCs, with higher overlap between both events in MDC 04 (Respiratory system) and MDC 17 (Neoplasms) in both medical and surgical contexts, as well as for medical treatment in MDC 05 (Circulatory system), MDC 07 (Hepatobiliary system), and MDC 16 (Blood/Immunological system).



Table 11 – Evolution of readmission, mortality rate and composite rate in the study population [Rate (difference end rate – start rate)]

	Readmission rates							Mortality rates			Composite rates		
	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022
All admissions	5.2% (-0.5 pp)	5.2% (-0.5 pp)	5.5%	5.0%	5.3% (-0.4 pp)	5.5%	5.0%	0.9% (0.1 pp)	0.9%	1.0%	6.0% (-0.3 pp)	6.1%	5.7%
Age													
Age group 0-15	4.2% (-0.1 pp)	4.1% (-0.2 pp)	4.3%	4.1%	4.4% (-0.2 pp)	4.4%	4.2%	0.0% (-0.0 pp)	0.0%	0.0%	4.4% (-0.2 pp)	4.4%	4.2%
Age group 16-45	3.5% (-0.9 pp)	3.5% (-0.6 pp)	4.0%	3.4%	3.4% (-0.4 pp)	3.5%	3.1%	0.0% (-0.0 pp)	0.0%	0.0%	3.4% (-0.4 pp)	3.6%	3.1%
Age group 46-60	3.8% (-1.0 pp)	3.9% (-0.6 pp)	4.3%	3.7%	3.8% (-0.6 pp)	4.0%	3.3%	0.2% (0.0 pp)	0.3%	0.3%	3.9% (-0.6 pp)	4.1%	3.5%
Age group 61-75	5.6% (-0.5 pp)	5.5% (-0.5 pp)	5.9%	5.4%	5.7% (-0.5 pp)	5.9%	5.4%	0.8% (0.1 pp)	0.7%	0.8%	6.2% (-0.5 pp)	6.3%	5.9%
Age group 76-85	8.2% (-0.7 pp)	8.1% (-0.8 pp)	8.4%	7.6%	8.2% (-0.8 pp)	8.5%	7.7%	1.9% (0.1 pp)	1.9%	1.9%	9.6% (-0.7 pp)	9.8%	9.1%
Age group over 85	9.8% (-0.9 pp)	9.9% (-1.1 pp)	10.3%	9.2%	9.8% (-0.5 pp)	9.9%	9.4%	5.3% (0.3 pp)	5.1%	5.4%	13.8% (-0.2 pp)	13.8%	13.6%
Elixhauser													
No comorbidities	3.3% (-0.7 pp)	3.3% (-0.4 pp)	3.7%	3.2%	3.2% (-0.4 pp)	3.4%	3.0%	0.1% (-0.0 pp)	0.1%	0.1%	3.2% (-0.4 pp)	3.4%	3.0%
1 comorbidity	4.6% (-1.4 pp)	4.8% (-0.9 pp)	5.3%	4.4%	4.3% (-0.7 pp)	4.6%	3.9%	0.4% (-0.1 pp)	0.4%	0.3%	4.6% (-0.8 pp)	4.9%	4.1%
2 comorbidities	6.2% (-1.7 pp)	6.4% (-1.3 pp)	7.1%	5.8%	6.0% (-0.9 pp)	6.4%	5.4%	1.0% (-0.1 pp)	1.1%	1.0%	6.7% (-1.0 pp)	7.1%	6.1%
3 or more comorbidities	9.6% (-1.1 pp)	9.6% (-1.2 pp)	10.2%	9.0%	9.6% (-0.9 pp)	9.9%	9.1%	2.9% (0.2 pp)	2.9%	3.1%	11.6% (-0.7 pp)	11.9%	11.3%
MDCs													
MDC 01 (Medical): Nervous System	5.6% (-1.3 pp)	5.7% (-1.2 pp)	6.5%	5.3%	5.6% (-0.5 pp)	5.8%	5.3%	1.5% (0.2 pp)	1.4%	1.6%	6.7% (-0.3 pp)	6.8%	6.5%
MDC 02 (Medical): Eye	4.8% (0.5 pp)	4.8% (-0.1 pp)	4.7%	4.6%	4.9% (0.4 pp)	4.8%	5.2%	0.6% (0.2 pp)	0.5%	0.7%	5.3% (0.5 pp)	5.1%	5.7%
MDC 03 (Medical): Ear, Nose, Throat (ENT)	2.4% (-1.2 pp)	2.7% (-0.6 pp)	3.0%	2.4%	2.2% (-0.5 pp)	2.4%	1.9%	0.2% (0.0 pp)	0.1%	0.2%	2.3% (-0.5 pp)	2.5%	2.0%
MDC 04 (Medical): Respiratory System	8.3% (-1.3 pp)	8.4% (-1.0 pp)	9.0%	8.0%	8.2% (-1.1 pp)	8.8%	7.7%	2.5% (0.1 pp)	2.4%	2.5%	10.0% (-1.0 pp)	10.5%	9.5%
MDC 05 (Medical): Circulatory System	7.3% (0.1 pp)	7.0% (-0.6 pp)	7.5%	6.9%	7.6% (0.0 pp)	7.6%	7.6%	1.8% (0.5 pp)	1.6%	2.1%	8.8% (0.4 pp)	8.6%	9.0%
MDC 06 (Medical): Digestive System	6.3% (-0.1 pp)	6.1% (-0.2 pp)	6.3%	6.0%	6.5% (-0.3 pp)	6.4%	6.2%	1.1% (0.1 pp)	1.1%	1.2%	7.3% (-0.2 pp)	7.2%	7.0%
MDC 07 (Medical): Hepatobiliary System	10.1% (0.1 pp)	9.7% (-1.0 pp)	10.4%	9.4%	10.5% (0.1 pp)	10.4%	10.5%	2.8% (0.1 pp)	2.8%	2.9%	12.6% (0.1 pp)	12.5%	12.5%
MDC 08 (Medical): Musculoskeletal System	6.8% (0.1 pp)	6.6% (-0.3 pp)	6.7%	6.4%	7.0% (-0.3 pp)	7.1%	6.8%	1.6% (0.7 pp)	1.3%	1.9%	8.2% (0.2 pp)	8.0%	8.2%
MDC 09 (Medical): Skin/Breast	5.9% (-0.2 pp)	5.8% (-0.5 pp)	6.1%	5.6%	6.0% (-0.0 pp)	5.9%	5.9%	1.6% (0.4 pp)	1.3%	1.7%	7.2% (0.3 pp)	6.9%	7.1%

	Readmission rates							Mortality rates			Composite rates		
	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022
MDC 10 (Medical): Endocrine/Metabolic	6.4% (0.4 pp)	6.1% (-0.8 pp)	6.4%	5.7%	6.7% (0.1 pp)	6.7%	6.8%	1.7% (0.1 pp)	1.6%	1.7%	7.9% (0.2 pp)	7.9%	8.1%
MDC 11 (Medical): Kidney/Urinary	8.5% (-0.2 pp)	8.3% (-0.6 pp)	8.6%	8.0%	8.8% (-0.5 pp)	8.9%	8.4%	1.8% (0.4 pp)	1.7%	2.0%	10.1% (-0.1 pp)	10.1%	10.0%
MDC 12 (Medical): Male Reproductive	6.8% (-1.3 pp)	6.8% (-1.2 pp)	7.5%	6.4%	6.8% (-0.5 pp)	6.7%	6.2%	1.7% (-0.0 pp)	1.8%	1.7%	8.1% (-0.3 pp)	8.0%	7.7%
MDC 13 (Medical): Female Reproductive	4.9% (0.2 pp)	4.7% (0.2 pp)	4.6%	4.8%	5.2% (-0.6 pp)	5.4%	4.8%	1.8% (0.7 pp)	1.3%	2.0%	6.6% (0.1 pp)	6.4%	6.4%
MDC 14 (Medical): Pregnancy/Childbirth	4.2% (-1.0 pp)	4.3% (-0.5 pp)	4.7%	4.2%	4.0% (-0.5 pp)	4.2%	3.7%	0.0% (0.0 pp)	0.0%	0.0%	4.0% (-0.5 pp)	4.2%	3.7%
MDC 15 (Medical): Newborn/Neonates	5.7% (0.6 pp)	5.5% (0.1 pp)	5.3%	5.4%	5.8% (0.0 pp)	5.9%	5.9%	0.1% (-0.0 pp)	0.1%	0.1%	5.9% (-0.0 pp)	6.0%	6.0%
MDC 16 (Medical): Blood/Immunological	8.3% (-0.2 pp)	8.2% (-0.8 pp)	8.4%	7.5%	8.5% (-0.4 pp)	8.6%	8.2%	2.0% (-0.1 pp)	1.9%	1.9%	9.9% (-0.5 pp)	9.9%	9.5%
MDC 17 (Medical): Neoplasms	10.6% (0.2 pp)	10.2% (0.1 pp)	10.0%	10.2%	11.0% (-1.0 pp)	11.2%	10.2%	2.6% (0.6 pp)	2.3%	2.9%	12.7% (-0.6 pp)	12.6%	12.1%
MDC 18 (Medical): Infectious Diseases	6.6% (-0.3 pp)	6.3% (-0.5 pp)	6.6%	6.1%	6.9% (-0.5 pp)	6.8%	6.4%	1.5% (0.2 pp)	1.4%	1.6%	8.1% (-0.2 pp)	7.9%	7.7%
MDC 01 (Surgical): Nervous System	5.0% (-0.5 pp)	5.2% (0.1 pp)	5.0%	5.1%	4.8% (-0.5 pp)	5.0%	4.5%	0.6% (0.3 pp)	0.5%	0.7%	5.2% (-0.3 pp)	5.3%	5.0%
MDC 02 (Surgical): Eye	2.3% (-0.9 pp)	2.6% (-0.3 pp)	2.7%	2.4%	2.0% (-0.3 pp)	2.1%	1.8%	0.1% (0.0 pp)	0.1%	0.1%	2.0% (-0.3 pp)	2.2%	1.9%
MDC 03 (Surgical): Ear, Nose, Throat (ENT)	2.6% (-0.0 pp)	2.4% (-0.0 pp)	2.6%	2.6%	2.8% (-0.1 pp)	2.8%	2.6%	0.1% (0.0 pp)	0.0%	0.1%	2.9% (-0.1 pp)	2.8%	2.7%
MDC 04 (Surgical): Respiratory System	7.2% (0.5 pp)	6.7% (-0.6 pp)	7.0%	6.4%	7.7% (-0.7 pp)	8.2%	7.5%	1.6% (-0.1 pp)	1.6%	1.5%	8.8% (-0.5 pp)	9.1%	8.6%
MDC 05 (Surgical): Circulatory System	5.8% (-0.9 pp)	5.8% (-0.7 pp)	6.3%	5.6%	5.9% (-0.7 pp)	6.2%	5.4%	0.5% (0.1 pp)	0.5%	0.5%	6.2% (-0.7 pp)	6.4%	5.7%
MDC 06 (Surgical): Digestive System	4.7% (0.4 pp)	4.4% (-0.0 pp)	4.5%	4.5%	5.1% (0.0 pp)	4.9%	4.9%	0.4% (0.1 pp)	0.4%	0.4%	5.3% (0.1 pp)	5.1%	5.2%
MDC 07 (Surgical): Hepatobiliary System	4.5% (0.7 pp)	4.0% (-0.2 pp)	4.4%	4.1%	5.0% (0.3 pp)	4.8%	5.0%	0.5% (0.1 pp)	0.5%	0.5%	5.3% (0.3 pp)	5.1%	5.4%
MDC 08 (Surgical): Musculoskeletal System	2.7% (-0.3 pp)	2.6% (-0.3 pp)	2.8%	2.5%	2.7% (-0.2 pp)	2.8%	2.6%	0.4% (0.1 pp)	0.4%	0.4%	3.0% (-0.2 pp)	3.0%	2.9%

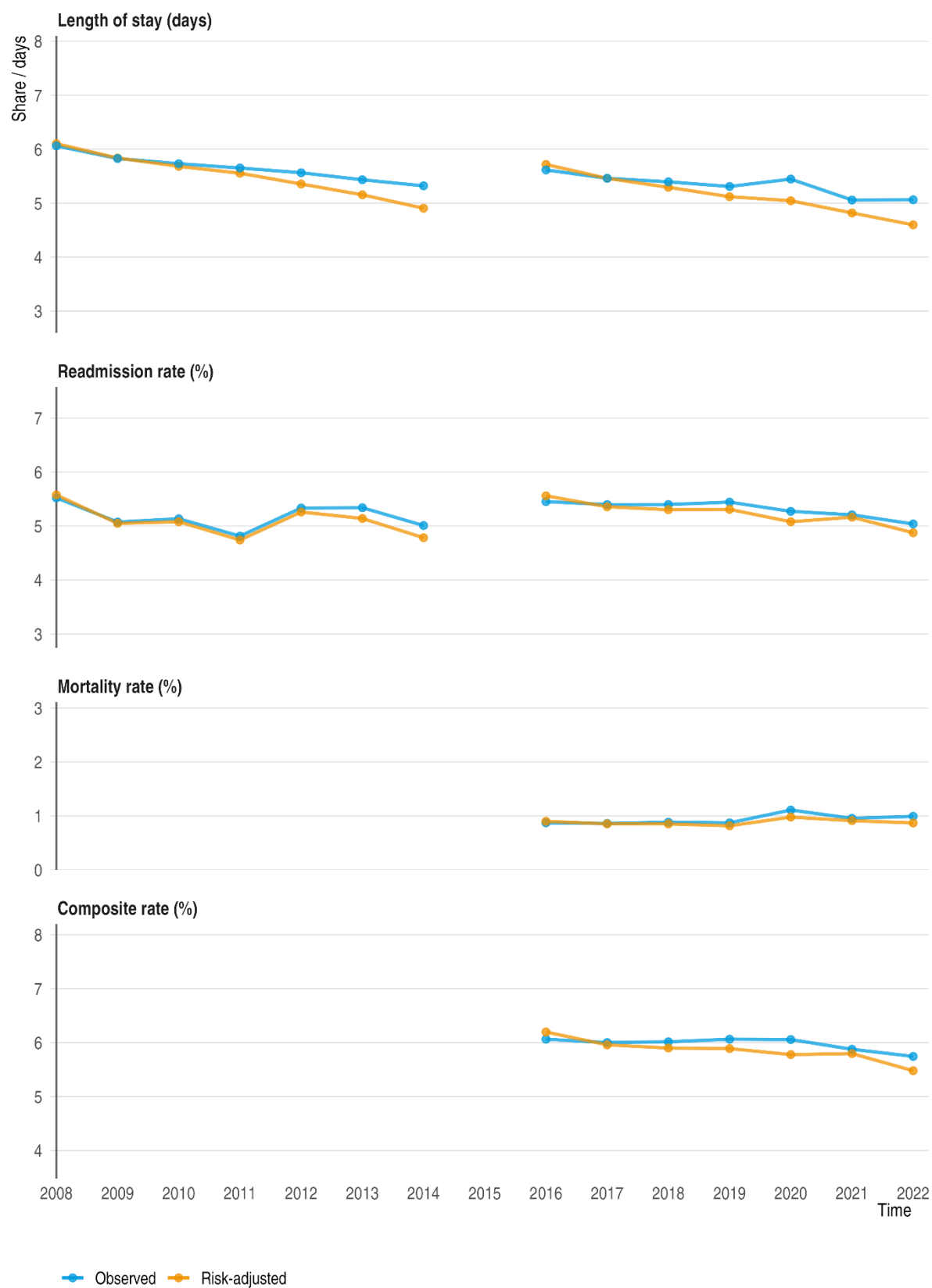
	Readmission rates							Mortality rates			Composite rates		
	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022
MDC 09 (Surgical): Skin/Breast	2.4% (-0.4 pp)	2.4% (-0.2 pp)	2.5%	2.4%	2.5% (-0.6 pp)	2.7%	2.1%	0.2% (0.0 pp)	0.1%	0.2%	2.6% (-0.6 pp)	2.8%	2.2%
MDC 10 (Surgical): Endocrine/Metabolic	3.3% (0.0 pp)	3.1% (-0.0 pp)	3.1%	3.1%	3.4% (-0.1 pp)	3.3%	3.2%	0.1% (0.0 pp)	0.1%	0.1%	3.4% (-0.1 pp)	3.3%	3.2%
MDC 11 (Surgical): Kidney/Urinary	7.3% (0.0 pp)	7.1% (-0.2 pp)	7.3%	7.1%	7.6% (-0.3 pp)	7.7%	7.4%	0.5% (0.0 pp)	0.5%	0.5%	7.9% (-0.3 pp)	8.0%	7.7%
MDC 12 (Surgical): Male Reproductive	6.3% (1.1 pp)	5.7% (0.8 pp)	5.5%	6.3%	6.8% (-0.3 pp)	6.9%	6.6%	0.2% (-0.1 pp)	0.2%	0.1%	6.9% (-0.3 pp)	7.0%	6.7%
MDC 13 (Surgical): Female Reproductive	2.6% (-0.1 pp)	2.5% (-0.1 pp)	2.7%	2.6%	2.8% (-0.4 pp)	3.0%	2.6%	0.1% (0.0 pp)	0.0%	0.0%	2.8% (-0.4 pp)	3.0%	2.6%
MDC 14 (Surgical): Pregnancy/Childbirth	1.6% (-0.3 pp)	1.6% (-0.3 pp)	1.8%	1.5%	1.6% (-0.2 pp)	1.8%	1.5%	0.0% (0.0 pp)	0.0%	0.0%	1.6% (-0.2 pp)	1.8%	1.5%
MDC 15 (Surgical): Newborn/Neonates	12.2% (-2.7 pp)	13.2% (0.2 pp)	14.8%	15.0%	11.4% (-1.6 pp)	13.7%	12.1%	0.4% (-0.3 pp)	0.3%	0.0%	11.6% (-2.0 pp)	14.0%	12.1%
MDC 16 (Surgical): Blood/Immunological	4.9% (0.4 pp)	4.8% (0.5 pp)	4.4%	4.9%	5.1% (-0.2 pp)	5.1%	4.9%	0.4% (0.5 pp)	0.2%	0.8%	5.3% (0.0 pp)	5.3%	5.3%
MDC 17 (Surgical): Neoplasms	7.4% (1.1 pp)	6.6% (0.8 pp)	6.6%	7.4%	7.9% (0.3 pp)	7.5%	7.7%	1.6% (0.6 pp)	1.4%	2.0%	9.0% (0.2 pp)	8.6%	8.8%
MDC 18 (Surgical): Infectious Diseases	8.7% (1.3 pp)	7.6% (0.5 pp)	7.0%	7.5%	9.4% (-1.5 pp)	9.7%	8.3%	2.0% (0.3 pp)	1.8%	2.1%	10.8% (-1.4 pp)	11.1%	9.7%

Table 12 – Descriptives of readmissions [Rate or days (difference end – start)]

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
<i>Share inpatient admissions</i>	97.6% (6.2 pp)	96.8% (5.9 pp)	92.2%	98.0%	98.4% (0.2 pp)	98.2%	98.4%
<i>Share admitted in same hospital as index</i>	84.4% (-0.4 pp)	84.6% (1.2 pp)	83.8%	85.1%	84.3% (-1.6 pp)	84.9%	83.4%
<i>Days between index and readmission</i>	11.8 (-0.4)	11.8 (-0.3)	12.0	11.7	11.7 (-0.3)	11.8	11.6
<i>Acute length of stay (in days)</i>	10.2 (-1.9)	10.7 (-1.1)	10.9	9.8	9.7 (-1.2)	10.2	9.0
<i>Share with same MDC as index</i>	40.4% (0.4 pp)	40.7% (1.9 pp)	39.3%	41.2%	40.0% (-0.9 pp)	40.5%	39.7%



Figure 18 – Evolution of main outcomes (observed and risk-adjusted values)



2.3.2.2 Risk-adjusted outcomes

ESTIMATION MODELS

Information on the estimation models is provided in the Supplement to Chapter 2. The C-statistics of the models ranged from 0.56 to 0.87 (mean = 0.68) for readmission, from 0.78 to 0.94 (mean = 0.88) for mortality, and from 0.56 to 0.85 (mean = 0.70) for the composite rate. These values indicate that the 30-day mortality models had substantially better discriminatory ability than those for readmission and the composite outcome.

For LoS, the mean absolute error (MAE), expressed as a ratio of the mean observed LoS, ranged from 29% to 85%, with an average of 62%.

In Supplement to Chapter 2 also the most influential covariates included in the estimation models are summarised. Age group, Elixhauser comorbidity burden, DRG classification, and a previous emergency contact (within 180 days prior to admission) were the explanatory variables accounting for the largest share of variation in the outcomes. Moreover, in the mortality models, palliative status was a particularly strong determinant, frequently emerging as the single most predictive covariate.

RISK ADJUSTMENT ACCENTUATES THE DECLINE IN LOS

Table 13 and Figure 6 show that risk-adjusted length of stay (LoS) decreased from 6.1 days in 2008 to 4.6 days in 2022 (-1.5 days), representing a stronger reduction than the unadjusted decline of length of stay. This suggests that, after accounting for changes in case mix and patient characteristics – notably the higher shares of older and multimorbid patients – reductions in LoS were even more pronounced than indicated by the crude figures. Hence, patients are in reality staying for shorter periods than would be expected given their risk profiles and historical hospital practices. The risk-adjusted results thus reinforce the interpretation of sustained efficiency gains in terms of LoS in inpatient care over the study period. Declines were observed in both subperiods.

A clear gradient in LoS by age remained evident after risk adjustment, with stays being longer with higher age, from 3.9 days among children (0-15 years) to 11.7 days among patients aged 85 years or older. However, the risk-adjusted analysis shows that reductions in LoS were considerably steeper in the two oldest age groups (-2.6 to -3.6 days) than in the unadjusted estimates (-1.9 to -2.0 days, see Table 3). This indicates that much of the apparent stability in crude LoS among elderly patients was attributable to the increasing severity and comorbidity burden of their case mix.

The same pattern holds for comorbidity. The risk-adjusted analysis reveals larger absolute reductions, particularly for patients with multiple comorbidities. Among those with three or more Elixhauser conditions, risk-adjusted LoS declined by 3.3 days compared with a 2.6-day decline in the unadjusted figures.

Across most MDCs, risk adjustment accentuates the decline in LoS, revealing stronger efficiency gains than suggested by crude trends. The reductions in LoS were revised upwards by more than one day in several major groups: for medical MDC 04 (Respiratory system) and MDC 08 (Musculoskeletal system), and for surgical MDC 08 (Musculoskeletal system), MDC 15 (Newborn/Neonates), MDC 17 (Neoplasms), and MDC 18 (Infectious diseases).



Table 13 – Evolution of risk-adjusted LoS in the study population [days (difference end – start)]

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
All admissions	5.3 (-1.5)	5.5 (-1.2)	6.1	4.9	5.2 (-1.1)	5.7	4.6
Age							
Age group 0-15	3.9 (-0.7)	4.0 (-0.5)	4.3	3.8	3.8 (-0.4)	4.0	3.6
Age group 16-45	3.3 (-1.0)	3.6 (-0.5)	3.8	3.3	2.9 (-0.4)	3.1	2.8
Age group 46-60	3.9 (-1.3)	4.2 (-0.8)	4.6	3.8	3.6 (-0.6)	4.0	3.3
Age group 61-75	5.5 (-1.8)	5.8 (-1.3)	6.5	5.1	5.3 (-1.2)	5.9	4.7
Age group 76-85	8.7 (-2.6)	9.0 (-2.2)	10.1	7.9	8.5 (-2.0)	9.5	7.5
Age group over 85	11.7 (-3.6)	12.0 (-3.1)	13.6	10.5	11.5 (-3.2)	13.2	10.0
Elixhauser							
No comorbidities	3.2 (-1.0)	3.5 (-0.6)	3.8	3.2	3.0 (-0.4)	3.2	2.7
1 comorbidity	4.6 (-2.0)	5.1 (-1.1)	5.6	4.5	4.1 (-0.9)	4.5	3.7
2 comorbidities	6.5 (-2.7)	7.1 (-1.6)	7.9	6.3	5.9 (-1.4)	6.6	5.2
3 or more comorbidities	10.4 (-3.3)	11.1 (-2.2)	12.2	10.0	10.0 (-2.2)	11.2	9.0
MDCs							
MDC 01 (Medical): Nervous System	7.3 (-1.6)	7.3 (-1.9)	8.3	6.4	7.4 (-1.4)	8.2	6.8
MDC 02 (Medical): Eye	5.1 (-0.8)	5.2 (-1.1)	5.8	4.7	5.1 (-0.6)	5.5	5.0
MDC 03 (Medical): Ear, Nose, Throat (ENT)	2.1 (-0.7)	2.3 (-0.4)	2.5	2.1	1.9 (-0.4)	2.2	1.8
MDC 04 (Medical): Respiratory System	7.6 (-2.7)	7.8 (-1.4)	8.6	7.2	7.3 (-2.1)	7.9	5.9
MDC 05 (Medical): Circulatory System	5.4 (-1.1)	5.4 (-1.1)	6.0	4.9	5.3 (-1.0)	5.9	4.9
MDC 06 (Medical): Digestive System	4.4 (-1.2)	4.6 (-0.9)	5.1	4.2	4.2 (-0.6)	4.5	3.9
MDC 07 (Medical): Hepatobiliary System	7.0 (-1.7)	7.4 (-1.3)	8.0	6.7	6.7 (-0.9)	7.2	6.3
MDC 08 (Medical): Musculoskeletal System	8.7 (-0.3)	8.2 (-1.5)	8.9	7.4	9.3 (-1.5)	10.0	8.6
MDC 09 (Medical): Skin/Breast	6.8 (-1.3)	6.9 (-1.5)	7.7	6.1	6.7 (-0.8)	7.2	6.4
MDC 10 (Medical): Endocrine/Metabolic	6.6 (-1.0)	6.8 (-1.0)	7.3	6.3	6.5 (-0.6)	6.9	6.3
MDC 11 (Medical): Kidney/Urinary	5.5 (-0.8)	5.5 (-1.0)	6.0	4.9	5.5 (-0.9)	6.0	5.2
MDC 12 (Medical): Male Reproductive	4.8 (-0.5)	4.7 (-0.6)	5.0	4.4	4.9 (-0.7)	5.2	4.5
MDC 13 (Medical): Female Reproductive	3.6 (-0.7)	3.7 (-0.6)	3.9	3.2	3.6 (-0.8)	4.0	3.1
MDC 14 (Medical): Pregnancy/Childbirth	3.7 (-1.3)	4.2 (-0.5)	4.4	3.9	3.2 (-0.3)	3.4	3.1
MDC 15 (Medical): Newborn/Neonates	15.9 (-5.2)	18.3 (-1.8)	19.1	17.3	14.3 (-0.7)	14.5	13.8
MDC 16 (Medical): Blood/Immunological	6.4 (-0.8)	6.5 (-0.8)	6.8	6.0	6.3 (-0.6)	6.6	6.1
MDC 17 (Medical): Neoplasms	4.5 (-0.4)	4.4 (-0.5)	4.7	4.2	4.5 (-0.5)	4.7	4.2
MDC 18 (Medical): Infectious Diseases	6.9 (-0.6)	6.8 (-1.0)	7.3	6.3	6.9 (-0.6)	7.4	6.7
MDC 01 (Surgical): Nervous System	7.5 (-1.5)	7.6 (-1.6)	8.2	6.6	7.4 (-1.4)	8.1	6.7
MDC 02 (Surgical): Eye	1.5 (-0.5)	1.6 (-0.3)	1.7	1.5	1.4 (-0.2)	1.5	1.3
MDC 03 (Surgical): Ear, Nose, Throat (ENT)	2.0 (-0.4)	2.0 (-0.2)	2.1	1.9	1.9 (-0.3)	2.1	1.8
MDC 04 (Surgical): Respiratory System	10.8 (-1.9)	10.9 (-2.0)	11.7	9.7	10.7 (-1.8)	11.6	9.8

	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022
MDC 05 (Surgical): Circulatory System	5.2 (-2.1)	5.8 (-1.3)	6.5	5.1	4.8 (-1.0)	5.3	4.3
MDC 06 (Surgical): Digestive System	4.9 (-1.8)	5.2 (-1.4)	5.9	4.5	4.6 (-1.1)	5.2	4.1
MDC 07 (Surgical): Hepatobiliary System	3.9 (-2.0)	4.3 (-1.3)	4.9	3.6	3.5 (-1.2)	4.1	2.9
MDC 08 (Surgical): Musculoskeletal System	5.6 (-1.8)	5.6 (-1.8)	6.5	4.7	5.7 (-2.0)	6.7	4.7
MDC 09 (Surgical): Skin/Breast	3.7 (-1.5)	4.0 (-0.9)	4.4	3.5	3.4 (-0.9)	3.8	3.0
MDC 10 (Surgical): Endocrine/Metabolic	3.1 (-2.2)	3.7 (-1.1)	4.3	3.1	2.6 (-1.0)	3.1	2.1
MDC 11 (Surgical): Kidney/Urinary	4.2 (-2.1)	4.7 (-1.0)	5.2	4.2	3.7 (-1.1)	4.3	3.1
MDC 12 (Surgical): Male Reproductive	4.1 (-2.4)	4.7 (-1.1)	5.1	4.1	3.5 (-1.4)	4.2	2.8
MDC 13 (Surgical): Female Reproductive	3.1 (-1.7)	3.5 (-0.9)	4.0	3.0	2.6 (-0.9)	3.1	2.2
MDC 14 (Surgical): Pregnancy/Childbirth	5.0 (-2.0)	5.7 (-0.8)	6.1	5.2	4.3 (-0.5)	4.7	4.1
MDC 15 (Surgical): Newborn/Neonates	43.6 (-13.8)	47.1 (-6.7)	51.8	45.1	40.5 (-2.1)	40.1	38.0
MDC 16 (Surgical): Blood/Immunological	4.9 (-0.9)	5.0 (-1.6)	5.8	4.2	4.8 (0.1)	4.8	4.9
MDC 17 (Surgical): Neoplasms	7.7 (-2.1)	8.0 (-1.6)	9.0	7.3	7.5 (-1.3)	8.1	6.8
MDC 18 (Surgical): Infectious Diseases	16.9 (0.3)	15.2 (-3.8)	17.2	13.4	17.9 (-1.9)	19.4	17.5

Note: Zero-truncated Poisson regressions were used instead of zero-truncated negative binomial regressions for Medical MDC 08 (Musculoskeletal system), Surgical MDC 04 (Respiratory system), Surgical MDC 15 (Newborn/Neonates), and Surgical MDC 18 (Infectious diseases) in period 2, as well as for Medical MDC 06 (Digestive system) in period 1.

RISK ADJUSTMENT CONFIRMS BROADER IMPROVEMENTS IN READMISSION OUTCOMES

Table 14 and Figure 6 show that risk-adjusted 30-day readmission rates declined from 5.6% in 2008 to 4.9% in 2022 (-0.7 pp), representing a slightly stronger reduction than the unadjusted decrease of 0.5 pp. This suggests that, after accounting for differences in case mix and patient risk, the readmission rate improved more than suggested by the unadjusted trend.

The familiar gradients by age and comorbidity burden persisted, but declines were steeper among the oldest and most multimorbid patients. For example, readmission rates among those aged 85 years and older fell by 1.7 pp (compared with 0.9 pp unadjusted), while reductions among patients with three or more Elixhauser comorbidities reached -1.4 pp (versus -1.1 pp unadjusted).

Across pathologies, most MDCs showed slightly larger decreases over time in readmission rates after adjustment. MDCs with an important revision in LoS, also had more substantial changes in readmission rates. In a few surgical MDCs with previously increasing unadjusted trends, these upward evolutions were reinforced, in particular in MDC 12 (Male reproductive), MDC 17 (Neoplasms), and MDC 18 (Infectious diseases).

MORTALITY RISE IN OLDEST AND MOST MULTIMORBID PATIENTS REVERSED AFTER ADJUSTMENT

Table 14 and Figure 6 shows that risk-adjusted 30-day mortality rates remained stable at 0.9% between 2016 and 2022, mirroring the unadjusted average but without the slight upward drift observed in the crude data (+0.1 pp). The crude increase was primarily driven by the oldest and most multimorbid patients.



The pronounced gradients by age and comorbidity burden persisted and were even accentuated after adjustment. Among individuals aged 85 years and older, the risk-adjusted 30-day mortality rate reached 6.1%, compared with 5.3% unadjusted. For this group, the small crude increase over time (+0.3 pp) was reversed to a decline of -0.5 pp after adjustment (from 6.3 % in 2016 to 5.8% in 2022). Such a reversal may for example be the result of improvements in care quality compared to baseline practices, or shifts in case mix, such as an increasing concentration of older patients in higher-risk pathologies. Similarly, for patients with three or more Elixhauser comorbidities, the slight rise observed in the unadjusted data (+0.2 pp) translated into a stable trend once differences in case mix, patient and admission characteristics were controlled for.

Across pathologies, the most notable adjustments appeared as stronger reductions in mortality over time for MDC 17 (Neoplasms) and for the medical MDCs 04 (Respiratory system), 05 (Circulatory system), and 08 (Musculoskeletal system).

BROADER DECLINES IN COMPOSITE OUTCOMES AFTER ADJUSTMENT

Table 14 shows that the risk-adjusted 30-day composite rate (readmission or mortality) declined from 6.2% in 2016 to 5.5% in 2022 (-0.7 pp), representing a steeper reduction than the unadjusted decrease (-0.3 pp). This indicates that, after accounting for case mix and patient characteristics, overall outcomes improved more than suggested by the crude data. As illustrated in Figure 6, the discrepancy between risk-adjusted and unadjusted composite rates was most pronounced in 2020 and 2022. Overall, risk adjustment reinforces the picture of gradual improvement across age, comorbidity, and pathologies.

The familiar gradients by age and comorbidity persisted: composite rates ranged from 3.4% among patients aged 16-45 years to 13.5% among those aged 85 years or older. Unlike the unadjusted trends, declines were now steeper with advancing age and comorbidity burden, reaching -1.5 pp among the oldest and -1.3 pp among patients with three or more Elixhauser comorbidities.

Across MDCs, risk-adjusted composite rates generally showed broader and stronger declines than in the unadjusted data, though substantial heterogeneity between pathologies remains. Among medical MDCs, the largest reductions (≥ 1 pp) occurred in MDC 04 (Respiratory system, -2.1 pp), MDC 12 (Male reproductive system, -1.1 pp), MDC 16 (Blood/Immunological, -1.0 pp), and MDC 17 (Neoplasms, -1.2 pp). Risk adjustment notably strengthened declines in MDC 04 (Respiratory system), MDC 05 (Circulatory system), and MDC 08 (Musculoskeletal system) by more than one percentage point.

Among surgical MDCs, reductions were generally smaller. Notable declines (≥ 1 pp) were found in MDC 18 (Infectious diseases, -2.0 pp), MDC 15 (Newborn/Neonates, -1.9 pp), MDC 04 (Respiratory system, -1.1 pp), and MDC 05 (Circulatory system, -1.1 pp).

Table 14 – Evolution of risk-adjusted readmission, mortality rate and composite rate in the study population [Rate (difference end rate – start rate)]

	Readmission rates							Mortality rates			Composite rates		
	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022
All admissions	5.2% (-0.7 pp)	5.1% (-0.8 pp)	5.6%	4.8%	5.2% (-0.7 pp)	5.6%	4.9%	0.9% (-0.0 pp)	0.9%	0.9%	5.9% (-0.7 pp)	6.2%	5.5%
Age													
Age group 0-15	4.2% (-0.3 pp)	4.0% (-0.4 pp)	4.3%	4.0%	4.3% (-0.4 pp)	4.5%	4.1%	0.0% (-0.0 pp)	0.0%	0.0%	4.3% (-0.4 pp)	4.5%	4.1%
Age group 16-45	3.5% (-0.8 pp)	3.5% (-0.7 pp)	4.0%	3.4%	3.4% (-0.3 pp)	3.5%	3.2%	0.0% (-0.0 pp)	0.0%	0.0%	3.4% (-0.4 pp)	3.6%	3.2%
Age group 46-60	3.8% (-0.9 pp)	3.9% (-0.6 pp)	4.3%	3.7%	3.7% (-0.6 pp)	4.0%	3.3%	0.2% (-0.0 pp)	0.2%	0.2%	3.9% (-0.6 pp)	4.1%	3.5%
Age group 61-75	5.6% (-0.6 pp)	5.5% (-0.6 pp)	5.9%	5.2%	5.6% (-0.8 pp)	6.0%	5.2%	0.7% (0.0 pp)	0.7%	0.7%	6.1% (-0.8 pp)	6.5%	5.7%
Age group 76-85	8.1% (-1.0 pp)	8.0% (-1.3 pp)	8.6%	7.3%	8.2% (-1.2 pp)	8.8%	7.6%	1.6% (-0.1 pp)	1.6%	1.5%	9.4% (-1.2 pp)	10.0%	8.8%
Age group over 85	9.6% (-1.7 pp)	9.6% (-1.9 pp)	10.6%	8.7%	9.6% (-1.2 pp)	10.2%	9.0%	6.1% (-0.5 pp)	6.3%	5.8%	13.5% (-1.5 pp)	14.3%	12.8%
Elixhauser													
No comorbidities	3.3% (-0.7 pp)	3.3% (-0.5 pp)	3.7%	3.2%	3.2% (-0.4 pp)	3.4%	3.0%	0.0% (-0.0 pp)	0.0%	0.0%	3.3% (-0.4 pp)	3.4%	3.0%
1 comorbidity	4.6% (-1.3 pp)	4.9% (-0.7 pp)	5.3%	4.6%	4.4% (-0.6 pp)	4.6%	4.0%	0.4% (-0.1 pp)	0.4%	0.4%	4.6% (-0.7 pp)	4.9%	4.2%
2 comorbidities	6.3% (-1.6 pp)	6.5% (-1.1 pp)	7.1%	6.0%	6.0% (-0.9 pp)	6.4%	5.5%	1.0% (-0.1 pp)	1.1%	1.0%	6.7% (-1.0 pp)	7.2%	6.2%
3 or more comorbidities	9.5% (-1.4 pp)	9.5% (-1.5 pp)	10.3%	8.8%	9.5% (-1.2 pp)	10.1%	8.9%	2.9% (-0.0 pp)	2.9%	2.9%	11.5% (-1.3 pp)	12.2%	10.9%
MDCs													
MDC 01 (Medical): Nervous System	5.6% (-1.4 pp)	5.6% (-1.3 pp)	6.5%	5.2%	5.5% (-0.7 pp)	5.9%	5.1%	1.4% (0.1 pp)	1.4%	1.5%	6.6% (-0.7 pp)	7.0%	6.3%
MDC 02 (Medical): Eye	4.6% (0.3 pp)	4.5% (-0.4 pp)	4.7%	4.3%	4.7% (0.2 pp)	4.7%	5.0%	0.5% (0.1 pp)	0.5%	0.6%	5.1% (0.2 pp)	5.1%	5.4%
MDC 03 (Medical): Ear, Nose, Throat (ENT)	2.4% (-1.1 pp)	2.7% (-0.6 pp)	3.1%	2.5%	2.2% (-0.6 pp)	2.5%	2.0%	0.2% (0.0 pp)	0.2%	0.2%	2.3% (-0.6 pp)	2.7%	2.1%
MDC 04 (Medical): Respiratory System	8.3% (-1.7 pp)	8.3% (-1.6 pp)	9.1%	7.6%	8.2% (-1.7 pp)	9.1%	7.4%	2.4% (-0.4 pp)	2.5%	2.1%	9.9% (-2.1 pp)	10.9%	8.8%
MDC 05 (Medical): Circulatory System	7.1% (-0.6 pp)	6.9% (-1.2 pp)	7.6%	6.4%	7.3% (-0.9 pp)	7.8%	6.9%	1.7% (0.0 pp)	1.7%	1.7%	8.4% (-0.9 pp)	8.9%	8.1%
MDC 06 (Medical): Digestive System	6.2% (-0.5 pp)	6.0% (-0.8 pp)	6.4%	5.7%	6.3% (-0.7 pp)	6.6%	5.9%	1.0% (-0.0 pp)	1.1%	1.0%	7.1% (-0.7 pp)	7.4%	6.7%
MDC 07 (Medical): Hepatobiliary System	10.0% (-0.3 pp)	9.6% (-1.5 pp)	10.6%	9.1%	10.4% (-0.3 pp)	10.6%	10.3%	2.8% (-0.1 pp)	2.9%	2.8%	12.4% (-0.5 pp)	12.7%	12.2%
MDC 08 (Medical): Musculoskeletal System	6.6% (-0.5 pp)	6.4% (-0.9 pp)	6.8%	5.9%	6.8% (-0.9 pp)	7.3%	6.4%	1.4% (0.2 pp)	1.4%	1.6%	7.9% (-0.8 pp)	8.3%	7.5%

	Readmission rates							Mortality rates			Composite rates		
	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022
MDC 09 (Medical): Skin/Breast	5.8% (-0.6 pp)	5.6% (-1.1 pp)	6.2%	5.2%	5.9% (-0.4 pp)	6.0%	5.6%	1.5% (0.2 pp)	1.3%	1.5%	7.0% (-0.3 pp)	7.0%	6.7%
MDC 10 (Medical): Endocrine/Metabolic	6.3% (-0.2 pp)	6.0% (-1.3 pp)	6.6%	5.3%	6.6% (-0.5 pp)	7.0%	6.5%	1.6% (-0.1 pp)	1.7%	1.6%	7.8% (-0.6 pp)	8.3%	7.7%
MDC 11 (Medical): Kidney/Urinary	8.4% (-0.6 pp)	8.2% (-0.9 pp)	8.7%	7.8%	8.7% (-0.9 pp)	9.0%	8.2%	1.7% (0.0 pp)	1.7%	1.7%	9.9% (-0.8 pp)	10.3%	9.5%
MDC 12 (Medical): Male Reproductive	6.6% (-1.8 pp)	6.6% (-1.8 pp)	7.6%	5.8%	6.6% (-1.1 pp)	6.8%	5.8%	1.6% (-0.3 pp)	1.8%	1.6%	7.8% (-1.1 pp)	8.2%	7.1%
MDC 13 (Medical): Female Reproductive	4.7% (-0.1 pp)	4.5% (-0.1 pp)	4.6%	4.5%	4.9% (-0.8 pp)	5.4%	4.5%	1.6% (0.3 pp)	1.3%	1.6%	6.3% (-0.5 pp)	6.4%	6.0%
MDC 14 (Medical): Pregnancy/Childbirth	4.2% (-0.8 pp)	4.3% (-0.6 pp)	4.8%	4.2%	4.1% (-0.2 pp)	4.2%	4.0%	NE	NE	NE	4.1% (-0.2 pp)	4.2%	4.0%
MDC 15 (Medical): Newborn/Neonates	5.6% (0.7 pp)	5.4% (0.1 pp)	5.2%	5.3%	5.8% (-0.0 pp)	5.9%	5.9%	NE	NE	NE	5.8% (-0.1 pp)	5.9%	5.9%
MDC 16 (Medical): Blood/Immunological	8.2% (-0.6 pp)	8.0% (-1.5 pp)	8.5%	7.0%	8.3% (-0.8 pp)	8.7%	7.9%	1.9% (-0.3 pp)	2.0%	1.7%	9.6% (-1.0 pp)	10.1%	9.1%
MDC 17 (Medical): Neoplasms	10.4% (-0.2 pp)	10.1% (-0.4 pp)	10.1%	9.7%	10.9% (-1.4 pp)	11.3%	10.0%	2.4% (0.2 pp)	2.4%	2.6%	12.5% (-1.2 pp)	12.9%	11.6%
MDC 18 (Medical): Infectious Diseases	6.4% (-0.6 pp)	6.1% (-1.1 pp)	6.8%	5.7%	6.7% (-0.9 pp)	7.1%	6.2%	1.4% (-0.0 pp)	1.5%	1.4%	7.8% (-0.9 pp)	8.2%	7.3%
MDC 01 (Surgical): Nervous System	4.8% (-0.8 pp)	5.0% (-0.4 pp)	5.1%	4.7%	4.7% (-0.8 pp)	5.1%	4.3%	0.5% (0.2 pp)	0.4%	0.6%	5.0% (-0.6 pp)	5.4%	4.7%
MDC 02 (Surgical): Eye	2.3% (-1.0 pp)	2.5% (-0.3 pp)	2.7%	2.4%	1.9% (-0.5 pp)	2.2%	1.7%	0.1% (0.0 pp)	0.1%	0.1%	2.0% (-0.5 pp)	2.2%	1.7%
MDC 03 (Surgical): Ear, Nose, Throat (ENT)	2.6% (0.1 pp)	2.4% (-0.1 pp)	2.6%	2.5%	2.9% (-0.1 pp)	2.8%	2.7%	0.1% (0.0 pp)	0.0%	0.1%	2.9% (-0.1 pp)	2.9%	2.7%
MDC 04 (Surgical): Respiratory System	7.0% (0.2 pp)	6.5% (-1.0 pp)	7.0%	6.0%	7.5% (-1.2 pp)	8.4%	7.2%	1.6% (-0.3 pp)	1.7%	1.4%	8.6% (-1.1 pp)	9.3%	8.2%
MDC 05 (Surgical): Circulatory System	5.7% (-1.2 pp)	5.6% (-1.2 pp)	6.4%	5.2%	5.8% (-1.1 pp)	6.3%	5.2%	0.5% (0.0 pp)	0.5%	0.5%	6.0% (-1.1 pp)	6.6%	5.5%
MDC 06 (Surgical): Digestive System	4.6% (0.2 pp)	4.3% (-0.4 pp)	4.6%	4.1%	4.9% (-0.2 pp)	5.0%	4.7%	0.4% (0.0 pp)	0.4%	0.4%	5.2% (-0.2 pp)	5.2%	5.0%
MDC 07 (Surgical): Hepatobiliary System	4.4% (0.3 pp)	4.0% (-0.4 pp)	4.3%	3.9%	4.8% (-0.2 pp)	4.9%	4.7%	0.4% (-0.1 pp)	0.5%	0.4%	5.1% (-0.3 pp)	5.2%	4.9%

	Readmission rates							Mortality rates			Composite rates		
	Overall	Period 1	Year 2008	Year 2014	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022	Period 2	Year 2016	Year 2022
MDC 08 (Surgical): Musculoskeletal System	2.6% (-0.5 pp)	2.5% (-0.5 pp)	2.9%	2.3%	2.6% (-0.5 pp)	2.8%	2.4%	0.4% (-0.0 pp)	0.4%	0.4%	2.9% (-0.5 pp)	3.1%	2.6%
MDC 09 (Surgical): Skin/Breast	2.4% (-0.6 pp)	2.3% (-0.4 pp)	2.6%	2.2%	2.4% (-0.7 pp)	2.7%	2.1%	0.2% (0.0 pp)	0.2%	0.2%	2.6% (-0.6 pp)	2.9%	2.2%
MDC 10 (Surgical): Endocrine/Metabolic	3.2% (-0.1 pp)	3.0% (-0.4 pp)	3.2%	2.8%	3.3% (-0.2 pp)	3.3%	3.2%	0.0% (-0.0 pp)	0.1%	0.1%	3.4% (-0.2 pp)	3.4%	3.2%
MDC 11 (Surgical): Kidney/Urinary	7.2% (-0.4 pp)	7.0% (-0.5 pp)	7.4%	6.9%	7.4% (-0.7 pp)	7.8%	7.1%	0.4% (-0.0 pp)	0.5%	0.5%	7.7% (-0.7 pp)	8.1%	7.4%
MDC 12 (Surgical): Male Reproductive	6.1% (0.8 pp)	5.6% (0.3 pp)	5.5%	5.9%	6.7% (-0.6 pp)	7.0%	6.4%	0.2% (-0.1 pp)	0.2%	0.1%	6.8% (-0.7 pp)	7.1%	6.5%
MDC 13 (Surgical): Female Reproductive	2.6% (-0.1 pp)	2.5% (-0.3 pp)	2.7%	2.4%	2.8% (-0.4 pp)	3.0%	2.6%	NE	NE	NE	2.8% (-0.4 pp)	3.0%	2.6%
MDC 14 (Surgical): Pregnancy/Childbirth	1.6% (-0.3 pp)	1.6% (-0.4 pp)	1.8%	1.5%	1.6% (-0.2 pp)	1.7%	1.5%	NE	NE	NE	1.6% (-0.2 pp)	1.7%	1.5%
MDC 15 (Surgical): Newborn/Neonates	11.7% (-3.1 pp)	12.6% (-0.4 pp)	14.4%	14.0%	10.9% (-1.6 pp)	12.9%	11.3%	NE	NE	NE	11.1% (-1.9 pp)	13.3%	11.3%
MDC 16 (Surgical): Blood/Immunological	4.5% (0.1 pp)	4.4% (0.2 pp)	4.2%	4.3%	4.6% (-0.5 pp)	4.8%	4.2%	NE	NE	NE	4.8% (-0.4 pp)	5.0%	4.6%
MDC 17 (Surgical): Neoplasms	7.1% (0.8 pp)	6.3% (0.4 pp)	6.4%	6.8%	7.7% (-0.3 pp)	7.6%	7.2%	1.5% (0.2 pp)	1.6%	1.7%	8.7% (-0.6 pp)	8.8%	8.2%
MDC 18 (Surgical): Infectious Diseases	8.4% (0.9 pp)	7.0% (-0.4 pp)	7.0%	6.6%	9.2% (-2.0 pp)	9.9%	7.9%	1.8% (0.1 pp)	1.8%	1.9%	10.5% (-2.0 pp)	11.2%	9.2%

Note: Mortality models for MDC 14 (Pregnancy/Childbirth), MDC 15 (Newborn/Neonates), MDC 13 (Surgical: Female reproductive system), MDC 16 (Surgical: Blood/Immunological) were not estimated (NE) due to an insufficient number of events.



2.3.3 Association between LoS rate and readmission, mortality and composite rates

REDUCTIONS IN LOS WERE NOT ASSOCIATED WITH DETERIORATIONS IN READMISSIONS OR MORTALITY

Figure 9 displays scatterplots illustrating the relationship between the evolution in LoS (vertical axis) and the evolution in readmission, mortality, and composite rates (horizontal axis), for both observed and risk-adjusted data. Each panel represents a distinct period or outcome. Movements toward the lower-left quadrant (green area) indicate simultaneous improvements, i.e. reductions in both LoS and patient outcomes, whereas shifts toward the upper-right (red area) signal deterioration in both dimensions.

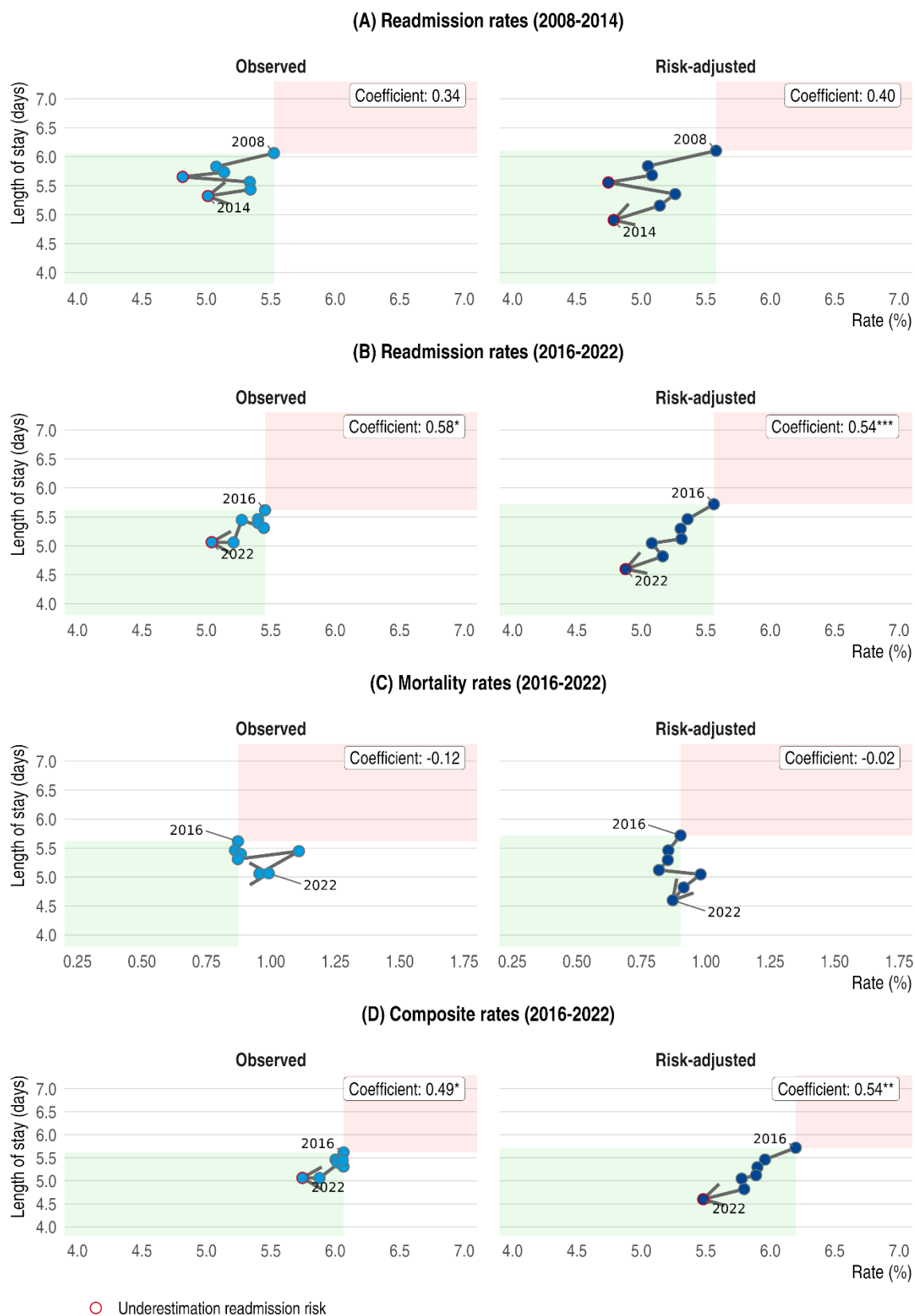
Reductions in LoS did not appear to lead to higher readmission or mortality risks. For readmission rates (Panels A and B), both observed and risk-adjusted trajectories moved consistently in the desired direction, with stronger and statistically significant associations in the second period (2016–2022). After risk adjustment, a one-day reduction in LoS during this period was significantly associated with a 0.54 pp reduction in readmission rates, confirming that efficiency gains were not achieved at the expense of more readmissions.

For mortality (Panel C), no systematic relationship with LoS was observed. The near-zero risk-adjusted coefficient (-0.02) indicates that reductions in LoS were achieved without increases in 30-day mortality, suggesting a neutral or favourable evolution after accounting for risk.

Composite outcomes (Panel D) largely mirrored the patterns seen for readmissions, consistent with the latter being the dominant component of the combined indicator.

Finally, years with a potential risk for underestimating readmission risk (see section 1.2.3 in Chapter 1 on day surgery), highlighted by the red circles, effectively had the lowest readmission rates, but do not appear to bias the overall conclusions.

Figure 19 – Relationship between LoS and readmission, mortality and composite rates (observed and risk-adjusted), by period



Note: Significance level: * = ≤ 0.05 ; ** = ≤ 0.01 ; *** = ≤ 0.001 .



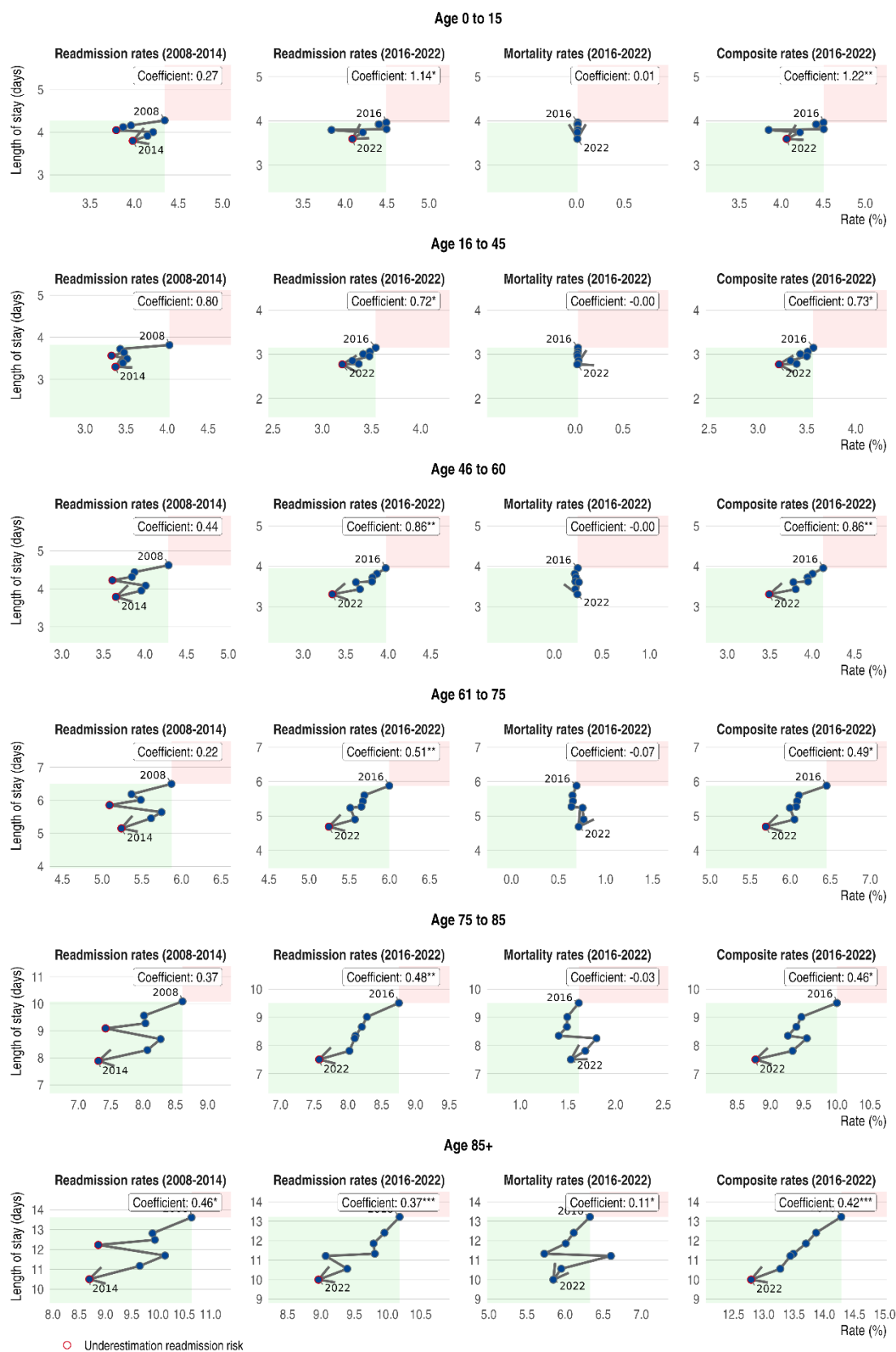
EVEN FOR OLDER AND MULTIMORBID PATIENTS, SHORTER STAYS WENT HAND IN HAND WITH FEWER READMISSIONS

Figure 11 and Figure 12 present the same risk-adjusted evolutions, disaggregated by age group and comorbidity burden, respectively. The largest absolute gains in both LoS and outcomes were observed among the two oldest age groups and the two highest comorbidity categories, which also started from higher baseline values. Across all age and comorbidity groups and outcomes, trajectories moved either within the green area (for readmission and composite rates) or along its boundary (no improvement or deterioration in mortality for most groups). This pattern indicates that reductions in LoS did not coincide with worsening outcomes and, in many cases, were accompanied by improvements, particularly for readmissions during the second period (2016–2022).

Regression coefficients confirm these trends. The relationship between LoS and readmissions, as well as the composite rate, was statistically significant across all age and comorbidity groups in the second period, while for mortality, significance was observed only among the oldest patients (85 years and over).

Larger COVID-related disruptions were visible in mortality trajectories for the oldest two age groups and the two highest comorbidity categories.

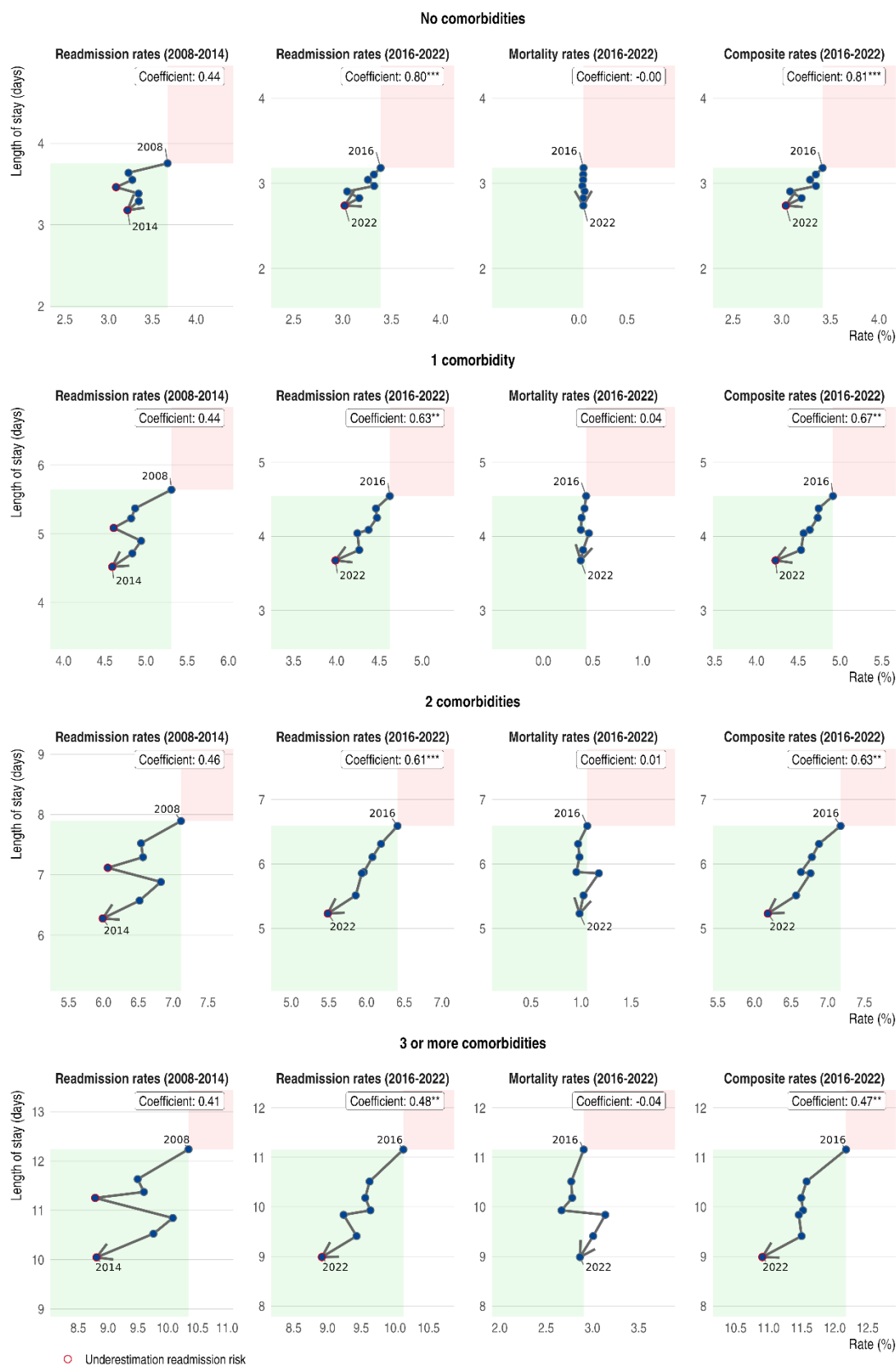
Figure 20 – Relationship between risk-adjusted LoS and risk-adjusted readmission, mortality and composite rates, by period and age group



Note: Significance level: * = ≤ 0.05 ; ** = ≤ 0.01 ; *** = ≤ 0.001 .



Figure 21 – Relationship between risk-adjusted LoS and risk-adjusted readmission, mortality and composite rates, by period and Elixhauser comorbidity burden



Note: Significance level: * = ≤ 0.05 ; ** = ≤ 0.01 ; *** = ≤ 0.001 .

EFFICIENCY GAINS WITHOUT HIGHER RISKS FOR MOST MDCs, BUT SOME WARNING SIGNS REMAIN

Figure 13 zooms in on the combined risk-adjusted evolutions of LoS, readmission, and mortality at the level of the MDCs further subdivided in medical and surgical treatment. Several trajectories appear irregular, which may partly reflect small numbers of observations (e.g. surgical MDC 15 (Newborn/Neonates)), or contextual effects (e.g. medical MDC 04 (Respiratory system), with smaller shifts during and a larger shift after COVID).

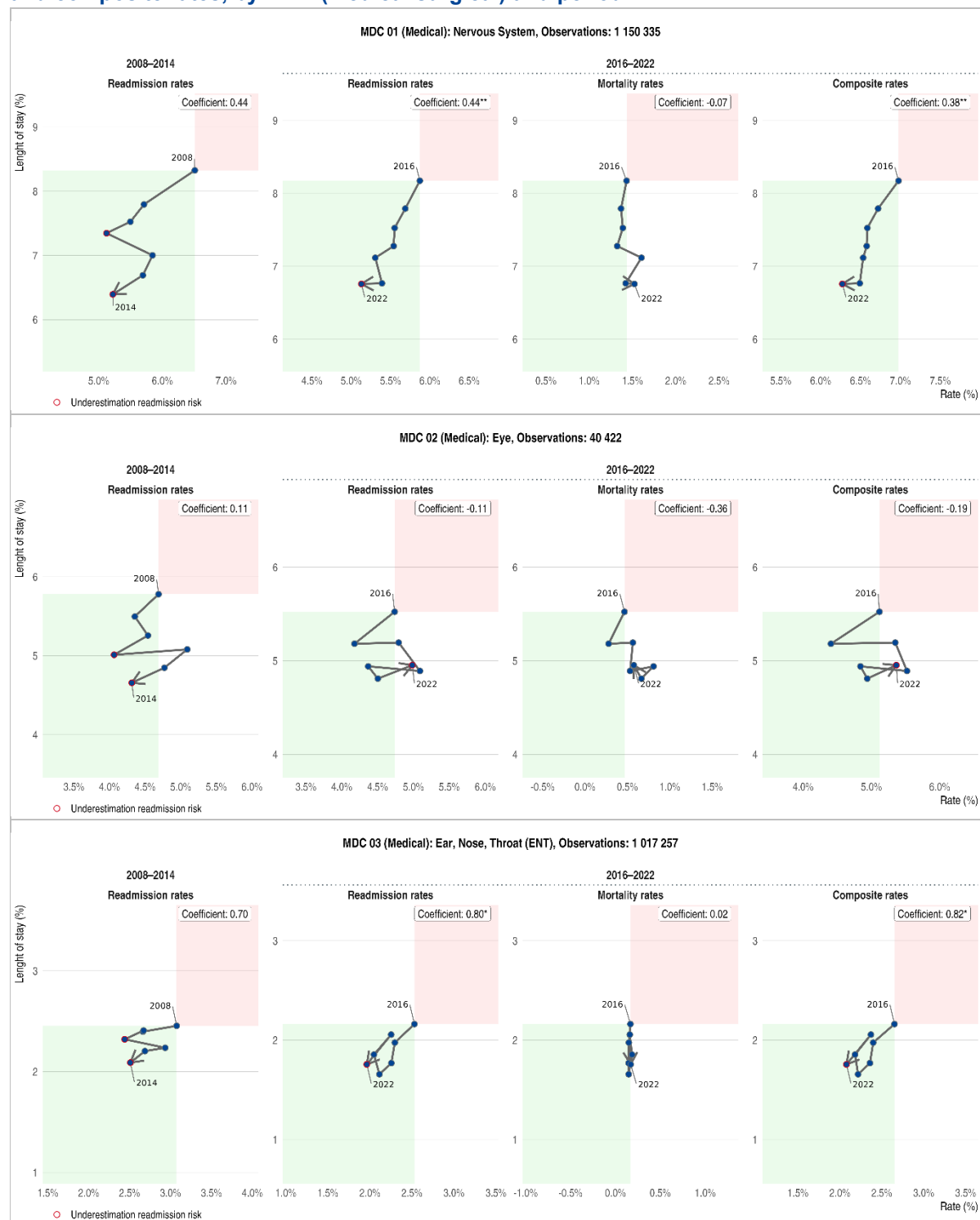
Overall, however, the pattern clearly indicates that for nearly all pathologies, reductions in LoS did not lead to higher readmission or mortality risks. However, some warning signals emerged. Shorter stays were associated with increased readmissions in 2008-2014 for surgical MDC 12 (Male reproductive system), mainly linked to DRG 482 (Transurethral prostatectomy). Increased mortality was observed in medical MDC 17 (Neoplasms), MDC 09 (Skin/Breast), and MDC 08 (Musculoskeletal system). For mortality, DRG 691 (Lymphoma, Myeloma, and non-acute Leukaemia) contributed most to the increased mortality risk in MDC 17. Similarly, DRGs 383 (Cellulitis and other bacterial skin infections) and 384 (Contusion, open wound, and other trauma to skin and subcutaneous tissue) accounted for most of the rise in mortality within MDC 09, while a combination of DRGs explained the results for MDC 08.

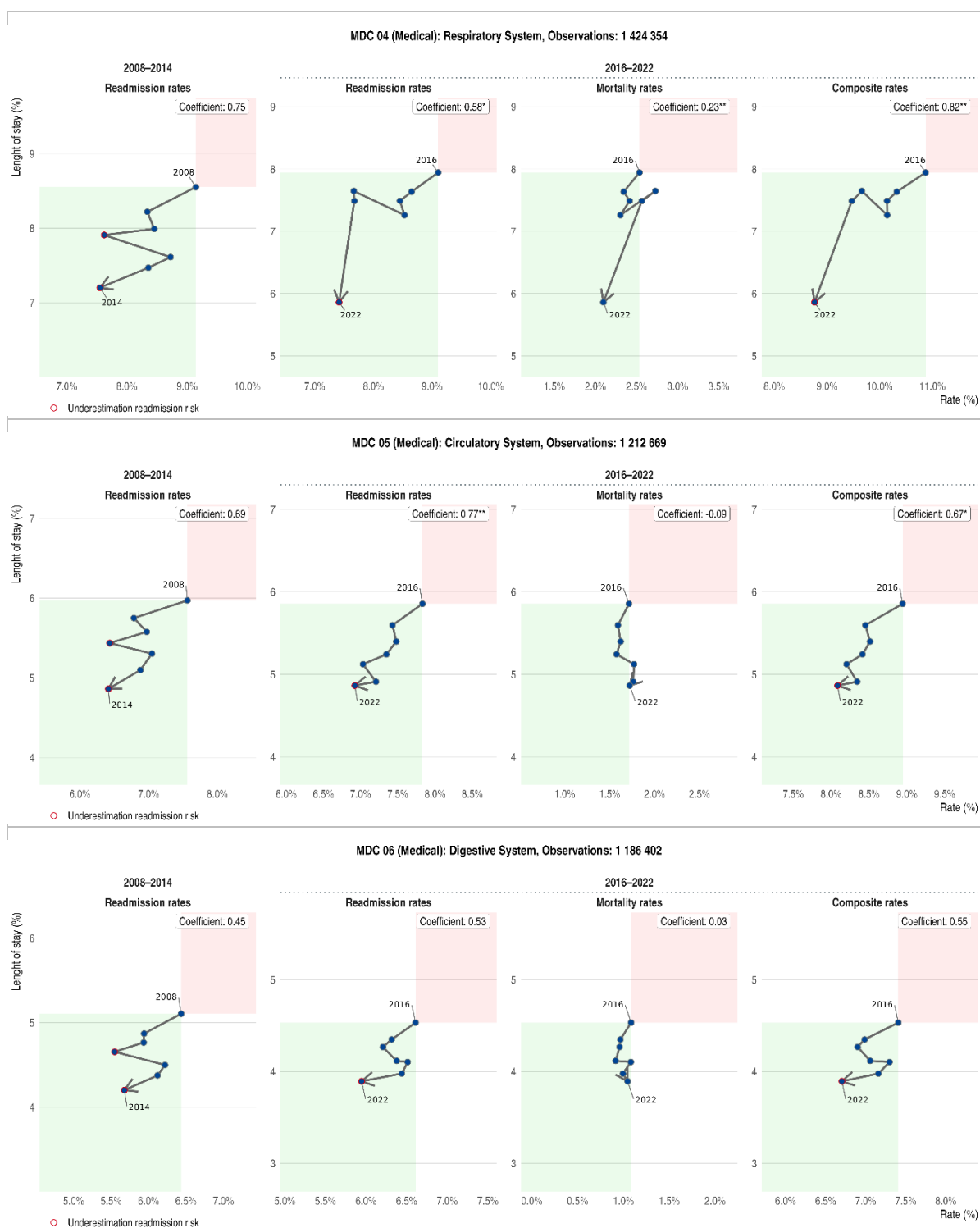
Results for readmission rates were more favourable in the second period (2016-2022). In the first period (2008-2014), only five MDC-medical/surgical combinations showed significant associations between shorter stays and lower readmission rates: medical and surgical MDC 10 (Endocrine/Metabolic system), medical MDC 12 (Male reproductive system), surgical MDC 04 (Respiratory system), and surgical MDC 14 (Pregnancy/Childbirth). By contrast, in 2016-2022, improvements were much broader with 18 MDC-medical/surgical combinations displaying a favourable evolution, particularly among medical groups such as MDC 04 (Respiratory system), MDC 05 (Circulatory system), MDC 11 (Kidney/Urinary system), MDC 14 (Pregnancy/Childbirth), and MDC 17 (Neoplasms), as well as among surgical MDCs 04 (Respiratory system), 05 (Circulatory system), and 09 (Skin/Breast). These favourable evolutions were generally observed across DRGs within each MDC-medical/surgical combination, although some heterogeneity remained, with not all DRGs following the same pattern.

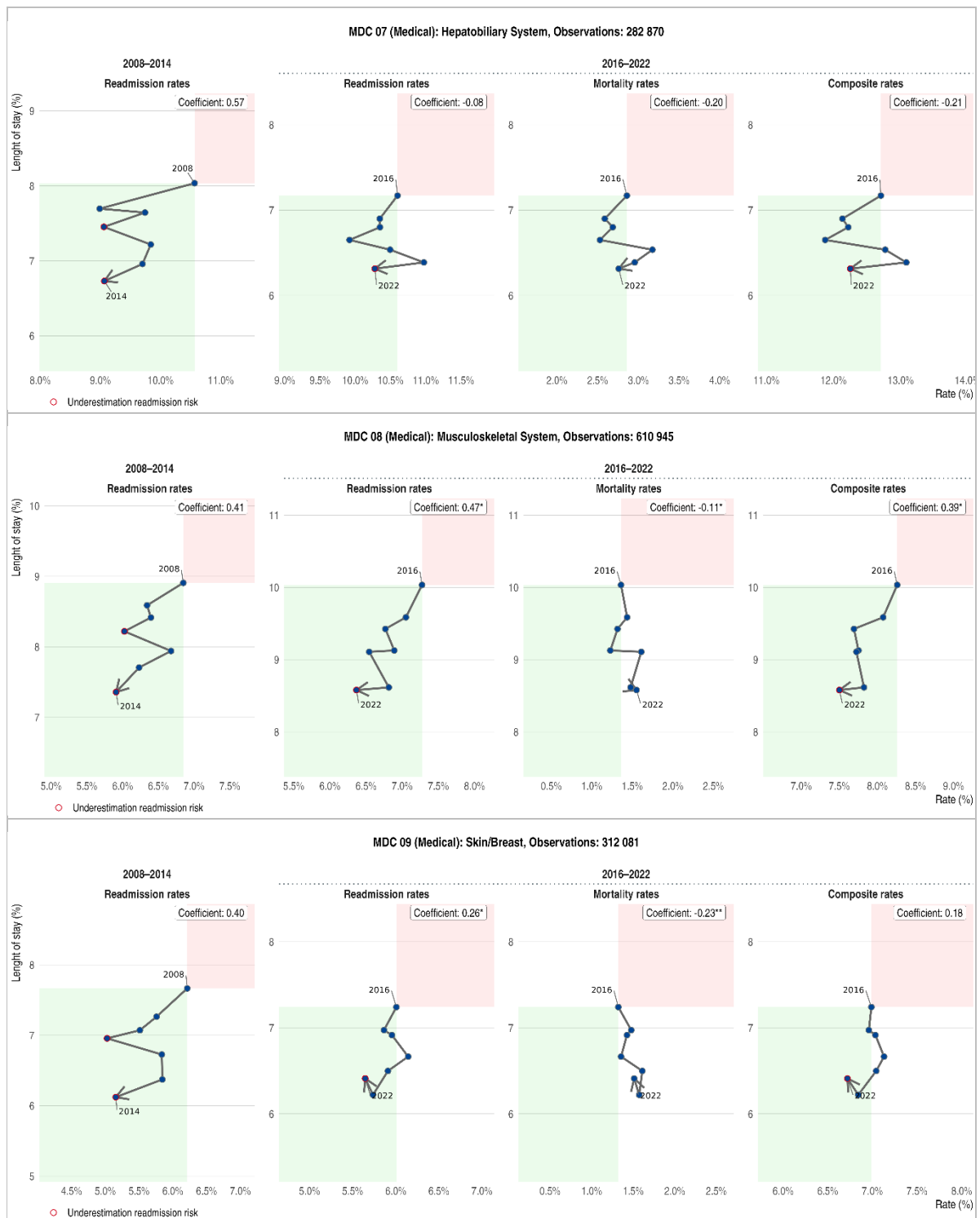
Two MDCs, medical MDC 12 (Male reproductive system) and surgical MDC 02 (Eye), stood out with high coefficient values, indicating that relatively small reductions in LoS corresponded to comparatively large decreases in readmission rates.

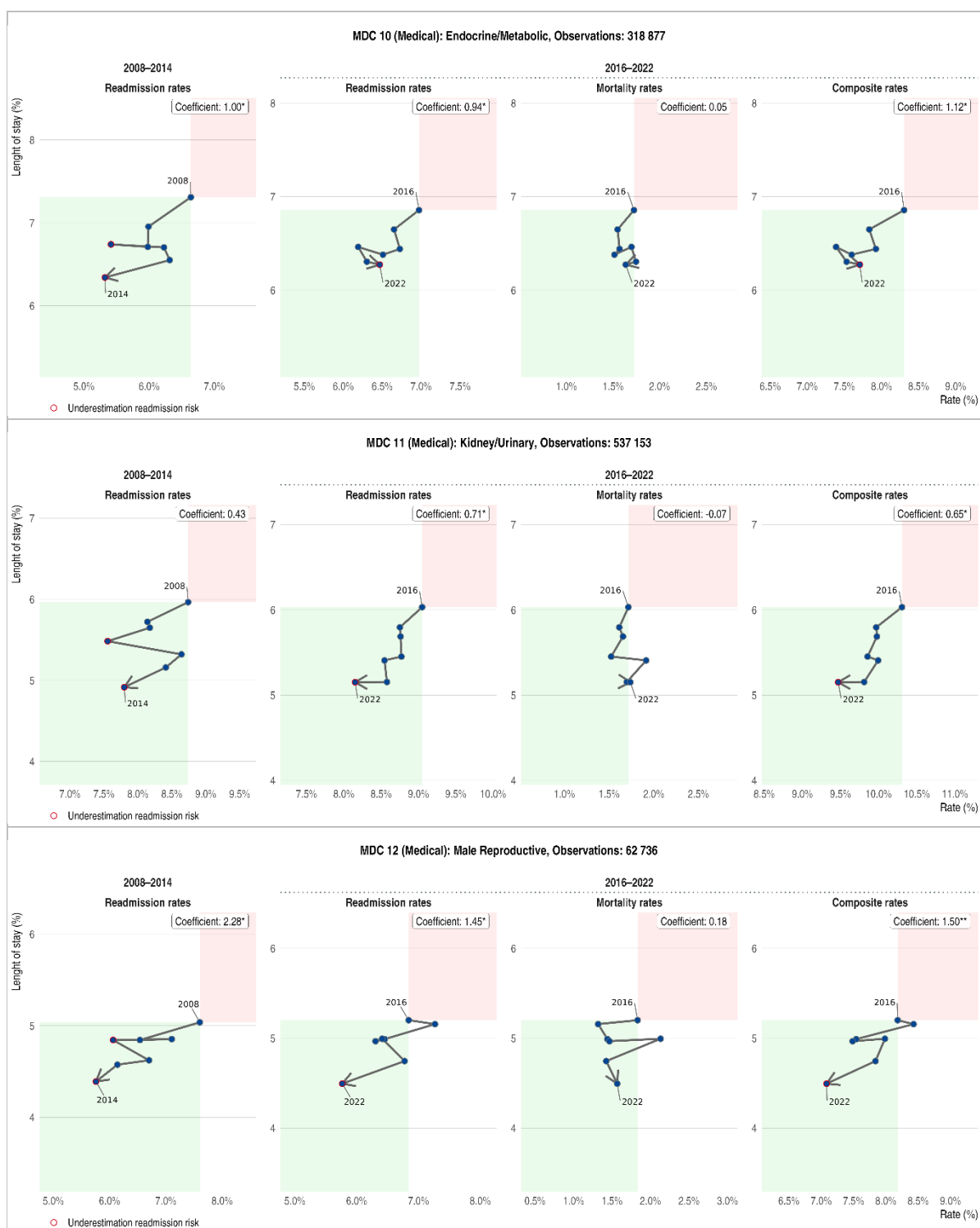
For mortality, a few deteriorations emerged where shorter stays coincided with higher mortality (see above). In some of these cases, the adverse mortality shift offset the improvements in readmissions, rendering the association between LoS and the composite rate non-significant. Conversely, medical MDC 16 (Blood/Immunological system) and medical MDC 04 (Respiratory system) showed improvements in mortality alongside reduced LoS. For MDC 04 (Respiratory system) this reflects COVID-related dynamics with observed increases in mortality in 2020-2021 and improvements in 2022.

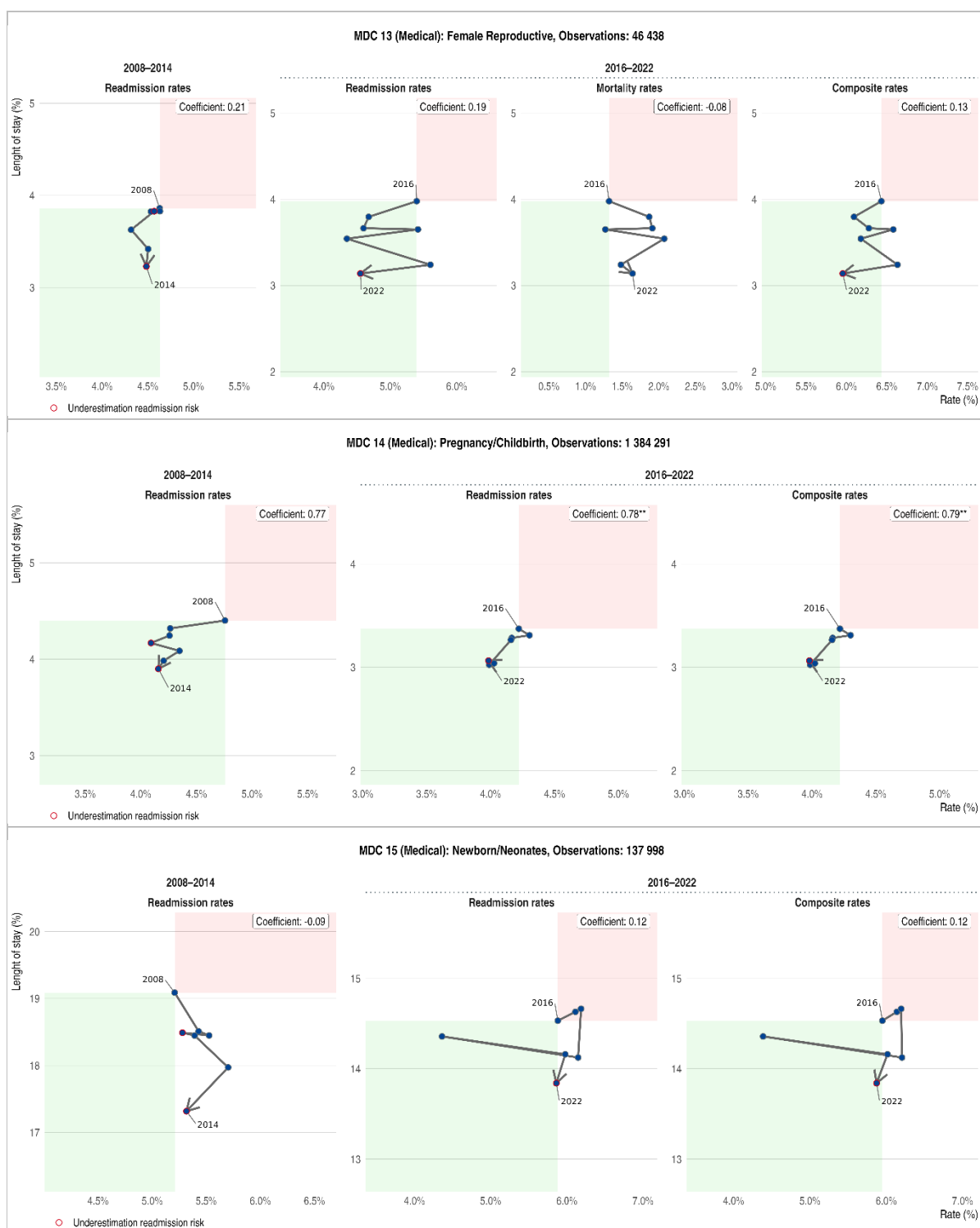
Figure 22 – Relationship between risk-adjusted LoS and risk-adjusted readmission, mortality and composite rates, by MDC (medical/surgical) and period

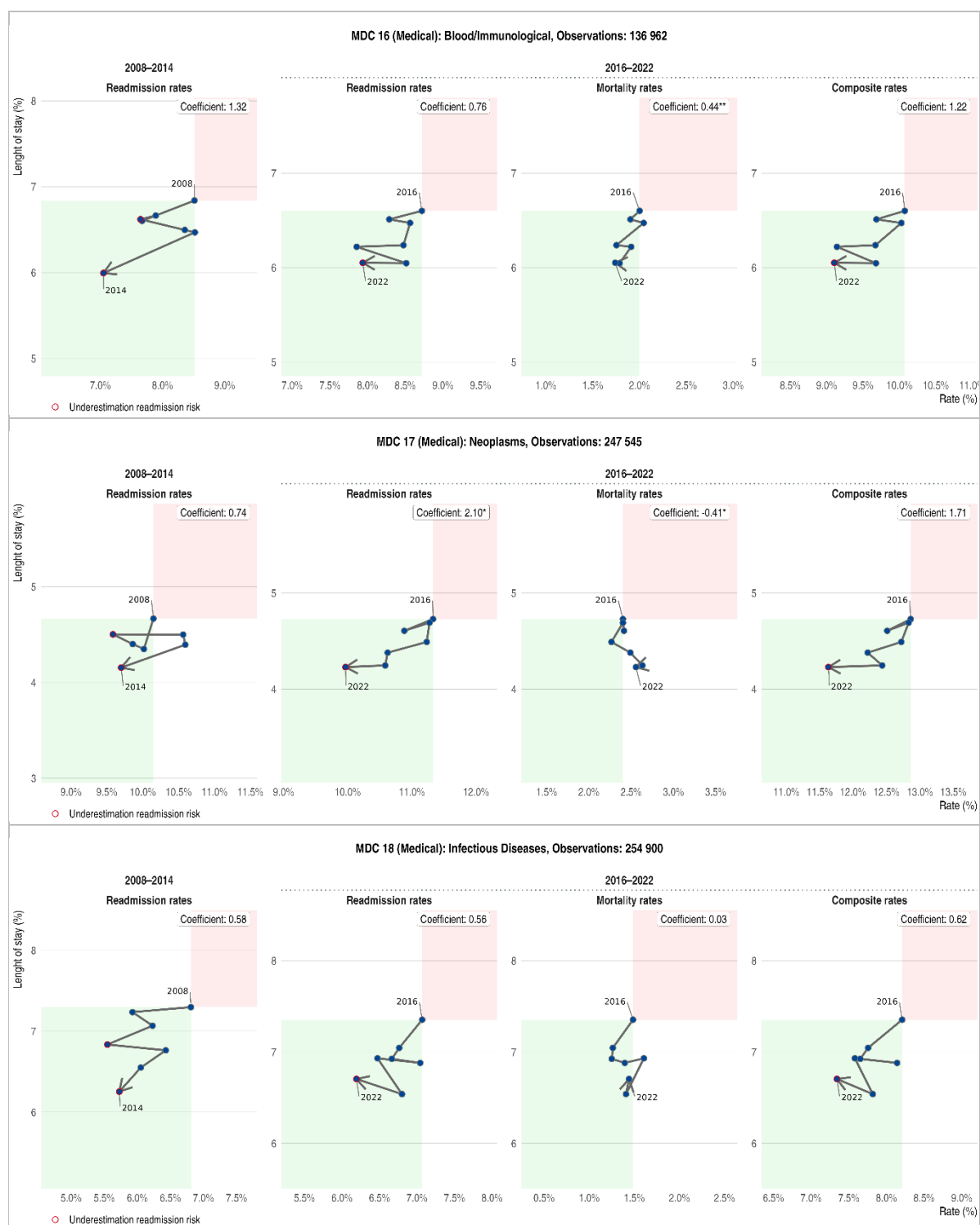


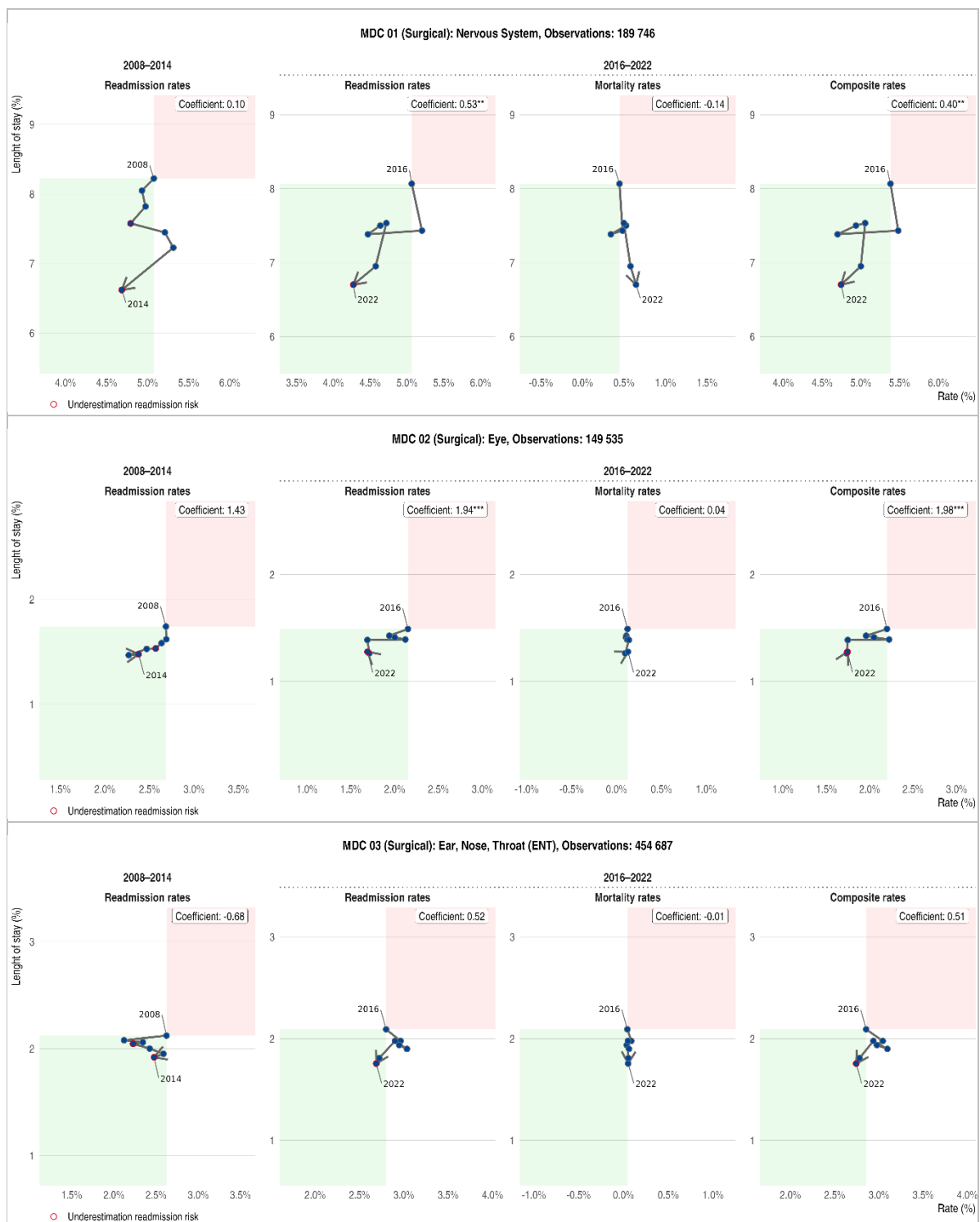


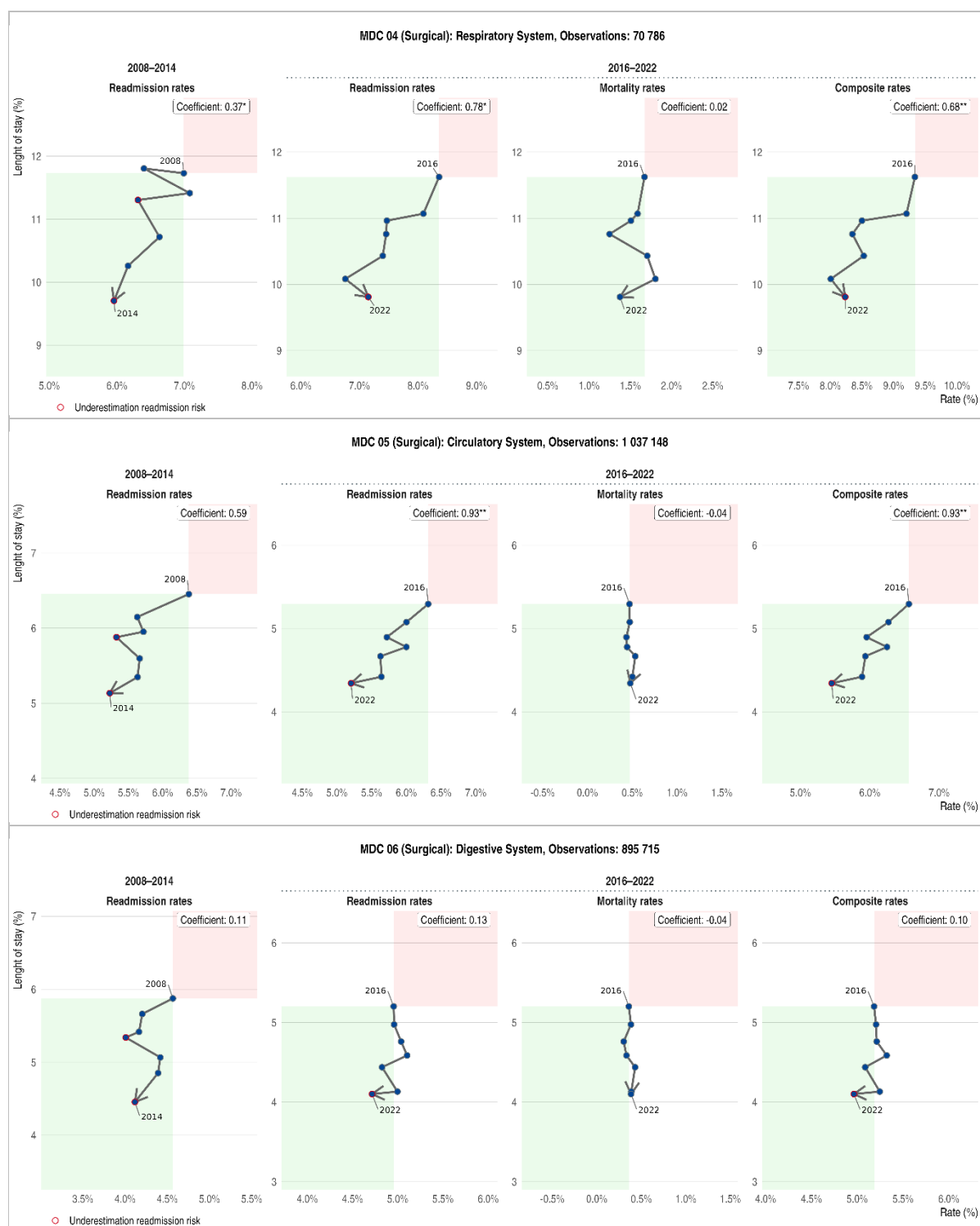


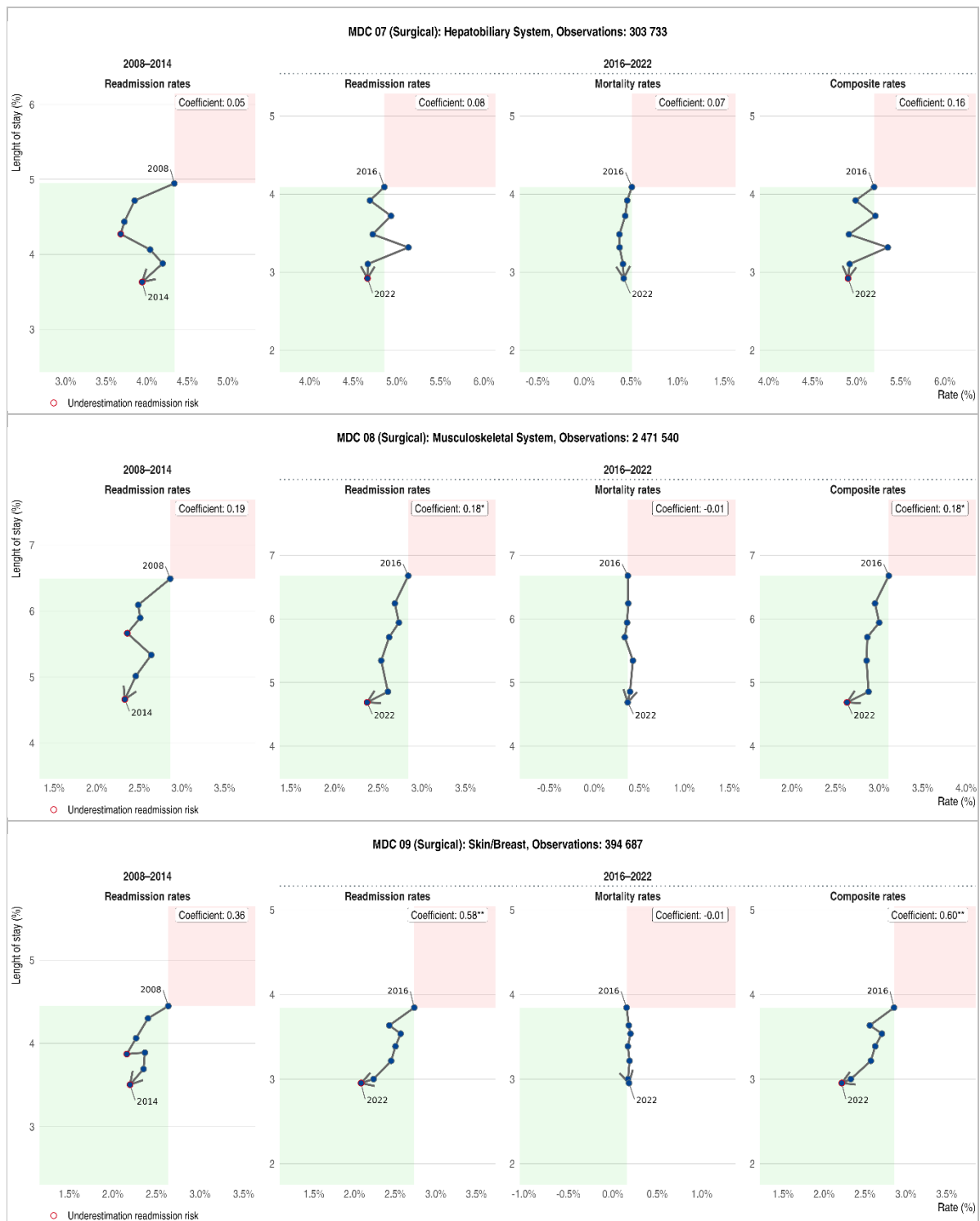


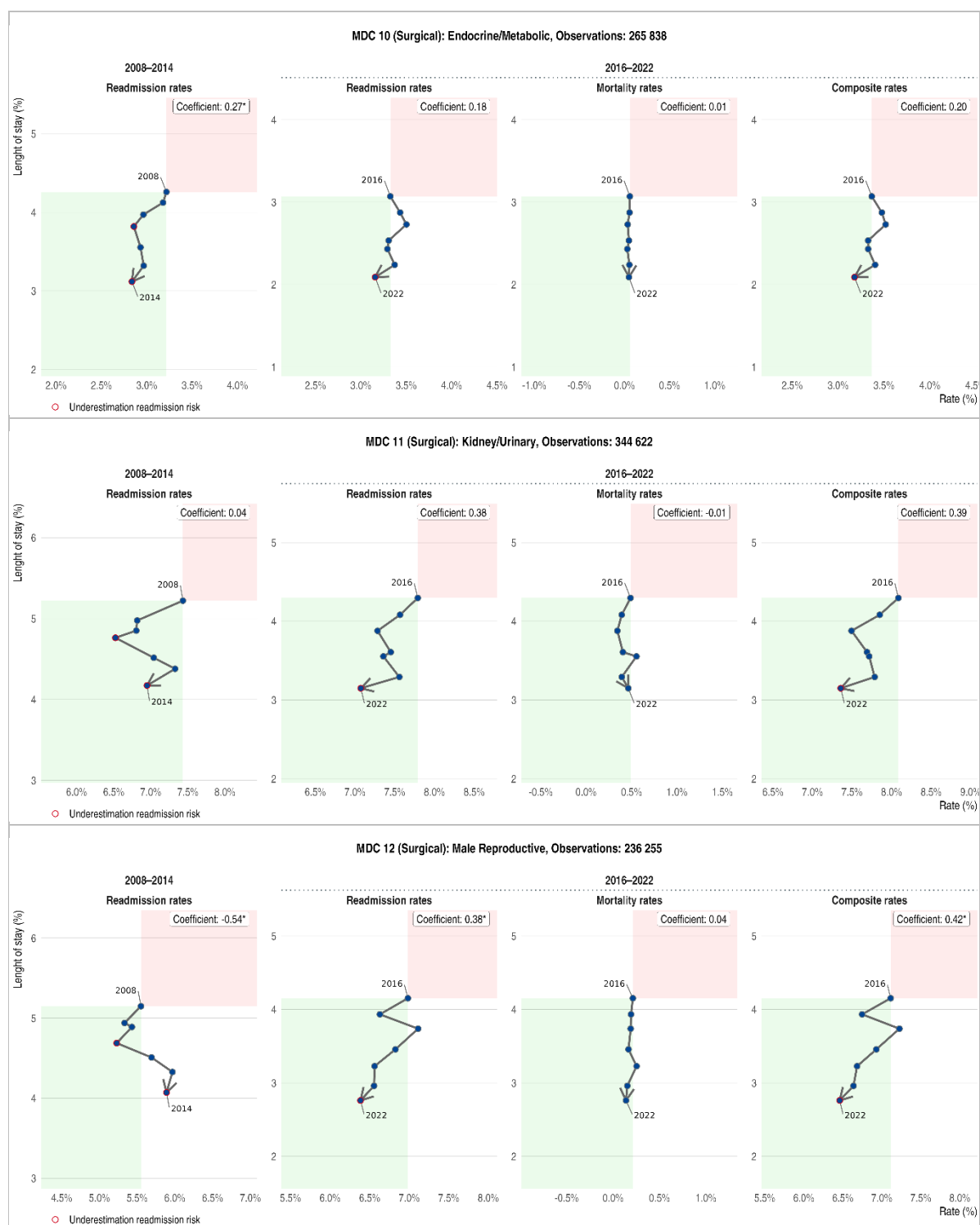


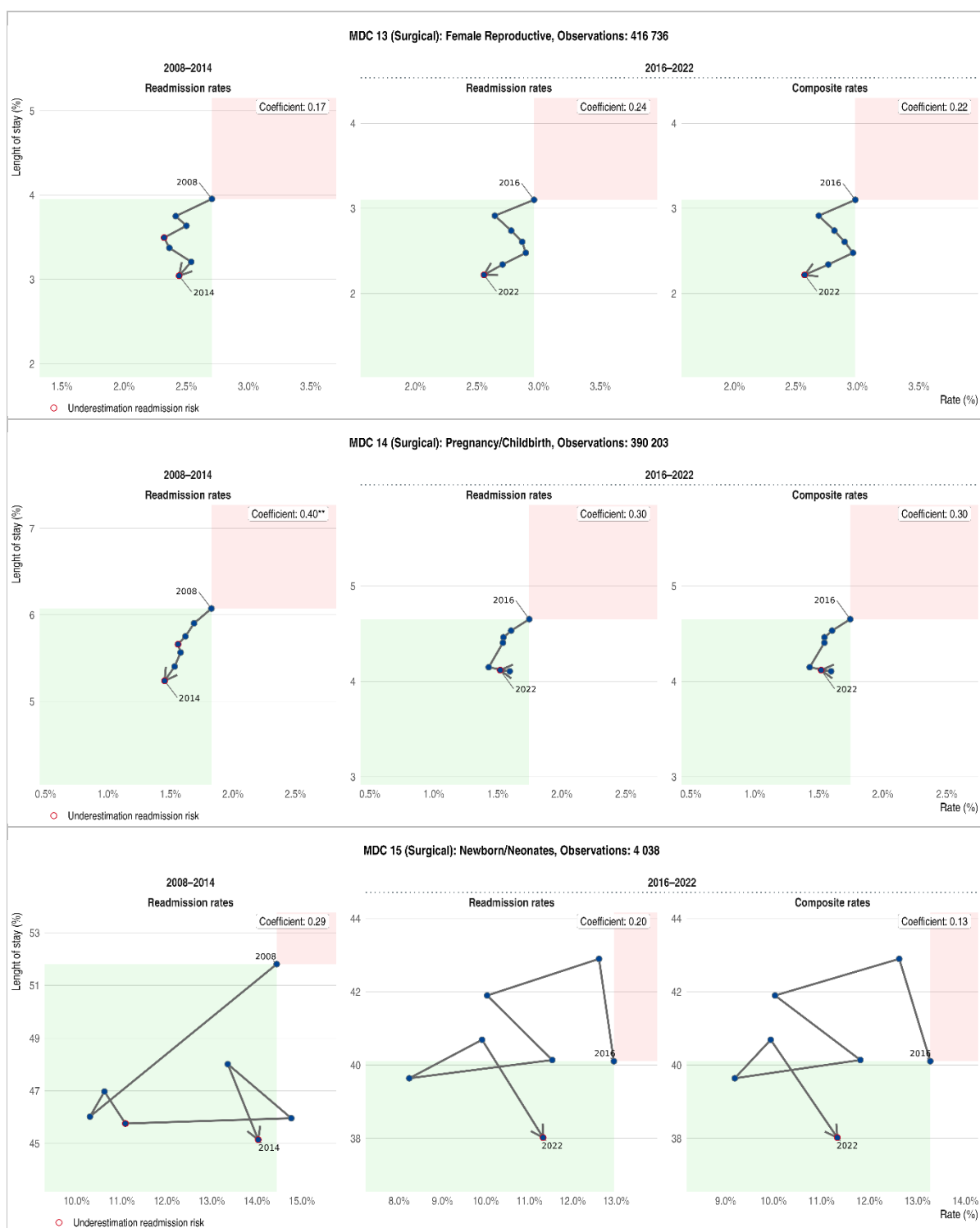


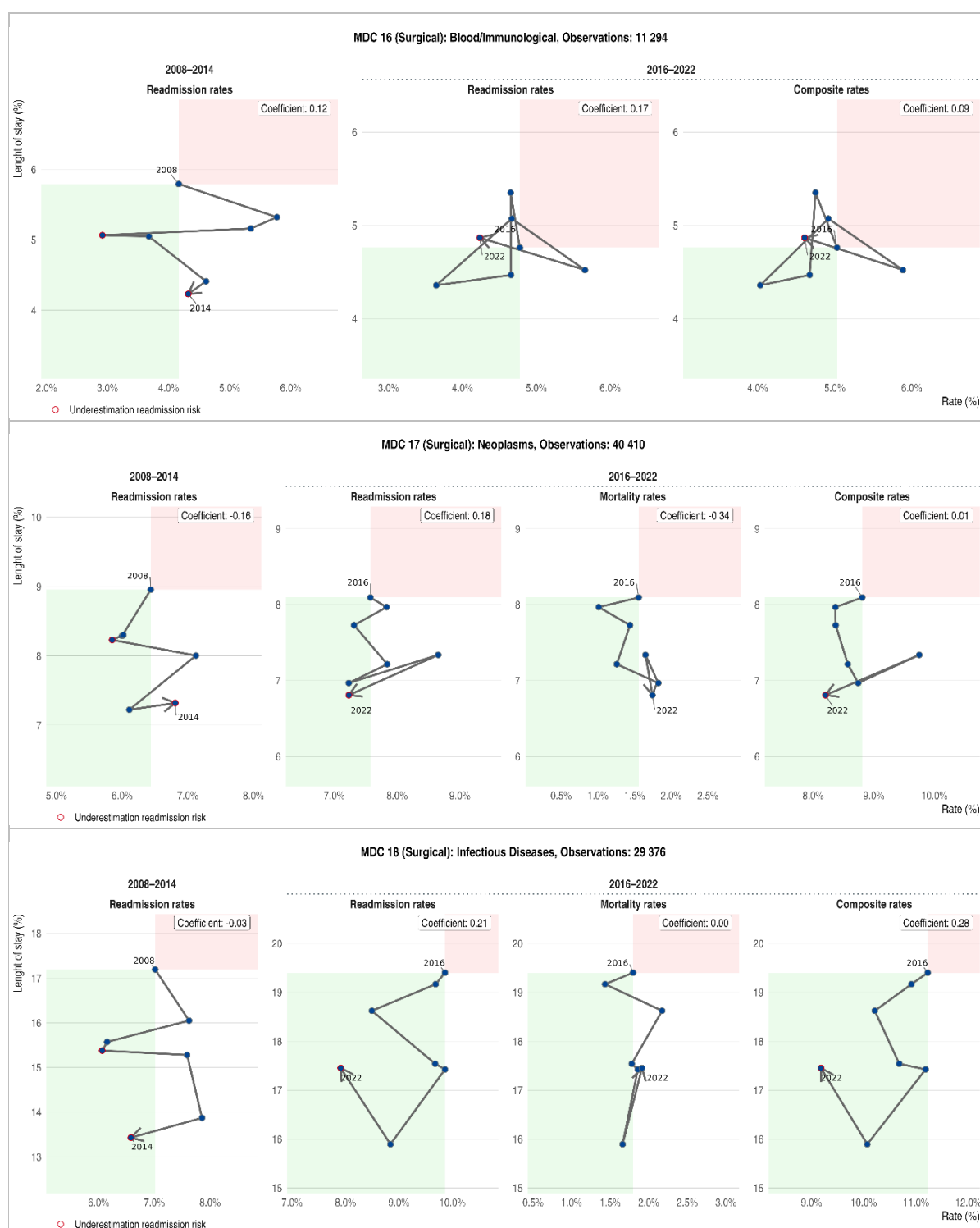












Note: Significance level: * = ≤ 0.05 ; ** = ≤ 0.01 ; *** = ≤ 0.001 . Mortality models for MDC 14 (Pregnancy/Childbirth), MDC 15 (Newborn/Neonates), MDC 13 (Surgical: Female reproductive system), MDC 16 (Surgical: Blood/Immunological) were not estimated (NE) due to an insufficient number of events.



2.4 Discussion

This chapter provides evidence that efficiency gains were obtained in Belgian general hospitals between 2008 and 2022 by a reduction in hospital length of stay (LOS). This reduction in LOS was not accompanied by a corresponding increase in unplanned readmissions or post-discharge mortality. On the contrary, while risk-adjusted post-discharge mortality rates remained relatively stable over time, risk-adjusted readmission rates declined (especially in the second period from 2016-2022). Moreover, the decline in risk-adjusted LOS and readmission rates was most pronounced among older patients and those with multiple comorbidities, suggesting that even among high-risk populations, shorter hospital stays can be achieved without compromising the measured outcomes.

Nonetheless, caution is warranted in interpreting these results. First, the study employs a descriptive analytical approach and does not investigate the underlying factors that may simultaneously influence trends in LoS and outcomes. This precludes causal inference. The observed trends in LOS and outcomes may reflect a complex interplay of factors, including improved care coordination, advances in medical technology, increased adherence to evidence-based practices, enhanced support structures outside the hospital setting, and a strengthened culture of quality within healthcare institutions.

Second, the use of administrative data imposes inherent limitations (see also discussion section Chapter 1, 1.4). While adjustments were made for key clinical variables such as age, pathology, and comorbidity burden, other potentially influential factors – such as socioeconomic status, availability of informal care, and home environment – could not be accounted for and noise might result from different coding practices (e.g. POA indicator, palliative care status). Moreover, the scope of outcome measures was restricted to unplanned hospital readmissions and post-discharge mortality. Important dimensions such as post-discharge emergency visits, patient-reported outcomes, and quality of life were not included in the current analysis, although follow-up studies are planned to address some of these gaps. In addition, this analysis focused exclusively on post-discharge outcomes. While in-hospital mortality is an important indicator for broader quality monitoring initiatives (which fall outside the scope of this report), it was deliberately excluded here. Excluding in-hospital deaths could introduce survivor bias in a quality-monitoring context. For the present study, which aims to examine population-level trends and the association between shortening length of stay and post-discharge events the choice to exclude in-hospital mortality is, however, justified since in-hospital mortality is not directly related to policy decisions on early discharge.

Therefore, it would be premature to conclude that reductions in LOS are entirely unrelated to quality of care. What can be stated with confidence is that, over the study period, hospitals achieved significant efficiency improvements without a concomitant rise in the adverse outcomes examined, particularly among patients with elevated baseline risk.

3 THE ASSOCIATION BETWEEN LOS REDUCTIONS AND READMISSION RATES OR POST-DISCHARGE MORTALITY: A SYSTEMATIC REVIEW

Main Findings

- **This review** investigates whether reductions in hospital length of stay including shifts from inpatient to day-care are associated with increased readmission rates or post-discharge mortality for selected surgical procedures and medical conditions (2012–June 2025). The review included 11 systematic reviews and 45 primary studies covering hip and knee arthroplasty, percutaneous coronary intervention (PCI), Heart Failure, Appendectomy, Cholecystectomy, COPD, diabetes, ENT Procedures, and more.
- **Daycare compared to inpatient setting** was not associated with worse **30-day readmission** for patients undergoing PCI, total hip and knee arthroplasty, appendectomy and laparoscopic cholecystectomy, but it was associated with worse 30-day readmission for patients with heart failure. Most evidence comes from systematic reviews with meta-analysis often supplemented with evidence from multicentre observational studies, except for heart failure where no systematic review was available.
- **Daycare compared to inpatient setting** was not associated with worse **30-day mortality** for patients undergoing PCI and total hip and knee arthroplasty, and for patients with heart failure. Due to a lack of events, the association could not be estimated in appendectomy and laparoscopic cholecystectomy. Part of the evidence comes from systematic reviews with meta-analysis, supplemented with evidence from multicentre observational studies.
- **A shorter LoS** was not associated with worse all-cause **30-day readmission rates** for patients undergoing PCI, total hip and knee arthroplasty, and in patients with heart failure and COPD. Inconsistent results were found regarding heart-failure specific readmissions (in heart failure patients). The evidence comes mostly from multicentre observational studies, except for PCI where the evidence comes from systematic reviews with meta-analysis.
- **A shorter LoS** was not associated with worse all-cause **30-day mortality** in patients undergoing PCI and for patients with heart failure and COPD. In patients with total hip or knee replacement, the number of events was too small to draw firm conclusions. The evidence comes from multicentre observational studies, except for PCI where the evidence comes from systematic reviews with meta-analysis.
- When a **temporal trend** was analysed, often a significant decrease in LoS over time was described. Firm conclusions regarding the temporal trend for readmission and mortality were not possible however, in patients with PCI, total hip and knee arthroplasty, heart failure, and COPD, **readmission** was mostly stable or decreasing over time. Other (inconsistent or increasing) results came from studies with serious risk of bias or dating back to 2012. **Mortality** in patients undergoing total hip and knee replacement and heart failure, was mostly stable over time. Evidence comes from multicentre observational studies with moderate and serious risk of bias.

3.1 Research question

In most high-income countries, a strong pressure exists on hospitals to increase efficiency by reducing the length of stay (LoS) of inpatient care. In addition to medical innovation, many hospitals have introduced care pathways or other initiatives to shift inpatient to day-care or decrease length of stay, while improving or maintaining quality of care and optimizing use of resources.⁶⁷ However, a shift towards day-care or reduction in length of stay may conflict with quality indicators such as hospital readmissions and 30-day mortality rates. Moreover, it is possible that hospitals move care out of the hospital without having alternatives in place. Therefore, the main research question of this review is:



- Is there an association between the reduction in length-of-stay, including a shift from inpatient to day-care in acute hospitals and readmission rates or post-discharge mortality for a selection of surgical procedures and medical conditions.

3.2 Methods

1. Search strategy

We developed a comprehensive search strategy to identify primary studies and systematic reviews in OVID-MEDLINE, Embase, and Cochrane Database of Systematic Reviews. The search string for OVID-MEDLINE was developed first and subsequently adapted to the other databases. The search string consisted of MeSH terms (or similar index terms for other databases) and free text key words related to the intervention (i.e. LoS reduction) and the outcomes (i.e. readmission and mortality at 30 days). The search strategy can be found in the Supplement to Chapter 3. The search strategy was first executed on 22 November 2023 and repeated on 20 June 2025 to update the review.

2. In- and exclusion criteria

We included primary studies and systematic reviews published from 2012 onwards in all languages. The design of the studies included either a temporal trend analysis or a comparator (e.g. matched-control cohorts, before-after). Studies without control group or temporal trend analysis were excluded as well as single centre studies. Systematic reviews of RCTs, observational studies or a combination of both were included. We excluded narrative reviews, realist reviews, (non-systematic) scoping reviews, integrative reviews, meta-syntheses, systematic reviews published by one author or based on one database, case reports, qualitative studies, conference abstracts, posters or presentations, editorial reports, and letters to the editor or other correspondence.

Setting. We included studies conducted in the acute inpatient and day-care hospital setting. Studies with a focus on psychiatric or rehabilitation hospitals were excluded. Studies focusing specifically on low- and middle-income countries were excluded. The categorisation of countries into low-, middle- and high-income countries was made based on the classification made by the World Bankⁱ.

For developing in- and exclusion criteria, the **PICO** framework was used:

- **Population:** Studies were eligible if they studied adults hospitalized for specific surgical procedures or medical conditions including: appendectomy, laparoscopic cholecystectomy, total hip replacement, total, bi- or uni-compartmental knee replacement, ethmoidectomy, excision of a lesion in the maxillary sinus, turbinectomy, tonsillectomy, rhinoplasty, septoplasty, myringoplasty, arthroscopy, shoulder surgery (but not shoulder arthroplasty), percutaneous coronary intervention (PCI), transurethral prostatectomy (TURP), chronic obstructive pulmonary disease (COPD), heart failure and diabetes.
 - The selection for surgical procedures was based on KCE report 282 (2011-2013)¹⁰ considering absolute volume in total (> 3000 cases) and relative frequency of the procedures in day-care (between 5% and 80%), as well as the results from the survey (<60% not in favour of day-care).
 - The selection of medical conditions was based on a preselection by Vlaams Instituut voor Kwaliteit van Zorg (VIKZ)^j, volume, observed reduction in LoS and availability of literature on reduction of LoS.

ⁱ <https://blogs.worldbank.org/en/opendata/new-world-bank-group-country-classifications-income-level-fy24>

^j <https://www.zorgkwaliteit.be/>

- **Intervention.** Studies were eligible if they studied the impact of length-of-stay reduction (e.g. early discharge) including a shift from inpatient towards day-care or outpatient (in the remainder of the Chapter we report the terminology used by the authors: outpatient surgery is often used as a synonym for day-surgery). Two types of studies were included: studies evaluating if patients or hospitals with a shorter LoS experienced an increased risk of readmission and/or post-discharge mortality and studies exploring the temporal trend of LoS, readmission and post-discharge mortality.
- **Comparator:** Studies were included if they compared a shorter LoS with a longer LoS or day-care (LoS=0) with inpatient stays. Alternatively, the comparator can be a temporal trend in LoS.
- **Outcome:** Studies were included if they reported on all-cause or condition specific readmission or post-discharge mortality. We were especially interested in studies reporting 30-day outcomes, but we also included studies with an unspecified or a longer time window (up to 90-days maximum).

An overview of all in- and exclusion criteria can be found in Table 15.



Table 15 – In- and exclusion criteria

	Inclusion	Exclusion
Time	From 2012 onwards Primary studies published after the search date of the most recent selected systematic review with the same PICO	Before 2012 Primary studies published before the most recent selected systematic review with the same PICO
Language	All languages	/
Setting	Acute (inpatient or day-care) hospital setting; high-income countries	Studies focusing specifically on <u>low- and middle-income countries</u> ; psychiatric hospitals; rehabilitation hospitals
Design	Primary studies including an intervention and control group, or temporal analysis. Systematic reviews including such studies.	Single centre studies, case reports or qualitative studies. Narrative reviews, realist reviews, (non-systematic) scoping reviews, integrative reviews, meta-syntheses, systematic reviews published by one author or based on one database. Conference abstracts, posters or presentations, editorial reports, letters to the editor or other correspondence
Population	Hospitalized adults for specific surgical procedures or medical conditions: • appendectomy, • laparoscopic cholecystectomy • total hip replacement • total, bi- or unicompartmental knee replacement • ethmoidectomy, excision of a lesion in the maxillary sinus, turbinectomy, tonsillectomy, rhinoplasty, septoplasty, myringoplasty (ENT procedures) • arthroscopy • shoulder surgery • PCI • TURP • COPD • heart Failure • diabetes mellitus	Children Adults in • psychiatric hospitals • rehabilitation hospital • hospital at home • shoulder arthroplasty
Intervention	LoS reduction – Short LoS (early discharge, next day discharge, 24h discharge) – Same-day-surgery (outpatient, ambulatory, day-care or day-case)	No comparator or temporal trend

	Temporal trend LoS	Specific intervention to reduce LoS e.g. ERAS, SSU
Outcome	Primary: • 30-day readmission • 30-day post-discharge mortality • Readmission or mortality with another or unspecified time window (max 90-day)	

COPD chronic obstructive pulmonary disease, ENT ear nose throat, ERAS enhanced recovery after surgery, LoS length of stay, PCI percutaneous coronary intervention, PICO population intervention control outcome, SSU short stay unit, TURP transurethral coronary intervention



3. Study selection

Duplicates were removed after the search results from different databases were merged into one overview using Rayyan. Two reviewers (KOV and REZ) independently screened the titles and abstracts of the retrieved papers and discussed any conflicting results. When necessary, a third party was involved to resolve the discussion. The papers identified as potentially relevant, underwent a full-text screening. A hierarchical stepwise selection process was used whether a manuscript could be included in the review, starting with the systematic reviews. As no restrictions were made on language, the identified systematic reviews first underwent the hierarchical selection process counting five further steps focusing consecutively on design, setting, population, intervention, and outcome. Time restrictions (i.e. published from 2012 onwards) were a filter in the search strategy, and thus were not a step in the hierarchical selection process as articles published before 2012 were filtered out automatically. In a second step the identified primary studies underwent a hierarchical stepwise selection focusing on timing (i.e. published in the same year or later than the most recent selected systematic review with the same PICO), followed by design, setting, population, intervention, and outcome. The reasons for exclusion of full-texts were documented and categorized according to the predefined in- and exclusion criteria. In case of doubt the reviewers consulted each other to determine eligibility or reason for exclusion. Next, for all included studies, we performed reference and citation searching. This comprises abstract and full-text screening of potentially relevant studies following the above mentioned hierarchical stepwise selection process. Reference and citation searching was performed using Web of Science. The study selection process is presented in a flowchart.

4. Data extraction and synthesis

Relevant data from the included reviews was extracted and tabulated in a data extraction form. This was done by one reviewer and checked by a second reviewer. Data extraction and synthesis was first pilot-tested. A template for pilot testing of data extraction was developed and it was decided to do this in a pragmatic way depending on the harvest of identified studies.

- For systematic reviews data extraction included reference, population, intervention and comparator, outcome of interest, meta-analysis characteristics (number and type of primary studies and number of patients included) and result.
- For primary studies data extraction included reference, setting and design, population, intervention and comparator, and outcome.

If available, 30-day mortality and/or 30-day readmission were reported. Data from other time frames were only reported if no 30-day data were available. Data on emergency department (ED) visits or costs were also extracted if available. Study characteristics and study results were summarized in tables per included procedure or medical condition. Endnote was used as reference software when synthesizing the review results in the draft chapter.

5. Quality appraisal

For quality appraisal of the included literature, readily available critical appraisal tools were used: AMSTAR 2⁶⁸ was used for systematic reviews, Version 2 of the Cochrane risk-of bias tool for randomized trials (RoB2)⁶⁹ and Risk of bias in non-randomized studies of interventions (ROBINS-I)⁷⁰ for observational studies. For the purpose of our review, to facilitate the comparisons of the quality of the different SRs included in this review, those with up to 7 positive ("yes") answers to the AMSTAR 2 checklist, were considered of low quality, those with 8-12 were considered of moderate quality and those above 12 were classified as high quality. No studies were removed from the synthesis based on the quality appraisal. After having pilot-tested the quality appraisal process in five selected studies, the remaining quality appraisals were done independently by one reviewer.

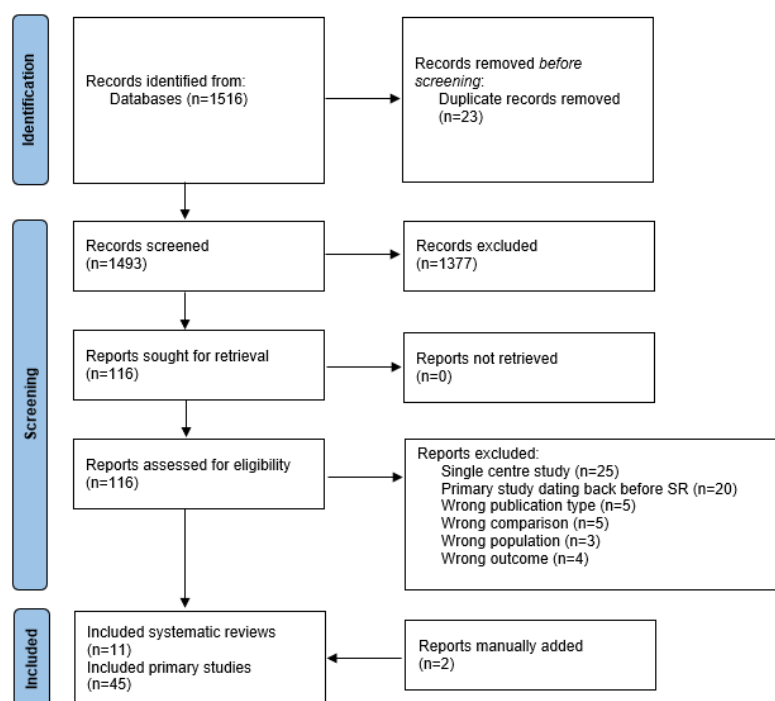
3.3 Results

3.3.1 Literature search

The searches in bibliographic databases in November 2023 and June 2025 yielded a total of 1516 references of which 23 were duplicates. After screening based on title and abstract, 116 reports were retained for full text evaluation and eligibility assessment, 14 systematic reviews and 102 (93 and 9) primary studies. By following the selection methodology described above, 62 reports were excluded in six categories: primary study dating back before systematic review (timing), single centre study (design), wrong publication type (design), wrong comparison (intervention), wrong population or wrong outcome.

The process and reasons for exclusion and distribution of the reasons are visualised in a PRISMA flow diagram (Figure 23).

Figure 23 – PRISMA flow diagram



The screened full texts included 102 primary studies and 14 reviews. Full texts of primary studies mentioned in the systematic reviews were not retrieved. All information on these was extracted from the included systematic review. The screened full texts could be divided into 9 different procedures or medical interventions: hip and knee arthroplasty (46); percutaneous coronary intervention (25); heart failure (20); appendectomy (6); laparoscopic cholecystectomy (5); COPD (3); diabetes (2); transurethral prostatectomy (1); and ear-nose-throat (ENT) procedures (1). A final category 'miscellaneous' contained reports with a mix of surgical procedures or medical conditions (7).

The distribution of the reports among these categories and the selection process is summarized in a table in the Supplement to Chapter 3. After screening of the full texts and manual addition of 2 reports from the checked references (one on hip and knee arthroplasty and one on heart failure), we included 45 primary studies and 11 systematic reviews in the final selection. These could be divided in 6 categories: hip and knee arthroplasty (22), PCI (9), heart failure (15), laparoscopic cholecystectomy (3), appendectomy (2) and COPD (2). No reports were selected for diabetes, ENT and TURP. In the category miscellaneous, 3 reports with results on a selected procedure were included and are further discussed in the respective category: one in heart failure⁵⁷ and two in hip and knee arthroplasty.^{71, 72}



The list of excluded papers per category with references and reason for exclusion can be found a table in the Supplement to Chapter 3.

The impact of LoS on outcomes after different surgical procedures and medical conditions could be studied in three different ways: the comparison between outpatient (ambulatory, same day discharge) and inpatient (overnight stay), the comparison between a different LoS (as a continuous or categorical variable) and the investigation of a temporal trend of LoS, readmission and mortality. In the next sections we will discuss the available results per type of comparison for each selected surgical procedure or medical intervention. Full details on study characteristics, results and quality appraisal is available in the Supplement to Chapter 3. Full justification of the quality appraisal is available on request. For the included systematic reviews a list of included primary studies is also available in the Supplement to Chapter 3.

3.3.2 *Outpatient versus inpatient*

3.3.2.1 *PCI*

The comparison between same day discharge (SDD) and overnight stay (ON) in PCI patients was the topic of 2 systematic reviews^{73, 74} and 3 primary multicentre studies published after the last systematic review in 2017.⁷⁵⁻⁷⁷

The first systematic review with meta-analysis on 30-day readmission concerned 107 866 patients with uncomplicated PCI and included 5 RCTs with 2962 patients and 5 observational studies with 105 827 patients.⁷³ The second systematic review evaluated 8 RCTs, which included the 5 RCTs from the previous systematic review and performed meta-analysis of 1 205 patients from 3 RCTs on 30-day readmission and 2 449 patients from 3 RCTs on 30-day mortality. The meta-analysis concerned patients with stable coronary artery disease (CAD), but some of the included studies included other patient groups with acute coronary syndrome or unstable angina.⁷⁴ No significant differences were identified between SDD and ON stay for readmissions or mortality (Supplement to Chapter 3).^{73, 74} The quality of these systematic reviews was evaluated with AMSTAR2 and was rated moderate with a score of 8 for the first systematic review⁷³ and a score of 10 for the second.⁷⁴ The AMSTAR2 evaluation and list of primary studies included in systematic reviews and different meta-analysis can be found in the Supplement to Chapter 3.

Since the most recent systematic review in 2017, three multicentre primary observational studies have been published, including 2 cohorts^{75, 77} and one post-hoc analysis from an international multicentre RCT⁷⁶, comparing SDD with ON stay in patients undergoing elective PCI (Supplement to Chapter 3). The post hoc-analysis only included a specific population with left main coronary artery disease (LMCAD)⁷⁶ and one of the cohort studies included only PCI with stent.⁷⁵ SDD was not found to be associated with worse 30-day mortality^{75, 76} or 30-day readmission.⁷⁷ Although one of the studies showed a higher rate of 30-day readmissions associated with SDD, it also showed a faster decrease over time of this outcome in SDD compared to ON stay (from 2009 to 2017). Mortality in this study did not change over time.⁷⁵ The results should be interpreted with caution as the last study was evaluated to be at serious risk of bias⁷⁵, and the other two at moderate risk of bias (Supplement to Chapter 3).^{76, 77}

3.3.2.2 *laparoscopic cholecystectomy*

Three systematic reviews with meta-analysis were identified that compared day-surgery with overnight stay for patients undergoing a **laparoscopic cholecystectomy** including a 2013 Cochrane review.⁷⁸⁻⁸⁰ All systematic reviews evaluated mortality and readmissions.⁷⁸⁻⁸⁰ Characteristics and results of the systematic reviews are summarized in the Supplement to Chapter 3.

The quality of meta-analyses was moderate to high, with the oldest one being of the high quality (AMSTAR2 score 16)⁸⁰ and the two other meta-analyses of moderate quality (AMSTAR 2 score 12 and 10).^{78, 79} (Supplement to Chapter 3)

The list of primary studies included in the different systematic reviews can be found in the Supplement to Chapter 3. Complete mortality data were only reported by one RCT with 86 patients⁸¹ that was included in all three meta-analysis.⁷⁸⁻⁸⁰ and three clinical controlled trials (CCT) with 631 patients⁸²⁻⁸⁴ that were only included in the meta-analysis by Tang et al.(2015).⁷⁹ However, none of these primary studies reported any events, so the relative effect could not be estimated.⁷⁸⁻⁸⁰

More primary studies included data on readmission, in total 8 RCTs and 3 CCTs, that were studied in different combinations in the three meta-analyses (number of patients ranging between 464 and 790) depending on the timing of the review and the design of included primary studies. Follow-up times were not specified in the systematic reviews, but were usually short, ranging between 4 days and 6 weeks if specified (Supplement to Chapter 3). None of the meta-analyses could identify significant differences between readmission rates in day-surgery compared to overnight stay. However, even the highest quality meta-analysis on 5 RCT graded the quality of evidence very low because of high risk of bias and inconsistency (risk of random errors).⁸⁰

Two systematic reviews included results on post-discharge consultation rates^{78, 79} and one on costs.⁷⁸ Pooling results from 6 RCT or 5 RCT and 2 CCT showed no significant differences between day-surgery and overnight stay for the consultation rate.^{78, 79} Descriptive results on costs from 4 RCT reported 3.8% to 372.6% higher costs for outpatients.

No additional primary multicentre studies were identified that were published after the most recent systematic review with the same PICO.

3.3.2.3 Appendectomy

There was one systematic review with meta-analysis of moderate quality (AMSTAR2 score 12) (Supplement to Chapter 3), which compared patients with same day discharge (SDD) and inpatients with discharge on post-operative day (POD) 1 or 2, or SDD and historical controls, but only observational studies were included.⁸⁵ A summary of characteristics and results of this systematic review and the primary studies included in meta-analysis can be found in the Supplement to Chapter 3.

Although pooling of unadjusted results from 3 studies with 50 435 patients showed an association of SDD with reduced 30-day readmissions compared to discharge on POD1 or POD2,⁸⁶⁻⁸⁸ this result could not be confirmed with adjusted results that were available for two of these studies (37 732 patients).^{86, 87}

Only unadjusted results from 4 cohorts were available for the comparison of SDD to a historical control cohort (with lower percentage of SDD), therefore increasing the risk of bias of the non-significant result of meta-analysis on 2032 patients for 30-day readmission.⁸⁹⁻⁹² The systematic review also included unadjusted results on 30-day unplanned hospital visits from 3 cohort studies with 1462 patients, but they found no association between SDD and unplanned hospital visits.⁹¹⁻⁹³

Only one additional primary multicentre study on appendectomy was identified after the included systematic review from 2021 with the same comparison as the meta-analysis.⁹⁴ The characteristics and results of this study are summarized in the Supplement to Chapter 3. This observational study on 16 391 patients had moderate risk of bias according to ROBINS-I (Supplement to Chapter 3). Adjusted results for 30-day readmission confirmed results from the meta-analysis, that there was no significant difference between SDD and POD 1-2. No adjusted results were available for mortality, since there was only one event in each group.⁹⁴



3.3.2.4 THA and TKA

The first literature search in November 2023 identified only one systematic review on hip and knee arthroplasty comparing outpatient and inpatient settings by Xu et al. (2020)⁹⁵. The characteristics and results of this systematic review are available in the Supplement to Chapter 3. The systematic review with meta-analysis on 177 792 patients included only one RCT⁹⁶ and six retrospective observational studies⁹⁷⁻¹⁰² and was of moderate quality (AMSTAR 2 score 10, Supplement to Chapter 3). The included studies were either small in sample size (between 128 and 486 patients) or included a relatively small number of outpatients compared to inpatients (0.5%-0.7%). The definition of 'outpatient' varied between studies. In most studies, outpatient was defined as 'same day discharge', which means discharge was on the same day as the procedure,^{96, 98, 99, 101, 102} but in two studies it was defined discharge within 23 hours,^{97, 100} which thus could include an overnight stay. Complications were the main focus of this meta-analysis and despite a reported results for meta-analysis on readmission, important information was lacking (number of studies, number of patients) and no forest plot was published on this outcome. Readmission was found not to be significantly different for outpatients compared to inpatients both for knee and hip replacement combined or for these procedures separately. Because the results of RCTs and observational studies were pooled and only the unadjusted results of the observational studies were included, the results should be interpreted with caution.

Five multicentre retrospective cohorts were identified from 2020 onwards, all with moderate risk of bias comparing outpatients and inpatients¹⁰³⁻¹⁰⁶ except for one with serious risk of bias.⁷¹ The characteristics and results of these primary studies are summarized in the Supplement to Chapter 3. Risk of bias evaluation can be found in the Supplement to Chapter 3. Outpatient was defined as discharge on the day of surgery,^{104, 106} LoS 0d,¹⁰³ or discharge <24h.¹⁰⁵ Multiple definitions of the comparator inpatient were used: one single overnight stay¹⁰⁴, at least one overnight stay with mean LoS 2d (SD 1.2d),¹⁰⁶ categories LoS 1-2d and LoS ≥3d,¹⁰³ or LoS ≥1d.¹⁰⁵ Outpatient was not clearly defined by Iweala et al. (2019)⁷¹, nor was inpatient. The outcome 30-day readmission was found not to be significantly different in three studies using the North American National Surgical Quality Improvement Program (NSQIP) registry database^{71, 103, 105} and one study using the Danish National Patient Register (DNPR) database.¹⁰⁴ The three studies with NSQIP data differed from each other in their duration (1 year, 3 years and 11 years) and method of statistical analysis (multivariate analysis with adjustment for confounders or propensity matched cohorts) and outcome (30-day mortality was reported in two of the three studies). In the fourth study with matched cohorts using the American Premier Health database, 90d readmission was significantly lower in outpatients with a specific knee implant compared to inpatients (Attune knee system).¹⁰⁶ Only three of the trials looked at mortality: one unadjusted after 90 follow-up,¹⁰⁴ and two with a propensity-matched cohorts after 30 days of follow-up.^{71, 105} None of them showed significantly different results between inpatients and outpatients. Higher 90-day costs were described for inpatients compared to outpatients in one study.¹⁰⁶

The June 2020 search update identified an additional systematic review of moderate quality (AMSTAR 2 score 12, Supplement to Chapter 3) comparing hip and knee arthroplasty in inpatient and outpatient settings for safety, efficacy and cost-effectiveness.¹⁰⁷ (Supplement to Chapter 3). Although the review included two RCTs and 9 observational studies, only one RCT on THA,⁹⁶ which was also identified in the first systematic review by Xu et al.⁹⁵ and 5 observational studies on THA and/or TKA.¹⁰⁸⁻¹¹² were included in the meta-analysis for evaluating readmissions (1871 patients in total). In contrast to the first systematic review, retrospective cohorts were excluded, except for in the cost analysis. The follow-up time was also longer, mostly 90 days, and in one study even 360 days.¹⁰⁸ Additionally, the proportion of outpatients included in the meta-analysis was better balanced (36% for THA and 46% for TKA). However, the final conclusion was the same, because the meta-analysis found no significant difference in the number of readmissions between inpatients and outpatient groups. On the other hand, costs were significantly lower in the outpatient group based on data from 392 patients from one RCT, one prospective and two retrospective cohorts.¹⁰⁷

Following the same methodology as previously, only one additional primary study was identified after the search date of the latter systematic review (October 2023) comparing a subgroup of inpatients and outpatients with morbid obesity (BMI > 40 kg/m²) undergoing primary elective TKA or THA (Supplement to Chapter 3).¹¹³ Results showed significantly less 30-day readmissions in outpatients with TKA and no statistical difference between inpatients and outpatients with THA. On the other hand, inpatients had significantly less ED visits and higher costs for both TKA and THA. The results of this retrospective cohort considered moderate risk of bias (Supplement to Chapter 3) were matched for age, sex and CCI.¹¹³

3.3.2.5 Heart failure

Two cohort studies compared 30-day readmission and mortality in patients with heart failure between inpatient and outpatient setting (Supplement to Chapter 3). The first study was a retrospective cohort from US between 2008 and 2015, that reported only descriptive unadjusted results for the 30-day outcomes (serious risk of bias on ROBINS-I, Supplement to Chapter 3), which included higher all-cause and HF readmission and a lower mortality for outpatients compared to inpatients.¹¹⁴ At 1 year follow-up, adjusted results showed that an outpatient heart failure (HF) stay was associated with higher all-cause and HF readmissions, but there was no association with mortality. A second study was a prospective cohort from Spain during one month in 2014 which compared acute decompensated HF patients without STEMI discharged from the emergency department (considered outpatient) and discharged after hospitalization (considered inpatients) (moderate risk of bias on ROBINS-I, Supplement to Chapter 3).¹¹⁵ and showed similar adjusted results for 30-day readmission and mortality: an inpatient stay was associated with lower 30-day readmission, but not with 30-day mortality. Additionally, there was an association between inpatient stay and fewer ED visits. This suggests a protective effect of inpatient stay.

3.3.2.6 Summary of results

We conclude that same day discharge in selected **PCI** patients was not associated with worse 30-day readmissions or 30-day mortality compared to overnight stay and that no association was found between day-surgery and readmissions in patients undergoing **laparoscopic cholecystectomy** and **appendectomy**. Due to a lack of events the association between day-surgery and mortality could not be estimated in these patients. For patients undergoing total **hip or total knee** arthroplasty outpatient setting was not associated with worse readmission or mortality compared to inpatients, however it must be emphasized that the definition of outpatient in some studies included stays less than 24 hours with one overnight stay. A different follow-up time of 30 days or 90 days did not change results consistently. There were different results for **heart failure** patients, where outpatient setting was associated with worse 30-day readmission, but 30-day mortality was not significantly different.



Table 16 – Summary outpatient versus inpatient

Procedure or medical condition	30-day readmission		30-day mortality	
PCI	74 73	77 75*	74 75*	76
Laparoscopic cholecystectomy	78-80 (mix FU)		78-80 (mix FU) (not estimable)	
Appendectomy	85, 94		94 (not estimable)	
THA/TKA	95, 103-105 71* 107 (mix FU, mostly 90d)	106 (90d) 113 (30d)	71* 105 104 (90d)	
Heart failure	114(all-cause)* (90d) 114(specific)*(90d) 115 (all cause)		114*(90d)	115

d days, FU Follow-up, THA total hip arthroplasty, TKA total knee arthroplasty.

Systematic review (bold), ° **low quality**, Primary study (normal font), * serious risk of bias

	Not reported outcome	
	negative correlation (shorter LoS more readmissions/mortality)	
	Study with mixed results inverse correlation and no significant difference	
	No significant difference	Non-inferior
	Study with mixed results no significant difference and positive correlation	
	Positive correlation (shorter LoS fewer readmissions/mortality)	

3.3.3 LoS reduction

3.3.3.1 PCI

The comparison between early versus late/ordinary discharge with a cut-off of 3 days for PCI in patients with ST-elevation^k myocardial infarction was the topic of 2 systematic reviews.^{117, 118} (Supplement to Chapter 3). The first meta-analysis pooled data from 1 004 patients from 3 RCTs on 30-day readmission and 30-day mortality.¹¹⁸ The second meta-analysis on readmission included 38 158 patients from 6 RCTs and 2 observational cohorts and on mortality included 38 359 patients from 6 RCTs and 3 cohorts.¹¹⁷ No significant differences were identified between early and late discharge for readmission and mortality, except for the subgroup analysis of observational studies, where early discharge was associated with reduced mortality.^{117, 118} The systematic reviews were of moderate quality (AMSTAR2 score 8 and 9, Supplement to Chapter 3). Since the meta-analysis by Asad et al. (2020)¹¹⁷ was performed on the raw data of the observational studies and not on adjusted results, these results are probably biased and should be interpreted with caution.¹¹⁷

A third systematic review of moderate quality (AMSTAR 2 score 8, Supplement to Chapter 3) with meta-regression included both primary studies on the comparison same day discharge versus overnight stay as on early versus conventional discharge at 48-72 hours, so with a variable cut-off . As a result the population was more heterogeneous, despite only RCTs being included. Pooling the data from 2962 patients from 12 RCTs could not identify a significant difference in 30-day readmissions between early and conventional discharge, moreover early discharge was associated with fewer complications and less costs.¹¹⁹ No multicentre primary studies were identified after the last systematic review in 2020.

3.3.3.2 THA and TKA

As no systematic review was available for the comparison of early (shorter LoS) versus late (longer LoS) discharge, all available multicentre primary studies from 2012 onwards were eligible. The included seven studies were all retrospective cohorts from North America using the NSQIP database,^{103, 120-122}; Kaiser Permanente TJA registry,¹²³ or regional healthcare databases.^{124, 125} (Supplement to Chapter 3). Three studies focused on TKA,^{103, 123, 124} the other four included both TKA and THA with both procedures reported separately.^{120-122, 125} The exact comparisons were different for each study, with early discharge somewhere between LoS 0 and LoS 2d and late discharge LoS between 2 midnights and 4 or more days and sometimes with intermediate comparators. All reported 30-day readmissions, with the exception of Charpentier et al. (2018)¹²⁴, who described 90d readmissions. The results for 30-day readmission were all either adjusted for confounding^{103, 120, 122, 123} or propensity score matched^{121, 125} and showed either no significant difference^{122, 125}, non-inferior results for shorter LoS^{120, 121, 123} or association of a shorter LoS with lower readmissions¹⁰³. Also, for the study with propensity score matching on 90d readmission, there was no significant difference between shorter and longer LoS.¹²⁴ Risk of bias was considered moderate for all, mostly due to possible residual confounding and selection of population, except one with serious risk of bias due to risk of missing data (readmission to another institution may not have been captured).¹²³ (Supplement to Chapter 3)

Only two studies reported 30-day mortality.^{121, 122} One study showed no significant difference¹²² and the other showed a U-shaped relation with higher mortality in early and late discharge compared to intermediate LoS,¹²¹ but for both only unadjusted results were available because of a low number of events, leading to a serious risk of bias for this outcome (Supplement to Chapter 3)

^k ST-elevation is a finding on an electrocardiogram; the ST segment is the flat, iso-electric section of the ECG between the end of the S wave and the beginning of the T-wave; An acute myocardial infarction resulting from an occlusive thrombus is recognized on an electrocardiogram by ST-segment elevation¹¹⁶.



Two studies reported ED visits post-discharge and showed no significant difference after 30 days¹²⁵ or 90 days follow-up.¹²⁴ The first study also reported no significant differences in annual healthcare costs between short and long stay.¹²⁵

3.3.3.3 *Heart failure*

The effect of LoS on readmission and mortality was evaluated in 13 studies on heart failure (Supplement to Chapter 3). Four of these were post-hoc analyses of RCTs,¹²⁶⁻¹²⁹ and the others were cohort studies. There was a moderate risk of bias in all studies (Supplement to Chapter 3),

Five studies considered LoS as a continuous variable,^{57, 126-128, 130} five studies considered LoS as a categorical variable,^{129, 131-134} and three studies applied both approaches.¹³⁵⁻¹³⁷ In each of these papers, the difference in approach did not affect the overall conclusion.¹³⁵⁻¹³⁷ Most studies reported non-inferior 30-day all-cause readmission for a shorter LoS.^{126, 127, 129-131, 134-137} In one paper, a shorter LoS was associated with a higher readmission rate, but only for international results and not for US results.¹²⁸ The average or cut-off for the categories was usually 4-5d, but it could vary significantly in international studies. Three papers did not report all-cause readmissions.^{57, 132, 133}

Specific HF-related 30-day readmission was not analysed in three studies,^{126, 131, 134} In the study by Carey et al.(2014)⁵⁷ specific readmissions restricted to major diagnostic category (MDC) 5 (circulatory system) were reported.⁵⁷ Results for HF-related 30-day readmissions were not inferior for shorter LoS in four studies.^{127, 130, 135, 136} Two studies with LoS as a continuous variable showed an association of shorter LoS with more specific readmissions (Carey (in MDC5)⁵⁷ and Eapen (international, not significant in US ¹²⁸) and three studies comparing different LoS categories showed an association of at least one shorter LoS category with higher readmissions (compared with intermediate or long LoS).^{129, 132, 133} One study showed an U-shaped association with the optimal LoS being intermediate.¹³⁷

A shorter LoS showed non-inferior results for 30-day or 90d (if 30-day not available) mortality in seven studies.^{126, 127, 131, 134-137} The others did not report results for mortality after discharge.

3.3.3.4 *COPD*

Only two studies were included on COPD, both cohort studies from US and from overlapping time periods. Characteristics and results are summarized in the Supplement to Chapter 3. The first one compared short, medium and long patient and hospital LoS regarding 30-day all-cause readmissions in Veterans between, 2008 and 2011. They concluded that a shorter patient LoS was associated with fewer readmissions, but identified no difference between the hospital LoS categories.¹³⁸ The second cohort evaluated LoS as a continuous variable and concluded that a longer LoS was associated with a small but significant increase in 30-day COPD-related readmission.¹³⁹ The results of both observational studies were evaluated as moderate risk of bias (Supplement to Chapter 3).^{138, 139}

3.3.3.5 *Summary of results*

LoS reduction in PCI patients was not associated with significantly different results for 30-day readmission and not with worse results for mortality. For total hip and total knee arthroplasty, shorter LoS was also not associated with worse 30-day or 90-day readmission, whereas due to low number of events for mortality it was difficult to draw firm conclusions. Although LoS reduction was overall not associated with worse 30-day all-cause readmission and mortality in heart failure, no firm conclusions can be drawn on HF-specific readmissions with results going in all directions. A limited amount of evidence (only two studies) showed an association of shorter LoS with decreased all-cause or COPD-specific readmission.



Table 17 – Summary LoS reduction

Procedure or medical condition	30-day readmission					30-day mortality		
PCI	118 119 117 (mix FU)					118	117 (mix FU)	
THA/TKA	122, 125 124 (90d)	120, 121 123*	103			122*	121* U-shaped	
Heart failure (all-cause)	128	126, 127, 129, 131, 136		134, 137	130, 135	57	134, 137	135, 136 126, 127 (90d)
Heart failure (HF-specific)	57 140*	128, 129, 132, 133	127, 135, 136	130	137 U-shaped			
COPD	138 (all-cause) 139 (specific)							

d days, FU Follow-up, THA total hip arthroplasty, TKA total knee arthroplasty. **Systematic review (bold)**, Primary study (normal), * serious risk of bias

	Not reported outcome	
	negative correlation (shorter LoS more readmissions/mortality)	
	Study with mixed results inverse correlation and no significant difference	
	No significant difference	Non- inferior
	Study with mixed results no significant difference and positive correlation	
	Positive correlation (shorter LoS fewer readmissions/mortality)	
	Complex relationship	



3.3.4 Temporal trend LoS and associated outcomes

3.3.4.1 PCI

One multicentre American cohort investigated the temporal trend of LoS and of the 30-day readmission rate between 1997 and 2006 for patients after PCI (Supplementary Table 6). Although there was a significant decrease in LoS from 2.6d to 1.9d, the trend of 30-day readmissions was variable and did not increase. However, confounding was not adjusted for and risk of bias for this study was serious (Supplement to Chapter 3).¹⁴¹

3.3.4.2 THA and TKA

There was no systematic review on the time trends in LoS, readmission and mortality. Ten multicentre primary studies on temporal trends were selected from 2012 onwards (Supplement to Chapter 3). All but one were retrospective cohort studies from North America using the NSQIP database¹⁴²⁻¹⁴⁵, different Medicare databases,^{39, 146} or different regional healthcare databases.^{72, 147, 148} One retrospective study was based on data from Denmark (DNPR).¹⁴⁹ The time intervals of the studies with NSQIP data were sometimes overlapping. There were two studies on TKA, one from 2006-2016¹⁴⁵ and one from 2010-2020,¹⁴⁴ but the latter was only descriptive without statistical testing. Two other studies focused on THA, one from 2006-2016¹⁴³ and one from 2011-2017,¹⁴² however the latter focused only on the Hispanic and Latino subpopulation. Other (non-NSQIP) datasets focused on TKA only for the indication osteoarthritis,¹⁴⁶ on TKA^{39, 148} or both on THA and TKA.^{72, 147, 149} A time trend over a period between 5 to 20 years was described in these studies, with the longest study (from 1991 to 2010) also being the oldest.³⁹ A statistically significant decrease in LoS (or LoS >2 midnights) was reported in most studies. An exception was the study from Rullan et al.(2023)¹⁴⁴, who only described LoS, readmission and mortality over time without any statistical test being performed, so no conclusions regarding statistical significance could be drawn. Results of this study showed a decrease of LoS over time, a decrease of 30-day readmissions for inpatients and an increase for outpatients. Overall the 30-day readmission rate for outpatients remained lower than the one for inpatients. The evolution of mortality, although overall low, was complex with an unexplained peak between 2015 and 2016 in outpatients and a decrease in 2010-2011 for inpatients.¹⁴⁴ Three studies reported unplanned readmissions,^{120, 143, 145} whereas the other studies made no distinction between planned and unplanned readmission. Four studies performed univariate analysis showed no significant change of 30-day readmission^{142, 143, 148} or 90d readmission.¹⁴⁷ Five studies adjusted for confounders^{39, 72, 145, 146, 149} reporting different results: significant increase³⁹, no change¹⁴⁶, significant decrease in 30-day readmission,^{72, 145} or significant decrease in 90d readmission.¹⁴⁹ It is important to note that the first two studies are both older studies (data from 1991-2010 or 2002-2007),^{39, 146} whereas the study by Jenssen et al.(2023)¹⁴⁹ is the most recent one, studying 2010-2020. Risk of bias of the included studies varied between moderate and serious, mostly depending on the adjustment for confounding. (Supplement to Chapter 3) So far, we conclude that the significant decrease in LoS over time, was not associated with an increase in readmissions.

For mortality only one study reported a risk adjusted decrease over time during 90d follow-up.¹⁴⁹ The studies performing univariate analysis did not show significant change over time in 30-day mortality.^{142, 143, 145}

Costs and 30-day ED visits were outcomes each reported in one study, a cohort from South Carolina and from Ontario respectively. The first one reported significantly increasing costs (index costs and average costs per day) over time, unadjusted for confounding.¹⁴⁷ The second reported an increasing trend of 30-day ED visits over time without performing any statistical analysis.¹⁴⁸ The added value of these results is limited.

3.3.4.3 Heart failure

The first search for literature in November 2023 yielded only one multicentre cohort study examined time trends for patients with heart failure from 2005 to 2015 and reported a significant decrease in LoS in Canada, but a stable trend for LoS in US (Supplement to Chapter 3). Over the same time period, they detected at hospital level a decrease in both 30-day all-cause and HF specific readmissions, but these results were not adjusted for risk factors.¹³⁰ At patient level, there was a small, but significant increase of 30-day all-cause and HF specific readmission over time in both countries after adjustment for confounding.¹³⁰ The risk of bias was moderate for the patient level analysis and serious for the hospital level analysis (Supplement to Chapter 3).

The June 2025 search update identified one additional primary study on retrospective data from an administrative health database in the Italian Lombardy region with moderate risk of bias (Supplement to Chapter 3).¹⁵⁰ This study analysed 414,164 hospitalisations from 286,028 patients between 2003 and 2018, divided into four 4-year periods. The LoS increased from a median of eight days in the first time period to nine days in the subsequent three time periods. After adjusting for major confounders, no significant changes in 30-day mortality over time were observed, but there was a significant decrease in 30-day readmissions due to acute heart failure.¹⁵⁰

3.3.4.4 COPD

One study with moderate risk of bias on a retrospective cohort in Florida reported on time trends for LoS, 30-day COPD-related readmission rates and total charge for index and readmission (Supplement to Chapter 3). Between 2009 and 2014 there was a significant decrease in hospital LoS for COPD index admission, despite for example increasing age, and after adjusting for patient characteristics, health care systems and hospitalization-related factors, readmission rates also decreased slightly, but significantly.

3.3.4.5 Summary of results

Although a significant decrease in LoS over time was reported in most of the studies, it was difficult to draw any conclusions regarding the temporal trend for readmission and mortality. For total hip and total knee arthroplasty, most of the studies (a mix of adjusted and unadjusted results) showed a stable or increasing trend for 30-day or 90-day readmission and mortality, but one older study, dating back to 2021 showed an increasing trend in readmission in TKA and one recent study with serious risk of bias reported inconsistent results for readmissions and mortality in TKA. Only a limited number of studies were available for PCI, HF and COPD, and some of them were also found to be at serious risk of bias. No significant changes were found in 30-day readmissions for PCI and 30-day mortality for heart failure over time. The temporal trend for 30-day readmissions was decreasing for COPD and heart failure, except in one study on heart failure with inconsistent results that was evaluated to be at serious risk of bias.



Table 18 – Summary on time trend

Procedure or medical condition	30-day readmission				30-day mortality		
PCI	141*						
THA/TKA	39	146 142, 148* 147* (90d)	72, 145 149 (90d)	144*	142, 143, 145*	149 (90d)	144*
Heart failure (all-cause and specific)	130*		150 HF specific		150		
COPD (specific)	139						

Legend

Primary study (normal), * serious risk of bias

	Not reported outcome	
	Increase over time (whilst LoS decreases)	
	No significant difference	Non-inferi
	Decrease over time (whilst LoS decreases)	
	inconsistent relationships	

3.3.5 Discussion

3.3.5.1 *Shorter Length of Stay (LoS) and Outpatient Shifts are not associated with worse outcomes*

Overall results showed that shorter LoS including a shift to outpatients, did not lead to worse outcomes. Usually, there was no significant difference in readmission or mortality for outpatients compared to inpatients and only few observational studies reported that the outpatient setting was associated with better outcomes. Procedures and medical conditions that were studied for LoS reduction, also reported overall non-inferior results for the shorter length of stay.

The results of this literature review demonstrated that there is no evidence that the widespread practice of decreasing LoS lead to overt increases in readmissions or mortality. Especially for the switch of surgical procedures to outpatient care, it seems safe to do so, but only if the eligible patients are well-selected. The selection criteria to be eligible for early discharge were outside the scope of this literature review, but the reviewed literature often also included the study of risk-factors for worse outcomes, which could be considered for building these selection criteria together with experience of involved clinicians. Also out of scope of this systematic review were outcomes on postoperative complications and patient satisfaction.

3.3.5.2 *Heart Failure is an Exception*

The only exception was heart failure, where the outpatient setting was associated with worse 30-day readmission. For LoS reduction, for heart failure specific readmissions results were inconsistent.

3.3.5.3 *Limited Evidence on Time Trends*

A time trend for LoS, readmission and mortality was far less studied and more often non-adjusted results were reported. The reported decrease (mostly significant) in LoS was usually seen together with a stable trend or decline in readmissions or mortality, except for an older study and two studies with a serious risk of bias that did not allow to draw conclusions.

3.3.5.4 *Methodological and Scope Limitations*

For this systematic review we included only a limited amount of surgical procedures and medical conditions, partly because there was no eligible literature available for selected procedures/conditions or because the procedure or condition was included in our search strategy. This limits of course the generalizability of our results. Differences between conditions/procedures can arise from the existence of established selection criteria or strategies to reduce readmission rates, a less predictable course of the disease or lack of support at home after discharge. Although we identified several systematic reviews with meta-analysis of moderate to high quality, part of our evidence is based on (large multicentre) observational studies that carry a higher risk of bias including selection bias and confounding. It is possible that our decision not to include monocentre studies and not to perform meta-analysis ourselves has affected our results. The reason why included studies were serious risk of bias, was mostly due to unadjusted confounding, which was especially a problem for the temporal trend analysis, and to a lesser extend due to missing data. The lack of adjusted results for mortality was partly due to the low number of events. One must take into account that heterogeneity can play a part in the results of this systematic review. For example in the definition of inpatients and outpatients (with or without an overnight stay), in the cut-off used to define short, medium and long LoS. Despite including both 30-day and 90-day follow up, this did not seem to have impacted the overall results. Possibly this is due to the fact that readmissions occur mostly within the shorter time period and frequency tends to decrease over time, but we have not collected data to confirm this.



4 UMBRELLA REVIEW ON INTERVENTIONS FACILITATING SHORTER LENGTH OF STAY

KEY POINTS TABLE

- This chapter presents an umbrella review of 49 systematic reviews conducted to address the following research question: *What is the effectiveness of various interventions in promoting early hospital discharge while reducing or preventing unnecessary early readmissions (i.e., within 30 days)?*
- The included reviews cover a wide range of interventions, including Enhanced Recovery After Surgery (ERAS), nurse-led discharge planning and coordination, clinical decision support systems, multidisciplinary care and case management, rehabilitation and transition programs, short-stay hospital units, pharmacist-led interventions, clinical pathways, lean healthcare approaches, and utilization management strategies.
- No systematic reviews (SRs) included in this umbrella review found an increase of length of stay (LoS) with any of the interventions studied.
- Enhanced recovery after surgery (ERAS) in multiple indications (e.g. total hip arthroplasty - THA, total knee arthroplasty - TKA, cholecystectomy, pancreatoduodenectomy) has been the topic of 24 recent SRs. Their results consistently show a reduction in LoS, while not affecting 30-day readmissions or mortality.
- Several other interventions also appear to have similar results. However, evidence is limited in most cases to one SR. These other interventions include:
 - Nurse-led discharge planning in the general hospitalised population - acute medical (3 SRs, including overall 24 relevant primary studies: 23 RCTs and 1 observational).
 - Orthogeriatric/geriatric unit (vs orthopaedic unit) for elderly patients with hip fractures (1 SR including 15 relevant prospective/retrospective cohort studies).
 - Comprehensive care management programme in chronic obstructive pulmonary disease (COPD) patients (1 SR including 1 relevant observational study, n=1 564).
 - Case management based on nurse coordinated multicomponent care in heart failure (HF) (1 SR including overall 11 relevant studies: 8 RCTs and 3 observational studies).
 - Pharmacy-led interventions (1 SR with a MA of 11 studies, of which 3 were RCTs, n= 4 905).
 - Weekend allied health services in acute and subacute care (1 SR including 15 relevant studies overall: 5 RCTs and 10 observational studies).
 - Acute geriatric units for elderly patients (1 SR including 12 relevant studies, 6 of them RCTs).
- Great uncertainties surround the results of our umbrella review and should be recognised: e.g. most evidence relies on observational studies; great heterogeneity exists between study populations and the interventions studied (combining different components); poor descriptions of the comparator "usual care"; an important number of primary studies conducted in North America, Australia and, to a lesser extent, Asia; inclusion of old primary studies; lack of consideration of important aspects such as adherence to interventions; lack of standardisation in the studied interventions, etc...).



4.1 Introduction

Over the years, multiple healthcare interventions have been developed with the aim of shortening hospital LoS, while maintaining (or even improving) the quality of services and patient outcomes. Such interventions vary greatly, ranging from advancements in medical technology to improvements in care coordination and patient management. This chapter aims at answering the following research question:

- What is the effectiveness of different interventions to promote early discharge while reducing or preventing unnecessary early (i.e. within 30 days) hospital readmissions?

4.2 Methods

A preliminary search carried out in March 2024 identified a number of published systematic reviews (SRs) covering our field of interest. A decision was made to perform an umbrella review in order to systematically collect and evaluate the information from published SRs and meta-analyses (MAs).

A search strategy was developed by an information specialist (NIF), in January 2025 and updated in October 2025 using the PICOS (Participants-Interventions-Comparator-Outcomes-Study Design) framework presented in Table 19.



Table 19 – PICOS framework for research question

	Inclusion	Exclusion
Population	Hospitalised adults for any surgical procedures or medical conditions	Non-hospitalised patients.
Intervention	Any interventions promoting early hospital discharge and avoiding inappropriate (early) re-admissions.	• No intervention (standard care). • Studies looking at the impact of intervention on re-admissions, not considering LoS. • Studies looking at interventions promoting early hospital discharge, not considering (early) re-admissions.
Comparator	Any comparators (eg. absence of intervention, standard of care) or temporal trends (ie. before and after).	No a priori exclusions.
Outcome	• (Shorter) length of stay. • (Early) transfer to day care/home care. • 30-day readmission. • 30-day post-discharge mortality.	
Design	Systematic reviews and meta analyses, including controlled studies.	Any other study design. Conference abstracts, posters or presentations, editorial reports, letters to the editor or other correspondence.
Setting	Acute (inpatient or day-care) hospital setting.	Limited to home care or outpatient setting.
Time	Published on 2012 or later.	Published before 2012.
Language	All languages.	No a priori exclusions.

4.2.1 Literature search and selection

The following electronic databases were searched:

- Medline (SRs)
- EMBASE (SRs)
- Cochrane Library:
 - Cochrane Database of Systematic Reviews (SRs).

First, a search string for OVID-MEDLINE was developed and adapted to the other databases. MeSH terms (or similar index terms for other databases) and free text key words related to the interventions and the outcomes of interest were combined. The search strategies are documented in an appendix. Moreover, the grey literature was consulted using the following terms: “length of stay”, “readmission”, “rehospitalisation”, “home care services”, “patient plan”, “discharge plan”, “individualised (patient care) plan”, “home care support”, “community of care”, “multidisciplinary”, “interdisciplinary care”, “transition/nal care”, “remote monitoring”, “telemonitoring”, “telehealth”, “follow-up”, “nurse/ing care”, “patient education”, “counselling”, “enhanced recovery after surgery”, “ERAS”, “short-stay” “efficiency”, “systematic review”, “review”.

Finally, the reference lists of any relevant articles were checked to identify further relevant studies/reports.

To be eligible, a SR had to be published in 2012 or later. Only SRs looking at hospitalised patients were included. Any intervention aimed at shortening LoS was considered, for as long as hospital readmissions were looked at, to ensure the shorter LoS did not come at the expenses of lower quality (measured as early readmissions). Early mortality (at 30-days) was also captured and reported, if available.

If the time frame for the readmissions was explicitly mentioned in the SRs or the primary studies included in them, only the results of those looking at readmissions at 30 days were considered. If on the contrary, the time frame was not stated, studies were still considered and included in our review, but a specific mention was made on that respect.

Comparators such as absence of an intervention or standard of care, as well as pre and post comparisons were considered.

No a priori language limitations were imposed.

Letters, editorials, comments, presentations, abstracts and narrative reviews were excluded.

4.3 Quality appraisal and data extraction

4.3.1 Quality appraisal

Quality appraisal of the included studies was done using the AMSTAR 2 checklist for systematic reviews.¹ A pilot test on the quality appraisal process was performed by two researchers in parallel on five SRs, in order to discuss and resolve any discordant scores. The remaining quality appraisals were performed independently by one reviewer. In case of any doubts, experts from the KCE team were consulted.

For the purpose of our review, to facilitate the comparisons of the quality of the different SRs included in this review, those with up to 7 positive (“yes” or “partial yes”) answers to the AMSTAR 2 checklist were considered of low quality, those with 8-12 were considered of moderate quality and those above

¹ https://www.amstar.ca/Amstar_Checklist.php



12 were classified as high quality. Nevertheless, no studies were excluded from our synthesis based on their quality appraisal.

Regarding the quality of the primary studies included in each of the selected SRs, this was taken as described by the authors of the SRs.

6. Study selection

Studies captured via the searches were imported into RAYYAN to facilitate their triage. After excluding any duplicates, two reviewers (KOV and LOS) independently screened the titles and abstracts of the retrieved papers. Any doubts or conflicting results were discussed and if necessary, a third researcher was consulted, to reach an agreement.

Articles identified as potentially relevant, underwent full-text screening. Any reasons for exclusion of full-texts were documented and grouped on the basis of the PICOS previously presented. Figure 24 presents the results of our study selection process in a flowchart.

7. Data extraction and synthesis

The following data were extracted in a tabular form, for each of the included SRs:

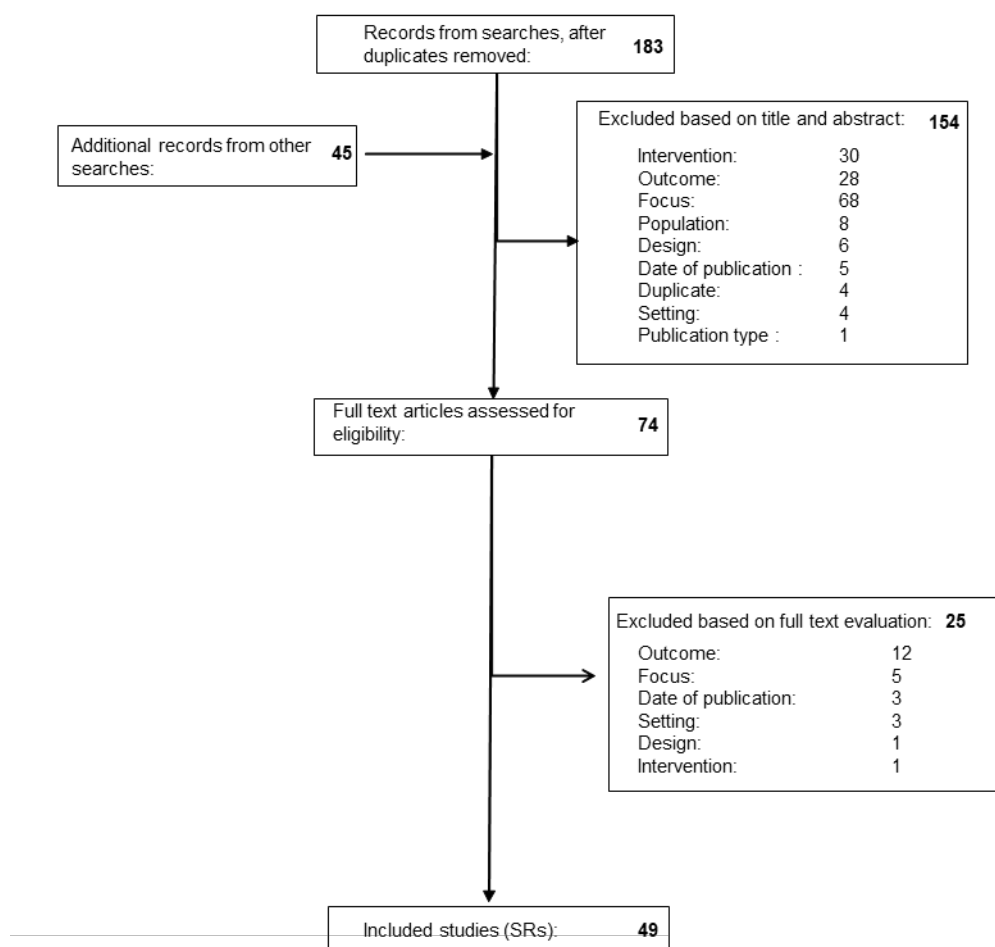
- Author, year of publication and reference, funding sources, search date, number and types of included studies (RCT, comparative cohort study or other study type), eligibility and exclusion criteria, number of participants, patient and disease characteristics, details of the intervention and comparator groups, results for the outcomes as defined in the PICO question, and limitations. Data extraction was completed by one reviewer.

Endnote was used as reference software.

Given the wide range of interventions relevant for the purpose of our umbrella review, as well as the different scope, methods and populations of the studies included in the selected SRs, narrative results with descriptive tables are offered and no attempt was made to meta analyse the extracted information.

Primary studies were not revisited. Instead, all information was extracted from the included SRs and their supplements.

Figure 24 – Flow chart for study selection



4.4 Results

4.4.1 Literature search

Our searches resulted in 185 references of which 2 were duplicates. After screening based on title and abstract, 33 articles were selected for full text analysis. One of these¹⁵¹ referred to the results of a another study already included in our review,¹⁵² while a further three were umbrella reviews^{53, 153, 154} and were thus, used for reference-checking purposes only. This left us with 29 SRs to be included. After checking the references of these and those of the umbrella reviews identified, and adding in the results from our hand search of the grey literature, 45 additional references were considered. From these, 25 were excluded for the following reason: 5 because of their focus, 12 because of their outcomes, 3 because they had been published before 2012, 3 because of the setting in which the study was carried out (i.e. home care), 1 because of its design and 1 because of the intervention. Overall, 49 SRs were finally retained for this review.

Table 20 summarises the characteristics of these included studies.



Table 20 – Characteristics of included systematic reviews

Author (yr)	Population	Intervention	Outcomes	N. and type of studies
Agarwal (2019) ¹⁵⁵	Aged 65-84, admitted to hospital for heart failure (HF)	To improve quality of care for patients hospitalised with HF (e.g. therapeutic guidelines, new organisation and procedures, education...)	Mortality, hospital readmissions, LoS	14 RCTs: 2 included LoS, 1 readmissions at 30 days, 2 early mortality.
Allen (2014) ¹⁵⁶	Adults ≥ 60 with chronic illnesses	To promote safe & timely transfer between levels and settings of care	LoS, readmissions, healthcare costs, functional status, QoL and patient satisfaction	12 RCTs: 4 included LoS, 1 readmissions at 30 days.
Austin (2020) ¹⁵⁷	Inpatients in a hospital using electronic medical records (EMR)	To improve safety and quality of inpatient therapeutic anticoagulant use in hospitals using EMRs	Prescribing or documentation compliance, medication errors, AEs, mortality, LoS, readmissions, quality use of anticoagulant, end-user acceptance, cost effectiveness.	3 RCTs and 24 observational: 3 (observational) included LoS, 2 (observational) readmissions at 30 days.
Berkovic (2023) ¹⁵⁸	Adults undergoing unilateral or bilateral, total or uni-compartmental KR or THR	Short-stay programmes (incl. early mobilisation, perioperative information, perioperative oral analgesia, criteria-based discharge ...)	Safety measures, amongst which readmissions and mortality (at max 90 days)	3 RCTs and 46 quasi-experimental: 24 (2 RCTs) included readmissions at max 90 days. LoS reduction presented as part of the intervention in all but 6 observational studies, mortality included in 14 (no RCTs)
Chakraborty (2021) ¹⁵⁹	Hospitalised adults with diabetes	Initiated in hospital and multifaceted for the management of diabetes (eg. nutrition, physical activity, education...)	Hospital readmissions and/or LoS	2 RCTs and 7 observational: 4 (1 RCT), included LoS, 2 (1 RCT) readmissions at 30 days.
Coffey (2019) ¹⁶⁰	Hospitalised patients, all ages	To facilitate: (i) in-patient discharge from acute hospitals to other settings, (ii) discharge from one in-patient setting to another or (iii) reduction or prevention of inappropriate hospital admissions	LoS and/or readmissions	90 studies overall, incl. Meta reviews, MAs, SRs, RCTs and observational: 5 (4 RCTs) included LoS, 5 (4 RCTs) readmissions at 30 days, 1 RCT 30-day mortality.
Coolsen (2013) ¹⁶¹	Adults undergoing major elective resectional pancreatic surgery	ERAS protocols. Considered “ERAS” when ≥4 different items included, (pre-, intra- and postoperative phases)	LoS. time to recovery of normal function, complication rates, readmissions, mortality.	8 observational: 8 included LoS, 4 readmissions at 30 days, 4 30-day mortality.
Deng (2018) ¹⁶²	Patients undergoing THA or TKA.	ERAS	Mortality, transfusion rate, range of motion, 30-day readmissions, complications, LoS.	11 RCTs and 14 observational: 15 (RCTs) looked at LoS, 6 (3 RCTs) readmissions at 30 days, 4 (observational) post-operative mortality.

Doshmangir (2022) ¹⁶³	Adult hospitalised patients	To manage adult hospital services (e.g. case management/care coordination, discharge planning and utilisation management)	Hospital services and/or emergency department (ED) use, frequency of hospital admissions, LoS, use of diagnostic tests.	14 RCTs and 50 observational: 10 (4 RCTs) included LoS, 3 (1 RCT) readmissions at 30 days.
Ellis (2017) ¹⁶⁴	Aged ≥65 with medical, psychological, functional, or social problems. Hospitalised for acute care or rehab	Inpatient comprehensive geriatric assessment (CGA), delivered in geriatric wards or by mobile teams	Return to live at home, LoS and/or readmissions, mortality at discharge.	29 RCTs: 17 included LoS, 13 readmissions at 30 days.
Fox (2013) ¹⁶⁵	In-patients ≥65 years, acute phase	Early discharge planning	LoS, readmissions, mortality, patient satisfaction or QoL.	7 RCTs and 2 observational: MA for LoS included 7 studies (5 RCTs), 1 observational study included readmissions at 28 days.
Fox 2012 ¹⁶⁶	In-patients ≥65 years acute illness or injury phase	Acute Care for Elders (ACE) model	Iatrogenic complications, functional decline, LoS, discharge destination, mortality, costs, hospital readmissions	9 RCTs and 4 quasi experimental: MA for LoS included 11 (7 RCTs), MA for readmissions 5 (RCTs), 2 (RCTs) readmissions at 30 days.
Gonçalves-Bradley (2022) ¹⁶⁷	Hospitalised with a medical condition, a mix of medical and surgical conditions, following a fall, a psychiatric diagnosis or a mix of mental health and medical diagnosis.	In hospital, personalised discharge plans	LoS, unscheduled readmissions, patient health status, patient and HCP satisfaction, healthcare resources and costs	33 RCTs: MA of 11 including LoS for medical conditions, MA of 2 RCTs for surgical interventions, 5 RCTs readmissions at 30 days, 1 RCT 30-day mortality.
Guerin (2013) ¹⁶⁸	Adults aged ≥ 65, admitted to an acute care hospital	Community services to facilitate transition from hospital to community	Readmissions, LoS, healthcare costs	5 RCTs and 7 observational: 2 looking at LoS and monthly readmissions (pre and post studies)
Harij (2024) ¹⁶⁹	Adults undergoing emergency abdominal surgery	Protocolised care pathways (ERAS)	LoS, 30-day morbidity, 30-day mortality and 30-day readmission and reoperations rates	6 RCTs and 11 observational: 4 RCTs included LoS, 10 studies (5 RCTs) readmissions at 30 days, 14 (4 RCTs) 30-day mortality.
Heymans 2022 ¹⁷⁰	Patients undergoing hip and/or knee arthroplasty	ERAS	(Serious) AEs, readmissions, LoS, clinician-derived clinical outcomes, PROMs	5 RCTs and 35 observational: 38 (5 RCTs) included LoS, 24 (2 RCTs) readmissions (follow up from 1 month to 2 years).
Huntley (2016) ¹⁷¹	Adults with HF diagnosis	Case-management (CM) based on nurse coordinated multi component care	Unplanned hospital re-admissions, LoS, ED visits, costs	17 RCTs and 5 observational: 9 (8 RCTs) included LoS, 2 (observational) readmissions at 30 days.



Kalogera (2019) ¹⁷²	Adults undergoing minimally invasive gynaecologic procedures with bowel surgery:	ERAS	LoS, perioperative complications and readmissions	12 observational. All considered LoS 5 considered readmissions at 30 days.
Kennelly (2025) ¹⁷³	Adults undergoing oesophagectomy for oesophageal cancer	ERAS	LoS, hospital readmissions, complication rate, mortality	6 RCTs. All considered LoS, 2 included 30-day readmissions, 3 30-day mortality.
Kuemmerli (2024) ¹⁷⁴	Aged ≥70 years undergoing pancreatoduodenectomy (PD) for any indication	ERAS	Postoperative morbidity, LoS, readmissions, functional recovery, mortality	2 RCT and 13 observational. 14 (2 RCTs) included LoS, 7 (2 RCTs) readmissions at ≥30 days and 14 (2 RCTs) mortality at 30-90 days.
Kuemmerli (2022) ¹⁷⁵	Patients undergoing PD (classical (cPD) or pylorus-preserving ppPD) for any indication	ERAS	Functional recovery elements, morbidity, LoS, readmission	2 RCTs and 15 observational: 16 (2 RCTs) included LoS, 14 readmissions (follow-up 30-90 days), 16 mortality (follow-up 30-90 days).
Lee (2020) ¹⁷⁶	Patients undergoing elective gastric cancer surgery	ERAS	LoS, hospital costs, time to first flatus, defecation, oral intake, ambulation after surgery, complications.	18 RCTs: 17 considered LoS and 8 readmissions (timeline not specified).
Mabire (2018) ¹⁵²	(≥65 years) discharged home from an acute care or a post-acute rehab setting	Nursing discharge planning interventions, involving multidisciplinary and/or interdisciplinary care models	Hospital readmission, LoS, health care utilisation, functional ability, unmet needs after discharge, satisfaction	11 RCTs and 2 observational: 6 (4 RCTs) included LoS, 2 (1 RCT) readmissions at 30 days.
McKechnie (2024) ¹⁷⁷	Adults undergoing emergency intra-abdominal surgery, including upper GI, lower GI, trauma, and general surgery.	ERAS	LoS, postoperative morbidity, mortality, 30-day readmission, return of bowel function, prolonged postoperative ileus (PPOI)	9 RCTs and 11 observational. LoS included in 19 studies (9 RCTs), 30-day readmission in 16 studies (7 RCTs), 30-day mortality in 12 studies (5 RCTs).
Malczak (2017) ¹⁷⁸	Bariatric surgery patients	ERAS	LoS, overall morbidity, specific complications, mortality, readmissions, costs.	2 RCTs and 9 observational: 10 included LoS, 9 readmissions (time frame not specified), 8 mortality (time frame not specified).
Mao (2022) ¹⁷⁹	Adult surgical patients discharged from hospital to home with no long-term condition	Nurse-led discharge services	LoS, readmissions, ED visits.	12 RCTs: MA on LoS included 5 studies, MA on readmissions at 30 days 4.



Malik (2018) ¹⁸⁰	Patients aged ≥ 65	Geriatric nurse assessment and interventions in the ED	Admissions, readmissions, hospital utilisation, LoS	7 RCTs and 2 observational: 2 RCTs included LoS, 3 RCTs and 1 pre/post readmissions at 30 days.
Morrel (2021) ¹⁸¹	Patients undergoing 1ary elective THA or TKA	ERAS	LoS, total procedure-related morbidity, and readmissions	3 RCTs and 6 observational: All considered LoS; 5 (observational) readmissions with a time frame from 30 days to 5 years.
Nair (2023) ¹⁸²	Patients undergoing laparoscopic cholecystectomy with and without common bile duct exploration	ERAS	LoS, pain, nausea/vomiting, 30-day readmissions, complications (medical and surgical), time to first flatus, cost	4 RCTs and 2 observational: All looked at LoS, 5 considered 30-day readmissions.
Naserlallah (2024) ¹⁸³	Patients undergoing surgery in perioperative settings across various specialties (orthopedic, general, bariatric, transplant, etc.)	Pharmacist-led interventions (e.g., medication reconciliation, discharge counseling, education).	LoS, readmissions, ED visits, unplanned outpatient visits.	5 RCTs and 20 observational. LoS included in 11 (3 RCTs), readmissions (mostly at 30 days) considered in a MA of 8 studies (2 RCTs).
Noba (2023) ¹⁸⁴	Patients undergoing pancreaticoduodenectomy	ERAS	Hospital cost, LoS, complications, delayed gastric emptying (DGE), readmissions, reoperation, mortality, compliance.	3 RCTs and 28 observational: All included LoS, 28 readmissions at 30 days, 30 mortality (time frame not specified).
Noba (2020) ¹⁸⁵	Adults undergoing liver surgery	ERAS	Hospital cost, LoS, complications, readmissions, mortality, compliance	6 RCTs and 21 observational studies: All 27 included LoS, 21 (6 RCTs) readmissions at 30 days, 25 (6 RCTs) 30-day mortality.
Pang (2024) ¹⁸⁶	Lower risk patients who present to the ED with decompensated HF	Short stay hospital units	Mortality or readmission within 30 to 90 days. Days-alive-and-out-of-hospital at 30 days, LoS, mortality at 30 and 90 days, readmission at 30 and 90 days, revisit to the ED, QoL, cost.	1 RCT and 3 observational: 3 included LoS, 3 readmissions at 30 days, 2 30-day mortality.
Pannick (2015) ¹⁸⁷	Adult patients on general medical wards	Interventions altering the composition of interdisciplinary teams, or changing where or how team members work together	Mortality, type of discharge destination, LoS, readmission rates, AEs, composite end points of those previously mentioned	8 RCTs, 9 cluster RCTs and 13 observational: MA of 13 studies (6 RCTs) included LoS, MA of 8 studies (2 RCTs) readmissions at 30 days, 1 RCT 30-day mortality.
Patel (2020) ¹⁸⁸	Elderly patients with a hip fracture	Multidisciplinary team approaches (orthogeriatric models or geriatric-led models)	Time to surgery, LoS, readmission, postoperative mortality	1 RCT and 16 observational: 14 (observational) included LoS, 2 (observational)



				readmissions (timeline not specified), 4 (observational) 30-day mortality.
Peerbocus (2021) ¹⁸⁹	Patients undergoing radical cystectomy (RC) for bladder cancer.	ERAS	LoS, 30-day readmissions	15 observational studies. 13 included LoS, 8 considered 30-day readmissions.
Qin (2024) ¹⁹⁰	Patients undergoing cholecystectomy	ERAS	LoS, visual analog scale, time to first flatus, operative times, nausea and vomiting, readmissions, blood loss, complications, bile leakage.	4 RCTs and 5 observational: 5 (1 RCT) included LoS, 5 (3 RCTs) readmissions (timeline not specified).
Sarkies (2018) ¹⁹¹	Patients admitted to acute general medical, surgical wards, or subacute rehab wards.	Health professional services delivered by allied health professionals during weekends	Hospital LoS, readmissions, AEs, discharge destination, functional independence, QoL, cost of hospital care	10 RCTs and 10 observational. Acute setting: 5 (2 RCTs) included LoS, 3 (2 RCTs) readmissions at 28 days. Subacute: 6 (3 RCTs) included LoS, 1 RCT readmissions at 30 days.
Saunders (2019) ¹⁹²	Adults with advanced progressive illness or serious illnesses requiring pain management. Those not being treated with curative intent; or those having a life expectancy of <2 years.	Screening tool for inpatient palliative care consultation, hospital discharge planning or transitional care	Patient-reported quantitative outcomes (incl. LoS and readmissions) and health care utilisation	2 RCTs and 6 observational: 4 (2 RCTs) included LoS, 4 (1 RCT) readmissions at 30 days.
Strøm (2018) ¹⁹³	Patients with internal medicine diseases and conditions	Short-stay in-hospital units for internal medicine diseases and conditions, such as pneumonia or chest pain	Mortality, serious AEs, QoL, activities of daily living, hospital readmission, non-serious AEs, and costs	14 RCTs: 12 included LoS, 2 readmissions at 30 days, 2 30-day mortality.
Stumpo (2021) ¹⁹⁴	Adults undergoing elective craniotomy	ERAS	LoS, length of ICU stay, pain, costs, complications, readmissions, patient satisfaction.	5 RCTs and 22 observational: 19 (2 RCTs) included LoS, 1 RCT readmissions at 30-days.
Tan (2021) ¹⁹⁵	Patients requiring flaps (reconstruction breast or neck surgery)	ERAS	LoS. complication within 30 days, readmission within 30 days, surgical site infections and medical complications	16 studies: 12 included LoS, 8 readmissions at 30 days.

Tinguely (2021) ¹⁹⁶	Liver transplanted patients	ERAS	Morbidity, mortality, LoS, readmissions	2 RCTs and 3 observational: 4 (1 RCT) included LoS, 3 (1 RCT) readmissions, 4 (1 RCT) mortality. No time frame specified for readmissions or mortality.
Villatte (2019) ¹⁹⁷	Elderly undergoing total hip arthroplasty	ERAS	LoS, complications, readmissions, mortality, costs	2 RCTs, 7 literature reviews, 23 observational: 23 (1 RCT) included LoS, 1 (observational) readmissions at 30 days, 2 (observational) 30-day mortality.
¹⁹⁸ Zepeda-Lugo (2020)	Hospitalised patients in different departments where lean health care (LHC) is implemented	LHC, combination of LHC and Six Sigma, rapid improvement event (RIE) and Baystate patient progress initiative (BPPI)	LoS, readmissions, discharge times, turn over time (TOT), turnaround time (TAT), and on-time starts (OTS), patient and staff satisfaction	39 observational: 23 included LoS, 6 readmissions at 30 days, 2 30-day mortality.
Zhang (2024) ¹⁹⁹	Patients undergoing hip and knee arthroplasty	ERAS	LoS, complications, readmissions, transfusions, mortality, visual analogue score (VAS), the Western Ontario and McMaster University Osteoarthritis Index (WOMAC), Short Form 36 (SF-36) pain, SF-36 physical function, oxford knee score, range of motion	11 RCTs and 36 observational: 30 (9 RCTs) included LoS, 9 (observational) readmissions at 30 days, 6 (type not specified) 30-day mortality.
Zhou (2024) ²⁰⁰	Patients undergoing THA or TKA	ERAS	Operative time, intraoperative blood loss, visual analogue scale, 30-day readmissions, mortality, transfusions, LoS, complications	15 RCTs: 9 included LoS, 4 readmissions at 30 days, 3 mortality (time frame not specified).
Zhu (2017) ²⁰¹	Patients undergoing THA or TKA	ERAS	LoS, 30-day readmissions, complications.	10 studies overall: RCTs and observational: 7 included LoS, 5 readmissions at 30 days. N. of studies by type not specified
Zhu (2015) ²⁰²	In patients with chronic illness or on rehab	Nurse-led early discharge planning	LoS, hospital readmission, readmission LoS, all-cause mortality, readmissions, costs, QoL, satisfaction	10 RCTs: MA of 5 included LoS, MA of 2 readmissions at 30 days, 2 (RCTs) 30-day mortality.

AEs: Adverse events, AGU: Acute geriatric unit, CM: case management, CGA: Comprehensive geriatric assessment, ED: emergency department, EMR: Electronic medical records, HCP: Health care providers, HF: Heart failure, LHC: Lean health care, LoS: Length of stay, Mas: Meta analysis, QoL: Quality of life, RCT: Randomised controlled trial. THA: Total Hip Arthroplasty, TKA: Total Knee Arthroplasty.



4.4.2 Study characteristics

The interventions studied varied from one SR to another, with most consisting of **multiple components** which differed in their nature and description from one study to another. In some cases, there was some overlap between the types of interventions, in particular, “multidisciplinary care”, often included other interventions such as “discharge planning”.

By far, the more studied intervention was **enhanced recovery after surgery (ERAS)** with 24 SRs. Seven of these focused on total hip and or knee arthroplasty,^{162, 170, 181, 197, 199-201} four on pancreaticoduodenectomy,^{161, 174, 175, 184} two on cholecystectomy,^{182, 190} and two in abdominal surgery.^{169, 177} The remaining consisted of single SRs on bariatric surgery,¹⁷⁸ liver surgery,¹⁸⁵ and liver transplants,¹⁹⁶ craniectomy,¹⁹⁴ gastric cancer,¹⁷⁶ minimal gynaecological interventions with or without bowel surgery,¹⁷² oesophagectomy,¹⁷³ urology¹⁸⁹ and flaps in breast or neck reconstructions.¹⁹⁵

Six SRs focused on **nurse-led discharge** interventions and coordination.^{152, 160, 163, 167, 179, 202} **Clinical decision support** systems were investigated by Austin et al,¹⁵⁷ who focused specifically on electronic medical records linked to anticoagulant use.

Seven SRs covered the area of **multidisciplinary care, care coordination and case management**.^{160, 163, 164, 171, 180, 187, 188}

Rehabilitation and transition interventions, including pre hospital discharge activities and immediate post hospital discharge follow-up at the next location of care, were explored in four studies.^{156, 160, 165, 168}

One SR studying acute geriatric units (ACEs) was identified,¹⁶⁶ while a further three looked at **short stay hospital units or programmes**. One of them in patients with internal medicine diseases and conditions.¹⁸⁶ a second one in decompensated heart failure¹⁹³ and the remaining in adults undergoing total or uni-compartmental KR or THR or KR.¹⁵⁸

Other types of interventions considered included clinical pathways,^{155, 159} lean health care and utilisation management,^{163, 198} palliative in-hospital care interventions,¹⁹² pharmacist-led interventions¹⁸³ and weekend support acute or subacute (in or out of hospital) services.¹⁹¹ Most of the included systematic reviews (SRs) captured **multiple outcomes**, with some of them using very general descriptions in their PICO, such as “resource use outcomes”. Consequently, not all primary studies within the selected SRs addressed our outcomes of interest (i.e. length of stay and early hospital readmissions) and in some cases, they included either one or the other, but not necessarily both.

Regarding early hospital readmissions, some primary studies within the SRs specified a 30-day timeframe, while others extended this period. For our analysis, we focused on primary studies within these SRs that were pertinent to our objectives. Thus, when the timeframe for early readmissions was specified, we report only the results for 30-day readmissions. In cases where no timeframe was provided, a mention was made. Few SRs included early mortality.

4.4.3 Study findings per intervention type

Table 3 summarises the findings from the included studies. A more detailed table, including the primary studies of the SRs considered in this review is available for consultation in appendix.

4.4.3.1 Enhanced recovery after surgery

Twenty-four recent SRs on enhanced recovery after surgery (ERAS) were identified via our search. Despite a wide coverage of indications and the lack of standardisation in terms of the items included in the ERAS, results were highly consistent with all but one SRs showing significant reductions in LoS with the intervention, without affecting early readmission or mortality. The exception was a SR focused on elderly patients (aged ≥70) undergoing pancreaticoduodenectomy, in which significant reductions in

LoS were observed only in patients aged ≥ 80 years ($p = 0,048$), while the overall effect did not reach significance ($p = 0,071$).¹⁷⁴

The most common **indication** was total hip or knee arthroplasty, which was studied in 7 SRs.^{162, 170, 181, 197, 199-201} From these, only one was evaluated as low quality (AMSTAR 6), while from the other 6, half presented a high quality and the remaining were of moderate quality. Four SRs of moderate to high quality evaluated ERAs in pancreas surgery.^{161, 174, 175, 184} Two SRs of moderate to high quality looked at patients undergoing cholecystectomy,^{182, 190}, while a further two, both assessed as having moderate quality, focused on liver surgery.^{185, 196} One of these focused entirely on liver transplanted patients.¹⁹⁶ Finally, another two looking at abdominal surgery showed to have moderate to high quality according to AMSTAR 2.^{169, 177}

The remaining studied fields for ERAS were covered by individual SRs: craniotomy,¹⁹⁴ breast and neck reconstructive surgery,¹⁹⁵ gastric cancer,¹⁷⁶ bariatric surgery,¹⁷⁸ oesophagectomy,¹⁷³ urology¹⁸⁹ and gynaecological surgery.^{169, 172} From these, the evaluation focused in gynaecological surgeries was assessed as low quality (AMSTAR 4), while the SR on oesophagectomy was of high quality (AMSTAR 15). All others presented moderate quality according to AMSTAR 2.

One SR of moderate quality¹⁷⁶ performing a MA of 8 studies on 938 patients undergoing surgery for gastric cancer, concluded that ERAS protocols resulted in a significant increase of **readmissions** (risk ratio 2.43 (95%CI : 1.09-5.43, $p < 0.03$, $I^2=0\%$). Nevertheless, the increase was caused by 1 single study²⁰³ which included patients aged 75–89 and did not specify the timeframe for hospital readmissions. The remaining primary studies included in this MA showed no significant differences with or without the ERAS protocol.

The remaining twenty-three SRs identified on ERAS found non-significant differences in short-term readmissions. Most of these ($n=13$) were of moderate quality according to AMSTAR 2, 8 had high quality and only 2 were classified as having low quality.

With regards to **mortality**, 11 SRs found no significant differences with or without the intervention, while 3 saw a significant decrease in mortality with ERAS protocols. However, one of the later was a SR of low quality which based their results for mortality on 2 retrospective studies¹⁹⁷ and a further, of high quality, did not specify the time frame for this outcome.¹⁶² The remaining,¹⁹⁹ also of high quality, focused on THA and TKA and reported a significant decrease in 30-day mortality with the ERAS protocol, based on a MA of 6 comparative studies (Supplement to Chapter 4).

It is important to note that all SRs looking at ERAS found a **lack of standardisation in terms of the items included in the ERAS** studies as well as a lack of measure of adherence to guidelines or ERAS items. This impedes to draw clear conclusion on what aspects of the ERAS protocols were the most valuable at facilitating shorter LoS. Commonly included items were the following:

- for pre-operative care: counselling and education as well as fasting considerations (most often limiting fasting times);
- for peri-operative care: management of intraoperative fluids, and standardised anaesthesia protocols;
- for post-operative: early mobilisation and oral food intake and standardised discharged criteria.

Most of these SRs used the Cochrane RoB tool to assess the quality of the RCTs^m and the Newcastle Ottawa Scale (NOS) for **assessing the quality** of observational studies.ⁿ Despite the mix quality of the identified primary studies included in these SRs, an important proportion of them presented high RoB. In particular, blinding of assessors was lacking, biases due to confounding were frequent, so

^m <https://methods.cochrane.org/bias/resources/rob-2-revised-cochrane-risk-bias-tool-randomized-trials>

ⁿ https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp



were those linked to reporting. Most of the primary studies were observational and the few RCTs in this field tended to be small in size.

4.4.3.2 Nurse-led discharge planning and coordination

Three SRs, including both RCTs and observational studies on hospitalised populations found nurse-led discharge to significantly reduce LoS versus standard practice.^{160, 163, 167} In the case of Gonçalves et al.¹⁶⁷, they included studies on medical conditions, surgical conditions, or a mix of both. However, most of the primary studies identified referred to medical conditions (mainly cardiovascular diseases, but also COPD or neurological conditions), and while they saw significant reductions in LoS with nurse-led discharge for these (MA of 11 RCTs, n=2 113), no significant differences between the intervention or lack of it were found for older patients who had undergone surgery (MA of 2 RCTs, n=184).

None of these three SRs saw an increase in 30-day hospital readmissions, while one of them,¹⁶³ a SR, reported a significant reduction in this outcome based on one pre and post study on 2139 patients.²⁰⁴ Early mortality (within 30-days post discharge) was not captured in any of these SRs. Two of them were rated as moderate-high quality, (AMSTAR 2 scores 9 and 13), and the evidence in which they are based was considered of good quality in one (CCAT tool)¹⁶⁰ and moderate in the other (GRADE).¹⁶⁷ The third one was found to have a low quality (AMSTAR 2 score 7)²⁰⁴. The authors of this review rated the quality of the available evidence as weak, according to the Quality Assessment Tool for Quantitative Studies, developed by the Effective Public Health Practice Project. The items that ranked lower were generally linked to confounders and blinding.

A further three SRs, all of moderate quality, two including only RCTs^{179, 202} and a third one including both RCTs and observational studies,¹⁵² evaluated the same intervention but focusing on specific patient populations. None of them identified significant reductions in LoS between the intervention and usual care. Mabire et al.¹⁵² studied adults aged ≥ 65 discharged home from acute or post-acute community rehabilitation centres. The authors scored the quality of the evidence to be moderate to high according to the JBI-MAStARI tool,^o with reliability and consistency of outcome measurements being the items most commonly rated as unclear or scoring “no” in the checklist. Zhu et al.,²⁰² focused their analysis on patients with chronic illness or on rehabilitation. The authors also rated the quality of the evidence to be moderate-high according to the Cochrane RoB assessment tool, with primary studies judged to be at low risk of selection and attrition bias.

Finally, Mao et al.¹⁷⁹ looked at adult surgical patients, discharged home with no long-term conditions. The analysis of potential RoB performed by the authors of this SR, using the Cochrane RoB tool, highlighted an important number of unclear scores linked to different RoB for the available primary studies. The most frequent problems included: unclear or high RoB linked to blinding of the assessors, unclear blinding of participants and/or personnel, and unclear allocation concealment.

Regarding the outcome 30-day readmissions, Mao et al.¹⁷⁹ observed a significant reduction with the intervention, while the other two patient specific SRs found non statistical differences for that outcome. Only Zhu et al.²⁰² considered mortality, and saw significant differences in favour of the intervention (MA of 5 RCTs, n=2729, RR 0.70, 95% CI : 0.52-0.95, $I^2=0\%$, $p = 0.020$). However, the meta analysed studies considered different time horizons, which were not always relevant for our purposes (i.e within 30 days, 24 weeks or 12 months). Thus, when only the two primary studies looking at mortality within 30-days were considered, no significant differences were found with or without the intervention.

4.4.3.3 Clinical decision support systems (CDSS)

One Australian SR published in 2020¹⁵⁷ compared interventions using electronic medical records (EMR), designed to improve the safety and quality of anticoagulant therapy in adult and paediatric inpatients, with routine care i.e. prior to implementation of EMR. The SR included both RCTs and

^o <https://jbi.global/critical-appraisal-tools>

observational studies. However, for the purpose of our study, only two relevant primary studies were identified. First, one pre and post study (n=190) looked at multiple CDSS and computerised physician order entries (CPOE)^p interventions,²⁰⁵ while the second, a retrospective study (n=5 879), focused specifically on order sets^q.²⁰⁶ None of these found significant differences in either LoS or 30-day hospital readmissions with or without the interventions. The authors of the SR concluded that for this type of interventions limited gains in outcomes have been demonstrated to date and that further work would be necessary to draw clearer conclusions on their potential benefits. The authors rated the available evidence by means of the Cochrane RoB assessment tool, as having low quality in general with the included cohort studies lacking sound recruitment allocation strategies which could have resulted in potential contamination due to the knowledge of the intervention. The SR was rated as moderate quality (AMSTAR 2 score 11).

4.4.3.4 *Multidisciplinary care/acute medical unit/care coordination/case management*

Seven SRs overall were identified looking at different interventions based on multidisciplinary care and or case management and coordination, but differing in their descriptions. None of these saw an increase in either LoS or early readmissions with the intervention.

Three SRs focusing on specific patient populations saw a significant reduction in LoS with the intervention.^{160, 171, 188}

First, Coffey et al.¹⁶⁰ looked at the effects of a comprehensive care management programme, involving multidisciplinary teams in a hospitalised population of patients with COPD. Their findings indicate significant reductions in LoS with the intervention compared to usual care of 2.5 days (pre-intervention vs first year of intervention), or 4 days (pre-intervention vs second year of intervention), while no significant differences were perceived in early readmissions. Their results were based on a single, non-randomised controlled trial (n=1 564) and no measurement of early mortality was captured. This SR by Coffey et al. was rated as moderate quality (AMSTAR 2 score 9), while the authors of this SR scored the quality of the single primary study relevant for the purpose of our umbrella review, to be good, (31/40 according to CCAT tool). However, no details were provided on this score.

Huntley et al.¹⁷¹ studied case management based on nurse coordinated multicomponent care versus usual care in hospitalised patients with heart failure. Their results show that the intervention significantly reduced both LoS (MA of 8 RCTs and 1 observational study, n=1 765) and 30-day readmission (2 observational studies, samples sizes: 140 and 447). This SR was also found to be of moderate quality (AMSTAR 2 score 11) and its authors rated the overall risk of bias of the evidence to be low for the RCTs and high or unclear for the observational studies. In particular, observational studies were at high RoB on allocation concealment, while the completeness of the data and the protection against contamination were rated as unclear.

Finally, Patel et al.¹⁸⁸ studied the impact of orthogeriatric/geriatric units vs orthopaedic units, specifically in elderly patients presenting to hospital with hip fractures. Fourteen prospective/retrospective cohort studies with samples sizes varying from 146 to 23 973 looked at LoS as an outcome. Twelve of them found significant reductions linked to the intervention, one (n=11 461) saw no significant differences and the remaining (n=614), reported an increase with the intervention.

With regards to hospital readmissions, the authors state that 4 observational primary studies reported on this outcome. However, an analysis of the data they present in their main publication and

^p Systems allowing healthcare providers to enter medical prescriptions directly into a computer. These are typically integrated in electronic health records (EHR) and are used for ordering medications, laboratory tests, radiology exams, and other treatments.

^q Clinical decision support tools aimed at helping physicians to prescribe appropriate treatments using a pre-defined set of applicable drugs and recommended dosages, based on evidence-based guidelines for specific diseases.



supplements, identified only two studies reporting on hospital readmission.^{207, 208} While Soong et al (n=571) saw no significant differences between the two units, Greenberg et al. (n=614) showed a significant increase ($p=0.0001$) in readmissions in patients admitted in a geriatric care-led unit (29.8%) versus an orthopaedic unit (23.1%). No specification of the timeframe for these readmissions was provided, so the relevancy of these results remains unclear.

The authors of this SR also looked at early mortality and found conflicting results, with three primary studies²⁰⁹⁻²¹¹ with sample sizes between 401 and 11 461 showing non-significant differences between the intervention (i.e geriatric care-led unit or orthogeriatrics co-management unit) and standard practice (orthopaedics unit), and a further (n=614)²¹² presenting a significant higher mortality in the orthopaedic care ($p=0.004$) vs the orthogeriatric co-management unit. The quality of this SR by Patel et al.¹⁸⁸ was rated as low (AMSTAR 2 score 7). The authors of this SR rated the quality of the primary studies relevant for our purposes as high based on the Ottawa Newcastle grading system.^r No further detail was offered on these ratings. It is important to highlight that all were observational studies and more than half were retrospective.

From the other four, two evaluations performed for the general adult hospitalised population saw no significant differences in LoS between the intervention and usual care.^{163, 187} First, Pannick et al.¹⁸⁷ split the intervention in two groups: the first captured interventions that changed the composition of the interdisciplinary team, for which they based their results on LoS in a MA of 6 studies (4 RCTs) with a sample size of 8 403. Second, they looked at interventions changing interdisciplinary team practices. For this second group, they based their evaluation on the impact of such interventions on LoS on a MA of 7 evaluations (2 RCTs) on 32 272 patients. No significant differences on LoS were found for any of the two subgroups analysed. This SR did not find significant differences either in 30-day readmissions (based on a MA of 3 studies of which 2 RCTs for team composition adaptations, n=7 921 and on a MA of 5 observational studies for different practices, n=44 424), or on early mortality at 30 days (1 RCT, n=608).

This SR was rated as having moderate quality (AMSTAR 2 score 11) and its authors appraised the identified evidence as having a medium to high risk of bias. No further details on this regard are provided.

Second, Doshmangir et al.,¹⁶³ (low quality, AMSTAR 2 score 7), included 4 studies (1 RCT) with sample sizes from 51 to 252 looking at the impact of care coordination/case management on LoS. Three of these, including the only RCT identified (Sandberg, n=153),²¹³ saw no significant differences in LoS, while the remaining, an observational study on 227 patients, found a significant reduction in LoS of 11.6 days ($p<0.05$) with the intervention. Significant reductions on 30-day readmissions were also found, but this relied on a single, small RCT (n=41) study.²¹⁴ None of the primary studies captured early mortality. The quality of the evidence was rated as weak by the authors of the SR. Selection bias and confounding were the main problems highlighted.

Ellis et al,¹⁶⁴ (high quality AMSTAR 2, score 15) captured data from 29 RCTs comparing inpatient comprehensive geriatric assessment (CGA) delivered by a multidisciplinary team in geriatric wards or by mobile teams versus usual care. An attempt to meta analyse data from 17 of these studies (n=5 303) on the impact of such an intervention on LoS was made, but too much statistical heterogeneity impeded the authors to make clear conclusions. The authors of this SR also considered early readmissions (MA of 13 RCTs, n=6 698) but did not find significant differences in any of these two outcomes. Mortality was only measured at discharge and at 30 months, so it was excluded from our analysis. The authors rated the evidence on LoS to be of low certainty, and that on 30-day readmissions of high certainty according to GRADE.

A further SR¹⁸⁰ (moderate quality, AMSTAR 2 score 8) compared geriatric nurse assessment and interventions in the ED, versus usual care in elderly patients (≥ 65), and concluded that there were no

^r https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp

significant differences in either LoS (based on two RCTs of sample sizes 224 and 427), or in 30-day readmissions (MA of two RCTs, $n=685$; a further RCT $n=739$ and an observational study, ($n=2\ 139$). The risk of bias was rated as high or unclear by the authors of the SR, with the main problems highlighted being blinding, allocation concealment and incomplete outcome data.

4.4.3.5 Clinical pathways

Two SRs looking at clinical pathways were identified.

Chrakaborty et al.¹⁵⁹ (moderate quality, AMSTAR 2 score 11). studied the impact of clinical pathways initiated at the hospital and including multifaceted management (eg. nutrition, physical activity, education...) for hospitalised adults with an existing or newly diagnosed diabetes. They found unclear results for LoS. On the one hand, two studies (one pre and post $n=169$ and one audit study $n=28\ 016$), including staff education and protocol development as components of their intervention and involving both nurses and diabetologists, showed significant reductions with the intervention. A further two (1 RCT $n=31$ and a retrospective audit $n=19\ 471$) found non-significant differences. The later specified the inclusion of clinical education and clinical protocols, but further details were not provided. In terms of readmissions at 30 days, no significant differences were identified (1 RCT, $n=31$), while no primary study captured early mortality. The authors of this review, rated the quality of the evidence to be good overall, based on the JBI tool.^s

Agarwal et al.¹⁵⁵ (High quality, AMSTAR 2 score 13) focused on therapeutic guidelines, new organisation and procedures and patient education for elderly patients admitted to hospital for heart failure and reached unclear conclusions based on 2 cluster RCTs with sample sizes 429 and 2906, with the smaller trial showing significant reductions in LoS with the intervention and the larger no significant differences. Only one RCT ($n=137$) covered hospital readmissions at 30-days and saw a significant risk reduction of 12% ($p=0.04$). Early mortality was explored in two 2 RCTs with sample sizes of 137 and 17 544. None of these found significant differences with the intervention versus usual care. The authors of this SR ranked the quality of the evidence for all relevant outcomes as low according to GRADE.

4.4.3.6 Acute geriatric unit care

One SR published in 2012¹⁶⁶ focused on the impact on patient and system level outcomes of acute geriatric care units based on all or part of the acute care for elders (ACE) unit model,²¹⁵ compared to standard acute geriatric care for elderly patients. This SR was rated as moderate quality (AMSTAR 2 score 12). The authors meta analysed the results of 11 studies (7 RCTs) on a total of 6 098 patients ≥ 65 years of age, and found the intervention to significantly reduce LoS, but great heterogeneity was observed ($I^2=87\%$). After 7 outliers were excluded, a MA of 3 studies on 3 956 patients confirmed the significant reductions in LoS linked to the intervention (WMD: -0.61, 95% CI: - 1.16 to -0.05; $I^2=45\%$, $p=0.03$). No significant differences in hospital readmissions at 1 or 3 months were identified in a MA of 5 RCTs ($n=3\ 983$). However, the authors did not perform a subgroup analysis of the primary studies covering 30-day readmissions only. Nevertheless, looking at the results of the only two RCTs which specified in their description that they looked at one month hospital readmissions, they seem to confirm the results of the MA, since neither of them showed any significant differences with or without the introduction of acute geriatric units of care. Regarding mortality, the SR only considered in-hospital mortality, which was not relevant for our purposes. The authors of this SR highlighted a lack of detail in the evidence that made it generally difficult to assess their risk of bias. The risk of selection bias was high in 3 studies and unclear in a further 3, while the risk of performance, linked to double blinding proved to be a problem in 10 studies (7 at an unclear and 3 at a high risk of bias). In addition to this,

^s <https://jbi.global/critical-appraisal-tools>



the risk of detection bias was unclear for 11 studies overall, with only one specifying the blinding of the outcome assessors. Attrition or reporting bias were also common problems.

4.4.3.7 *Lean Health care/utilisation management*

One SR of moderate quality (AMSTAR 2 score 11), published in 2020 focused on lean health care (LHC), in combination or not with Six Sigma¹⁹⁸. These are methodological approaches considering empirical data to measure and assess certain operational scenarios and choose the best one to improve processes and ultimately quality of care. While LHC focuses more on reducing waste, Six sigma aims primarily at reducing variability/errors.

The authors of the SR looked at hospitalised patients in different departments where LHC and Six Sigma are implemented (e.g. surgery, operating room, trauma, ED, ICU, paediatric gastroenterology and transplant centres). No MA was performed due to the existing heterogeneity in methods, populations and hospital department. Overall, 23 pre and post studies with samples sizes ranging from 102 to 75 490, looking at the impact of these interventions on LoS were included. From these, 16 found a significant decrease in LoS following the introduction of this type of interventions, while 7 studies saw no significant differences. The differences in this outcome did not reflect a difference in the intervention being studied (LHC or Six Sigma alone or both combined).

The same SR included 6 pre and post studies, with samples sizes from 103 to 4 253, evaluating hospital readmission rates at 30 days, with none reporting an increase, 4 showing no change, and 2 reporting significant reductions with the intervention versus an absence of it. One of the later, was an observational study with the largest sample size amongst those considering hospital readmissions (Sorensen et al., n=4 253).²¹⁶ This study, found a decrease from 3.1% to 1.1% at 30 days; ($p=0.032$) with LHC alone (not in combination with Six Sigma). All other primary studies considering this outcome, evaluated the association of both approaches (i.e. Lean Six Sigma). The other primary study that found a significant difference in early readmissions in favor of the intervention, had a sample of 1 394, and saw a decrease in 30-day readmissions from 28.4 to 18.9% ($p<0.01$) with the intervention.

Finally, although the authors of this SR mention mortality to be measured in six studies, the analysis of their data extraction tables in the supplements identified only two primary studies looking at 30-day mortality. From these, Yousri et al.(2011)²¹⁷ a before and after study on n=608 patients found a significant reduction in this outcome, from 11.7 to 6.7, ($p=0.034$) with the intervention. The other, also a before and after evaluation on 103 patients, saw no significant differences with the intervention compared to an absence of it. No statistics were provided.

The authors of this SR assessed the quality of the evidence by means of the Cochrane's tool ROBINS-I (Risk Of Bias In Non-randomized Studies of Interventions). Overall, the evidence was rated as having a moderate to high risk of bias. Only two items were generally ranked as having a low risk of bias. These were linked to outcome measurements and missing data. All studies were considered at a high risk of selection bias, while confounding also appeared to be a problem with an important number of studies (10).

A further SR¹⁶³ (low quality, AMSTAR 2 score 7) investigated the impact of utilisation management on different outcomes, and included two observational primary studies looking at LoS. Only one of these, an old time series published in 1997, with a sample size of 1 790 performed a statistical analysis.²¹⁸ Cardiff et al.²¹⁸ described the intervention as the identification of patients not needing an acute bed, according to specific criteria in order to modify accordingly their care. Their results showed significant reductions in the intervention group. The same primary study was the only one included in Doshmangir 's review¹⁶³ looking at 30-day hospital readmissions and also showed significant reductions linked to the intervention. Mortality was not captured in this SR. The authors of the SR rated the relevant evidence to be weak in selection bias, drop outs, and cofounders. The tool used for their quality

assessment consisted of an adapted version of the Quality Assessment Tool for Quantitative Studies (developed by the Effective Public Health Practice Project).^t

4.4.3.8 Rehab care and transition interventions

Four SRs were identified covering rehabilitation care or transition interventions. Two of these, both published in 2013, studied adults ≥ 65 years admitted to an acute hospital ward.^{165, 168} Fox et al.¹⁶⁵ (high quality, AMSTAR 2 score 14) looked at early discharge planning (i.e. intervention facilitating transition between hospital and community care) and saw no significant differences between the intervention and usual care on LoS (MA of 7 studies, of which 5 were RCTs, $n=789$). Only one Australian study, a pseudo randomised controlled trial on 111 patients, captured early readmissions within a time frame relevant for the purpose of our analysis (at 28 days), and found no significant differences with the intervention versus standard care.²¹⁹ No primary studies captured in Fox et al. looked at mortality at 30 days. The authors of the SR rated the quality of the evidence for LoS to have a high or unclear risk of performance bias (linked to double blinding), as well as an unclear risk of detection bias (in 4 out of the 7 studies included in the MA for LoS). For 30-day readmissions, the only primary study relevant for our purposes was a pseudo randomised trial and as such was rated as high risk of selection bias due to its inappropriate randomisation methods. The study was also rated to have an unclear risk of detection bias relating to blinding of assessors.

The second SR focusing on the geriatric population¹⁶⁸ (low quality AMSTAR 2, score 7) looked at community nursing participation across the hospital and community interface.¹⁶⁸ Based on two pre and post studies (samples sizes 1 464 and 2 139), the authors of this SR concluded that no significant differences in LoS existed with or without the intervention. With regards to readmission at 30 days, the same primary studies showed unclear results with one presenting significant reductions in readmissions with the intervention and a further reporting non-significant differences versus standard care. Early mortality was not captured in any of the primary studies included in this review. The authors of this SR rated the quality of the evidence using McMaster qualitative and quantitative critical appraisal tools and highlighted important weaknesses in the evidence, regarding no sample size justification, a lack of detail regarding the validity and reliability of outcome measures, insufficient information regarding drop outs or possible contamination.

A SR from 2019,¹⁶⁰ (moderate quality, AMSTAR 9) investigated the potential impact of a community in-reach rehabilitation and care transition (CIRACT) services in elderly (≥ 70 years) hospitalised in medical wards as an acute medical emergency. They only identified one primary study (RCT, $n=250$), looking at the impact of such intervention on LoS and early (28-day) hospital readmissions, which found no significant differences in any of these two outcomes between the intervention and standard rehabilitation. Mortality was not considered in the only relevant primary study identified. The authors rated this evidence to be of good quality (CCAT tool, 31/40).

Finally, an Australian SR¹⁵⁶ (moderate quality, AMSTAR 2 score 10) looked at promoting safe and timely transfer between levels and settings in patients aged ≥ 60 with chronic conditions. They found conflicting results regarding the impact of different specific interventions on LoS (4 RCTs, samples sizes from 40 to 598). Only the larger of these primary studies looking at LoS (Lim 2003, $n=598$)²²⁰ saw significant reductions with discharge case management versus standard practice. The remaining three found no significant differences with interventions that differed in their definition, with an old, small study ($n=40$) focusing on discharge protocols and advance nursing care,²²¹ and two primary studies looking at GP and primary care nurse models.^{222, 223} Regarding hospital readmissions at 30 days, they only identified one primary study, an RCT ($n=747$) considering such an outcome, which presented a significant reduction in favour of the intervention, defined as self-management, supported by a transition coach. No primary studies captured 30-day mortality data. The quality of the evidence

^t <https://www.ehphp.ca/quality-assessment-tool-for-quantitative-studies/>



was considered by the authors to be mostly of moderate quality for LoS, while the only relevant evaluation for 30-days readmissions was rated as having a high quality (low risk of bias) .

4.4.3.9 *Palliative care in hospital*

One SR¹⁹² (moderate quality, AMSTAR 2 score 11) studied screening tools for inpatient palliative care consultations and hospital discharge planning or transitional care in adults that: 1. had any type of advanced progressive illness or any serious illness that required management of pain or other distressing symptoms, such as difficulty breathing or swallowing; 2. adults not being treated with curative intent; or 3. adults having an expected life expectancy of less than 2 years. Due to the heterogeneity of the primary studies included in the review in terms of interventions, methods and outcomes, no meta-analysis was performed.

For the intervention defined as screening tools for palliative care consultations, three primary studies (1 RCT) considering LoS as an outcome were identified. These presented conflicting results. Thus, while two of them, (1 RCT, n=84 and 1 pre/post study, n=113), found non-significant differences in LoS between the intervention and standard practice, the remaining (a post-test only, control study n=405) saw a significant decrease in LoS of 1.7 days (95% CI -3.1 to -1.2) in LoS with the intervention. The outcome early hospital readmissions was considered in 3 primary studies, two of these (1 RCT, n=84 and 1 post-test only, n=405) found non-significant differences between the intervention and an absence of it. The third one, (pre/post study, n=113) saw a significant reduction from 35% to 18% (p=0.04).

For the interventions grouped in the SR by Saunders et al.¹⁹² under interventions spanning the hospital and the community, one RCT (n=517) found no significant differences between the intervention and standard of care in LoS (7 days for both, p=0.57). A pre and post study (n=4 551) presented significant reductions in 30 day readmissions. These went from 27.4% to 22.9%, a RR of 18% (p<0.005).

Early mortality was not measured in any of the primary studies included in this review.

The authors of this SR rated the quality of the available evidence using the Cochrane RoB tool for the two RCTs, and the Newcastle for the observational studies. The main potential biases identified in the observational studies, were linked to the lack of clarity regarding the blinding nature of outcome assessments, and insufficient length of follow-up, and missing data that could have resulted in misleading results. RCTs also presented important biases. These were primarily linked to their randomisation process, a possible deviation from the intended interventions, and selection of the reported results.

4.4.3.10 *Short stay in-hospital units and short stay programmes*

Two SRs looking at the impact of short stay hospital units on resource use or patient outcomes were identified via our search. First, a SR published in 2018²²⁴ (high quality, AMSTAR 2 score 16) looked at the influence that in-hospital short stay units could have on multiple outcomes (incl. LoS and readmissions), in patients with internal medicine diseases and conditions. The authors of this review identified 12 RCTs looking at LoS but great heterogeneity in reporting of outcomes and methodologies impeded the completion of a MA. Overall, shorter LoS was found with the intervention, with a mean or median LoS ranging from a minimum of 9 hours to a maximum of 96 in the intervention arms and from 37 to 216 in the usual care arms. The implementation of short stay units resulted in a LoS shorter than 24 hours in two trials, while a further 5 found a LoS between 24 and 48 hours.

Only two RCTs captured readmissions at 30 days^{193, 225} while all others looked at longer time frames for this outcome. From these Strom et al.¹⁹³ found an statistical significant reduction in 30-day readmission with the intervention in a population suffering from internal medicine diseases, while Than et al.²²⁵ saw no statistical differences between the two groups in patients presenting to the ED with chest pain.

Mortality at 30 days was reported in two RCTs both on patients with chest pain, none of which saw any deaths in either the intervention or the control group.

The authors of this review used GRADE to assess the quality of the evidence. They stated that certainty of the evidence for LoS, readmissions and mortality was very low due to the fact that they considered all relevant trials for the evaluation of these specific outcomes to be at high risk of bias. High risk of contamination and unclear risk linked to blinding of outcome assessment, were the most frequent biases identified.

A second SR published in 2024²²⁶ (moderate quality, AMSTAR 2 score 10), studied the same intervention in lower risk patients who present to the ED with decompensated HF (DHF). The authors found 4 studies (1 RCT), with varied sample sizes ranging from 64 to 359. Three of the studies reported on LoS but although all found lower LoS with ERAS, only one of these, the only RCT¹⁸⁶ presented statistics that indicated non-significant differences (mean days: 3.7 with ERAS, versus 4.9 without it ($p=0.13$). Results for 30-day readmissions did not show any significant differences between the different arms. A MA of 3 studies, ($n=367$): resulted in a relative risk of 1.12 (95% CI : 0.71-1.75, $p=0.63$) with no sign of heterogeneity ($I^2 = 0\%$). Finally, mortality at 30 days was explored in two studies ($n= 258$) that found only 2 deaths and could not identify any significant differences. The risk ratio was 0.21 (95%CI : 0.01-4.37, $p=0.32$) Heterogeneity was not studied in this case, given the low number of studies considering this outcome.

The authors of this second SR used the Cochrane RoB tool (for RCTs) and the NOS (for non-RCTs) to assess the quality of the evidence. They concluded that on the one hand, the only RCT included in their review presented a high risk of bias overall, primarily due to a lack of blinding of outcome assessors.¹⁸⁶ On the other hand, only one observational had a low ROB, with 9/9 stars on the NOS. The other, lacked sufficient data to be included in the MA, and presented low to moderate ROB with 7 stars. No quality assessment could be performed on the abstract.

A third and last study identified in our review consisted of a SR published in 2023¹⁵⁸ (high quality, AMSTAR 2 score 14) looking at safety outcomes (including readmissions) of short stay programmes in total hip or knee replacement. The reviewers identified 49 studies. The most common components of such programmes were early mobilisation (in 84% of studies); perioperative information (in 76%), perioperative oral analgesia (in 71%), use of local anaesthesia for infiltration analgesia and nerve blocks (in 69%) and criteria-based discharge (63%). The follow-up period was described as a maximum of 90 days. Regarding LoS, no statistics were presented on this variable since it was not considered an outcome. Nevertheless, given the fact that most of the included primary studies reported on it (43/49), it was decided to keep this SR in given its relevancy. Reported LoS for the intervention and the control groups varied from one study to another but only 1 study reported no differences LoS. The remaining (including 1 RCT) found LoS reductions ranging from a minimum of a few hours²²⁷ to more than 5 days.²²⁸

With regards to hospital readmission, the authors based their conclusions on the results from the RCTs which found no significant differences between the short stay programme and the traditional care arm (OR: 0.95, 95%CI : 0.12-7.46, $p=0.96$). However, such findings could only be based on 1 RCT,²²⁹ given the lack of events captured in the other RCT which considered readmissions as an outcome. Thus, the low certainty of such findings (according to GRADE) was highlighted by the authors. Mortality within maximum 90 days was also studied. Evidence from registries as well as from observational studies with methods other than interrupted time series found significant differences in favour of the intervention. However, no significant differences were derived from a MA of interrupted time series. While quality of the evidence per outcome was assessed using the GRADE framework, the RoB for the studies was performed with the Joanna Briggs Institute Risk of Bias Tool for RCTs and quasi- experimental studies^u. All RCTs included in this review were considered by the authors of

^u <https://jbi.global/critical-appraisal-tools>



the SR to have a low risk of selection bias but high risk of performance and detection bias as no blinding for surgeons or participants was performed. All but one quasi-experimental study were at high risk of selection bias.

4.4.3.11 Pharmacist-led interventions

One SR of high quality (AMSTAR 2 14) published in 2024 assessed pharmacist-led interventions in perioperative care across 25 studies, of which 5 were RCTs. Most interventions were multicomponent and continuous, involving medication reconciliation, discharge counselling, and education.¹⁸³

A MA of 11 studies (n=4905), including three RCTs, looked into LoS and showed a significant reduction with pharmacist interventions: SMD -0.09 (95% CI : -0.49 to -0.15, p=0.0002). Heterogeneity was high ($I^2 = 86\%$) and was attributed by the authors to variation in interventions and patient populations. No subgroup analysis was performed.

For 30-day readmissions the results of 8 studies (2 RCTs) were pooled in a MA (n=3271). The pooled result showed a significant reduction with pharmacist interventions: OR 0.60 (95% CI : 0.39-0.91, p<0.05, $I^2 = 46\%$).

None of the primary studies included in this SR reported 30-day mortality outcomes.

4.4.3.12 Others

One SR published in 2018¹⁹¹ (high quality, AMSTAR 2 score 13) investigated the impact of weekend allied health services in acute and in subacute care on multiple patient health, and system care outcomes.

On the one hand, in the acute (medical and surgical) setting, a MA of two RCTs (n= 27 508) demonstrated no significant differences between the intervention and control groups in hospital LoS. The consideration of diagnosis did not seem to have an influence on the results that still showed no significant differences between the intervention or an absence of it. This MA suffered from very high levels of heterogeneity ($I^2=79\%$), which was looked at in a post-hoc exploratory analysis²³⁰ that suggested the heterogeneity came from significant changes in hospital length of stay outcomes between control conditions. A further MA was also performed for 6 observational evaluations, but this also presented high heterogeneity, which was reduced by performing a MA of three studies (n=1 177) focusing specifically on total hip arthroplasty patients. This MA also failed to show significant differences between the intervention and standard care, with a WMD of 0.08 days (95% CI : -0.12 to 0.29, $I^2 = 24\%$).

On the other hand, in the subacute setting, a MA of 3 RCTs (n=1 437) showed that weekend allied health services significantly reduced hospital LoS (WMD 2.35 days, 95% CI : 0.45-4.24, $I^2= 0.0\%$). The results from a MA of non-randomised studies showed non-significant reductions, but once more, great heterogeneity was found in this case.

With regards to early hospital readmissions, a MA of two large RCTs (n = 27 508) showed no significant difference in the proportion of patients with hospital re-admissions at 28 days of discharge with or without weekend health services in the acute medical or surgical hospital wards (risk difference 0.01, 95% CI : 0.00-0.02, $I^2=43\%$). This was consistent with the results of one Japanese non randomised trial.(n= 3 072) ²³¹ Finally, although no MAs could be performed for the subacute setting, one RCT in that setting (n=996) also showed no significant results in readmissions between the intervention and the control at 30 days with a RR of 1.01 (95%CI : 0.95-1.07). No primary studies evaluated early mortality. The authors of the study rated the evidence using the Cochrane RoB tool for RCTs and the Newcastle-Ottawa Quality Assessment Scale for observational studies, and found it to be at high risk of bias in both blinding of participants and personnel, and more importantly, of outcome assessors. In addition to this, the only primary study looking at 30-day hospital readmissions in the subacute setting was considered to have a high risk of selection bias due to its random sequence generation.

4.4.4 *Quality of SRs*

The quality of the included SRs according to AMSTAR 2 was high to moderate, with only 5 SRs having less than 8 items from the checklist rated as 'yes' or 'partial yes' (see summary AMSTAR tables in appendix). The most common omissions were: the source of funding for the included studies, which was only covered in one SR, a list of excluded studies ("no" in 40 SRs), a clear and explicit justification of the type of studies included in the review ("no" in 30 SRs), an adequate investigation of publication bias ("no" in 24 SRs), an explicit statement on protocol prior to conducting of review ("no" in 21 SRs) and carrying out the data extraction in duplicate ("no" in 12 SRs, and not specified in 3 SRs).

The risk of bias in the primary studies was often rated by the authors of the SRs as moderate to high, with many studies being pre and post studies, and the included RCTs often lacking appropriate blinding. Although blinding of participants and personnel may be difficult or even impossible in studies comparing different approaches or interventions, blinding of assessor should nevertheless, be ensured. The heterogeneity in the interventions studied and a lack of measurement of adherence to them (particularly in the case of ERAS and short-stay programmes) were the most common problems mentioned by the authors of the included SRs. Risks of bias due to confounding and reporting bias, were also frequent. Details of the SRs as well as on the primary studies included in them are offered in an appendix.



Table 21 – Summary results from included SRs depending on the type of intervention

Categorisation of interventions	Examples of interventions studied	N. of included SRs	Impact on LoS	Impact on readmissions	Impact on early mortality
Enhanced recovery after surgery	Includes different items during pre, peri and post-surgery	24	23 sig ↓, 1 NS diff	23 NS diff, 1 sig ↑	11 NS diff, 3 sig ↓
Multidisciplinary care/acute medical unit/care coordination/case management	Multiprofessional teamwork, communication, collaboration and coordination	7	3 sig ↓, 4 NS diff, 1 unclear	4 NS diff, 2 sig ↓, 1 unclear	1 NS diff, 1 unclear
(Nurse-led) discharge planning and coordination	Planning and scheduling of follow up assessments, coordination with community services	6	3 sig ↓, 3 NS diff	2 sig ↓, 2 NS diff, 2 unclear	1 NS diff
Rehab care and transition interventions	Community transition, rehabilitation planning and coordination, etc	4	3 NS diff, 1 unclear	2 NS diff, 1 sig ↓, 1 unclear	NA
Short stay units/programmes	Hospital units or programmes providing short-term care for selected patients	3	1 sig ↓, 1 unclear, 1 no stats performed	1 unclear, 2 NS diff.	3 NS diff.
Clinical pathways	Protocols, evidence based clinical pathways, quality coordinators, etc	2	2 unclear	1 sig ↓, 1 NS diff,	1 NS diff
Lean Health care/utilisation management	Analysis of individual needs to reduce unnecessary treatments, reducing waste and or increasing efficiency	2	2 sig ↓	1 sig ↓, 1 unclear	NA
Acute geriatric unit care	Acute Care for the Elderly (ACE model) paradigm of care.	1	1 sig ↓	1 NS diff	NA
Clinical decision support systems/Telemonitoring or telehealth	Computer programs helping clinical decisions based on guidelines and patient electronic health records, telemonitoring systems or communication systems	2	1 unclear, 1 NS diff	1 sig ↓, 1 NS diff	1 NS diff, 1 NA
Pharmacist-led interventions	Multicomponent interventions including medication reconciliation, discharge counselling, and education.	1	1 sig ↓	1 sig ↓	NA
Palliative care in hospital	Assessment for needs and coordination of palliative care at home	1	unclear	unclear	NA
Additional availability/services	Weekend services	1	1 sig ↓ in subacute, NS diff in acute	NS diff.	NA

NS: non-significant

Table 22 – Results of interventions on length of stay and readmissions

Author (yr)	Population	Intervention	Impact of intervention on LoS	Impact of intervention on 30-day readmissions	Impact of intervention on 30-day mortality
Agarwal (2019) ¹⁵⁵	Aged 65-84 and admitted to hospital for HF	Clinical pathway (therapeutic guidelines, new organisation and procedures, patient education)	Panella 2009 , n=429: sig. ↓ of 1 day with intervention from 11.4 (95%CI : 10.5-12.3) to 10.4 (95%CI : 9.6-11.0), p=0.028. Philbin 2006 , n=2 906: NS diff. Intervention effect: -1.1 (95%CI : -2.9 to 0.7) days.	Sales 2013 , n=137: sig. ↓ with intervention: Absolute RR 12%, p=0.04.	Sales 2013 , n=137: NS diff: Absolute RR 0.4%, p=1.00. Tu 2009 , n=17 544: NS diff: Absolut diff: -1.1% (95%CI : -3.2% to 0.9%), p=0.26.
Allen (2014) ¹⁵⁶	Adults aged ≥ 60 with chronic illnesses	Aimed at promoting safe & timely transfer between levels and settings of care	No stats provided. Discharge protocol and advance nurse: Naylor 1990 , n=40: NS diff in LoS. Discharge case management: Lim 2003 , n=598: sig ↓ in LoS. GP and 1ary care nurse models McInnes 1999 , n=364; & Preen 2005 , n=189: NS diff.	No stats provided. Self-management supported by a transition coach: Coleman 2006 , n=747: Sig. ↓ with intervention.	NA
Austin (2020) ¹⁵⁷	Patients in a hospital using EMR	Clinical support systems (Anticoagulant use in EMRs)	Alerts to choose anticoagulant or dose: Milani 2011 , n=80: sig. ↓ mean LoS: from 9.1 +/- 10.2 in control arm to 4.8 +/- 4 with intervention, p=0.01. Order sets: Ballesca 2014 , n=5 879: NS diff. median LoS from 68.9 hrs in control arm to 68.3 hrs with intervention, p=0.26. Multiple CSS: Maynard 2014 , n=190: NS diff: Mean LoS: pre: 22.3 days, post: 17.3 days, p=0.27.	Maynard 2014 , n=190: NS diff. pre: 15.9%, post: 11.4%, p= 0.62. Ballesca 2014 , n=5 879: NS diff: from 17.1% in control arm to 16.3% with intervention, p=0.44.	Mortality at 30 days not included in any study (Maynard 2014 and Ballesca 2014 looked at inhospital mortality).
Berkovic (2023) ¹⁵⁸	Adults undergoing unilateral or bilateral, total or uni-compartmental KR or THR	Short-stay programmes	No MA performed and no stats provided. 43 studies showed shorter LoS with intervention: Diff ranging from less than 1 day (Picart 2021), to 5.3 days	Time frame specified at max. 90 days: MA of 2 RCTs , n=98: OR: 0.95 (95%CI : 0.12-7.46), p=0.96, I ² =NA.; 1 Registry ,	Time frame specified at max. 90 days: MA of 2 registries , n=130 441: OR 0.64 (95%CI : 0.52-0.79), p<0.0001, I ² =0%; MA of 9 ITS , n=20 289: OR:



			(Tasso 2022). 6 studies did not report LoS. 1 reported no differences.	n=13 910: OR: 1.06 (95%CI : 0.96-1.17), p=0.27; MA of 21 ITS , n=25 893: OR: 0.86 (95%CI : 0.72-1.03), p=0.10, I ² =18%.; 1 observational (other) , n=6 146: OR: 1.48 (95%CI : 1.01-2.17), p=0.05,	0.42 (95%CI : 0.13-1.35), p=0.14, I ² =74%; MA of 3 observational (others) , n=48 555: OR: 0.57 (95%CI : 0.34-0.95), p=0.03, I ² =0%.
Chakraborty (2020) ¹⁵⁹	Hospitalised adults with an existing or new diagnosis of diabetes	Initiated in hospital and multifaceted for the management of diabetes (eg. nutrition, physical activity, education...)	Schnipper 2009 , n=169: sig. ↓ mean LoS 4.7 vs 3.6 days. Adjusted diff: -25% (-6% to -44%), p<0.001. Flanagan 2009 , n=28 022: sig. ↓ mean LoS -0.6 +/-0.1, p<0.002. Hardee 2015 , n=19 471: NS diff: 3 pre, 3 post 1ary diagnosis, p=0.34 and 4 pre and 4 post 2ary, p=0.94. Wexler 2012 , RCT, n=31: NS diff 5 with intervention vs 6 with usual care, p=0.7.	Hardee 2015 , n=19 471: % of readmission: NS diff ↑ 3.1 with intervention for 1ary diagnosis, p=0.14; ↑ 0.4 with 2ary diagnosis, p=0.42. Wexler 2012 n=31: NS diff ↓ with intervention 33% vs 50%, p=0.3.	NA
Coffey (2019) ¹⁶⁰	Hospitalised patients of all ages	Nursing-led discharge planning	Dawes 2007 , n=111: sig. ↓ with intervention: 4.71 SD (1.64) vs 6.06 S.D. (1.41), p= 0.001. Wong 2005 , n=111: sig. ↓ with intervention: 2.2 vs 5.9 days, p< 0.001.	Dizon 2017 , n=NA; Dawes 2007 , n=111: NS diff. No quantitative info. Goldman 2014 , n=698: NS diff: 1.08 (95%CI : 0.90-1.30).	NA
Coffey (2019) ¹⁶⁰	Hospitalised patients of all ages	Comprehensive care management programme	Alshabanat 2017 , n=1 564: for COPD-related admissions: sig ↓ with intervention. Mean LoS: 10.8 days (pre-program), 8.3 (yr1), 6.8 (yr2).	Alshabanat 2017 , n=1 564: sig.↓ in readmissions from pre-program through program yr 1 and 2: 16.3% (pre-program) to 14.9% (yr1) and 12.9% (yr2). Readmissions for COPD: NS diff. 6.5% (pre-program) 3.8% (yr1), 8.2% (yr2).	NA

Coffey (2019) ¹⁶⁰	Hospitalised patients of all ages	Home telemonitoring	Blum 2014 , n=204: NS diff. No data provided.	Blum 2014 , n=204: sig. ↓ with intervention: from 62.5% to 45.3%, p<0.05. Non persistent effects, seen only in yr1.	Blum 2014 , n=204: No data provided. From graphical analysis, NS diff.
Coffey (2019) ¹⁶⁰	Hospitalised patients of all ages	Community In-reach Rehab. and Care Transition (CIRACT) service.	Sahota 2017 , n=250: NS diff. in mean LoS: 7.8 with intervention vs 8.7 days with standard rehabilitation (95%CI : 0.74-1.10).	Sahota 2017 , n=250: NS diff. 17% with intervention vs 13% with traditional hospital-based rehabilitation: RD 3.8% (95%CI : -5.8% to 13.4%), p=0.442.	NA
Coolsen (2013) ¹⁶¹	Adult patients undergoing major elective resectional surgery of the pancreas	ERAS	No MA performed: 8 observational studies, n=1 306: sig ↓ from 2 to 6 days.	MA of 4 studies, n=744: NS diff: RD 0.008 (95%CI : -0.026 to 0.041), p=0.64, I ² =0%.	MA 4 studies, n=744: NS diff: RD: -0.002 (95%CI : -0.021 to 0.017), p = 0.83, I ² =0%.
Deng (2018) ¹⁶²	Patients undergoing THA or total knee arthroplasty	ERAS	MA of 15 studies, n=9 209: MD -2.03 (95%CI : -2.64 to -1.42), p<0.0001, I ² =98%.	MA of 6 studies, n=7 465: RR 0.86, (95%CI : 0.56-1.30, p=0.4660, I ² =55%.	MA of 4 studies, n=8 169. RR: 0.48, (95%CI : 0.27-0.85), p=0.0123, I ² =10%. Time frame unclear.
Doshmangir (2022) ¹⁶³	Adult hospitalised patients	Nurse led discharge planning using a risk screening tool	Moher 1992 , n=267: sig. ↓ in mean LoS: -1.97, 9.4 in control and 7.4 in intervention, p<0.05. Kennedy 1987 , n=80: sig. ↓ in mean LoS: -1.9, 9.7 in control and 7.8 in intervention, p<0.05. Hegney 2006 , n=2 139: small ↓ in mean LoS: -0.8; 6.17 pre, 5.37 post. No stats provided Styrborn 1995 , n=536: NS diff. in adjusted LoS: -1.1; 9.6, intervention; 10.5 and 10.9, control, p>0.05.	Hegney 2006 : sig. ↓ after intervention: 5.5%, from 10.2% to 4.7%, p<0.05.	NA
Doshmangir (2022) ¹⁶³	Adult hospitalised patients	Care coordination/case management	Sandberg 2015 , RCT, n=153: NS diff: 3.90 (pre) and 4.05 (post) with control; 5.05 (pre) and 4.60 (post) with intervention, p>0.05.	Koehler 2009 , RCT, n=41: sig. ↓ with intervention: 2 (10%) with intervention vs 8 (38%) with control, p<0.05.	NA



			Joo 2014, n=252: NS differences: 3.05 pre, 2.28 post, $p>0.05$. Tadros 2012, n=51: NS diff in LoS (in days): -27.9%, 122 (pre), 88 (post), $p>0.05$. Mahendran, n=227: sig. ↓ in mean LoS with intervention - 11.6, from 15.6 to 4, $p<0.05$.		
Doshmangir (2022) ¹⁶³	Adult hospitalised patients	Utilisation management	Cardiff 1997 n=1 790: sig. ↓ with intervention; Woodside 1991, n=264: -23% in adjusted LoS; 9,1 with intervention vs 11,8 without. No stats performed.	Cardiff 1997 n=1 790: sig ↓ pre and post and the after periods for both intervention hospitals, and for 1 out of two control hospitals, $p<0.05$.	NA
Ellis (2017) ¹⁶⁴	Aged ≥ 65 with medical, psychological, functional, or social problems and hospitalised for acute care or rehab	Inpatient comprehensive geriatric assessment (CGA), delivered in geriatric wards or by mobile teams	MA of 17 trials, n=5 303: Not retained because high level of statistical heterogeneity ($I^2=80\%$). Unclear results: Mean LoS from 3.4 days to 40.7 days with CGA, from 3.1 to 42.8 days with control group, mean difference of -23.60 to 9.00 days.	MA of 13 trials, n=6 698: NS diff: R. ratio: 1.02 (95%CI : 0.94-1.11), $p=0.62$, $I^2=0\%$. High-certainty evidence.	Only measured at discharge and at 3 months.
Fox (2012) ¹⁶⁶	Adults older than 65 years	ACE units	MA of 11 trials, n=6 098: sig. ↓ with intervention: WMD - 0.61 (95%CI : - 1.16 to - 0.05), $p=0.02$, $I^2=87\%$. Removal of 7 trials during SA resolved heterogeneity and confirmed results: WMD -0.61, (95%CI : - 1.16 to -0.05), $p=0.03$, $I^2=45\%$.	MA of 5 studies, n=3 983: NS diff at 1 or 3 months: WMD 1.05 (95%CI : 0.92-1.18, $p=0.49$, $I^2=0\%$). Only 2 of these on 30-day readmissions, both showing NS diff.	Only in-hospital mortality studied
Fox (2013) ¹⁶⁵	In-patients over 65 years	Early discharge planning (intervention facilitating transition between hospital and community care)	MA of 7 studies (n=789): NS differences: Mean difference: - 0.41 (95%CI : -1.19 to 0.36); $p=0.30$, $I^2=34\%$.	Choong 2000 , n=789: NS diff. 4% vs 11%, $p=0.28$.	Only capture in-hospital mortality or mortality at 2, 3, 6 or 12 months.

Gonçalves-Bradley (2022) ¹⁶⁷	Hospitalised with a medical condition, a mix of medical and surgical conditions, following a fall, a psychiatric diagnosis or a mix of mental health and medical diagnosis.	Inhospital, personalised discharge plans	For medical conditions: MA of 11 RCTs, n=2 113: sig. ↓ in mean LoS with intervention: 0.73 (95%CI : -1.33 to -0.12), p=0.02, I ² = 9%. For older people after surgery: MA of 2 RCTs, n=184: NS diff: -0.06, (95%CI : -1.23 to 1.11), p=0.92, I ² = 0%.	For medical conditions: Bonetti 2018 , n=104: NS diff: RR 0.59 (95%CI : 0.18-1.91); Farris 2014 , n=624: NS diff: RR 1.05 (95%CI : 0.73-1.52); Goldman 2014 , n=698: NS diff: 1.08 (95%CI : 0.90-1.30); Lisby 2019 , n=200: NS diff: 1.13 (95%CI : 0.66-1.96). For medical and surgical conditions: Evans 1993 , n=835: sig ↓: - 10.5% (95%CI : - 16.6% to - 4.3%), p < 0.001.	Bonetti 2018 , n=133: No stats provided. All other studies captured outcomes at different time spans.
Guerin ¹⁶⁸	Adults aged > 65, admitted to an acute care hospital	Community nurse working across the hospital/community interface	Hegney 2006 , n=2 139: small ↓ in mean LoS: -0.8, 6.17 (pre), 5.37 (post). No stats provided; Ornstein 2011 , n=1464: NS diff in mean LoS for independent nurses working across the hospital/community: 6.23+/- 5.42 (pre) vs 6.60 +/-5.5 (post) intervention, p=0.10	Hegney 2006 , n=2 139: sig. ↓ post intervention: 5.5% (from 10.2% to 4.7%), p<0.05; Ornstein 2011 , n=532: NS ↓: from 119 (pre), 90 (post), p>0.05.	No study measured mortality at 30 days
Harij (2024) ¹⁶⁹	Adults undergoing emergency abdominal surgery	Protocolised ERAS pathway	MA of 4 RCTs, n=316: SMD: - 2.47 (95% CI : -4.01 to -0.93), p = 0.002, I ² = 97%.	NS diff.: MA of 5 RCTs, n= 451: OR: 2.09, (95% CI : 0.58-7.57, p=0.260, I ² = 0%. MA of 5 observational studies, n= 1 520, OR: 1.10, (95%CI : 0.79-1.55), p=0.570, I ² = 0%.	MA of 4 RCTs, n=535: NS diff: OR: 0.87 (95%CI : 0.41-1.87, p=0.72, I ² = 0%). MA of 10 observational studies, n= 20 132: sig. ↓ in mortality: OR: 0.78 (95% CI : 0.71-0.86), p < 0.001, I ² = 0%.
Heymans (2022) ¹⁷⁰	Patients undergoing hip and/or knee arthroplasty	ERAS pathways	38 studies, n=2 221 832, no MA performed: All found ↓ with	MA of 24 studies, n=416 013, RR: 0.85 (95%CI :	NA



			ERAS. 20 reported sig. ↓. Median reduction 6.5 days.	0.67-1.07), p=0.17, I ² =48%.	
Huntley (2016) ¹⁷¹	Adults with HF diagnosis	Case management (CM) based on nurse coordinated multi component care	MA of 9 studies (8 RCTs), n=1 765: sig ↓ with intervention: MD -1.28 days (95%CI : -2.04 to -0.52), p=0.001, I ² =63%. Removal of 1 study for SA: MD -1.76 (95%CI : -2.29 to -1.23), p<0.00001, I ² =14%.	Stauffer 2011 , observational, n=140: sig. ↓: mean: -12; (95%CI : -20.5 to -4.07). Russell 2011 , observational, n=447: sig. ↓ with intervention: adj OR: 0.57; (95%CI : 0.38-0.87), p<0.01.	NA
Kalogera (2019) ¹⁷²	Patients undergoing minimally invasive gynecologic procedures with bowel surgery:	ERAS pathways	No MA performed. 10/12 studies, sample size from 22 to 573: sig ↓ in LoS or sig. ↑ in % of patients discharged within 24 hrs of surgery. 2: NS diff.	5 studies (no MA), sample sizes from 127 to 573: NS diff: 3.6%, (post) vs 5.6% (pre)	NA
Kennelly (2025) ¹⁷³	Adults undergoing oesophagectomy for oesophageal cancer	ERAS	MA of 6 RCTs, n = 850 : sig. ↓ with intervention : MD -2.31 (95% CI : -3.49 to -1.13, p < 0.0001, I ² = 98%)	MA of 2 RCTs, n = 328: NS diff: OR 1.29 (95% CI: 0.30-5.47, p = 0.73, I ² = 0%)	MA of 3 RCTs, n = 492: NS diff: OR 1.37 (95% CI : 0.26-7.4, p = 0.71, I ² = 0%)
Kuemmerli (2024) ¹⁷⁴	Aged ≥70 years undergoing pancreatoduodenectomy (PD) for any indication	ERAS	MA of 14 studies (2 RCTs), n = 1109: NS↓ SMD -0.14 (95% CI: -0.29 to 0.01), p = 0.071, I ² = 13.6%	MA of 7 studies (2 RCTs), n=571 : OR 1.68 (95% CI : 0.79-3.55), p = 0.142, I ² = 8.7%	MA of 14 studies (2 RCTs), n = 1109: OR 0.89 (95% CI: 0.54–1.45), p = 0.592, I ² = 0%
Kuemmerli (2022) ¹⁷⁵	Patients undergoing PD (classical (cPD) or pylorus-preserving (ppPD) PD)	ERAS protocols	MA of 16 studies (2 RCTs), n=2 996: RD -2.33 (95%CI : -2.98 to -1.69), p = 0.001, I ² = 30.8%.	MA of 14 studies (most observational), n=NA. MD 0.02 (95%CI : 0.01-0.05), p=0.144, I ² = 0%.	MA of 16 studies (most observational), n=NA: MD 0 (95%CI : 0.02-0.01), p=0.836, I ² = 0%.
Lee (2020) ¹⁷⁶	Patients undergoing elective gastric cancer surgery	ERAS	MA of 17 studies, n= 1 782: sig. ↓. MD -1.78 days (95%CI : -2.17 to -1.40), p< 0.0001, I ² = 91%.	MA of 8 studies, n=938: RR 2.43 (95%CI : 1.09-5.43), p< 0.03, I ² =0%. ↑ largely caused by 1 study looking at patients aged 75–89.	NA
Mabire (2018) ¹⁵²	(≥65 years) discharged home from acute or postacute community rehab centres	Nursing discharge planning interventions incl. multidisciplinary care models	MA of 6 studies (4 RCTs), n=1 731: sig. ↑ in LoS with intervention: WMD 0.29 (95%	NS diff: Dedhia 2019 (observational), n=185: OR 0.63 (95%CI : 0.37 to 1.06); Kwok 2005 (RCT),	NA

			CI : 0.24-0.35), $p = 0.01$, $I^2 = 0.0\%$.	$n=157$: OR 1.54 (95%CI : 0.80-2.96).	
Malczak (2017) ¹⁷⁸	Bariatric surgery patients	ERAS protocols	MA of 10 studies (2 RCTs), $n=3657$: SMD -2.4 (95 %CI : -3.9 to -0.9), $p = 0.002$, $I^2 = 99\%$.	MA of 9 studies (1 RCT), $n=5007$: RR 0.9 (95%CI : 0.6-1.30), $p = 0.5$; $I^2 = 46\%$.	MA of 8 studies, $n=316$: RR 0.4, (95%CI : 0.1-2.2), $p=0.3$, $I^2 = 0\%$.
Malik (2018) ¹⁸⁰	Patients aged ≥ 65	Geriatric nurse assessment and interventions in the ED	Basic 2005 , RCT, $n=224$: NS diff. HR 1.1 (95%CI : 0.5-3.3); Gagnon 1999 , RCT, $n=427$: NS diff. MD 1.10 (95%CI : -2.19 to 4.39, $p = 0.51$.	MA of 2 RCTs: NS diff. OR 0.99 (95%CI : 0.62-1.61), $p = 0.98$, $I^2 = 0\%$. Two observational studies also looked at 30-day readmissions: Hegney 2006 , $n=2139$: sig. $\downarrow$ post intervention of 5.5%, from 10.2% to 4.7%, $p < 0.05$. Caplan 2004 , RCT, $n=739$: sig. $\downarrow$ with intervention 16.5% vs 22.2%, $p=0.048$.	NA
Mao (2022) ¹⁷⁹	Adult surgical patients discharged home with no long term conditions	Nurse-led discharge services	MA of 5 RCTs, $n=647$: NS diff. WMD -0.49 (95%CI : -1.01 to 0.02), $p = 0.06$, $I^2 = 49\%$.	MA of 4 studies, $n=591$: sig. $\downarrow$ with intervention. RR 0.42 (95%CI : 0.28-0.63), $p < 0.0001$, $I^2 = 0\%$.	NA
McKechnie (2024) ¹⁷⁷	Adults undergoing emergency intra-abdominal surgery, including upper GI, lower GI, trauma, and general surgery.	ERAS	MA 7 RCTs (upper and lower GI), $n=554$: MD -3.20 (95%CI : -3.82 to -2.59, $p < 0.00001$, $I^2 = 73\%$). MA of 4 RCTs (upper GI only), $n=384$: MD -3.35 (95% CI : -4.17 to -2.52, $p < 0.00001$, $I^2 = 61\%$). MA of 2 RCTs (lower GI only), $n=170$: MD -2.80 (95% CI : -2.99 to -2.62, $p < 0.00001$, $I^2 = 0$).	MA of 7 RCTs (upper, lower and general GI), $n=710$: NS diff. : RR 1.60 (95% CI : 0.57-4.50, $p = 0.50$, $I^2 = 0\%$)	MA of 4 RCTs (upper GI), $n=267$: NS diff. : RR 0.73 (95% CI : 0.09-5.66, $p = 0.76$, $I^2 = 0\%$)
Morrel (2021) ¹⁸¹	Patients undergoing 1ary elective total hip arthroplasty (THA) or total knee arthroplasty (TKA)	ERAS	No MA performed. 9 studies, $n=7789$: (adjust. outcomes) 8 sig $\downarrow$. 1 NS diff. $I^2 = 99\%$.	5 studies, $n=6985$: No MA performed. NS diff. (adjust. outcomes)	NA



Nair (2023) ¹⁸²	Patients undergoing laparoscopic cholecystectomy with and without common bile duct exploration	ERAS	MA of 6 studies, n=1 489: MD - 31.37 (95%CI : -54.69 to -8.05), p = 0.008, I ² =99%.	MA of 5 studies, n=1 044: RR: 0.54 (95%CI : 0.23-1.27), p=0.16), I ² = 0%.	NA
Naseralallah (2024) ¹⁸³	Patients undergoing surgery in perioperative settings across various specialties (orthopedic, general, bariatric, transplant, etc.)	Pharmacist-led interventions (e.g., medication reconciliation, discharge counseling, education).	MA of 11 (3 RCTs), n = 4905: sig. ↓: SMD -0.09 (95% CI : - 0.49 to -0.15, p = 0.0002, I ² = 86%)	MA of 8 studies (2 RCTs), n = 3271: sig. ↓: OR 0.60 (95% CI : 0.39-0.91, p < 0.05, I ² = 46%)	NA
Noba (2023) ¹⁸⁴	Patients undergoing pancreaticoduodenectomy	ERAS	MA of 31 studies, n=5 382: MD - 3.15 (95%CI : - 3.94 to - 2.36), p< 0.00001, I ² = 94%.	MA of 28 studies, n=5 101: RR 1.07 (95%CI : 0.91-1.25) p= 0.40, I ² = 0%.	MA of 30 studies, n=5 341: RR 0.76 (95%CI : 0.58-1.00) p = 0.05, I ² = 0%.
Noba (2020) ¹⁸⁵	Adults undergoing liver surgery	ERAS protocols	MA of 27 studies, n=3 739: MD -2.22 (95%CI : -2.77 to -1.68) p< 0.00001, I ² =98.	MA of 21 studies, n=2 878: RR 0.94 (95%CI : 0.70-1.26), p= 0.68, I ² = 0%.	MA of 25 studies, n=3 343: RR 0.67 (95%CI : 0.30-1.49) p= 0.33, I ² = 0%.
Pang (2024) ¹⁸⁶	Lower risk patients who present at the ED with decompensated HF (DHF)	Short stay units	Carpenter 2015 , observational, n=359: 0.69 with ERAS vs 1,79 without, p=NA; Pang 2024 , RCT, n=193: mean LoS 3.7 with vs 4.9 without intervention, p=0.13. Storrow 2005 , observational, n= 64: median LoS 1.1 with vs 2.4 without intervention, p=NA.	MA of 3 studies, 1 RCT, n=367: NS diff. RR: 1.12 (95%CI : 0.71-1.75), p=0.63; I ² : 0%.	MA of 2 studies (1 RCT), n = 258: RR 0.21 (95%CI : 0.01-4.37), p= 0.32, I ² =NA.
Pannick (2015) ¹⁸⁷	Adult patients on general medical wards	Interdisciplinary team practice interventions	Interdisciplinary team composition interventions: MA of 6 studies (4 RCTs), n=8 403: NS diff: WMD 0.087 (95%CI : -0.083 to 0.257), p>0.05. Interdisciplinary team practice interventions: MA of 7 studies (2 RCTs), n=32 272: WMD 0.001 (95%CI : -0.035 to 0.037), p>0.05.	Interdisciplinary team composition interventions: MA of 3 studies (2 RCTs), n=7 921: sig ↑ but important confounding factors. WRR: 1.341 (95%CI : 1.120-1.607) p<0.05. Interdisciplinary team practice interventions: MA of 5 observational studies, n=44 424: NS diff. WRR:	Interdisciplinary team composition interventions: Fine 2003 , RCT, n=608: NS diff. No stat data provided.



				0.995 (95%CI : 0.912-1.085), $p>0.05$.	
Patel (2020) ¹⁸⁸	Elderly patients with a hip fracture	Multidisciplinary team approaches (orthogeriatric models or geriatric-led models)	No stats provided: 12 prospective and retrospective observational studies (not meta analysed): sig. ↓ with intervention, $p<0.05$. (see Table on relevant primary studies included in SR, in appendix, for details on these studies). Kirstensen 2016 , n=11 461: NS diff. Greenberg 2016 n=614: sig. ↑ in LoS. .	Soong 2016 , n= 571: NS diff. $p=0.56$. No time frame provided. Greenberg 2016 , n=614: sig. ↑ when patients admitted to a geriatric care-led unit (29.8%), vs and orthopaedic unit (23.1%), $p=0.0001$. No time frame provided.	Collinge 2013 , n=657: NS diff. No stats provided. Flikweert 2014 , n=401: NS diff. No stats provided Kristensen 2016 , n=11461: NS diff. No stats provided. Forni 2016 , n=614: sig. ↑ in orthopaedic care vs orthogeriatrics co-management, $p=0.004$.
Peerbocus (2021) ¹⁸⁹	Patients undergoing radical cystectomy (RC) for bladder cancer.	ERAS	MA of 13 studies (1 RCT), n = 1471, sig. ↓ with ERAS: SMD - 0.49 (95% CI : -0.77 to -0.20, $p < 0.00001$, $I^2 = 85\%$)	MA of 8 studies (1 RCT), n = 1077, NS diff. : RR 0.97 (95% CI : 0.73-1.28, $p = 0.52$, $I^2 = 0\%$) No significant difference	NA
Qin (2024) ¹⁹⁰	Patients undergoing cholecystectomy	ERAS protocols	MA of 5 studies, n=911, WMD - 1.23 (95%CI : -1.98 to -0.47) $p=0.001$, $I^2=98\%$.	MA of 5 studies, n=1 125: OR: 0.48 (95%CI : 0.21-1.10) $p=0.08$, $I^2=0\%$.	NA
Sarkies (2018) ¹⁹¹	Patients admitted to acute general medical, surgical wards, or subacute rehab wards.	Health professional services delivered by allied during weekends	Acute (medical and surgical) setting: MA of 2 RCTs, n= 27 508: NS diff: WMD 0.08 days (95%CI : -0.15 to 0.32), $I^2 = 99\%$. Results consistent with MA of 3 observational studies n=1 177: WMD 0.08 days (95%CI -0.12 to 0.29), $I^2 = 24\%$. Subacute setting: MA of 3 RCTs, n= 1 437: sig. ↓. WMD 2.35 days (95%CI : 0.45-4.24) $I^2 = 0.0\%$.	Acute (medical or surgical) setting: MA of 2 RCTs, n= 27 508: NS diff. at 28 days: RD 0.01 (95%CI : 0.00-0.02), $I^2 = 43\%$. Consistent with 1 observational study. Subacute setting: Brusco 2014 , RCT, n=996, NS diff. RR 1.01, (95%CI : 0.95-1.07).	NA
Saunders (2019) ¹⁹²	Adults that may need palliative care	Screening tool for inpatient palliative care consultation,	Screening tools to initiate consultations:	Palliative consultations: Adelson 2017 , n=113: sig. ↓ from 35% to 18%, $p=$	NA



		hospital discharge planning or transitional care	Adelson 2017 , n=113: NS diff. 11 days with vs 14 days without intervention, p= 0.15; Wong 2016 , n=84: NS diff. 6 with vs 5 days without intervention, p=0.93; Zalenski 2017 , n=405: sig ↓ with intervention: Adj. OR: -1.7 (95%CI : -3.1 to -1.2). Interventions spanning the hospital and the community: Gade 2008 , n=517: NS diff: 7 vs 7, p=0.57.	0.04; Zalenski 2017 , n=405: NS diff: Adj. OR 0.7 (95% CI : 0.5-1.0); Wong 2016 , n=84: NS ↓. No stats provided. Interventions spanning hospital and community: Montero 2016 , n=4 551: sig. ↓ with intervention. 27.4% to 22.9%, RR:18%, p < 0.005.	
Strøm (2018) ¹⁹³	Patients with internal medicine diseases and conditions	Short stay in-patient units	No stats provided: 12 RCTs, n=2 224 (not meta analysed): sig. ↓ with intervention, p<0.05.	Strøm 2017 , n=402: sig. ↓. RR 0.45 (95%CI : 0.29-0.68), p<0.05); Than 2014 , n=542: NS diff. RR: 1.11 (95%CI : 0.62-1,98), p>0.05.	Gomez 1996 , n= 100, NS diff: 0 deaths at 30 days in both arms. Than 2014 , n=542, NS diff: 0 deaths at 30 days in both arms.
Stumpo (2021) ¹⁹⁴	Adult undergoing elective craniotomy	ERAS	19 studies. No stats provided: sig. ↓ with intervention.	Liu 2019 , n=120: NS diff. 0% in both arms.	NA
Tan (2021) ¹⁹⁵	Patients requiring flaps (reconstruction breast or neck surgery)	ERAS	MA of 8 studies for breast reconstruction, n=1 947: Mean ↓ -1.08 days (95%CI : - 1.57 to - 0.60), p<0.0001, I ² =96%). MA of 4 studies in head and neck: Mean ↓ -3.73 days (95%CI : - 5.56 to - 1.89), p<0.0001, I ² =54%.	NS diff.	NA
Tinguely (2021) ¹⁹⁶	Liver transplanted patients	ERAS	4 studies (1 RCT), n=498. No MA performed: Median (IQR) 12 (7.6; 16.3) with intervention vs 17 (11.3; 23) with standard care. Reduction: -29%.	3 studies (1 RCT), n=251: OR 1.71 (95%CI : 0.3-9.77) p=0.54, I ² = 0%	4 studies (1 RCT), n=498: OR: 0.64 (95%CI : 0.15-2.76) p= 0.55), I ² =0%.

Villatte (2019) ¹⁹⁷	Elderly subjects undergoing total hip arthroplasty	ERAS	23 studies (3 reviews, 1 RCT and 19 observational), n=NA: ↓ with intervention by 1-2 days vs standard. No stats provided.	4 (observational) studies, n=NA: NS diff. No stats provided.	2 (retrospective) studies, n=NA: ↓ with ERAS. Stats not provided.
Zepeda-Lugo (2020) ¹⁹⁸	Hospitalised patients in different departments where lean health care is implemented	LHC, combination of LHC and Six Sigma, rapid improvement event (RIE) and Baystate patient progress initiative (BPPI)	23 studies (no MA). with samples from 46 to 75 490: 16 studies showed sig. ↓ with intervention. 7 studies: NS diff.	4 studies (Toledo 2013 , n=103, Molla 2018 , n=1 471, Sayed 2018 , n=505, Moo-young 2019 , n=355): NS diff. Sorensen 2019 , n=4 253: sig. ↓ from 3.1% to 1.1%, p=0.032; Johnson 2016 , n=1 394: sig. ↓ from 28.4% to 18.9%, p<0.01.	Yousri 2011 , n=608: sig. ↓ from 11.7 to 6.7, p=0.034 with intervention; Toledo 2013 , n=103: NS diff. No stats provided.
Zhang (2024) ¹⁹⁹	Patients undergoing hip and knee arthroplasty	ERAS protocols	MA of 30 studies, n=11 460: WMD -2.65 (95%CI : -3.03 to -2.26), p< 0.001, I ² =99%.	9 studies, n=23 767, OR 1.13 (95%CI : 0.89-1.44) p=0.32, I ² =50.4%.	MA of 6 studies, n=19 711: OR: 0.46 (95%CI : 0.25-0.85) p=0.01, I ² =30.3%.
Zhou (2024) ²⁰⁰	Patients who underwent total hip arthroplasty (THA) and total knee arthroplasty (TKA)	ERAS pathways	MA of 9 studies, n=800: MD -3.14 (95%CI : -4.23 to -2.06), p<0.00001, I ² =96%.	MA of 4 studies, n=648: OR 0.78 (95%CI : 0.39-1.56, p=0.49, I ² =32%.	MA of 3 studies, n=560: OR 0.32 (95%CI : 0.05-2.08) p=0.23, I ² =0%.
Zhu (2017) ²⁰¹	Patients who received total hip arthroplasty (THA) or total knee arthroplasty (TKA).	ERAS	MA of 7 studies, n=8 346: MD -1.44 (95%CI : -2.29 to -0.60) p=0.0008, I ² =99%.	MA of 5 studies, n=6 430: OR 0.84 (95%CI : 0.65-1.08) p=0.18, I ² =34%.	NA
Zhu (2015) ²⁰²	Inpatients with chronic illness or on rehab	Nurse-led early discharge planning	MA of 5 RCTs, n=1 912: NS diff: SMD: 0.03 (95% CI : -0.06 to 0.12), I ² =0%, p= 0.540.	MA of 2 RCTs, n=1 293: NS diff: RR= 0.73 (95%CI : 0.46-1.15), p= 0.170, I ² = 75%.	Altfield 2013 , n=720: NS diff: RR 0.69 (95%CI : 0.35-1.36); Jack 2009 , n=749: NS diff: RR: 0.50 (95%CI : 0.05-5.55).

CSS: , CGA: , ERAS: Enhanced Recovery After Surgery; ITS: Interrupted time series, MA: Meta Analysis, MD: Mean difference, OR: Odd ratio, RCT: Randomised Clinical Trial; RD: Risk Difference, RR: Risk Reduction, SD: standard deviation, SMD: Standard Mean Difference, WMD: weighted mean difference, WRR: Weighted Risk Ratio.



4.5 Conclusion and discussion

None of the SRs included in this umbrella review found an increase of LoS with any of the interventions studied. Instead, several interventions were shown to reduce this specific outcome. These were the following:

- Enhanced recovery after surgery, including different items during pre, peri and post-surgery, versus an absence of such programmes. Supported by 24 recent SRs.
- Nurse-led discharge planning for the general hospitalised population versus an absence of it, supported by three SRs, relying mainly on RCTs.
- Orthogeriatric or geriatric units for elderly patients with hip fractures, as opposed to traditional orthopedic units, based on one SR including 13 prospective and retrospective cohort studies.
- Comprehensive care management programs for patients with chronic obstructive pulmonary disease (COPD), though evidence is limited to one non randomised study trial (n=1 564).
- Case management involving nurse-coordinated, multicomponent care for heart failure patients, was supported by one SR that performed a MA of nine primary studies, eight of which were RCTs (n=1 765).
- Pharmacy-led interventions were supported by one SR with a MA of 11 studies (n = 4 905), of which 3 were RCTs.
- Weekend allied health services in subacute care settings, supported by one SR which performed a MA of 3 RCTs (n= 1 437).
- Acute geriatric units for elderly patients, supported by one SR that carried out a MA of 11 studies (7 RCTs, n=6 098).

According to the SRs included in our umbrella review none of the above mentioned interventions increased early hospital readmissions, defined as readmissions at 30-days. In some cases, the primary studies included in the SRs evaluated for our purposes showed a significant reduction in this specific outcome.

Our review also identified certain interventions which do not appear to facilitate reductions in LoS. These included:

- Nursing discharge planning in the following specific populations:
 - (≥65 years) discharged home from acute or post-acute community rehabilitation centres (1 SR with a MA of 6 relevant studies of which 4 RCTs, n=1 731)
 - Adult surgical patients discharged home with no long term conditions (1 SR with a MA of 5 relevant RCTs, n=647).
 - Inpatients with chronic illness or on rehabilitation 1 SR with a MA of 5 relevant RCTs (n=1 912).
- Interdisciplinary team practice interventions in adults hospitalized in general medical wards (MA of 13 relevant studies of which 6 RCTs, n=66 548)
- Geriatric nurse assessment and interventions in the ED (1 SR, including 2 relevant RCTs, with sample sizes 224 and 427).
- Community in-reach Rehab. and Care Transition (CIRACT) service (1 SR including 1 relevant RCT n=250).

- Community nurse working across the hospital/community interface with elderly (≥ 65), admitted to an acute care hospital (1 SR including 2 relevant pre and post studies with sample sizes 1 464 and 2 139).
- Screening tool for inpatient palliative care consultation, hospital discharge planning or transitional care in adults that may require palliative care (1 SR including 5 relevant studies of which 2 consisted of RCTs).

Finally, unclear or conflicting results were found for a number of interventions:

- Clinical support systems, specifically for anticoagulant use via EMRs (1 SR including 3 relevant observational studies with samples sized from 80 to 5 879).
- Care coordination/case management in hospitalised adults (1 RCT and 3 observational; sample sizes from 51 to 252).
- Therapeutic guidelines, new organisation and procedures, patient education in elderly admitted to hospital for HF (1 SR with 2 relevant RCTs; sample sizes: 429 and 3 335).
- Initiated in hospital and multifaceted (eg. nutrition, physical activity, education...) for the management of hospitalised diabetic patients (1 SR including 4 relevant studies of which 1 is an RCT, with sample sizes ranging from a low of 31 to a high of 28 022)
- Early discharge planning (intervention facilitating transition between hospital and community care) in elderly patients (1 SR with a MA on 7 relevant studies of which 5 RCTs; $n=789$).
- Promoting safe and timely transfer between levels/settings in adults over 60 years suffering from chronic illnesses (1 SR including 4 relevant RCTs with sample sizes between 40 and 598).
- Inpatient comprehensive geriatric assessment (CGA) delivered in geriatric wards or by mobile teams (1 SR performed a MA including 17 RCTs ($n=5\,303$), but their results showed high heterogeneity and thus, no clear conclusions could be drawn on this intervention.
- In-hospital short stay units, were studied in two SRs. One included 14 RCTs overall, on 2 872 patients with internal medicine diseases or conditions, and the other included 4 studies (1 RCT) with sample sizes ranging from 64 to 359 patients with decompensated heart failure. The former found significant reductions in LoS, but the evidence was evaluated by the authors of the review to be highly uncertain and of very low quality. The second SR identified no significant differences.
- One SR on short stay programmes including different components, considered 49 studies (3 RCTs). LoS was not counted as an outcome and thus, no statistical analysis was provided on it. No significant differences were seen in readmissions. The evidence was considered by the authors as highly uncertain.

Our analysis has several important **limitations** that should be acknowledged.

First, we opted for an umbrella review rather than a detailed SR due to the broad scope of the topic and the substantial volume of evidence to be analysed. This decision was influenced by a preliminary search that indicated a large number of relatively recent SRs. Consequently, our approach limited the information we had access to, relying on what was extracted by the authors of the selected SRs. In some cases, these did not offer enough detail to fully assess the generalisability of the results (e.g., it was not always possible to determine if readmissions were measured at 30 days or over a longer time frame). Furthermore, that same lack of detail, impeded an analysis on the specific influence that different intervention components may have had on our outcomes of interest.

The populations studied were heterogeneous, ranging from very broad to highly specific patient groups. For example, the SR by Coffey et al.¹⁶⁰ examined nursing-led discharge as an intervention, with one of the two relevant RCTs measuring outcomes on women undergoing surgery for a benign gynaecological problem, and the other focusing on any patients “who might benefit from a person centred intervention and patients who were at high risk for readmission”. In this example, the primary



studies presented conflicting results on 30-day readmissions, with one showing significant reductions with the intervention and the other presenting no significant differences. Such differences may have influenced the inconclusive or conflicting results reached in an important number of SRs.

Many systematic reviews (SRs) focused on elderly populations. These studies primarily aimed to avoid readmissions, a common issue in this group, rather than reducing the LoS. Although some primary studies did measure LoS along with other outcomes and were therefore, included in our umbrella review, their results should be approached with caution.

There was also large variation within interventions, often combining multiple components. The classification used to summarise the findings remains a pragmatic way to present the results, but overlap between some of the categories is highly likely (e.g., clinical pathways and multidisciplinary care). Additionally, the descriptions of the different interventions included in the SRs were sometimes lacking in detail.

One of the most significant limitations is related to the description of the comparator. This was most often simply presented as “usual care,” “standard care,” or an absence of the intervention. Such poor descriptions make it challenging to assess the validity of the evidence in the Belgian context.

An important number of the primary studies included in the identified SRs were performed in North America, Australia and to a lesser extent Asia. The generalisability of these remains unknown, as differences in standard practice between these non-European countries and Belgium are likely.

Although our umbrella review included only systematic reviews (SRs) published in 2012 or later, some of the primary studies within these SRs were over two decades old (see Table on primary studies in the appendix for details). Consequently, standard practices and mean lengths of stay may have evolved, introducing uncertainty in the transferability of the results. Some SRs included only RCTs or these accounted for a significant number of the primary studies considered, while others relied more on observational studies. Additionally, while most SRs captured outcomes related to healthcare usage, including LoS, this was often not their primary focus, resulting in a small number of relevant primary studies in some cases. Frequently, the primary studies covering LoS were not the same as those that included the second outcome our umbrella review focused on (i.e. 30-day hospital readmissions), necessitating comparisons of different outcomes across multiple primary studies despite the clear limitations of such an approach.

In conclusion, our umbrella review shows that although some interventions could significantly reduce LoS without increasing, or even reducing, early hospital readmissions, for many others the available evidence presents unclear or non-significant differences when compared to standard care. This highlights the complexity of healthcare interventions and the need for standardization and tailored approaches. Therefore, a cautious interpretation of the results presented here is warranted.

5 DISCUSSION

This report presents the first part of a two-phase study assessing the association of hospital care transitions in Belgium (the shift from inpatient to day surgery and the reduction in hospital length of stay - LoS) with 30-day unplanned readmissions and post-discharge mortality rates. These transitions are actively encouraged through national financing mechanisms and reflect broader international efforts to improve healthcare efficiency and reduce costs. It is important to assess potential trade-offs on quality.

5.1 General trends in day surgery and outcomes

Our analyses, based on nationwide administrative data covering over 11.5 million surgical stays, confirm a steady increase in day surgery rates from 57.6% in 2008 to 65.6% in 2022 (+8.0 pp). Risk-adjusted analyses show an even stronger increase (+8.6 pp), particularly due to higher rates than expected among the youngest and older patients.

Post-discharge mortality was low (<0.05%) and showed no adverse trends, which aligns with expectations given the elective nature of the procedures studied. Consequently, no further risk-adjusted mortality analyses were conducted. Nevertheless, from a quality of care perspective these mortality cases remain important. The same holds for the observed in-hospital mortality cases. Yet, this was not the scope of the current study as we were interested in analysing the association between shifts towards outpatient care with trends in post-discharge events.

Readmission rates remained stable or slightly declined over time (2.0% in 2008 to 1.8% in 2022), with risk-adjusted rates showing a more pronounced decline (2.0% to 1.7%). Day surgery consistently showed lower readmission rates (~1.2%) compared to inpatient stays (~3.0%).

Approximately 20% of readmissions after day surgery and 17% after inpatient stays (medical and surgical) occurred in a different hospital than the index admission, a finding not captured in previous Belgian studies.^{27, 28, 232} This broader view enhances the validity of our conclusions and highlights the added value of nationwide data linkage.

The observed increase in day surgery rates over the study period was not associated with a deterioration in unplanned readmission outcomes. On the contrary, the expansion of day surgery coincided with modest improvements in readmission rates, particularly among older adults (>45 years), where both a marked rise in day surgery utilisation and a decline in readmission rates were observed. While both day surgery rates and readmission trends varied across Major Diagnostic Categories (MDCs), the majority demonstrated either stable or improved outcomes.

5.2 General trends in length of stay reduction and outcomes

Similar observations can be made for length of stay (LOS) reduction. Our analyses, based on over 18 million inpatient admissions in Belgian general hospitals, reveal a consistent decline in LOS from 6.1 days in 2008 to 5.1 days in 2022 (-1.0 day). After risk adjustment, the reduction was even more pronounced (-1.5 days), with the most substantial improvements observed among older patients and those with multiple comorbidities. For example, patients aged 85 and above experienced a 3.6-day reduction in risk-adjusted LOS, while those with three or more comorbidities saw a 3.3-day decline.

Importantly, this reduction in LOS among inpatient admissions was not associated with adverse post-discharge outcomes. Risk-adjusted 30-day readmission rates decreased from 5.6% in 2008 to 4.9% in 2022, with the steepest declines observed in high-risk groups. Risk-adjusted 30-day mortality rates remained stable at 0.9% between 2016 and 2022, despite slight increases in crude rates. Among older patients and those with multiple comorbidities, mortality rates either declined or remained unchanged.



after adjustment. Composite outcomes (readmission or mortality) followed similar patterns, with notable improvements in the higher risk groups.

Our findings suggest that the efficiency gains achieved through LOS reduction were not associated with the measured outcomes. As with day surgery, the observed trends likely reflect broader systemic improvements, including enhanced care coordination, technological advancements, and strengthened quality cultures within hospitals. However, given the descriptive nature of the analyses and the limitations of administrative data (see below), caution is warranted in interpreting these associations.

5.3 Interpretation and policy implications

The observed trends suggest that Belgian hospitals and clinicians, in general, steadily move in the desired policy direction of increased hospital efficiency. The increase in day surgery and reduction in LoS were not associated with increased readmissions or mortality, even among higher-risk groups. These findings support the notion that care transitions can be safely implemented when supported by adequate infrastructure, care optimization, quality improvement initiatives and clinical judgment (e.g. patient selection). Yet, there are important cautionary notes linked to our study limitations (see below) as the analysis of the administrative data limits the scope of the included risk-factors for which we could adjust as well as the outcomes measures. Therefore it gives only a partial image.

Yet, several important caveats must be considered. The use of administrative data inherently limits the scope of risk adjustment and outcome measurement. While adjustments were made for instance for age, comorbidity burden, and procedure and pathology type, other relevant factors—such as socioeconomic status and the availability of informal care—could not be accounted for. Moreover, key outcome dimensions such as outpatient emergency visits, patient experience, and quality of life were not captured. As such, the analysis provides only a partial view of care quality.

Importantly, this study does not demonstrate the absence of problems related to unplanned readmissions or post-discharge mortality. It merely shows that, over time, the evolution of these outcomes has not followed an unfavorable trajectory. Unplanned readmissions, for instance, remain clinically significant: in 2022, risk-adjusted readmission rates among inpatient stays for those aged 85 and above were still 9%. Moreover, the readmission rates were in general higher for medical compared to surgical stays (in 2022: risk-adjusted readmission rates were 5.8% versus 3.6%; LoS was 5 days versus 4 days and risk-adjusted mortality was 1.3% versus 0.3% for medical and surgical stays, respectively). Furthermore, existing literature highlights substantial variation in readmission rates between hospitals (Van Wilder et al., 2022)^{28, 232}, underscoring the need for continued monitoring - particularly in high-risk populations and pathologies - to further reduce avoidable readmissions and improve post-discharge outcomes.

It is also important to avoid overly simplistic conclusions regarding the implications of care substitution for the organisation of conventional inpatient wards. The shift towards day surgery and shorter hospital stays does not imply that the infrastructure and staffing of traditional hospital units can be linearly scaled down. Evidence from KCE Report 325 indicates that reductions in length of stay are accompanied by an increase in the average care intensity of the remaining inpatient days. This trend necessitates appropriate adjustments in nursing staffing and skill mix to ensure safe and high-quality care delivery (Van den Heede et al., 2019).²³³ As such, policy responses must account for the evolving complexity and acuity of inpatient care, rather than assuming that efficiency gains automatically translate into reduced resource needs.

5.4 Literature context and comparative evidence

Our findings are consistent with a broad literature review covering 45 primary studies and 11 systematic reviews. Although methodological heterogeneity complicates direct comparisons of outcome rates, the literature reports similar trends regarding length of stay (LoS), readmission rates, and mortality (see chapter X for more details). Nevertheless, the majority of studies present unadjusted findings. The consideration of case mix differences in the analysis of temporal trends represents a

methodological strength of our study. In addition, most studies found no association between shorter LoS or shift towards day care and worse outcomes for procedures such as PCI, hip/knee arthroplasty, appendectomy, and cholecystectomy. Heart failure emerged as an exception, with outpatient care associated with higher readmission rates. This underscores the need for condition-specific analyses, which will be addressed in the second part of this research.

An umbrella review of 49 systematic reviews further supports the effectiveness of interventions such as Enhanced Recovery After Surgery (ERAS), nurse-led discharge planning, and geriatric units in reducing LoS without increasing readmissions. However, evidence for many other interventions remains inconclusive due to heterogeneity, poor comparator descriptions, and reliance on observational studies.

5.5 Limitations and future directions

5.5.1 *Limitations of the Systematic and Umbrella Reviews*

Both the systematic and umbrella reviews included in this study have important limitations. The systematic review covered only a limited number of procedures and conditions, restricting generalizability. Many included studies were observational, with risks of selection bias and unadjusted confounding. Mortality outcomes were often underpowered due to low event rates. The umbrella review relied on existing SRs, which varied in scope, quality, and detail, especially regarding intervention components and comparators. Heterogeneity in definitions (e.g., LoS, inpatient/outpatient status) and inclusion of older primary studies further complicate interpretation. Additionally, a notable share of the evidence originated from non-European contexts, limiting applicability to Belgian healthcare settings.

5.5.2 *Unmeasured risk factors*

We controlled for risk factors available in administrative databases, including age, sex, DRG, Elixhauser comorbidities, and prior emergency department utilization. However, several relevant clinical predictors were not captured. A recent review by Zhang et al. (2025)²³⁴ identified additional predictors of unplanned readmissions following day surgery, such as ASA classification, infection risk, and surgical complexity, which require access to clinical data. The same holds for a more accurate risk-adjustment for oncological pathology requiring information on tumor staging, etc. Similarly, Selmer et al. (2025)²⁹ highlighted laboratory parameters (e.g., sodium, hemoglobin, albumin) as important risk factors for readmissions among medical patients. These variables were not available in our dataset.

As mentioned above, socioeconomic factors²³⁵ and the availability of informal care²³⁶ may also influence post-discharge outcomes. Although not included in the current study, socio-economic aspects will be explored in the second phase using enriched data sources. Besides the unmeasured factors the use of administrative data has the limitation of introducing noise due to differences in coding practices and coding optimization (e.g. upcoding for financial reasons). Despite these limitations, it has several advantages (e.g. data availability at population level, standardized data collection across years) from which this study benefits.

5.5.3 *Outpatient emergency department visits*

A major limitation of this study is the lack of data on outpatient emergency department (ED) visits. Although readmission and mortality rates remained stable, it is possible that a shift in care burden occurred toward ED visits, which we were unable to capture. ED visits within 30 days after elective surgery are increasingly used as quality indicators and may reflect preventable complications.²³⁷⁻²⁴⁰

Several studies have reported variable rates of ED utilization following surgery. Brown et al. (2020) found that 7.9% of patients undergoing common procedures presented to the ED within 30 days.²³⁸ Sivasundaram et al. (2020)²³⁹ reported a 4.4% ED visit rate after hand surgery, with most patients



discharged without intervention. Williams et al. (2021)²⁴¹ observed a 5.4% ED visit rate after elective orthopedic surgery, with only 0.4% requiring readmission. Risk factors included patient characteristics (e.g., smoking) and procedure type (e.g., tendon repair/graft with 11.0% ED visits). It is important to distinguish visits that are truly complication-related, which could be avoided through improved discharge planning, optimized multimodal pain control, clear communication about the expected postoperative course, patient education and those which are due to unrelated reasons.^{242, 243 240} Given the variability in ED visit prevalence across procedures and the potential for prevention, it will be important to include outpatient ED visits as an outcome measure in future analyses when data become available. This should be done across a range of surgical procedures and conditions to better understand patterns of utilization rates and to identify opportunities for quality improvement.

5.5.4 Cost shifts

Another limitation is the absence of cost data. As a result, we were unable to assess whether the observed care transitions led to cost transfers to other sectors, such as general practitioners, outpatient specialists, home nursing, or physiotherapy. This is a crucial aspect, as the economic impact of shifting care from inpatient to outpatient settings remains highly debated.²³³

A Nuffield Trust report (2019)²⁴⁴ emphasized that while some initiatives to shift care out of hospitals have improved patient outcomes, many fail to deliver net savings and may increase overall system costs due to implementation challenges, workforce shortages, and underestimated fixed hospital costs. The scheduled follow-up report will include cost analyses to better understand the broader economic implications of these transitions.

5.5.5 Patient experiences

This study focused on hard outcomes such as readmissions and mortality, which offer only a partial perspective on care quality. The absence of a readmission does not necessarily imply that the patient experienced no problems or that care was optimal. The shift toward day surgery and shortened hospital stays introduces new challenges for patients and informal caregivers.

Sig et al. (2025)²⁴⁵ found that patients often perceive day surgery as a “minor” procedure, underestimating the preparation and complexity of postoperative self-care. This mismatch contributes to recovery difficulties, with symptoms such as pain, fatigue, and emotional imbalance proving more burdensome than anticipated. Thoen et al. (2024)²² emphasized the importance of timely preoperative information and counselling to enhance self-care capacity. Despite postoperative problems, patients often hesitate to contact healthcare professionals, uncertain about the legitimacy of their concerns or reluctant to disturb busy staff. Support in the home environment is essential for safe recovery, and the presence of informal caregivers is often a prerequisite for performing day surgery, as also emphasized in KCE report 282 (Leroy, 2017).¹⁰

Similar challenges are observed among older patients following early discharge. Studies by Lilleheie et al. (2021)²⁴⁶, Smith et al. (2022)²⁴⁷, and Kinsey et al. (2024)²⁴⁸ identified poor communication, lack of coordination, and limited participation opportunities as key barriers. Strengthening patient education, involving families in discharge planning, and ensuring accessible follow-up care are essential steps toward safe, person-centred care pathways.

To complement the quantitative analysis in the current and follow-up report, the next phase will include a structured consultation of field experts, such as physicians, nurses, hospital managers, umbrella organizations, and patient associations, to capture contextual, organizational, and practical factors beyond the metrics quantified in this study.

6 REFERENCES

1. Seys D, Bruyneel L, Deneckere S, Kul S, Van der Veken L, van Zelm R, et al. Better organized care via care pathways: A multicenter study. *PLoS One*. 2017;12(7):e0180398.
2. Van de Voorde C, Van den Heede K, Mertens R, Annemans L, Busse R, Callens S, et al. Conceptual framework for the reform of the Belgian hospital payment system. *Health Services Research (HSR)*. Brussels: Belgian Health Care Knowledge Centre (KCE); 2014. KCE Reports (229)
3. Vandenbroucke F. Verschuiving naar het dagziekenhuis is belangrijke bouwsteen in brede ziekenhuishervorming. 2023 Available from: https://vandenbroucke.belgium.be/sites/default/files/articles/Nota_dagziekenhuis_als_belangrijke_deelhervorming.pdf
4. Van de Voorde C, Lefèvre M, Van den Heede K. Expenditure control measures in DRG-based hospital payment systems. *Health Services Research (HSR)*. Brussels: Belgian Health Care Knowledge Centre (KCE); 2024. KCE Reports (392C)
5. Vanhaecht K, Van der Auwera C, Claessens F, Leenaerts Z, Seys D, De Ridder D. Flanders Quality Model (FlaQuM): towards the development of a sustainable, integrated quality management system *International Journal of Integrated Care*. 2023;23.
6. Van Wilder A, Brouwers J, Cox B, Bruyneel L, De Ridder D, Claessens F, et al. A decade of commitment to hospital quality of care: overview of and perceptions on multicomponent quality improvement policies involving accreditation, public reporting, inspection and pay-for-performance. *BMC Health Serv Res*. 2021;21(1):990.
7. Van de Voorde C, Van den Heede K, Beguin C, Bouckaert N, Camberlin C, de Bekker P, et al. Required hospital capacity in 2025 and criteria for rationalisation of complex cancer surgery, radiotherapy and maternity services. *Health Services Research (HSR)*. Brussel: Belgian Health Care Knowledge Centre (KCE); 2017. KCE Reports (289)
8. Stanak M, Strohmaier C. Minimum volume standards in day surgery: a systematic review. *BMC Health Serv Res*. 2020;20(1):886.
9. Brick A, Walsh B, Kakoulidou T, Humes H. Variation in day surgery rates across Irish public hospitals. *Health Policy*. 2025;152:105215.
10. Leroy R, Camberlin C, Lefèvre M, Mistiaen P, Van den Heede K, Van De Sande S, et al. Proposals for a further expansion of day surgery in Belgium. *Health Services Research (HSR)*. Brussels: Belgian Health Care Knowledge Centre (KCE); 2017. KCE Reports (282)
11. Gray WK, Takhar AS, Navaratnam AV, Day J, Swart M, Snowden C, et al. Safety of day-case paediatric tonsillectomy in England: an analysis of administrative data for the Getting It Right First Time programme. *Anaesthesia*. 2022;77(3):277-85.
12. OECD. Ambulatory surgery. 2021.
13. Leroy R, Camberlin C, Lefevre M, Van den Heede K, Van de Voorde C, Beguin C. Variability in elective day-surgery rates between Belgian hospitals - Analyses of administrative data explained by surgical experts. *Int J Surg*. 2017;45:118-24.
14. Messerle R, Schreyogg J. Country-level effects of diagnosis-related groups: evidence from Germany's comprehensive reform of hospital payments. *Eur J Health Econ*. 2024;25(6):1013-30.
15. Gilliard N, Eggli Y, Halfon P. A methodology to estimate the potential to move inpatient to one day surgery. *BMC Health Serv Res*. 2006;6:78.
16. Brungger B, Bahler C, Schwenkglenks M, Ulyte A, Dressel H, von Wyl V, et al. Surgical procedures in inpatient versus outpatient settings and its potential impact on follow-up costs. *Health Policy*. 2021;125(10):1351-8.



17. Messerle R, Hoogestraat F, Wild EM. Which factors influence the decision of hospitals to provide procedures on an outpatient basis? -Mixed-methods evidence from Germany. *Health Policy*. 2024;150:105193.
18. Barrenho E, Miraldo M, Propper C, Walsh B. The importance of surgeons and their peers in adoption and diffusion of innovation: An observational study of laparoscopic colectomy adoption and diffusion in England. *Soc Sci Med*. 2021;272:113715.
19. Kreutzberg A, Eckhardt H, Milstein R, Busse R. International strategies, experiences, and payment models to incentivise day surgery. *Health Policy*. 2024;140:104968.
20. Gaughan J, Gutacker N, Grasic K, Kreif N, Siciliani L, Street A. Paying for efficiency: Incentivising same-day discharges in the English NHS. *J Health Econ*. 2019;68:102226.
21. Baumann A, Wyss K. The shift from inpatient care to outpatient care in Switzerland since 2017: Policy processes and the role of evidence. *Health Policy*. 2021;125(4):512-9.
22. Thoen CW, Saele M, Strandberg RB, Eide PH, Kinn LG. Patients' experiences of day surgery and recovery: A meta-ethnography. *Nurs Open*. 2024;11(1):e2055.
23. Van De Sande S, Swartenbroekx N, Van de Voorde C, Devos C, Devriese S. Evolution of day care: impact of financing and regulations. *Health Services Research (HSR)*. Brussels: Belgian Health Care Knowledge Centre (KCE); 2012. KCE Reports (192)
24. Garcea G, Majid I, Pattenden CJ, Sutton CD, Neal CP, Berry DP. Predictive factors for unanticipated admission following day case surgery. *J Eval Clin Pract*. 2008;14(1):175-7.
25. Rajan N, Rosero EB, Joshi GP. Patient Selection for Adult Ambulatory Surgery: A Narrative Review. *Anesth Analg*. 2021;133(6):1415-30.
26. Dhaliwal JS, Dang AK. Reducing Hospital Readmissions. In: *StatPearls*. Treasure Island (FL); 2025. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/39163436>
27. Braet A, Weltens C, Sermeus W, Vleugels A. Risk factors for unplanned hospital re-admissions: a secondary data analysis of hospital discharge summaries. *J Eval Clin Pract*. 2015;21(4):560-6.
28. Van Wilder A, Cox B, De Ridder D, Tambour W, Vanden Boer G, Brouwers J, Claessens F, Bruyneel L, Vanhaecht K. A comprehensive analysis of temporal trends of between-hospital variation in mortality, readmission and length of stay using logistic regression. *Health analytics*. 2022;2(100123).
29. Selmer N, Berthelsen C, Van Grootven B, Meyer G, Loft MI. Identifying risk prediction models and predictors for hospital readmission in patients with medical conditions: A systematic review and meta-analysis. *Int J Nurs Stud*. 2025;171:105188.
30. Sweeny L, Curry JM, Crawley MB, DiLeo M, Bonaventure CA, Luginbuhl AJ, et al. Age and Comorbidities Impact Medical Complications and Mortality Following Free Flap Reconstruction. *Laryngoscope*. 2022;132(4):772-80.
31. Chen S, Zhang S, Cai S, Wang H. Impact of frailty on outcomes following coronary artery bypass grafting: a systematic review and meta-analysis. *BMC Surg*. 2024;24(1):419.
32. Ornaghi PI, Afferi L, Antonelli A, Cerruto MA, Mordasini L, Mattei A, et al. Frailty impact on postoperative complications and early mortality rates in patients undergoing radical cystectomy for bladder cancer: a systematic review. *Arab J Urol*. 2020;19(1):9-23.
33. Breen K, Finnegan L, Vuckovic K, Fink A, Rosamond W, DeVon HA. Multimorbidity in Patients With Acute Coronary Syndrome Is Associated With Greater Mortality, Higher Readmission Rates, and Increased Length of Stay: A Systematic Review. *J Cardiovasc Nurs*. 2020;35(6):E99-E110.
34. AHRQ. Elixhauser Comorbidity Software for ICD-9-CM [Web page]. 2017 [cited 21/10/2025]. Available from: <https://hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp>

35. AHRQ. Elixhauser Comorbidity Software Refined for ICD-10-CM [Web page].2025 [cited 21/10/2025]. Available from: https://hcup-us.ahrq.gov/toolssoftware/comorbidityicd10/comorbidity_icd10.jsp
36. Moore BJ, White S, Washington R, Coenen N, Elixhauser A. Identifying Increased Risk of Readmission and In-hospital Mortality Using Hospital Administrative Data: The AHRQ Elixhauser Comorbidity Index. *Med Care*. 2017;55(7):698-705.
37. Baker DW, Einstadter D, Husak SS, Cebul RD. Trends in postdischarge mortality and readmissions: has length of stay declined too far? *Arch Intern Med*. 2004;164(5):538-44.
38. Baker DW, Einstadter D, Thomas CL, Husak SS, Gordon NH, Cebul RD. Mortality trends during a program that publicly reported hospital performance. *Med Care*. 2002;40(10):879-90.
39. Cram P, Lu X, Kates SL, Singh JA, Li Y, Wolf BR. Total knee arthroplasty volume, utilization, and outcomes among Medicare beneficiaries, 1991-2010. *Jama*. 2012;308(12):1227-36.
40. Iezzoni LI. Risk Adjustment for Measuring Health Care Outcomes. Health Administration Press; 2013.
41. Kaboli PJ, Go JT, Hockenberry J, Glasgow JM, Johnson SR, Rosenthal GE, et al. Associations between reduced hospital length of stay and 30-day readmission rate and mortality: 14-year experience in 129 Veterans Affairs hospitals. *Ann Intern Med*. 2012;157(12):837-45.
42. Cox B, Van Wilder A, De Ridder D, Tambeur W, Maertens P, Stijnen P, et al. Convergent Validity of 2 Widely Used Methodologies for Calculating the Hospital Standardized Mortality Ratio in Flanders, Belgium. *J Patient Saf*. 2023;19(7):415-21.
43. Naing NN. Easy way to learn standardization : direct and indirect methods. *Malays J Med Sci*. 2000;7(1):10-5.
44. O'Donnell OVD, Eddy; Wagstaff, Adam; Lindelow, Magnus. Analyzing health equity using household survey data: a guide to techniques and their implementation. Washington, DC: World Bank Group; 2008.
45. Pouw ME, Peelen LM, Lingsma HF, Pieter D, Steyerberg E, Kalkman CJ, et al. Hospital standardized mortality ratio: consequences of adjusting hospital mortality with indirect standardization. *PLoS One*. 2013;8(4):e59160.
46. Varewyck M, Goetghebeur E, Eriksson M, Vansteelandt S. On shrinkage and model extrapolation in the evaluation of clinical center performance. *Biostatistics*. 2014;15(4):651-64.
47. Firth D. Bias reduction of maximum likelihood estimates. *Biometrika*. 1993;80(1):27-38.
48. van der Laan J, Kolk D, Witvliet-Penning C, de Bruin A. HSMR 2021: Methodological report. The Hague: Statistics Netherlands; 2022. Available from: <https://www.cbs.nl/en-gb/our-services/methods/surveys/comprehensive-description/hsmr-2021-methodological-report>
49. Austin PC, Merlo J. Intermediate and advanced topics in multilevel logistic regression analysis. *Statistics in Medicine*. 2017;36(20):3257-77.
50. OECD. Length of hospital stay [Web page]. OECD;2025 [cited 21/10/2025]. Available from: <https://www.oecd.org/en/data/indicators/length-of-hospital-stay.html>
51. OECD. Health at a Glance 2023: OECD Indicators. Paris: OECD; 2023. Health at a Glance Available from: https://www.oecd.org/en/publications/health-at-a-glance-2023_7a7afb35-en.html
52. Bueno H, Ross JS, Wang Y, Chen J, Vidan MT, Normand SL, et al. Trends in length of stay and short-term outcomes among Medicare patients hospitalized for heart failure, 1993-2006. *JAMA*. 2010;303(21):2141-7.
53. Siddique SM, Tipton K, Leas B, Greysen SR, Mull NK, Lane-Fall M, et al. Interventions to Reduce Hospital Length of Stay in High-risk Populations: A Systematic Review. *JAMA Netw Open*. 2021;4(9):e2125846.



54. Rachoin JS, Aplin KS, Gandhi S, Kupersmith E, Cerceo E. Impact of Length of Stay on Readmission in Hospitalized Patients. *Cureus*. 2020;12(9):e10669.
55. Milstein R, Schreyogg J. The end of an era? Activity-based funding based on diagnosis-related groups: A review of payment reforms in the inpatient sector in 10 high-income countries. *Health Policy*. 2024;141:104990.
56. Cram P. Hospital Length of Stay ... A Measure of What, Exactly? *Med Care*. 2019;57(10):751-2.
57. Carey K, Lin MY. Hospital length of stay and readmission: an early investigation. *Med Care Res Rev*. 2014;71(1):99-111.
58. Regenbogen SE, Cain-Nielsen AH, Norton EC, Chen LM, Birkmeyer JD, Skinner JS. Costs and Consequences of Early Hospital Discharge After Major Inpatient Surgery in Older Adults. *JAMA Surg*. 2017;152(5):e170123.
59. Leppin AL, Gionfriddo MR, Kessler M, Brito JP, Mair FS, Gallacher K, et al. Preventing 30-day hospital readmissions: a systematic review and meta-analysis of randomized trials. *JAMA Intern Med*. 2014;174(7):1095-107.
60. Martin S, Street A, Han L, Hutton J. Have hospital readmissions increased in the face of reductions in length of stay? Evidence from England. *Health Policy*. 2016;120(1):89-99.
61. Vuagnat A, Yilmaz E, Roussot A, Rodwin V, Gadreau M, Bernard A, et al. Did case-based payment influence surgical readmission rates in France? A retrospective study. *BMJ Open*. 2018;8(2):e018164.
62. Wu Y, Fung H, Shum HM, Zhao S, Wong EL, Chong KC, et al. Evaluation of Length of Stay, Care Volume, In-Hospital Mortality, and Emergency Readmission Rate Associated With Use of Diagnosis-Related Groups for Internal Resource Allocation in Public Hospitals in Hong Kong. *JAMA Netw Open*. 2022;5(2):e2145685.
63. Moran JL, Duke GJ, Santamaria JD, Linden A, Pilcher D, Secombe P, et al. Modelling of intensive care unit (ICU) length of stay as a quality measure: a problematic exercise. *BMC Medical Research Methodology*. 2023;23(1):207.
64. Liu J, Larson E, Hessels A, Cohen B, Zachariah P, Caplan D, et al. Comparison of Measures to Predict Mortality and Length of Stay in Hospitalized Patients. *Nurs Res*. 2019;68(3):200-9.
65. Yang Y, Yang KS, Hsann YM, Lim V, Ong BC. The effect of comorbidity and age on hospital mortality and length of stay in patients with sepsis. *Journal of Critical Care*. 2010;25(3):398-405.
66. Long JS. Regression models for categorical and limited dependent variables. London: SAGE Publications; 1997.
67. Vanhaecht K, Sermeus W, De Witte K. The impact of clinical pathways on the organisation of care processes: KU Leuven 2007.
68. Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ*. 2017;358:j4008.
69. Sterne JAC, Savovic J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*. 2019;366:l4898.
70. Sterne JA, Hernan MA, Reeves BC, Savovic J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*. 2016;355:i4919.
71. Iweala U, Lee D, Lee R, Weinreb JH, O'Brien JR, Yu W. Characterizing efficiency in the ambulatory surgery setting: An analysis of operating room time and cost savings in orthopaedic surgery. *J Orthop*. 2019;16(6):534-42.

72. Sedrakyan A, Kamel H, Mao J, Ting H, Paul S. Hospital Readmission and Length of Stay Over Time in Patients Undergoing Major Cardiovascular and Orthopedic Surgery: A Tale of 2 States. *Med Care*. 2016;54(6):592-9.
73. Abdelaal E, Rao SV, Gilchrist IC, Bernat I, Shroff A, Caputo R, et al. Same-day discharge compared with overnight hospitalization after uncomplicated percutaneous coronary intervention: a systematic review and meta-analysis. *JACC Cardiovasc Interv*. 2013;6(2):99-112.
74. Bundhun PK, Soogund MZ, Huang WQ. Same Day Discharge versus Overnight Stay in the Hospital following Percutaneous Coronary Intervention in Patients with Stable Coronary Artery Disease: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *PLoS One*. 2017;12(1):e0169807.
75. Bradley SM, Kaltenbach LA, Xiang K, Amin AP, Hess PL, Maddox TM, et al. Trends in Use and Outcomes of Same-Day Discharge Following Elective Percutaneous Coronary Intervention. *JACC Cardiovasc Interv*. 2021;14(15):1655-66.
76. Gaba P, Serruys PW, Karmaliotis D, Lembo NJ, Banning AP, Zhang Z, et al. Outpatient Versus Inpatient Percutaneous Coronary Intervention in Patients With Left Main Disease (from the EXCEL Trial). *Am J Cardiol*. 2021;143:21-8.
77. Liew S, Dinh D, Liew D, Brennan A, Duffy S, Reid C, et al. Prevalence, Outcomes and Cost Implications of Patients Undergoing Same Day Discharge After Elective Percutaneous Coronary Intervention in Australia. *Heart Lung Circ*. 2020;29(8):e185-e93.
78. Hao XY, Shen YF, Wei YG, Liu F, Li HY, Li B. Safety and effectiveness of day-surgery laparoscopic cholecystectomy is still uncertain: meta-analysis of eight randomized controlled trials based on GRADE approach. *Surg Endosc*. 2017;31(12):4950-63.
79. Tang H, Dong A, Yan L. Day surgery versus overnight stay laparoscopic cholecystectomy: A systematic review and meta-analysis. *Dig Liver Dis*. 2015;47(7):556-61.
80. Vaughan J, Gurusamy KS, Davidson BR. Day-surgery versus overnight stay surgery for laparoscopic cholecystectomy. *Cochrane Database Syst Rev*. 2013(7):Cd006798.
81. Dirksen CD, Schmitz RF, Hans KM, Nieman FH, Hoogenboom LJ, Go PM. [Ambulatory laparoscopic cholecystectomy is as effective as hospitalization and from a social perspective less expensive: a randomized study]. *Ned Tijdschr Geneesk*. 2001;145(50):2434-9.
82. Fiorillo MA, Davidson PG, Fiorillo M, D'Anna JA, Jr., Sithian N, Silich RJ. 149 ambulatory laparoscopic cholecystectomies. *Surg Endosc*. 1996;10(1):52-6.
83. Lezana Pérez M, Carreño Villarreal G, Lora Cumplido P, Alvarez Obregón R. [Comparative study of ambulatory laparoscopic cholecystectomy versus management of laparoscopic cholecystectomy with conventional hospital stay]. *Cir Esp*. 2013;91(7):424-31.
84. Rosen MJ, Malm JA, Tarnoff M, Zuccala K, Ponsky JL. Cost-effectiveness of ambulatory laparoscopic cholecystectomy. *Surg Laparosc Endosc Percutan Tech*. 2001;11(3):182-4.
85. de Wijkerslooth EML, Bakas JM, van Rosmalen J, van den Boom AL, Wijnhoven BPL. Same-day discharge after appendectomy for acute appendicitis: a systematic review and meta-analysis. *Int J Colorectal Dis*. 2021;36(6):1297-309.
86. Cairo SB, Raval MV, Browne M, Meyers H, Rothstein DH. Association of Same-Day Discharge With Hospital Readmission After Appendectomy in Pediatric Patients. *JAMA Surgery*. 2017;152(12):1106-12.
87. Grigorian A, Kuza CM, Schubl SD, Nguyen NT, de Virgilio C, Kim D, et al. Same-Day Discharge after Non-Perforated Laparoscopic Appendectomy Is Safe. *Journal of Investigative Surgery*. 2019;34(3):270-5.
88. Scott A, Shekherdimian S, Rouch JD, Sacks GD, Dawes AJ, Lui WY, et al. Same-Day Discharge in Laparoscopic Acute Non-Perforated Appendectomy. *Journal of the American College of Surgeons*. 2017;224(1):43-8.



89. Cash CL, Frazee RC, Abernathy SW, Childs EW, Davis ML, Hendricks JC, et al. A Prospective Treatment Protocol for Outpatient Laparoscopic Appendectomy for Acute Appendicitis. *Journal of the American College of Surgeons*. 2012;215(1):101-5.
90. Lefrancois M, Lefevre JH, Chafai N, Pitel S, Kerger L, Agostini J, et al. Management of Acute Appendicitis in Ambulatory Surgery: Is It Possible? How to Select Patients? *Annals of Surgery*. 2015;261(6):1167-72.
91. Putnam LR, Levy SM, Johnson E, Williams K, Taylor K, Kao LS, et al. Impact of a 24-hour discharge pathway on outcomes of pediatric appendectomy. *Surgery*. 2014;156(2):455-61.
92. Rosen DR, Inaba K, Oh PJ, Gutierrez AC, Strumwasser AM, Biswas S, et al. Outpatient Laparoscopic Appendectomy: Feasible in a Public County Hospital? *Journal of the American College of Surgeons*. 2017;224(5):862-7.
93. Dubois L, Vogt KN, Davies W, Schlachta CM. Impact of an outpatient appendectomy protocol on clinical outcomes and cost: a case-control study. *J Am Coll Surg*. 2010;211(6):731-7.
94. Grigorian A, Kuza CM, Schubl SD, Nguyen NT, de Virgilio C, Kim D, et al. Same-Day Discharge after Non-Perforated Laparoscopic Appendectomy Is Safe. *J Invest Surg*. 2021;34(3):270-5.
95. Xu J, Cao JY, Chaggar GS, Negus JJ. Comparison of outpatient versus inpatient total hip and knee arthroplasty: A systematic review and meta-analysis of complications. *J Orthop*. 2020;17:38-43.
96. Goyal N, Chen AF, Padgett SE, Tan TL, Kheir MM, Hopper RH, Jr., et al. Otto Aufranc Award: A Multicenter, Randomized Study of Outpatient versus Inpatient Total Hip Arthroplasty. *Clin Orthop Relat Res*. 2017;475(2):364-72.
97. Aynardi M, Post Z, Ong A, Orozco F, Sukin DC. Outpatient surgery as a means of cost reduction in total hip arthroplasty: a case-control study. *Hss j*. 2014;10(3):252-5.
98. Bovonratwet P, Ondeck NT, Nelson SJ, Cui JJ, Webb ML, Grauer JN. Comparison of Outpatient vs Inpatient Total Knee Arthroplasty: An ACS-NSQIP Analysis. *J Arthroplasty*. 2017;32(6):1773-8.
99. Darrih B, Frisch NB, Tetreault MW, Fice MP, Culvern CN, Della Valle CJ. Inpatient Versus Outpatient Arthroplasty: A Single-Surgeon, Matched Cohort Analysis of 90-Day Complications. *J Arthroplasty*. 2019;34(2):221-7.
100. Kolisek FR, McGrath MS, Jessup NM, Monesmith EA, Mont MA. Comparison of outpatient versus inpatient total knee arthroplasty. *Clin Orthop Relat Res*. 2009;467(6):1438-42.
101. Nelson SJ, Webb ML, Lukasiewicz AM, Varthi AG, Samuel AM, Grauer JN. Is Outpatient Total Hip Arthroplasty Safe? *J Arthroplasty*. 2017;32(5):1439-42.
102. Springer BD, Odum SM, Vegari DN, Mokris JG, Beaver WB, Jr. Impact of Inpatient Versus Outpatient Total Joint Arthroplasty on 30-Day Hospital Readmission Rates and Unplanned Episodes of Care. *Orthop Clin North Am*. 2017;48(1):15-23.
103. DeMik DE, Carender CN, An Q, Callaghan JJ, Brown TS, Bedard NA. Longer Length of Stay Is Associated With More Early Complications After Total Knee Arthroplasty. *Iowa Orthop J*. 2022;42(2):53-9.
104. Jensen CB, Troelsen A, Foss NB, Nielsen CS, Lindberg-Larsen M, Gromov K. No difference in short-term readmissions following day-case vs. one overnight stay in patients having hip and knee arthroplasty: a nationwide register study of 51,042 procedures from 2010-2020. *Acta Orthop*. 2023;94:516-22.
105. Mai HT, Mukhdomi T, Croxford D, Apruzzese P, Kendall MC, De Oliveira GS. Safety and outcomes of outpatient compared to inpatient total knee arthroplasty: a national retrospective cohort study. *Reg Anesth Pain Med*. 2021;46(1):13-7.
106. Mantel J, Ruppenkamp JW, Cantu M, Holy CE. Total knee arthroplasty in the outpatient vs inpatient settings: impact of site of care on early postoperative economic and clinical outcomes. *Journal of orthopaedic surgery and research*. 2023;18(1):273.



107. Ponugoti N, Magill H. Safety, efficacy and cost-effectiveness of outpatient versus inpatient joint arthroplasty: a systematic review and meta-analysis. *BMC Musculoskelet Disord.* 2025;26(1):349.
108. Coenders MJ, Mathijssen NMC, Vehmeijer SBW. Three and a half years' experience with outpatient total hip arthroplasty. *Bone Joint J.* 2020;102-b(1):82-9.
109. Gauthier-Kwan OY, Dobransky JS, Dervin GF. Quality of Recovery, Postdischarge Hospital Utilization, and 2-Year Functional Outcomes After an Outpatient Total Knee Arthroplasty Program. *J Arthroplasty.* 2018;33(7):2159-64.e1.
110. Gromov K, Jørgensen CC, Petersen PB, Kjaersgaard-Andersen P, Revald P, Troelsen A, et al. Complications and readmissions following outpatient total hip and knee arthroplasty: a prospective 2-center study with matched controls. *Acta Orthop.* 2019;90(3):281-5.
111. Husted CE, Husted H, Nielsen CS, Mikkelsen M, Troelsen A, Gromov K. No increase in postoperative contacts with the healthcare system following outpatient total hip and knee arthroplasty. *Acta Orthop.* 2021;92(5):557-61.
112. Schmidt AM, Garval M, Gromov K, Holm C, Larsen JR, Runge C, et al. Feasibility, safety, and patient-reported outcomes 90 days after same-day total knee arthroplasty: a matched cohort study. *Acta Orthop.* 2022;93:509-18.
113. Daher M, Liu J, Smith N, Daniels AH, El-Othmani MM, Barrett TJ, et al. Outpatient Versus Inpatient Total Hip and Knee Arthroplasty in Morbidly Obese Patients. *J Arthroplasty.* 2025;40(5):1180-4.
114. Masri A, Althouse AD, McKibben J, Thoma F, Mathier M, Ramani R, et al. Outcomes of Heart Failure Admissions Under Observation Versus Short Inpatient Stay. *J Am Heart Assoc.* 2018;7(3).
115. Miró Ò, Gil V, Xipell C, Sánchez C, Aguiló S, Martín-Sánchez FJ, et al. IMPROV-ED study: outcomes after discharge for an episode of acute-decompensated heart failure and comparison between patients discharged from the emergency department and hospital wards. *Clin Res Cardiol.* 2017;106(5):369-78.
116. Wang K, Asinger RW, Marriott HJ. ST-segment elevation in conditions other than acute myocardial infarction. *N Engl J Med.* 2003;349(22):2128-35.
117. Asad ZUA, Khan SU, Amritphale A, Shroff A, Lata K, Seto AH, et al. Early vs Late Discharge in Low-Risk ST-Elevation Myocardial Infarction Patients Treated With Percutaneous Coronary Intervention: A Systematic Review and Meta-Analysis. *Cardiovasc Revasc Med.* 2020;21(11):1360-8.
118. Gong W, Li A, Ai H, Shi H, Wang X, Nie S. Safety of early discharge after primary angioplasty in low-risk patients with ST-segment elevation myocardial infarction: A meta-analysis of randomised controlled trials. *Eur J Prev Cardiol.* 2018;25(8):807-15.
119. Abdelnoor M, Andersen JG, Arnesen H, Johansen O. Early discharge compared with ordinary discharge after percutaneous coronary intervention - a systematic review and meta-analysis of safety and cost. *Vasc Health Risk Manag.* 2017;13:101-9.
120. Mundi R, Axelrod DE, Najafabadi BT, Chamas B, Chaudhry H, Bhandari M. Early Discharge After Total Hip and Knee Arthroplasty—An Observational Cohort Study Evaluating Safety in 330,000 Patients. *Journal of Arthroplasty.* 2020;35(12):3482-7.e3.
121. Otero JE, Gholson JJ, Pugely AJ, Gao Y, Bedard NA, Callaghan JJ. Length of Hospitalization After Joint Arthroplasty: Does Early Discharge Affect Complications and Readmission Rates? *J Arthroplasty.* 2016;31(12):2714-25.
122. Sutton JC, 3rd, Antoniou J, Epure LM, Huk OL, Zukor DJ, Bergeron SG. Hospital Discharge within 2 Days Following Total Hip or Knee Arthroplasty Does Not Increase Major-Complication and Readmission Rates. *J Bone Joint Surg Am.* 2016;98(17):1419-28.
123. Bini SA, Inacio MC, Cafri G. Two-Day Length of Stay is Not Inferior to 3 Days in Total Knee Arthroplasty with Regards to 30-Day Readmissions. *J Arthroplasty.* 2015;30(5):733-8.



124. Charpentier PM, Srivastava AK, Zheng H, Ostrander JD, Hughes RE. Readmission Rates for One Versus Two-Midnight Length of Stay for Primary Total Knee Arthroplasty: Analysis of the Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI) Database. *J Bone Joint Surg Am.* 2018;100(20):1757-64.
125. Leroux TS, Maldonado-Rodriguez N, Paterson JM, Aktar S, Gandhi R, Ravi B. No Difference in Outcomes Between Short and Longer-Stay Total Joint Arthroplasty with a Discharge Home: A Propensity Score-Matched Analysis Involving 46,660 Patients. *J Bone Joint Surg Am.* 2020;102(6):495-502.
126. Cotter G, Davison BA, Milo O, Bourge RC, Cleland JGF, Jondeau G, et al. Predictors and Associations With Outcomes of Length of Hospital Stay in Patients With Acute Heart Failure: Results From VERITAS. *Journal of Cardiac Failure.* 2016;22(10):815-22.
127. Davison BA, Metra M, Senger S, Edwards C, Milo O, Bloomfield DM, et al. Patient journey after admission for acute heart failure: length of stay, 30-day readmission and 90-day mortality. *European Journal of Heart Failure.* 2016;18(8):1041-50.
128. Eapen ZJ, Reed SD, Li Y, Kociol RD, Armstrong PW, Starling RC, et al. Do countries or hospitals with longer hospital stays for acute heart failure have lower readmission rates?: Findings from ASCEND-HF. *Circ Heart Fail.* 2013;6(4):727-32.
129. Khan H, Greene SJ, Fonarow GC, Kalogeropoulos AP, Ambrosy AP, Maggioni AP, et al. Length of hospital stay and 30-day readmission following heart failure hospitalization: insights from the EVEREST trial. *Eur J Heart Fail.* 2015;17(10):1022-31.
130. Samsky MD, Ambrosy AP, Youngson E, Liang L, Kaul P, Hernandez AF, et al. Trends in Readmissions and Length of Stay for Patients Hospitalized With Heart Failure in Canada and the United States. *JAMA Cardiol.* 2019;4(5):444-53.
131. Carbajosa V, Martín-Sánchez FJ, Llorens P, Herrero P, Jacob J, Alquézar A, et al. [Factors associated with short stays for patients admitted with acute heart failure]. *Emergencias.* 2016;28(6):366-74.
132. Miyazaki D, Tarasawa K, Fushimi K, Fujimori K. Risk Factors with 30-Day Readmission and the Impact of Length of Hospital Stay on It in Patients with Heart Failure: A Retrospective Observational Study Using a Japanese National Database. *Tohoku J Exp Med.* 2023;259(2):151-62.
133. Moriyama H, Kohno T, Kohsaka S, Shiraishi Y, Fukuoka R, Nagatomo Y, et al. Length of hospital stay and its impact on subsequent early readmission in patients with acute heart failure: a report from the WET-HF Registry. *Heart Vessels.* 2019;34(11):1777-88.
134. Reynolds K, Butler MG, Kimes TM, Rosales AG, Chan W, Nichols GA. Relation of Acute Heart Failure Hospital Length of Stay to Subsequent Readmission and All-Cause Mortality. *Am J Cardiol.* 2015;116(3):400-5.
135. Arundel C, Lam PH, Faselis C, Sheriff HM, Dooley DJ, Morgan C, et al. Length of stay and readmission in older adults hospitalized for heart failure. *Archives of Medical Science.* 2021;17(4):891-9.
136. Kociol RD, Liang L, Hernandez AF, Curtis LH, Heidenreich PA, Yancy CW, et al. Are we targeting the right metric for heart failure? Comparison of hospital 30-day readmission rates and total episode of care inpatient days. *Am Heart J.* 2013;165(6):987-94.e1.
137. Sud M, Yu B, Wijeyesundera HC, Austin PC, Ko DT, Braga J, et al. Associations Between Short or Long Length of Stay and 30-Day Readmission and Mortality in Hospitalized Patients With Heart Failure. *JACC Heart Fail.* 2017;5(8):578-88.
138. Rinne ST, Graves MC, Bastian LA, Lindenauer PK, Wong ES, Hebert PL, et al. Association between length of stay and readmission for COPD. *Am J Manag Care.* 2017;23(8):e253-e8.
139. Jiang X, Xiao H, Segal R, Mobley WC, Park H. Trends in Readmission Rates, Hospital Charges, and Mortality for Patients With Chronic Obstructive Pulmonary Disease (COPD) in Florida From 2009 to 2014. *Clin Ther.* 2018;40(4):613-26.e1.



140. Zaprutko J, Michalak M, Nowicka A, Dankowski R, Drożdż J, Ponikowski P, et al. Hospitalisation length and prognosis in heart failure patients. *Kardiol Pol.* 2017;75(4):323-31.
141. Ricciardi MJ, Selzer F, Marroquin OC, Holper EM, Venkitachalam L, Williams DO, et al. Incidence and predictors of 30-day hospital readmission rate following percutaneous coronary intervention (from the National Heart, Lung, and Blood Institute Dynamic Registry). *Am J Cardiol.* 2012;110(10):1389-96.
142. Gronbeck C, Cusano A, Cardenas JM, Harrington MA, Halawi MJ. Primary Total Hip Arthroplasty in Hispanic/Latino Patients: An Updated Nationwide Analysis of Length of Stay, 30-Day Outcomes, and Risk Factors. *Arthroplast Today.* 2020;6(4):721-5.
143. Grosso MJ, Neuwirth AL, Boddapati V, Shah RP, Cooper HJ, Geller JA. Decreasing Length of Hospital Stay and Postoperative Complications After Primary Total Hip Arthroplasty: A Decade Analysis From 2006 to 2016. *J Arthroplasty.* 2019;34(3):422-5.
144. Rullán PJ, Xu JR, Emara AK, Molloy RM, Krebs VE, Mont MA, et al. Major National Shifts to Outpatient Total Knee Arthroplasties in the United States: A 10-Year Trends Analysis of Procedure Volumes, Complications, and Healthcare Utilizations (2010 to 2020). *Journal of Arthroplasty.* 2023;38(7):1209-16.e5.
145. Sarpong NO, Boddapati V, Herndon CL, Shah RP, Cooper HJ, Geller JA. Trends in Length of Stay and 30-Day Complications After Total Knee Arthroplasty: An Analysis From 2006 to 2016. *J Arthroplasty.* 2019;34(8):1575-80.
146. Vorhies JS, Wang Y, Herndon JH, Maloney WJ, Huddleston JI. Decreased length of stay after TKA is not associated with increased readmission rates in a national Medicare sample. *Clin Orthop Relat Res.* 2012;470(1):166-71.
147. Kirkland PA, Barfield WR, Demos HA, Pellegrini VD, Drew JM. Optimal Length of Stay Following Total Joint Arthroplasty to Reduce Readmission Rates. *Journal of Arthroplasty.* 2020;35(2):303-8.e1.
148. Ross TD, Dvorani E, Saskin R, Khoshbin A, Atrey A, Ward SE. Temporal Trends and Predictors of Thirty-Day Readmissions and Emergency Department Visits Following Total Knee Arthroplasty in Ontario Between 2003 and 2016. *Journal of Arthroplasty.* 2020;35(2):364-70.
149. Jensen CB, Troelsen A, Foss NB, Nielsen CS, Lindberg-Larsen M, Gromov K. 10-year evolution of day-case hip and knee arthroplasty: a Danish nationwide register study of 166,833 procedures from 2010 to 2020. *Acta Orthop.* 2023;94:178-84.
150. Marenzi G, Cosentino N, Imparato L, Trombara F, Leoni O, Bortolan F, et al. Temporal trends (2003-2018) of in-hospital and 30-day mortality in patients hospitalized with acute heart failure. *Int J Cardiol.* 2025;419:132693.
151. Mabire C, Dwyer A, Garnier A, Pellet J. Effectiveness of nursing discharge planning interventions on health-related outcomes in discharged elderly inpatients: a systematic review. *JB I Database System Rev Implement Rep.* 2016;14(9):217-60.
152. Mabire C, Dwyer A, Garnier A, Pellet J. Meta-analysis of the effectiveness of nursing discharge planning interventions for older inpatients discharged home (76). *J Adv Nurs.* 2018;74(4):788-99.
153. Hunt-O'Connor C, Moore Z, Patton D, Nugent L, Avsar P, O'Connor T. The effect of discharge planning on length of stay and readmission rates of older adults in acute hospitals: A systematic review and meta-analysis of systematic reviews. *J Nurs Manag.* 2021;29(8):2697-706.
154. Straßner C, Hoffmann M, Forstner J, Roth C, Szecsenyi J, Wensing M. Interventions to Improve Hospital Admission and Discharge Management: An Umbrella Review of Systematic Reviews. *Qual Manag Health Care.* 2020;29(2):67-75.
155. Agarwal A, Bahiru E, Yoo SGK, Berendsen MA, Harikrishnan S, Hernandez AF, et al. Hospital-based quality improvement interventions for patients with heart failure: a systematic review. *Heart.* 2019;105(6):431-8.



156. Allen J, Hutchinson AM, Brown R, Livingston PM. Quality care outcomes following transitional care interventions for older people from hospital to home: a systematic review. *BMC Health Serv Res*. 2014;14:346.
157. Austin J, Barras M, Sullivan C. Interventions designed to improve the safety and quality of therapeutic anticoagulation in an inpatient electronic medical record. *Int J Med Inform*. 2020;135:104066.
158. Berkovic D, Vallance P, Harris IA, Naylor JM, Lewis PL, de Steiger R, et al. A systematic review and meta-analysis of short-stay programmes for total hip and knee replacement, focusing on safety and optimal patient selection. *BMC medicine*. 2023;21(1):511.
159. Chakraborty A, Pearson O, Schwartzkopff KM, O'Rourke I, Ranasinghe I, Mah PM, et al. The effectiveness of in-hospital interventions on reducing hospital length of stay and readmission of patients with Type 2 Diabetes Mellitus: A systematic review (38). *Diabetes Res Clin Pract*. 2021;174:108363.
160. Coffey A, Leahy-Warren P, Savage E, Hegarty J, Cornally N, Day MR, et al. Interventions to Promote Early Discharge and Avoid Inappropriate Hospital (Re)Admission: A Systematic Review (57). *Int J Environ Res Public Health*. 2019;16(14).
161. Coolsen MM, van Dam RM, van der Wilt AA, Slim K, Lassen K, Dejong CH. Systematic review and meta-analysis of enhanced recovery after pancreatic surgery with particular emphasis on pancreaticoduodenectomies. *World J Surg*. 2013;37(8):1909-18.
162. Deng QF, Gu HY, Peng WY, Zhang Q, Huang ZD, Zhang C, et al. Impact of enhanced recovery after surgery on postoperative recovery after joint arthroplasty: results from a systematic review and meta-analysis. *Postgrad Med J*. 2018;94(1118):678-93.
163. Doshmangir L, Khabiri R, Jabbari H, Arab-Zozani M, Kakemam E, Gordeev VS. Strategies for utilisation management of hospital services: a systematic review of interventions (17). *Global Health*. 2022;18(1):53.
164. Ellis G, Gardner M, Tsiachristas A, Langhorne P, Burke O, Harwood RH, et al. Comprehensive geriatric assessment for older adults admitted to hospital. *Cochrane Database Syst Rev*. 2017;9(9):Cd006211.
165. Fox MT, Persaud M, Maimets I, Brooks D, O'Brien K, Tregunno D. Effectiveness of early discharge planning in acutely ill or injured hospitalized older adults: a systematic review and meta-analysis (108). *BMC Geriatr*. 2013;13:70.
166. Fox MT, Persaud M, Maimets I, O'Brien K, Brooks D, Tregunno D, et al. Effectiveness of acute geriatric unit care using acute care for elders components: a systematic review and meta-analysis. *J Am Geriatr Soc*. 2012;60(12):2237-45.
167. Gonçalves-Bradley DC, Lannin NA, Clemson L, Cameron ID, Shepperd S. Discharge planning from hospital (157). *Cochrane Database of Systematic Reviews*. 2022(2).
168. Guerin M, Grimmer K, Kumar S. Community services' involvement in the discharge of older adults from hospital into the community. *Int J Integr Care*. 2013;13:e032.
169. Harji DP, Griffiths B, Stocken D, Pearse R, Blazeby J, Brown JM. Protocolized care pathways in emergency general surgery: a systematic review and meta-analysis. *Br J Surg*. 2024;111(3).
170. Heymans MJ, Kort NP, Snoeker BA, Schotanus MG. Impact of enhanced recovery pathways on safety and efficacy of hip and knee arthroplasty: A systematic review and meta-analysis. *World J Orthop*. 2022;13(3):307-28.
171. Huntley AL, Johnson R, King A, Morris RW, Purdy S. Does case management for patients with heart failure based in the community reduce unplanned hospital admissions? A systematic review and meta-analysis. *BMJ Open*. 2016;6(5):e010933.
172. Kalogera E, Glaser GE, Kumar A, Dowdy SC, Langstraat CL. Enhanced Recovery after Minimally Invasive Gynecologic Procedures with Bowel Surgery: A Systematic Review. *J Minim Invasive Gynecol*. 2019;26(2):288-98.

173. Kennelly P, Davey MG, Griniouk D, Calpin G, Donlon NE. Evaluating the impact of enhanced recovery after surgery protocols following oesophagectomy: a systematic review and meta-analysis of randomised clinical trials. *Diseases of the esophagus : official journal of the International Society for Diseases of the Esophagus*. 2025;38(1).
174. Kuemmerli C, Balzano G, Bouwense SA, Braga M, Coolsen M, Daniel SK, et al. Are enhanced recovery protocols after pancreatoduodenectomy still efficient when applied in elderly patients? A systematic review and individual patient data meta-analysis. *Journal of hepatobiliary-pancreatic sciences*. 2024;31(5):308-17.
175. Kuemmerli C, Tschuor C, Kasai M, Alseidi AA, Balzano G, Bouwense S, et al. Impact of enhanced recovery protocols after pancreatoduodenectomy: meta-analysis. *Br J Surg*. 2022;109(3):256-66.
176. Lee Y, Yu J, Doumouras AG, Li J, Hong D. Enhanced recovery after surgery (ERAS) versus standard recovery for elective gastric cancer surgery: A meta-analysis of randomized controlled trials. *Surg Oncol*. 2020;32:75-87.
177. McKechnie T, Tessier L, Archer V, Park L, Cohen D, Levac B, et al. Enhanced recovery after surgery protocols following emergency intra-abdominal surgery: a systematic review and meta-analysis. *European journal of trauma and emergency surgery : official publication of the European Trauma Society*. 2024;50(3):679-704.
178. Małczak P, Pisarska M, Piotr M, Wysocki M, Budzyński A, Pędziwiatr M. Enhanced Recovery after Bariatric Surgery: Systematic Review and Meta-Analysis. *Obes Surg*. 2017;27(1):226-35.
179. Mao H, Xie Y, Shen Y, Wang M, Luo Y. Effectiveness of nurse-led discharge service on adult surgical inpatients: A meta-analysis of randomized controlled trials (16). *Nurs Open*. 2022;9(5):2250-62.
180. Malik M, Moore Z, Patton D, O'Connor T, Nugent LE. The impact of geriatric focused nurse assessment and intervention in the emergency department: A systematic review. *Int Emerg Nurs*. 2018;37:52-60.
181. Morrell AT, Layon DR, Scott MJ, Kates SL, Golladay GJ, Patel NK. Enhanced Recovery After Primary Total Hip and Knee Arthroplasty: A Systematic Review. *J Bone Joint Surg Am*. 2021;103(20):1938-47.
182. Nair A, Al-Aamri HHM, Borkar N, Rangaiah M, Haque PW. Application of Enhanced Recovery After Surgery Pathways in Patients Undergoing Laparoscopic Cholecystectomy With and Without Common Bile Duct Exploration: A systematic review and meta-analysis. *Sultan Qaboos Univ Med J*. 2023;23(2):148-57.
183. Naserallah L, Koraysh S, Aboujabal B, Alasmar M. Interventions and impact of pharmacist-delivered services in perioperative setting on clinically important outcomes: a systematic review and meta-analysis. *Ther. Adv. Drug Saf*. 2024;15.
184. Noba L, Rodgers S, Doi L, Chandler C, Hariharan D, Yip V. Costs and clinical benefits of enhanced recovery after surgery (ERAS) in pancreaticoduodenectomy: an updated systematic review and meta-analysis. *J Cancer Res Clin Oncol*. 2023;149(9):6639-60.
185. Noba L, Rodgers S, Chandler C, Balfour A, Hariharan D, Yip VS. Enhanced Recovery After Surgery (ERAS) Reduces Hospital Costs and Improve Clinical Outcomes in Liver Surgery: a Systematic Review and Meta-Analysis. *J Gastrointest Surg*. 2020;24(4):918-32.
186. Pang PS, Berger DA, Mahler SA, Li X, Pressler SJ, Lane KA, et al. Short-Stay Units vs Routine Admission From the Emergency Department in Patients With Acute Heart Failure: The SSU-AHF Randomized Clinical Trial. *JAMA Netw Open*. 2024;7(1):e2350511.
187. Pannick S, Davis R, Ashrafian H, Byrne BE, Beveridge I, Athanasiou T, et al. Effects of Interdisciplinary Team Care Interventions on General Medical Wards: A Systematic Review. *JAMA Intern Med*. 2015;175(8):1288-98.



188. Patel JN, Klein DS, Sreekumar S, Liporace FA, Yoon RS. Outcomes in Multidisciplinary Team-based Approach in Geriatric Hip Fracture Care: A Systematic Review. *J Am Acad Orthop Surg.* 2020;28(3):128-33.
189. Peerbocus M, Wang ZJ. Enhanced recovery after surgery and radical cystectomy: A systematic review and meta-analysis. *Res. Reports Urology.* 2021;13:535-47.
190. Qin J, Gou LY, Zhang W, Pu X, Zhang P. Enhanced Recovery After Surgery versus Conventional Care in Cholecystectomy: A Systematic Review and Meta-Analysis. *J Laparoendosc Adv Surg Tech A.* 2024;34(8):710-20.
191. Sarkies MN, White J, Henderson K, Haas R, Bowles J. Additional weekend allied health services reduce length of stay in subacute rehabilitation wards but their effectiveness and cost-effectiveness are unclear in acute general medical and surgical hospital wards: a systematic review (70). *J Physiother.* 2018;64(3):142-58.
192. Saunders S, Killackey T, Kurahashi A, Walsh C, Wentlandt K, Lovrics E, et al. Palliative Care Transitions From Acute Care to Community-Based Care-A Systematic Review (59). *J Pain Symptom Manage.* 2019;58(4):721-34.e1.
193. Strøm C, Rasmussen LS, Löwe AS, Lorentzen AK, Lohse N, Madsen KHB, et al. Short-stay unit hospitalisation vs. standard care outcomes in older internal medicine patients-a randomised clinical trial. *Age Ageing.* 2018;47(6):810-7.
194. Stumpo V, Staartjes VE, Quddusi A, Corniola MV, Tessitore E, Schröder ML, et al. Enhanced Recovery After Surgery strategies for elective craniotomy: a systematic review. *J Neurosurg.* 2021;135(6):1857-81.
195. Tan YY, Liaw F, Warner R, Myers S, Ghanem A. Enhanced Recovery Pathways for Flap-Based Reconstruction: Systematic Review and Meta-Analysis. *Aesthetic Plast Surg.* 2021;45(5):2096-115.
196. Tinguely P, Morare N, Ramirez-Del Val A, Berenguer M, Niemann CU, Pollok JM, et al. Enhanced recovery after surgery programs improve short-term outcomes after liver transplantation-A systematic review and meta-analysis. *Clin Transplant.* 2021;35(11):e14453.
197. Villatte G, Mathonnet M, Villemainot J, Savary M, Theissen A, Ostermann S, et al. [Interest of enhanced recovery programs in the elderly during total hip arthroplasty A systematic review]. *Geriatr Psychol Neuropsychiatr Vieil.* 2019;17(3):234-42.
198. Zepeda-Lugo C, Tlapa D, Baez-Lopez Y, Limon-Romero J, Ontiveros S, Perez-Sanchez A, et al. Assessing the Impact of Lean Healthcare on Inpatient Care: A Systematic Review (44). *Int J Environ Res Public Health.* 2020;17(15).
199. Zhang Q, Chen Y, Li Y, Liu R, Rai S, Li J, et al. Enhanced recovery after surgery in patients after hip and knee arthroplasty: a systematic review and meta-analysis. *Postgrad Med J.* 2024;100(1181):159-73.
200. Zhou W, Chu S, Zhou Y, Huang Y. Enhanced recovery after surgery for hip and knee arthroplasty: A systematic review and meta-analysis on randomized control trials. *Geriatr Nurs.* 2024;60:249-57.
201. Zhu S, Qian W, Jiang C, Ye C, Chen X. Enhanced recovery after surgery for hip and knee arthroplasty: a systematic review and meta-analysis. *Postgrad Med J.* 2017;93(1106):736-42.
202. Zhu QM, Liu J, Hu HY, Wang S. Effectiveness of nurse-led early discharge planning programmes for hospital inpatients with chronic disease or rehabilitation needs: a systematic review and meta-analysis (99). *J Clin Nurs.* 2015;24(19):2993-3005.
203. Bu J, Li N, Huang X, He S, Wen J, Wu X. Feasibility of Fast-Track Surgery in Elderly Patients with Gastric Cancer. *J Gastrointest Surg.* 2015;19(8):1391-8.
204. Hegney D, Buikstra E, Chamberlain C, March J, McKay M, Cope G, et al. Nurse discharge planning in the emergency department: a Toowoomba, Australia, study. *J Clin Nurs.* 2006;15(8):1033-44.

205. Maynard G, Humber D, Jenkins I. Multidisciplinary initiative to improve inpatient anticoagulation and management of venous thromboembolism. *Am J Health Syst Pharm.* 2014;71(4):305-10.
206. Ballesca MA, LaGuardia JC, Lee PC, Hwang AM, Park DK, Gardner MN, et al. An electronic order set for acute myocardial infarction is associated with improved patient outcomes through better adherence to clinical practice guidelines. *J Hosp Med.* 2014;9(3):155-61.
207. Greenberg SE, VanHouten JP, Lakomkin N, Ehrenfeld J, Jahangir AA, Boyce RH, et al. Does Admission to Medicine or Orthopaedics Impact a Geriatric Hip Patient's Hospital Length of Stay? *J Orthop Trauma.* 2016;30(2):95-9.
208. Soong C, Cram P, Chezard K, Tajammal F, Exconde K, Matelski J, et al. Impact of an Integrated Hip Fracture Inpatient Program on Length of Stay and Costs. *J Orthop Trauma.* 2016;30(12):647-52.
209. Collinge CA, McWilliam-Ross K, Beltran MJ, Weaver T. Measures of clinical outcome before, during, and after implementation of a comprehensive geriatric hip fracture program: is there a learning curve? *J Orthop Trauma.* 2013;27(12):672-6.
210. Flikweert ER, Wendt KW, Diercks RL, Izaks GJ, Stewart R, Stevens M, et al. A comprehensive multidisciplinary care pathway for hip fractures better outcome than usual care? *Injury.* 2021;52(7):1819-25.
211. Kristensen PK, Thillemann TM, Søballe K, Johnsen SP. Can improved quality of care explain the success of orthogeriatric units? A population-based cohort study. *Age Ageing.* 2016;45(1):66-71.
212. Forni S, Pieralli F, Sergi A, Lorini C, Bonaccorsi G, Vannucci A. Mortality after hip fracture in the elderly: The role of a multidisciplinary approach and time to surgery in a retrospective observational study on 23,973 patients. *Arch Gerontol Geriatr.* 2016;66:13-7.
213. Sandberg M, Kristensson J, Midlöv P, Jakobsson U. Effects on healthcare utilization of case management for frail older people: a randomized controlled trial (RCT). *Arch Gerontol Geriatr.* 2015;60(1):71-81.
214. Koehler BE, Richter KM, Youngblood L, Cohen BA, Prengler ID, Cheng D, et al. Reduction of 30-day postdischarge hospital readmission or emergency department (ED) visit rates in high-risk elderly medical patients through delivery of a targeted care bundle. *J Hosp Med.* 2009;4(4):211-8.
215. Palmer RM, Landefeld CS, Kresevic D, Kowal J. A medical unit for the acute care of the elderly. *J Am Geriatr Soc.* 1994;42(5):545-52.
216. Sorensen L, Idemoto L, Streifel J, Williams B, Mecklenburg R, Blackmore C. A multifaceted intervention to improve the quality of care for patients undergoing total joint arthroplasty. *BMJ Open Qual.* 2019;8(3):e000664.
217. Yousri TA, Khan Z, Chakrabarti D, Fernandes R, Wahab K. Lean thinking: can it improve the outcome of fracture neck of femur patients in a district general hospital? *Injury.* 2011;42(11):1234-7.
218. Cardiff K, Anderson G, Sheps S. Evaluation of a hospital-based utilization management program. *Healthc Manage Forum.* 1995;8(1):38-45.
219. Choong PF, Langford AK, Dowsey MM, Santamaria NM. Clinical pathway for fractured neck of femur: a prospective, controlled study. *Med J Aust.* 2000;172(9):423-6.
220. Lim WK, Lambert SF, Gray LC. Effectiveness of case management and post-acute services in older people after hospital discharge. *Med J Aust.* 2003;178(6):262-6.
221. Naylor MD. Comprehensive discharge planning for hospitalized elderly: a pilot study. *Nurs Res.* 1990;39(3):156-61.
222. McInnes E, Mira M, Atkin N, Kennedy P, Cullen J. Can GP input into discharge planning result in better outcomes for the frail aged: results from a randomized controlled trial. *Fam Pract.* 1999;16(3):289-93.



223. Preen DB, Bailey BE, Wright A, Kendall P, Phillips M, Hung J, et al. Effects of a multidisciplinary, post-discharge continuance of care intervention on quality of life, discharge satisfaction, and hospital length of stay: a randomized controlled trial. *Int J Qual Health Care*. 2005;17(1):43-51.
224. Strøm C, Stefansson JS, Fabritius ML, Rasmussen LS, Schmidt TA, Jakobsen JC. Hospitalisation in short-stay units for adults with internal medicine diseases and conditions. *Cochrane Database Syst Rev*. 2018;8(8):Cd012370.
225. Than M, Aldous S, Lord SJ, Goodacre S, Frampton CM, Troughton R, et al. A 2-hour diagnostic protocol for possible cardiac chest pain in the emergency department: a randomized clinical trial. *JAMA Intern Med*. 2014;174(1):51-8.
226. Pang PS, Collins SP, Cox ZL, Roumpf SK, Strachan CC, Swigart W, et al. Clinical and utilization outcomes with short stay units vs hospital admission for lower risk decompensated heart failure: a systematic review and meta-analysis. *Heart Fail Rev*. 2024;29(6):1279-87.
227. Picart B, Lecoœur B, Rochcongar G, Dunet J, Pégoux M, Hulet C. Implementation and results of an enhanced recovery (fast-track) program in total knee replacement patients at a French university hospital. *Orthop Traumatol Surg Res*. 2021;107(3):102851.
228. Tasso F, Simili V, Di Matteo B, Monteleone G, Martorelli F, De Angelis A, et al. A rapid recovery protocol for hip and knee replacement surgery: a report of the outcomes in a referral center. *Eur Rev Med Pharmacol Sci*. 2022;26(10):3648-55.
229. Reilly KA, Beard DJ, Barker KL, Dodd CA, Price AJ, Murray DW. Efficacy of an accelerated recovery protocol for Oxford unicompartmental knee arthroplasty--a randomised controlled trial. *Knee*. 2005;12(5):351-7.
230. Haines TP, Bowles KA, Mitchell D, O'Brien L, Markham D, Plumb S, et al. Impact of disinvestment from weekend allied health services across acute medical and surgical wards: 2 stepped-wedge cluster randomised controlled trials. *PLoS Med*. 2017;14(10):e1002412.
231. Kinoshita S, Momosaki R, Kakuda W, Okamoto T, Abo M. Association Between 7 Days Per Week Rehabilitation and Functional Recovery of Patients With Acute Stroke: A Retrospective Cohort Study Based on the Japan Rehabilitation Database. *Arch Phys Med Rehabil*. 2017;98(4):701-6.
232. Van Wilder A, Cox B, De Ridder D, Tambeur W, Maertens P, Stijnen P, et al. Unwarranted Between-hospital Variation in Mortality, Readmission, and Length of Stay of Urological Admissions: An Important Trigger for Prioritising Quality Targets. *Eur Urol Focus*. 2022;8(5):1531-40.
233. Van den Heede K, Bruyneel L, Beeckmans D, Boon N, Bouckaert N, Cornelis J, et al. Safe nurse staffing levels in acute hospitals. *Health Services Research (HSR)*. Brussels: Belgian Health Care Knowledge Center; 2019. KCE Reports (325)
234. Zhang H, Gao X, Chen Z. The Impact of Preoperative Risk Factors on Unplanned Readmission After Day Surgery: A Meta-Analysis. *J Pers Med*. 2025;15(7).
235. Garcia-Perez L, Linertova R, Lorenzo-Riera A, Vazquez-Diaz JR, Duque-Gonzalez B, Sarria-Santamera A. Risk factors for hospital readmissions in elderly patients: a systematic review. *QJM*. 2011;104(8):639-51.
236. Longacre ML, Wong YN, Fang CY. Caregiver psychological health and hospitalization characteristics of older adult care recipients: an integrative review of U.S. studies. *Res Gerontol Nurs*. 2014;7(3):139-47.
237. Shibuya N, Patel H, Graney C, Jupiter DC. Factors associated with emergency room visits within 30 days of outpatient foot and ankle surgeries. *Proc (Bayl Univ Med Cent)*. 2018;31(2):157-60.
238. Brown CS, Yang J, Meng Z, Henderson J, Dimick JB, Telem DA. Trends in emergency department utilization following common operations in New York State, 2005-2014. *Surg Endosc*. 2020;34(5):1994-9.



239. Sivasundaram L, Wang JH, Kim CY, Trivedi NN, Liu RW, Voos JE, et al. Emergency Department Utilization After Outpatient Hand Surgery. *J Am Acad Orthop Surg*. 2020;28(15):639-49.
240. Ross K, Glazebrook H, Douglas JA, MacLellan J, Krauss EM. Emergency Department Visits Within 90 Days of Elective Hand Surgery: A Healthcare Utilization Study. *Plast Surg (Oakv)*. 2025;22925503251371057.
241. Williams BR, Smith LC, Only AJ, Parikh HR, Swiontkowski MF, Cunningham BP. Unplanned Emergency and Urgent Care Visits After Outpatient Orthopaedic Surgery. *J Am Acad Orthop Surg Glob Res Rev*. 2021;5(9).
242. Kelly MP, Prentice HA, Wang W, Fasig BH, Sheth DS, Paxton EW. Reasons for Ninety-Day Emergency Visits and Readmissions After Elective Total Joint Arthroplasty: Results From a US Integrated Healthcare System. *J Arthroplasty*. 2018;33(7):2075-81.
243. Hartwell MJ, Tjong VK. Editorial Commentary: Emergency Department Evaluation After Hip Arthroscopy Occurs More than Expected: Here's Where Patient Education and a Multimodal Approach to Pain Management Can Be Helpful. *Arthroscopy*. 2020;36(6):1584-6.
244. Imison C, Curry N, Holder H, Castle-Clarke S, Nimmons D, Appleby J, et al. Shifting the balance of care: great expectations. 2017.
245. Sig JR, Nielsen C, Bille C, Thomsen JB, Sorensen JA. Patients' Experiences of Day Surgery: A Qualitative Systematic Review. *J Adv Nurs*. 2025.
246. Lilleheie I, Debesay J, Bye A, Bergland A. The tension between carrying a burden and feeling like a burden: a qualitative study of informal caregivers' and care recipients' experiences after patient discharge from hospital. *Int J Qual Stud Health Well-being*. 2021;16(1):1855751.
247. Smith H, Grindey C, Hague I, Newbould L, Brown L, Clegg A, et al. Reducing delayed transfer of care in older people: A qualitative study of barriers and facilitators to shorter hospital stays. *Health Expect*. 2022;25(6):2628-44.
248. Kinsey D, Carrieri D, Briscoe S, Febrey S, Kneale D, Lovegrove C, et al. Experiences of interventions to reduce hospital stay for older adults following elective treatment: Qualitative evidence-synthesis. *Int J Older People Nurs*. 2024;19(2):e12602.