ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

DOTTORATO DI RICERCA IN

SCIENZE MEDICHE GENERALI E SCIENZE DEI SERVIZI

Ciclo 37

Settore Concorsuale: 06/M1 - IGIENE GENERALE E APPLICATA, SCIENZE INFERMIERISTICHE E STATISTICA MEDICA

Settore Scientifico Disciplinare: MED/01 - STATISTICA MEDICA

MONITORING AND EVALUATING COMMUNITY HOSPITALS USING A MULTIDIMENSIONAL APPROACH TO ENHANCE HEALTHCARE QUALITY: A REAL-WORLD ASSESSMENT IN ROMAGNA'S LOCAL HEALTHCARE AUTHORITY

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Esame finale anno 2025

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Acronyms

ADL – Activities of Daily Living

AIC – Akaike Information Criterion

AUC – Area Under the Curve

BIC – Bayesian Information Criterion

CH – Community Home

CoH – Community Hospital

COVID-19 – Coronavirus disease 2019

DALYs – Disability-adjusted life years

EBM – Evidence-Based Medicine

EIDM – Evidence-Informed Decision-Making

EIPH – Evidence-Informed Public Health

EBPH – Evidence-Based-Public Health

GBD – Global Burden of Disease

HH – Healthcare Homes

IHME – Institute for Health Metrics and Evaluation

MBI – Modified Barthel Index

NAIC – National Audit of Intermediate Care

NICE – National Institute for Health and Care Excellence

NHP – National Health Plan

OECD – Organisation for Economic Co-operation and Development

HCQI – Healthcare Quality Indicators

PaRIS – Patient-Reported Indicator Surveys

PREMs – Patient-Reported Experience Measures

PROMs – Patient-Reported Outcomes Measures

RLHA – Romagna Local Healthcare Authority

WHO – World Health Organization

Abstract

Community-based care has gained increased attention, especially after the impact of the Coronavirus disease 2019 pandemic. In Italy, Ministerial Decree No. 77, issued in May 2022, established standards to develop and strengthen community-based care nationwide, particularly focusing on two types of settings that can address people's (socio)health needs in the face of a profound change in the epidemiological structure of the population: Community Homes and Community Hospitals. A project in the Romagna Local Healthcare Authority explored organisational solutions and management approaches for Healthcare Homes, considering the desired transition toward Community Homes. Contextual factors were found to play a crucial role in shaping these models, underscoring the need to balance standardisation and customisation in healthcare service organisation.

The thesis study examined seven Community Hospitals within the same geographical area, focusing on characterising the patient's case-mix, referral sources, discharge destinations, and using different types of quality indicators. These included examining risk and performance models for prolonged length of stay, improvement in the Activity of Daily Living, and re-admissions to these facilities, as well as implementing a new-generation indicator: the Patient-Reported Experience Measures (PREMs) questionnaire.

Logistic regression was the primary methodology, with fractional polynomials applied to assess the logit scale of continuous variables. For PREMs, in-depth analysis focused on responses per question and on calculating normalised mean scores per Community Hospital. A multi-indicator representation summarises each facility's performance.

The analyses outlined a strong rehabilitation vocation of these settings, confirming its positive impact on the outcomes considered. Other key factors that emerged included both clinical factors, such as pressure injuries, and social factors, like living alone. Normalised mean questionnaire scores were globally high, although analysis revealed variations among facilities depending on the question, highlighting potential areas for improvement and facilitating a positive deviance approach in examining best practices.

Further developments will include organisational assessments of Community Hospitals, regular sharing of questionnaire results, and an annual report to ensure ongoing quality improvement.

Preface

Building sustainable healthcare systems entails the promotion, development, implementation, and evaluation of strategies to ensure health services of high quality. It is now recognised that pursuing the goal of universal health coverage by providing poor quality services is counterproductive [1, 2]. Thus, it is critically important to have tools and methodologies to measure the quality of care delivered and, more generally, the performance of healthcare services.

Quality of care has now become an integral part of health services, and its evaluation should be structured and systematic; however, this has not always been the case in the past. In the face of a great and renewed focus on the quality of care delivered especially in the last five or six decades, previously quality-related initiatives were linked to great pioneering figures in this field whose work, bit by bit, laid the foundation for the approach we have today.

To ensure the quality of health services it is necessary to address various levels; certainly, the choice of organisational models can have an influence in this regard.

According to the World Health Organization, the common thread that should guide the strategic choices and design of services, and health systems more generally, is that they should be highly integrated and person-centred. This would enhance not only the quality of care delivered, but also equity of access, responsiveness and participation, efficiency and resilience [3]. Thus, it is crucial to develop health services through various settings, to build a network that can respond to the different (socio)health needs of people and toward whose components appropriate referral occurs.

Intermediate care can be an important building block in this regard. Developed mainly from UK in the late 1990s, these are basically understood as services that stand between the acute care hospital and home and can be implemented through different approaches, from bed-based services to services delivered directly at patient's home. Bed-based services took the form of Community Hospitals, also referred to in the literature as rural hospitals or hospital health centres, depending on the country.

Especially after the Coronavirus disease 2019 pandemic, there has been a major boost toward reorganisation and in particular the strengthening of the community-based component of health services, to which intermediate care has traditionally been ascribed, also to respond more appropriately to the evolving needs of the population.

Also, in the UK context, these services have received a great deal of attention over the years, starting with the operational effort of benchmarking among facilities that has been

producing performance assessments for many years now, providing concrete elements for evidence-informed decision making. Given the increasing importance that these settings may acquire over time, it is critical to assess the quality of the care they deliver, using specific indicators to maximise their impact and usefulness and to enhance their role in the health system. In addition to the use of more traditional indicators, it may be of interest to place side by side the use of indicators that the Organization for Economic Co-operation and Development defines as "new-generation". Patients' views, in terms of experience and reported outcomes, are formalised and incorporated into health system performance assessment. The use of different domains can broaden the perspective on potential targeted interventions to improve the quality of care.

Multiple sources of information can thus contribute to the assessment particularly of Community Hospitals, which are the most developed intermediate care setting in Italy, starting from databases that were not developed for this objective, but with administrative purposes, namely administrative data. These databases are the basis for the so-called Real-World Evidence/Evaluation, in somewhat reductive terms contrasted in methodological and literature discourse with approaches based on structured and rigid ad hoc data collections. Also, the strong involvement of health professionals and caregivers should be an integral part of the process of Real-World Evaluation of the care provided.

For the evaluation of the quality of care delivered by these facilities in Romagna's Local Healthcare Authority, some outcomes closely related to their salient features, such as length of stay, which should be limited to six weeks, and improvement in Activities of Daily Living at discharge, given their strong rehabilitative imprint, were examined. Readmissions to this type of facilities were also investigated in exploratory terms. The development of risk models, to identify factors associated with outcomes, and performance models, to compare performance across facilities, represents the focus of the work, alongside the evaluation of Patient-Reported Experience Measures questionnaires, to build a performance summary that encompasses different dimensions as outlined above.

The insights that emerge are interesting both in terms of confirming the effectiveness of some types of activities that are specifically carried out in these settings, namely rehabilitation, and in terms of the role not only of clinical factors, but also of social factors. On the performance of the different facilities a comparison can be set up that leads to the identification of good practices in place in the facilities with more favourable results.

The assessment and monitoring process needs to be continuous and dynamic; therefore, while agreeing to periodic discussions with professionals on the updating of these analyses, it is also essential to move toward expanding the assessment to include organisational factors that may contribute to differences across Community Hospitals.

In view of the above, this thesis work is presented in four blocks corresponding to its chapters. The first chapter is devoted to the quality of health services and represents an attempt at synthesis on the conceptualisation and evolution of quality of care, certainly not exhaustive, but functional in providing an overview on the topic. The great boost toward community-based care is addressed in the second chapter, in which the settings on which most attention is currently focused in Italy, Community Homes and Community Hospitals, are examined in depth, with a dutiful focus on Intermediate Care. The third chapter contains the analysis of original data; part of the results has been reported in four specific appendices for the sake of smoother reading in the main body. Finally, the fourth and last chapter focuses on the discussion on the work done and future prospects.

Chapter 1
Healthcare Services Quality Assessment

1.1 Historical Overview

In 1966, Avedis Donabedian (1919–2000) published an article that is now regarded as one of the fundamental contributions to the field of healthcare quality evaluation [4]. The article, titled "Evaluating the Quality of Medical Care", introduced the renowned conceptual framework that categorises quality indicators into "structure", "process", and "outcome". This categorisation allows a focus on various aspects, from the organisation of the health system (structure) to the way services are delivered (process) to the results of care (outcome). Limiting the discussion to the indicator framework alone would, however, be reductive; in fact, this work has not only the great merit of having introduced a conceptual framework for measuring quality, but also of stimulating a broader discourse on the subject, recognising the complexity of what is referred to as quality of care, considering the multidimensional nature and the interconnections between various dimensions, including aspects of values and ethics. It explored quality as perceived by patients and even laid the foundations for viewing quality improvement as a process to be pursued dynamically and continuously [5]. The fiftieth anniversary of the publication of the article was celebrated with Berwick and Fox writing about him:

"The organizing concepts of structure, process, and outcome remain central to measuring and improving quality. No less important has been his insistence that research on quality and the use of findings from that research should emphasize measurement, analysis, management, and governance [5]"

They emphasised a fundamental concept: not only it is important to implement efforts to measure what is being implemented and to improve our ability to interpret the data in practice, but these activities must also have a concrete impact on management and governance. Thus, quality measurement must be an integral part of a virtuous process, moving from the intention to measure healthcare activity, through the design and construction of a performance evaluation system, to a structured mechanism for informing decisions.

The concept of quality in health care has ancient roots. Consider, for example, Hippocratic medicine, which is based on the use of the best available evidence [6]. While the concept of quality of care did not originate with Donabedian, it was with him that it received greater structure. Historically, quality of care was associated more with the reputation of the doctor

or hospital rather than with objective measures. With the advent of the scientific and industrial revolutions, the importance of standardisation and measurement also began to emerge in healthcare services. From the second half of the nineteenth century, efforts to measure service quality became increasingly significant and began to acquire a more systematic approach. Florence Nightingale (1820 – 1910), the founder of modern nursing, is recognized as a pioneer in this field.

Nightingale is considered an early advocate of the environment as a therapeutic factor: in her "Notes on Nursing: What It Is, and What It Is Not [7]", she emphasised the importance of adequate ventilation and temperature, noise control, lighting, cleanliness, and an efficient sewage system, particularly in hospitals.

"It may seem a strange principle to enunciate as the very first requirement in a hospital that it should do the sick no harm [8]"

Nightingale realised that to improve British healthcare outcomes, it was necessary to work on some basic concepts such as hygiene of environments and lifestyles, the organisation of social welfare services, and the helping relationship with the sick. She demonstrated that basic sanitation and hygiene standards reduced mortality when caring for soldiers wounded in the Crimean War [9]. It was during this war that she began the work that would later lead her to be referred to as a "pioneer statistician". She began collecting statistics and applying mathematical models, through which she was able to prove the soundness of her theories, eventually leading to a significant reduction in mortality and morbidity rates, even among the civilian population. The so-called "wedge" graph, which Nightingale used to represent the causes of mortality during the Crimean War, can be considered one of the earliest examples of welfare applications. Her merit goes further: she used the statistics she had collected to demand reforms from the British Army and Government, using data to support the call for change [10]—realising, in essence, what Donabedian would emphasise a century later: data, methodology, and decision support.

A slightly later figure was the American surgeon Ernest Amory Codman (1869–1940), whose work is particularly recognised for its contribution to outcome studies, thanks to his "end result idea": patient outcomes should be monitored to assess the effectiveness of the care provided. This concept, commonplace today, was revolutionary for the time, particularly because Codman argued that hospitals should not only track but also publish their data to improve quality and transparency.

"We believe it is the duty of every hospital to establish a follow-up system, so that as far as possible, the result of every case will be available at all times for investigation by members of the staff, the trustees, or administration, or by other authorized investigators or statisticians [11]"

In 1914, Codman set up the Registry of Bone Sarcoma, the forerunner of all cancer registries, and published the results to demonstrate the effectiveness of his surgical techniques [12]. Codman's ideas were not well received at the time, and he faced considerable opposition from the medical community. However, his vision laid the foundation for the future development of quality assessment and patient safety.

Before the 1960s, quality of care was somewhat fragmented. Starting in the 1960s, interest in quality assessment in healthcare began to grow worldwide [13]. The adoption of statistical methods and the use of data to analyse clinical outcomes became increasingly widespread. In the 1970s, the concept of clinical audit emerged as a key tool for evaluating medical practice against defined standards, and the standardisation of clinical protocols began to take hold [14]. In 1972, the foundations for Evidence-Based Medicine (EBM) were laid when Archibald Cochrane (1909–1988) published ''Effectiveness and Efficiency: Random Reflections on Health Services" [15], commissioned by the Nuffield Provincial Hospitals Trust [16]:

"Two of the most striking changes in word usage in the last twenty years are the upgrading of "opinion" in comparison with other types of evidence, and the downgrading of the word "experiment" [15]"

The use of evidence is a key factor in improving the quality of care. The concept of EBM, later systematised by Gordon Guyatt et al. in the early 1990s [17], originated as an approach to clinical practice that is based on the use of the best available evidence and was subsequently expanded into the so-called Evidence-Based Public Health (EBPH). This defines a process that integrates evidence-based interventions with community preferences, with the overall aim of improving population health [18]. A further evolution, Evidence-Informed Public Health (EIPH), is strongly rooted in both EBM and EBPH, particularly emphasising that multiple factors might influence decision-making beyond scientific evidence alone [19]. Building EIPH interventions often requires a multidisciplinary process that takes place in a highly dynamic way and must deal with a sometimes-changing local context, following specific phases such as "define", "search", "appraise", "synthesise", "adapt", "implement", and "evaluate" [19]. An even broader concept, Evidence-Informed Decision-Making (EIDM), is described in a World Health Organization (WHO) report published in 2021 [20]. EIDM emphasises that health policy decisions and interventions should be informed by the best available evidence from research, but also by other factors such as context, public opinion, equity, feasibility, sustainability, and stakeholders' acceptability. As highlighted in this report, EIDM has great potential to improve the effectiveness, efficiency, and equity of health policies and interventions, facilitating a more effective use of resources, which are increasingly scarce in the healthcare sector.

However, even the best available evidence may not automatically lead to changes in policy or practice—the so-called research-to-policy gap. The WHO report emphasised that researchers often confront a literature that rarely provides empirical evidence of impact or a clear understanding of the policy-making process, while decision-makers frequently demand evidence that is more practice-based. Reciprocity and structured exchange between decision-makers and researchers is widely recognised as a key factor for effective EIDM [21]. Only a stable, codified, and sustained interaction over time can foster fruitful collaboration and bridge the gap between research and real-world practice.

From the second half of the 20th century, efforts to measure, standardise, and define methodological approaches to healthcare quality intensified, leading to the development of clinical governance:

> *"The framework through which healthcare organisations are accountable for continuously improving the quality of their services and safeguarding high quality of care [22]"*

Clinical governance represented a significant shift in system culture and was progressively enriched with components and methodologies such as EBM, guidelines, research and development, and clinical audit, among others [23]. Ideally, quality of care ceased to be a separate and parallel dimension and became an integral part of defining the system's strategic objectives, allocating resources, defining operational processes, and training healthcare professionals.

In modern times, quality assessment has become an integral part of everyday healthcare practice. Internationally, many initiatives concerning quality measurement and, more generally, health system performance assessment have been developed, such as those by the Organisation for Economic Co-operation and Development (OECD) [24] and the European Observatory on Health Systems and Policies [25]. In Italy, efforts have been made to encourage benchmarking at different levels (regional level, Local Healthcare Authority level, and facility levels), such as through the development of the National Outcomes Programme (*Programma Nazionale Esiti*, PNE [26]) and the Performance Evaluation System [27] developed by the Management and Healthcare Laboratory (MeS Laboratory), part of the Sant'Anna School of Advanced Studies [28]. With reference to the Italian context, some references to legislation and some of the main planning documents in relation to the quality of care are shown in table 1.

Legislative Decrees 502/517 (1992, 1993) [29, 30]	Criteria for accreditation of healthcare facilities
National Health Plan 1998/2000 [31]	Strong reorganisation and innovation in the Italian healthcare system. Improving the efficiency of the healthcare system, equity in access to care, focus on prevention, quality of care with a focus on the appropriateness of treatment and evaluation of hospital performance
Legislative Decree 229/99 [32]	Quality of services, adoption of quality indicators, continuous evaluation of the efficiency of health services
Legislative Decree 150/2009 [33]	Guidelines for performance evaluation in the public sector, including the health sector. Improving transparency, efficiency and quality of services provided by public administrations
Law 189/ 2012 (Balduzzi Decree) [34]	Evidence-based medicine (adoption of national clinical guidelines), medical liability, requalification of primary care, new organisational models
Ministerial Decree 70/2015 [35]	Quality, structural, technological and quantitative standards for hospital care in Italy
Law 125/2015 [36]	Appropriateness of prescription
National Chronicity Plan (2016) [37]	Improving the management of chronic diseases with targeted interventions on the quality of care, promoting an integrated and multidisciplinary approach
Digital Health Pact (2016) [38]	Key component for the modernisation and quality of the healthcare system, aim of improving access and quality of care through digital tools
Law 24/2017 (Gelli-Bianco Law) [39]	Safety of care and professional responsibility. Quality of care as integral part of the right to health, establishment of

	a national system for clinical risk management and patient safety
Establishment of the National Guidelines System [40]	Evaluation, updating, and publication of the guidelines
National Prevention Plan 2020-2025 (2020) [41]	Strategic actions in prevention, with a strong focus on quality of care, appropriateness of care and reduction of health inequalities
National Recovery and Resilience Plan - Mission 6: Health (2021) [42]	Investments aimed at improving access to care and the quality of health services. Enhancing digital health, telemedicine, and improving territorial healthcare
Ministerial Decree 77/2022 [43]	Milestone in the reform of territorial care. Strengthening proximity healthcare, implementing new organisational models that improve access and quality of care, through a more integrated network of territorial and hospital services

Table 1. Quality of care. Selected legislation and planning documents, Italy.

This chapter goes straight to the heart of the concept of quality of care and briefly summarises some key steps in its development. However, to better understand the current state of the art with respect to the measurement of quality of care, it is necessary to also explore the very meaning of quality of care or, rather, its definition.

> *"The widespread use of the term quality explains part of the confusion around the concept of healthcare quality when policymakers or researchers use the term for all kinds of positive or desirable attributes of health systems [44]"*

1.2 What We Mean by "Quality of Care"

There is wide recognition of the importance of "quality of care" in the health system, both in the literature and in the agenda of policymakers. However, this concept has evolved over time, differing depending on the context, disciplinary paradigms, and levels of analysis [44]. The recent and meaningful publication titled "Improving Healthcare Quality in Europe: Characteristics, Effectiveness and Implementation of Different Strategies" [44], systematised the state of the art on the subject (see table 2). The first reported definitions of "quality of care" referred to generic concepts such as "expectations" and "probabilities",

whereas more recent definitions focus on defined core dimensions of "quality of care": effectiveness, safety, and people-centredness. These build upon the framework devised within the OECD Healthcare Quality Indicators (HCQI) project, first published in 2006 [45] and further developed in subsequent years [46]. According to this framework, quality of care is part of a broader conceptualisation of health system performance, which also encompasses other dimensions, namely "access" and "cost/expenditure".

Donabedian (1980) In: "Explorations in quality assessment and monitoring. The definition of quality and approaches to its assessment"	Quality of care is the kind of care which is expected to maximize an inclusive measure of patient welfare, after one has taken account of the balance of expected gains and losses that attend the process of care in all its parts.
Institute of Medicine, IOM (1990) In: "Medicare: A Strategy for Quality Assurance"	Quality of care is the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.
Council of Europe (1997) In: "The development and implementation of quality improvement systems (QIS) in health care. Recommendation No. R (97) 17"	Quality of care is the degree to which the treatment dispensed increases the patient's chances of achieving the desired results and diminishes the chances of undesirable results, having regard to the current state of knowledge.
European Commission (2010) In: "Quality of Health care: policy actions at EU level. Reflection paper for the European Council"	[Good quality care is] health care that is effective, safe and responds to the needs and preference of patients. *The Paper also notes that "Other dimensions of quality of care, such as efficiency, access and equity, are seen as being part of a wider debate and are being addressed in other fora."*
WHO (2018)	Quality health services across the world should be:

In: "Handbook for national quality policy and strategy"	○ Effective: providing evidence-based health care services to those who need them. ○ Safe: avoiding harm to people for whom the care is intended. ○ People-centred: providing care that responds to individual preferences, needs and values. In order to realize the benefits of quality health care, health services must be timely […], equitable […], integrated […], and efficient […]

Table 2. Selected definition of quality, 1980-2018. Table from [44].

According to the latest definitions, quality of care encompasses two aspects on which there has traditionally been reflection and effort for a long time, and one aspect—patient-centredness—that, although a cornerstone of the medical profession, is a relatively new focus in terms of measurement. The ability to respond to patients' expectations has attracted much attention in recent years [47], leading to the development of specific patient-reported indicators, namely Patient-Reported Experience Measures (PREMs) and Patient-Reported Outcomes Measures (PROMs). The OECD has been at the forefront of this effort with its Patient-Reported Indicator Surveys (PaRIS) initiative, focused on developing these indicators to measure the "outcomes and experiences of healthcare that matter most to people" [48], with particular emphasis on Primary Care. In the Tuscany region, as of 2018, the PREMs Observatory was introduced to collect and provide managers and healthcare professionals with feedbacks from patients on their experience of ordinary hospitalisation, supporting improvements in service delivery processes [49].

The growing importance of patient-centredness is further highlighted by the recent renewed health system performance assessment framework developed by the OECD [50], which places "people's health needs and preferences" at its core. This is viewed from a dual perspective: as both an objective of health systems and a functional tool for achieving other policy objectives. This framework was developed in response to the Coronavirus disease 2019 (COVID-19) pandemic and global megatrends such as ageing, digitisation, and climate change. Interestingly, new dimensions such as environmental sustainability, resilience, and commercial determinants of health have been incorporated. Quality of care remains a fundamental objective of healthcare systems.

Chapter 2
Boosting Community Healthcare

2.1 A Renewed Focus

At the end of what is called by the WHO the Decade of Healthy Ageing (2020–2030), worldwide the number of people aged 60 and over will increase by 34.0%, from 1 billion in 2019 to 1.4 billion [51]. Estimates for 2050 are 2.1 billion. This demographic transition brings with it an epidemiological shift; in fact, disease patterns have also gradually changed over time. The scenario that is emerging is that of a progressively ageing population, with an increase in chronic diseases and frailty [52, 53], a condition characterised by an increased vulnerability to adverse events of endogenous and exogenous origin. This condition exposes individuals to a higher risk of negative outcomes such as falls, fractures, depression, delirium, cognitive impairment, hospitalisation, reduced self-sufficiency, need for long-term care, and premature death [54, 55]. With this comes the risk of increasing years of life spent in poor health.

According to the Global Burden of Disease (GBD)—a worldwide observational epidemiological study led by the Institute for Health Metrics and Evaluation (IHME)—since 1990, chronic diseases and injuries have increasingly contributed to the calculation of Disability-adjusted life years (DALYs) [56]. A DALY represents the loss of the equivalent of one year of life spent in good health. Data show how disability, especially in older population groups, underpins the disease burden of an ageing population, significantly impacting health needs and the cost of care. What is required is a progressive change in care models aimed at improving healthcare appropriateness, stratified by health needs.

The COVID-19 pandemic has brought to the surface and, in some cases, exacerbated pre-existing issues within healthcare systems. While the fundamental role of Primary Health Care has been confirmed, it has been widely recognised that its potential has not yet been fully realised [57]. Thus, a renewed focus on primary care systems and, more generally, on community-based care has developed.

The Italian National Recovery and Resilience Plan (*Piano Nazionale di Ripresa e Resilienza*, PNRR) [42] and National Decree No. 77 [43] boosted the reorganisation of community-based care, focusing on Community Homes (CHs), an evolution of Healthcare Homes (HHs), and Community Hospitals (CoHs). These two settings were already present in some Italian regions, including Emilia-Romagna region, and are now setting the standards for territorial care at the national level. In addition to these settings, the decree emphasised the implementation of new professional roles, such as the "community and family nurse", and

the development of new organisational models. It also defined junction points between services, such as the "territorial operations centre", which is central to transitional care, aiming to create the most integrated care possible.

This reform represents not only a significant organisational change but also a cultural paradigm shift. It attempts to bring to life principles and concepts that have long been discussed, such as the need for a proactive approach and early detection of people's needs. However, attempts to implement these concepts have so far proven unsatisfactory.

Efforts are being made to improve accessibility to services by expanding the presence of non-hospital structures throughout the territory and assigning specific functions to the community and family nurse, such as directing people to the most appropriate services based on their health needs. CHs facilities are becoming not only places for the provision of services but also community meeting and participation points. This is an ambitious reform that will continue to require substantial efforts.

2.2 Healthcare Homes: The Example of the Romagna Local Healthcare Authority

The region of Emilia-Romagna was one of the first in Italy to introduce HHs in an experimental way, regulating them through the first regional norm in 2010, later updated in 2016. Decree No. 77 envisages the development, by 2026, of 89 hub CHs, 45 CoHs, and 45 territorial operations centres in this region.

Precisely in light of this territorial care reform, a project was carried out in Romagna's Local Healthcare Authority (RLHA), the southernmost part of the Emilia-Romagna region, in 2022 to explore organisational solutions and management approaches for HHs. The project aimed to assess the current "maturity" of these settings in view of their envisaged transition to CHs [58].

In the first stage, a review of the international, national, and regional normative documents and of scientific literature was conducted to identify guiding principles for community-based care. In the second stage, based on the review results, an interview scheme was developed, including sections on general information, location and size, hub-and-spoke network configurations, key professional roles, board of directors, communication flows, and clinical and social integration. A sample of seven HHs was selected, and 14 healthcare professionals were interviewed. Content analysis was carried out, and the results were validated in two communities of practice.

It is interesting to note that 6 out of 7 HHs were the result of hospital conversions. There were some differences in the services provided; in some cases, these were purely clinical,

while in others there was a closer connection with the social services. An outpatient clinic for patients with chronic conditions was consistently established. Informal communication among the professionals working in HHs was found to be critical and was especially facilitated by spatial proximity. However, structured information sharing through digital tools remained an issue. The organisational manager of the HH was always a nurse, overseeing a variable number of facilities that did not necessarily coincide with the hub&spoke network, often being managed based on geographic divisions rather than functional ones.

Among the various organisational, managerial, and procedural solutions, an interesting finding was the different configurations of managerial boards in these structures, as shown in table 3.

Boards dedicated to one HH only and overseeing strategic planning
Boards related to one HH only, but responsible of operational planning, while strategic issues are centralised
Boards common to more HHs (not necessarily coinciding with the hub&spoke network), which oversee strategic or operational planning
Hybrid configuration, with boards involved in both strategic and operational planning activities simultaneously

Table 3. Different configurations of the managerial board. Elaborated from [58].

The project's conclusions, which can be better explored by reading the full article, highlight how pre-existing structures can influence the network configuration of HHs and the services provided. Decisions regarding these settings, such as the implementation of specific services, could depend on the expertise available and the practices established over time. Organisational culture also plays an important role, particularly in fostering the ability to work in networks. The organisation of these settings may be influenced by the strength of connections with external actors, such as social services or voluntary associations. What emerges is how much the organisation is shaped by contextual factors, underscoring the importance of studying variability in organisational and managerial solutions to maximise value. The overview of HHs, in light of their transition to CHs, suggests that, in organising health services, there may not be a single best solution for all contexts. Instead, the optimal approach is a "best fit", balancing between standardisation and customisation. Another key point is the need to develop information systems and a structured monitoring system, which are currently lacking in these settings, to better understand what works under which conditions.

2.3. Intermediate Care

The progressive ageing of the population, frailty, and multimorbidity, require care that addresses clinical conditions adequately and, at the same time, ensures holistic patient care through the development of integrated care models to address complex needs [59]. The traditional hospital approach, still largely based on functionally and structurally closed organisational models built around individual disciplines, has proved unable to respond adequately on its own to these complex health needs, which require multidisciplinary and coordinated care across different settings [60]. This is understandable, as hospitals have evolved as places for the treatment of acute events in an epidemiological context different from today's. The role of hospitals is specifically to manage individuals suffering from acute medical or surgical conditions with significant functional impairment, and to manage scheduled activities that require a technologically and organisationally complex context [61].

Therefore, it is necessary to enhance the proactive management of chronic diseases, territorial care services, and real integration among the different levels of care and between all the types of settings involved—specifically, between hospitals and community-based services [62, 63, 64].

Since the late 1990s, intermediate care services for the elderly and frail have been developed across Europe to ensure an intensity of care appropriate to different health needs [65, 66]. Specifically, the term "intermediate care" was introduced in the United Kingdom's NHS Plan [67] and further refined in the "National Service Framework for Older People" [68]. The main objectives of these settings — "promoting independence" and "preventing unnecessary hospital admissions"—were considered to be pursued through the provision of new services between hospital and home, without defining a specific model for service delivery [69]. Several definitions have been developed, the broadest of which comes from the Royal College of Physicians of London, which defines intermediate care as services that do not require the resources of a hospital but are beyond the scope of traditional primary care teams [70].

According to the realist review by Pearson et al [71], intermediate care aims to provide care for older patients and those with complex conditions, going beyond the specificity of a single disease or condition, and providing support to patients both in residential settings (CoHs, nursing homes, etc.) and at home. In addition, the service should be time-limited (maximum 6 weeks), with a primarily rehabilitative focus, emphasising therapeutic education and self-care, while ensuring continuity and coordination between different settings and services (health, social, etc.). Intermediate care services should help counteract

functional and cognitive decline, improve the quality of life, and reduce long-term institutionalisation.

The conceptual framework subsequently developed by Pearson et al. [72] provides a foundation for understanding how intermediate care is delivered and helps identify factors that may undermine effective provision. The authors suggest that this framework is useful for designing an evidence-based "roadmap", identifying key factors for decision-makers to critically consider when planning intermediate care services in a specific local context. In September 2017, the National Institute for Health and Care Excellence (NICE) published guidelines specific to Intermediate Care. This document contains detailed recommendations on the core principles of intermediate care, with a focus on rehabilitation, assessment of needs, referrals, and entry into intermediate care. Interestingly, recommendations are also provided regarding how intermediate care should be delivered, emphasising the importance of an approach tailored as much as possible to the person's needs and shared goals. The types of services that may fall under intermediate care are also outlined and categorised into four classes, namely home-based intermediate care, reablement, bed-based intermediate care, and crisis response, which will be explored further in the text. A year later, NICE published four quality statements regarding intermediate care, reinforcing the importance of communication and shared pathways between patients and health professionals [73]:

- Statement 1: Adults being assessed for intermediate care have a discussion about the support the service will and will not provide.
- Statement 2: Adults accepted for bed-based intermediate care start the service within two days of referral.
- Statement 3: Adults starting intermediate care discuss and agree personalised goals.
- Statement 4: Adults using intermediate care services discuss and agree a transition plan for when their support ends.

As of 2019, according to NHS England, intermediate care services are provided to patients, usually older people, after they leave the hospital or when they are at risk of being admitted to hospital. These services provide a link between hospitals and patients' homes, and between different parts of the health and social care system: community services, hospitals, general practitioners, and social care [74]. Intermediate care should provide person-centred care, involving family and carers, and promote self-management of the condition [75].

With respect to the outlined objectives, those of intermediate care services can be summarised into two broad categories:

- Preventive: To avoid unnecessary hospitalisation and delayed discharge by providing alternatives to hospital care, meeting health needs with an intensity proportionate to the care required, and achieving greater system efficiency; interestingly, a recent study explored this goal through simulations aimed at reducing waiting times for access to these settings in the Netherlands, with potential impacts on reducing avoidable hospitalisations in acute care settings [76];
- Rehabilitative: To support discharge, facilitate access to rehabilitation and functional recovery services, and assist the patient's return home.

A recent scoping review examined the characteristics that should define intermediate care [77]: *"There was agreement that intermediate care represents time-limited services which ensure continuity and quality of care, promote recovery, restore independence and confidence at the interface between home and acute services, with transitional care representing a subset of intermediate care. Models are best delivered by an interdisciplinary team within an integrated health and social care system where a single contact point optimises service access, communication and coordination"*.

Beyond definitions, the importance of the rehabilitative role of these settings is underscored by the 2023 NHS "Intermediate care framework for rehabilitation, reablement and recovery following hospital discharge", which focuses on priorities and best practices to be pursued to strengthen this role [78]. Of note, the importance of focusing on the development of real-time data to be integrated into day-to-day operational practice and the statement that NHS England is developing a new national standard for rapid discharge into intermediate care.

2.3.1 The National Audit of Intermediate Care

One of the main structured efforts in the evaluation and monitoring of intermediate care services has been the National Audit of Intermediate Care (NAIC), an audit of the commissioning and provision of intermediate care in England and Wales. It collected data from 2012 to 2018, run by the NHS Benchmarking Network, and has more recently become part of the core work of the network as the Intermediate Care project [79]. Specifically, the NAIC focused on two levels:

- Organisational level audit, which collected annual data on the service model, measures taken, funding received, staffing, etc.;
- Patient level audit, which used indicators such as the Modified Barthel Index (MBI) as measure of the Activities of Daily Living (ADL) to investigate the patient's degree of functional independence at admission and discharge, and assessed patient experience using PREMs questionnaires.

The audit covered the four categories of intermediate care services that have developed in the United Kingdom:

- Crisis response: services providing short-term care for up to 48 hours;
- Bed-based services: services that provide care in facilities with beds, such as CoHs;
- Home-based services: basic home-based services providing care directly in people's homes;
- Reablement: services aimed at social reintegration.

According to the 2015 report [80], the age of most patients using intermediate care services was over 65. Bed-based services in particular had an older profile, with 51.0% of patients over the age of 85, compared with 39.0% for home-based services and 43.0% for reablement services. Noteworthy was the percentage of patients who improved their level of dependency: 86.5% for patients in bed-based services, 76.1% in reablement services, and 71.7% in home-based services respectively. The audit also collected data on the mix of disciplines working in intermediate care, and the 2015 survey also focused on the development of "transdisciplinary" roles. The clinical governance model was also analysed. The 2015 NAIC introduced a new set of questions to assess the accessibility of mental health support services at the intermediate care level. Subsequently, the 2018 NAIC [81] confirmed positive results for this type of services.

2.3.2 Intermediate Care in Italy: Community Hospitals

The previously mentioned 2021 National Recovery and Resilience Plan allocated funds to strengthen community-based health care, with an estimated total investment of € 1 billion for the construction of 381 CoHs by mid-2026.

In Italy, three National Health Plans have addressed the issue of service integration and promoted the development of intermediate care services. The need for greater integration between hospitals and home care emerged in 2003 with the National Health Plan (NHP) 2003–2005, which paid particular attention to the rehabilitation sector [82]. In the subsequent NHP 2006–2008, emphasis was placed for the first time on intermediate care services, particularly on specific settings such as CoHs, which act as a "link" between primary care and hospital care. These facilities, managed by general practitioners, are dedicated to sustaining the recovery process of patients discharged from acute or post-acute units [83].
A community-based organisation for the management of chronic conditions was envisaged by the NHP 2011–2013, which introduced community-based beds and residential services managed by general practitioners and nurses within specialised intermediate care facilities. This contributed to the development of CoHs as a response to the need for integration across different care settings [84].

The Health Pact 2014–2016 [85] and Ministerial Decree No. 70, which regulated hospital standards, provided specific guidelines regarding the development of intermediate care services, mainly conceived as "bed-based" services with community-based management. In particular, the Decree outlined the characteristics and requirements for CoHs, including the number of beds, the professionals involved in care provision, organisational and managerial responsibilities, length of stay, access modalities, and the types of eligible patients (see table 4).

Facility with a limited number of beds (15–20) staffed by nurses, where medical care is provided by general practitioners or paediatricians or other physicians employed by or contracted with the NHS
Hygienic organisational and management responsibility lies within the socio-health district, which also provides the necessary experts advice
Patients who require health interventions that could potentially be provided at home, but require admission to these facilities due to lack of home suitability (structural and familiar); or continuous nursing supervision
The average expected hospital stay is 15 to 20 days
Access can be from home or residential care, on the recommendation of the general practitioner, from hospital wards or directly from the emergency department
Care will be provided on a 24-hour basis by nurses and support staff, general practitioners, paediatricians, and continuity of care physicians
The physical location of the community hospital may be in a converted hospital ward and/or in a residential facility

Table 4. Community Hospitals according to Ministerial Decree n. 70/2015 [35].

CoHs were also mentioned in the 2016 National Chronicity Plan, which focused on the implementation of specific services and care pathways for elderly and frail patients, integrating these facilities into the overall network of services [86].

On February 20th 2020, an agreement was reached at the State-Regional Conference on CoHs, defining the minimum structural, technological, and organisational requirements for authorisation to operate. These guidelines aligned with the indications of the 2014–2016 Health Pact and Ministerial Decree No. 70 [87]. One of the innovations introduced in intermediate care was the distinction between managerial/organisational and clinical responsibilities within the facility management function, which was formalised in this document.

A snapshot of the development of CoHs across Italian regions can be found in a document on intermediate care requested by the Conference of the Regions in December 2020, commissioned by the Social Affairs Department of the Study Service of the Chamber of Deputies. Emilia-Romagna region, acting as coordinator, requested that the Regions and Autonomous Provinces provide a list of HHs and CoHs in their territories. Based on this documentation, the Technical Secretariat of the "Community-based Assistance" area prepared the "Report on the Development of Health Homes and Community Hospitals in the Italian Regions (year 2020)" in February 2021 [88].

An important point concerns the types of patients eligible for CoHs. According to the State–Region Agreement of February 20th 2020, eligible patients are those with minor acute diseases that do not require hospitalisation, or those with exacerbated chronic conditions needing to complete their clinical stabilisation, with a prognostic assessment of short-term resolution (15–20 days). These patients may come from home, other residential facilities, emergency departments, or be discharged from hospitals. Previously, different eligibility criteria existed among regions, as highlighted in the 2017/2018 report of the Non-Self-Sufficiency Network [89]. According to this report, CoH facilities were mostly located in hospitals that have been converted into outpatient facilities. In only a few cases have they been placed within hospitals or socio-health residential facilities.

In Emilia-Romagna region, CoHs have been established since 2013 as part of the redefinition of community-based services and hospital network [90]. To monitor the care provided by these facilities, a regional administrative data flow (SIRCO) was in parallel established [91]. Particularly, the purposes of the data flow are:

- assessment of the quality of care and volume of services;
- monitoring of the care pathway;
- epidemiological assessments of the characteristics of users accessing intermediate care facilities;
- support for the construction of structure, process and outcome indicators, and service planning.

The data collected refer to sociodemographic characteristics of the patients; hospitalisation's characteristics such as the reason for admission, diagnoses, source of referral, and destination at discharge; presence or occurrence of pressure injuries; and presence of any social issues. ADL are also recorded through the MBI scale both on admission and discharge to define the patient's level of dependence on a scale from 0 to 100, where 0 represents maximum dependence, 100 the maximum level of autonomy.

2.3.3 Community Hospitals: Insights from the Literature

The article by Pianori et al. (2016) [92] examined patients discharged from 14 CoHs in Emilia-Romagna region. The main reasons for admission were: nursing supervision and care (40.7%), rehabilitative care (37.7%), patient or carer education (12.0%), minor acute or chronic illness (5.5%) or other (4.1%). The patients were predominantly elderly, with 75.3% having multiple chronic conditions. Specifically, one-third of the study population presented a multimorbidity profile, including heart failure, arrhythmia and conduction disorders, renal disease and chronic lung disease. The presence of patients with multiple organ failure varied across facilities, suggesting that patient access may depend on different organisational factors.

The study found that in Emilia-Romagna region, 71.8% of patients admitted to CoHs came from an acute hospital, while 27.0% came from home. This reflects the heterogeneity, of patient origins and aligns with the role of CoHs, which can adapt to the needs of their catchment area, as supported by another study by Pianori et al [93]. However, it also highlights potentially different ways of working among professionals in various contexts involved in referring patients to these facilities. Another important finding was the high 90-day hospital readmission rate of 20.2% [92], underscoring the need to review patient access criteria in relation to the health needs of the target population to prevent potentially avoidable hospitalisations. In this regard, the second study identified several predictors of unplanned transfer to acute hospitals: chronic kidney disease, lower independence at admission, and longer length of stay. Predictors of longer stays included female gender, hip fracture, cerebrovascular disease, and again, lower independence at admission.

CoHs have developed not only in Italy, but also internationally. Many examples from the literature demonstrate the considerable variability in the definition and role of these facilities across different countries.

A 2016 scoping review [94] covering the period from 2005 to 2014 provided a range of definitions for this type of setting in high-income countries. The review revealed significant variability in the services provided by CoHs, as well as in the mix of skills among healthcare professionals. Different professionals, in addition to general practitioners and nurses, contributed to the development of a framework focused on the nature and aims of these facilities, which is illustrated by a figure from the same article (see figure 1): *"This conceptualisation sees community hospitals as occupying the space between, and to some extent encompassing, primary care services, nursing and residential care services, and acute hospital care. At the same time, the services provided by community hospitals span acute, chronic and end-of-life care"*.

Thus, this figure is paradigmatic in summarising how flexible the definition of this type of setting can be in terms of service delivery, being able to range from services more closely aligned with primary care to services more closely aligned with acute hospital, and, consequently, in terms of population served, being able to range between acute and chronic needs.

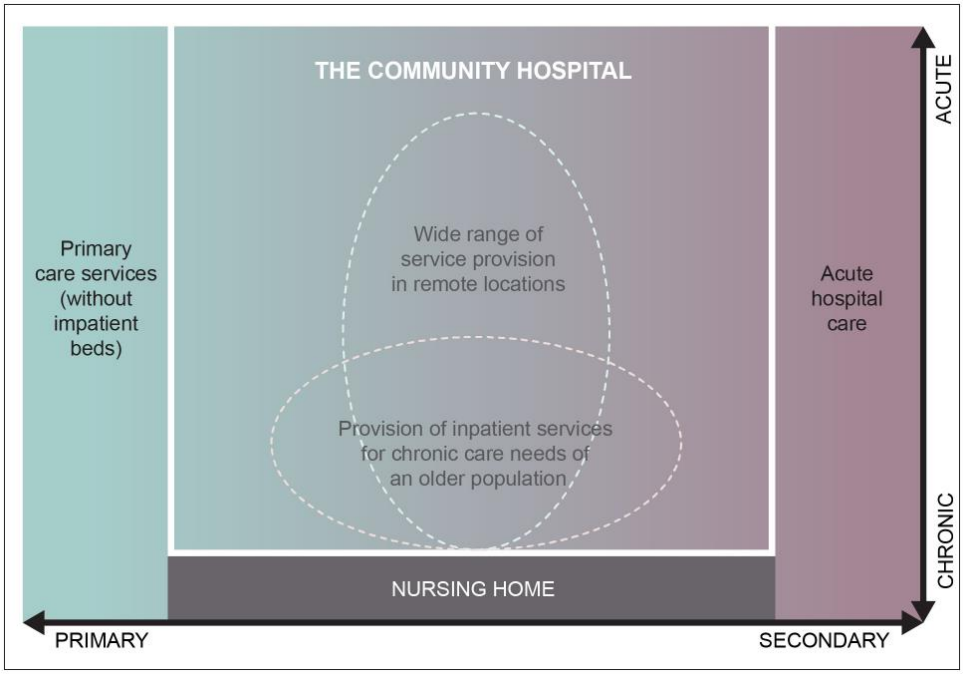

Figure 1. Nature and Scope of Community Hospitals. Figure from [94].

This great flexibility is found across different countries, where these settings, identified not only as CoHs, but also as rural, regional, base, general practitioners, intermediate care hospitals, or even as hospital health centres, covered wide areas of care, from preventive and primary care to outpatient services, inpatient medical care, surgery, minor injuries, and accident and emergency care. Notably, the introduction of innovative service delivery methods that had not been previously available, such as fracture clinics, or chemotherapy services, has been reported by several studies, emphasising how much the inherent flexibility of these settings can also allow them to range in terms of innovation.

In England and Scotland, where these settings have a more established tradition, studies particularly reported on the provision of non-acute hospital services, such as post-acute geriatric care, rehabilitation services, and palliative care, in line with the rehabilitation-type goal pursued in the first instance within the NHS. Several CoHs in the United Kingdom offered all or most of the non-acute hospital care for people with chronic or elderly conditions. Similarly, CoHs in Ireland provided services for the elderly such as relief care, rehabilitation, and palliative care.

In Australia, New Zealand and Canada, the type of services offered was wide, including, for example, maternity services, reflecting the geographic peculiarities of these countries and in particular the presence of vast remote areas, which is also reflected in the designation of these settings in these contexts, namely rural hospitals. A recent study from New Zealand focused on community perspectives regarding the role of these settings in a low socioeconomic context, highlighting some interesting themes. Participants viewed the rural hospital as a safety net—a place where the entire family could receive support, where individualised and culturally appropriate care is provided, and where efforts are made to optimise resources and deliver the best possible care despite limitations [95].

Also, regarding Norway, studies described intermediate care for people who would otherwise be at risk of prolonged hospitalisation or inappropriate admission to acute hospitals, including the chronically ill and elderly. A notable case of CoH was *Hallingdal Sjukestugu* in central Norway, described as a "decentralised specialised health service" run by family doctors under telephone supervision from specialists working an acute hospital 170 km away. This CoH included an inpatient unit functioning as an intermediate care unit, as well as for example psychiatric and outpatient services, and ambulance and air ambulance services. The role of technology, and in particular video consultations in emergencies, was also explored by a recent study on patient experience in a rural community hospital in northern Sweden with mixed results [96]. The use of telemedicine and new technologies to expand the range of services offered and increase level of care specialisation was quite highlighted by the review, with examples such as tele-ophthalmology services or video conferencing equipment for medical oncology services.

An experience in the Netherlands described a CoH where the 20 beds were designated as "general practitioner beds", "recovery beds" for rehabilitation of postoperative patients, or "nursing home beds" for patients awaiting admission to a nursing home. The reported services included low-level care and observation, diagnostic facilities, allied health services, and outpatient clinics.

Chapter 3
Real-World Assessment of Community Hospitals in Romagna's Local Healthcare Authority

3.1 The Romagna Local Healthcare Authority

The Romagna Local Health Authority (RLHA) was established by Regional Law No. 22 of 21 November 2013, following the merger of the LHAs of Cesena, Forlì, Ravenna, and Rimini [97].

As reported in the 2021 Health Profile, the RLHA covers an area of about 5160 km^2 and includes 75 municipalities organised into eight Socio-Health Districts: Cesena e Valle Savio, Rubicone, Forlì, Faenza, Lugo, Ravenna, Riccione, and Rimini [98, 99].

The resident population is 1,128,000, with a higher density in the lowland areas and in the southern districts (see figure 2).

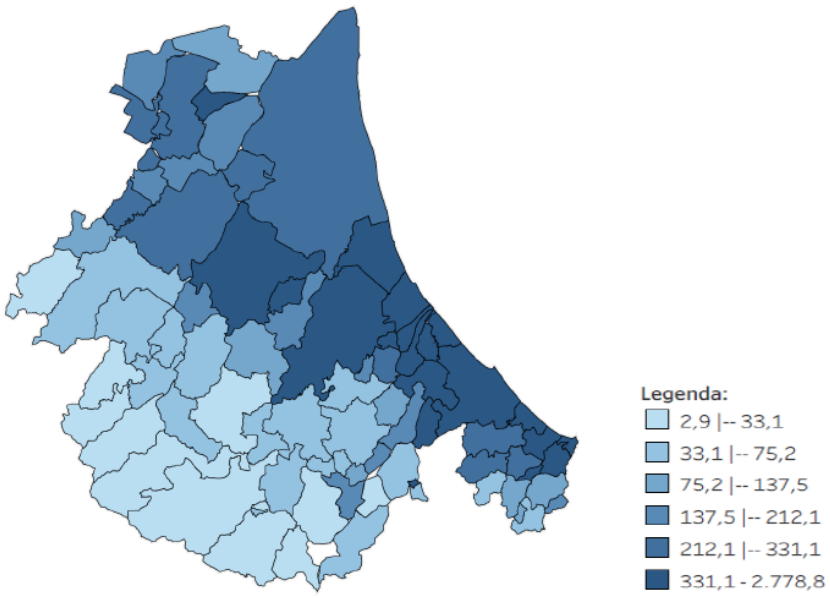

Figure 2. RLHA. Population Density (inhabitants/km^2), Year 2021. Image from Health Profile 2021 [98].

Like Italy as a whole and many other countries, the area of Romagna is undergoing a demographic transition, with a gradual increase in the older segments of the population. As reported in the Health Profile, as an example, people aged 80 years and older increased from 56,000 in 2002 to 95,500 in 2020. Currently, people over 65 years of age exceed 275,000, making up about a quarter of the resident population. In 2021, the old-age index—the ratio

of the elderly population (65 years and older) to that younger (0-14 years)—was 195, exceeding the regional value of 190.

Hospital care is provided by hospitals located in Cesena, Forlì, Faenza, Lugo, Ravenna, Rimini, and Riccione [100]. Additionally, at the time of writing, the area comprised 38 CHs and seven CoHs. The RLHA employs approximately 17,000 staff members.

3.2 Aims

Given the distinctive characteristics of CoHs outlined in depth in Chapter 2, the aim of this study is threefold. In particular:

- Characterising the case-mix of patients admitted to the CoHs of the RLHA, their referral source and their destination at discharge, and evaluating a set of indicators for quality-of-care assessment for these specific settings;
- Identifying the predictors of (1) lengths of stay longer than 42 days, (2) changes in ADL from admission measured through the MBI score, and (3) re-admissions to these facilities and evaluating the performance of individual CoHs according to these outcomes;
- Evaluating the implementation and usefulness of a PREMs questionnaire for quality assessment in these settings.

3.3 Methods

This retrospective observational study includes all patients discharged from January 2021 to December 2023 from the seven CoHs of the RLHA. Data were retrieved from the regional information system of CoHs (SIRCO) [101], and include different information such as socio-demographic characteristics, destination at discharge and MBI score on admission and discharge.

The study "OSCO-QUALITY" was approved by the Romagna Ethics Committee on November 9th 2023, protocol 6842/2023, I.5/193.

Descriptive statistics were carried out on patients admitted to CoHs and on the total number of admissions, to accommodate for multiple admissions per patient. Particularly, reasons for admission, main diagnosis, source of referral, and destination at discharge were examined in detail, both overall and by CoH. A Sankey diagram was used to graphically depict the patient flow from referral to discharge.

The outcomes of interest, i.e. length of stay longer than 42 days, improvement in the ADL measured through MBI score defined as an increase > 10 from admission to discharge, and readmissions to these facilities were first summarised using descriptive statistics, box- and dot-plots and compared among CoHs using chi-squared tests. Subsequently, for binary outcomes, a logistic regression analysis was carried out to build a risk model that included both baseline and process covariates. In these analyses, two CoHs that started their activity later than 2021 were excluded (CoH_1 and CoH_6). The analyses related to improvement in the ADL were carried out excluding patients deceased during hospital stay and, for the regressions, patients with an admission MBI score > 90 [93]. The readmissions analyses were carried out excluding deceased patients and patients with the index hospitalisation after June 30th 2023.The presence of multiple hospitalisations was addressed using robust standard errors.

Multiple variables were considered for adjustment, both in terms of patient socio-demographic characteristics (e.g., "age", "sex") and in terms of additional variables that might imply differences among facilities and influence patients' care pathways (e.g., "reasons for admission", social issues). Covariate selection followed the model building method proposed by Hosmer and Lemeshow [102]. "Marital status" and "level of education" were excluded from the analyses because of the high proportion of cases with missing information, while "relational issues", "housing difficulties", "absence of caregiver", "continuous nursing monitoring" and "chronic disease flared up" were excluded because of the high variability among CoHs. Quartile design variables method was used for identifying non-linear covariates in the logit scale, while the method of fractional polynomials was used to select the ideal transformation of such covariates for the logistic regression [103, 104, 105]. Forest plot was used to illustrate regression estimates. The goodness of fit of the models was evaluated using the Hosmer–Lemeshow test and the area under the curve (AUC). Confidence intervals of the AUC were calculated using bootstrapping. Logistic regression diagnostics included two influence statistics: Pregibon's $\Delta\beta$ and Hosmer's $\Delta\chi^2$ [102, 106].

Patients' experience was assessed through an anonymous digital or paper survey using the PREMs for intermediate care services, a questionnaire validated in Italian [107]. Specifically, the questionnaire includes sixteen questions about the patient's perceived experience relating to dimensions such as, for example, involvement in setting personalised goals of hospitalisation and in decision making about care, perception of being treated with respect and dignity, trust in staff, and having received sufficient information. The use of the questionnaire was proposed in the RLHA in April 2022; afterwards, a number of meetings with healthcare professionals were held regarding its implementation and to discuss any critical issues. Questionnaire data analyses refer to the period from September 1st 2022 to

December 31st 2023. Observations with missing CoH were excluded from the analyses. Stacked bar charts were used to describe the frequency distribution of all answers by CoH. Following [108], a set of questions in the questionnaire was scored and results were then summarised by normalising the mean score per CoH accounting for missing values. Box plots were used to visualise the distribution of these scores.

Finally, for the years 2023, the full set of indicators was normalized and reported in a bar chart to obtain a performance summary per facility that included different dimensions of quality of care, with higher bars corresponding to better performance for each specific indicator.

Analyses were conducted using Stata 18 [109] and Python [110] software.

In October 2024, the results of the analyses were shared and discussed with RLHA professionals in a specific working group on innovation and evaluation of CoHs.

3.4 Results

From 2021 to 2023, 3537 patients were admitted to the seven CoHs of RLHA, resulting in 3981 hospitalisations. Sociodemographic characteristics of the sample are shown in table 5, while the total number of admissions over the three years is summarised in table 6. The average annual number of admissions per facility was 189.6.

	CoH_1	CoH_2	CoH_3	CoH_4	CoH_5	CoH_6	CoH_7
Female (%)	69.9%	58.8%	57.3%	61.9%	62.1%	54.0%	62.4%
Age [yr] (mean±SD)	80.6±10.7	80.2 ±11.4	77.5 ± 12.8	81.7±8.8	80.6±10.8	76.4 ±13.9	80.7 ± 11.5
Italian citizenship (%)	97.4%	98.2%	95.9%	98.7%	97.2%	96.0%	99.5%
Marital status							
Unmarried (%)	12.2%	15.9%	11.5%	8.7%	14.2%	6.8%	6.2%
Married (%)	31.0%	30.3%	22.5%	42.0%	23.9%	33.5%	12.6%
Separated (%)	1.3%	4.0%	30.0%	3.4%	1.9%	3.4%	0.5%
Divorced (%)	3.1%	4.0%	2.1%	2.0%	3.8%	0.6%	0.3%
Widowed (%)	44.1%	45.5%	25.4%	44.5%	43.3%	19.9%	17.6%
N/A (%)	8.3%	0.4%	35.5%	0.0%	12.9%	35.8%	62.9%
Level of education (%)							
Primary school	62.0%	61.4%	3.6%	59.1%	4.3%	1.7%	22.5%
Middle school	17.0%	27.1%	2.5%	18.9%	4.0%	0.0%	9.4%
High school	10.9%	8.7%	3.0%	14.0%	1.6%	0.0%	4.0%
Academic degree	3.9%	2.5%	0.7%	4.2%	0.7%	1.1%	0.3%

N/A	6.1%	0.4%	90.2%	3.8%	89.4%	97.2%	63.9%

Table 5. Sociodemographic Characteristics of the Patient Admitted to the Community Hospitals of Romagna's Local Healthcare Authority from 2021 to 2023.

Year	Frequency (%)
2021	1,116 (28.0)
2022	1,280 (32.2)
2023	1,585 (39.8)
Total	3,981 (100.0)

Table 6. Yearly Admissions to the Community Hospitals of Romagna's Local Healthcare Authority (2021–2023).

A total of 137 falls occurred during hospitalisations (3.4%). In the study period, the rate of pressure injuries occurring during hospitalisation declined, from 7.5% (2021), to 6.6% (2022) to 6.3% (2023).

3.4.1 Reasons for admission, referral and discharge

The reasons for admission are described in table 7. Of note, it was possible to report multiple reasons for a single hospitalisation, up to a maximum of nine. "Functional reactivation" and "rehabilitative/re-educational/single-district interventions of completion of comprehensive interventions" (henceforth, "rehabilitation") were the most frequent, accounting for almost half of the reasons.

Reasons for admission	Frequency (%)
Functional reactivation	2,082 (24.7)
Rehabilitative/re-educational/single-district interventions or completion of comprehensive interventions ("rehabilitation")	1,911 (22.7)
Clinical monitoring and therapeutic stabilisation	1,390 (16.5)
Patient and carer education/training	1,021 (12.1)
Continuous nursing monitoring and care	986 (11.7)
Chronic disease flared up	579 (6.9)
Other	378 (4.5)
Minor acuities	54 (0.6)
COVID-19 patient	34 (0.4)

Total	8,435 (100.0)

Table 7. Reasons for Admission to the Community Hospitals of Romagna's Local Healthcare Authority (2021-2023).

The main diagnoses with a frequency greater than 1.0% are shown in table 8. Those with a frequency < 1.0% are merged into the "other" category. The rehabilitation/functional category stood out, with the most frequent diagnoses being "physiotherapy" and "consequences of femoral neck fractures". Trauma-related diagnoses together reached 8.8%, while cancer-related diagnoses nearly 3.0%.

Main diagnoses	Frequency (%)
Physiotherapy	788 (19.8)
Consequences of femoral neck fractures	376 (9.4)
Consequences of complications of medical and surgical treatment	309 (7.8)
Treatment requiring the use of other specific rehabilitation procedures	165 (4.1)
Other sequelae of cerebrovascular disease	111 (2.8)
Fracture of an unspecified part of the femur	66 (1.7)
Congestive heart failure unspecified	63 (1.6)
Bedding condition	60 (1.5)
Muscle atrophy from inactivity not elsewhere classified	43 (1.1)
Treatment requiring an unspecified rehabilitation procedure	42 (1.1)
Senility without psychosis	42 (1.1)
Other	1,876 (47.1)
Total	3,981 (100.0)

Table 8. Main Diagnosis of Patients Admitted to The Community Hospitals of Romagna's Local Healthcare Authority (2021-2023).

Figure 3 shows in deeper detail the pathway connecting the referral source with patients' destination at discharge. The Sankey diagram indicates that the largest proportion of admissions was from "public hospital", followed to a lesser extent by "domicile", while "home" represented the most common destination at discharge, both in terms of ordinary and sheltered discharges.

When focusing on the source of referral by CoHs (see figure 4), two CoHs in particular received a significant proportion of admissions from the "domicile", which probably highlights context-specific attitudes in the way professionals work and interact. Another noteworthy element is the referral from other intermediate care facilities, especially in CoH_1. As for the destination at discharge (see figure 5), no differences emerged among CoHs, except for CoH_5 that had a lower proportion of ordinary home discharges.

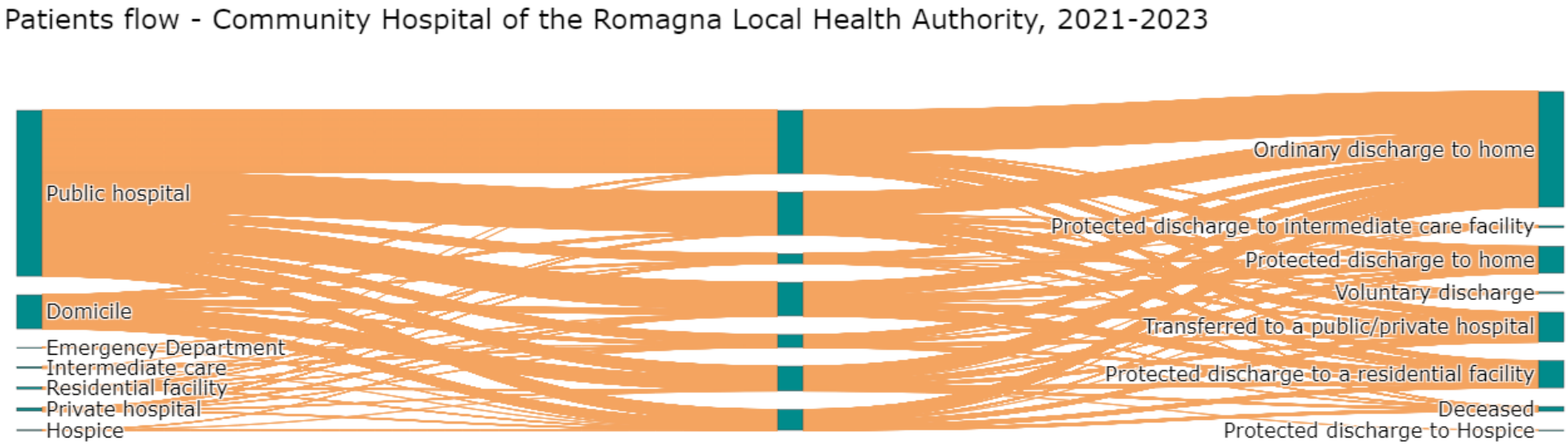

Figure 3. Sankey Diagram Showing the Flow of Patients from Referral to Destination at Discharge. All Admissions to the Community Hospitals of Romagna's Local Healthcare Authority are considered (2021–2023).

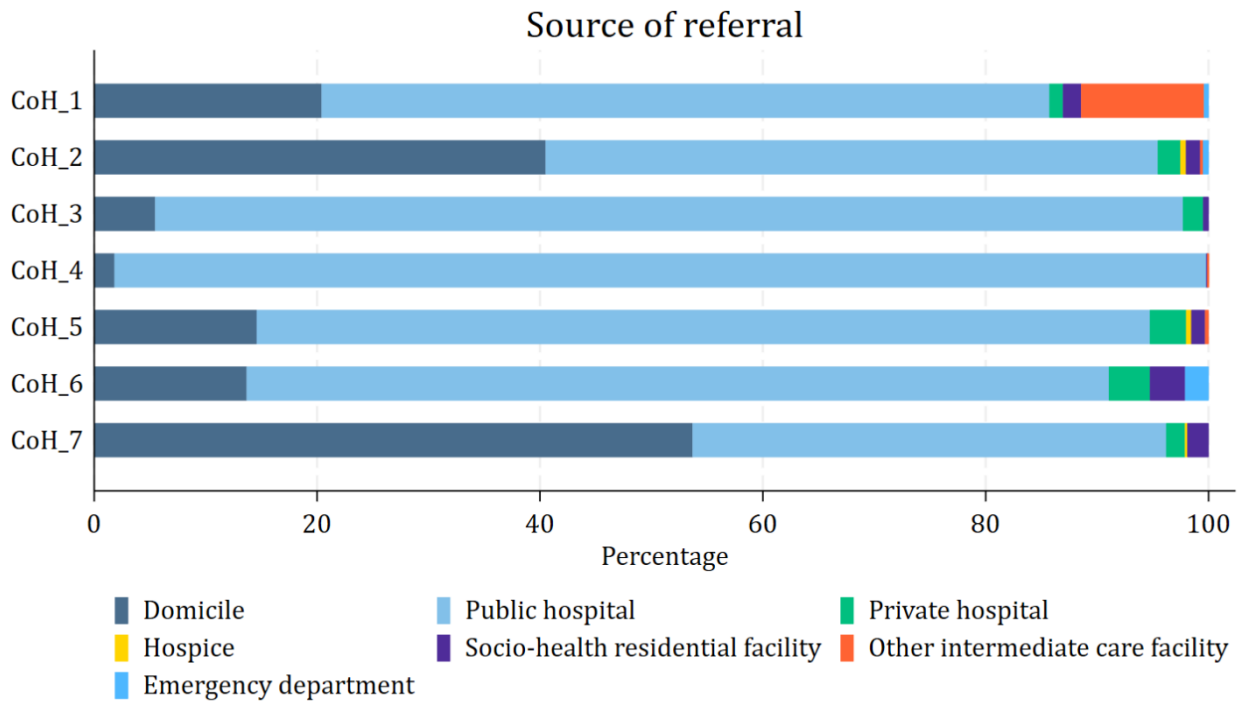

Figure 4. Source of Referral for Patients Admitted to the Community Hospitals of Romagna's Local Healthcare Authority (2021–2023).

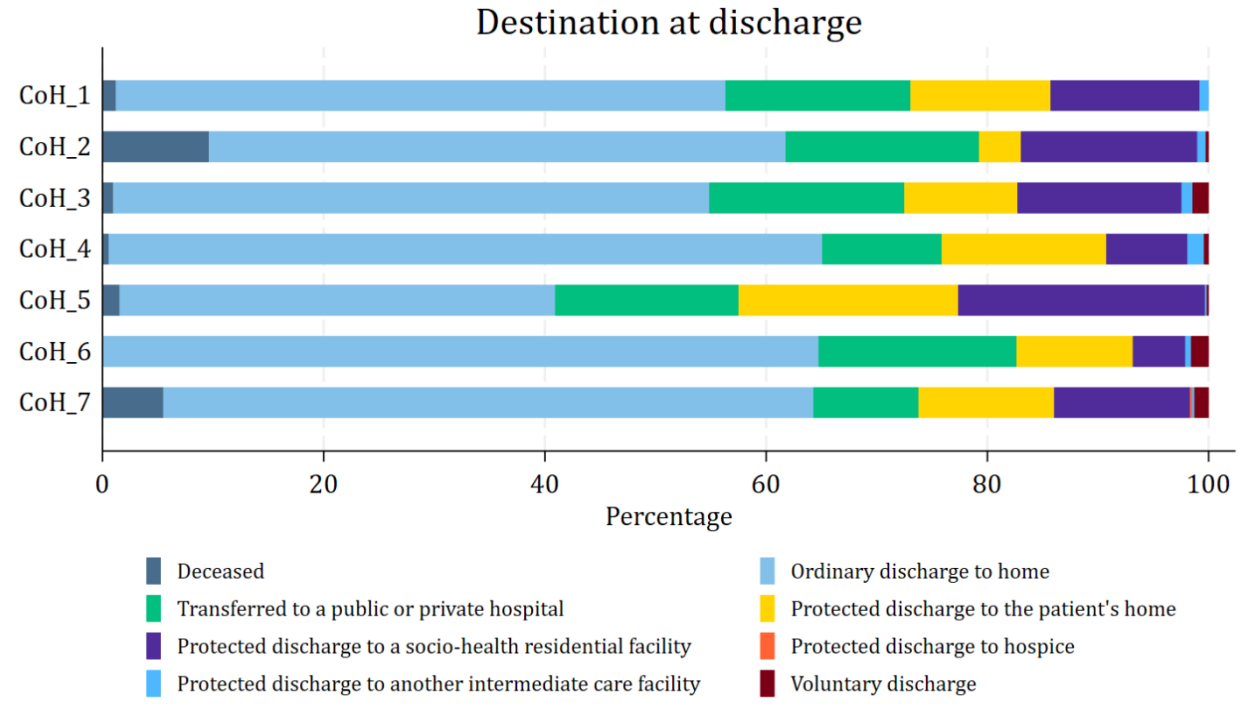

Figure 5. Destination at Discharge for Patients Hospitalised in the Community Hospitals of Romagna's Local Healthcare Authority (2021–2023).

Source of referral and destination at discharge were crossed to identify the most frequent pathways occurring during the study period (see figure 6). Except for hospice and socio-health residential facility, the most common destination at discharge for all sources of referral was "home". Patients admitted from hospice were more frequently transferred to public or private hospitals, while patients admitted from socio-health residential facilities were more frequently discharged to the same type of setting.

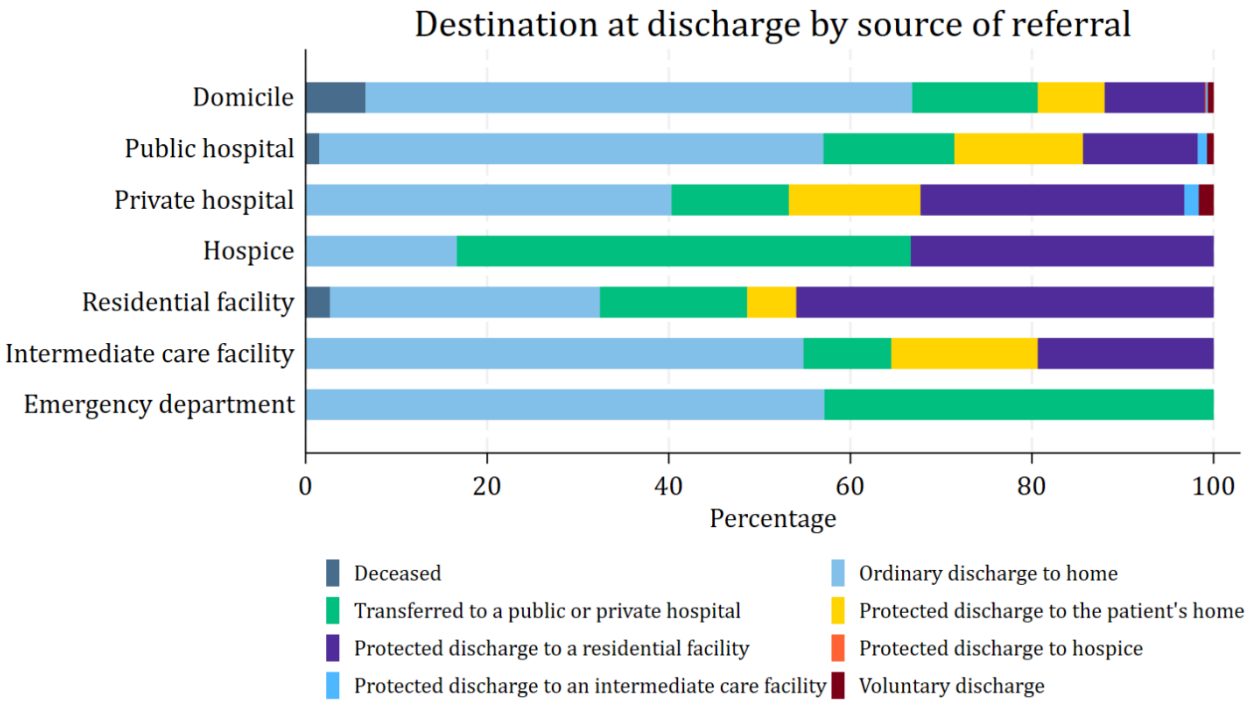

Figure 6. Destination at Discharge by Source of Referral. All Admissions to the Community Hospitals of Romagna's Local Healthcare Authority Are Included (2021–2023).

3.4.2 Length of stay

Most hospitalisations lasted less than 42 days (93.2%). Figure 7 shows the distribution of hospital length stay by CoH, highlighting outliers with longer hospitalisations. Admissions lasting more than 42 days were associated with more discharges to social-health residential facilities, and higher falls rates ($p < 0.01$).

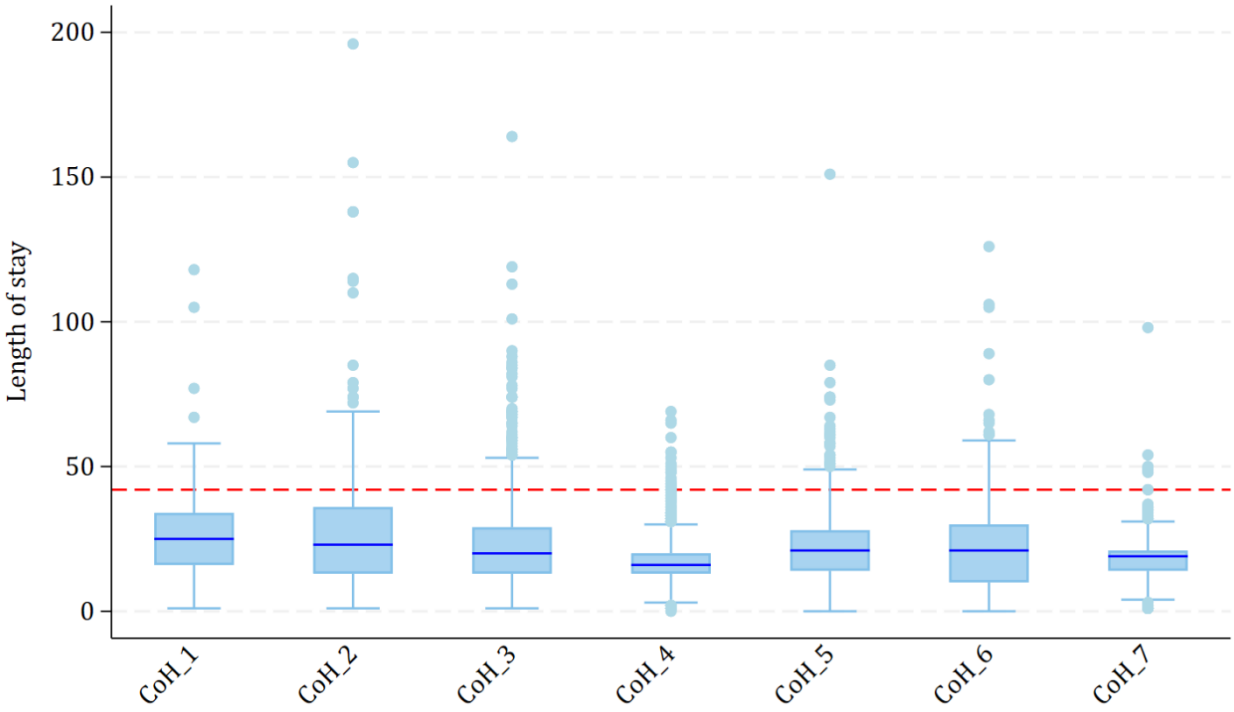

Figure 7. Box Plot of Length of Stay for Admissions to the Community Hospitals of Romagna's Local Healthcare Authority (2021-2023). The Red Dash Line Corresponds to the Cutoff of 42 Days.

Based on the findings of univariable models, "age", "sex", "citizenship", "fall", "source of referral", "pressure injury arising during hospitalisation", "surgical wound", "being in the care of social services", "problems with autonomy, physical disability", "living alone", "clinical monitoring and therapeutic stabilisation", "patient and carer education/training", "functional reactivation", "rehabilitation" were identified as potential predictors for a multivariable risk model (see table 9). Each variable excluded during this step, namely "ADL at admission" and "pre-hospitalisation pressure injury", was added back into the multivariable risk model, one at a time. "ADL at admission" was included as it proved to be significant.

	β	Robust SE (β)	OR	95% CI	Log pseudolikelihood	p-value	Wald stat p-value	Decision
Age	-0.035	0.005	0.97	0.96 - 0.98	-798.625	0.000	0.000	V
Male sex	0.418	0.143	1.52	1.15 - 2.01	-814.741	0.003	0.003	V
Italian citizenship	-1.253	0.297	0.29	0.16 - 0.511	-812.562	0.000	0.000	V
ADL at admission	0.003	0.002	1.00	1.00 - 1.01	-818.595	0.258	0.258	O
Fall (yes)	0.514	0.313	1.67	0.91 - 3.09	-817.977	0.100	0.100	V
Source of referral (domicile)					-814.997	0.069		V
Public hospital	0.011	0.191	1.01	0.70 - 1.47			0.956	
Private hospital	1.062	0.423	2.89	1.26 - 6.63			0.012	
Hospice	1.158	1.110	3.18	0.36 - 28.02			0.297	
Residential facility	0.241	0.756	1.27	0.29 - 5.60			0.750	
Intermediate care facility	1.668	1.170	5.30	0.54 - 52.54			0.154	
Emergency Department	-	-	-	-	-	-	-	
Pre-hospitalisation pressure injury	0.090	0.198	1.10	0.74 - 1.61	-819.074	0.647	0.647	O
Pressure injury arising during hospitalisation	0.923	0.205	2.52	1.68 - 3.76	-810.587	0.000	0.000	V
Surgical wound	-0.259	0.168	0.77	0.55 - 1.07	-817.919	0.123	0.123	V
Social service	0.584	0.208	1.803	1.19 - 2.70	-815.214	0.005	0.005	V
Autonomy/disability issues	0.304	0.144	1.36	1.02 - 1.80	-816.847	0.035	0.035	V
Living alone	0.406	0.143	1.50	1.13 - 1.99	-815.180	0.005	0.005	V
Clinical monitoring and therapeutic stabilisation	0.725	0.142	2.06	1.56 - 2.73	-806.588	0.000	0.000	V
Patient and carer education/training	0.442	0.162	1.56	1.13 - 2.13	-815.618	0.006	0.006	V
Functional reactivation	0.637	0.144	1.89	1.43 - 2.51	-808.955	0.000	0.000	V
Rehabilitation	-0.770	0.160	0.46	0.34 - 0.63	-806.139	0.000	0.000	V

V = in ($p < 0.20$)
O = out

Table 9. Logistic Regression Univariable Analyses of Length of Stay Longer than 42 Days. Admissions to Five Community Hospitals of Romagna's Local Healthcare Authority Are Included (2021-2023).

After excluding non-significant variables, the preliminary effects model included “age”, “sex”, “citizenship”, “pressure injury arising during hospitalisation”, “living alone”, “clinical monitoring and therapeutic stabilisation”, “functional reactivation”, “rehabilitation”, and “ADL at admission”.

The next step in the model development was to ascertain whether the continuous variables “age” and “ADL at admission” were linear in the logit. Thus, the quartile design variables method was used for assessing the scale of these variables. Age could be considered linear in the logit (see figure A1), while ADL at admission was not linear in the logit (see figure A2). The method of fractional polynomials was thus used to select the scale for this covariate.

Greater precision (Model_1)

The method of fractional polynomials indicated that the model with powers m=2 had the lowest deviance (1503.3) and provided a better fit than the other models. Therefore, the ADL value at admission was transformed from the original continuous variable according to the powers found (0.5 0.5) and accounting for the value “0” of the variable in the transformation (Model_1).

Figure A3 shows the forest plot of the risk model obtained. The occurrence of pressure injuries during hospitalisation was associated with an increased probability of prolonged hospital stays, as well other factors like clinical monitoring and therapeutic stabilisation, and functional reactivation. In addition, rehabilitation was a protective factor, probably because rehabilitation programs and protocols were well defined and structured since the time of admission. Moreover, living alone was a risk factor, while Italian citizenship was protective against a length of stay longer than 42 days.

The goodness of fit of this model was evaluated using the Hosmer–Lemeshow test and the AUC (see figure 8). Both tests outlined a fairly good performance of the model (0.790 and 0.716, respectively).

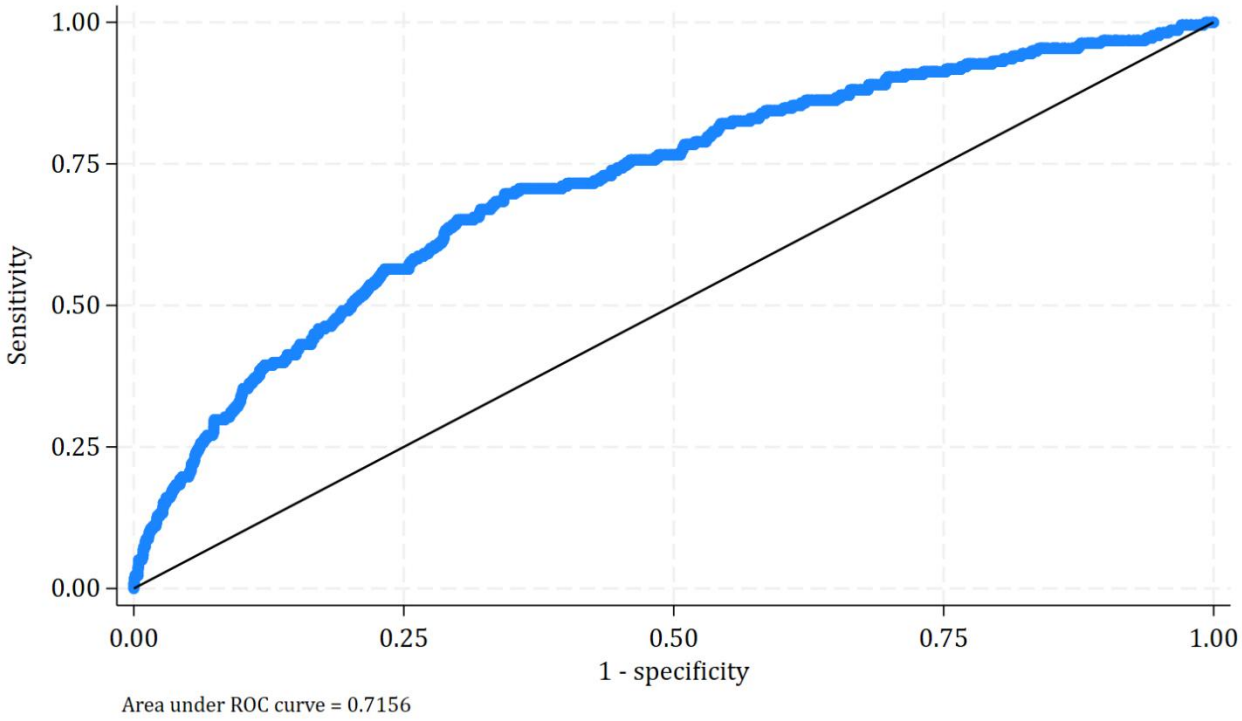

Figure 8. Area Under the Curve (AUC) for Model_1.

The different types of bootstrap confidence intervals for the AUC (see table 10) were similar, indicating that the normality assumption of model postestimations was confirmed.

AUC	Observed coefficient	Bias	Bootstrap std. err.	[95% CI]
	0.716	0.002	0.018	0.68 0.75 (N) 0.68 0.75 (P) 0.67 0.75 (BC)

Table 10. Area Under the ROC Curve and Bootstrap Confidence Intervals. Model_1. Assumption of Normality of the Distribution of Estimators (N), Percentiles of the Bootstrap Distribution (P), Corrected Interval for the Bias in the Bootstrap Distribution (BC).

Greater simplicity (Model_2)

Model_1 had a good discrimination. However, the fractional polynomials of baseline ADL made the results hardly usable in practice due to the use of a transformation with powers of 2.

Therefore, since the best m=1 transformation was the quadratic one, the regression was again conducted using squared ADL at admission (deviance 1506.6). The goodness of fit of this model was evaluated using the Hosmer–Lemeshow test and the AUC, and both tests showed a generally good performance of the model (0.775 and 0.713, respectively). The confidence intervals for the AUC are shown in table 11.

AUC	Observed coefficient	Bias	Bootstrap std. err.	[95% CI]
	0.713	0.002	0.019	0.68 0.75 (N) 0.68 0.75 (P) 0.67 0.74 (BC)

Table 11. Area Under the ROC Curve and Bootstrap Confidence Intervals. Model_2.

Models comparison

Lastly, the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC), that do not directly measure the goodness of fit, rather the efficiency of the model in balancing complexity with predictive ability, were used to compare the most complex model (Model_1, "unrestricted") with the simplest model (Model_2, i.e. the one including ADL at admission squared, "restricted") (see table 12).

Model	AIC	BIC
Model_1, "unrestricted"	1525.926	1593.836
Model_2, "restricted"	1526.586	1588.321

Table 12. Models comparison. AIC and BIC for Model_1 and Model_2.

Interestingly, AIC and BIC were discordant. The lower AIC for the unrestricted model indicates that this model better accounts for the variability of the data than the restricted, at the cost of having more parameters. In other words, the more complex model offers a better balance between efficiency and complexity penalty. The BIC value, on the other hand, penalises complexity more severely than the AIC, especially when the sample is large. The lower BIC for the restricted model suggests that this model is preferable in terms of simplicity and stability for potential validation on external samples. Therefore, Model_2 was chosen as the final risk model for length of stay. Forest plot for this model is shown in figure 9.

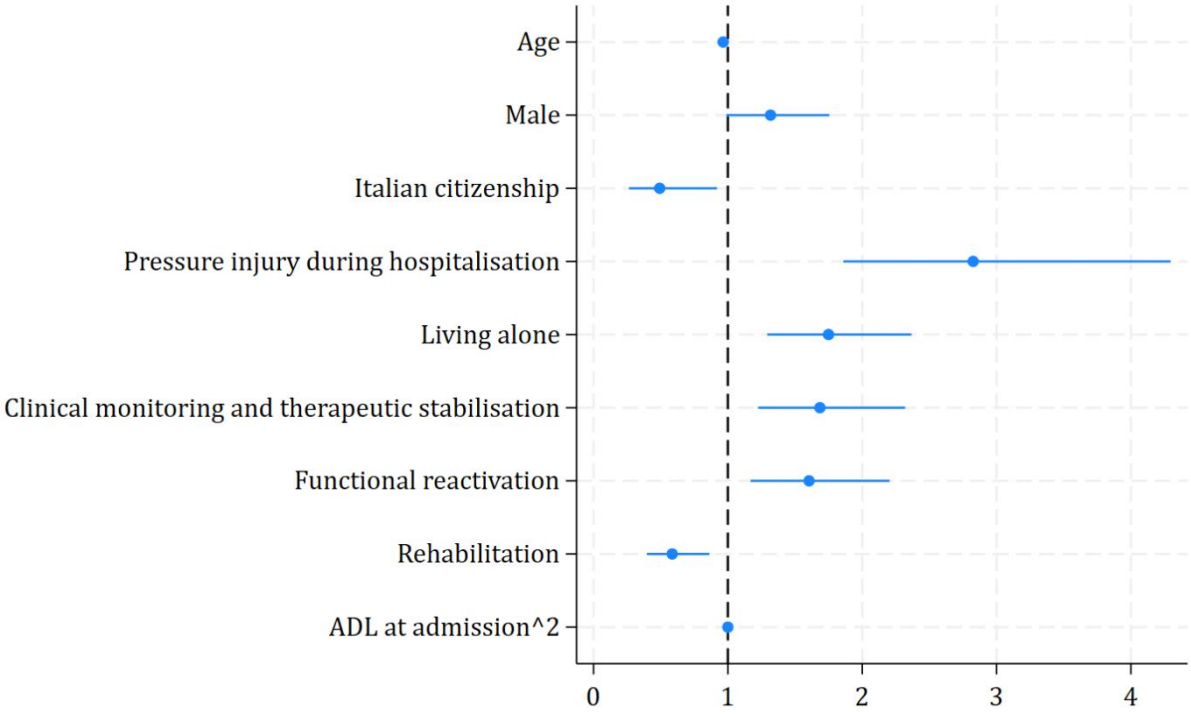

Figure 9. Model_2. Forest Plot of Odds Ratios Resulting from Logistic Regression Analysis of Length of Stay Longer than 42 Days. Admissions to Five Community Hospitals of Romagna's Local Healthcare Authority Are Included (2021–2023).

Logistic regression diagnostics for Model_2

Some diagnostic statistics were used to identify poor fit or overly influential subjects (see figure A4). There was only one observation that stands out more from the others; however, considering the number of parameters and the number of observations, there are no high leverage observations in this case.

Sensitivity analysis

A sensitivity analysis introducing into the model the two CoHs that had been excluded confirmed the stability of the results, as shown in figure A5. Stability of the results has been tested after excluding influential observations resulting from diagnostics. Results were virtually unchanged.

Performance of Community Hospitals with respect to the length of stay

After building the risk model, potential differences in the performance of CoHs were investigated. Only baseline variables were considered and, among these, only those significant in univariable analyses (see table 13). Each variable excluded during this step, namely "ADL at admission" and "pre-hospitalisation pressure injury", was added back into the multivariable risk model, one at a time. ADL at admission was included as it resulted significant. After excluding non-significant variables, the preliminary effects model included "age", "sex", "citizenship", "living alone", "clinical monitoring and therapeutic stabilisation", "functional reactivation", "rehabilitation" and "ADL at admission". The following step was to ascertain whether the continuous variables "age" and "ADL at admission" were linear in the logit. Thus, the quartile design variables method was used for assessing the scale of these variables. The variable "age" was linear in the logit, while "ADL at admission" was not; therefore, the fractional polynomials were used to assess its scale. Once again, the model with power m=1 (2) was chosen.

Variable	β	Robust SE (β)	OR	95% CI	Log pseudolikelihood	p-value	Wald stat p-value	Decision
Age	-0.035	0.005	0.97	0.96 - 0.98	-798.625	0.000	0.000	V
Male sex	0.418	0.143	1.52	1.15 - 2.01	-814.741	0.003	0.003	V
Italian citizenship	-1.253	0.297	0.29	0.16 - 0.51	-812.562	0.000	0.000	V
ADL at admission	0.003	0.002	1.00	1.00 - 1.01	-818.595	0.258	0.258	O
Source of referral (domicile)					-814.997	0.068		V
Public hospital	0.011	0.191	1.01	0.69 - 1.47			0.956	
Private hospital	1.062	0.423	2.89	1.26 - 6.63			0.012	
Hospice	1.158	1.110	3.18	0.36 - 28.02			0.297	
Residential facility	0.241	0.756	1.27	0.29 - 5.60			0.750	
Intermediate care facility	1.668	1.170	5.30	0.54 - 52.54			0.154	
Emergency Department	-	-	-	-			-	
Previous pressure injury	0.090	0.198	1.09	0.74 - 1.61	-819.074	0.647	0.647	O
Surgical wound	-0.259	0.168	0.77	0.55 - 1.07	-817.919	0.123	0.123	V
Social services	0.584	0.208	1.79	1.19 - 2.70	-815.214	0.005	0.005	V
Autonomy/disability issues	0.304	0.144	1.35	1.02 -1.80	-816.847	0.035	0.035	V
Living alone	0.406	0.143	1.50	1.13 - 1.99	-815.180	0.005	0.005	V
Clinical monitoring and therapeutic stabilisation	0.725	0.142	2.06	1.56 - 2.73	-806.588	0.000	0.000	V
Patient and carer education/training	0.442	0.162	1.56	1.13 - 2.13	-815.618	0.006	0.006	V
Functional reactivation	0.637	0.144	1.89	1.43 - 2.51	-808.955	0.000	0.000	V
Rehabilitation	-0.767	0.160	0.46	0.34 - 0.63	-806.139	0.000	0.000	V

V = in ($p < 0.20$)
O = out

Table 13. Logistic Regression Univariable Analysis of Length of Stay Longer than 42 Days for CoH Profiling. Admissions to five Community Hospitals of Romagna's Local Healthcare Authority (2021–2023).

Next, CoH dummies were included in the model to analyse the performance of each facility. The overall estimated percentage of length of stay longer than 42 days was 6.1%; this indicates that the model was well calibrated because this figure was in line with the overall observed percentage (6.2%). As compared with the overall rate, there were two CoHs with significantly lower rates of prolonged length of stay, while other two had significantly higher rates (see figure 10).

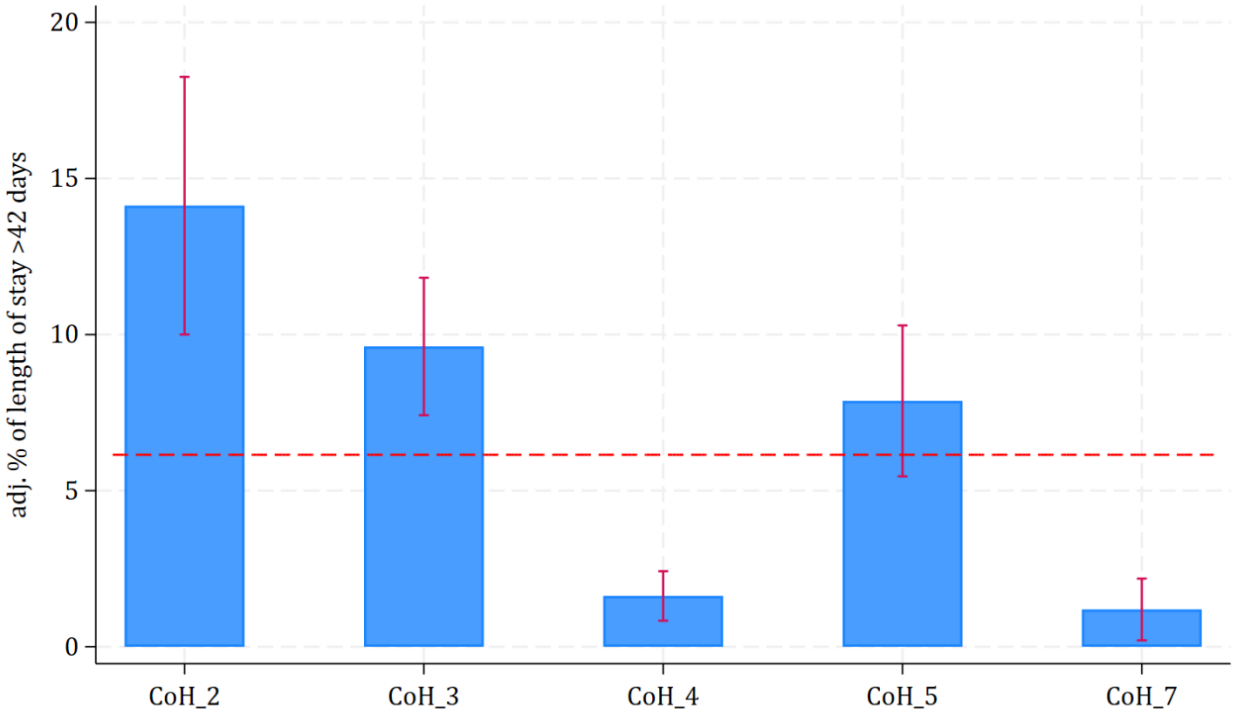

Figure 10. CoH-Specific Adjusted Probability of Length of Stay Longer than 42 Days. Covariate Adjustment Was Performed to Account for Patient Case Mix.

3.4.3 Activities of Daily Living

ADL are a set of basic activities that a person must be able to perform in order to live independently. They are routinely measured at admission and at discharge in the CoHs of the Emilia-Romagna Region to assess a patient's level of function and autonomy. In order to provide a comprehensive overview, table 14 shows mean and median by year, while table 15 shows mean and median by year of the difference in ADL at discharge with respect to admission measured through the MBI score.

Year	Mean; median
2021	25.15; 16
2022	29.26; 24
2023	32.24; 27
Total	29.30; 23

Table 14. Mean and Median Values of ADL at Admission. Patients Admitted to The Community Hospitals of Romagna's Local Healthcare Authority (2021-2023).

Year	Mean; median
2021	18.53; 12
2022	19.29; 14.5
2023	24.16; 21
Total	21.02; 16

Table 15. Mean and Median values of difference in ADL score at discharge with respect to admission. Patients Admitted to The Community Hospitals of Romagna's Local Healthcare Authority (2021-2023).

Figure 11 shows the mean value of ADL at admission and at discharge per CoH. From a purely descriptive point of view, on average across all facilities, there was an improvement.

The Kruskal-Wallis test showed that there was a significant difference in the median ADL score on admission among CoHs. Dunn's test and Benjamini-Hochber test were applied as the method of adjustment for multiple comparisons to explore the significant differences among CoHs. The same steps were applied to examine significant differences in the change of ADL score at discharge. Out of 21 pairwise post-hoc comparisons, four were not significant.

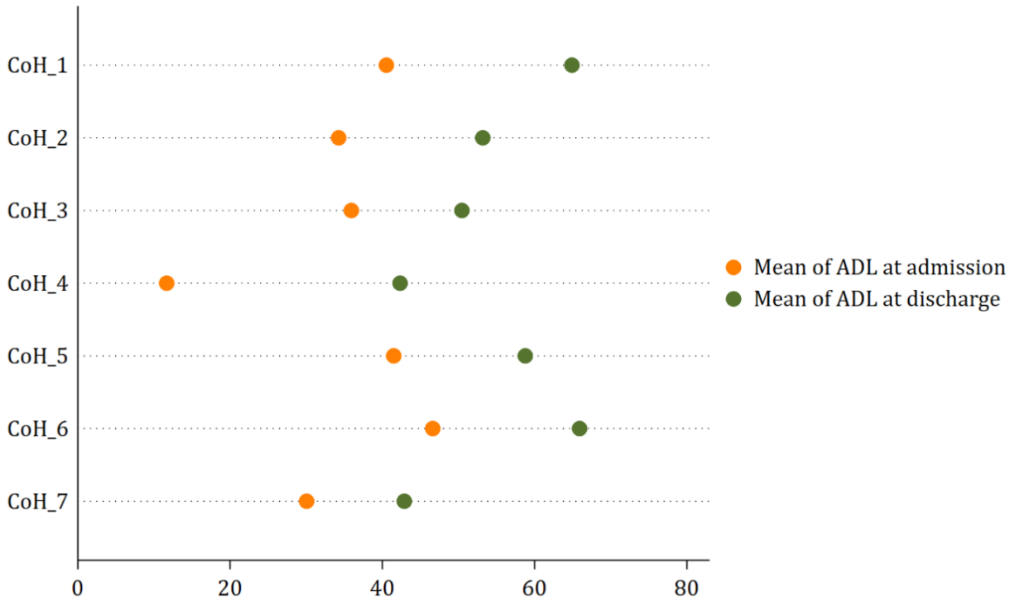

Figure 11. Dot Plot of the Mean Values of ADL at Admission and Discharge per Community Hospital. Admissions to The Community Hospitals of Romagna's Local Healthcare Authority (2021-2023).

A logistic regression was performed with > 10 points improvement in the ADL measured through MBI score as the dependent variable. The same steps were followed for model building as in the previous section (see section 3.4.2). Based on the fitting of univariable models (see table 16), "age", "sex", "citizenship", "length of stay", surgical wound", "previous pressure injury", "pressure injury arising during hospitalisation", "autonomy/disability issues", "living alone", "clinical monitoring and therapeutic stabilisation", "patient and caregiver education", "functional reactivation", and "rehabilitation" were identified as potential variable for a multivariable risk model. Each variable excluded, namely "ADL at admission", "source of referral", "fall" and "social services" were add into the model one at a time to test for significance. After excluding non-significant variables, the preliminary effects model included "age", "sex", "length of stay", "surgical wound", "pre-hospitalisation pressure injury", "pressure injury arising during hospitalisation", "problems with autonomy, physical disability", "living alone", "functional reactivation", and "rehabilitation".

The quartile design variables method was used for assessing the scale of continuous variables. "Age" and "ADL at admission" could be considered linear in the logit, while "length of stay" was not (see figure A6, A7, A8) and the Method of Fractional Polynomials was used to select the scale of this covariate.

Variable	β	Robust SE (β)	OR	95% CI	Log pseudolikelihood	p-value	Wald stat p-value	Decision
Age	-0.020	0.004	0.98	0.97 - 0.99	-2226.683	0.000	0.000	V
Male sex	-0.191	0.074	0.83	0.71 - 0.95	-2240.872	0.010	0.010	V
Italian citizenship	0.741	0.281	2.10	1.21 - 3.63	-2240.696	0.008	0.008	V
Length of stay	0.009	0.003	1.01	1.00 - 1.01	-2238.981	0.004	0.004	V
ADL at admission	-0.001	0.001	1.00	1.00 - 1.00	-2244.066	0.447	0.447	O
Source of referral (domicile)					-2193.486	0.000		O
Public hospital	0.916	0.101	2.50	2.05 - 3.05			0.000	
Private hospital	-0.042	0.300	0.96	0.53 - 1.72			0.888	
Hospice	-0.379	0.871	0.68	0.12 - 3.78			0.664	
Residential facility	-0.091	0.419	0.91	0.40 - 2.07			0.828	
Intermediate care facility	0.315	1.004	1.37	0.19 - 9.81			0.754	
Emergency Department	0.315	1.417	1.37	0.09 - 22.04			0.824	
Previous pressure injury	-0.391	0.103	0.68	0.55 - 0.83	-2236.957	0.000	0.000	V
Surgical wound	0.582	0.082	1.79	1.52 - 2.10	-2218.537	0.000	0.000	V
Pressure injury arising during hospitalisation	-0.576	0.136	0.56	0.43 - 0.73	-2235.356	0.000	0.000	V
Fall (no)	-0.084	0.187	0.92	0.64 - 1.33	-2244.270	0.652	0.652	O
Social services	-0.009	0.119	0.99	0.79 - 1.25	-2244.364	0.941	0.941	O
Autonomy/disability issues	-0.658	0.072	0.52	0.45 - 0.60	-2201.770	0.000	0.000	V
Living alone	0.572	0.078	1.77	1.52 - 2.07	-2216.619	0.000	0.000	V
Clinical monitoring and therapeutic stabilisation	-0.531	0.079	0.59	0.50 - 0.69	-2221.436	0.000	0.000	V
Patient and carer education/training	-0.145	0.090	0.87	0.72 - 1.03	-2243.056	0.109	0.109	V
Functional reactivation	0.168	0.073	1.18	1.03 - 1.36	-2241.586	0.021	0.021	V
Rehabilitation	0.746	0.074	2.11	1.82 - 2.44	-2191.361	0.000	0.000	V

V = in ($p < 0.20$)
O = out

Table 16. Logistic Regression Univariable Analysis of ADL Improvement. Admissions to five Community Hospitals of Romagna's Local Healthcare Authority (2021–2023).

Steps as in the previous section (see section 3.4.2) were followed in building the two models (Model_3, deviance 4,148.2, "unrestricted" and Model_4, deviance 4,162.4, "restricted"). In an attempt of simplification, a third model (Model_5) was built using length of stay with a median split at 19 days. For the sake of synthesis, the characteristics of each of the three models are shown in table 17.

Model_3 presented a theoretical better fir than the other models, however it could be difficult to interpret, and lead to instability in the OR estimates. Model_4 presented similar problems, therefore, Model_5 was chosen as the final risk model. Figure 11 shows the forest plot for this latter model.

test	Model_3 (-0.5 -0.5)	Model_4 (-2)	Model_5
Hosmer–Lemeshow	0.067	0.061	0.006
Area under the curve (ROC)	0.706	0.702	0.680
AUC CI (bootstrap results)	0.687 - 0.724 (N)	0.683 - 0.720 (N)	0.662 - 0.698 (N)
AIC	4041.556	4067.775	4177.289
BIC	4121.058	4141.161	4250.682

Table 17. Models comparison for "ADL improvement" outcome.

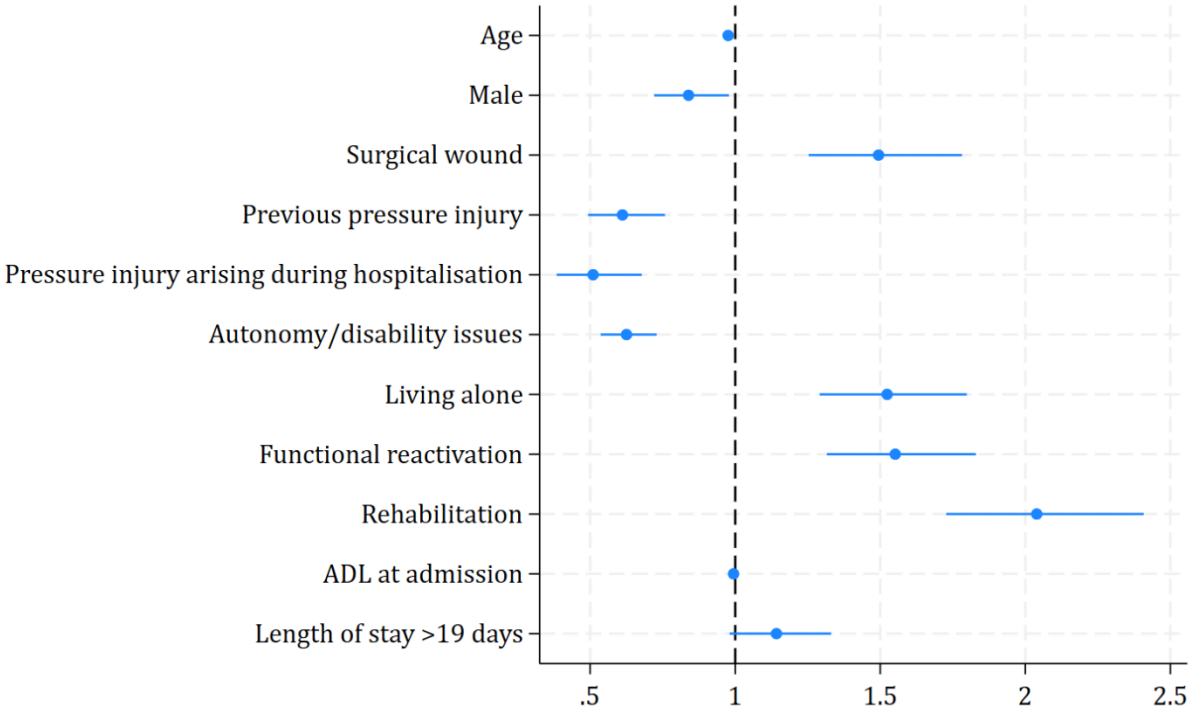

Figure 12. Model_5. Forest Plot of Odds Ratios Resulting from Logistic Regression Analysis of Improvement in the ADL. Admissions to Five Community Hospitals of Romagna's Local Healthcare Authority Are Included (2021–2023).

Logistic regression diagnostics for Model_5

Some diagnostic statistics were used to identify poor fit or overly influential subjects (see figure A9).

Sensitivity analysis

A sensitivity analysis introducing into the model the observations of the two CoHs that had been excluded confirmed the stability of the results as shown in figure A10. Of note, the variable "length of stay" transformed into categories became significant.

Performance of Community Hospitals with respect to ADL Improvement

The performance of the CoHs was analysed with respect to improvement in the ADL measured through MBI score; only variables at baseline were considered. The steps that were followed are the same as in the previous section (see section 3.4.2). Table 18 shows the results of the univariable analyses and the preliminary selection of covariates. Continuous variables were linear in the logit. Figure 13 shows the adjusted probability of ADL improvement per CoHs considering "age", "sex", "surgical wound", "previous pressure injury", "autonomy/disability issues", "living alone", "functional reactivation", and "rehabilitation" for adjustment. The overall estimated percentage of ADL improvement was 60.6%; this indicates that the model was well calibrated because this figure was in line with the overall observed percentage (59.2%). As compared with the overall rate, there were two CoHs with significantly lower rates of ADL improvement, while one had significantly higher rates; the other two exhibited tendency towards higher rates, albeit not significantly.

Variable	β	Robust SE (β)	OR	95% CI	Log pseudolikelihood	p-value	Wald stat p-value	Decision
Age	-0.020	0.004	0.98	0.97 - 0.99	-2226.683	0.000	0.000	V
Male sex	-0.190811	0.074	0.83	0.71 - 0.95	-2240.872	0.010	0.010	V
Italian citizenship	0.7405468	0.281	2.10	1.21 - 3.64	-2240.696	0.008	0.008	V
ADL at admission	-0.0011243	0.001	1.00	1.00 - 1.00	-2244.066	0.447	0.447	O
Source of referral (domicile)					-2193.486	0.000		O
Public hospital	0.916	0.101	2.50	2.05 - 3.05			0.000	
Private hospital	-0.042	0.299	0.96	0.53 - 1.72			0.888	
Hospice	-0.379	0.871	0.68	0.12 - 3.78			0.664	
Residential facility	-0.091	0.419	0.91	0.40 - 2.07			0.828	
Intermediate care facility	0.315	1.004	1.37	0.19 - 9.81			0.754	
Emergency Department	0.315	1.417	1.37	0.09 - 22.04			0.824	
Previous pressure injury	-0.391	0.103	0.68	0.55 - 0.83	-2236.957	0.000	0.000	V
Surgical wound	0.582	0.082	1.79	1.52 - 2.10	-2218.537	0.000	0.000	V
Social services	-0.009	0.119	0.99	0.79 - 1.25	-2244.364	0.941	0.941	O
Autonomy/disability issues	-0.658	0.072	0.52	0.45 - 0.60	-2201.773	0.000	0.000	V
Living alone	0.572	0.078	1.77	1.52 - 2.07	-2216.619	0.000	0.000	V
Clinical monitoring and therapeutic stabilisation	-0.531	0.079	0.59	0.50 - 0.69	-2221.436	0.000	0.000	V
Patient and carer education/training	-0.145	0.090	0.87	0.72 - 1.03	-2243.056	0.109	0.109	V
Functional reactivation	0.168	0.073	1.18	1.03 - 1.36	-2241.586	0.021	0.021	V
Rehabilitation	0.746	0.074	2.11	1.82 – 2.44	-2191.361	0.000	0.000	V

V = in ($p < 0.20$)
O = out

Table 18. Logistic Regression Univariable Analysis of ADL Improvement CoH Profiling. Admissions to five Community Hospitals of Romagna's Local Healthcare Authority (2021–2023).

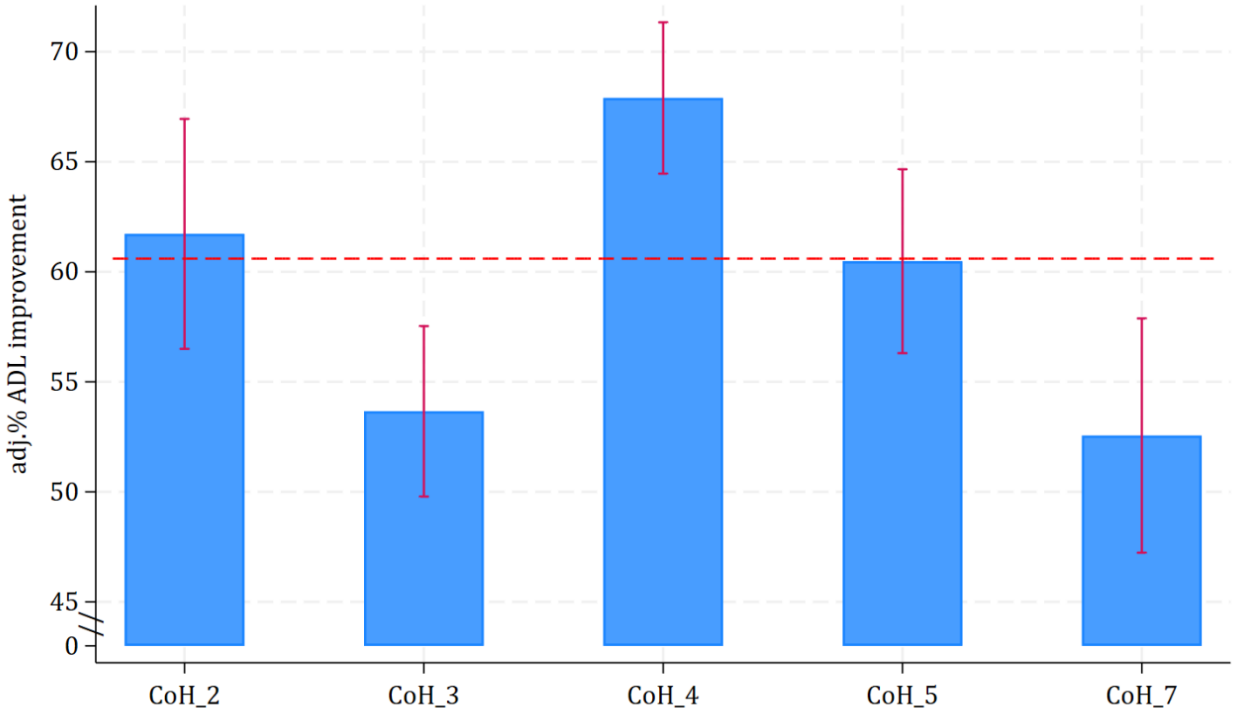

Figure 13. CoH-Specific Adjusted Probability of ADL improvement. Covariate Adjustment Was Performed to Account for Patient Case Mix.

3.4.4 Readmissions to Community Hospitals

Globally, 11.8% patients experienced readmissions to these facilities. The number of readmissions ranged from 2 up to 7.

A logistic regression was performed considering readmission to CoHs as the dependent variable; the steps as in the previous sections were followed (see section 3.4.2) and table 19 shows the results of the univariable analyses. After excluding non-significant variables, and checking for linearity in the logit of the variable "age", the preliminary multivariable risk model included "age", "sex", "year of admission", "previous pressure injury", "pressure injury arising during hospitalisation", "being in care of social services", "autonomy/disability issues", and "living alone". Figure 14 shows the forest plot.

Variable	β	SE (β)	OR	95% CI	Log pseudolikelihood	p-value	Wald stat p-value	Decision
Age	-0.013	0.005	0.99	0.98 - 1.00	-936.582	0.013	0.011	V
Male sex	0.323	0.122	1.38	1.09 - 1.76	-936.207	0.008	0.008	V
Italian citizenship	-0.695	0.520	0.50	0.18 - 1.39	-938.590	0.141	0.182	V
Year (2021)					-933.935	0.003		V
2022	0.003	0.135	0.68	0.52 - 0.88			0.004	
2023	-0.454	0.170	0.63	0.45 - 0.89			0.008	
ADL at admission	0.005	0.002	1.00	1.00 - 1.01	-937.403	0.033	0.031	V
Fall	-0.338	0.376	0.71	0.34 - 1.49	-939.234	0.347	0.368	V
Pre-hospitalisation pressure injury	0.644	0.146	1.90	1.43 - 2.54	-930.769	0.000	0.000	V
Pressure injury arising during hospitalisation	0.474	0.197	1.61	1.10 - 2.36	-937.016	0.021	0.016	V
Social service	0.840	0.164	2.32	1.68 - 3.20	-928.052	0.000	0.000	V
Autonomy/disability issues	1.507	0.149	4.51	3.37 - 6.04	-876.973	0.000	0.000	V
Living alone	0.592	0.122	1.81	1.42 - 2.30	-928.170	0.000	0.000	V

V = in ($p < 0.20$)

O = out

Table 19. Logistic Regression Univariable Analysis of Readmission. Patients admitted to Five Community Hospitals of Romagna's Local Healthcare Authority (2021–2023).

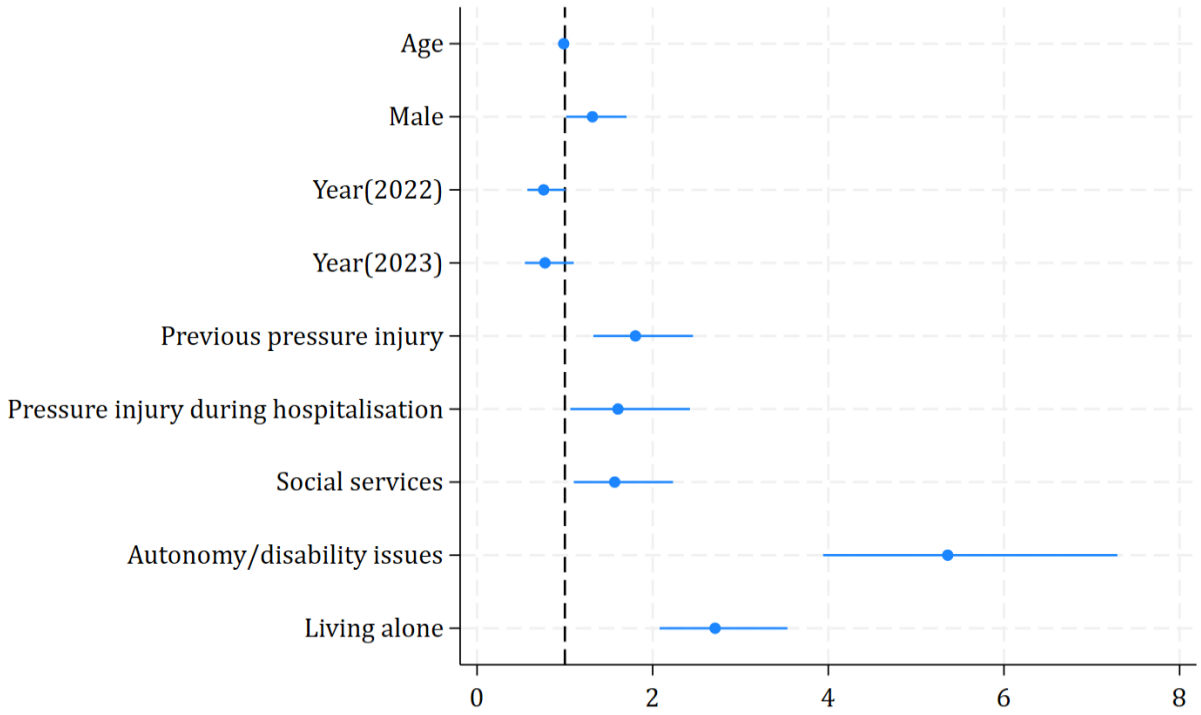

Figure 14. Forest Plot of Odds Ratios Resulting from Logistic Regression Analysis of Readmission. Patients admitted to Five Community Hospitals of Romagna's Local Healthcare Authority Are Included (2021–2023).

The goodness of fit of this model was evaluated using the Hosmer–Lemeshow test and the calculation of the AUC, and both tests showed a good performance of the model (0.194 and 0.746, respectively; bootstrap 95.0% CI for AUC was 0.716 - 0.776 (N)). See appendix for logistic regression diagnostics (see figure A11).

Sensitivity analysis

A sensitivity analysis introducing into the model the observations of the two CoHs that had been excluded confirmed the stability of the results as shown in figure A12. Of note, "year" became globally significant. Stability of results has been tested after excluding influential observations, and results were virtually unchanged.

Performance of Community Hospitals with respect to readmissions

To assess the performance of CoHs in relation to readmission, the steps as in the previous sections were followed (see section 3.4.2). Table 20 shows the results of the univariable analyses. Covariates for adjustment were "age", "sex", "citizenship", "previous pressure injury", "social services", "autonomy/disability issues", and "living alone". Figure 15 shows that there is one CoH with a significant higher probability of readmission than the others.

The overall estimated percentage of readmission was 12.2%; this indicates that the model was well calibrated because this figure was in line with the overall observed percentage (11.8%).

	β	SE (β)	OR	95% CI	Log likelihood	p-value	Wald stat p-value	Decision
Age	-0.013	0.005	0.99	0.98 - 1.00	-936.582	0.013	0.011	V
Male sex	0.323	0.122	1.38	1.09 - 1.76	-936.207	0.008	0.008	V
Italian citizenship	-0.695	0.521	0.50	0.18 - 1.39	-938.590	0.141	0.182	V
Year (2021)					-933.935	0.003		V
2022	0.003	0.135	0.68	0.52 - 0.88			0.004	
2023	-0.454	0.170	0.63	0.45 - 0.89			0.008	
ADL at admission	0.005	0.002	1.00	1.00 - 1.01	-937.403	0.033	0.031	V
Pre-hospitalisation pressure injury	0.644	0.146	1.90	1.43 - 2.54	-930.769	0.000	0.000	V
Social service	0.840	0.164	2.32	1.68 - 3.20	-928.052	0.000	0.000	V
Autonomy/disability issues	1.507	0.149	4.51	3.37 - 6.04	-876.973	0.000	0.000	V
Living alone	0.592	0.122	1.81	1.42 - 2.30	-928.170	0.000	0.000	V

V = in ($p < 0.20$)

O = out

Table 20. Logistic Regression Univariable Analysis of Readmission CoH Profiling. Admissions to five Community Hospitals of Romagna's Local Healthcare Authority (2021–2023).

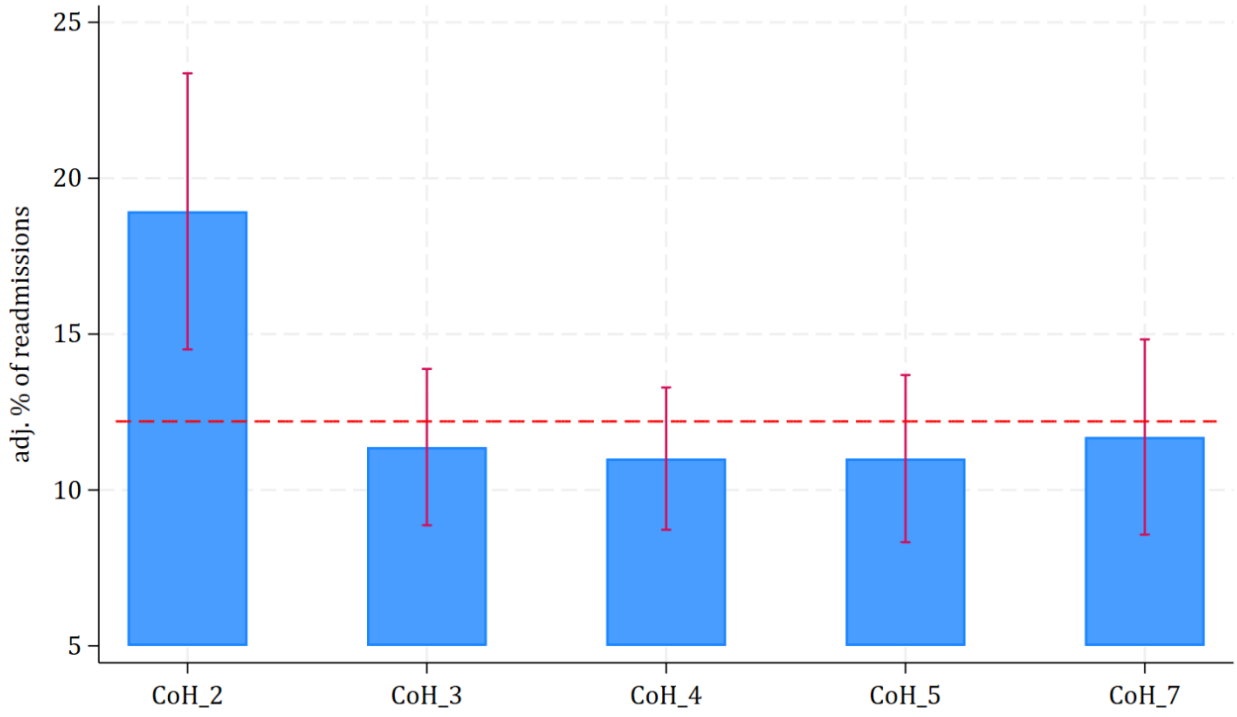

Figure 15. CoH-Specific Adjusted Probability of Readmission. Covariate Adjustment Was Performed to Account for Patient Case Mix.

3.4.5 Patient Reported Experience Measures

Table 21 shows the completed questionnaires from September 2022 to December 2023, 88.5% which were paper-based and 67.1% of which were completed by the patient (vs caregiver/family member).

Year	Frequency (%)
2022	280 (31.35)
2023	613 (68.65)
Total	893 (100.00)

Table 21. Completed questionnaires in Seven Community Hospitals of Romagna's Local Healthcare Authority (September 2022 – December 2023).

In particular, considering the specific question '' Overall, I felt treated with respect and dignity while receiving assistance from this service", on which the NAIC places

particular emphasis, the answer "yes, always" had an overall frequency for the seven CoHs of 91.4%, ranging from 88.9% to 100.0%.
The graphs of the answers to each specific question of the questionnaire are presented in the Appendix 4. Globally, completely negative answers represent a small share. From the results it is possible to analyse the aspects to work on, such as greater patient involvement in terms of goal setting and treatment decisions and giving sufficient information to the patients about other services.

Figure 16 shows the normalised mean score, highlighting rather high median values in all CoHs, although there were also outliers with very low scores.

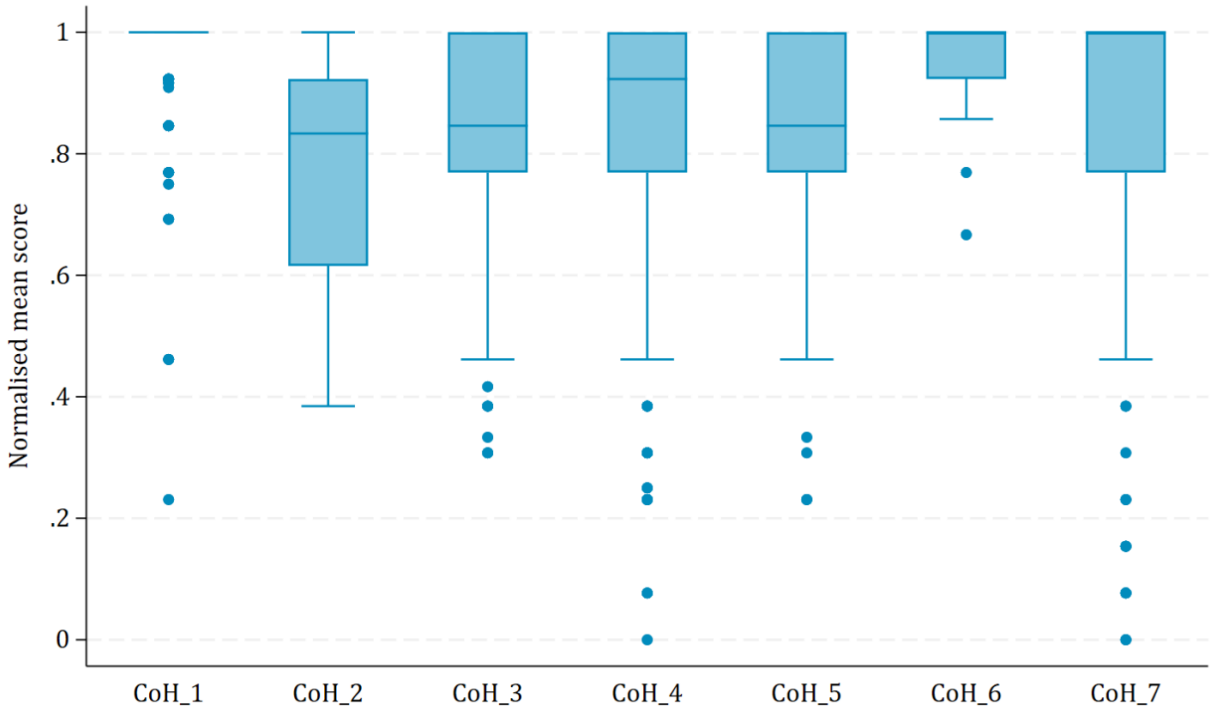

Figure 16. Box Plot of the Normalised Mean Score per CoH.

3.4.6 Overall Performance

The estimated probabilities in relation to the three outcomes considered and the normalised PREMs mean score have been reported in a single graph to visually represent different dimensions of quality for each facility (see figure 17). The adjusted probabilities of unfavourable outcomes (length of stay > 42 days and readmissions) were presented using the complement rule for consistency.

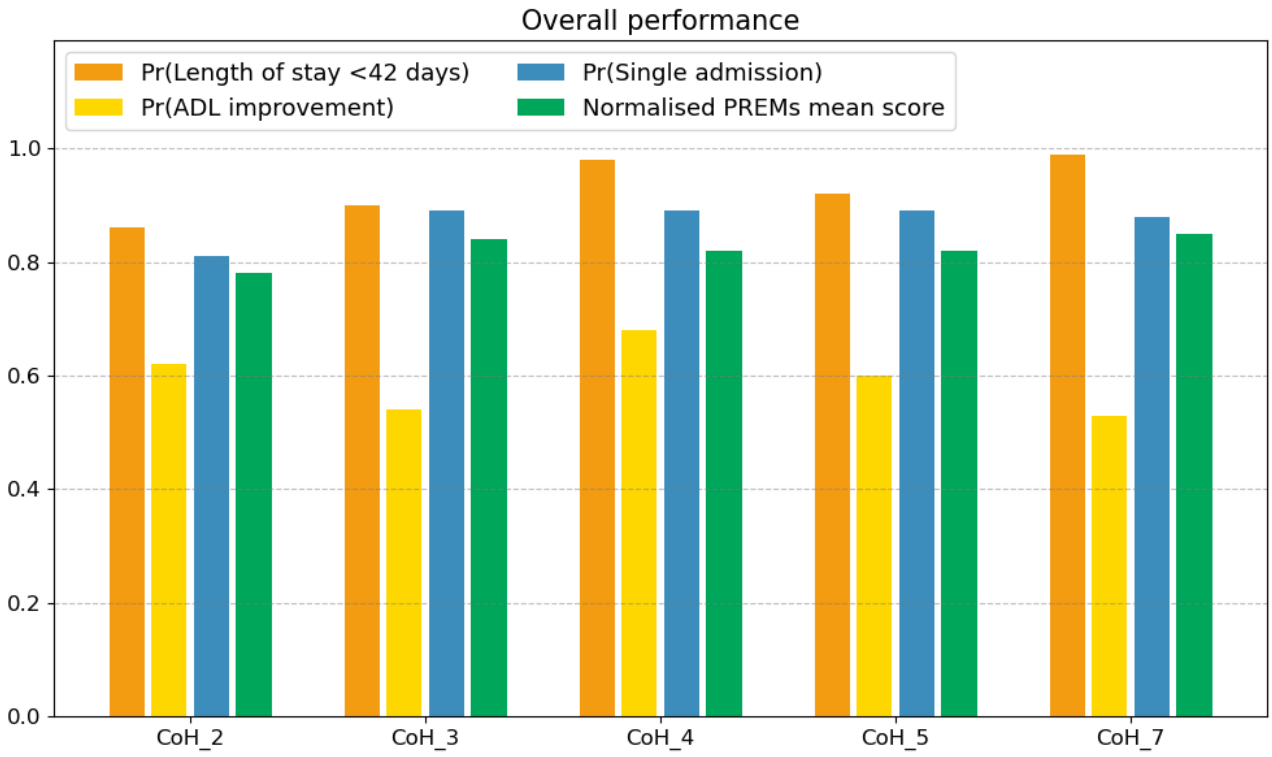

Figure 17. Overall Performance for Five Community Hospitals of Romagna's Local Healthcare Authority.

Chapter 4
Discussion and Concluding Remarks

The COVID-19 pandemic accelerated the shift toward healthcare systems with strong community-based components. This transition, long advocated since the 1978 Alma Ata declaration on Primary Health Care, has become increasingly urgent due to deep changes in the population's epidemiological structure. Settings beyond hospitals, which primarily manage acute episodes with high specialisation and technological complexity, are needed. In this context, CHs, outlined by Ministerial Decree No. 77, may address diverse social and healthcare needs on a broader scale. These facilities also offer innovative development as places for integration between Public Health and Primary Care and as venues for community participation. However, developing specific information flows and structured monitoring systems for these settings remains an essential task.

The decree also emphasises the role of CoHs, which are integral to intermediate care, in decentralising low-complexity services to alleviate hospital pressure and address social needs [111]. This is in contrast to international reports highlighting underinvestment in such settings, with a risk of underutilisation [112].

Results from the RLHA analysis showed that most patients accessing these facilities came from the acute care hospitals and were primarily discharged home. According to the NAIC, considering the preventive and rehabilitative goals of intermediate care services, home discharge from CoHs can be considered a proxy for outcome. In this analysis, home discharge was achieved in nearly 68.0% of cases, in line with the results from the NHS Benchmarking Network's 2021 report [79].

Although intermediate care services have developed primarily with preventive and rehabilitative goals, the international scientific literature reports that CoHs exhibit very flexible service delivery depending on the context; however, within the RLHA, a strong rehabilitative focus was observed, as reflected in both admission reasons and main diagnoses emphasising their role in functional recovery. In the study, the positive role of rehabilitation has emerged in both shortened lengths of stay and improvements in ADL, highlighting the effectiveness of this type of activity in CoHs, consistent with recent literature [113, 114] and other reports [80, 81]. Generally, evidence from the literature supports the effectiveness of CoHs in improving ADL and reducing length of stay [115, 116].

Risk models underscored the importance of social factors, such as "living alone", which impacted the likelihood of all three outcomes considered. Interestingly, living alone correlated with a higher likelihood of ADL improvement and further investigation into this factor would be beneficial.

Pressure injuries also emerged as a significant variable in all three risk models, increasing the likelihood of unfavourable outcomes. Preventive actions to avoid pressure injuries during hospitalisation, which may be likely considering the average age of hospitalised patients and the median length of stay, are therefore crucial. It is noteworthy, however, that the occurrence of these injuries decreased gradually over the study period.

Additionally, male sex was associated with a higher likelihood of adverse outcomes, aligning with literature findings on greater risks of conditions such as COVID-19 and sarcopenia. Although women generally suffer from a higher burden of comorbidities in older age, these are often nonfatal chronic conditions such as migraine or autoimmune disorders, whereas men are more frequently affected by life-threatening conditions like cardiovascular disease and diabetes [117, 118].

Once the factors that may have an impact on the outcomes considered have been considered as a whole, it is important to investigate whether there are specific differences among CoHs. Regarding facility performance, it is essential to consider outcome probabilities adjusted for baseline covariates in order to account for case-mix differences. This approach enables profiling of CoHs to identify best-performing facilities whose practices may merit further exploration, following a positive deviance approach that shifts the traditional focus of evaluation and monitoring in healthcare from poor performance to focus on excellent performance ("positively deviant") in order to identify successful practices and disseminate strategies that can improve the quality of services [119, 120].

The RLHA's implementation of new-generation indicators, such as PREMs, has been well received and represents an important advancement in quality assessment; in 2023, for example, questionnaire completion reached 40% of hospitalisations. Overall, normalised mean scores were high, though this could partly reflect a possible "social desirability" effect. However, by examining responses to each question it is possible to find potential differences among facilities representing "food for thoughts" for improvement. Lower percentages in some domains may indicate the dimensions on which specific improvement actions should be focused. Responses related to receiving satisfactory answers to questions, trust in the staff, and feeling treated with dignity and respect indicated a positive experience with the healthcare personnel. This is

particularly meaningful, as literature suggests that a supportive relationship with healthcare staff is crucial for patients in improving mobility and regaining independence [121].

The main goal of this work was to integrate different dimensions related to quality of care to identify areas for improvement, including "non-classical" indicators. The combination of indicators traditionally considered "hard" (such as the length of stay) with other indicators whose conceptualisation is more recent and which focus on aspects related to patient perception (such as PREMs), makes it possible to build a more multifaceted assessment of performance, allowing to capture different and specific aspects that may vary from one structure to another. This is evident by observing, for example, the performance of CoH_7, which shows highly positive results for length of stay, readmissions and normalised PREMs mean score, while in relation to the other facilities it shows less improvement in ADL measured through MBI score. A subsequent "positive deviance" approach is proposed to identify best performers and explore best practices for broader application. In general, benchmarking among facilities is also crucial for creating a network open to comparison and for fostering collective growth.

From a methodological point of view, some residual confounding likely influenced the risk and performance models; however, this work represents an important starting point for setting up a structured assessment and monitoring system. Future studies could include other scores such as the MCD-S [122] and Deprivation Index [123] to better characterise the case-mix, though certain variables, like ADL at admission, pressure injury occurrence, and social issues already provide indications regarding patient autonomy and social fragility.

The main methodology used in this work, logistic regression, is a powerful tool for investigating binary outcomes, while fractional polynomials offer valuable flexibility in modelling; however, a trade-off between model complexity and interpretability must be ensured. In this work, the de facto choice has often fallen on "simpler" yet "more interpretable" models.

In future models, it may be interesting to include patient referral sources, which could provide insights into patient autonomy or functionality. In this study, such data were not considered due to low-number categories. However, one solution could be grouping referral sources into the three macro categories "home", "hospital", and "other".

It is also important to mention that a multilevel analysis was not possible due to the low number of second-level units. Moreover, readmission analyses are exploratory and should be refined in future research by considering timeframes and settings. For instance, it might be interesting to investigate long-term impact of CoHs on patient trajectories through longitudinal studies, including admissions to acute care hospitals within 90 days of CoH discharge to gain indications on CoHs' "preventive" role in hospitalisation and, more broadly, a more comprehensive understanding of their role within the healthcare system.

Some considerations with respect to data sources are essential. Administrative databases, initially designed for administrative purpose, are a great resource for assessing the healthcare service organisation and effectiveness, and are fundamental to Real-World-Evidence [124]. The data infrastructure needed to support this type of research, especially in light of recent technological advancements, deserves further attention to facilitate the effective use of such data.

The results of this work were shared and discussed with healthcare professionals in the RLHA to promote evidence-informed decision-making. Future proposals were made, including periodic sharing of PREMs questionnaires results, the production of an annual report containing a basic version of the analysis presented here and modified or supplemented according to the needs of professionals to better support decision-making, and further organisational-level studies in line with the NAIC. Regarding this last point, it is important to examine professionals' roles, resource allocation, and weekly hours in these settings, such as those of general practitioners, physiotherapists, and palliative care teams [125, 126]. This would allow for greater refinement of model accuracy by considering managerial and organisational aspects unique to each CoH and would also support the positive deviance approach to identify best practices and success strategies. The importance of mapping the workforce, emphasised by the NHS 2023 report [78], supports this approach. All the proposed steps were approved, indicating the potential value of this research.

The findings highlighted that CoHs in the RLHA effectively facilitate transitions from acute care, enhance functional recovery, and incorporate patient-centred measures into performance evaluations. The observed improvements in ADL suggest that rehabilitation programs in CoHs are impactful and emphasised their value in these settings. The successful implementation of PREMs demonstrated the feasibility and value of integrating patient feedback into quality assessment and may allow areas for improvement to be identified to elevate standards across facilities, such as patient involvement in decision-making.

CoHs can serve as a model for sustainable healthcare delivery by reducing the burden on acute hospitals, enhancing patient independence, and aligning services with community needs, thus fostering healthcare quality and equity. It is therefore essential that these facilities are equipped with the resources needed to meet evolving challenges.

Continuing evaluation research on healthcare services is essential to provide insights into the effectiveness of organisational models and support EIDM.

Appendix 1 – Length of stay

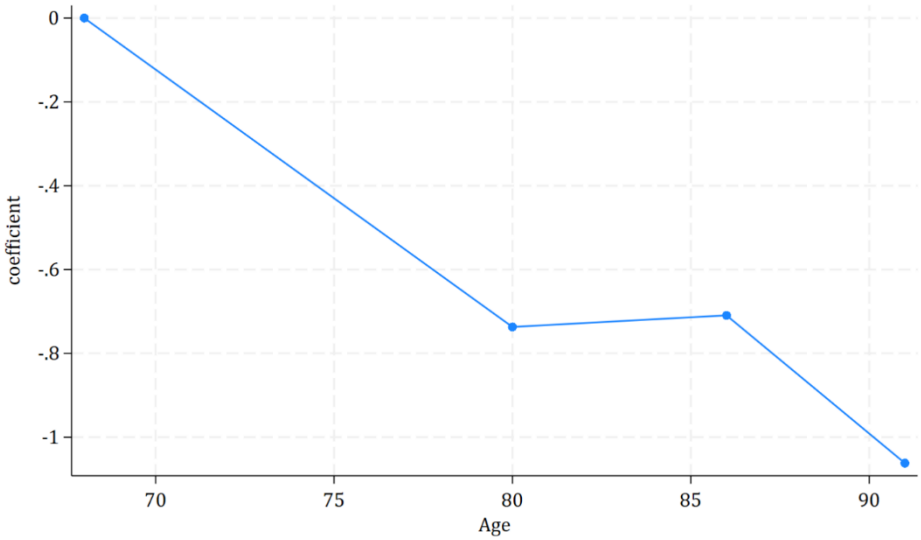

Figure A1. Quartile Design Variables Method for Assessing the Linearity of Age in the Logit Scale.

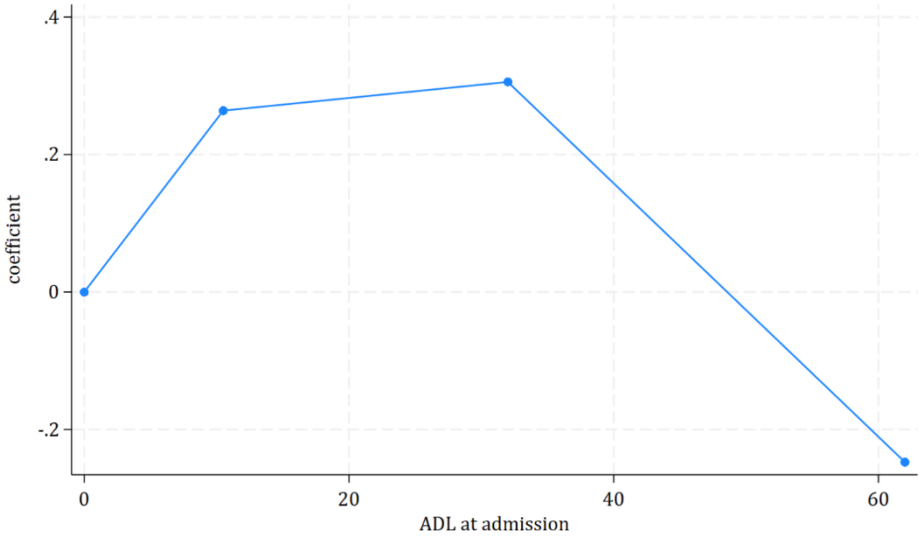

Figure A2. Quartile Design Variables Method for Assessing the Linearity of ADL at Admission in the Logit Scale.

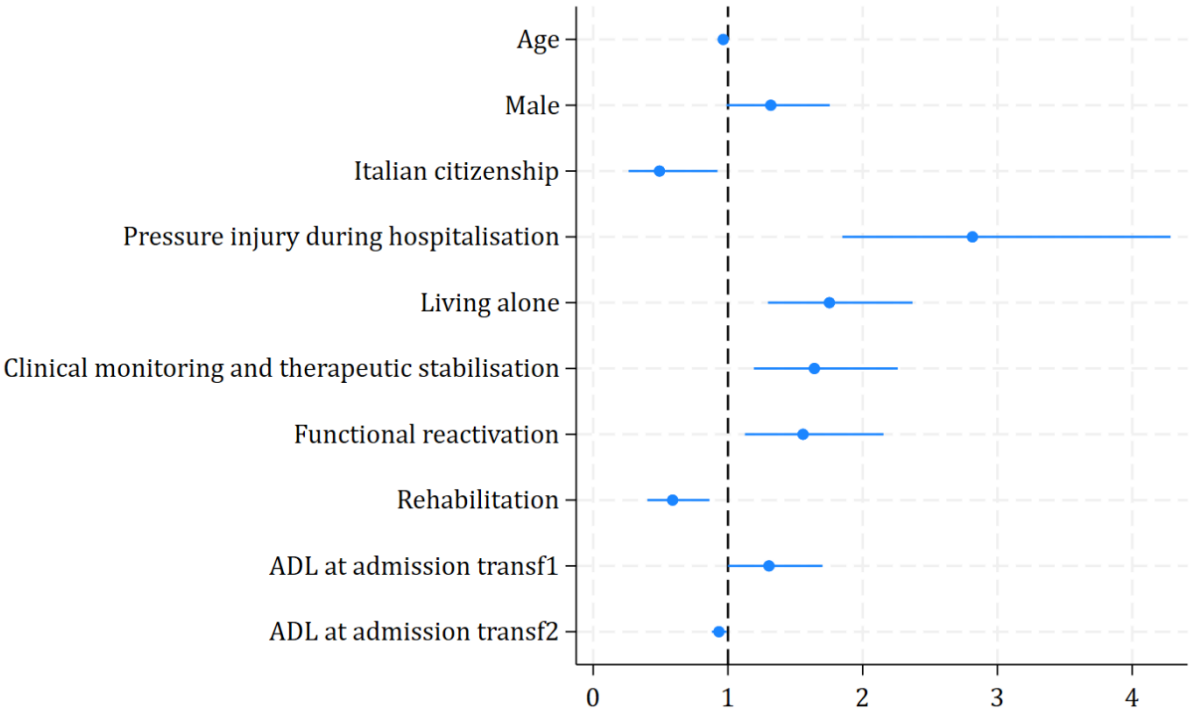

Figure A3. Model_1. Forest Plot of Odds Ratios Resulting from Logistic Regression Analysis of Length of Stay Longer than 42 Days. Admissions to Five Community Hospitals of Romagna's Local Healthcare Authority Are Included (2021–2023).

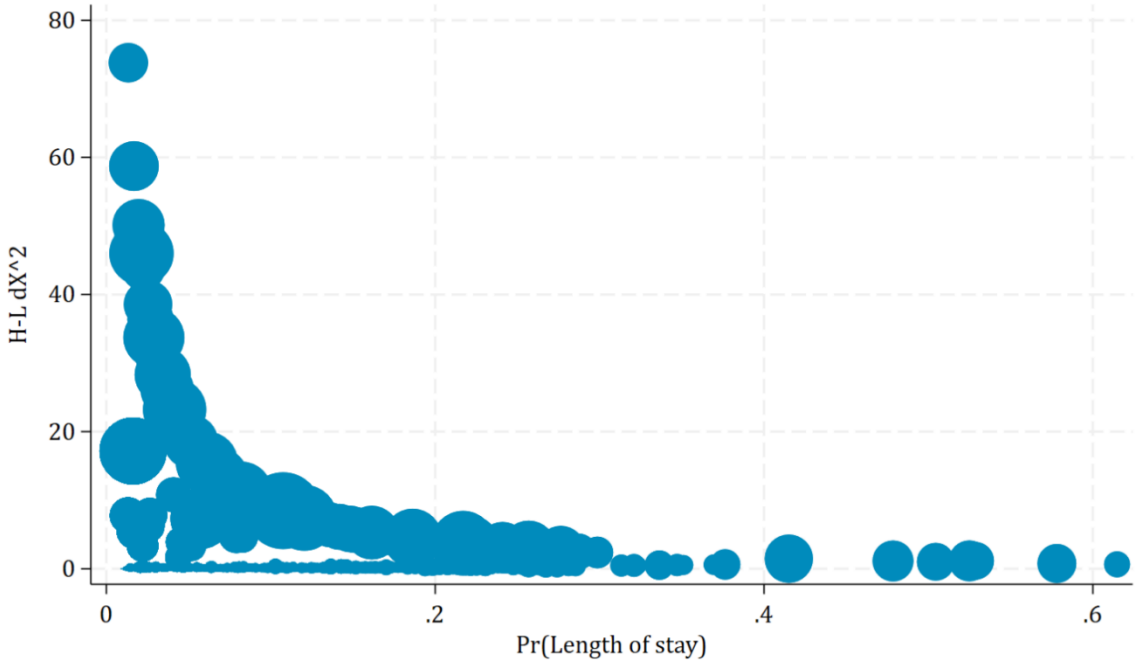

Figure A4. Logistic regression diagnostics for Model_2. Combination of "Δχ2 Influence Statistics" and "Δβ Influence Statistics" for Length of Stay Longer than 42 Days.

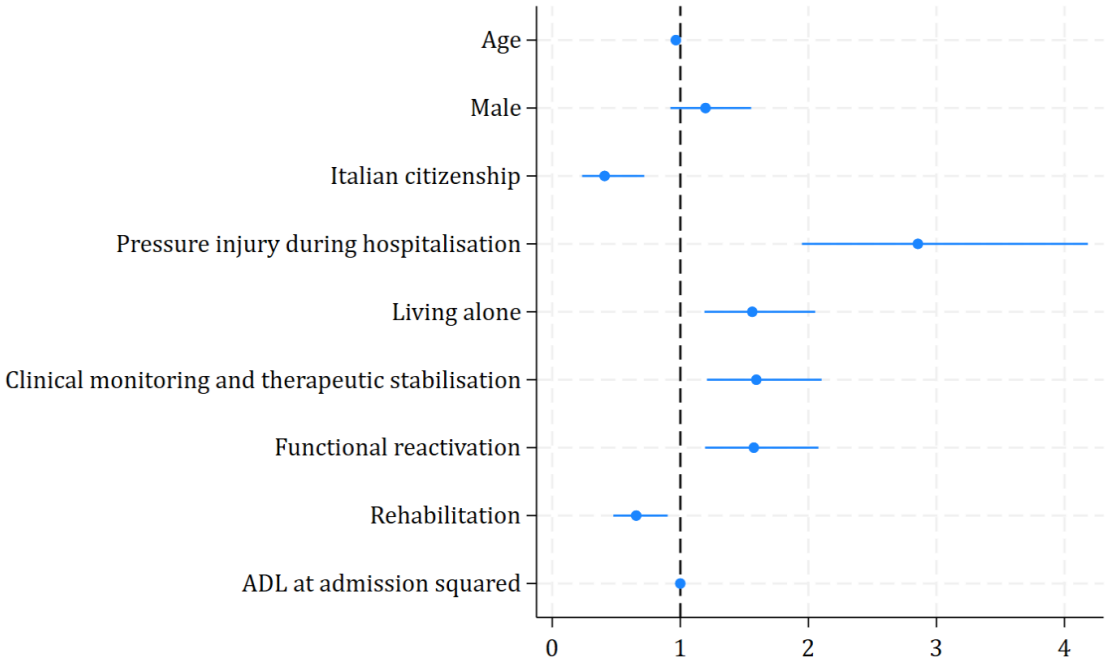

Figure A5. Sensitivity Analysis for Model_2. Forest Plot of Odds Ratios Resulting from Logistic Regression Analysis of Length of Stay Longer than 42 Days. Admissions to All the Seven Community Hospitals of Romagna's Local Healthcare Authority Are Included (2021–2023).

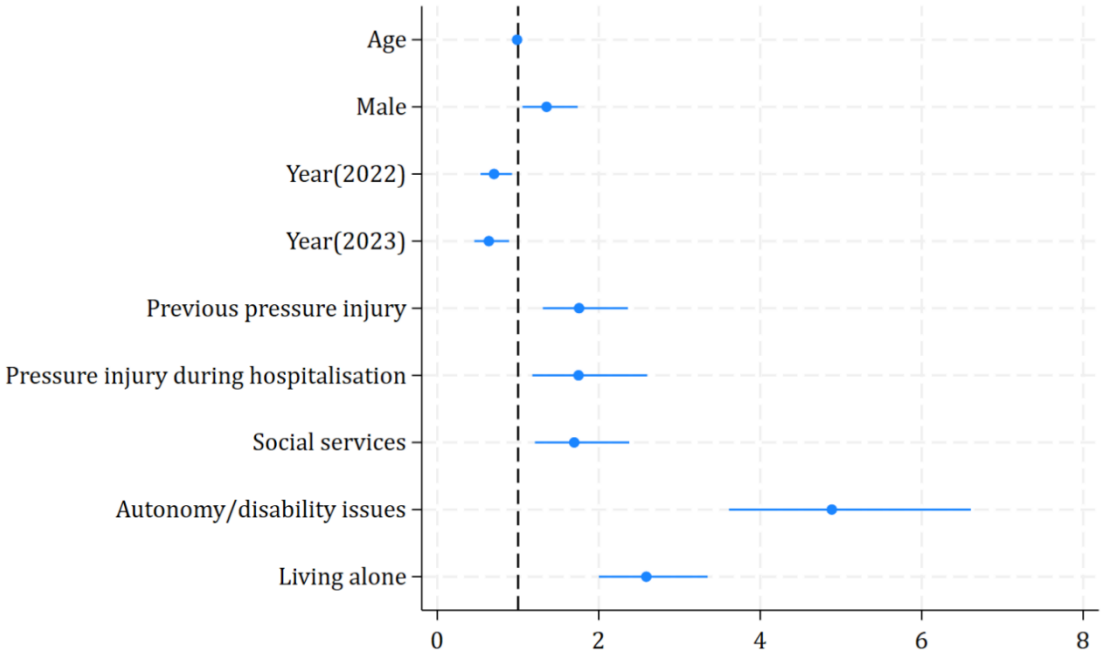

Figure A6. Forest Plot of Odds Ratios Resulting from Logistic Regression Analysis of Readmission. Patients admitted to Seven Community Hospitals of Romagna's Local Healthcare Authority Are Included (2021–2023).

Appendix 2 – Activities of Daily Living

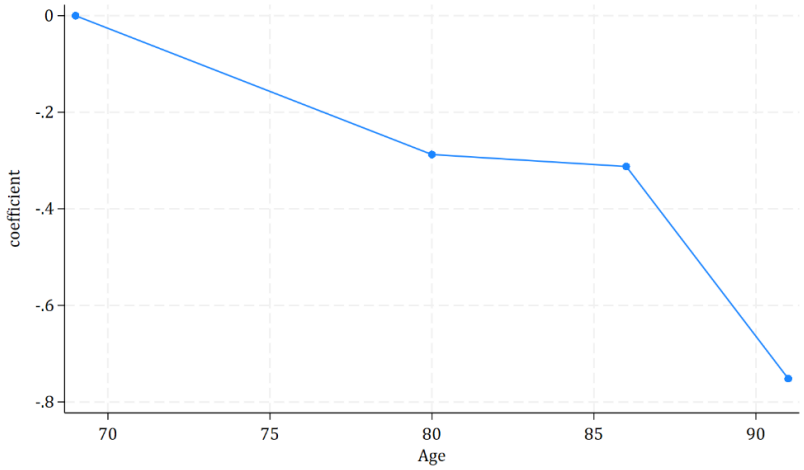

Figure A7. Quartile Design Variables Method for Assessing the Scale of the Variable "Age".

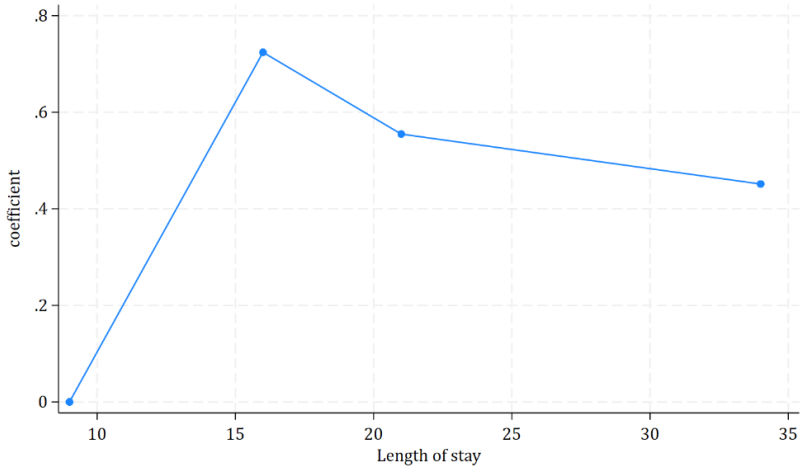

Figure A8. Quartile Design Variables Method for Assessing the Scale of the Variable "Length of Stay".

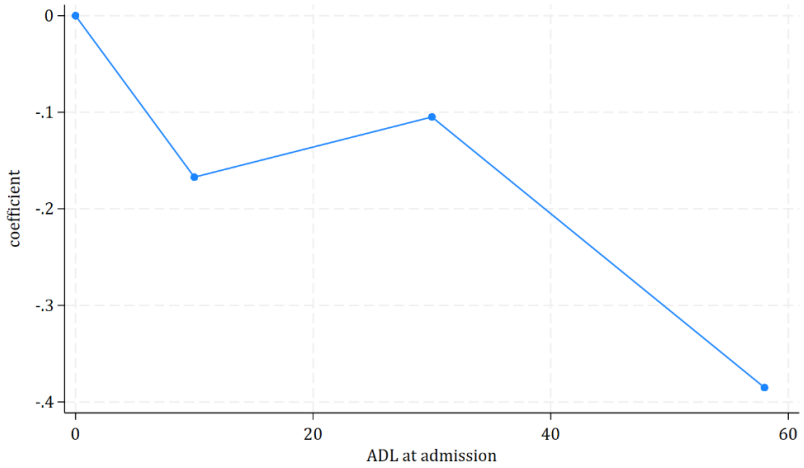

Figure A9. Quartile Design Variables Method for Assessing the Scale of the Variable "ADL at Admission".

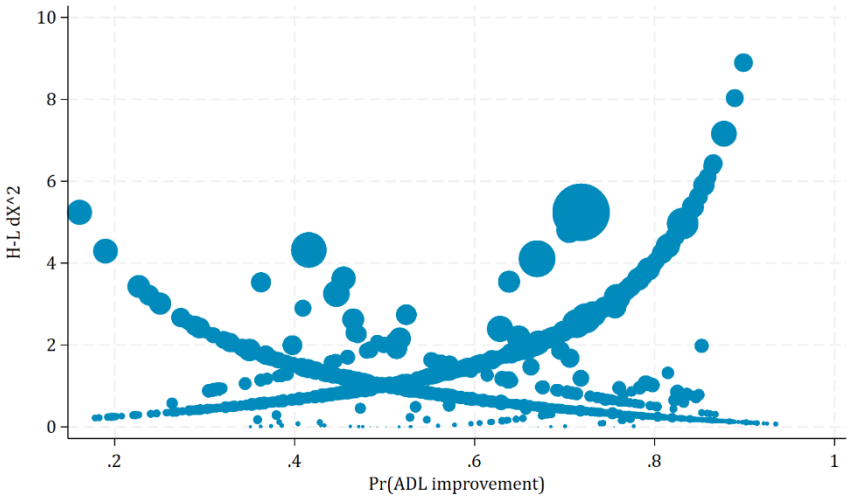

Figure A10. Logistic Regression Diagnostics for Model_5. Combination of "Δχ2 Influence Statistics" and "Δβ Influence Statistics" for ADL Improvement.

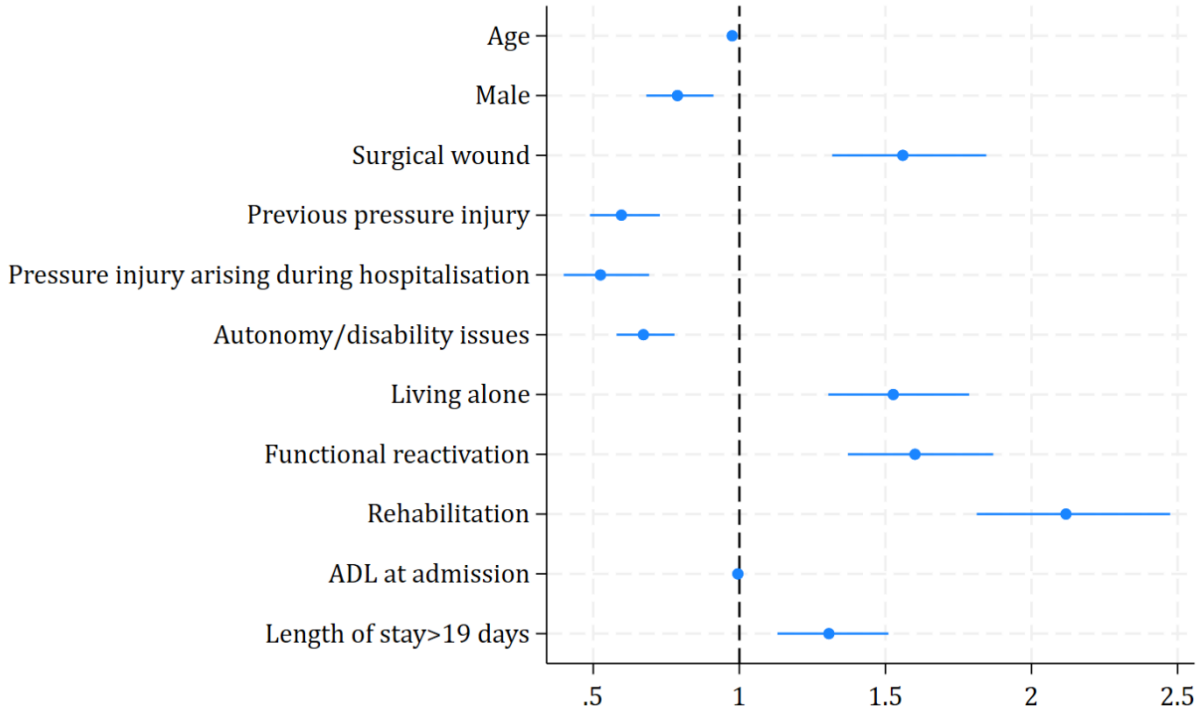

Figure A11. Sensitivity Analysis for Model_2. Forest Plot of Odds Ratios Resulting from Logistic Regression Analysis of Improvement in the ADL. Admissions to All the Seven Community Hospitals of Romagna's Local Healthcare Authority Are Included (2021–2023).

Appendix 3 – Readmissions to Community Hospitals

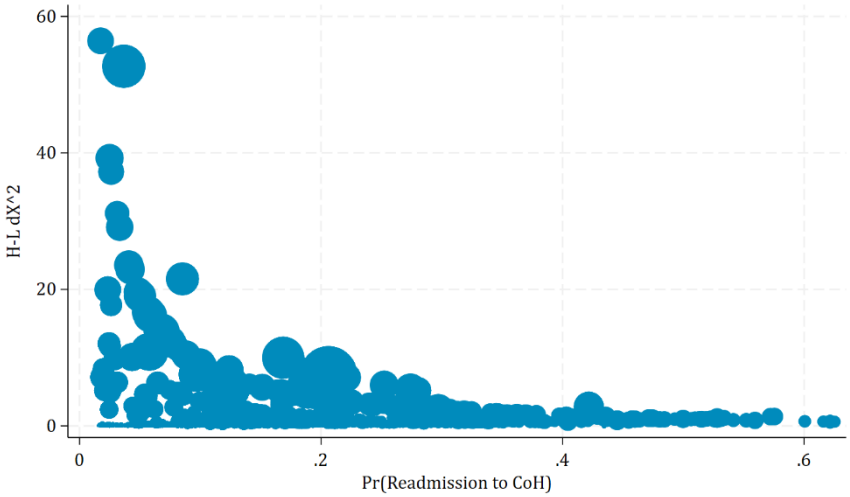

Figure A12. Logistic Regression Diagnostics. Combination of "Δχ2 influence statistics" and "Δβ influence statistics" for Readmission to CoHs.

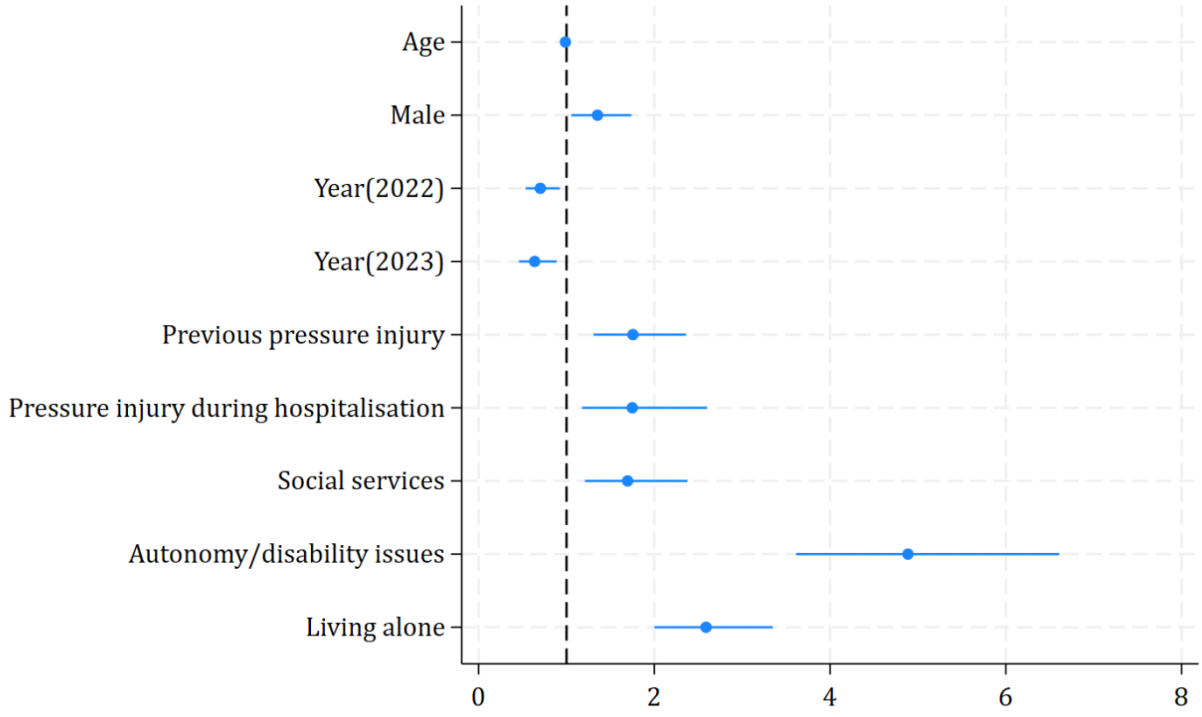

Figure A13. Sensitivity Analysis. Forest Plot of Odds Ratios Resulting from Logistic Regression Analysis of Readmission. Patients admitted to Seven Community Hospitals of Romagna's Local Healthcare Authority Are Included (2021–2023).

Appendix 4 – Patients Reported Experience Measures, results by CoH

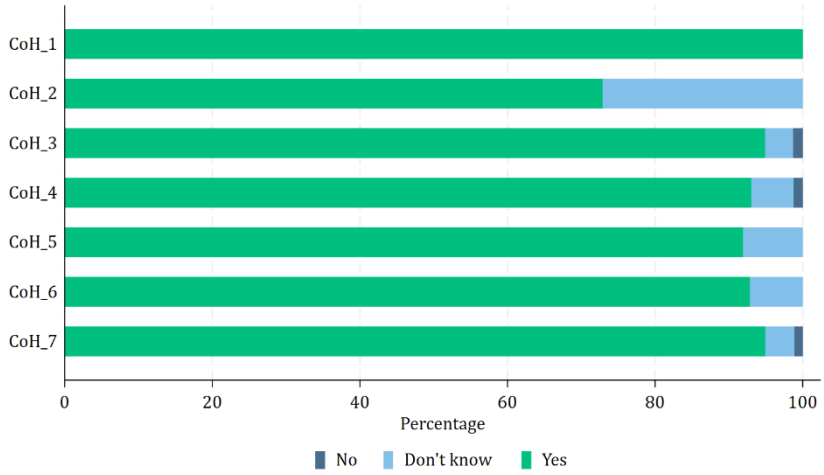

Figure A14. The staff who took care of me had all the necessary information about my illness or health condition.

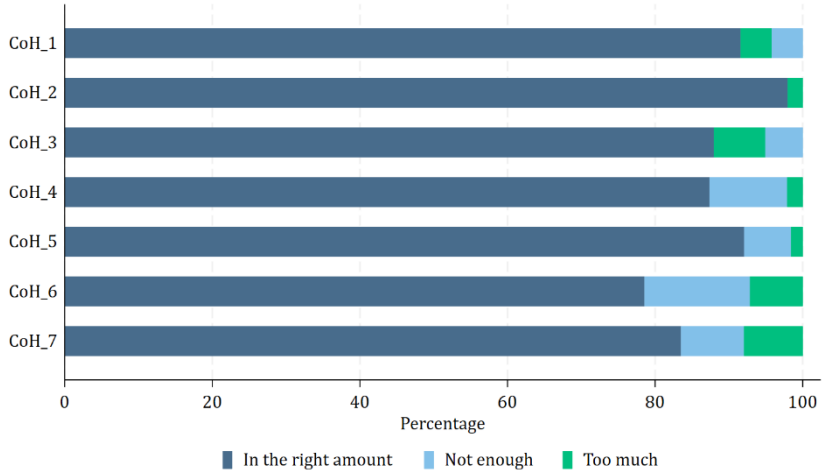

Figure A15. I have been given sufficient information about my health condition and/or treatment.

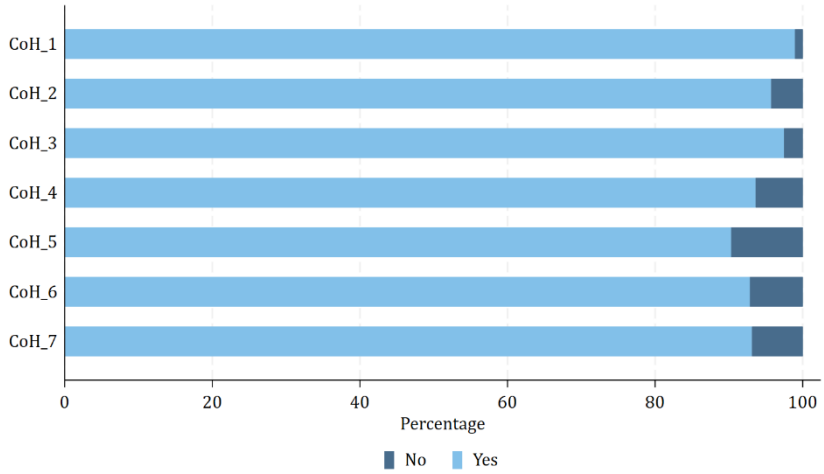

Figure A16. The goals to be achieved during hospitalisation were explained to me (e.g. moving around the house, being independent at home, being able to go shopping).

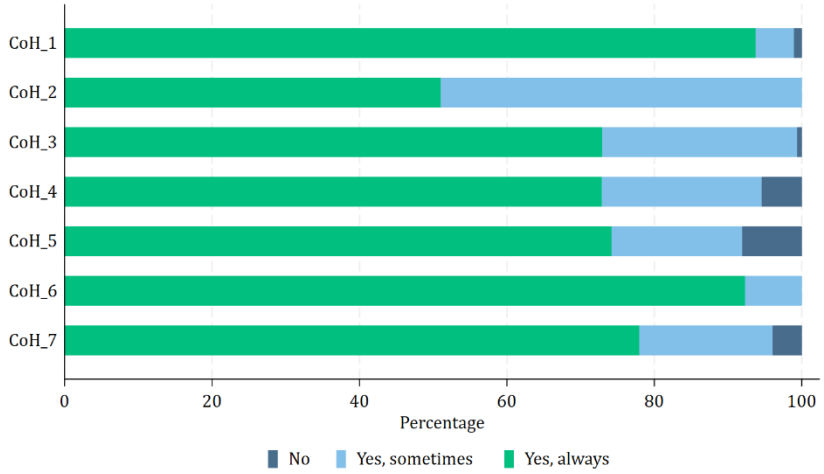

Figure A17. I was involved in defining these objectives.

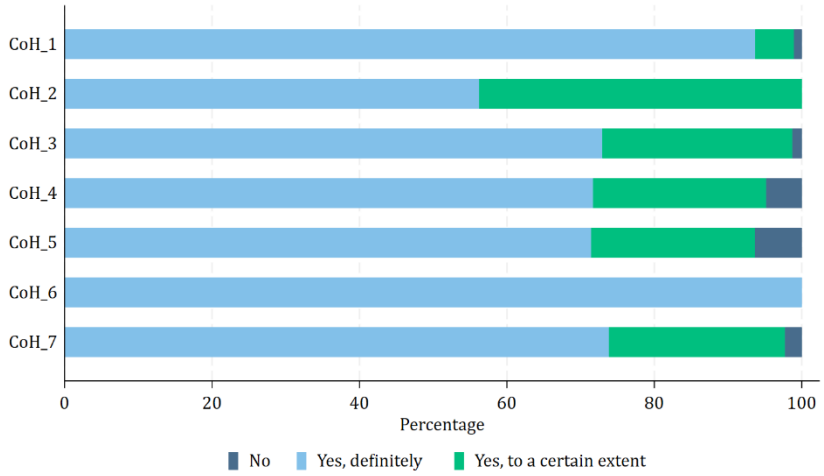

Figure A18. I was as involved in decisions about care, support and treatment as I would have liked to be.

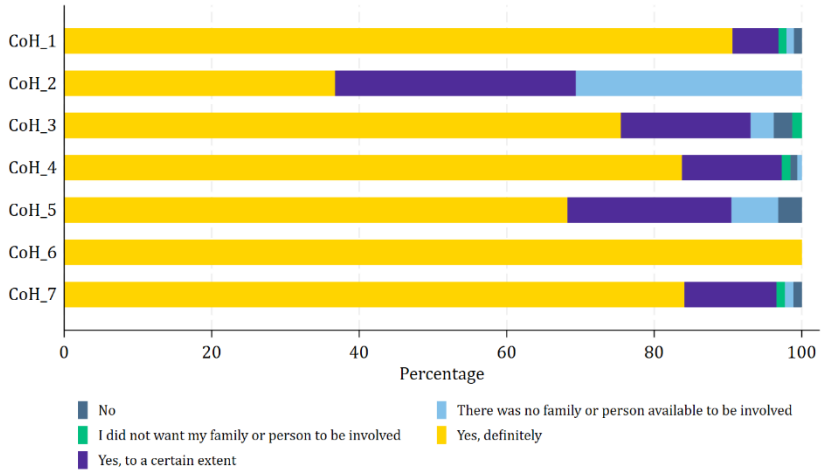

Figure A19. My family or carer were as involved in these decisions as I would have liked.

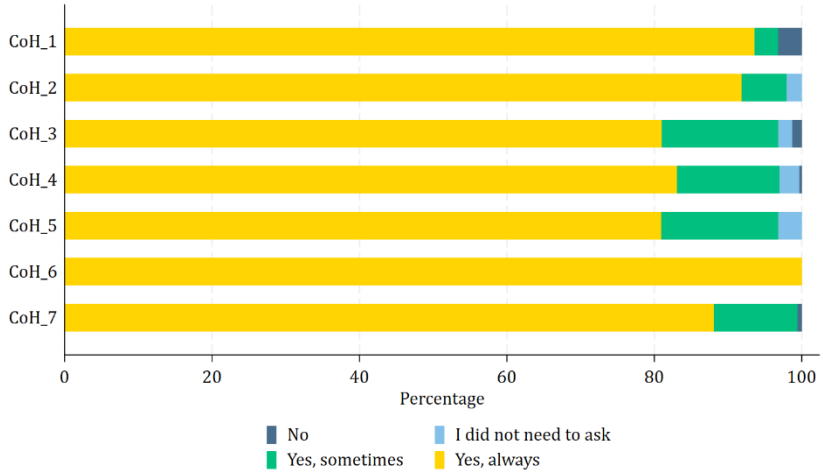

Figure A20. When I had important questions, the staff answered them satisfactorily.

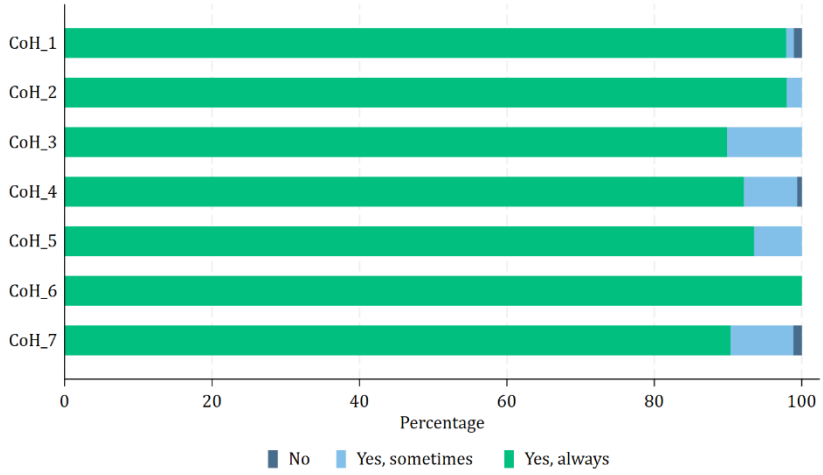

Figure A21. I trusted the staff who assisted and helped me.

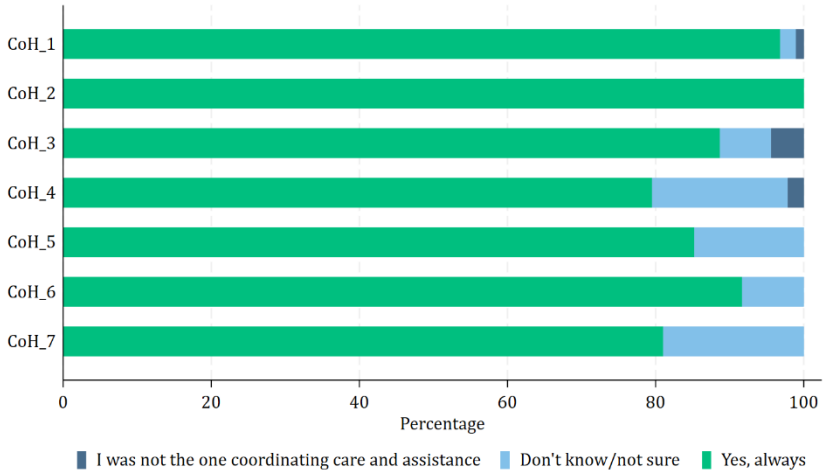

Figure A22. I always knew who was coordinating my assistance.

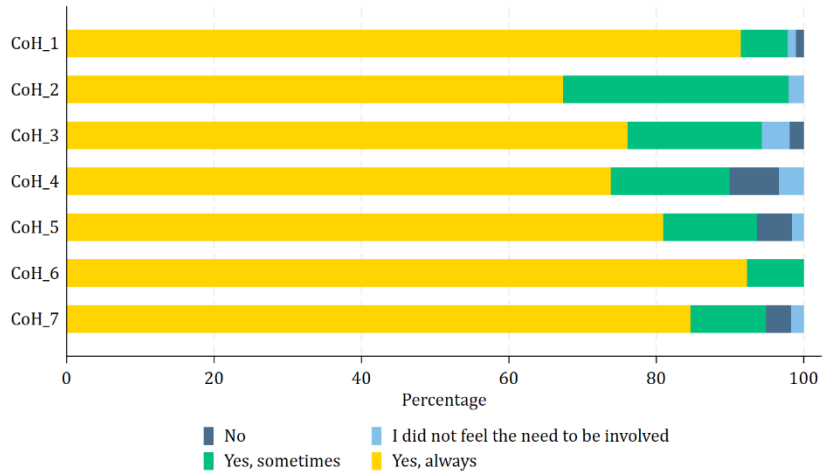

Figure A23. I was involved in decisions about my return home.

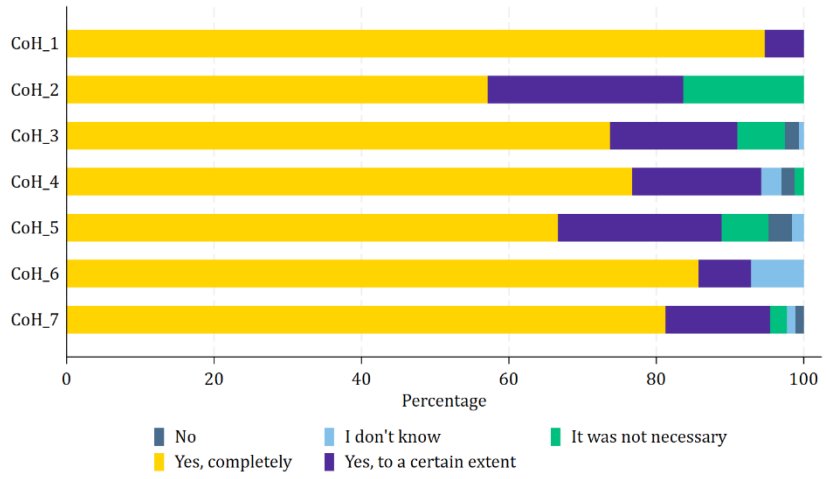

Figure A24. The staff took my family and home situation into account when organising my return home.

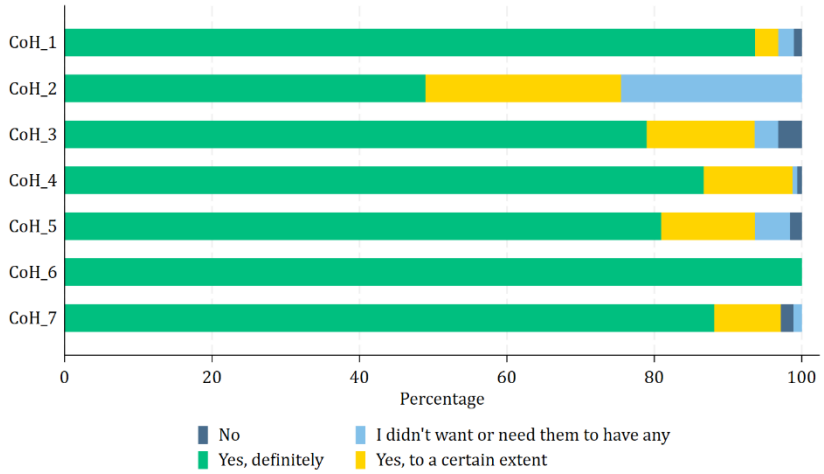

Figure A25. The staff gave my family or someone close to me all the information they needed to take care of me.

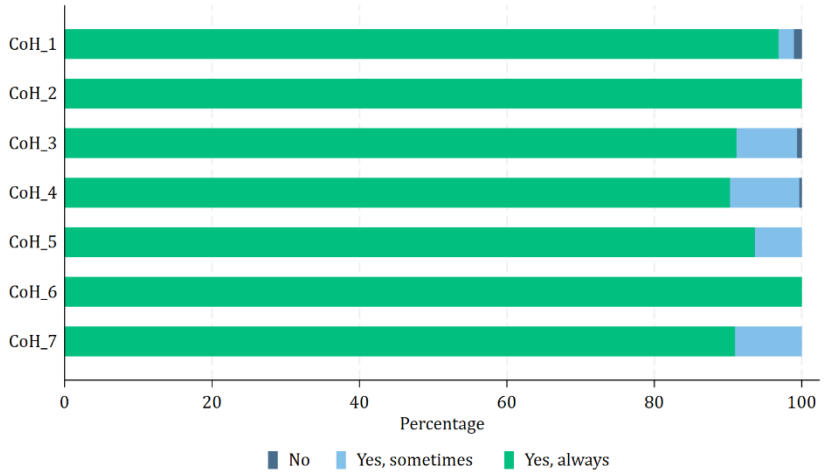

Figure A26. Overall, I felt treated with respect and dignity while receiving assistance from this service.

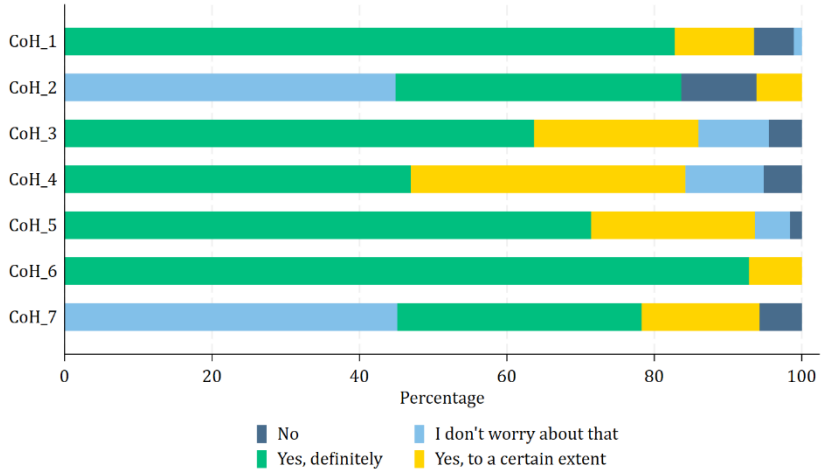

Figure A27. Since being treated at this service, my ability to maintain relationships with others has improved.

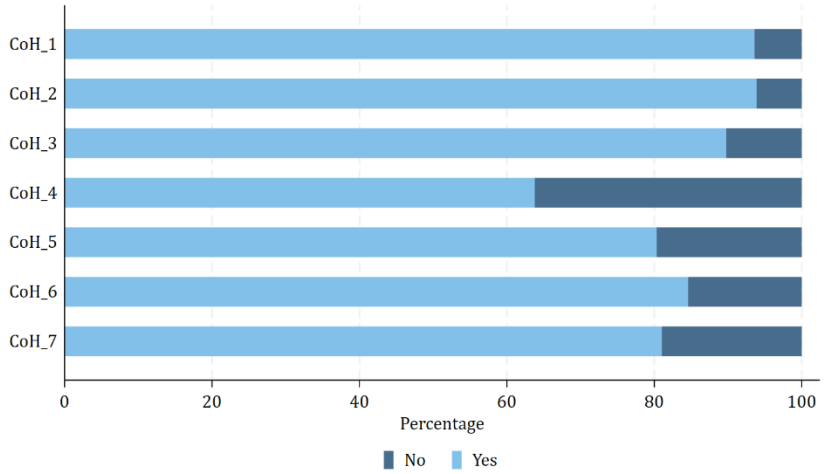

Figure A28. I was sufficiently informed about other services available for people with my health condition, including voluntary associations.

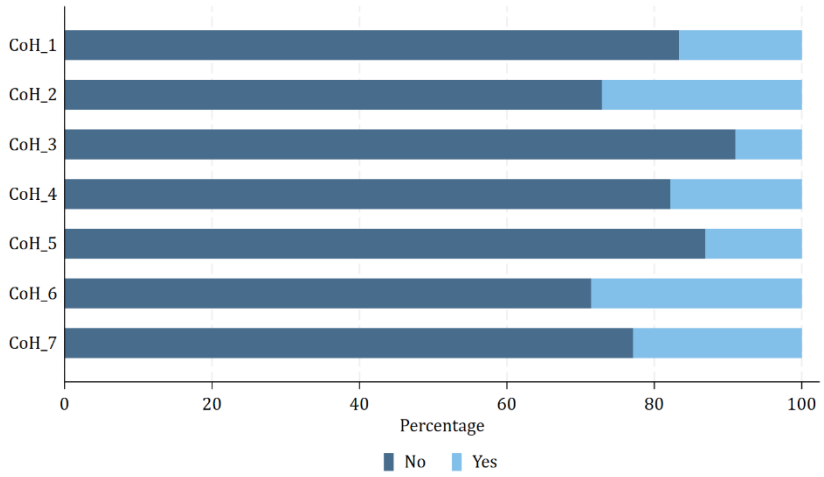

Figure A29. Do you think there is anything that could have made your experience of the service better?

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