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Optimizing medication management for polymedicated home-dwelling older adults with multiple chronic conditions

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**OPTIMIZING MEDICATION MANAGEMENT FOR
POLYMEDICATED HOME-DWELLING OLDER ADULTS WITH
MULTIPLE CHRONIC CONDITIONS**

**A GESTÃO TERAPÊUTICA EM IDOSOS NO DOMICÍLIO COM
CONDIÇÕES CRÓNICAS MÚLTIPLAS E POLIMEDICAÇÃO**

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To the extreme generations that share my life: from the eldest — my grandparents, Alzira and Benjamin, and my auntie Lena, who started out on this adventure with me and who would have been so happy to see my dreams fulfilled — to the youngest — my son Gabriel and his little brother, who is on the way.

"Ageing is a privilege not a predicament..."

Martin Firrell (1963-)

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ABSTRACT

Introduction: Inappropriate medication management may lead to polymedicated home-dwelling older adults having medication-related problems (MRPs), particularly during care transitions. MRPs are often responsible for physical and cognitive decline, avoidable health costs, and early death. Optimizing medication management should be a priority to prevent MRPs. Nurses' roles in ensuring safe medication management for this population remain poorly explored.

Objectives: Develop an interprofessional model to support medication management and prevent MRPs among polymedicated home-dwelling older adults after hospital discharge.

Methods: A sequential, explanatory mixed-methods study—conducted from February 2019 to January 2022—investigated medication management among polymedicated home-dwelling older adults after discharge from a hospital in French-speaking Switzerland. The quantitative phase retrospectively examined the hospital's electronic patient records (N = 105,243) to identify geriatric inpatient profiles at risk of 30-day hospital readmission or unplanned nursing home admission. The qualitative phase explored the perspectives of older adults (n = 28), their informal caregivers (n = 17), and their healthcare professionals (n = 13) on medication management after hospital discharge. A systematic literature review was conducted simultaneously.

Results: Retrospective findings revealed patient-, medication-, and environment-related factors that increased the risks of polymedicated home-dwelling older adults experiencing hospital readmission or unplanned nursing home admission. Prospective findings revealed poor patient-centeredness and dysfunctions in communication, collaboration, and coordination between the multiple stakeholders involved in post-discharge medication management at home. The combined findings enabled us to design an interprofessional, collaborative medication management model composed of four interactive fields of action: giving voice to polymedicated home-dwelling older adults and their informal caregivers; involving older adults and their informal caregivers in shared, medication-related decision-making; empowering older adults and their informal caregivers for safe medication self-management; and optimizing collaborative medication management practices.

Conclusions: Safe, effective post-discharge medication management at home faces numerous hindrances. More nurse-led, interprofessional, patient-centered practices can help improve safe medication management. Future studies should explore the effectiveness of our collaborative, patient-centered medication management model for polymedicated home-dwelling older adults after hospital discharge.

Keywords: older adults; home-dwelling; care transitions; hospital discharge; medication management; polypharmacy; medication-related problems; mixed-methods research; patient-centered model; nurses' role.

RESUMO

Introdução: A gestão inadequada do regime medicamentoso pode levar a que idosos polimedicados tenham problemas relacionados com a medicação (MRPs), particularmente na transição de cuidados de saúde. Os MRPs são frequentemente responsáveis pelo declínio físico e cognitivo, custos de saúde evitáveis, e morte prematura. A otimização da gestão do regime medicamentoso deve ser uma prioridade para evitar os MRPs. O papel dos enfermeiros na segurança da gestão do regime medicamentoso para esta população tem sido pouco explorado.

Objetivo: Desenvolver um modelo interprofissional para apoiar a gestão domiciliária do regime medicamentoso e prevenir os MRPs em idosos polimedicados após a alta hospitalar.

Métodos: Um estudo sequencial e explicativo de método misto—conduzido de Fevereiro de 2019 a Janeiro de 2022—investigou a gestão domiciliária do regime medicamentoso em idosos polimedicados após a alta de um hospital na Suíça francófona. A fase quantitativa examinou retrospectivamente os registos electrónicos dos pacientes do hospital (N = 105 243) para identificar os perfis de idosos com risco de readmissão hospitalar em 30 dias ou institucionalização num lar de idosos. A fase qualitativa explorou as perspectivas de idosos (n = 28), cuidadores informais (n = 17), e profissionais de saúde (n = 13) sobre a gestão do regime medicamentoso após a alta hospitalar. Uma revisão sistemática da literatura foi realizada simultaneamente.

Resultados: Os resultados retrospectivos revelaram factores individuais, relacionados com o regime medicamentoso e o contexto hospitalar responsáveis pelo aumento do risco, em idosos polimedicados, de readmissão hospitalar ou institucionalização num lar. Os resultados prospectivos revelaram uma fraca centralidade do doente e disfunções na comunicação, colaboração, e coordenação entre os múltiplos intervenientes envolvidos na gestão do regime medicamentoso pós-alta hospitalar. Os resultados combinados permitiram-nos conceber um modelo interprofissional e colaborativo de gestão do regime medicamentoso composto por quatro campos de ação interativos: dar voz aos idosos e aos seus cuidados informais; envolver os idosos e os seus cuidados informais na tomada de decisões partilhadas relacionadas com o regime medicamentoso; capacitar os idosos e os seus cuidados informais para a segurança da autogestão do regime medicamentoso; e otimizar as práticas de gestão colaborativa do regime medicamentoso.

Conclusões: A segurança e a eficácia da gestão domiciliária do regime medicamentoso do idoso polimedicado pós-alta hospitalar enfrentam inúmeros obstáculos. Práticas mais interprofissionais, dirigidas por enfermeiros, e centradas no idoso polimedicado podem ajudar a melhorar a gestão do regime medicamentoso no domicílio. Futuros estudos deveriam explorar a eficácia do nosso modelo de gestão colaborativa do regime medicamentoso centrado no idoso polimedicado após a alta hospitalar.

Palavras-chave: idosos; domicílio; transição de cuidados de saúde; alta hospitalar; gestão do regime medicamentoso; polimedicação; problemas relacionados com a medicação; investigação de método misto; modelo centrado no doente; papel dos enfermeiros.

RÉSUMÉ

Introduction: Une gestion inappropriée des médicaments peut conduire à des problèmes liés à la médication (MRPs) chez les personnes âgées polymédicamentées vivant à domicile, en particulier pendant les transitions de soins. Les MRPs sont souvent responsables d'un déclin physique et cognitif, de coûts de santé évitables et d'un décès précoce. L'optimisation de la gestion médicamenteuse devrait être une priorité pour prévenir les MRPs. Le rôle des infirmiers·ères pour assurer la sécurité de la gestion médicamenteuse pour cette population reste peu exploré.

Objectifs: Développer un modèle interprofessionnel pour soutenir la gestion médicamenteuse et prévenir les MRPs chez les personnes âgées polymédicamentées vivant à domicile après leur sortie de l'hôpital.

Méthodes: Une étude séquentielle, explicative mixte–menée de février 2019 à janvier 2022–a examiné la gestion médicamenteuse chez les personnes âgées polymédicamentées vivant à domicile après leur sortie d'un hôpital en Suisse romande. La phase quantitative a examiné rétrospectivement les dossiers électroniques des patients de l'hôpital (N = 105 243) afin d'identifier les profils de patients âgés hospitalisés présentant un risque de réadmission à l'hôpital à 30 jours ou d'admission non planifiée en établissement médico-social. La phase qualitative a permis d'explorer les perspectives des personnes âgées (n = 28), de leurs proches aidants (n = 17) et de leurs professionnels de santé (n = 13) sur la gestion médicamenteuse après la sortie de l'hôpital. Une revue systématique de la littérature a été menée simultanément.

Résultats: Les résultats rétrospectifs ont révélé des facteurs liés aux patients, aux médicaments et à l'environnement qui augmentaient les risques de réadmission à l'hôpital ou d'admission non planifiée en établissement médico-social des personnes âgées polymédicamentées vivant à domicile. Les résultats prospectifs ont révélé un manque de centrage sur le patient et des dysfonctionnements dans la communication, la collaboration et la coordination entre les multiples intervenants impliqués dans la gestion médicamenteuse à domicile après la sortie de l'hôpital. Les résultats combinés nous ont permis de concevoir un modèle interprofessionnel de gestion collaborative des médicaments composé de quatre champs d'action interactifs: donner la parole aux personnes âgées polymédicamentées vivant à domicile et à leurs proches aidants; impliquer les personnes âgées et leurs proches aidants dans la prise de décision partagée concernant les médicaments; donner aux personnes âgées et à leurs proches aidants les moyens d'une autogestion médicamenteuse; et optimiser les pratiques de gestion collaborative des médicaments.

Conclusions: La gestion sécuritaire et efficace de la médication à domicile après la sortie de l'hôpital se heurte à de nombreux obstacles. Davantage de pratiques dirigées par des infirmiers·ères, interprofessionnelles et centrées sur le patient peuvent contribuer à améliorer la sécurité de la gestion médicamenteuse. Des études futures devraient explorer l'efficacité de notre modèle de gestion collaborative des médicaments, centré sur le patient, pour les personnes âgées polymédicamentées vivant à domicile, après leur sortie de l'hôpital.

Mots clés: personnes âgées ; domicile ; transitions de soins ; sortie d'hôpital ; gestion médicamenteuse ; polymédication ; problèmes liés aux médicaments ; méthode mixte ; modèle centré sur le patient ; rôle infirmier.

LIST OF ABBREVIATIONS

ACI	Agency for Clinical Innovation
CER-VD	Human Research Ethics Committee of the Canton of Vaud
FLD	Flexible Line of Defense
LR	Lines of Resistance
MRPs	Medication-related Problems
NSM	Neuman systems model
NLD	Normal Line of Defense
PCNE	Pharmaceutical Care Network Europe
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
RAI-HC	Resident Assessment Instrument-Home Care
SR-M3	Systematic Review about Medication Management Models

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PREAMBLE

“Optimizing medication management for polymedicated home-dwelling older adults with multiple chronic conditions” is a project thesis developed within the Doctoral Programme in Nursing Sciences at the Institute of Biomedical Sciences Abel Salazar, part of the University of Porto, in Portugal. It is part of the “ME@home” research project conducted from February 2019 to January 2022 and funded by the Swiss National Science Foundation within the framework of National Research Programme 74: “Smarter Health Care” [grant number 407440_183434/1]. All the data were collected in the canton of Valais, in Switzerland. The study was conducted according to the guidelines of the Declaration of Helsinki and was approved by the Human Research Ethics Committee of the Canton of Vaud (CER-VD) (2018-02196) (Appendix 1).

The project thesis is presented in the form of research articles published in scientific peer review journals with Open Access. The candidate was jointly responsible for study design, data collection, data analysis, interpretation and analysis of results, and preparation of the final manuscript for each of these articles. To improve clarity and provide a better understanding of how the research progressed, the thesis is organized into seven main chapters. Each chapter presents not only the relevant research articles but also the scientific knowledge-transfer events participated in via oral and poster presentations. Chapter 1, *“Introduction”*, presents the project’s background (Article 1) and the thesis’ overall aim. Chapter 2, *“Theoretical framework”*, describes the Neuman systems model and its contribution to the thesis project. Chapter 3, *“Methods”*, presents the study protocol for the overall project (Article 2) and the protocol for our project-concurrent systematic literature review (Article 3). As the systematic review process is not yet complete, this chapter presents its current state of progress. The overall project’s results are presented across two chapters. Chapter 4, *“Retrospective quantitative phase: from hospital admission to discharge”*, focuses on polymedicated home-dwelling older adults’ profiles while in hospital, before discharge home, and is composed of three articles based on quantitative data. Chapter 5, *“Prospective qualitative phase: medication management at home”*, focuses on how polymedicated home-dwelling older adults perceived their hospital discharge home and how they dealt with their new reality of medication management there. It also describes the perceptions of their informal and professional caregivers on these issues. This chapter includes two articles based on qualitative data. Chapter 6, *“A collaborative, patient-centered, medication management model: from the diagnostic to the solution-design phase”*, connects these quantitative and qualitative data and proposes a model to optimize medication management and prevent adverse health outcomes associated with medication-related problems (Article 9, submitted). This chapter also presents other research perspectives and collaborations within the scope of the thesis (Article 10, submitted). Finally, Chapter 7, *“Conclusions and future perspectives”*, highlights the thesis’ most important aspects and implications for clinical practice and further research.

Each article was published with its own particular list of abbreviations and references. To simplify reading, the list of figures, tables and appendices only presents those relevant to the main body of the thesis and not those of each separate article.

SCIENTIFIC OUTPUTS WITHIN THE SCOPE OF THE THESIS

Articles published in peer-reviewed journals

Pereira F, von Gunten A, Rosselet Amoussou J, De Giorgi Salamun I, Martins MM, Verloo H. Polypharmacy Among Home-Dwelling Older Adults: The Urgent Need for an Evidence-Based Medication Management Model. Patient Preference and Adherence. 2019;13 2137–2143. doi:10.2147/PPA.S232575.

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Pereira F, Meyer-Massetti C, del Río Carral M, von Gunten A, Wernli B, Martins M, Verloo H. A collaborative, patient-centered medication management model for poly-medicated home-dwelling older adults after hospital discharge: results of a mixed-methods study (Submitted to BMC Geriatrics on June 10th, 2022).

Pereira F, Coelho Rodrigues Dixe M, Santos Gonçalves Pereira, S, Meyer-Massetti C, Verloo, H. Intervention programme to reduce medication-related problems among polymedicated home-dwelling older adults (OptiMed): a pre-post multi-site pilot and feasibility study protocol (Submitted to JMIR Protocols on April 30th, 2022).

Abstract submitted to a peer-reviewed journal

Pereira F, Wernli B, von Gunten A, Santiago-Delefosse M, del Rio Carral M, Martins M, Verloo H. Polymedicated home-dwelling older adults' risk factors for hospital readmission and unplanned institutionalization: preliminary results from the retrospective study phase of the PNR74 ME@home project. (Accepted by Primary and Hospital Care, publication scheduled for September 2022).

Contributions in related publications

Roux P, **Pereira F**, Santiago-Delefosse M, Verloo H. Medication practices and experiences of older adults discharged home from hospital: a feasibility study protocol. *Patient preference and adherence*. 2018;12:1055. doi:10.2147/PPA.S160990.

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Oral presentations in scientific meetings

Pereira F, Taushanov Z, Wernli B, Verloo H. Longitudinal data analysis of a regional hospital register to explore the profiles of polymedicated older inpatients with multiple chronic conditions: a multiple-cluster model strategy. Presented at the 10th International Conference of Panel Data Users. 2019. Lausanne, Switzerland.

Pereira F, Verloo H., Wernli B. Methodological considerations and outcomes from an analysis of routinely collected, highly sensitive health data from a hospital register. Presented at a Seminar of the Foundation for Research in Social Sciences (FORS), University of Lausanne. 2021. Lausanne, Switzerland.

Pereira F, Martins M, del Río Carral M, Verloo H. Optimising medication management for polymedicated home-dwelling older adults. Presented on the EANS Virtual Summer School. 2021. Cologne, Germany.

Pereira F, Coelho Rodrigues Dixe M, Santos Gonçalves Pereira, S, Verloo, H. Intervention programme to reduce medication-related problems among polymedicated home-dwelling older adults: the OptiMed study. Oral presentation on the First International Seminar on CCISP–HES-SO Collaborative Research. 2021. Leiria, Portugal.

Pereira F, del Río Carral M, Verloo H, Martins M. Optimizing medication management: contributions from an interdisciplinary approach. Oral presentation at the Interdisciplinary Research Seminar on Health and Clinical Psychology. 2022. Lausanne, Switzerland.

Pereira F, Martins M, del Río Carral M, Verloo H. Optimising medication management for polymedicated home-dwelling older adults. Oral presentation at the EANS Summer School. 2022. Vilnius, Lithuania.

Poster presentations in scientific meetings

Pereira F, Martins M, Verloo H. Medication management for polymedicated home-dwelling older adults: the ME@HOME study. Poster presented at Asserting the Essence of Nursing: 10 years of the Doctoral Programme in Nursing Sciences. 2019. Institute of Biomedical Sciences Abel Salazar, University of Porto, Porto, Portugal.

Pereira F, Martins M, del Río Carral M, Meyer-Masseti C, Verloo H. Optimizing medication management for polymedicated home-dwelling older adults: the ME@HOME study. Poster presented at the Synthesis Conference of NRP 74, Smarter HealthCare. 2022. Luzern, Switzerland.

Pereira F, Martins M, del Río Carral M, Meyer-Masseti C, Verloo H. Optimizing medication management for polymedicated home-dwelling older adults: the ME@HOME study. Poster presented at the EANS Summer Conference 2022. Vilnius, Lithuania.

CHAPTER 1 – INTRODUCTION

INTRODUCTION

This chapter contains the thesis' background, rationale, and overall aim. The rationale led to a publication (Article 1) presenting an overview of the current state of medication management among polymedicated home-dwelling older adults and evidence-based strategies to improve effective medication management and patient safety.

Background

There are now thousands of medications available for prescription to prevent, treat, and lessen the impact of health conditions that would have been fatal just a few generations ago. Medication palliates suffering, improves the quality of life, and extends and saves lives [1]. However, those medications can sometimes turn into a major challenge for patients, healthcare professionals, healthcare systems, and society in general. This is particularly the case with regards to polymedicated older adults with chronic health conditions. Today's rapidly ageing populations have a higher prevalence of multiple chronic noncommunicable diseases, partly explaining why older adults are prescribed substantially higher numbers of medications than younger patients. Their health conditions often require complex, multi-drug pharmacotherapy, commonly known as polypharmacy when five or more medications are taken daily [2]. Polypharmacy may be appropriate (when it is therapeutically beneficial or prescribed according to best evidence) or inappropriate (if the prescribing of multiple medications does not follow best evidence or when its intended benefits are not attained). Due to age-related changes in pharmacokinetics and pharmacodynamics [3], polypharmacy is particularly problematic among older adults and often leads to potentially inappropriate prescriptions and medication-related problems (MRPs) [4, 5].

The definition of MRPs is wide and encompasses all sorts of difficulties, complications, adverse events, and health outcomes ranging from patients not being able to open a blister pack to an adverse medication reaction or a lethal medication error. The Pharmaceutical Care Network Europe (PCNE) has classified the different causes and types of MRPs [6] (Figure 1).

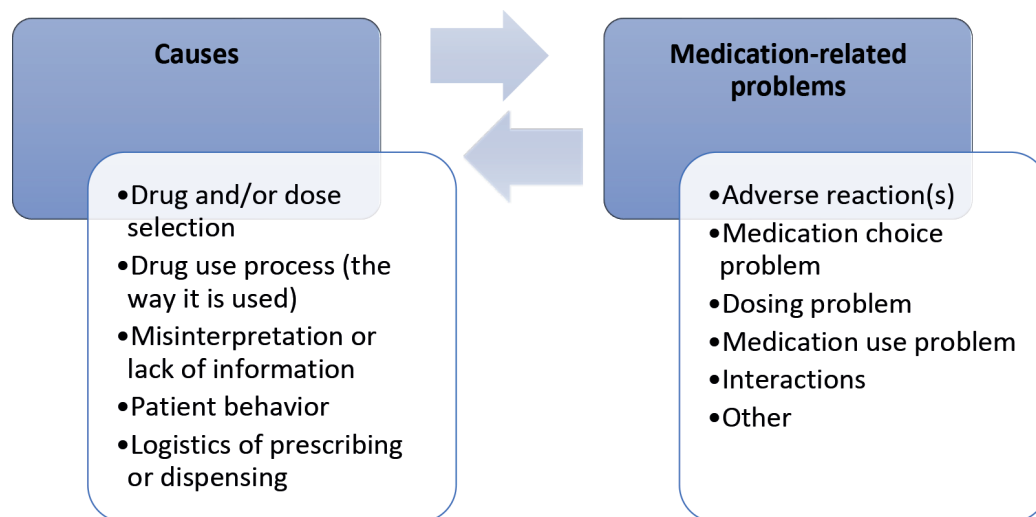


Figure 1: Causes and types of MRPs based on Pharmaceutical Care Network Europe's classification [6].

According to the PCNE classification, the causes of MRPs include: 1) inappropriate medication and/or dosage selection, pharmacokinetic problems such as those caused by ageing or deteriorations in organ function, deteriorations or improvements in disease state, the appearance of new symptoms or indications, and inappropriate timing of administration and/or dosing intervals; 2) medication-use processes in cases of underused or overused medication or if patients cannot use medication as prescribed; 3) the misinterpretation or lack of information resulting from patients being unaware of the reasons for their medication treatment or the instructions for their medication use, patients being unable to understand the local language, and even a lack of communication between healthcare professionals; 4) patient behavior when they suffer from a heavy burden of therapy, forget to use/take medication, ingest food that interacts with medications, suspect side-effects, are unwilling to adapt their lifestyle or to carry the financial costs, and when their treatment is not in line with their health beliefs; and 5) logistical processes resulting from prescribed medications being unavailable or from prescribing or dispensing errors [6].

MRPs can also be of different forms, such as: 1) adverse reactions (allergic or non-allergic side effects); 2) medication choice problems when patients get the wrong medication (or no medication) for their condition; 3) dosing problems when patients get more or less than the amount of medication they require (e.g., medication dose too low or not frequent enough, duration of treatment too short, etc.); 4) medication use problems when the wrong medication or no medication is taken/administered; 5) interactions such as drug–drug or drug–food interactions; and 6) others problems such as therapy failures for unknown reasons [6].

Preventable MRPs may be responsible for 10% to 15% of unplanned hospital admissions [7] and up to 25% of emergency department visits by older adults [8]. Because around 60% of these events are not categorized, these statistics may be underestimated [9]. Most MRPs (up to 92%) and medication mismanagement, includ-

ing errors made by patients and professionals, are preventable, particularly with enhanced monitoring [10]. Medication incidents rarely have a single explanation. There is often a complex interaction between a series of mistakes, oversights, or system failures that combine to create a risk of patient harm [11]. Medication incidents can be illustrated using the *Swiss Cheese Model*, in which each slice represents a safeguard and the holes represent inherent weaknesses [12]. Normally, if the patient falls into a hole, the next slice stops their progression down an error pathway, safeguarding them. The system fails when the holes in each slice are momentarily aligned, leading to an incident. Even when almost every safeguard has been breached, the very last slice can block the initial error's pathway before it affects the patient [12]. The last safeguard before a medication incident affects patient safety is often a nurse [13].

However, nurses' roles in the optimization of medication management remain unclear [14]. A recent mixed-methods study about UK professionals' perceptions of medication management optimization revealed the consensus that nurses' roles should be expanded in medication monitoring, adherence, prescribing, and patient education, but only about 50% of nurses were willing to do this [13]. The study also highlighted that nurses and physicians assumed that the other profession was monitoring for MRPs. Collaboration between nurses and physicians was considered suboptimal (rated 7/10 at best), and collaboration between nurses and pharmacists was worse (6/10 at best) [13].

MRPs can lead to a patient's functional decline and avoidable health costs, both of which deviate from the original intention of therapeutic benefit [8, 15]. Because of the risks of MRPs, polymedicated older adults require optimal medication management [16], particularly during care transitions like discharge home after hospitalization [11, 15]. Older adults and their informal caregivers often experience the medication changes made during care transitions as a disruption to their knowledge, routines, and ability to manage their medication prescriptions safely [17]. Older adults may feel vulnerable, with a reduced capacity to comprehend information and a lack of integrated care in the community [18].

Medication management is optimal when the process of selecting and managing medications results in optimal patient outcomes [19]. This requires an interprofessional, patient-centered approach to getting the best out of using medications, minimizing MRPs, promoting medication adherence, and enhancing medication safety [10, 11, 16]. Ensuring more individualized care, more carefully monitored outcomes, more frequently reviewed medications, and better supported older adults requires collaborative practice between healthcare professionals and patients [20].

Article 1 provides an overview of the burgeoning body of evidence about medication management among polymedicated home-dwelling older adults and patient-centered approaches for optimizing medication management and preventing MRPs.

ARTICLE 1

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Polypharmacy Among Home-Dwelling Older Adults: The Urgent Need for an Evidence-Based Medication Management Model

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Abstract: Ageing populations with multiple chronic conditions challenge low-, middle-, and high-income countries. Older adults frequently depend on complex medication regimens and polypharmacy, both of which can lead to potentially devastating and debilitating medication-related problems and to subsequent far-reaching public health, social, and economic effects. This perspectives article provides an overview of the current state of medication management, reflects on its relevance among polymedicated home-dwelling older adults living with multiple chronic conditions, and proposes patient-centered approaches for optimizing medication management and preventing medication-related problems.

Keywords: multiple chronic conditions, medication-related problems, caregivers, interprofessional collaboration, patient-centered care

Ageing Populations with Multiple Chronic Conditions Challenge Low-, Middle-, and High-Income Countries

Ageing populations represent one of the most significant current challenges to the long-term sustainability and efficiency of the world's healthcare and social services systems.¹ Despite increases in life expectancy, older adults are not experiencing better health than previous generations.² Worldwide, the prevalence of multimorbidity in older adults ranges from 55–98%.³ In Switzerland, 25.2% of adults aged from 65–79 years old, and 41.3% of those aged 80 or more, live at home with multimorbidity.⁴ Three major operational definitions of multimorbidity co-exist in the literature: co-occurrence of at least two diseases in the same individual; cumulative indices considering both the number and severity of concurrent diseases; and the simultaneous presence of not only diseases but also their associated symptoms and physical and cognitive dysfunctions.³ To properly cover the heterogeneity and complexity of older adults' health statuses, this paper uses the term multiple chronic conditions to encompass all three definitions.⁵ Older adults living with multiple chronic conditions present a poorer quality of life, declines in functional ability and mobility,³ and shorter life expectancy, particularly those with cognitive impairment and/or cardiovascular disease.⁶ The concept of multiple chronic conditions is also associated with increased psychological distress and repeated and prolonged hospitalizations.³ Although the expanding number of patients with multiple chronic conditions is considered a public health concern, prevalence often remains unclear, especially given the absence of any

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consensual definition in ongoing epidemiological investigations. Nonetheless, regardless of the definition, multiple chronic health conditions among home-dwelling older adults have been strongly associated with polypharmacy and medication-related problems (MRPs) in multiple observational and epidemiological studies.^{7,8}

Polypharmacy and Medication-Related Problems

Older people with multiple chronic conditions—particularly those with cognitive impairment and/or psychiatric disorders—frequently depend on complex medication regimens. A recent Swiss study reported that more than 80% of home-dwelling older adults took at least one drug daily, with some taking up to 17.⁹ Indeed, 27% had a daily intake of five or more drugs, with numbers increasing with age: 18% of those aged 69–74, rising to 38% of those aged 85 or more. However, nearly 50% of older adults took at least one medication that was not medically required.⁹

Although the use of multiple medicines or polypharmacy may be clinically appropriate in many cases, it is imperative to identify those older adults with inappropriate polypharmacy prescriptions that may put them at a greater risk of MRPs and adverse health outcomes.^{10,11} To distinguish between appropriate and inappropriate polypharmacy, Masnoon et al (2017) conducted a systematic literature review to explore the different definitions of polypharmacy.¹² They found 138 definitions of polypharmacy and associated terms. Although the most commonly used definition of polypharmacy is taking five or more medicines,¹² the variety of definitions could confuse clinicians in practice and make it difficult to assess the safety and appropriateness of a medication therapy in clinical settings. There is an urgent need for an international consensus definition of polypharmacy, including how to assess inappropriate polypharmacy, in order to optimize medication management and clinical follow-up and to enable precisely comparable criteria in research.

Regardless of polypharmacy's definition, polymedicated older adults are more susceptible to MRPs, including adverse drug reactions, medication errors, and non-adherence, which often result in emergency department visits and hospitalizations.^{10,11} Up to 25% of emergency department visits by home-dwelling older adults with multiple chronic conditions are attributable to an MRP.¹³ Nonetheless, 60% of MRPs in older patients visiting emergency departments with non-specific signs and symptoms (such as weakness) may go

undiagnosed as such, whereas 83% of those MRPs may be accountable for acute morbidity.¹³ MRPs also frequently result in readmission: in one study following older patients for six months after hospital discharge, they were the most frequent cause.¹⁴ Evidence suggests that the risk of an MRP increases not only with age and the number of comorbidities but also with the number of medications prescribed and with certain classes of drugs, such as medicines for cardiovascular diseases and diabetes.^{11,13} Thus, MRPs can lead to a degradation in the patient's clinical condition, physical and cognitive decline, an exacerbation of chronic medical conditions, and avoidable health costs.^{13,15} MRPs can be devastating and debilitating for older people, and they can have far-reaching public health, social, and economic impacts.

A possible explanation for high numbers of MRPs is that most clinical guidelines and intervention care models were designed using short-term randomized controlled trials involving single health conditions. This contrasts with the current reality of the multiple, chronic, and often interacting health conditions affecting older people. Trying to implement multiple clinical guidelines for a single disease among older adults with multiple chronic conditions may result in contradictory and potentially harmful recommendations.¹⁶ The pathophysiological processes, clinical features, and interactions of age-related conditions must be disentangled, as much as possible, in order to personalize medication and its management and to realign older adults, caregivers, and healthcare systems so as to prevent MRPs.

Due to the high prevalence of polypharmacy and MRPs, together with their impact on older adults' quality of life and public healthcare expenditure, medication management has emerged as a priority in clinical settings. Its necessity among older adults has also become the focus of considerable research interest and media attention over the last decade (Figure 1). However, the mechanisms behind poor medication management are not well defined.

The present paper provides a timely addition to the burgeoning body of evidence offering new perspectives on our understanding of medication management—well beyond the act of medical prescription itself—among polymedicated home-dwelling older adults with multiple chronic conditions.

Optimizing Medication Use Among Older Adults with Multiple Chronic Conditions

MRPs are a reflection of the complexity of dealing with polypharmacy and age-related multiple chronic conditions;

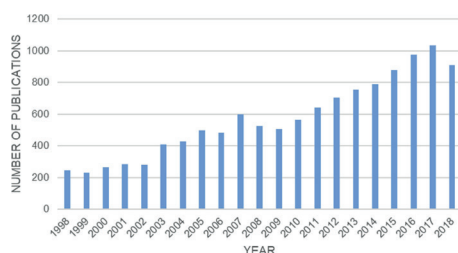


Figure 1 Papers referenced in Pubmed over the last 20 years on medication management among older adults.

Notes: Graph obtained with the following research equation: ("Aged"[Mesh] OR "Geriatrics"[Mesh] OR "Geriatric Psychiatry"[Mesh] OR "Geriatric Nursing"[Mesh] OR "Geriatric Assessment"[Mesh] OR "Health Services for the Aged"[Mesh]) AND ("Medication Therapy Management"[Mesh] OR "Drug Monitoring"[Mesh] OR "Product Surveillance, Postmarketing"[Mesh] OR "Drug Utilization Review"[Mesh] OR "Deprescriptions"[Mesh] OR "Potentially Inappropriate Medication List"[Mesh] OR "Medication Reconciliation"[Mesh] OR "Medication Systems"[Mesh] OR "Medication Errors/prevention and control"[Mesh] OR "Prescription Drug Overuse/prevention and control"[Mesh] OR ("Drug Therapy"[Mesh] OR "Drug Prescriptions"[Mesh]) AND ("Self-Care"[Mesh] OR "Patient Education as Topic"[Mesh])) AND ("1998/01/01"[PDAT]: "2018/12/31"[PDAT]).

they are causally underpinned by interacting and often unclear pathophysiological, pharmacodynamic, and pharmacokinetic processes. Furthermore, the signs of a normal ageing process are not always easy to tell apart from the potential pathophysiological deviations induced by underlying chronic conditions.^{17,18} The occurrence of MRPs is strongly affected by a broad range of factors and determinants, which are not confined to single biological systems or human health domains.¹⁷ Environmental and social factors also substantially influence MRPs.¹¹

MRPs are nonetheless preventable with appropriate, well-coordinated primary care.^{11,13,19} For example, 20–30% of avoidable older adult readmissions have been directly related to non-adherence.²⁰ Some of the current evidence-based strategies for medication safety and the prevention of MRPs include medication reconciliation, systematic review of prescribed medications, deprescribing, and electronic medication management systems.^{21,22}

Medication reconciliation is a well-documented good practice corresponding to the process of creating and updating a single list of an older adult's medication;²³ this ensures a systematic, comprehensive review of all the patient's current medicines. Prior research has shown that discharge letters received by primary care professionals are frequently inaccurate and lack key information.²⁴ Regular medication reconciliation reduces medication errors by consistent communication across transitions of care, including changes in the clinical setting, medical practitioner, or level of care.²⁵

Regularly and systematically reviewing prescribed medications is a straightforward, effective means of reducing inappropriate prescribing and, therefore, a preventive strategy for avoiding MRPs. Inappropriate prescribing includes potentially inappropriate medications and potential prescribing omissions. Existing screening tools—such as the STOPP/START criteria (Screening Tool of Older Persons' Prescriptions/Screening Tool to Alert to Right Treatment)—recognize the dual nature of inappropriate prescribing by including a list of potentially inappropriate medications (STOPP criteria) and potential prescribing omissions (START criteria).²⁶ Complementary to this, the American Geriatrics Society Beers Criteria is a list of potentially inappropriate medications that it is preferable for older adults to avoid in most situations or particular health conditions.²⁷

Deprescribing attempts to balance the potential benefits and harms of tapering or ceasing inappropriate medication with the aim of managing polypharmacy and improving outcomes.²⁸ Deprescribing is particularly relevant among frail older adults with multiple chronic conditions, as they face high risks of MRPs, hospitalization, and early death.²¹

Electronic medication management systems are recent digital developments covering prescriptions, administration, pharmacy reviews, medication administration using barcodes, and all the electronic devices devoted to medication management processes.²² Electronic medication management systems contribute to reducing medication errors and enhancing interprofessional collaboration and patient safety by using red flag strategies.^{29,30} In recent years, smartphone applications for optimizing medication use have also emerged. However, older adults, who can experience the greatest benefits from more electronic support to improve their medication use, are also the least accustomed to using them.²¹

Integrating Older Adults' Preferences into Medication Management

Preventability and an understanding of risk factors are crucial to co-constructing interventions to minimize MRPs.^{11,19} However, research about MRPs and medication management currently focuses on healthcare professionals' perspectives, to which the perspectives and experiences of patients and informal caregivers are often secondary. Research into medication management has evolved with little consideration of the perspectives and preferences of older adults themselves. Further studies—

using qualitative or mixed research designs—will be essential to identify the logic which home-dwelling older adults with multiple chronic conditions apply to the management of their daily medication and how they integrate it into the rhythm of their daily lives and home environments.^{14,19} Shared decision-making must be promoted, notably via operational tools providing information on the benefits and risks of medicines in a format which older adults can embrace more easily.³¹ Even though empowering patients to participate in their medication management has beneficial effects—particularly in medication adherence³²—the concept of older adult empowerment and self-management of complex medication regimens, along with their impact on MRPs, has been poorly investigated. Quasi-experimental studies and randomized controlled trials will be essential for any adequate exploration of the effectiveness of innovative interventions aiming to empower older adults' medication management, improve their competences, and enhance shared decision-making with healthcare professionals.

The Roles and Accountability of Healthcare Professionals

The complexity of care required by home-dwelling older adults with multiple chronic conditions leads them to be significant users of healthcare services and to consult many different healthcare professionals.³³ Medication management among this population consequently requires interprofessional collaboration across different healthcare and social services providers and organizations.¹⁶ Besides prescribers, usually general practitioners and different specialist physicians, pharmacists, nurses, and other allied health professionals may be involved in and accountable for medication management.¹⁶ In Australia, collaborative home medicines reviews (involving a general practitioner and a pharmacist) have demonstrated their effectiveness in detecting, preventing, and resolving MRPs among home-dwelling older adults with multiple chronic conditions.¹⁶ Furthermore, adherence to prescribed medication can also be improved by pharmacist- and nurse-led interventions.^{34–37} However, the higher the number of healthcare professionals consulted by home-dwelling older adults with multiple chronic conditions, the greater the chance that care may be fragmented and uncoordinated.¹⁶ This can be explained by the different treatment preferences of different healthcare professionals. Home-dwelling older adults with multiple chronic conditions often fail to receive the efficient, effective, and coordinated

care that they could gain so much from.^{38,39} Failure to coordinate care for home-dwelling older adults with multiple chronic conditions undeniably increases the risk of MRPs.¹⁶ Those who consult three or more healthcare professionals report receiving conflicting advice, which makes it difficult for them to know which guidance they should follow. Inadequate explanations about medication result in omissions and incorrect dosages, but also in anxiety and confusion in older adults.⁴⁰ Healthcare professionals should feel accountable for optimizing medication management among home-dwelling older adults, particularly during their transitions home from acute care settings. Implementing effective primary care management should be a priority among home-dwelling older adults with multiple chronic conditions in order to prevent adverse health outcomes and to promote autonomy in their daily lives. Older adults at a high risk of MRPs should systematically be assigned a primary care manager whose aim is to meet their needs with regards to prevention and chronic conditions. By using planned interactions and ensuring appropriate follow-up, primary care managers can contribute significantly to the prevention of hospital admissions, rehospitalizations, institutionalization in nursing homes, and early death.^{41,42}

The Role of Informal Caregivers

In addition to healthcare professionals' contributions to medication management, informal caregivers help to ensure safe, appropriate medication use at home by older adults with multiple chronic conditions, notably among those who may also have cognitive impairment.^{43–45} Although the role of informal caregivers in medication management is very relevant, various constraints have been reported regarding the time required, anxiety about making mistakes, and the uncollaborative behavior of older adults.⁴⁶ They also face difficulties maintaining continuous supplies of medicines, supporting administrative work, making clinical decisions, and handling conflicts or disagreements with the older adult,⁴⁶ or even with healthcare professionals in regards to ineffective medicinal practices.^{43,46} Although several studies have furthered understanding about the daily challenges faced by informal caregivers managing medication for older adults, there has been less insight into any educational or training interventions aimed at improving caregivers' medication management competences. More studies are required to explore how to efficiently support informal caregivers in their roles as medication managers. Psychoeducation, digital applications, or specialized counselling services

provided by pharmacists or advanced practice nurses should also be considered.^{44,45,47} Cooperating with informal caregivers and integrating their experiences of shared decision-making should be one of the tasks assigned to primary healthcare professionals. To make this a reality, they could receive backing from their hierarchies and perhaps even financial incentives to support informal caregivers in the optimization of medication management. More research will be needed to analyze the effectiveness of such incentives.

Ways to Bridge the Gap

Optimal medication management is one of the basic preconditions for home-dwelling older adults with multiple chronic conditions to be able to remain at home and preserve their quality of life.^{7,48} Improving medication management for them not only requires regular monitoring of MRPs and reviewing of prescriptions to eliminate unnecessary medication but also coordinated care by different healthcare and social services providers.⁴⁹ This calls for an integrated, multi-stakeholder model to optimize medication management among home-dwelling older adults with multiple chronic conditions. Such a medication management model should be rigorously structured using a care model process embracing development, implementation, and sustainability milestones.⁵⁰ It should also consider the quadruple aim of enhancing the patient's experience, improving population health, reducing costs, and improving healthcare professionals' working lives.⁵¹ Indeed, both these frameworks underpin the ongoing mixed-methods research by Pereira et al, which brings together retrospective and prospective findings to promote medication management and prevent MRPs.⁵² Such a model should be able to more adequately capture the biological, clinical, psychosocial, and pharmacological complexities of multiple chronic conditions and polypharmacy. A robust, integrated, multi-stakeholder model that embeds care in the context of where and how older adults with multiple chronic conditions live needs to be developed to prevent the onset and/or progression of MRPs.

Disclosure

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Thesis rationale and aim

This project was based on our preliminary feasibility study—conducted between 2017 and 2019—aimed at investigating the medication practices and experiences of older adults discharged home from hospital, as well as the tools and interventions used during care transitions to prepare older adults for medication management at home [21]. Findings revealed the significant issues of adjusting to new spatiotemporal medication routines after hospital discharge and the complex medication management role taken on by older adults and their informal and professional caregivers [22]. Findings also revealed the heterogeneity of the older participants' situations and their different levels of autonomy in medication management. Although we were able to answer our research questions regarding the study's feasibility, the complexity of the data collected revealed the need for further investigation, notably predetermining the factors of a higher risk of MRPs among older adults. Because optimal medication management implies interprofessional, patient-centered approaches, further research should combine older adults', informal caregivers', and professionals' perspectives to provide a comprehensive description of the phenomenon. Moreover, nurses' roles within interprofessional collaborative practices aimed at optimal medication management deserve more consideration.

Therefore, the present thesis relies on a multi-source data investigation combining older adults' risk factors for MRPs and a description of older adults', informal caregivers', and professional caregivers' perceptions about effective medication management. The overall aim was to develop a model to support medication management and prevent MRPs among polymedicated home-dwelling older adults after hospital discharge.

The thesis project addressed the following research questions:

- 1) Which factors determine a higher risk of adverse health outcomes related to MRPs among polymedicated home-dwelling older adults after hospital discharge?
- 2) What are the difficulties and response strategies perceived by polymedicated home-dwelling older adults and their informal and professional caregivers as ensuring safe medication management after hospital discharge?
- 3) How can medication management among polymedicated home-dwelling older adults be optimized to prevent MRPs and subsequent adverse health outcomes after hospital discharge?
- 4) How can nurses contribute to optimizing medication management for polymedicated home-dwelling older adults during care transitions within an interprofessional research team?

OTHER SCIENTIFIC OUTPUTS RELATED TO THIS CHAPTER

Contributions in related publications

Roux P, **Pereira F**, Santiago-Delefosse M, Verloo H. Medication practices and experiences of older adults discharged home from hospital: a feasibility study protocol. *Patient preference and adherence*. 2018;12:1055. doi:10.2147/PPA.S160990.

Roux P, Verloo H, Santiago-Delefosse M, **Pereira F**. The spatial dimensions of medication management by home-dwelling older adults after hospital discharge. *Health & place*. 2019;60:102230. doi:10.1016/j.healthplace.2019.102230.

CHAPTER 2 – THEORETICAL FRAMEWORK

THEORETICAL FRAMEWORK

The Neuman systems model (NSM) guided this research project. As Fawcett described it, this conceptual model provides “the lens for viewing the phenomena” [23]. The NSM has been documented as an appropriate guide to research projects [23, 24]. Holistic and wellness-oriented, the NSM is based on a comprehensive, open-system conceptual framework for nursing and allied healthcare disciplines. Nursing’s role is focused on prevention as an intervention to retain, attain, or maintain human beings’ optimal wellness.

The following section presents the NSM’s main components—structured using nursing metaparadigm concepts—and a concise description of their application to the phenomenon being explored: medication management by polymedicated home-dwelling older adults after hospital discharge and how to optimize that medication management and prevent MRPs using a collaborative, multiple-stakeholder, patient-centered model of care.

Human Beings as Clients/Client Systems

Within the NSM, the human being is perceived as a client or a client system, represented as an individual, a family, a group, a community, or even a social issue [25]. The NSM diagram illustrates the client system as a series of concentric circles surrounding a basic structure (Figure 2). The basic structure, or the central core, consists of factors common to all people, such as body temperature, blood pressure, genetic features, and the strengths and weaknesses of their organ systems. This structure is also the source of five interacting client-system variables at varying stages of development and with different interactive styles: physiological (bodily structure and internal functions), psychological (mental processes and interactive environmental effects, both internal and external), sociocultural (combined effects of social–cultural conditions and influences), developmental (age-related development processes and activities), and spiritual (spiritual beliefs and influences).

The concentric circles surrounding the basic structure have a protective function for the client system's integrity. The outside circle is the flexible line of defense (FLD), which performs as a protective buffer to prevent stressors from invading the client system. The FLD is characterized by accordion-like motion: when it expands away from the system, it provides greater protection, and when it draws nearer, it gives less protection. The FLD is dynamic as it can be altered by single or multiple stressors over short periods. Stressful conditions such as fatigue or poor nutrition can bring the FLD closer to the middle line—the normal line of defense (NLD). The NLD, protected by the FLD, represents the client system's usual level of wellness. The NLD is dynamic too, as it can expand or contract over time and is conditioned by system-interacting variables such as lifestyle, coping patterns, developmental, spiritual, and cultural influences, client expectations, and motivation. If the NLD is overrun by environmental stressors, the lines of resistance (LR) are activated to protect the basic structure and the system's integrity. Effective LR allow system re-constitution. In contrast, ineffective LR lead to energy depletion and death.

Each line of defense and resistance is influenced by the five interacting variables and contains known and unknown internal and external resource factors supporting system integrity.

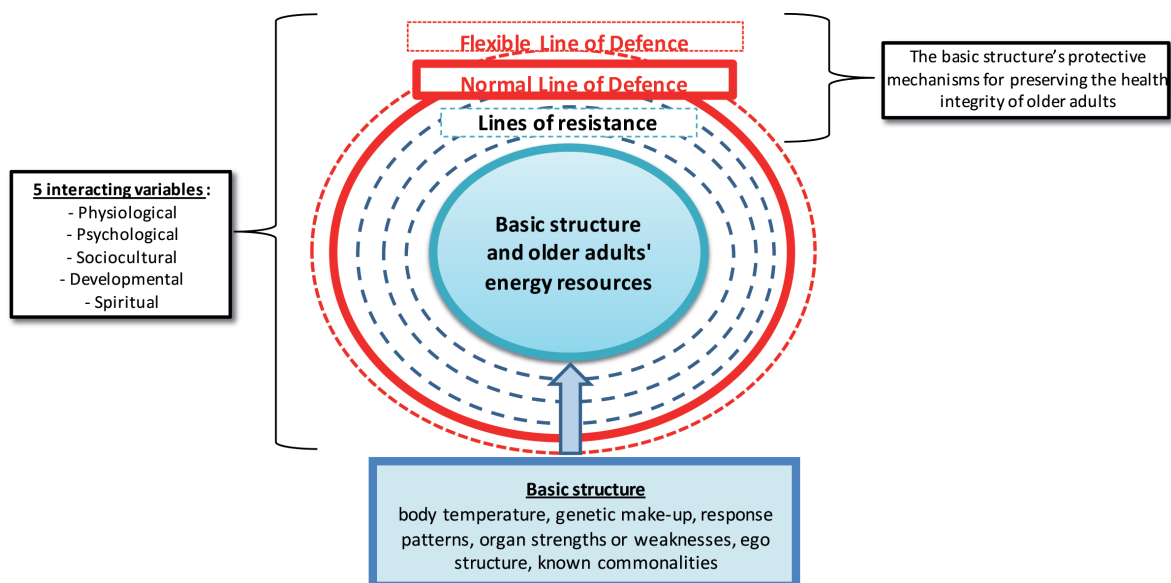


Figure 2: The *client system* from the Neuman systems model perspective (adapted from Neuman & Fawcett, 2011, p. 15) [25]. For educational purposes (including theses and dissertations), the Neuman Systems Model Trustees Group, Inc. grants permission for the reproduction of any figures developed by Neuman and Fawcett [25].

Environment

Stressors are described as “tension-producing stimuli or forces occurring within the internal and external environmental boundaries of the client system”, and they “have the potential to cause system instability” (p. 22). The NSM identifies three relevant environments: internal, external, and created environments (Figure 3). The internal environment consists of all the interactive influences contained within the client system’s boundaries, and it correlates with intrapersonal stressors. The external environment consists of all the interactive influences occurring outside the client system, and it correlates with both inter- and extra-personal stressors. These stressors occur at the proximal and distal ranges of the client system, respectively. The created environment represents an open system exchanging with both the internal and external environments. The created environment acts unconsciously—beyond the internal and external environments—but pushes the five interacting variables and the basic structure toward system stability.

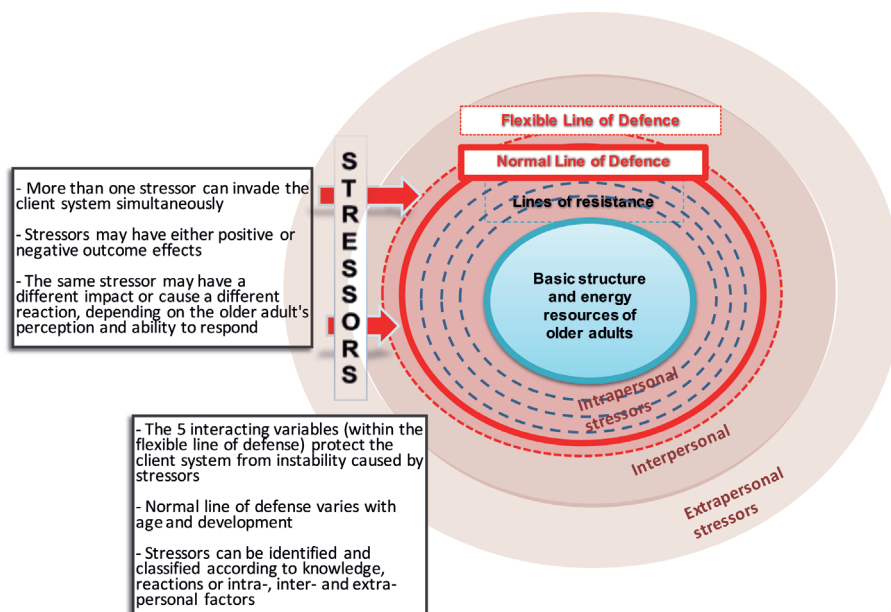


Figure 3: The nursing metaparadigm of *environment* from the Neuman systems model perspective (adapted from Neuman & Fawcett, 2011, p. 20).

Health

The concept of health is perceived as a continuum where wellness and illness are at opposite extremities. The client system is closer to wellness when more energy is available and stored than is expended (negentropy); it is closer to illness or death when more energy is required than is available to support life (entropy). Health corresponds to optimal system stability, which is “the best possible wellness state at any given time” (p. 23). In a robust older adult, the flexible line of defense is strong enough to maintain system stability and prevent stressor invasion (Figure 4).

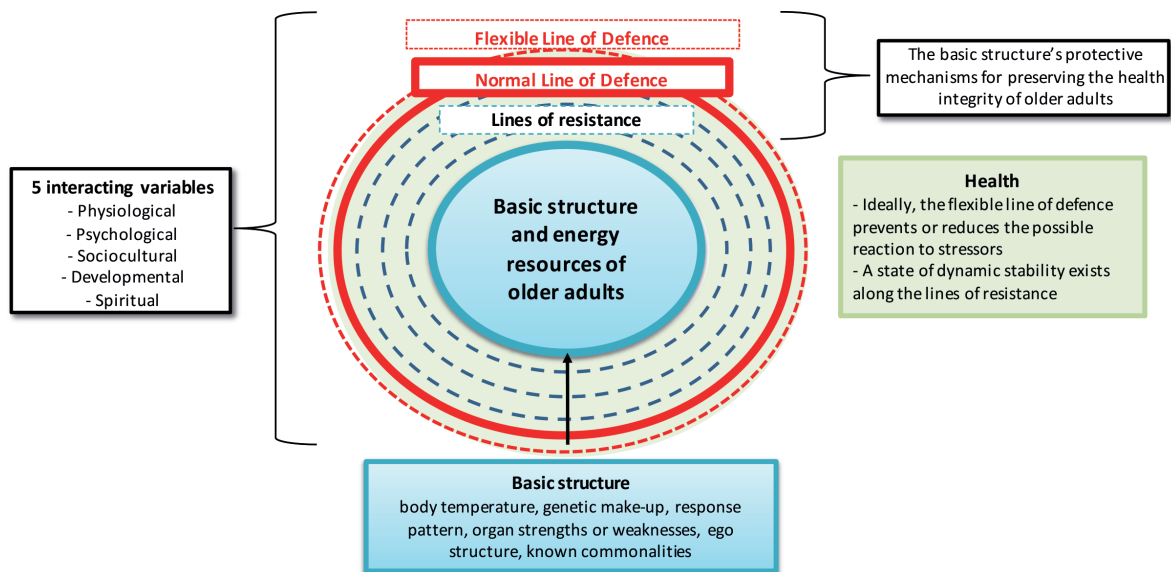


Figure 4: The nursing metaparadigm of *health* from the Neuman systems model perspective (adapted from Neuman & Fawcett, 2011, p. 25).

Nursing

In order to retain or attain client-system stability and optimal client health, three types of nursing interventions are proposed: primary, secondary, and tertiary [25, 26] (Figure 5). Primary prevention aims to protect and reinforce the client-system's normal defenses to prevent any invasion by stressors and retain system stability. Secondary prevention aims to protect the basic structure that has been penetrated by a stressor. When carrying out secondary prevention, it is essential to detect stressors, reduce or eliminate their impact, treat symptoms, and strengthen the LR. Tertiary prevention aims to protect the reconstitution of client-system stability after treatment or secondary prevention. Once a stressor has overrun the NLD and the LR, and symptoms are being treated, the client system attempts to recover system stability (Figure 5). Reconstitution may result in a higher or lower level of system stability and wellness than before the stressor hit. According to the NSM, psychological, sociocultural, developmental, and spiritual variables are as important as the physiological variable during the process of reconstitution following an invasion by stressors.

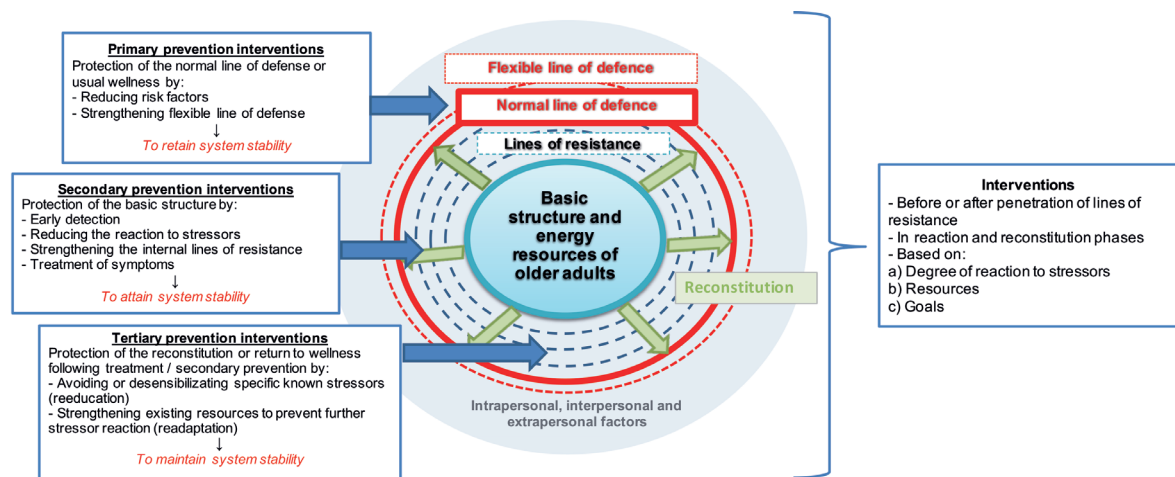


Figure 5: The nursing metaparadigm of *nursing* from the Neuman systems model perspective (adapted from Neuman & Fawcett, 2011, p. 25).

The Neuman Systems Model's relevance for the thesis project

In this project, the client system was our population of polymedicated, home-dwelling older adults. We hypothesized that their lines of defense were subject to several stressors after hospital discharge [27, 28]. Given their multiple chronic conditions, polymedicated older adults may present with a diminished ability to withstand stressors, leading to a decline in their physiological reserves and difficulty maintaining homeostasis. This could be explained by the overarching frailty syndrome, defined by Clegg *et al.* as increased vulnerability and a decreased ability to maintain homeostasis after a minor stressor event [29].

Thus, the NSM guided our project towards identifying the stressors affecting this population and those stressors' impact on client-system stability. Furthermore, the NSM guided the project's development of nursing and collaborative interventions to support medication management and prevent potentially harmful consequences.

CHAPTER 3 – METHODS

METHODS

This chapter schematizes the overall study design to answer the research questions introduced in Chapter 1. It includes the protocol for our systematic review about medication management models (SR-M3) (Article 2) and—as the systematic review process is still underway—its state of progress. Finally, the study protocol for the overall project is detailed in Article 3. Nevertheless, each article presented in Chapters 3, 4, and 5 had a specific methodological design described in their “Material and Methods” sections.

Overall study design

To fulfil our aim of developing a model to support medication management and prevent MRPs among polymedicated home-dwelling older adults after hospital discharge, we guided our methodology using the Agency for Clinical Innovation (ACI) framework [30]. This comprises five stages for the review and development of Models of Care: project initiation, diagnostic process, solution design, implementation, and sustainability (Figure 6).

The project initiation stage was completed during the feasibility study [21, 22]. This thesis documents the “diagnostic process” and the “solution design” for our Medication Management Model. The diagnostic process consisted of:

- a) A systematic review (Phase 0) to identify evidence-based medication management models and analyze their impact on managing and preventing MRPs for polymedicated home-dwelling older adults. This systematic review’s protocol is presented in Article 2.
- b) A sequential, explanatory mixed-methods research design (Phases 1 and 2) to analyze and better define the problem. Mixed-methods research was chosen for its “multiple ways of seeing and hearing”, as Greene (2007, p.20) described it [31]. Relying on our feasibility findings, qualitative data on medication management at home would be guided by quantitative data describing the

determinants of older adults' higher risks of MRPs. We, therefore, selected a sequential explanatory design—a mixed-methods research technique beginning with a quantitative phase and then following up on specific results with a qualitative phase aimed at completing and explaining the quantitative findings. Article 3 presents the study protocol for the overall project.

Once the diagnostic phase was completed (results presented in Chapters 4 and 5), solutions were developed and selected in the solution-design phase (Phase 3). The solutions proposed are presented in Chapter 6 and were inspired by the quadruple-aim of enhancing the patient's experience, improving population health, reducing costs, and improving healthcare professionals' working lives [32].

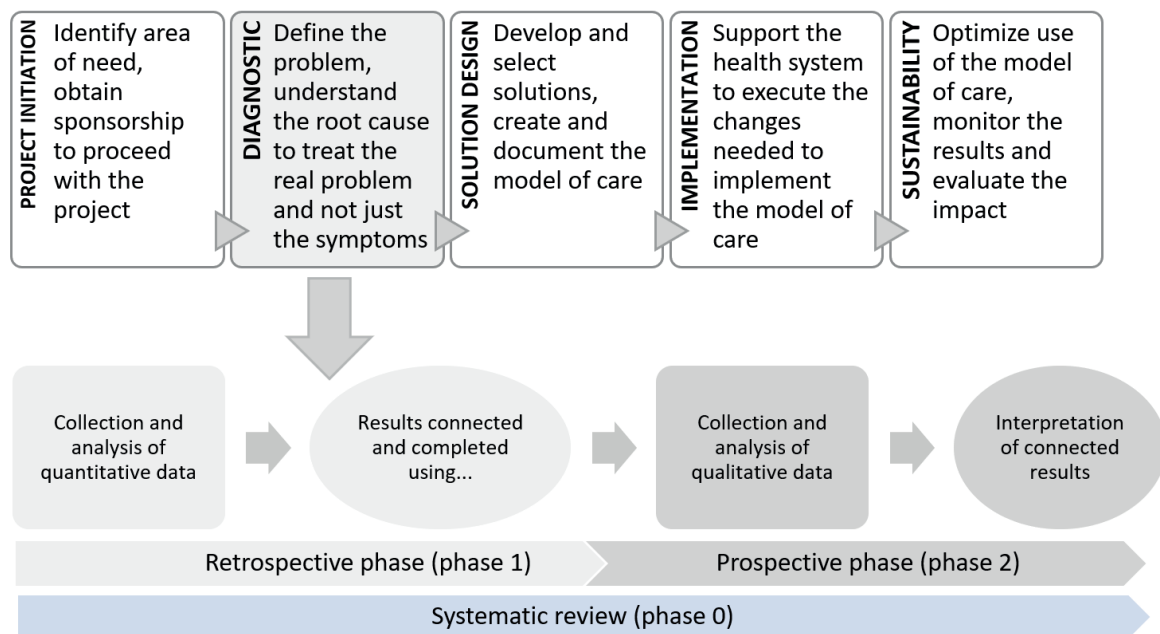


Figure 6: Methodological framework for developing our Medication Management Model: a systematic review and mixed-methods research using a sequential explanatory design.

ARTICLE 2

Pereira F, Roux P, Rosselet Amoussou J, Martins MM, von Gunten A, Verloo H. Medication Management Models for Polymedicated Home-Dwelling Older Adults With Multiple Chronic Conditions: Protocol of a Systematic Review. JMIR Res Protoc. May 2019;8(5). doi:10.2196/13582.

Altmetrics*	
Total article views	1,625
Total number of citations	3 (including 1 self-citation)
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Quartile	Q2
Indexing	PubMed, PubMed Central, Scopus, EMBASE, Emerging Sources Citation Index (ESCI)

*Confirmed until July 11th, 2022.

Protocol

Medication Management Models for Polymedicated Home-Dwelling Older Adults With Multiple Chronic Conditions: Protocol of a Systematic Review

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Abstract

Background: Older adults with multiple chronic diseases commonly require complex medication regimes. When combined with frailty, cognitive impairment, and changing pharmacological prescriptions, older adults' polymedication regimes increase the risk of medication-related problems (MRPs) and hospitalization. Effective, well-organized medication management could avoid MRPs and their clinical outcomes.

Objective: Identify medication management models and analyze their impact on managing and preventing MRPs for polymedicated, home-dwelling older adults.

Methods: We will conduct a systematic review of published articles in relevant professional scientific journals from inception until March 31, 2019, in the following electronic databases: Embase; Medline OvidSP; PubMed (NOT Medline[sb]); Cumulative Index to Nursing and Allied Health Literature (CINAHL) EBSCO; PsycINFO OvidSP; Cochrane Library, Wiley; and Web of Science. We will also hand search the bibliographies of all the relevant articles found and search for unpublished studies. We will consider publications in English, French, German, Spanish, Italian, and Portuguese. Retrieved articles will be screened for eligibility. Statistical analyses will be conducted following the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), and Meta-analysis Of Observational Studies in Epidemiology (MOOSE) statements. Data will be analyzed using SPSS Statistics for Windows, version 25.0 (IBM Corp), and Review Manager, version 5.5 (The Nordic Cochrane Centre, The Cochrane Collaboration).

Results: A preliminary search in Embase delivered 3272 references. This preliminary search allows us to complete our research strategy with equation development and to search the other databases. Relevant articles identified will allow for searching the reference lists for unpublished studies. The inclusion and exclusion criteria will be rigorously respected in the study selection. The entire study is expected to be completed by January 2020.

Conclusions: This review will provide an exhaustive view of medication management models that could be effective for polymedicated, home-dwelling older adults and will allow us to analyze their impact on managing and preventing MRPs.

Trial Registration: PROSPERO CRD42018117287; https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=117287 (Archived by WebCite at <http://www.webcitation.org/77fCbCjT>)

International Registered Report Identifier (IRRID): DERR1-10.2196/13582

<http://www.researchprotocols.org/2019/5/e13582/>

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KEYWORDS

medication-related problems; polymedication; older adults; frailty; home-dwelling; community-dwelling; models; clinical pathways; systematic review; protocol

Introduction

Health care systems across Europe are being challenged by an ageing population [1]. International statistics demonstrate that home-dwelling older adults consume huge amounts of prescribed and over-the-counter medication [2,3]. The risks of medication prescription and deprescription have been debated since the dissemination of systematic and umbrella reviews pointing out the inconsistency of some pharmacological treatments for older adults [4,5]. However, a substantial proportion of older adults have multiple chronic diseases requiring numerous treatment components and complex medication regimes [6]. Increasingly complex medication regimes, combined with frailty, reduced cognitive function, and changing pharmacokinetics and pharmacodynamics, increase the risk of adverse drug events and other medication-related problems (MRPs) in this population [7]. An MRP is “an event or circumstance involving medication therapy that actually or potentially interferes with desired health outcomes” [8]. MRPs include inappropriate prescribing (ie, wrong drug, dose, dosage frequency, or dosage form), drug interactions, adverse drug reactions, incorrect administration, the need for monitoring, and nonadherence to medication therapy [9]. MRPs occur frequently among polymedicated, home-dwelling older adults and are associated with increased risks of hospitalization, morbidity, and mortality [10-12]. Avoidable adverse drug events are the serious consequences of inappropriate drug prescribing [13]. For instance, adverse drug events alone contribute to 30%-40% of acute hospital admissions among older adults, although many are preventable [14]. The World Health Organization has estimated that 50% of patients suffering from chronic diseases either do not take their medication or fail to follow instructions for their medical prescription [15]. Medication management among polymedicated, home-dwelling older adults is a serious problem because of the increased burden of symptoms and disease, leading to the use of more medicines and a greater chance of suboptimal management. Estimates of medication nonadherence vary from 40% to 75% [16].

The misuse of categories of drugs such as sleeping pills, analgesics, tranquilizers, appetite suppressants, and stimulants is common [17]. Problems associated with low or zero therapeutic adherence are even more evident during the sensitive period following discharge home from hospital [18]. Suboptimal medication management may lead to a deterioration in the patient's clinical condition, avoidable short-term hospitalizations or readmissions, physical and cognitive decline, exacerbated chronic medical conditions, and, consequently, increased health care use and costs [18-20]. The indirect impacts of the adverse effects of drug nonadherence, such as falls, dehydration, or delirium, may also lead to hospitalizations [21]. Older adults often undergo changes to dosage and prescribed medication during hospitalization [22] and during the first few months after

hospital discharge due to comorbidities and the need for disease stabilization [19]. Such changes tend to decrease optimal medication management [23]. Older adults may also go back to taking medications that were discontinued during hospitalization, fail to begin a new treatment initiated during hospitalization, or take incorrect dosages [18]; they are particularly at risk of nonadherence in the first days or weeks after hospital discharge [18]. Home-dwelling older adults taking five or more drugs are considered to be more susceptible to the consequences of polypharmacy, such as adverse drug reactions, drug-drug interactions, nonadherence, or drug-food interactions. Monitoring, assessing, and reacting accordingly are requisite skills for optimal medication management in cases involving inappropriate polymedication or excessive polymedication [24]. Optimal medication management should thus be an integral part of older adults' daily lives and is an essential condition for successfully maintaining them at home [25,26]. Moreover, taking into account the high prevalence of multiple chronic conditions in this population, optimal medication management often becomes a determinant of an older adult's state of health and quality of life at home [27]. Medication management in polymedicated, home-dwelling older people has been described as the “single most important health care intervention in the industrialized world” [28]. This brings us to our search for the best practice models that optimize safety, the continuity of medication intake, and overall medication management among home-dwelling older adults [6]. With the overall aim of developing effective strategies to prevent MRPs and avoiding medication-related hospitalizations and rehospitalizations, many researchers and clinicians involved in primary care have tried to generate either general or specific structured, systematic, medication management models for polymedicated home-dwelling older adults.

One recent example of a structured action to prevent MRPs is the Medication Management Model. This is based on risk management and provides home-dwelling patients with medication review services comparable to those that benefit hospital and nursing home patients [29]. A second example concerns the Coordinated Medication Management Model, which involves home care nurses, nurses, physicians, and community pharmacists in medication processes for home-dwelling older adults, supported by home health care services [30]. Medication management models are interprofessional collaboration processes between patients, their informal caregivers, pharmacists, and nurses, based on evidence-based guidelines and bringing, if appropriate, identified problems to a physician's attention [26]. To the best of our knowledge, there have been no systematic reviews summarizing the medication management models developed in community health care and their impact on MRPs among polymedicated, home-dwelling older adults.

Methods

Overview

This protocol has been registered in the International Prospective Register of Systematic Reviews (PROSPERO) (protocol number CRD42018117287). The systematic review will be conducted following the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Protocols (PRISMA-P) and its checklist for reporting harms [31,32], the reporting proposals of the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) [33], and the methods outlined in the Cochrane Handbook for Systematic Reviews of Interventions [34].

Purpose and Research Question

This systematic review's purpose is to identify, examine, and summarize the models developed in community health care systems to optimize medication management for polymedicated, home-dwelling older adults. The following research question will guide this review: Which community health care models for optimizing medication management for polymedicated, home-dwelling older adults have been reported in interventional and observational studies?

Inclusion and Exclusion Criteria

Types of Studies

This review will include randomized controlled trials, cluster randomized controlled trials, and nonrandomized studies. Nonrandomized studies will include quantitative studies examining the effects of medication management models that do not use randomization to allocate patients to comparison groups [34]. We will include retrospective and prospective epidemiological studies, cohort studies, case-control studies, controlled before-and-after studies, interrupted-time-series studies, and controlled trials with inappropriate randomization (ie, quasi-experimental studies) [35,36]. We will search for papers in French, German, English, Spanish, Italian, and Portuguese.

Types of Participants

This review will consider studies involving polymedicated, home-dwelling older adults with multiple chronic conditions and a minimum mean age of 65 years, as well as studies with participants aged 55 years or older. In order to properly include heterogeneity and complexity, we will consider multiple chronic conditions: the co-occurrence of at least two diseases in the same individual, cumulative indices considering both the number and severity of concurrent diseases, and the simultaneous presence of not only diseases but also symptoms and physical and cognitive dysfunctions.

Types of Models

We will examine all types of medication management models, including strategies, interventions, and clinical pathways aimed at optimizing the effects of medication management for polymedicated, home-dwelling older adults with multiple chronic conditions. Given their impact in reducing medication errors and enhancing interprofessional collaboration and patient

safety, electronic medication management systems (EMMS) will be included in this study [37,38].

Where possible, these types of medication management models will be compared with usual care and will include strategies documented in models, interventions, and clinical pathways delivered by a primary health care provider alone or in collaboration with other allied health care professionals at home.

Based on the Effective Practice and Organization of Care (EPOC) taxonomy of health system interventions [39], we will consider medication management models, interventions, and clinical pathways targeting the health care professional level and the patient level, as discussed below, but we will exclude those targeting health care organizations:

1. Optimized medication management at the health care professional level:
 - a. Educational programs aimed at optimizing medication management.
 - b. Distribution of materials aimed at optimizing medication management.
 - c. Feedback to peers and other involved health care professionals on the effects and impact of medication management (ie, medication review from medical records).
 - d. Monitoring medication management models, including interventions and clinical pathways (ie, assessment, adjustment or change of medication, and medication deprescription).
 - e. Verbal recommendations to polymedicated, home-dwelling older adults by the health care providers involved to optimize medication management (eg, pharmacists and physicians).
 - f. The organized activities of teams for medication conciliation, prescription, and deprescription.
 - g. EMMS covering prescription, administration, pharmacy review, barcode medication administration, and anything that encompasses medication management processes for polymedicated, home-dwelling older adults with multiple chronic conditions [40].
 - h. Evaluations of the involvement of different health care professionals in the optimization of medication management.
2. Optimized medication management at the level of polymedicated, home-dwelling older adults:
 - a. Organized interventions aimed at optimizing medication management for polymedicated, home-dwelling older adults (ie, single- or multi-professional interactions conducted by nurses, pharmacists, or physicians, such as counselling on medication and medication compliance or patient education sessions).
 - b. Patient reminder systems aimed at optimizing medication management (ie, single- or multi-professional interventions conducted by nurses, pharmacists, or physicians, such as telephone contact and discharge planning; medication adherence aids, such as electronic monitors or pill dispensers; and meetings with the multi-professional health care team in the patient's home).

Types of Outcome Measures

This review's primary outcome measures will be:

1. The identification of models including interventions, clinical pathways, and EMMS aimed at optimizing medication management for polymedicated, home-dwelling older adults in primary health care.
2. The description of the components of the models, interventions, and clinical pathways and the identification of the stakeholders involved (ie, professional and nonprofessional caregivers).
3. The description of the impact of medication management models, interventions, and clinical pathways versus usual care on:
 - a. Rates of hospitalization for MRPs.
 - b. Rates of emergency department visits for MRPs.

Primary outcomes will be measured by different methods based on dichotomous (ie, yes or no), ordinal, or continuous rates and scores (eg, hospitalization or rehospitalization, frailty severity or progress, emergency department visits for MRP [10], and misuse of medication [41]).

This review's secondary outcome measures will be descriptions of the associations between sociodemographic characteristics, health data, and MRPs (ie, nominal, ordinal, or interval level).

Information Sources and Search Strategy

We will search the following databases, without restriction on the publication date: Embase (from 1947); Medline OvidSP (from 1946); a subset (sb) of PubMed (NOT Medline[sb]) (from 1996); Cumulative Index to Nursing and Allied Health Literature (CINAHL) EBSCO (from 1937); PsycINFO OvidSP (from 1887); Cochrane Library, Wiley (from 1992); and Web of Science (from 1900). Furthermore, we will search in the reference lists of relevant articles identified and for unpublished studies.

The search syntax will use Medical Subject Headings (MeSH) and text terms with Boolean operators. The syntax will consist of the search themes intersected by the Boolean terms "AND" and "OR." MeSH terms and free keywords will include the following:

1. Terms for "Medication management," "Drug therapy management," "Therapeutic medication management," and "Optimizing medication treatment."
2. Terms for "Community-dwelling older adults," "Home-dwelling older adults," "Elderly," "Aged,"

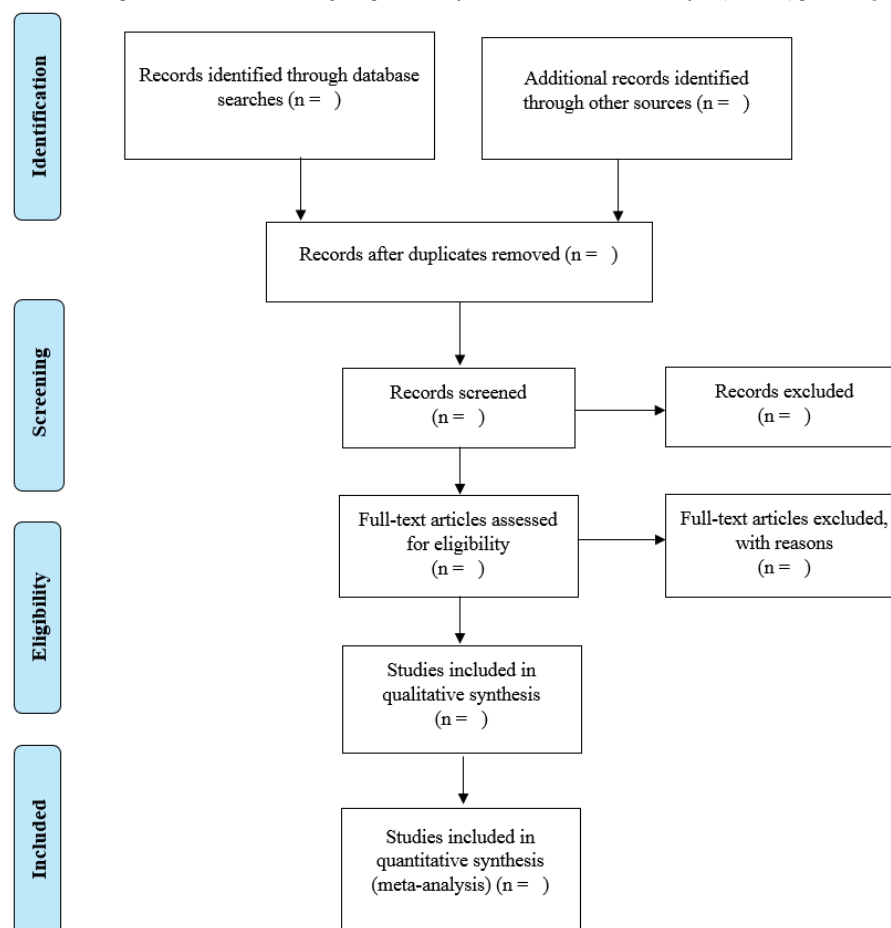
"Home-care patients," "Older adults," and "Very old adults."

3. Terms for "Home-dwelling," "Living in place," "Homebound," "Primary care," "Community health services," "Community hospital," "Ambulatory care," "Outpatient clinics," "Hospital," "Ambulatory care facilities," "Day care," "Primary health care," "Community health centers," "Health services for the aged," "Community," "Domicile," "Home or home-care or home-based," "Outpatient," "Day patient," "Community care," "Home-care services," "General practice," and "Urban population."
4. Terms for "Multiple chronic conditions," "Frailty," "Vulnerability," "Multimorbidity," "Multimorbid," "Muscle weakness," "Fatigue," "Slow motor performance," "Low physical activity," and "Unintentional weight loss."
5. Terms related to "Drug-related problems," "Medication-related problems," "Misuse of medication," "Medication abuse," "Inappropriate polypharmacy," "Polypharmacy," "Excessive polypharmacy," and "Polymedication."
6. Terms for models, interventions, and clinical pathways: "Care model," "Care map," "Multidisciplinary care," "Evidence-based care," "Guideline," "Patient care plans," "Clinical paths," "Clinical pathways," "Critical paths," and "Interventions."
7. Terms related to "Medication management model," "Medication optimization," and "Reconciliation."
8. Terms for "Computerized provider order entry," "Electronic prescribing," "Computer-assisted diagnosis," "Computer-assisted therapy," and "Medical device."

Study Selection

Two reviewers (FP and PR) will independently screen the titles and abstracts identified in the searches to assess which studies meet the inclusion criteria. Disagreements will be resolved through discussion or, if needed, a consensus will be reached after discussion with coauthors (MMM and HV). The reviewers will then independently assess the full-text articles to ensure that they meet the inclusion criteria. Disagreements will be discussed and resolved with coauthors (MMM and HV). A flowchart of the trial selection process has been drawn in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [42] (see Figure 1).

Figure 1. Blank flow diagram based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [42].



Data Extraction

Data will be extracted independently by two authors (FP and PR) using a specially designed, standardized data extraction form. Discrepancies will be resolved through discussion and consultation with coauthors (MMM and HV).

The following information will be extracted from each study included in the review: (1) study authors, year of publication, and country where the study was conducted; (2) study characteristics, including setting, design, duration of follow-up, and sample size; (3) participants' characteristics, including age, sex, social status, marital status, educational status, level of autonomy, history of hospitalization and rehospitalization for MRPs, and emergency department visits for MRPs; medication management model; interventions; and clinical pathways; (4) multiple chronic conditions measured using indices (ie, the

Charlson Comorbidity Index and the Cumulative Illness Rating Scale-Geriatric); and (5) types of outcome measures.

Assessment of the Risks of Bias in Included Studies

Two reviewers (FP and PR) will independently assess the risks of bias in all the randomized and nonrandomized studies for interventions (NRSI) included, using the validated Cochrane Risk of Bias Tool, version 2.0 (The Cochrane Collaboration) [43]. This tool is based on five domains: (1) bias arising from the randomization process, (2) bias due to deviations from intended interventions, (3) bias due to missing outcome data, (4) bias in outcome measurement, and (5) bias in the selection of the results reported. Each of these five domains will be rated as (1) low risk of bias, (2) some concerns about bias, or (3) high risk of bias. Declaring that a study has a particular level of risk of bias in any individual domain will mean that the study as a whole has a risk of bias. Disagreements will be resolved through discussion and consultation with coauthors (MMM and HV).

We will also use the validated Risk of Bias In Nonrandomized Studies of Interventions (ROBINS-I) tool for assessing the risk of bias in NRSI [44]. This tool covers two dimensions and seven domains through which bias might be introduced into NRSI: (1) preintervention and during the intervention (ie, bias due to confounding, selection of study participants, or classification of the intervention) and (2) postintervention (ie, bias due to deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported result) [44]. Any disagreements in quality assessments will be resolved through discussion.

Statistical Analyses

Statistical analyses will be conducted by FP and PR following the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions [34] and the PRISMA-P and MOOSE statements [31,33]. For dichotomous outcomes, average intervention effects (ie, pooled effect and meta-analysis) will be calculated as relative risks with 95% CIs using a random-effects model [45]. For continuous data, a random-effects model will be used to calculate weighted-mean differences with 95% CIs. If required, we will calculate standard deviations from the standard errors or 95% CIs presented in the articles. Heterogeneity will be quantified using the I^2 and chi-square tests. Funnel plots will be drawn and Egger's test will be computed to explore the possibility of publication bias [46].

Reasons for heterogeneity in effect estimates will be sought in meta-analyses [47,48]. To explore the possible determinants of heterogeneity, we will conduct subgroup analyses according to selected study characteristics (eg, participants' ages; country where the study was conducted; types of professions; and types of models, interventions, and clinical pathways). Furthermore, sensitivity analyses will be conducted by (1) excluding relatively small studies (ie, fewer than 20 participants per randomization group) and (2) restricting analyses to good-quality studies. Data will be analyzed using SPSS Statistics for Windows, version 25.0 (IBM Corp), and Review Manager, version 5.5 (The Nordic Cochrane Centre, The Cochrane Collaboration).

Results

To date, searches in Embase have been performed, delivering 3272 references. As of publication of this protocol, we are developing the search equations in the remaining databases to then initiate the process of study selection, rigorously applying the inclusion and exclusion criteria. The final results are expected in January 2020.

Discussion

Principal Considerations

To the best of our knowledge, this systematic review will be the first to synthesize evidence about medication management

models, including their interventions, clinical pathways, and EMMS, as well as their impacts on MRPs among polymedicated, home-dwelling older adults.

Since MRPs are associated with an increased risk of hospital readmissions, morbidity, and mortality and are significant issues for the health care system, it is very important to develop intervention strategies to resolve or prevent them. The suboptimal medication management causing MRPs involving the hospitalization of polymedicated, home-dwelling older adults is underrecognized by community health care providers, especially by frontline community health care nurses. Therefore, an important task for community health care providers is to identify, resolve, and prevent the occurrence of MRPs in this rapidly growing population of polymedicated, home-dwelling older adults.

The results of this systematic review may guide future research in this avenue. The results may also contribute to the development of comprehensive and implementable recommendations for primary health care practitioners and policy makers concerning medication management among polymedicated, home-dwelling older adults.

Strengths and Limitations

This systematic review protocol's strengths are as follows: (1) clear definitions of the major concepts of medication management models, multiple chronic conditions, clinical pathways, and interventions; (2) the use of an appropriate search strategy designed in collaboration with a health librarian experienced in conducting such reviews; and (3) the inclusion criteria, which impose few restrictions on the study's language, age, or geographic location. Nevertheless, there are several limitations that should be noted. The authors' personal judgements may introduce bias into the assessment. Nonetheless, this risk will be reduced by using two reviewers to select and assess the eligibility of studies independently. Furthermore, it is possible that some eligible studies may not be covered by our research strategy. We will seek to minimize this limitation through the contribution of an experienced health librarian. Finally, the expected heterogeneity of studies about medication management models for polymedicated, home-dwelling older adults with multiple chronic conditions may influence our ability to state comprehensive and implementable recommendations from the literature.

Conclusions

This systematic review will synthesize the available evidence about medication management models among polymedicated, home-dwelling older adults and their impact on MRPs. We expect our findings to provide meaningful evidence toward the optimization of health care models, programs, and services for polymedicated, home-dwelling older adults with multiple chronic conditions.

Conflicts of Interest

None declared.

Authors' Contributions

FP is the guarantor and all the authors contributed to drafting the protocol. All authors will contribute to the development of the selection criteria, data extraction and analysis, and the search strategy. All the authors approved the final protocol manuscript.

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Abbreviations

CINAHL: Cumulative Index to Nursing and Allied Health Literature
EMMS: electronic medication management systems
EPOC: Effective Practice and Organization of Care
MeSH: Medical Subject Heading
MOOSE: Meta-analysis Of Observational Studies in Epidemiology
MRP: medication-related problem
NRSI: nonrandomized studies for interventions
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PRISMA-P: Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Protocols
PROSPERO: International Prospective Register of Systematic Reviews
ROBINS-I: Risk of Bias In Nonrandomized Studies of Interventions
sb: subset

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SR-M3 state of progress

A total of 20,610 references were identified. The research equations for each of the ten data sources are provided in Appendix 2. After the removal of duplicates, 12,001 references were screened based on a review of their titles and/or abstracts, and 470 were selected for the next phase. We retained 12 eligible articles after analyzing the full texts. These articles had not been analyzed qualitatively at the time of the thesis' submission. Figure 7 represents the ongoing PRISMA flow diagram of SR-M3.

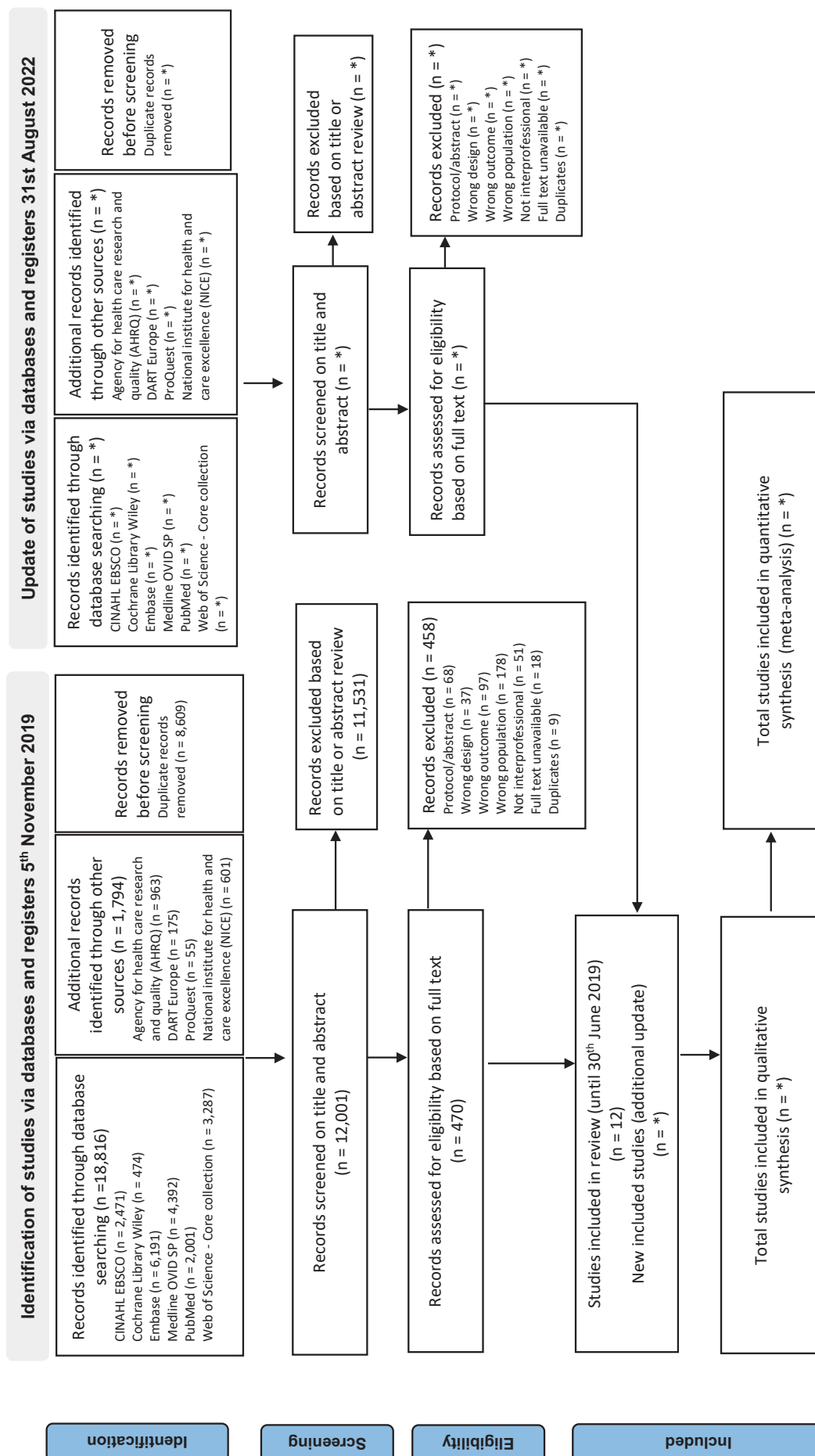


Figure 7: Flow diagram presenting SR-M3's state of progress based on the PRISMA statement: an updated guideline for reporting systematic reviews [33].

ARTICLE 3

Pereira F, Roux P, Santiago-Delefosse M, von Gunten A, Wernli B, Martins M, et al. Optimising medication management for polymedicated home-dwelling older adults with multiple chronic conditions: a mixed-methods study protocol. *BMJ Open*. 2019;9(10). doi:10.1136/bmjopen-2019-030030.

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Protocol

BMJ Open Optimising medication management for polymedicated home-dwelling older adults with multiple chronic conditions: a mixed-methods study protocol

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ABSTRACT

Introduction Optimal medication management is one of the basic conditions necessary for home-dwelling older adults living with multiple chronic conditions (OAMCC) to be able to remain at home and preserve their quality of life. Currently, the reasons for such high numbers of emergency department visits and the very significant rate of hospitalisations for OAMCC, due to medication-related problems (MRPs), is poorly explored. This study aims to reveal the current state of the medication management practices of polymedicated, home-dwelling OAMCC and to make proposals for improving clinical and medication pathways through an innovative and integrated model for supporting medication management and preventing adverse health outcomes.

Methods and analysis A mixed-methods study will address the medication management of polymedicated, home-dwelling OAMCC. Its explanatory sequential design will involve two major phases conducted sequentially over time. The quantitative phase will consist of retrospectively exploiting the last 4 years of electronic patient records from a local hospital (N ≈ 50 000) in order to identify the different profiles—made up of patient-related, medication-related and environment-related factors—of the polymedicated, home-dwelling OAMCC at risk of hospitalisation, emergency department visits, hospital readmission (notably for MRPs), institutionalisation or early death. The qualitative study will involve: (a) obtaining and understanding the medication management practices and experiences of the identified profiles extracted from the hospital data of OAMCC who will be interviewed at home (N ≈ 30); (b) collecting and analysing the perspectives of the formal and informal caregivers involved in medication management at home in order to cross-reference perspectives about this important dimension of care at home. Finally, the mixed-methods findings will enable the development of an innovative, integrated model of medication management based on the Agency for Clinical Innovation framework and Bodenheimer and Sinsky's quadruple aim.

Ethics and dissemination Ethical approval has been obtained from the Human Research Ethics Committee of the Canton Vaud (2018-02196). Findings will be disseminated in peer-reviewed journals, professional conferences and other knowledge transfer activities with primary healthcare providers, hospital care units, informal caregivers' and patients' associations.

Strengths and limitations of this study

- ⇒ This mixed methodology will rely on a closely coordinated combination of methods and on the utilisation of valuable existing data underexploited to date (patients' electronic hospital records and Resident Assessment Instrument-Home Care (RAI-HC) data).
- ⇒ The investigation draws on an interprofessional and interdisciplinary approach, which associates general practitioners, community healthcare nurses, pharmacists and researchers in health psychology, old age psychiatry, nursing and survey methodology.
- ⇒ Our findings will contribute to the development of an evidence-based and innovative, cooperative model of medication management for polymedicated, home-dwelling older adults with multiple chronic conditions.
- ⇒ Although patients' electronic hospital records and RAI-HC data provide a broad range of patient-related, medication-related and environment-related information, they rarely highlight factors that may influence the occurrence of medication-related problems.

INTRODUCTION

The number of older adults living at home with multiple chronic conditions (OAMCC) rises considerably around the world and has been estimated to affect 25.2% of people aged from 65 to 79% and 41.3% of those aged 80 and over.¹ Multiple chronic conditions is a comprehensive concept used to properly cover the diverse definitions of multimorbidity^{2–3} and therefore the complexity of older adults' health statuses. The concept encompasses the simultaneous presence of an individual's diseases and their chronic physical, mental or behavioural health problems requiring ongoing management over years or decades.⁴

These long-term health conditions require taking multiple medications,⁵ known as polypharmacy (PP) when the daily intake

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corresponds to five or more medicines.⁶ PP places older adults at higher risk of medication-related problems (MRPs), including adverse medication reactions, medication errors and potentially inappropriate medications.^{7,8} Potentially inappropriate medications are the intake of medicines for which the associated risks outweigh the potential benefits, particularly when more effective alternatives are available.⁹ Consequently, MRPs can lead to a degradation of the patient's clinical condition, physical and cognitive decline, an exacerbation of chronic medical conditions and avoidable health costs.^{10,11} Moreover, up to 25% of emergency department visits by home-dwelling OAMCC are due to MRPs.¹⁰ However, 60% of MRPs in patients visiting the emergency department with non-specific complaints (such as weakness) may go undiagnosed, whereas 83% of those MRPs may be responsible for acute morbidity.¹⁰ MRPs are also a frequent cause of readmission, and they were the most frequent cause in one study that followed older patients for 6 months after hospital discharge.¹² Care-coordination problems, associated with low or suboptimal medication management, are all the more evident in the sensitive period of discharge home from hospital.^{11,13} The complexity of OAMCC's care needs leads them to be significant users of health services and to consult many different healthcare professionals.¹⁴ The number of healthcare professionals consulted by home-dwelling OAMCC has been directly associated with fragmented and uncoordinated care.¹⁵ Moreover, different healthcare professionals may have different treatment preferences. Failure to coordinate care among home-dwelling OAMCC contributes to MRPs.¹³

In addition to the role of healthcare professionals in medication management, informal caregivers play a vital role in ensuring safe and appropriate medication use by home-dwelling OAMCC, especially among those who may also have cognitive impairment.^{15–17} Despite the important role of informal caregivers in medication management, several complications to do with their activities have been documented in relation to the time spent, anxiety making a mistake and the uncooperative behaviour of the home-dwelling OAMCC.¹⁸ They are also confronted with difficulties in maintaining continuous supplies of medication, assisting with administration, making clinical judgements (eg, in response to side effects and about over-the-counter medication), and solving conflictual communications or disagreements with the older adult,¹⁸ or even with healthcare professionals, with regard to ineffective and addictive medication practices.^{15,18}

Nonetheless, many MRPs are preventable.^{8,10,19} Studies about medicine-related hospitalisations suggest that up to 58% may be preventable with appropriate primary care.⁸ An essential strategy for medicine-related hospitalisations prevention and medication safety is medication reconciliation—the process of creating and maintaining a single list of the patient's current list of medications.²⁰ This process allows a systematic and comprehensive review of all the medications the patient is taking, reducing

medication errors by a consistent communication across transitions of care.²¹

Therefore, optimising medication management among home-dwelling OAMCC requires regular monitoring of MRPs, interprofessional collaboration across different health and social care providers, organisations and departments¹⁹ and medication reconciliation at every transition of care including changes in the clinical setting, practitioner or level of care.²²

Aim and objectives

This study's aim is to document the current state of medication management practices of polymedicated, home-dwelling OAMCC and to make proposals for improving evidence-based clinical and medication pathways through an innovative, integrated model intended to support medication management and to prevent adverse health outcomes related to MRPs (recurrent hospitalisation, emergency department visits, institutionalisation in nursing homes and early death). To achieve this aim, three main objectives will guide this project:

The first objective is to carry out a *retrospective analysis of patients'* hospital records, their medication and environment-related factors in order to identify those that increase the risk of hospitalisation, emergency department visits, hospital readmission (notably due to MRPs), institutionalisation or early death, among home-dwelling polymedicated OAMCC—factors that prevent OAMCC from staying at home.

The second objective is to use a *prospective qualitative study* to explore and better understand the *medication experiences and practices of home-dwelling OAMCC with different profiles*. We seek to identify the skills and strategies developed by them to manage polymedication within their social contexts and health trajectories despite possible cognitive impairment and particularly after a recent hospitalisation.

The third objective is to better understand the *roles and coordination of the different caregivers involved in the medication management of home-dwelling OAMCC*. We seek to investigate the perspectives of both professional caregivers (community healthcare nurses, pharmacists, general practitioners or specialist physicians) and non-professional/informal caregivers (family members, friends or neighbours).

METHODS

Study design

To enable us to meet our objectives, a mixed-methods study will address the medication management of polymedicated, home-dwelling OAMCC.²³ Two major phases will be conducted sequentially from February 2019 to January 2022: a quantitative data collection phase followed by a qualitative phase. The reasons for using an explanatory sequential design are, first, that existing data in electronic patient records from a local hospital will enable us to identify profiles affected by similar patient-related, medication-related and environment-related factors



among the polymedicated, home-dwelling OAMCC at risk of hospitalisation, emergency department visits, hospital readmission (notably due to MRPs), institutionalisation or early death. Second, the identified profiles extracted from the hospital data will allow proceeding to a purposive sampling—of those polymedicated, home-dwelling OAMCC who present with more risk factors—for the qualitative data collection focused on medication management at home. Thus, the analysis of the results from the retrospective quantitative phase will be integrated with the data collected from the prospective qualitative phase. Finally, phase 3 will develop a Medication Management Model based on interpreting the quantitative and qualitative findings.

Phase 1: retrospective quantitative analysis

To fulfil the first objective, the purpose of the quantitative phase is to identify the different profiles—made up of patient-related, medication-related and environment-related factors—of the polymedicated, home-dwelling OAMCC at risk of hospitalisation, emergency department visits, hospital readmission (notably for MRPs), institutionalisation in nursing homes or early death (before the average age of death described by the Organisation for Economic Cooperation and Development in 2018).²⁴ A systematic, retrospective chart analysis of the electronic patient records from a local hospital over the last 4 years using the evidence-based methodology developed by Vassar and Holzmann will provide substantial clinical information.²⁵ Motheral *et al*'s standardised extraction sheets will be adapted to explore and assess the data of older inpatients or emergency department-visiting home-dwelling older adults.²⁶ The 4-year analysis was selected based on the availability of systematic, well-coded patient data using the Swiss-Diagnostic Related Groups²⁷ and the Swiss Classification of Surgical Interventions (CHOP).²⁸

Research population

All home-dwelling OAMCC with somatic and/or mental health disorders who were hospitalised, rehospitalised or who consulted the emergency department (for MRPs or other reasons) at the partner hospital between 2015 and 2018 (estimated $n=50\,000$) will be included. The estimated sample of 50 000 older adults' electronic inpatient charts are part of the 40 000 yearly adult inpatients in acute care units and more than 40 000 adult emergency department consultations yearly at the partner hospital. To explore generalisability, we will compare their sociodemographic and health status characteristics with those of the national sample of hospitalised older adults in Swiss hospitals for the same period.

Data collection

Data from the hospitalisation and emergency admissions databases will be collected on patient-related, medication-related and environment-related factors that could have influenced the occurrence of MRPs that resulted in

hospitalisation, rehospitalisation or emergency department admission.

Patient-related factors comprise sociodemographic characteristics, the International Classification of Diseases 10th version (ICD-10) diagnostics (main diagnosis and comorbidities), the Swiss Classification of Surgical Interventions (CHOP) category and the reason for hospitalisation, rehospitalisation or emergency department admission. Supplementary filters will be added to discriminate polymedication, multimorbidity (secondary ICD-10 diagnosis), physical and cognitive impairment documented in the clinical data files (Function Independence Measure, Mini-Mental State Examination and Activities of Daily Living).

Medication-related factors include the number, types and changes in medication at admission, during hospitalisation and at discharge.

Environment-related factors include the presence of formal and/or informal caregivers, patient's provenance (rural or urban), hospital pathways (wards and eventual transfers), length of stay, readmissions (number of admissions in the previous year, 30-day readmission and unplanned readmission), discharge destination and, potentially, death during hospitalisation. A unique patient identification number will allow us to analyse rehospitalisations via the emergency department during the period from 2015 to 2018. Retrospective data collection began in April 2019.

Data analyses

The data set of polymedicated, home-dwelling OAMCC will be analysed using multivariate regression analysis, in order to identify the patient-related, medication-related and environment-related factors that can increase the risk of hospitalisation, emergency department visits, readmission (notably due to MRPs), institutionalisation or early death. Furthermore, the profiles of polymedicated, home-dwelling OAMCC hospitalised or visiting the emergency department due to MRPs, and identified via multicluster analysis, will serve to guide the qualitative study and lead to a purposive sampling of polymedicated, home-dwelling OAMCC presenting with more risk factors. A draft of the cluster analysis strategy is available as an online supplementary file.

Phase 2: prospective patient-centred qualitative analysis

To meet the second and third objectives, a qualitative investigation, based on purposive sampling, will draw on work done in a feasibility study.²⁹ This qualitative investigation will consist of collecting and understanding the medication practices and experiences of OAMCC presenting with the risk factors identified in the first phase. The focus will be on identified OAMCC who were recently hospitalised and are at risk of hospital readmission. The older adult will be interviewed at home on two separate occasions. This methodology is a way to analyse changes in their medication practises and their experiences following their recent hospitalisation. The data

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collection tools include a walking-interview³⁰ based on a medication journal and household photographs of where medication is stored. This allows us to focus on the tangible practices of OAMCC and contextualises them within the private space of their daily lives.

To discriminate the older adults' health profile, we will use the Resident Assessment Instrument-Home Care (RAI-HC) introduced by the Swiss Association for Home Care Services for all home care services in 2004. Based on a comprehensive geriatric assessment, the RAI-HC both allows for the establishment of an individualised care plan and generates quality indicators, plans resource use, optimises the medication management process by monitoring and documenting the number and types of medication and the persons involved in preparing medication, and regularly assesses adherence to the medication prescribed.³¹ This instrument will provide information on the patient-related, medication-related and environment-related factors which may influence the occurrence of MRPs, and it will be used to recruit OAMCC at risk of or already presenting with MRPs.

Furthermore, we will also collect and analyse the perspectives of the formal and informal caregivers involved in medication management at home to cross-reference perspectives about this important dimension of care at home.

Research population

The profiles of the polymedicated OAMCC hospitalised/rehospitalised or consulting the emergency department, as identified in the retrospective investigation, will be used to select participants for the qualitative investigation. A theoretical, purposive sampling will be carried out. Based on Guest *et al.*, the principal investigator will

recruit about 30 polymedicated OAMCC (until saturation of data), all recently hospitalised (within the last 90 days) and at risk of hospital readmission.³² For each OAMCC participant, an informal caregiver will also be integrated into the investigation. We defined informal caregivers as any family member, neighbour or friend assisting a dependent older adult with certain activities in their daily life. That assistance, help, care or physical presence must be given on a regular basis, for at least two basic activities or instrumental activities of daily living or to ensure patient safety, and for 6 months or more.³³ The informal caregiver will be included in the study if the recruited older adult identifies that person as being significant in their medication management and if they give informed written consent to participate.

Furthermore, a formal caregiver will be integrated into the investigation for each participant. Professional caregivers are those employed to provide professional healthcare services (ie, nurses, nursing assistants, general practitioners, pharmacists and social workers). They will be included in the study if the recruited OAMCC identifies them as the professional most involved in their medication management.

Table 1 presents the specific inclusion/exclusion criteria for each group of participants.

Participant recruitment

Polymedicated, home-dwelling OAMCC will be recruited via two paths so that all of the participants meet the eligibility criteria and fit corresponding profiles established in the quantitative phase. Some OAMCC will be receivers of care from Community Healthcare Centres and others will be functioning without that day-to-day support.

Table 1 Phase 2 inclusion and exclusion criteria

Participants	Inclusion criteria	Exclusion criteria
OAMCC	▶ Aged 65 or above ▶ Man or woman ▶ Hospitalised within the last 90 days ▶ Managing at least five different medications (prescribed and over-the-counter medications explored during recruitment) ▶ Suffering from multiple chronic conditions⁴ ▶ Living alone or in a couple, in a rural or urban area ▶ With or without support from a Community Healthcare Centre	▶ Not able to speak and understand French
Informal caregiver	▶ Designated by the OAMCC as the most significant informal caregiver involved in medication management ▶ Aged 18 or above	▶ Not able to speak and understand French
Professional caregiver	▶ Designated by the OAMCC as having a key role in medication management	▶ Student ▶ Apprentice
OAMCC, older adults living with multiple chronic conditions.		



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- For OAMCC who do not receive support from a Community Healthcare Centre, recruitment will be based on variables in their patient files and carried out in collaboration with different nursing departments from the partner hospital.
- For OAMCC who do receive support from a Community Healthcare Centre, recruitment will be based on the clinical and health data documented in the RAI-HC and carried out in collaboration with community healthcare nurses from Sion Community Healthcare Centre.

Research nurses partnering the project, from a hospital or a Community Healthcare Centre, will briefly explain the study to the patient. Potential participants will be asked for permission to give their name to the researchers. The principal investigator will contact the older adult by telephone during the week following hospital discharge and ask for their agreement to participate in the study. In case of agreement, a first meeting will be organised at the older adult's home in the next few days. Participant recruitment will start in October 2019.

Data collection from OAMCC

During the first home meeting with the OAMCC, the principal investigator will provide all the study details and will suggest two semistructured interviews, each lasting about an hour, starting on the first meeting and spaced 2–3 weeks apart. According to participants' levels of tiredness, it may be necessary to subdivide the interviews. The older adult will be invited to sign the informed written consent form, allowing the researcher to collect sociodemographic and health data (RAI-HC and the patient's hospital records). Eligible home-dwelling OAMCC from both recruitment paths will be screened using the RAI-HC Minimal Data Set (MDS), which includes information on polymedication (section P), multiple chronic conditions (sections J and K) and recent hospitalisation (section Ac). Research team members trained on the RAI-HC will also carry out this evaluation for participants who do not have an RAI-HC. The following multidimensional clinical data will be retrieved from the RAI-HC MDS: cognitive status, hearing, vision, mood status, functional and physical status, continence, healthcare problems and nutritional state. The MDS will aid interviews with OAMCC and the exploration of the facilitators and barriers to daily medication management.

The first semistructured interview will collect the perspectives of OAMCC with regard to their medication management, the return home, information received about their treatment and its possible modifications, whether their opinions and preferences were taken into account in the prescription of medications, and the informal and professional caregivers involved. OAMCCs will be interviewed alone or with an informal caregiver, if necessary. The principal investigator will then ask the participant to complete a week-long medication journal,^{34 35} either alone or with the help from informal or professional caregivers, emphasising that any

information on daily medication routines is helpful, even if the OAMCC feels unable to complete the journal for the full 7 days. The instructions will mention the importance of noting all the medicines taken—those prescribed by general practitioners or specialist physicians, but also any others taken at their own initiative (over-the-counter medications). Participants will be asked to note their perceptions of and satisfaction with their treatment in a week-long medication journal. This will provide information on the daily routines associated with the participant's medication and will form the basis of the second interview.

The second interview will be based on the participant's medication journal and will take the form of a walking-interview³⁶ using household photographs.³⁵ The principal investigator will ask the participant to explain their medication practises while pointing out the locations within their home where drugs are stored, prepared and taken. The hypothesis underlying this methodology is that the physical presence of drugs promotes discussion.^{37 38} We will identify and photograph, with the participants' agreement, the places where medication, contact details for medical professionals and other information are stored as well as the locations of any other objects involved in daily care practises. The collection and analysis of photographs provide a better understanding of the complexity of medication management in home settings. They help to capture the interviewee's concerns or strategies when they are pointed out to the interviewer. The interview guide will also investigate the issue of self-medication in order to reveal the extent and influence of this practice.

Data collection from informal caregivers

Sociodemographic data and information related to medication management will be collected. When possible and appropriate, a joint third interview³⁹ with the OAMCC and their principal informal caregiver³⁴ will be organised at the older adult's home 1–2 weeks after the walking interview. This type of interview provides access to the interactions between OAMCC and their informal caregivers with regard to medication management. We hypothesise that the main informal caregiver is deeply involved in the older adult's experience of medication management, but the caregiver's ideas about this may be similar to, overlapping with or different from those of an OAMCC.

Data collection from professional caregivers

A semistructured interview of about 1 hour will be conducted with a professional caregiver in order to explore their point of view on the OAMCC's medication management and other issues associated with the return home after hospitalisation. In agreement with the project's field partners and stakeholders, these interviews will take place in professionals' workplaces (Community Healthcare Centre, medical practice office or pharmacy), during working hours, 1–2 weeks after the interview with the OAMCC and their informal caregiver.

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Qualitative data analyses

A database will be prepared using the RedCap software platform to record and store the participants' sociodemographic, health and interview data. Information on their health statuses will be collected using the RAI-HC data and will be analysed using the IBM-Statistical Package for Social Sciences V.25.0.

Data collected via the interviews will be examined according to an analytical plan that integrates and compares two different methods. First, thematic content analysis,^{40, 41} using NVivo V.12 software, will be used to identify the themes emerging from the data, and this will provide a rich, detailed account of the data set. Themes will be compared by different members of the analysis team until a consensus is reached. Second, lexicometric analysis, using Iramuteq software—a technique derived from the Alceste method⁴²—will allow a very fine exploration, both within each interview and across the whole corpus of interviews, of the structures underlying the discourse. Each older adult's medication journal will be analysed and categorised according to the same principles as the interviews. The data collected from these documents will be put into perspective by the analysis of the interviews. In the final data analysis, links will be made between the interviews, the medication journal, the older adult's RAI-HC data and the photos of the medicines' locations.

Phase 3: development of a medication management model

Connecting retrospective and prospective findings, using an explanatory sequential design and participants' different perspectives, will contribute to a deep understanding of the current state of medication management practices of polymedicated, home-dwelling OAMCC. This mixed-methods study corresponds to the 'diagnostic' phase of the process of developing a Model of Care, as presented by the Agency for Clinical Innovation (ACI).⁴³ It will guide the 'solution design' phase—the next step in the creation of an innovative, integrated model for supporting medication management and preventing adverse health outcomes. In addition to the ACT's framework, the development of a proposed Medication Management Model will consider the quadruple aim of enhancing the patient's experience, improving population health, reducing costs and improving the working lives of healthcare providers.⁴⁴

Finally, our mixed-methods research findings will be completed with those of an ongoing systematic review of Medication Management Models.⁴⁵

The study phase outcomes are summarised in table 2.

Patient and public involvement

This study and the feasibility study on which it is based were developed in collaboration with representatives from a Community Healthcare Centre, a regional hospital, medical and pharmacy associations and an informal caregivers association. They shared their expertise on the study's relevance and the feasibility of data collection with

Table 2 Outcomes for each study phase

Phase 1 outcomes	Patient-related, medication-related and environment-related factors which can increase the risk of hospitalisation, emergency department visits, hospital readmission (notably due to MRPs), institutionalisation or early death. Profiles of polymedicated, home-dwelling OAMCC hospitalised or visiting the emergency department due to MRPs based on the previously identified patient-related, medication-related and environment-related factors.
Phase 2 outcomes	For OAMCC participants: ▶ Patient-related, medication-related and environment-related factors for MRPs (defined by phase 1's outcomes) extracted from the RAI-HC MDS and the patient's electronic hospital records (number and types of medication, multiple chronic conditions, recent hospitalisations, cognitive status, hearing, vision, mood status, functional and physical status, continence, healthcare problems and nutritional state). ▶ Medication practices and experiences of OAMCC following their recent hospitalisation, facilitators/barriers to medication management, informal and professional caregivers involved. For informal caregivers: ▶ Sociodemographic profiles. ▶ Practices and experiences related to medication management. For professional caregivers: ▶ Sociodemographic and professional profiles. ▶ Role and perspectives on OAMCC medication management. ▶ Coordination activities related to returning home after hospitalisation.
Phase 3 outcomes	Three first steps in the process of developing a Model of Care⁴³: ▶ 'Project initiation'. ▶ 'Diagnostic'. ▶ 'Solution design' considering the quadruple aim. Proposals for the Medication Management Model's 'Implementation' and 'Sustainability' steps⁴³ to support medication management and to prevent adverse health outcomes related to MRPs.

MDS, Minimal Data Set; MRPs, medication-related problems; OAMCC, older adults living with multiple chronic conditions; RAI-HC, Resident Assessment Instrument-Home Care.

the research team. Patients' priorities, experiences and preferences, collected during the feasibility study, were the drivers for the development of the research question and outcome measures.

A steering committee will involve these different actors at various stages in the project, both to contribute to data collection and to provide their expertise to the coconstruction of a Medication Management Model and its future implementation. As regards data collection, the hospital's medical informatics department will provide the appropriate data based on a data extraction protocol (phase 1) and the Community Healthcare



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Centre will help with OAMCC recruitment and access to participants' RAI-HC and professional caregivers (phase 2).

Results will be disseminated to study participants through presentations to associations of patients and informal caregivers and at professional training sessions.

ETHICS AND DISSEMINATION

With the approval, the medical informatics department of partner hospital will provide the appropriate data for the retrospective phase based on a data extraction protocol. Extracted data will be delivered and stored in the RedCap data platform via a secure coded data file. In coherence with the Data Management Plan submitted to the Swiss National Science Foundation, the collected data will be securely stored for future research.

The autonomy of the participants will be respected. Participation in the prospective phase in this research is free. It will be possible for participants to refuse to record the interview or to request the deletion of the recorded data. Participating in a structured effort to understand medication practices and the posthospital return home experience can contribute to improvements in health management in the community at large, and particularly in the area of home support.

Findings will be disseminated in peer-reviewed journals, professional conferences and other knowledge transfer activities with primary healthcare providers, hospital care units, informal caregiver and patient associations.

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Contributors FP, PR and HV had the original idea. MSD, AVG, BW, MMM and HV provided conceptual and methodological expertise to the design of the research protocol. FP, PR and HV were major contributors to writing the manuscript. All authors read, edited and approved the final manuscript.

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OTHER SCIENTIFIC OUTPUTS RELATED TO THIS CHAPTER

Abstract published in a journal's digital supplement

Pereira F, Verloo H, Martins M. Optimising medication management for polymedicated home-dwelling older adults with multiple chronic conditions. Suplemento digital Rev ROL Enferm. 2019;42(11-12)(Novas Perspetivas Da Enfermagem: Contributos para a Investigação em Enfermagem, Enfermagem do Trabalho e Supervisão Clínica):33.

Abstract published in a conference proceeding

Pereira F, Martins M, Verloo H. Protocol for a mixed methods study to optimize medication management for polymedicated home-dwelling older adults with multiple chronic conditions. Presented at the virtual 5th Annual Postgraduate Research Student Scholarly Event entitled “New challenges in Nursing and midwifery practice, research, education and leadership”, organized by the European Membership Involvement Committee of Sigma Theta Tau International and the Phi Xi Chapter. 2019. Nursing School of Coimbra, Coimbra, Portugal.

Poster presentation

Pereira F, Martins M, Verloo H. Medication management for polymedicated home-dwelling older adults: the ME@HOME study. Poster presented at Asserting the Essence of Nursing: 10 years of the Doctoral Programme in Nursing Sciences. 2019. Institute of Biomedical Sciences Abel Salazar, University of Porto, Porto, Portugal.

**CHAPTER 4 – RETROSPECTIVE QUANTITATIVE
PHASE: FROM HOSPITAL ADMISSION
TO DISCHARGE**

RETROSPECTIVE QUANTITATIVE PHASE: FROM HOSPITAL ADMISSION TO DISCHARGE

This chapter presents findings from the study's retrospective quantitative phase and focuses on polymedicated home-dwelling older adults' functional status and the risk factors for adverse health outcomes in hospital before discharge home. It contains three quantitative articles.

Article 4 explored and compared the functional status of polymedicated and non-polymedicated geriatric inpatients at hospital discharge. Article 5 determined the risks of 30-day hospital readmission for polymedicated, older adult inpatients discharged home. Article 6 investigated the risks of unplanned nursing home admission following an acute hospital admission or readmission.

Figure 8 gives an overview of the retrospective data collection and analysis strategy used for the raw hospital register data. After approval by the Human Research Ethics Committee of the Canton of Vaud (CER-VD) (Appendix 1) and the partner hospital (Appendix 3), a database containing the latter's electronic health records from 2015 to 2017 for all inpatients aged 18 or more ($N = 105,243$) was provided to the research team in early 2019. This database was used for Article 4. The hospital's data warehouse required more time to extract the database containing inpatients' medication lists, and an updated database was provided at the end of 2019. This database not only provided us with medication lists but also the data from the year prior to the analysis (2018). In accordance with our research protocol, the hospital's data warehouse had added filters: inpatients had to be aged 65 years old or more, polymedicated, and living at home and hospitalized in the hospital structures in the canton of Valais' French-speaking region ($N = 20,422$). The exploration of this database led to three publications. Taushanov *et al.* (not included in the thesis) describes the methods used to transform and synthesize the hospital patient registry dataset into an exploitable database for further investigation [34]. Article 5 considered 13,802 hospital stays, between 2015 and 2018, by polymedicated older adults who returned

home and had no missing data. This provided us with hospital stays involving 8,878 different individuals, with an average of 1.55 observations per person. Article 6 included all the hospital stays, between 2015 and 2018, by polymedicated older adults with no missing data who had not died during hospitalization ($N = 14,705$). These cases involved 9,430 different individuals, with an average of 1.56 hospital stays per person. The longitudinal, electronic patient dataset was analyzed between February 2019 and March 2020.

Not all the elements mentioned in the project protocol (Article 3) are presented in the articles included in this chapter. Indeed, we were unable to explore the changes to medication made during hospitalizations because patients' medication datasets at admission were often incomplete or unknown. Moreover, the existence or assistance of informal caregivers was not available in the dataset provided. Future studies are planned to explore survival analyses and emergency department visits related to MRPs.

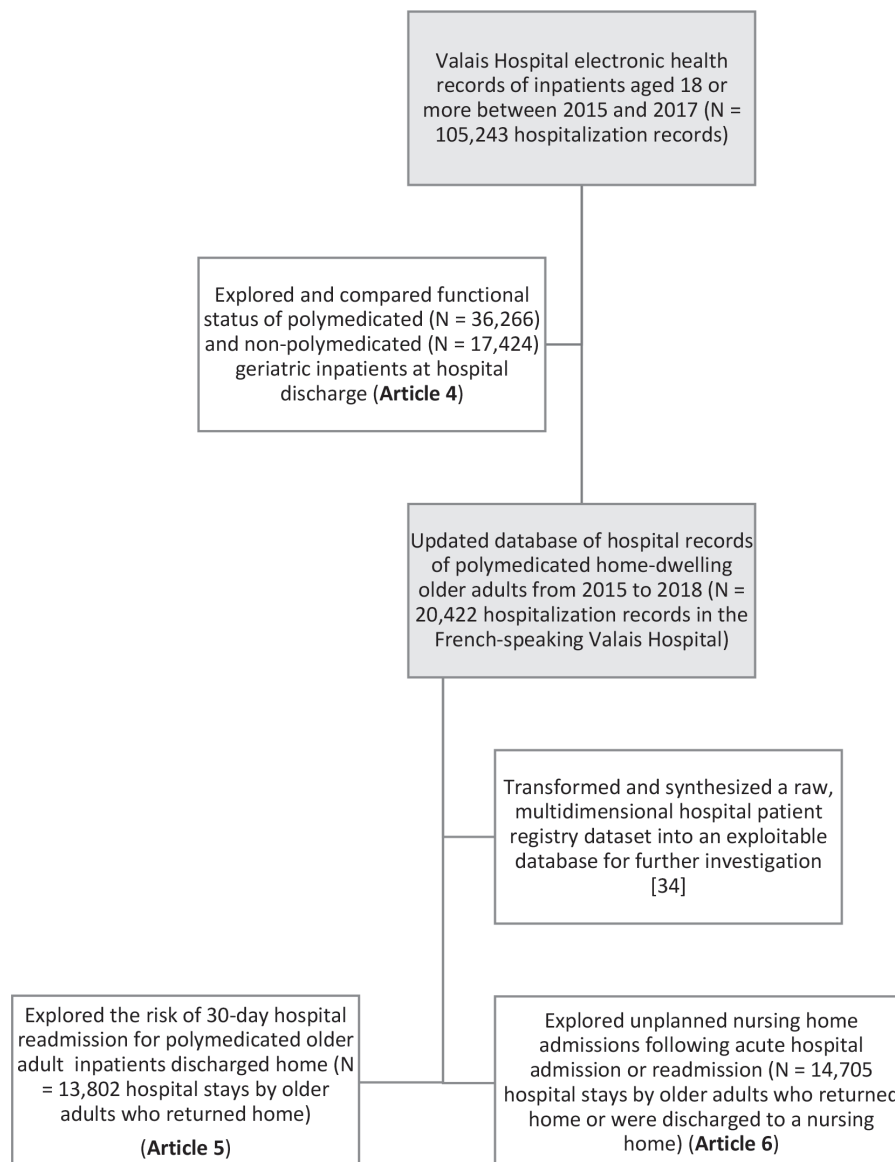


Figure 8: Overall view of the retrospective data collection and analysis strategy for the raw hospital register data.

ARTICLE 4

Pereira F, Wernli B, von Gunten A, Carral MdR, Martins MM, Verloo H. Functional Status among Polymedicated Geriatric Inpatients at Discharge: A Population-Based Hospital Register Analysis. *Geriatrics*. 2021;6(3):86. doi:10.3390/geriatrics6030086.

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Article

Functional Status among Polymedicated Geriatric Inpatients at Discharge: A Population-Based Hospital Register Analysis

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Abstract: This study explored and compared the functional status of polymedicated and non-polymedicated geriatric inpatients at hospital discharge. We used a cross-sectional registry of geriatric patients' hospital records from a multi-site public hospital center in Switzerland. The analysis included all inpatients aged 65 years old or more admitted between 1 January 2015 and 31 December 2017 ($n = 53,690$), of whom 67.5% were polymedicated at hospital discharge, 52.1% were women ($n = 18,909$), and 42.7% were 75–84 years old ($n = 15,485$). On average, the polymedicated patients' hospital lengths of stay were six days longer, they presented with more than three comorbidities, and they were prescribed more than nine medications at hospital discharge ($p < 0.001$). They showed more frequent general mobility decline (43.2% vs. 41.9%), gait disorders (46.2% vs. 43%), fatigue (48.6% vs. 43.4%) and dependence on lower-body care (49.7% vs. 47.6%), and presented a higher malnutrition risk ($OR = 1.411$; 95%CI 1.263–1.577; $p < 0.001$). However, the non-polymedicated inpatients had proportionally more physical and cognitive impairments. The comparison of the functional status of polymedicated and non-polymedicated geriatric inpatients at hospital discharge is important for clinicians trying to identify and monitor those who are most vulnerable to functional decline, and to design targeted strategies for the prevention of functional impairment and related adverse health outcomes.

Keywords: polypharmacy; older adults; hospital discharge; hospital register; population-based; functional status; physical impairment; cognitive disorders; epidemiology

1. Introduction

The world population is rapidly ageing. As people everywhere live longer, there will be dramatic increases in the prevalence of many chronic conditions—due to multiple underlying factors—that tend to occur later in life [1]. Older people living with chronic conditions often present with a functional decline that leads to them becoming significant users of healthcare services, particularly acute care [2,3]. Between 2010 and 2015, hospitalizations in Switzerland of people aged 60 years old or more increased by 11.6% for men and 9.0% for women [4]. This is particularly worrying because hospital admissions are frequently associated with functional decline, a greater risk of readmissions, and unplanned institutionalization in long-term care facilities [5–7]. Hospitalizations, especially if repeated and prolonged, may produce adverse events and irreversible health outcomes, precipitating geriatric syndromes, functional impairment, institutionalization,

and even early death [8–10]. Older inpatients are at a greater risk of declining functional status, frailty, delirium, falls, medication toxicity, nosocomial infections, malnutrition, dehydration, immobilization, and pressure sores while hospitalized [11].

Functional status is commonly defined as the basic physical and cognitive abilities enabling the routine activities of daily living—including eating, bathing, dressing, transferring, and toileting—and the everyday duties required to live in one's own home, especially if one lives alone [12]. According to Inouye's unifying conceptual model [13], shared risk factors among older adults—including older age and functional decline—may lead to geriatric syndromes, which may, in turn, lead to the overarching geriatric syndrome of frailty. Both generate feedback mechanisms intensifying those shared risk factors and geriatric syndromes [13]. Thus, geriatric inpatients are susceptible to complications and adverse events which are not directly related to the illness or event for which they were hospitalized [8,10,14,15].

The major increases in life expectancy have largely been due to advances in health-care, science and technology, notably the optimization and personalization of medication, enabling people to cope with the complex manifestations of their chronic conditions and their impacts on their daily lives [16]. Hence, the use of multiple medications, usually referred to as polypharmacy (PP), is common in older multimorbid populations, as one or more medications may be used to treat each health condition [17]. Although there is no consensus on the number of medications that should be considered the threshold for PP, a systematic review of PP definitions by Masnoon et al. found that the most commonly used numerical definition in research was five or more medications daily [18]. However, due to age-related pharmacokinetic and pharmacodynamic changes, PP places older people at a greater risk of medication-related problems (MRPs) such as adverse medication reactions, medication errors and potentially inappropriate prescriptions [19,20]. MRPs can engender functional decline and exacerbate medical conditions [21,22]. Consequently, MRPs are a frequent cause of readmission and avoidable health costs [23,24].

Midão and Giardini [25] examined the prevalence of PP and its associated effects among 29,342 older adults across 17 European countries and Israel, finding a range of PP from 26.3% to 39.9%. The overall prevalence of PP among older adults from 65–74 years old was 26.7%, whereas it was 43.1% for those aged 85 or more. PP was also more prevalent among women (33.0%) than men (31.2%). As expected, their study revealed that older adults with fewer than two chronic diseases were less susceptible to PP—12.1% instead of 42.3% among those with two or more chronic diseases—and that the older adults who received more prescriptions were those with a poorer health status. A prospective three-year Finnish cohort study of 294 older adults aged 75 or more at the baseline showed that excessive PP—defined as the use of ten or more medications—was associated with an increased risk of malnutrition ($p < 0.001$), functional decline ($p < 0.001$) and cognitive impairment ($p < 0.001$) compared to non-polymedicated subjects [26]. Figueiredo and Teixeira [27] reported different predictors of difficulties in medication intake across 16 European countries. Their findings suggested that younger age (OR = 0.441; 95%CI 0.376–0.517), maintained physical ability (OR = 0.822; 95%CI 0.736–0.918), having a sense of meaning in life (OR = 0.781; 95%CI 0.636–0.960), and memory and concentration (OR = 0.822; 95%CI 0.736–0.918) were significant predictors of fewer difficulties in medication intake and lower risks of MRPs. One qualitative review also showed that vision, memory, swallowing and hearing can affect patients' abilities to adhere to their medication prescriptions [28].

In addition to personal factors, nursing- and hospital-related factors may also contribute to functional decline [29]. Recovering from functional decline is challenging and can irreversibly impact older adults' transitions of care and quality of life [30]. Prevention starts with recognizing which geriatric inpatients are at risk of functional decline [31]. Early rehabilitation protocols applied during acute hospitalization are crucial to the prevention of functional decline [32]. Furthermore, comprehensive geriatric assessments and nursing interventions focused on functional independence can reduce the risk of hospital-acquired functional decline [33].

Despite the complex, multi-dimensional clinical situations facing geriatric patients in acute care hospitals, most of the published studies used small cohort, cross-sectional sample designs to report on single causes of hospitalization and their complications [34–36]. To the best of our knowledge, no studies to date have compared the functional status at hospital discharge of polymedicated and non-polymedicated geriatric inpatients, aged 65 years old or more, using patient records extracted from a population-based hospital register. This study aimed to fill that gap.

We hypothesized that older inpatients presenting functional decline at hospital discharge have a greater risk of being polymedicated than those with a normal functional status.

2. Materials and Methods

2.1. Study Design, Setting and Study Population

A cross-sectional, registry-based study of geriatric patients' hospital records was carried out. The data were derived from a large, longitudinal, electronic patient dataset extracted from the Valais Hospital (a public general hospital in the French-speaking part of Switzerland). Switzerland's healthcare system combines public and private elements, with private health insurers operating in a highly regulated market, and with the State co-financing hospitals. The cantons cover 55% of inpatient treatment costs, and the health insurance companies cover 45%; for outpatient care, the health insurance companies cover 100% of the costs. The current trend is, therefore, to favor outpatient treatment, and cantons are trying to shorten the hospital length of stay as much as possible [37].

The hospital register's electronic health records included all of the inpatients aged 18 years old or more admitted or readmitted between 1 January 2015 and 31 December 2017 (N = 105,243). Ethical approval (2018-02196) from the Human Research Ethics Committee of the Canton of Vaud (CER-VD) was obtained on 1 February 2019 and enabled the hospital's data warehouse to provide us with the appropriate dataset. In accordance with the Swiss Federal Act on Personal Data Protection, regulated at the federal and cantonal levels [38], sensitive personal data in the patients' records were excluded from the dataset, such as their date of birth, address, level of education and profession.

2.2. Customizing the Dataset and Selecting Variables of Interest

The extracted dataset was composed of sociodemographic, administrative, clinical, medical and medication data, and was delivered as an Excel csv. file. A three-year period was selected based on the availability of systematic, well-coded patient data, although no electronic patient records for the period were available from the adult psychiatry department. In order to fulfill the study's aim, the dataset was cleaned to focus on geriatric inpatients aged 65 or more at hospital discharge. In the absence of a unique patient identifier, the number of different patients and their readmission rate could not be explored.

2.3. Study Variables Selected

The variables were selected according to the study's aim and the shared risk factors for geriatric syndromes responsible for functional decline and adverse health outcomes among older adults, as documented in Inouye's unifying conceptual model [13]. These shared risk factors are older age, cognitive impairment, functional impairment and impaired mobility, as identified through five common geriatric syndromes (pressure ulcers, incontinence, falls, functional decline and delirium) [13].

The analysis included the following variables for each hospitalization: (i) sociodemographic characteristics, including the year of birth, sex, pre-hospital provenance and discharge destination, or death during hospitalization, and hospital length of stay (LOS); (ii) physical status, including general mobility, mobility for changing position, gait, balance disorders, fall risk, fatigue, independence in upper and lower body care, upper and lower body dressing/undressing, eating and drinking, swallowing disorders, bladder and bowel continence, independence in urination and defecation, hearing, vision, acute and chronic pain, malnutrition risk and Braden risk (for the prediction of pressure sore

risk [39]); (iii) cognitive status, including alertness/consciousness, orientation, concentration, verbal expression, capacity and skills to react to the demands of daily life, and the ability to learn; (iv) the number of comorbidities, calculated at each hospitalization using the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) [40]; and (v) the number of medications taken at discharge, as well as medications that increased fall and/or delirium risk. PP was defined as five or more prescribed medications [18].

2.4. Data Analysis

After an inspection of the dataset for extraction errors, missing values, and data consistency by two experienced data managers (BW, HV), the data were imported into Statistical Package for the Social Sciences (SPSS) software, version 27.0 (IBM-SPSS Inc., Chicago, IL, USA), for analysis. The missing values were analyzed based on the best practices for longitudinal datasets [41]. In accordance with the study's purpose, several categorical variables were recoded for the planned statistical analysis. The "discharge destination" variable, which had 16 categories in the original dataset, was recoded into home, deceased in hospital, and other destinations.

All of the physical and cognitive status variables were recoded as dichotomous variables (full ability/normal or impairment/disorder). The parametric properties were analyzed for the normality of their distributions and the equality of their variances using the Kolmogorov–Smirnov test. Non-parametric tests were performed for the variables with non-normal distributions in order to compare polymedicated and non-polymedicated geriatric inpatients. A descriptive analysis measured the frequencies for categorical variables and central tendencies for continuous and ordinal variables. The associations between polymedicated and non-polymedicated geriatric inpatients and their physical and cognitive conditions were computed using Cramér's V. Multivariate logistic regressions were computed to explore the risks of PP at hospital discharge associated with functional decline. Boxplots were used to identify the outliers in the dataset. In order to increase the study's internal validity, we adjusted our results for age, sex and LOS. The significance level was set at $p < 0.01$ in all of the analyses, given the large number of hospitalizations considered.

3. Results

3.1. Dataset

3.1.1. Total and Retrieved Study Population

The total dataset was composed of 105,243 hospitalization records. After applying the inclusion criteria for older adult inpatients aged 65 or more, 53,690 hospitalizations (51% of the dataset) from 2015–2017 were included in our analysis (Table 1).

3.1.2. Missing Values

There were few to no missing values per variable (99% of variables had less than 20% missing values, Supplementary Table S1), and these were missing at random. Bearing in mind the very low level of missing values, the large population size and our biostatistician's recommendation (BW), we did not apply any missing value strategies, and mentioned the population of interest for each variable.

3.1.3. Outliers

The hospital LOS variable featured some significantly long outliers, which were explored using boxplots (10% of hospitalizations). Based on the best practice, outliers of more than 200 days in hospital were replaced by the LOS mean score.

Table 1. Sociodemographic characteristics of the geriatric inpatients aged 65 or more (n = 53,690), and a comparison between those who were polymedicated (n = 36,266) and non-polymedicated (n = 17,424).

Variables	Geriatric Inpatients Aged 65 or More (n = 53,690)			p-Value
	Total n (%) 53,690	Polymedicated 36,266 (67.5)	Non-Polymedicated 17,424 (32.5)	
Sex				
Men	25,672 (47.8)	17,357 (67.6)	8315 (32.4)	0.763 ^a
Women	28,018 (52.2)	18,909 (67.5)	9109 (32.5)	
Age (years)				
Mean (SD)	78.37 (7.9)	78.75 (7.7)	77.58 (8.3)	<0.001 ^b
Min–Max	65–106	65–106	65–106	
Med (IQR-75)	78.00 (72–84)	79.00 (72–84)	77.00 (70–84)	
65–74	18,882 (35.2)	11,753 (62.2)	7129 (37.8)	<0.001 ^a
75–84	21,818 (40.6)	15,485 (71.0)	6333 (29.0)	<0.001 ^a
85 or more	12,990 (24.2)	9028 (69.5)	3962 (30.5)	<0.001 ^a
Admitted from				
Home	38,324 (71.4)	24,740 (64.6)	13,584 (35.4)	<0.001 ^a
Other locations ^d	15,366 (28.6)	11,526 (75.0)	3840 (25.0)	<0.001 ^a
Discharged to				
Home	33,771 (62.9)	23,747 (70.3)	10,024 (29.7)	<0.001 ^a
Other locations ^d	17,273 (32.2)	12,302 (71.2)	4971 (28.8)	
Died in hospital	2646 (4.9)	217 (8.2)	2429 (91.8)	
Length of stay (days)				
Mean (SD)	12.1 (14.5)	13.8 (15.1)	8.6 (12.4)	<0.001 ^c
Min–Max	1–197	1–197	1–192	
Med (IQR-75)	8 (4–15)	10 (5–17)	4 (1–11)	
65–74				
Mean (SD)	10.3 (14.7)	12.4 (16.0)	6.8 (11.4)	<0.001 ^b
Min–Max	1–197	1–197	1–192	
Med (IQR-75)	6 (13)	8 (4–15)	3 (1–7)	
75–84				
Mean (SD)	12.4 (14.0)	13.9 (14.4)	8.8 (12.2)	<0.001 ^b
Min–Max	1–194	1–194	1–189	
Med (IQR-75)	9 (13)	10 (1)	5 (10)	
85 or more				
Mean (SD)	14.3 (14.6)	15.5 (14.8)	11.6 (13.9)	<0.001 ^b
Min–Max	1–192	1–192	1–170	
Med (IQR-75)	11 (14)	12 (18)	8 (15)	

Note. ^a Chi-square test; ^b ANOVA; ^c Wilcoxon–Mann–Whitney; ^d other locations: hospitals and nursing homes.

3.2. Sociodemographic Characteristics

Our population of interest was distributed into the age categories of 65–74, 75–84, and 85 and over, containing 18,882 (35.2%), 21,818 (40.6%) and 12,990 (24.2%) older adults, respectively. The mean age was 78.4 (SD = 7.9), the median was 78 (IQR = 72–84), and they ranged from 65–106 years old (Table 1), with 28,018 (52.2%) female geriatric inpatients. However, the geriatric inpatients aged from 65–74 were predominantly male. The proportion of women hospitalized increased from 75 years old, whereas for men, the proportion decreased significantly ($p < 0.001$).

Almost three quarters (n = 38,324; 71.4%) of the geriatric inpatients were admitted from their homes, whereas one quarter (n = 15,366; 28.6%) were transferred from other healthcare settings. A smaller number (n = 1002; 1.9%) were referred to the hospital from long-term care facilities such as nursing homes. However, only 62.9% of those geriatric inpatients were discharged back home, and 7.4% were discharged to long-term care facilities. In

addition, 4.9% ($n = 2646$) of the hospitalizations resulted in death in the hospital. The LOS of the geriatric inpatients varied from 1 to 197 days, with an average of 12.1 days ($SD = 14.5$) and a median of 8 days ($IQR = 4\text{--}15$). As their age increased, the patients remained hospitalized for longer (Table 1).

Two thirds (67.5%) of the geriatric inpatients were polymedicated at hospital discharge. Most of the polymedicated geriatric inpatients were women ($n = 18,909$; 52.1%). The biggest group was aged from 75–84 years old ($n = 15,485$; 42.7%), and most had been admitted from ($n = 24,740$; 68.2%) and were returning to their homes ($n = 23,747$; 65.5%). Except for sex, all of the sociodemographic variables revealed statistically significant differences between the polymedicated and non-polymedicated geriatric inpatients (Table 1). On average, the polymedicated inpatients remained in hospital for six more days than the non-polymedicated inpatients ($p < 0.001$).

3.3. Description of Functional Status

3.3.1. Physical Status

Most of the geriatric inpatients had their full physical abilities at hospital discharge (Table 2). However, more than 40% showed gait disorders ($n = 21,768$; 40.5%), fatigue ($n = 22,638$; 42.2%), or impairment in lower body care ($n = 23,573$; 43.9%) and dressing/undressing ($n = 22,288$; 41.5%). There were significant differences between the groups, with a $p < 0.001$, for all of the physical variables except balance disorders, impairment in lower body dressing/undressing, chronic pain, hearing and vision. Within-group analyses showed that the polymedicated inpatients had proportionally more physical impairments in general mobility (43.2% vs. 41.9% in non-polymedicated inpatients), gait (46.2% vs. 43%), fatigue (48.6% vs. 43.4%), and lower body care (49.7% vs. 47.6%). Polymedicated inpatients suffered more acute pain (38% vs. 35.8%) and presented with a greater malnutrition risk (83.7% vs. 72.7%). However, only 14,835 (27.6%) geriatric patients were assessed for malnutrition risk, and 11,995 (22.3%) had a moderate to high risk.

Non-polymedicated inpatients had proportionally more physical impairment than the polymedicated inpatients in terms of mobility for changing position (32.7% among non-polymedicated against 28.8% among polymedicated), upper body care (39.4% vs. 35.5%) and dressing/undressing (37.1% vs. 32.2%), eating (23.1% vs. 13.2%), drinking (17.1% vs. 8.1%), swallowing disorders (8.6% vs. 3.1%), bladder (33.1% vs. 31.5%) and bowel continence (21.2% vs. 14.6%), dependence in urination (30.4% vs. 26.0%) and defecation (27.0% vs. 22.0%), and a higher Braden risk (25.0% vs. 17.7%). The risk for falls was proportionally higher in the non-polymedicated group (20.4% vs. 12.3%).

3.3.2. Cognitive Status

Most geriatric inpatients presented with normal cognitive status at discharge (Table 3). Nearly three quarters had preserved their sense of orientation ($n = 37,800$; 70.4%) and concentration ($n = 42,105$; 78.4%). The most well-preserved cognitive characteristics were alertness/consciousness ($n = 45,779$; 85.3%) and verbal expression ($n = 43,572$; 81.2%). In contrast, the least well-preserved cognitive abilities were the capacity and skills to react to the demands of daily life ($n = 34,644$; 64.5%) and the ability to learn ($n = 34,125$; 63.6%).

Within-group statistical analyses revealed that the proportions of geriatric inpatients with cognitive disorders were higher among the non-polymedicated for all of the cognitive variables (Table 3). More non-polymedicated geriatric inpatients were cognitively impaired than the polymedicated inpatients with regards to alertness/consciousness (12.0% vs. 1.7%) ($p < 0.001$). Indeed, the proportions were above 20% among non-polymedicated patients for orientation (26.3% of the non-polymedicated patients vs. 19.2% of the polymedicated patients), the capacity and skills to react to the demands of daily life (30.5% vs. 26.8%), and the ability to learn (31.5% vs. 27.8%). All of the cognitive indicators showed a significant difference between the groups ($p < 0.001$) (Table 3). Thus, geriatric inpatients with cognitive disorders were less medicated at hospital discharge. However, most patients whose

cognitive status had not been assessed were non-polymedicated. Thus, the polymedicated geriatric inpatients were more often subject to clinical cognitive assessments.

Table 2. Distribution and comparison of the physical status of the polymedicated (n = 36,266) and non-polymedicated (n = 17,424) geriatric inpatients at hospital discharge.

Physical Status	Geriatric Inpatients Aged 65 Years Old or More (n = 53,690)			p-Value
	Total n (%)	Polymedicated n (%) 36,266 (67.5)	Non-Polymedicated n (%) 17,424 (32.5)	
Mobility (n = 47,996; 89.4%)				
Full ability n (%)	27,444 (51.1)	19,786 (56.8)	7658 (58.1)	<0.001 ^a
Impairment n (%)	20,552 (38.3)	15,029 (43.2)	5523 (41.9)	
Mobility for changing position (n = 47,997; 89.4%)				
Full ability n (%)	33,660 (62.7)	24,795 (71.2)	8865 (67.3)	<0.001 ^a
Impairment n (%)	14,337 (26.7)	10,022 (28.8)	4315 (32.7)	
Gait (n = 47,997; 89.4%)				
Normal n (%)	26,229 (48.9)	18,717 (53.8)	7512 (57)	<0.001 ^a
Disorder n (%)	21,768 (40.6)	16,100 (46.2)	5668 (43)	
Balance disorders (n = 47,996; 89.4%)				
Normal n (%)	31,413 (58.5)	22,935 (65.9)	8478 (64.3)	0.002 ^a
Disorder n (%)	16,583 (30.9)	11,882 (34.2)	4701 (35.6)	
Fall risk (n = 31,744; 59.1%)				
Mild-to-moderate risk n (%)	27,203 (50.7)	20,989 (87.7)	6214 (79.5)	<0.001 ^a
Moderate-to-severe risk n (%)	4541 (8.4)	2943 (12.3)	1598 (20.4)	
Fatigue (n = 47,995; 89.4%)				
Normal n (%)	25,357 (47.2)	17,899 (51.4)	7458 (56.6)	<0.001 ^a
Disorder n (%)	22,638 (42.2)	16,917 (48.6)	5721 (43.4)	
Upper body care (n = 47,972; 89.3%)				
Full ability n (%)	30,411 (56.6)	22,432 (64.5)	7979 (60.6)	<0.001 ^a
Impairment n (%)	17,561 (32.7)	12,369 (35.5)	5192 (39.4)	
Lower body care (n = 47,972; 89.3%)				
Full ability n (%)	24,399 (45.4)	17,491 (50.3)	6908 (52.4)	<0.001 ^a
Impairment n (%)	23,573 (43.9)	17,310 (49.7)	6263 (47.6)	
Upper body dressing/undressing (n = 47,971; 89.3%)				
Full ability n (%)	31,861 (59.3)	23,581 (67.8)	8280 (62.9)	<0.001 ^a
Impairment n (%)	16,110 (30)	11,219 (32.2)	4891 (37.1)	
Lower body dressing/undressing (n = 47,970; 89.3%)				
Full ability n (%)	25,682 (47.8)	18,494 (53.1)	7188 (54.6)	0.005 ^a
Impairment n (%)	22,288 (41.5)	16,305 (46.9)	5983 (45.4)	
Eating (n = 47,973; 89.4%)				
Full ability n (%)	40,336 (75.1)	30,212 (86.8)	10,124 (76.9)	<0.001 ^a
Impairment n (%)	7637 (14.2)	4588 (13.2)	3049 (23.1)	
Drinking (n = 47,974; 89.4%)				
Full ability n (%)	42,915 (79.9)	31,995 (91.9)	10,920 (82.9)	<0.001 ^a
Impairment n (%)	5059 (9.4)	2808 (8.1)	2251 (17.1)	
Swallowing disorders (n = 47,972; 89.3%)				
Normal n (%)	45,750 (85.2)	33,718 (96.9)	12,032 (91.4)	<0.001 ^a
Disorder n (%)	2222 (4.1)	1083 (3.1)	1139 (8.6)	
Bladder continence (n = 47,960; 89.3%)				
Normal n (%)	32,644 (60.8)	23,837 (68.5)	8807 (66.9)	<0.001 ^a
Disorder n (%)	15,316 (28.5)	10,956 (31.5)	4360 (33.1)	
Independence in urination (n = 47,957; 89.3%)				
Normal n (%)	34,912 (65.0)	25,751 (74.0)	9161 (69.6)	<0.001 ^a
Disorder n (%)	13,045 (24.3)	9040 (26.0)	4005 (30.4)	
Bowel continence (n = 47,960; 89.3%)				
Normal n (%)	40,104 (74.7)	29,722 (85.4)	10,382 (78.8)	<0.001 ^a
Disorder n (%)	7856 (14.6)	5071 (14.6)	2785 (21.2)	

Table 2. Cont.

Physical Status	Geriatric Inpatients Aged 65 Years Old or More (n = 53,690)			p-Value
	Total n (%)	Polymedicated n (%) 36,266 (67.5)	Non-Polymedicated n (%) 17,424 (32.5)	
Independence in defecation (n = 47,960; 89.3%)				
Normal n (%)	36,749 (68.4)	27,137 (78.0)	9612 (73.0)	<0.001 ^a
Disorder n (%)	11,211 (20.9)	7656 (22.0)	3555 (27.0)	
Hearing (n = 47,943; 89.3%)				
Normal n (%)	40,876 (76.1)	11,164 (84.8)	29,712 (85.4)	0.105 ^a
Disorder n (%)	7067 (13.2)	1996 (15.2)	5071 (14.6)	
Vision (n = 47,943; 89.3%)				
Normal n (%)	5820 (10.8)	11,410 (86.7)	30,713 (88.3)	0.105 ^a
Disorder n (%)	42,123 (78.5)	1750 (13.3)	4070 (11.7)	
Acute pain (n = 47,887; 89.2%)				
No acute pain n (%)	29,992 (55.9)	21,552 (62.0)	8440 (64.2)	<0.001 ^a
Pain n (%)	17,895 (33.3)	13,189 (38.0)	4706 (35.8)	
Chronic pain (n = 47,872; 89.2%)				
No chronic pain n (%)	42,380 (78.9)	30,703 (88.4)	11,677 (88.9)	0.153 ^a
Pain n (%)	5492 (10.2)	4029 (11.6)	1463 (11.1)	
Malnutrition risk (n = 14,835; 27.6%)				
None n (%)	2840 (5.3)	1797 (16.3)	1043 (27.3)	<0.001 ^a
Increased n (%)	11,995 (22.3)	9219 (83.7)	2776 (72.7)	
Braden risk (n = 47,751; 88.9%)				
Improbable risk n (%)	38,340 (71.4)	28,510 (82.3)	9830 (75.0)	<0.001 ^a
Increased risk n (%)	9411 (17.5)	6127 (17.7)	3284 (25)	

Note. ^a Chi-square test.

Table 3. Distribution and comparison of cognitive status among polymedicated (n = 36,266) and non-polymedicated (n = 17,424) geriatric inpatients.

Cognitive Status	Geriatric Inpatients Aged 65 or More (n = 53,690)			p-Value
	Total n (%)	Polymedicated n (%) 36,266 (67.5)	Non-Polymedicated n (%) 17,424 (32.5)	
Alertness/consciousness (n = 47,947; 89.3%)				
Normal n (%)	45,779 (85.3)	34,196 (98.3)	11,583 (88.0)	<0.001 ^a
Disorder n (%)	2168 (4.0)	591 (1.7)	1577 (12.0)	
Orientation space, time, people (n = 47,949; 89.3%)				
Normal n (%)	37,800 (70.4)	28,102 (80.8)	9698 (73.7)	<0.001 ^a
Disorder n (%)	10,149 (18.9)	6686 (19.2)	3463 (26.3)	
Concentration (n = 47,948; 89.3%)				
Normal n (%)	42,105 (78.4)	31,377 (90.2)	10,728 (81.5)	<0.001 ^a
Disorder n (%)	5843 (10.9)	3410 (9.8)	2433 (18.5)	
Verbal expression (n = 47,944; 89.3%)				
Normal n (%)	43,572 (81.2)	32,391 (93.1)	11,181 (85.0)	<0.001 ^a
Disorder n (%)	4372 (8.1)	2392 (6.9)	1980 (15.0)	
Capacity and skills to react to the demands of daily life (n = 47,948; 89.3%)				
Normal n (%)	34,644 (64.5)	25,493 (73.3)	9151 (69.5)	<0.001 ^a
Disorder n (%)	13,304 (24.8)	9294 (26.8)	4010 (30.5)	
Ability to learn (n = 47,949; 89.3%)				
Normal n (%)	34,125 (63.6)	25,113 (72.2)	9012 (68.5)	<0.001 ^a
Disorder n (%)	13,824 (25.7)	9675 (27.8)	4149 (31.5)	

Note. ^a Chi-square test.

3.4. Comorbidities and the Number of Medications Prescribed at Hospital Discharge

Significant differences were found between the polymedicated and non-polymedicated geriatric inpatients' comorbidities ($p < 0.001$) (Supplementary Table S2). The median number of comorbidities was three higher among polymedicated ($\mu = 5.7$; $SD = 2.2$; $Med = 6$; $IQR = (4-8)$) than among non-polymedicated patients ($\mu = 4.4$; $SD = 2.2$; $Med = 3$;

IQR = (3–6)). Polymedicated geriatric inpatients had a median of nine medications prescribed at hospital discharge ($\mu = 9.9$; $SD = 3.8$; $Med = 9$; $IQR = (7–12)$) compared with just one for non-polymedicated ones ($\mu = 1.3$; $SD = 1.6$; $Med = 1$; $IQR = (0–3)$), and one third had medications that increased their fall and/or delirium risk ($n = 11,396$; 32.8% among polymedicated inpatients vs. $n = 3507$; 26.6% among non-polymedicated; $p < 0.001$).

3.5. Associations between Polypharmacy and Functional Status

In order to investigate the strength of the relationships between PP and functional status at hospital discharge, we computed the symmetric Cramér's V statistic. Based on Cohen's classification of the strength of associations in healthcare studies [42,43], PP showed moderate associations (0.100–0.131) with fall risk and nutritional status (swallowing disorders, malnutrition risk, eating and drinking) (Table 4).

Table 4. Associations between polypharmacy and physical status among geriatric inpatients at discharge ($n = 53,690$).

Physical Status	Polymedicated/Non-Polymedicated Geriatric Inpatients at Discharge ($n = 53,690$)	
	Cramér's V	Sign.
Chronic pain	0.007	<0.153
Hearing	0.007	0.105
Mobility	0.011	0.012
Lower body dressing/undressing	0.013	0.005
Balance disorders	0.014	0.002
Bladder continence	0.016	0.001
Pain assessment	0.020	<0.001
Lower body care	0.020	<0.001
Vision	0.022	<0.001
Gait	0.029	<0.001
Upper body care	0.036	<0.001
Mobility for changing position	0.039	<0.001
Independence in urination	0.044	<0.001
Upper body dressing/undressing	0.046	<0.001
Fatigue	0.046	<0.001
Independence in defecation	0.053	<0.001
Bowel continence	0.079	<0.001
Braden risk	0.082	<0.001
Fall risk	0.100	<0.001
Swallowing disorders	0.118	<0.001
Eating	0.122	<0.001
Malnutrition risk	0.122	<0.001
Drinking	0.131	<0.001

Regarding cognitive status, we found moderate associations between PP and concentration and verbal expression (0.118 and 0.127, respectively), and a strong association between PP and alertness/consciousness (0.221) (Table 5).

Table 5. Associations between PP and cognitive status among geriatric inpatients at discharge (n = 53,690).

Cognitive Status	Polymedicated/Non-Polymedicated Geriatric Inpatients at Discharge (n = 53,690)	
	Cramér's V	Sign.
Ability to learn	0.037	<0.001
Capacity and skills to react to the demands of daily life	0.037	<0.001
Orientation in space, time, and among people	0.077	<0.001
Concentration	0.118	<0.001
Verbal expression	0.127	<0.001
Alertness/consciousness	0.221	<0.001

3.6. Multivariate Logistic Regressions

Multivariate logistic regressions were calculated to assess whether the moderate and strong associations between PP and physical and cognitive status significantly predicted PP when adjusted for sex, age and LOS. Table 6 presents odds ratios (ORs) suggesting that the odds of PP were greatest among geriatric inpatients with malnutrition (OR = 1.411; 95%CI 1.263–1.577; $p < 0.001$). In contrast, inpatients with swallowing disorders (OR = 0.702; 95%CI 0.574–0.858; $p < 0.001$), alertness/consciousness disorders (OR = 0.188; 95%CI 0.151–0.235; $p < 0.001$) and eating impairments (OR = 0.714; 95%CI 0.619–0.823; $p < 0.001$) were at less risk of PP. Adjusting the model for sex, age and LOS improved its fit, with log-likelihood values from 11,404 to 11,307, and a predictivity of PP, calculated using Nagelkerke's R^2 , ranging from 0.139 to 0.150.

Table 6. Multivariate logistic regressions predicting PP among discharged geriatric inpatients, adjusted for age, sex and length of stay (LOS; n = 53,690).

Variables	B ^a	Std. Error	Wald ^b	Df ^c	Sig. ^d	Exp(B) ^e	95% Confidence Interval for Exp(B)	
							Under Limit	Upper Limit
Constant	1.954	0.278	49.334	1	<0.000	7.058	-	-
Fall risk	−0.161	0.068	5.555	1	0.018	0.851	0.745	0.973
Swallowing disorders	−0.354	0.102	11.936	1	0.001	0.702	0.574	0.858
Malnutrition risk	0.344	0.057	36.989	1	<0.000	1.411	1.263	1.577
Drinking	−0.045	0.086	0.276	1	0.599	0.956	0.807	1.131
Eating	−0.337	0.073	21.563	1	<0.000	0.714	0.619	0.823
Concentration	−0.103	0.071	2.083	1	0.149	0.903	0.785	1.037
Verbal expression	−0.230	0.084	7.558	1	0.006	0.794	0.674	0.936
Alertness/consciousness	−1.669	0.113	219.883	1	<0.000	0.188	0.151	0.235
Sex	−0.004	0.048	0.005	1	0.941	0.996	0.907	1.095
Age	−0.013	0.003	16.319	1	<0.000	0.987	0.980	0.993
Length of hospital stay (LOS)	0.018	0.002	88.784	1	<0.000	1.018	1.014	1.022

Note. ^a Estimated multinomial logistic regression coefficients for the models. ^b The Wald chi-square test tests the null hypothesis that the estimate equals 0. ^c Degrees of freedom for each of the variables included in the model. ^d p -values. ^e Odds ratios for the predictors.

4. Discussion

Our principal findings revealed that the majority of geriatric inpatients were polymedicated at hospital discharge. This may reflect the current trend in Switzerland's healthcare system of attempting to reduce the length of hospital stay as much as possible and promoting outpatient treatment instead of inpatient treatment. There is a possibility that this could lead to "medication-intensive hospital discharge". In addition, polymedicated inpatients were likely to have three comorbidities and nine prescribed medications at discharge. They were more likely to be women, aged from 75–84 years old, living at home, and had longer hospital LOS. Although polymedicated inpatients showed proportionally more physical decline in general mobility, gait, fatigue, and lower body care, and presented with a higher malnutrition risk, our findings revealed that non-polymedicated inpatients had proportionally more physical and cognitive impairments, which partially refuted our initial hypothesis.

In our dataset, the older the patients were, the more medications they were prescribed. Our results are in line with a prospective cohort study in Italy by Nobili and Licata [44], in which the rate of PP at hospital discharge (67.0%) was also associated with age and comorbidities. However, this prevalence was substantially lower (26.3–39.9%) among other European older adults living in the community, according to Midão and Giardini [25]. Bearing in mind that PP exposes older adults to greater risks of MRPs [19,20,27], and that MRPs are a frequent cause of functional decline, hospital readmission, and avoidable health costs [23,24], prescribing so many medications to this vulnerable population at hospital discharge is paradoxical and should be a public health concern [45].

Our findings revealed an unsurprising association between the number of medications prescribed and the number of comorbidities. However, the pathophysiological mechanisms behind this association remain poorly defined. Although it is understandable (but not always justifiable) that the more different medical diagnoses a patient has, the more medications they are likely to be prescribed, the opposite—the impact of the number of medications on the number of diagnoses—is unclear, and needs to be disentangled in order to improve future policies on medication management for older adults.

In the present study, most of the polymedicated inpatients were women and aged 75–84 years old. Higher numbers of hospitalizations among women have been documented in several studies [25], and are explained by higher female life expectancy [46], a higher prevalence of frailty among women [47], women more frequently taking on the role of the informal caregiver [48], and different patterns of multimorbidity according to sex [49].

The differences between the LOS of polymedicated ($\mu = 13.8$; $SD = 15.1$) and non-polymedicated ($\mu = 8.6$; $SD = 12.4$) older adult inpatients were higher in our study than in Nobili's ($x = 10.2$; $SD = 8.6$ and $x = 10.9$; $SD = 7.7$, respectively). Prolonged LOS is an indicator of both the clinical complexity of the hospitalized older adult's case and the functional decline during that period triggering adverse events and irreversible health outcomes [8,44]. An optimal LOS is impossible to determine for older adults with multiple health conditions [50].

As expected, our findings highlighted that home-dwelling geriatric inpatients do not always return home after hospital discharge. This can be interpreted not only via the progression of the pathological processes leading to hospitalization but also through shared risk factors that lead to a downward spiral of accumulated adverse events and irreversible health outcomes in hospital [11,13]. In a previous study examining the same population, we explored institutionalization after hospitalization. Our findings showed that functional mobility impairment, dependency in the activities of daily living, and cognitive impairment were strong determinants of unplanned institutionalization ($OR = 3.22$, 95%CI 2.67–3.87; $OR = 4.62$, 95%CI 3.76–5.67; and $OR = 3.75$, 95%CI 3.06–4.59, respectively) [51]. These results complement another recent Swiss study by Tröster and Thalmann [52], which highlighted that frailty, physical decline and being underweight were significantly associated with a greater risk of subsequent institutionalization.

Based on the 23 physical variables considered in our study, 20 showed statistically significant differences between the two groups. Although non-polymedicated inpatients had more physical impairments across 13 variables, polymedicated inpatients had more physical impairments across seven variables. These results are inconsistent with the systematic review by Katsimpris and Linseisen [53], which reported strong bidirectional associations between PP and physical function outcomes among older adults. Our analyses are also different from those of the three-year prospective cohort study by Jyrkkä and Enlund [26], which showed that excessive PP was associated with declines in functional ability and cognitive capacity. The fact that non-polymedicated geriatric inpatients in our study presented proportionally greater levels of functional decline may be explained by the beneficial effects of certain medications on functional status. However, it may also be that physicians try not to prescribe complex treatments to physically and/or cognitively dependent older adults at their discharge, as they would probably struggle to manage them during this specific period. Therefore, our results may indicate growing concerns about prescriptive practices in Switzerland [54].

Moreover, our results revealed that the fall risk was proportionally higher in the non-polymedicated group, even though polymedicated geriatric inpatients had more medications increasing fall and/or delirium risk ($n = 11,396$; 32.8% vs. $n = 3507$; 26.6%) ($p < 0.001$). This contrasts with Zaninotto et al. [55], whose data from the English Longitudinal Study of Ageing revealed that the prevalence of people admitted to hospital due to a fall increased according to the number of medications taken, from 1.5% of people reporting no medications being admitted for a fall, to 7.9% of those with PP, and 14.8% of those reporting heightened PP. This reinforces our assumption that physicians attempt to avoid prescribing medications to older adults presenting functional decline.

It was notable that the physical status of one tenth of the geriatric inpatients was not assessed before discharge. The number who were not assessed for malnutrition risk was considerably higher ($n = 38,855$; 72.4%). Given that of the 27.6% assessed, 22.3% presented a moderate to high risk of malnutrition, we can assume that a considerable number of at-risk geriatric inpatients were somehow not assessed. Despite this limitation, we found that malnutrition increased the risk of being polymedicated (OR = 1.411; 95%CI 1.263–1.577; $p < 0.001$), complementing a study by Jyrkkä and Enlund [26] revealing that medication may contribute to poor nutritional status by causing a loss of appetite, gastrointestinal problems, and other alterations in body function. This deserves reflection, considering the well-known association between malnutrition and adverse health outcomes. A study of underweight patients in Switzerland by Tröster and Thalmann [52] pointed to almost a five-fold higher (OR = 4.94, 95%CI 1.11–22.01) risk of institutionalization after discharge. Furthermore, Griffin and O'Neill [56] reported that malnourished older adults were more at risk of hospital readmission, nursing home admission, reduced quality of life, and functional decline. In contrast, our results revealed that people with swallowing disorders (OR = 0.702; 95%CI 0.574–0.858; $p < 0.001$) and eating impairments (OR = 0.714; 95%CI 0.619–0.823; $p < 0.001$) were less at risk of being polymedicated. This might be explained by their difficulties taking solid oral dosage forms, compromising medication adherence [57].

Even though acute pain was assessed more systematically ($n = 47,887$; 89.2%) than malnutrition risk ($n = 14,835$; 27.6%), pain management was not optimal. Although only 10.2% ($n = 5492$) of the geriatric inpatients reported suffering from chronic pain for more than three months, one third ($n = 17,895$; 33.3%) reported acute pain at hospital discharge. A greater (and statistically significant) proportion of polymedicated inpatients reported acute pain than did non-polymedicated patients (38% vs. 35.8%), whereas the reports of chronic pain were similar ($p = 0.153$). These rates indicate deficient pain medication management in both groups, which is of significant concern considering the well-known functional and mental impacts of pain on older adults, as well as the great healthcare costs [58].

Non-polymedicated inpatients showed greater cognitive impairment in all of the six cognitive variables considered. Moreover, the patients with severe cognitive impairments

had fewer medications at hospital discharge. Figueiredo and Teixeira [27] revealed that cognitive impairment was a predictor of noncompliance and difficulty in medication intake, thus increasing the risk of MRPs. However, this pattern contrasted with findings by de Lima and Teixeira [59], in a middle-income country, showing that older adults with mental disorders had greater odds for PP (OR = 22.00, 95%CI 6.11–79.11 for Alzheimer's disease; OR = 14.73, 95%CI 3.69–58.75 for major depressive disorder; and OR = 10.31, 95%CI 2.44–43.59 for mild cognitive impairment). This difference may be explained by the current concerns of clinicians in high-income countries about potentially inappropriate prescribing and deprescribing practices [54], probably leading them to follow the recommendations of good clinical practice in medication prescription more closely with geriatric populations presenting with cognitive disorders [60]. It may also be that current recommendations on deprescribing potentially futile medications in patients over 65 years old and with a limited life expectancy have shifted clinicians' focus away from disease prevention and towards maximizing the patient's quality of life [61]. Furthermore, we noticed that most patients whose cognitive status could not be assessed were non-polymedicated. Although our study could not explain this difference directly, our findings suggested that polymedicated geriatric inpatients tended to have their cognitive function assessed more often.

Geriatric inpatients are susceptible to greater functional decline and adverse health events which are not directly related to the illness for which they were hospitalized [11,14,15]. Additionally, they are at risk of not being able to return to their homes [52]. Therefore, planning a multi-dimensional, patient-centered treatment program as soon as they are hospitalized seems to be crucial to prevent functional decline while it is still reversible [15,62]. The failure to do this may explain why 5% of the older adult hospitalizations in our study ended in death. Our hospital register, from a regional hospital in French-speaking Switzerland, came from a healthcare system that is highly focused on hospital care. Some studies have shown that healthcare systems focused on primary care enable earlier responses to the complex, multi-factorial, and often accumulated needs of geriatric patients [63,64].

Considering that advanced age and PP are the main risk factors for MRPs [24], and that MRPs have a major impact on functional outcomes [21,22], the number of medications that geriatric inpatients have to manage, more or less autonomously, after hospital discharge deserves more attention from the healthcare professionals involved in discharge planning [33].

4.1. Study Strengths and Weaknesses

Few studies have descriptively analyzed population-based hospital registers to explore and compare the functional status of polymedicated and non-polymedicated inpatients at hospital discharge. This paper's in-depth description of the functional status of these populations is a timely addition to the burgeoning body of evidence offering new perspectives on the profiles of polymedicated geriatric inpatients at hospital discharge. Polypharmacy has become a determining factor in some healthcare decisions, notably whether older adults should receive home care services at hospital discharge [65]. However, our finding that non-polymedicated inpatients actually had proportionally more physical and cognitive impairments raises further interesting issues for individual discharge planning.

Our study had some limitations, particularly related to the dataset. In the absence of a unique, encrypted patient identifier, we were unable to track the inpatients over time to detect multiple hospitalizations from 2015–2017. Furthermore, no electronic patient records were available for the adult psychiatry department during that period. Because patients' medication datasets at admission and during hospitalization are often incomplete or unknown, we were unable to explore changes in the number of prescriptions during their hospitalization. It would be interesting to explore whether hospitalization tends to increase or decrease the number of medications prescribed to geriatric inpatients. Moreover, it would be interesting to explore whether hospitalization is the appropriate period in which to review prescribed medications, reduce inappropriate prescribing, and potentially

deprescribe medications across transitions of care in a straightforward, effective way. This could constitute a valuable preventive strategy for the avoidance of MRPs [66].

Another limitation concerned the missing values for some specific variables—such as fall risk and malnutrition risk—which restricted the power of some of the statistical analyses. These missing values revealed gaps in comprehensive geriatric assessment, and in the systematic, structured and rigorous screening of the shared risk factors for geriatric syndromes and frailty that are responsible for adverse health outcomes among older adults—as documented in Inouye’s unifying conceptual model [13]. These gaps and their adverse impacts on geriatric inpatients, healthcare professionals and the healthcare system were reported by Gronewold et al. [67]. Some of our other variables could not be assessed (e.g., gait and balance disorders). Given that walking speed is the strongest determinant of frailty [68], these missing values indicate that the systematic evaluation of frailty in acute care is embryonic. Because hospitalization among older adults is often a precipitating factor for worsening functional and clinical status [11], frailty should be systematically assessed at different stages of hospitalization. The essential components of a comprehensive geriatric assessment should be integrated into daily clinical practice, and should be provided to frail geriatric inpatients in a timely manner in order to minimize the adverse consequences of frailty [69].

4.2. Unanswered Questions and Future Research

Due to their complexity, the classes of medications taken at discharge will be analyzed in a separate study describing the medication profiles of geriatric inpatients.

It would be relevant for future research to explore registries from geriatric psychiatry departments, completing the profiles described. It would also be relevant to calculate the prevalence and level of frailty from the available registry variables, and to carry out a more in-depth comparison of the level of frailty among polymedicated and non-polymedicated geriatric inpatients on admission and at discharge. Comparing prescribed medications at admission with those at hospital discharge could facilitate an understanding of the clinical/medication/treatment pathways of polymedicated and non-polymedicated geriatric inpatients.

5. Conclusions

Our findings showed that polymedicated geriatric inpatients had proportionally more impairments in general mobility and gait, dependence in lower body care and fatigue, and they presented with a higher malnutrition risk. However, non-polymedicated geriatric inpatients had a proportionally higher number of physical and cognitive impairments.

Comparing the functional status of polymedicated and non-polymedicated patients over 65 years old at hospital discharge is an important means of identifying and monitoring those who are most vulnerable to functional decline. Interventions aimed at preventing functional decline must consider the diversity of factors linking polypharmacy and functional status. Only the systematic in-depth assessment of the functional status of geriatric inpatients will enable the appropriate design of targeted strategies for the prevention of functional impairment and related adverse health outcomes.

Supplementary Materials: The following are available online at <https://www.mdpi.com/article/10.3390/geriatrics6030086/s1>, Supplementary Table S1: Missing values; Supplementary Table S2: Distribution of diagnoses using the International Statistical Classification of Diseases and Related Health Problems (ICD-10) and medications increasing fall and/or delirium risk among polymedicated and non-polymedicated geriatric inpatients.

Author Contributions: F.P., B.W. and H.V. had the original idea. B.W. and H.V. provided methodological expertise, and H.V., F.P., M.d.R.C., M.M.M. and A.v.G. provided conceptual expertise. F.P. and H.V. were major contributors to writing the manuscript. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Patient consent was waived due to the retrospective data source. Obtaining consent from the patients concerned was impossible or posed disproportionate difficulties.

Data Availability Statement: The data are available upon reasonable request.

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ARTICLE 5

Pereira F, Verloo H, Zhivko T, Taushanov Z, Di Giovanni S, Meyer-Masseti C, et al. Risk of 30-day hospital readmission associated with medical conditions and drug regimens of polymedicated, older inpatients discharged home: a registry-based cohort study. *BMJ open*. 2021;11(7):e052755. doi:10.1136/bmjopen-2021-052755.

Altmetrics*	
Total article views	1,738
PDF downloads	402
Total number of citations	6 (including 2 self-citations)
Journal's metrics*	
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Indexing	Web of Science Core Collection: Science Citation Index Expanded, MEDLINE (Index Medicus), PubMed Central, Scopus, Embase (Excerpta Medica), DOAJ, Google Scholar

*Confirmed until July 11th, 2022.

Note. We requested that the journal's editor correct the abstract on page 1, line 12, together with page 3, line 35, and Table 2's title, from "13,802 readmissions" to "13,802 hospital stays by older adults who returned home and had no missing data."

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Original research

BMJ Open Risk of 30-day hospital readmission associated with medical conditions and drug regimens of polymedicated, older inpatients discharged home: a registry-based cohort study

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ABSTRACT

Objectives The present study analysed 4 years of a hospital register (2015–2018) to determine the risk of 30-day hospital readmission associated with the medical conditions and drug regimens of polymedicated, older inpatients discharged home.

Design Registry-based cohort study.

Setting Valais Hospital—a public general hospital centre in the French-speaking part of Switzerland.

Participants We explored the electronic records of 20 422 inpatient stays by polymedicated, home-dwelling older adults held in the hospital's patient register. We identified 13 802 hospital readmissions involving 8878 separate patients over 64 years old.

Outcome measures Sociodemographic characteristics, medical conditions and drug regimen data associated with risk of readmission within 30 days of discharge.

Results The overall 30-day hospital readmission rate was 7.8%. Adjusted multivariate analyses revealed increased risk of hospital readmission for patients with longer hospital length of stay (OR=1.014 per additional day; 95% CI 1.006 to 1.021), impaired mobility (OR=1.218; 95% CI 1.039 to 1.427), multimorbidity (OR=1.419 per additional International Classification of Diseases, 10th Revision condition; 95% CI 1.282 to 1.572), tumorous disease (OR=2.538; 95% CI 2.089 to 3.082), polypharmacy (OR=1.043 per additional drug prescribed; 95% CI 1.028 to 1.058), and certain specific drugs, including antiemetics and antinauseants (OR=3.216 per additional drug unit taken; 95% CI 1.842 to 5.617), antihypertensives (OR=1.771; 95% CI 1.287 to 2.438), drugs for functional gastrointestinal disorders (OR=1.424; 95% CI 1.166 to 1.739), systemic hormonal preparations (OR=1.207; 95% CI 1.052 to 1.385) and vitamins (OR=1.201; 95% CI 1.049 to 1.374), as well as concurrent use of beta-blocking agents and drugs for acid-related disorders (OR=1.367; 95% CI 1.046 to 1.788).

Conclusions Thirty-day hospital readmission risk was associated with longer hospital length of stay, health disorders, polypharmacy and drug regimens. The drug regimen patterns increasing the risk of hospital readmission were very heterogeneous. Further research is needed to explore hospital readmissions caused solely by specific drugs and drug–drug interactions.

Strengths and limitations of this study

- The records of 20 422 hospitalisations involving 8878 different polymedicated, home-dwelling, older patients readmitted to hospital at least once were studied to determine the risk of 30-day hospital readmission.
- The study included 4-year data from a comprehensive hospital register (2015–2018).
- A whole series of sociodemographic and clinical parameters, medical conditions, and prescribed drugs were used to predict the probability of hospital readmission.
- Analyses were correlational and causality was not explored.
- Although the study considered statistical associations between drugs and hospital readmissions, it did not consider clinically diagnosed drug–drug interactions.

INTRODUCTION

Longitudinal studies have demonstrated that approximately 20% of home-dwelling older adults supported by home healthcare services experienced hospital readmission within 30 days of their discharge.^{1–3} For many older adults, readmission to an acute hospital is associated with a functional decline that has not always recovered by the time they are discharged.⁴ However, the systematic review by Hansen *et al*⁵ revealed wide-ranging estimates (5%–79%) of how many hospital readmissions were preventable. The period between hospital discharge and readmission has not always been clearly stated in the literature, ranging from 30 days to 3 years. However, 30 days is the most frequently used in public health policy when measuring healthcare system performance.^{6–8}

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Numerous determinants have been identified and associated with hospital readmissions, for example, socio-demographic and individual characteristics, multimorbidity, and medical events.^{9 10} A substantial risk of 30-day hospital readmission has been associated with older inpatients treated for different diseases and surgical interventions involving hip fracture, cancer, bypass, acute cardiovascular events or complex surgery.¹¹ The reasons for hospital readmission after a surgical intervention are often not directly related to the surgery itself but rather to underlying chronic health conditions.¹² Thus, chronic diseases may play an important role in readmission risk, independent of the reason for the initial hospitalisation.^{13 14} Older adults' chronic diseases are not isolated health conditions; they can influence each other, and treatment for one disease may adversely affect another.¹⁵ For all these reasons, patterns of 30-day hospital readmissions may be very complex.¹⁶

Multimorbidity, in the case of two or more diseases,^{17 18} may require taking multiple medicines,¹⁹ known as polypharmacy (PP) when daily intake involves five or more drugs.²⁰ Increasing incidences of multimorbidity with age, and consequently PP, add to the complexity of managing older inpatients' drug prescriptions, particularly at hospital discharge.^{21 22} PP and inadequate drug management are significant risk factors for adverse drug events (ADEs)—the most common postdischarge complications—alongside hospital-acquired infections and procedural complications.^{23 24} ADEs resulting from inappropriate drug prescribing, discrepancies between prescribed and current regimens, poor adherence, and the inadequate surveillance of adverse effects frequently lead to hospital admissions, readmissions⁵ and other undesirable consequences such as increased morbidity, decreased autonomy, institutionalisation and even early death.^{25 26} A systematic review by El Morabet *et al*²⁷ indicated ADE rates of 18%–38% after hospital discharge and 4.5%–24% hospital readmission rates due to those ADEs. Because older adults use more drugs, they are at a greater risk of drug-related readmission. Numerous studies have found that nearly 30% of older inpatients experienced ADEs within 3 weeks of hospital discharge, almost three-quarters of which could have been prevented or lessened.^{10 28 29}

Despite the significant overall impact of ADEs on hospital readmission rates, little is known about the association of hospital readmission risk with medical conditions and drug regimens.^{30 31} El Morabet *et al* revealed the high prevalence of antibiotics, diuretics, vitamin K antagonists, opioids, antidiabetics, anticancer drugs, antihypertensives, digitalis glycosides, corticosteroids and psychotropic drugs in drug-related hospital readmissions.²⁷ Samoy *et al*³² reported that anticoagulants, hypoglycaemics, beta-blocking agents, antidepressants, calcium channel blockers and lenograstim were associated with high risk of hospital readmission. A retrospective patient record study by Teymorian *et al*³³ reported that anticoagulants and antiplatelet agents, diuretics and

antihypertensives, and opioids were associated with a high risk of persons aged 80 years old or more being readmitted to hospital within 30 days. Blanc *et al* reported the readmission scores of different drugs in a large sample of 10 374 adult hospital admissions in general medicine. Taking beta-blocking agents, calcium channel blockers, diuretics, hypoglycaemic drugs or opioids was a significant risk for 30-day readmission.⁹

Besides the higher risk of drug-related hospital readmission, some studies have also investigated the associations between combining drugs—a common practice when treating complex diseases or coexisting medical conditions—and drug-related hospital readmissions. Although using multiple drugs may be good clinical practice and compliant with guidelines for treating certain diseases, one significant consequence of combining drugs is that patients face much higher risk of ADEs, which can be caused by drug–drug interactions.^{34–36} ADEs can emerge because a drug's pharmacokinetics and pharmacodynamics change if taken with another drug.³⁶ Moura *et al*³⁷ found that participants with potential drug–drug interactions on their prescription list had 2.4 times higher adjusted OR of being readmitted.

Even though some studies have reported high numbers of readmissions among home-dwelling older patients for a variety of drugs,³⁸ this health issue was mostly investigated using prospective or cross-sectional studies with small samples. More insight is needed into the patterns of drug-related hospital readmissions and risk factors in order to design better interventions for addressing ADEs.^{39 40} As part of a broader project,⁴¹ the present study's goal was to use hospital register data to prioritise risk factors for hospital readmission. We hypothesised that sociodemographic characteristics, medical conditions (defined using the WHO's International Classification of Diseases, 10th Revision (ICD-10) and the Swiss Classification of Surgical Interventions (CHOP)) and drug prescriptions (based on the WHO's Anatomical Therapeutic Chemical (ATC) Classification System) were significant risk factors for 30-day hospital readmission for discharged older adults.

MATERIALS AND METHODS

Study design

This longitudinal study (2015–2018) used data on a population cohort taken from a hospital registry composed of 140 variables. These were used to investigate the associations between risk of 30-day hospital readmission and the medical conditions and drug regimens of polymedicated older inpatients discharged home. The study was performed with close regard to the RECORD (REporting of studies Conducted using Observational Routinely collected health Data) statement.⁴²

Population and data collection

Our custom, 4-year, registry-based data set included polymedicated inpatients (five or more drugs prescribed at



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hospital discharge), aged 65 years old or more, living in their own homes and hospitalised at least once at the Valais Hospital (a public general hospital in the French-speaking part of Switzerland). This specific population was selected due to its increased risk of hospital readmission.^{10 28 29} Older inpatients hospitalised once only or who died during hospitalisation were excluded, as were those hospitalised for fewer than 24 hours (the criterion to count as 'hospitalised' in Switzerland). Valais Hospital's register contains a comprehensive electronic health record composed of 140 variables routinely collected during hospital stays. However, no electronic patient records were available for adult psychiatry for 2015–2018. The extracted patient data contained sociodemographic characteristics, medical and surgical diagnoses, and routinely assessed clinical data (such as gait, falls risk or hearing) from hospitalised patients with at least five prescribed drugs at discharge. Medical and surgical diagnoses were coded based on the ICD-10 and CHOP.⁴³ Drug classification was based on the WHO's ATC Classification System.⁴⁴

The strategy for transforming and synthesising the data extracted from the register's multiple data set sources was based on Olsen's register-based methodological considerations⁴⁵ and has been documented elsewhere.⁴⁶ Our data set was composed of 20 422 hospital admission records running from January 2015 to December 2018, with similar numbers of annual hospital admissions: 5134, 5095, 5125 and 5068, respectively.

Data set customisation for predictive analysis

The data set was recoded and customised to identify the frequency of older patients' hospital admissions. Each subject's unique identifier was used to distinguish their different hospital stays from 2015 to 2018. The data set included 13 802 readmissions involving 8878 different older inpatients discharged home, readmitted to hospital within 30 days and whose data were complete (no missing values).

Sociodemographic and clinical data were considered independent variables and used to compute the predictive models. Readmission following discharge home was defined as the dependent variable of interest and was dichotomised (0=no, 1=yes) based on 30-day readmission between 2015 and 2018. Furthermore, the custom data set was composed of six clinical clusters based on agglomerative hierarchical clustering methods for identifying clinically relevant characteristics and representing older inpatients' health status. Medical status and drugs data were recoded and copied to an exploitable population database.⁴⁶

Sociodemographic variables and length of stay

The sociodemographic data set—almost exclusively composed of ordinal variables—included two categorical variables (sex and place of discharge from hospital) and three continuous variables (age and admission and discharge dates). Sex and age were included in

the analysis as sociodemographic control variables. Age was considered a continuous variable as its progressive impact has been proven in preliminary investigations and previous studies.⁴⁷

Health variables

Numerous variables were used to describe older patients' health status during each hospital stay. The health data set was composed of 23 categorical variables: 21 measured as ordinal variables (mobility, changing position, falls in the last year, etc) and two measured as nominal variables (altered gait and chronic pain). A cleaner, better-structured data set—composed of hierarchical clusters—was obtained in a previous study combining empirical and best-practice statistical approaches.⁴⁶ Three of six preliminarily computed hierarchical clusters were included in the modelling analysis as confounding variables: the mobility cluster, the dependency on the activities of daily living cluster and the mental state cluster.⁴⁶ These three clusters were selected because of their significant contributions to hospital readmissions.^{48–50} The data set of medical information was composed of patients' principal medical diagnosis and four secondary medical diagnoses, based on ICD-10. Finally, the year of hospitalisation was introduced as a control variable, based on the fact that earlier admission to hospital during this period led to a higher probability of unplanned readmissions during the entire period covered.

Included drugs

The hospital data set showed that discharged patients had been prescribed 2370 different drugs. Drug prescriptions were considered continuous, classified according to the WHO's ATC Classification System⁵¹ and then included in the predictive model as independent variables. To ensure robust statistical results, the model only included drug categories prescribed to at least 30 inpatients who were readmitted within 30 days. Online supplemental file 1 presents the prescribed ATC classified drugs included in the predictive model as independent variables.

For statistical purposes, drug–drug interactions between different ATC drug classes⁵¹ were operationalised as dichotomised variables (0=no simultaneous use of drugs from both classes, 1=simultaneous use of drugs from both classes) and added to the previous model. Drug class interactions were selected based on a literature review, significant ORs and expert opinions.⁵²

Data analysis strategy

Data were extracted into a Microsoft Excel spreadsheet (Microsoft, Redmond, Washington, USA) and then imported into SPSS V.26.0 software. We examined statistical associations between hospital readmissions and patient age and sex, length of stay (LOS), principal and related ICD-10 diagnoses, CHOP interventions, and drug prescriptions during hospitalisations. A causality analysis between those variables was impossible given our retrospective data collection method, our inability

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to calculate the time between drug intake and readmission, and the potential drug changes between hospitalisation sequences. We conducted a bivariate analysis relating the independent variables to 30-day readmission after discharge home from 2015 to 2018. Next, we calculated a series of multilevel logistic regression models for binary outcomes explaining the readmissions, within 30 days, of patients discharged home (0=no, 1=yes). These hierarchical models included two levels: the first level concerned hospital stays themselves, nested in the second level, that of individuals. First, we computed a baseline multilevel binary logistic regression model to estimate how sets of predictors influenced the probability of 30-day hospital readmission, which included individuals' characteristics, health conditions and hospital LOS. Second, we completed this baseline model with the drugs prescribed to older inpatients on their discharge home. Finally, to the baseline model completed with prescribed drugs, we added the known drug–drug interactions between different ATC drug classes, based on a literature review and expert opinions. The model computed each predictor's impact, other things being equal, by estimating its net impact, controlling for other factors (adjusted ORs). The model also considered correlations between each subject's different variables, which were generally not independent.⁵³ The model's random intercept design allowed each individual's intercept to vary, assuming that some unmeasured traits remained stable over time and allowing a better estimation of the model's parameters. The estimated parameters, on the other hand, had the same effect on every subject. Since the data were based on the whole population—not a sample—of polymedicated older inpatients discharged home from the Valais Hospital, the ORs' CIs and statistical tests were used to indicate the robustness of the relationships (they usually only make sense for statistical inference).

Patient and public involvement

Patients were not involved in the development of the research questions, study design, outcome measures and conduct of the study.

RESULTS

Descriptive results

The electronic records of 20 422 inpatient stays by polymedicated, home-dwelling older adults included the 13 802 hospital readmissions of 8878 different older inpatients previously discharged home—an average of 1.55 inpatient hospital readmissions. The total sample's mean age was 77.77 years old (SD=7.48) and 57% were men (table 1). The average hospital LOS was 8.44 days (SD=7.58). At discharge, 25% of the sample had impaired mobility, 4% were impaired in their activities of daily living and 4% showed mental impairment. Our sample population averaged 4.58 (SD=0.92) ICD-10 diagnoses and 1.83 (SD=1.76) surgical interventions (CHOP) performed during hospitalisation. The selected medical diagnoses

Table 1 Sociodemographic and hospitalisation data for inpatient stays by polymedicated, home-dwelling adults aged 65 or more (N=13 802)

Variables	Inpatient stays by polymedicated, home-dwelling adults aged 65 or more
Sex	
Stays by men (%)	7834 (56.8)
Stays by women (%)	5968 (43.2)
Age at discharge (years)	
Mean inpatient age at discharge (SD)	77.77 (7.48)
Minimum–maximum	65–106
Median (IQR 25–75)	77.00 (68.00–80.00)
65–69 (%)	2226 (16.1)
70–79 (%)	5811 (42.1)
80–89 (%)	4845 (35.1)
90 and more (%)	920 (6.7)
Year of discharge	
2015 (%)	3501 (25.4)
2016 (%)	3318 (24.0)
2017 (%)	3530 (25.6)
2018 (%)	3453 (25.0)
Length of stay (days)	
Mean (SD)	8.44 (7.58)
Minimum–maximum	1–149
Median (IQR 25–75)	7 (4–11)
Number of ICD-10 conditions	
Mean (SD)	4.58 (0.92)
Minimum–maximum	1–5
Median (IQR 25–75)	5 (5–5)
Principal ICD-10 diagnosis	
Circulatory (%)	3336 (24.2)
Infectious (%)	404 (2.9)
Respiratory (%)	1444 (10.5)
Trauma (%)	1043 (7.6)
Tumours (%)	1505 (10.9)
Number of CHOP surgical procedures	
Mean (SD)	1.83 (1.76)
Minimum–maximum	0–5
Median (IQR 25–75)	1 (0–3)
Number of medicines prescribed at hospital discharge	
Mean (SD)	8.95 (3.24)
Minimum–maximum	5–30
Median (IQR 25–75)	8 (7.50–16.00)

CHOP, Swiss Classification of Surgical Interventions; ICD-10, International Classification of Diseases, 10th Revision.

distinguished patients affected by circulatory (24%), infectious (3%) and respiratory (11%) diseases, as well as trauma (8%) and tumours (11%). On average, 8.95

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(SD=3.24) drugs were prescribed per patient at hospital discharge.

Associations between 30-day hospital readmission risk and sociodemographic characteristics and medical conditions

The rate of 30-day hospital readmission for older patients discharged home was 7.8%. Bivariate associations with χ^2 tests showed significant differences between older inpatients' sociodemographic characteristics and medical conditions (table 2). Men showed a slightly higher proportion of 30-day hospital readmissions than women (8.2% vs 7.3%). However, age did not significantly affect the probability of 30-day readmission. More readmissions were also seen among older patients with a circulatory disease (8.2% vs 6.5%), those not affected by trauma (8.0% vs 5.8%) and especially those with a tumour (15.1% vs 6.9%). Multimorbidity also increased the risk of 30-day hospital readmissions—from 1.5% for older patients with a single ICD-10 condition to 8.8% for those with five.

Associations between 30-day hospital readmission risk and drugs

On average, older patients readmitted within 30 days had more prescribed drugs than those who were not readmitted (9.95 vs 8.87 drugs). We found a linear relationship between the 30-day readmission rate and the average number of prescribed drugs ($p < 0.001$), which supported the absence of a cut-off point in this relationship (figure 1).

Among the most robust statistical associations (χ^2 tests) with 30-day hospital readmissions involved the classes of drugs including antineoplastics and immunomodulators (12.6% vs 7.6% for those not treated with them) and antiemetics and antinauseants (27.7% vs 7.7%). There was also a higher risk of 30-day hospital readmission among older inpatients taking drugs for functional gastrointestinal disorders (13.4% vs 7.4%) and antihypertensives (14.1% vs 7.7%) (table 3).

Baseline multivariate model

A baseline multivariate logistic regression model including older patients' sociodemographic and clinical variables, but not their prescribed drugs at discharge, was computed to predict 30-day hospital readmission after discharge home (table 4). Neither sex nor age had a significant impact. On the contrary, LOS had a significant impact (OR=1.014 for each additional day; 95% CI 1.006 to 1.021), as did mobility (OR=1.218 for older patients with an impaired mobility status; 95% CI 1.039 to 1.427). Dependence on the activities of daily living and mental health status showed no influence. Concerning diagnoses measured in the ICD-10, we found that older patients with a tumorous disease (OR=2.538; 95% CI 2.089 to 3.082) were much more susceptible to 30-day hospital readmission. Patients with circulatory pathologies showed no difference from the reference category (OR=0.938; 95% CI 0.783 to 1.124), nor did those with respiratory problems (OR=1.100; 95% CI 0.875 to 1.382), trauma

Table 2 30-day hospital readmission risk at different periods for different age groups (N=13 802 readmissions)

Variables	30-day hospital readmission (%)	P value
Complete sample	7.8	
Sex		*
Female vs male	7.3 vs 8.2	
Year-end age, in years		NS
65–69	7.5	
70–79	7.6	
80–89	8.4	
≥90	6.4	
Mobility cluster		NS
Preserved mobility vs impaired mobility	7.6 vs 8.5	
Activities in daily living (ADL)		NS
Full ADL ability vs impaired ADL	7.8 vs 7.2	
Cognitive status		NS
Preserved cognitive status vs cognitive impairment	7.8 vs 7.9	
ICD-10 diagnosis: circulatory problems		**
No vs yes	8.2 vs 6.5	
ICD-10 diagnosis: infection		NS
No vs yes	7.7 vs 9.9	
ICD-10 diagnosis: respiratory problems		NS
No vs yes	7.8 vs 8.0	
ICD-10 diagnosis: trauma		**
No vs yes	8.0 vs 5.8	
ICD-10 diagnosis: tumour		***
No vs yes	6.9 vs 15.1	
Number of ICD-10 conditions		***
1	1.5	
2	4.9	
3	3.6	
4	4.8	
5	8.8	
Number of surgical procedures (CHOP)		*
0	7.7	
1	7.8	
2	7.0	
3	7.3	
4	7.1	
5	9.7	
Year of discharge: 2015–2018		NS
2015	8.3	
2016	8.0	
2017	8.0	
2018	6.8	

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

CHOP, Swiss Classification of Surgical Interventions; ICD-10, International Classification of Diseases, 10th Revision; NS, non-significant.

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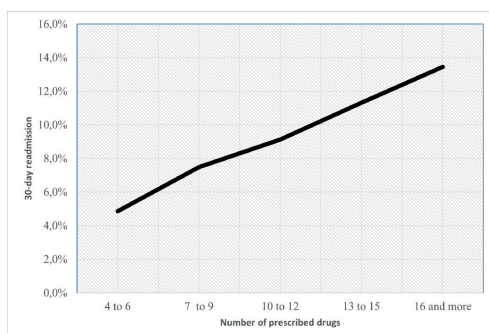


Figure 1 Relationship between 30-day readmission rate and the number of prescribed drugs at discharge.

(OR=0.847; 95% CI 0.633 to 1.134) or infection-related problems (OR=1.381; 95% CI 0.964 to 1.977; $p=0.078$). Multimorbidity predicted a higher probability of readmission (OR=1.419 per additional ICD-10 condition; 95% CI 1.282 to 1.572), whereas the number of surgical procedures had no noticeable impact (OR=0.978; 95% CI 0.938 to 1.020). The year of hospital stay did have an impact, however, as the earlier the hospitalisation during the 4 years under review, the higher the probability of readmission (OR=0.933 per additional year; 95% CI 0.880 to 0.990).

Some variables that were non-significant in bivariate analyses became significant in multivariate analyses. This was because the results of multivariate analyses were controlled by all the other parameters and interpretations were made with 'other things being equal'. Also, the composition of subgroups could be very different in some bivariate analyses.

Prediction of 30-day hospital readmission and drug prescriptions

Table 5 presents the baseline logistic regression model completed with the drugs prescribed to older patients at discharge home that were significantly associated ($p \leq 0.05$) with 30-day hospital readmission. It was not possible to introduce the total number of drugs prescribed jointly in this model because of their collinearity with other drug variables. Non-significant drugs and other variables have been omitted from table 3 in order to simplify the presentation. The probabilities of 30-day hospital readmission are presented in descending order of discharged older patients' ORs for each additional unit of the drugs in question. Intake of antiemetics and antinauseants was very strongly linked to 30-day readmission (OR=3.216 for each additional drug unit taken; 95% CI 1.842 to 5.617), as were those of antihypertensives (OR=1.771; 95% CI 1.287 to 2.438), gastrointestinal drugs (OR=1.424; 95% CI 1.166 to 1.739), systemic hormonal preparations (OR=1.207; 95% CI 1.052 to 1.385) and vitamins (OR=1.201; 95% CI 1.049 to 1.374). On the contrary,

the intake of lipid-modifying agents was associated with a decrease in 30-day hospital readmissions (OR=0.841 for each drug from this class prescribed; 95% CI 0.732 to 0.967).

Drug interactions and 30-day hospital readmissions

The model considered drug class interactions for the (1) cardiovascular system*central nervous system, gastrointestinal system, and metabolism*cardiovascular system; (2) gastrointestinal system and metabolism*central nervous system; (3) cardiovascular system*anti-infectives; and (4) central nervous system*anti-infectives. The analysis was carried out controlling for the basic model's variables (table 4), and the table reports the ORs for each additional unit of the statistically significant drugs in question as well as for significant drug interactions. Antiemetics and antinauseants were very strongly associated with 30-day readmission (OR=3.222; 95% CI 1.844 to 5.630), as were drugs regulating the gastrointestinal tract (OR=1.428; 95% CI 1.169 to 1.744) and systemic hormones (OR=1.210; 95% CI 1.054 to 1.390). The joint intake of beta-blocking agents and drugs for acid-related disorders was significantly associated with 30-day hospital readmission (OR=1.367; 95% CI 1.046 to 1.788); this is the only significant drug interaction in table 4. On the contrary, lipid-modifying agents were associated with lower 30-day hospital readmission (OR=0.838), as were substances acting on the renin-angiotensin system (OR=0.892; 95% CI 0.796 to 0.999) (table 6).

DISCUSSION

The present study examined the records of 20 422 hospitalisations involving polymedicated home-dwelling older patients, eventually discharged home, to identify the risk of 30-day hospital readmission. These records were obtained from 4-year data of a comprehensive hospital register. The 8878 individual older patients readmitted to the Valais Hospital showed a 30-day hospital readmission rate of almost 8%, corroborating previously published all-cause hospital readmission rates among home-dwelling older patients.^{9,27} However, Jencks *et al.*³ found a much higher 30-day readmission rate, reaching almost 20% among discharged older patients who had been hospitalised in acute medicine and surgery wards.³ As a bivariate association, multimorbid men were at a significantly higher risk of readmission than multimorbid women; however, in the adjusted multivariate analysis, this significance disappeared. Medical conditions, PP and multiple classes of prescribed drugs were all associated with higher 30-day readmission rates, in line with previous studies.^{27,54-56}

Our study found no significant differences in the risk of 30-day hospital readmission for men and women. However, some previous research found that men were more likely to forget to take their drugs or to not apply the changed drug dosages prescribed by their family physician, consequently increasing their risk of hospital readmission for



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Table 3 30-day hospital readmissions for different classes of drugs based on ATC (N=13 802)

Drug class	30-day readmission with no drugs in this class (%)	30-day readmission with drugs in this class (%)	P value
First level, anatomical main group			
Blood and blood-forming organ drugs (B)	7.1	8.0	NS
Dermatologicals (D)	7.7	9.4	NS
Genitourinary system and sex hormones (G)	7.7	8.3	NS
Systemic hormonal preparations, excluding sex hormones and insulins (H)	7.4	9.5	***
Anti-infectives for systemic use (J)	8.0	7.2	NS
Antineoplastic and immunomodulating agents (L)	7.6	12.6	***
Drugs for the musculoskeletal system (M)	8.0	6.5	*
Antiparasitic products, insecticides and repellents (P)	7.8	6.6	***
Respiratory system drugs (R)	7.4	9.9	***
Sensory organ drugs (S)	7.8	8.4	NS
Second level, therapeutic subgroup			
Stomatological preparations (A01)	7.8	12.2	NS
Drugs for acid-related disorders (A02)	7.0	8.5	***
Drugs for functional gastrointestinal disorders (A03)	7.4	13.4	***
Antiemetics and antinauseants (A04)	7.7	27.7	***
Bile and liver therapy drugs (A05)	7.8	14.3	NS
Drugs for constipation (A06)	7.3	10.8	***
Antidiarrhoeals, intestinal anti-inflammatory/anti-infective agents (A07)	7.7	12.9	***
Digestives, including enzymes (A09)	7.8	10.0	NS
Drugs used in diabetes (A10)	7.4	9.5	***
Vitamins (A11)	7.5	9.9	***
Mineral supplements (A12)	7.4	8.8	**
Other alimentary tract and metabolism products (A16)	7.8	6.3	NS
Cardiac therapy (C01)	7.6	8.9	NS
Antihypertensives (C02)	7.7	14.1	***
Diuretics (C03)	7.2	9.8	***
Peripheral vasodilators (C04)	7.8	15.2	NS
Vasoprotective drugs (C05)	7.8	9.8	NS
Beta-blocking agents (C07)	7.1	8.6	***
Calcium channel blockers (C08)	7.7	8.6	NS
Agents acting on the renin-angiotensin system (C09)	8.7	7.1	***
Lipid-modifying agents (C10)	8.3	7.1	**
Anaesthetics (N01)	7.8	18.8	*
Analgesics (N02)	7.8	7.8	NS
Antiepileptics (N03)	7.7	9.0	NS
Drugs for Parkinson's disease (N04)	7.8	6.9	NS
Psycholeptics (N05)	6.8	9.3	***
Psychoanaleptics (N06)	7.8	7.7	NS
Other nervous system drugs (N07)	7.9	5.1	NS

*P<0.05, **P<0.01, ***P<0.001.

ATC, Anatomical Therapeutic Chemical Classification System; NS, non-significant.

drug-related problems.⁵⁷ Opposite results were found in a population-based study by Manteuffel *et al.*⁵⁸ with women being less likely than men to properly adhere to their drug prescriptions. These differences may indicate a need for

more personalised drug prescription and drug management to improve clinical outcomes. Further research should explore associations between different types of drugs and sex,^{58 59} but this topic was beyond the scope

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Table 4 Baseline multilevel logistic regression model using 30-day readmission (0=no; 1=yes) as the dependent variable associated with independent sociodemographic, LOS and clinical variables (N=13 802 observations for 8878 different inpatients readmitted to hospital)

Variables	OR*	P value >z	95% CI
Sex	1.079	0.285	0.938 to 1.242
Year-end age, in years	0.999	0.878	0.990 to 1.009
Hospital LOS, in days	1.014	0.000	1.006 to 1.021
Mobility cluster†	1.218	0.015	1.039 to 1.427
Dependency on the activities of daily living†	0.794	0.248	0.537 to 1.174
Mental health status†	0.992	0.966	0.687 to 1.433
ICD 1st diagnosis: circulatory problems‡	0.938	0.491	0.783 to 1.124
ICD 1st diagnosis: infection‡	1.381	0.078	0.964 to 1.977
ICD 1st diagnosis: respiratory problems‡	1.100	0.414	0.875 to 1.382
ICD 1st diagnosis: trauma‡	0.847	0.265	0.633 to 1.134
ICD 1st diagnosis: tumour‡	2.538	0.000	2.089 to 3.082
Number of ICD	1.419	0.000	1.282 to 1.572
Number of CHOP	0.978	0.304	0.938 to 1.020
Number of drugs	1.043	0.000	1.028 to 1.058
Year: 2015–2018	0.933	0.022	0.880 to 0.990
Intercept	–	0.027	–

*Adjusted OR.

†0=good state; 1=impairment.

‡0=no; 1=yes.

CHOP, Swiss Classification of Surgical Interventions; LOS, length of stay.

of the present study. Another interesting issue regarding sex differences in hospital readmission rates is the study window. Some studies found higher rates among men than among women below 3-month readmissions. More extended time windows (eg, 1 year) revealed no significant sex differences.^{54 60} An analysis of our data set using a more extended readmission window might clarify this point and provide complementary knowledge about sex-associated hospital readmissions.

Our results indicated that ageing was not a risk factor for increased 30-day hospital readmission, in line with some previous publications.^{55 61} However, other research findings demonstrated that age was only positively associated with the likelihood of readmission up to 74 years old; above this, there no longer appeared to be any significant relationship between age and readmission.^{62 63} These contrasting results may be explained by the studies' designs, country settings, age of research populations or the medical conditions included.^{55 62 64}

Longer hospital stays were also associated with a higher risk of hospital readmission, in line with a cohort study

by Sud *et al*⁶⁵ concluding that an extended hospital LOS was associated with increased rates of all types of readmission, except for hospitalisation after heart failure, where a short LOS was associated with increased rates of readmission for cardiovascular disease and heart failure.

Our results indicated a significant positive association between the number of a patient's medical conditions and the 30-day hospital readmission rate, confirming other recent retrospective hospital register studies.^{66 67} More specifically, older patients with impaired mobility showed an increased risk of hospital readmission. This result was not surprising, bearing in mind that although these older patients were discharged home—and not to a nursing home—after their hospital stay, their health status might nevertheless require future readmission. Indeed, this corroborated publications about older patients discharged after orthopaedic treatment or who had been initially admitted for heart failure, myocardial infarction or pneumonia, but also presented with impaired mobility.^{68 69}

Cognitive impairment was not associated with increased 30-day hospital readmission rates, in line with findings from the systematic review by Pickens *et al*,⁷⁰ which pointed out that dementia had a modest impact on readmission rates. It was no surprise that inpatients hospitalised for cancer faced a high risk of readmission, corroborating prior studies by Burhenn *et al*, Chang *et al* and Butcher.^{71–73}

PP significantly increased the 30-day hospital readmission rate, but this result was based on the average number of drugs prescribed to the sample of readmitted patients versus those not readmitted. Although PP was confirmed as a strong determinant of 30-day hospital readmission in publications by Leendertse *et al*,^{74 75} our results showed a progressive linear relationship between PP and readmission rate, and this should be interpreted with caution. Despite our results and other publications and research underlining the challenge of PP among multimorbid older patients, there is no overall consensus about the best way to deal with the broad general relationship between PP and hospital readmission.⁷⁶

Our advanced statistical analysis demonstrated that some specific drugs and the concomitant use of specific drug combinations were significantly associated with 30-day readmission risk, although this was not unexpected and has been confirmed in previous publications.^{37 77} Mostly in line with the research findings of Zhang *et al*, drugs including hormones, antineoplastics, immunosuppressors, neoplastic antibiotics and bacterial vaccines were substantial risk factors for hospital readmission.⁷

In summary, extended hospital LOS, functional impairments, medical conditions and drugs have been demonstrated to be determinants of 30-day hospital readmission, although not all of them have clinically or pharmacologically relevant interpretations or explanations. Further research involving large samples is needed, notably to explore the drug–drug interactions with the highest risk of hospital readmissions. Statistical predictions of



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Table 5 Multilevel logistic regression model results for the drugs prescribed to older patients at discharge home that had significant predictive values (OR) for 30-day hospital readmission (controlled for variables in the baseline model: table 4) (N=13 802 observations for 8878 different inpatients readmitted to hospital)

Variables	OR*	P value >z	95% CI
First level, anatomical main group			
Blood and blood-forming organs drugs (B)	1.089	0.041	1.003 to 1.181
Systemic hormonal preparations, excluding sex hormones and insulins (H)	1.207	0.007	1.052 to 1.385
Respiratory system drugs (R)	1.146	0.003	1.046 to 1.254
Second level, therapeutic subgroup			
Drugs for functional gastrointestinal disorders (A03)	1.424	0.001	1.166 to 1.739
Antiemetics and antinauseants (A04)	3.216	0.000	1.842 to 5.617
Drugs for constipation (A06)	1.195	0.018	1.031 to 1.386
Drugs used in diabetes (A10)	1.125	0.021	1.018 to 1.243
Vitamins (A11)	1.201	0.008	1.049 to 1.374
Antihypertensives (C02)	1.771	0.000	1.287 to 2.438
Diuretics (C03)	1.149	0.024	1.018 to 1.296
Beta-blocking agents (C07)	1.156	0.040	1.007 to 1.327
Lipid-modifying agents (C10)	0.841	0.015	0.732 to 0.967
Psycholeptics (N05)	1.130	0.009	1.031 to 1.238

*Adjusted OR.

potential drug–drug interactions provide important information for modelling drug combinations and identifying pairs of drugs whose combination creates an exaggerated response.⁹ As the association between the number of drugs and the risk of hospital readmission was linear, more advanced inferential statistics would be needed to clarify a cut-off point for the mean number of drugs that would significantly increase the readmission rate. In addition, problems involving adherence to prescriptions, social support networks, and stronger or weaker

primary healthcare structures can all influence hospital readmission rates.³⁹ According to some publications, nearly 70% of people aged over 65 make mistakes with their drugs.^{78 79} Information about drug adherence, drug underuse and overuse, drug changes and deprescription by family physicians, as well as medication management at home would contribute to a more comprehensive understanding of disease-related and drug-related 30-day hospital readmissions.

Table 6 Drugs and drugs interactions from ATC classes A and B with a significant risk of 30-day hospital readmission (controlled for variables in the baseline model: table 4) (N=13 802 observations for 8878 different inpatients readmitted to hospital)

Variables	OR*	P value >z	95% CI
First level, anatomical main group			
Blood and blood-forming organ drugs (B)	1.089	0.040	1.004 to 1.182
Systemic hormonal preparations, excluding sex hormones and insulins (H)	1.210	0.007	1.054 to 1.390
Respiratory system drugs (R)	1.149	0.003	1.049 to 1.258
Second level, therapeutic subgroup			
Antiemetics and antinauseants (A04)	3.222	0.000	1.844 to 5.630
Drugs for functional gastrointestinal disorders (A03)	1.428	0.000	1.169 to 1.744
Beta-blocking agents (C07) and drugs for acid-related disorders (A02)	1.367	0.022	1.046 to 1.788
Drugs for constipation (A06)	1.199	0.017	1.033 to 1.392
Agents acting on the renin–angiotensin system (C09)	0.892	0.049	0.796 to 0.999
Lipid-modifying agents (C10)	0.838	0.013	0.729 to 0.964

*Adjusted OR.

ATC, Anatomical Therapeutic Chemical Classification System.

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Finally, it would be interesting to explore the risk of readmission according to different hospital wards. As psychiatric conditions are a frequent cause of rehospitalisation,⁸⁰ it would be relevant for future research to explore registries from adult psychiatry departments and investigate the hospital readmission risk faced by their inpatients.

Strengths and limitations

This study's main strength was its use of data recorded in a comprehensive register. We consider this retrospective study useful for clinical practice and future research because a whole series of sociodemographic and clinical parameters, medical conditions, and prescribed drugs were used to predict the probability of hospital readmission. Using both bivariate and multivariate analyses enabled an evaluation of the data's longitudinal nature.

Our study had several limitations, nevertheless. The design did not allow us to identify hospitalisations and readmissions lost to follow-up and to adjust our data for death outside the hospital. We were also unable to identify unnecessary hospitalisations or any bias towards hospitalisation rather than another healthcare solution for older inpatients. Our data set could not inform us about whether older inpatients had been first admitted to another hospital or were subsequently readmitted elsewhere during the study period. Because the reasons for hospital admission are not chosen from a list but are entered into the register as free descriptive text, these factors were not part of our data set, and the study was unable to explore the reasons for an admission's impact on 30-day rehospitalisation. Another limitation was the study's lack of formal screening methods to explain ADEs in detail, and it was impossible to distinguish between elective and urgent hospitalisations. Although the study considered statistical associations between drugs and rehospitalisations, it did not use clinically diagnosed drug–drug interactions. Finally, we were unable to consider any potential causality between PP and hospital readmission.

CONCLUSIONS

Hospital LOS, medical conditions, functional impairments and prescribed drugs were all critical factors in predicting hospital readmissions, thus affirming our hypotheses. Readmission patterns are complex and poorly understood because older patients often present with multiple chronic conditions, functional impairments and complex drug prescriptions. Hospital readmission is an underinvestigated topic deserving of additional, well-conducted, predictive research exploiting accurate longitudinal data from large samples.

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Competing interests None declared.

Patient consent for publication Not required.

Ethics approval Ethical approval was obtained from the Human Research Ethics Committee of the Canton of Vaud (CER-VD, 2018-02196), thus permitting our partner hospital's data warehouse to provide the appropriate data set. Given the retrospective data source, obtaining consent from the patients concerned was impossible or posed disproportionate difficulties. The present study respects the legal requirements for research projects involving data reuse without consent, as set out in Art 34 from the Swiss Human Research Act (HTA).

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Supplementary table. Descriptive statistics of drugs prescribed per hospital stays (N = 13,802 readmissions) at discharge based on the ATC Classification System.

Drug classes based on the ATC Classification System	Min-Max	Mean (SD)
<i>First level, anatomical main group</i>		
Blood and blood forming organs (B)	0–5	1.15 (0.86)
Dermatologicals (D)	0–3	0.04 (0.21)
Genitourinary system and sex hormones (G)	0–4	0.21 (0.47)
Systemic hormonal preparations, excl. sex hormones and insulins (H)	0–4	0.20 (0.46)
Anti-infectives for systemic use (J)	0–4	0.24 (0.47)
Antineoplastic and immunomodulating agents (L)	0–5	0.05 (0.23)
Musculo-skeletal system (M)	0–3	0.15 (0.39)
Antiparasitic products, insecticides and repellents (P)	0–2	0.02 (0.13)
Respiratory system (R)	0–7	0.28 (0.72)
Sensory organs (S)	0–6	0.10 (0.39)
<i>Second level, therapeutic subgroup</i>		
Stomatological preparations (A01)	0–1	0.00 (0.06)
Drugs for acid-related disorders (A02)	0–3	0.56 (0.52)
Drugs for functional gastrointestinal disorders (A03)	0–3	0.07 (0.28)
Antiemetics and antinauseants (A04)	0–1	0.01 (0.08)
Bile and liver therapy (A05)	0–1	0.00 (0.05)
Drugs for constipation (A06)	0–3	0.15 (0.40)
Antidiarrhoeals, intestinal anti-inflammatory/anti-infective agents (A07)	0–2	0.03 (0.18)
Digestives, incl. Enzymes (A09)	0–2	0.02 (0.13)
Drugs used in diabetes (A10)	0–5	0.26 (0.63)
Vitamins (A11)	0–4	0.15 (0.44)
Mineral supplements (A12)	0–3	0.29 (0.51)
Other alimentary tract and metabolism products (A16)	0–1	0.00 (0.05)
Cardiac therapy drugs (C01)	0–4	0.14 (0.42)
Antihypertensives (C02)	0–2	0.02 (0.17)
Diuretics (C03)	0–3	0.27 (0.53)
Peripheral vasodilators (C04)	0–1	0.00 (0.06)
Vasoprotectives (C05)	0–3	0.02 (0.14)
Beta-blocking agents (C07)	0–2	0.46 (0.51)
Calcium channel blockers (C08)	0–2	0.16 (0.37)
Agents acting on the renin-angiotensin system (C09)	0–3	0.64 (0.62)
Lipid modifying agents (C10)	0–3	0.43 (0.52)
Anaesthetics (N01)	0–1	0.00 (0.05)
Analgaesics (N02)	0–7	1.02 (0.91)
Antiepileptics (N03)	0–5	0.11 (0.35)
Drugs for Parkinson's disease (N04)	0–5	0.04 (0.24)
Psycholeptics (N05)	0–6	0.53 (0.73)
Psychoanaleptics (N06)	0–3	0.20 (0.44)
Other nervous system drugs (N07)	0–3	0.03 (0.19)
Total number of drugs	5–30	8.95 (3.24)

ARTICLE 6

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Unplanned nursing home admission among discharged polymedicated older inpatients: a single-centre, registry-based study in Switzerland

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ABSTRACT

Objective To investigate patient characteristics and the available health and drug data associated with unplanned nursing home admission following an acute hospital admission or readmission.

Design A population-based hospital registry study.

Setting A public hospital in southern Switzerland (Valais Hospital).

Participants We explored a population-based longitudinal dataset of 14 705 hospital admissions from 2015 to 2018.

Outcome measures Sociodemographic, health and drug data, and their interactions predicting the risk of unplanned nursing home admission.

Results The mean prevalence of unplanned nursing home admission after hospital discharge was 6.1% (n=903/N=14 705). Our predictive analysis revealed that the oldest adults (OR=1.07 for each additional year of age; 95% CI 1.05 to 1.08) presenting with impaired functional mobility (OR=3.22; 95% CI 2.67 to 3.87), dependency in the activities of daily living (OR=4.62; 95% CI 3.76 to 5.67), cognitive impairment (OR=3.75; 95% CI 3.06 to 4.59) and traumatic injuries (OR=1.58; 95% CI 1.25 to 2.01) had a higher probability of unplanned nursing home admission. The number of International Classification of Diseases, 10th version diagnoses had no significant impact on nursing home admissions, contrarily to the number of prescribed drugs (OR=1.17; 95% CI 1.15 to 1.19). Antiemetics/antinauseants (OR=2.53; 95% CI 1.21 to 5.30), digestives (OR=1.78; 95% CI 1.09 to 2.90), psycholeptics (OR=1.76; 95% CI 1.60 to 1.93), antiepileptics (OR=1.49; 95% CI 1.25 to 1.79) and anti-Parkinson's drugs (OR=1.40; 95% CI 1.12 to 1.75) were strongly linked to unplanned nursing home admission.

Conclusions Numerous risk factors for unplanned nursing home admission were identified. To prevent the adverse health outcomes that precipitate acute hospitalisations and unplanned nursing home admissions, ambulatory care providers should consider these risk factors in their care planning for older adults before they reach a state requiring hospitalisation.

INTRODUCTION

The hospitalisation of home-dwelling older adults, for any reason and even for a short admission, can lead to substantial functional

Strengths and limitations of this study

- A hospital registry of 14 705 hospital admissions, involving 9430 different polymedicated older adults admitted from their homes, was analysed to determine the risk of unplanned nursing home admission.
- Bivariate analyses were conducted on independent variables, and generalised estimating equations were computed to predict how sets of predictors influenced the adjusted probability of unplanned nursing home admission.
- Causality analysis was not feasible based on the nature of the routinely collected data.
- Although the study considered statistical associations between drugs and unplanned nursing home admission, it did not use clinically diagnosed drug-drug interactions.
- Our data were unable to identify hospitalisations that might have been triggered by limited home care options or those that became necessary while older adults awaited a place in a nursing home.

decline.^{1 2} Both their health disorder itself and the hospital environment can foster such functional decline, increase the risk of future illness and irreversibly diminish their quality of life.^{1 2} Most hospitalised older adult inpatients wish to return home and continue their everyday life as before. However, these different factors may hinder this wish at discharge.^{3 4} The unmet patient needs related to functional decline and safety after returning home can lead to a higher risk of hospital and emergency department readmissions and thus to subsequent unplanned nursing home admission.⁵ After hospitalisation, an unplanned nursing home admission can be a devastating and overwhelming experience for older adults and their relatives, and it increases overall healthcare system costs.⁶

Whether planned or unplanned, nursing home admission commonly follows two paths: (1) within the community, directly

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from home, or (2) from hospital, directly transitioning from hospital discharge.² In the community, transitions to nursing homes are generally the result of thoughtful decisions made by home-dwelling older adults, their families, and healthcare and social care providers based on the evolution of the person's long-term health and functional state or on an acute decline and corresponding increase in care needs that cannot be met at home. Recent findings have suggested that the predictors of nursing home admission are mainly based on underlying cognitive and functional impairments combined with a lack of support and assistance in daily living at home.⁷

The causes of unplanned nursing home admission directly after acute hospital discharge are heterogeneous. There are several reasons why older adults may require long-term care—that cannot be provided in a community setting—following acute hospital admission, for example, a new medical problem or the worsening of existing chronic disease(s) entailing dependency and requiring complex forms of care. Furthermore, there may be a breakdown of family circumstances and/or lack of social support.

Bellelli *et al* showed that advanced age (OR=4.8; 95% CI 2.6 to 8.9, $p<0.001$), cognitive impairment (OR=2.3; 95% CI 1.4 to 3.9, $p<0.001$) and poor functional status (OR=10.2; 95% CI 4.7 to 22.5, $p<0.001$) at discharge from a rehabilitation unit were the main predictors of subsequent nursing home admission.⁸ The integrative review by Fogg *et al* found a similar result for cognitive impairment (OR=2.14; 95% CI 1.24 to 3.70, $p<0.001$).⁹ A randomised controlled trial by Landefeld *et al* found that older inpatients in an acute care medical unit with a decline in their ability to perform one or more of the basic activities of daily living (ADLs) were more often discharged to a nursing home than those with less functional decline (22% and 14%, respectively; $p<0.01$).¹⁰ Ferrucci *et al* identified stroke, cancer, congestive heart failure, pneumonia, coronary heart disease and hip fractures as the leading medical precipitators of functional decline and nursing home admission.¹¹ Older adult inpatients are frequently subject to iatrogenic events during hospitalisation, including adverse drug reactions, nosocomial infections, and the consequences of falls, fractures, and using chemical or physical restraints.¹² Such events can lengthen hospitalisation, produce cognitive changes and lessen the ability to perform the ADL, all potentially leading to unplanned nursing home admission.¹² Indeed, hospitalisation causes an increased risk of the onset of acute cognitive decline in the form of delirium, with a prevalence of up to 60% on some surgical wards,¹³ often leading to unplanned nursing home admission.¹⁴ Dementia, Parkinson's disease and its associated risk of falls, and behavioural changes are common reasons for deciding to transfer inpatients from hospital to long-term care.^{15 16}

Polypharmacy has been associated with adverse health outcomes among home-dwelling older adults.¹⁷ Some prospective studies with small samples have established relationships between drug treatments during acute hospitalisation and unplanned nursing home admission.¹⁸ Cardiovascular drugs (particularly vasodilators, diuretics

and anticoagulants), drugs against diabetes, steroids, non-steroidal anti-inflammatory drugs, opiates, antibiotics, anticholinergics and benzodiazepines have all been associated with unplanned nursing home admission.¹⁸

To the best of our knowledge, and despite more frequent post-discharge nursing home admissions in Switzerland than in other countries, there is scarce research exploring how unplanned admissions to nursing homes are related to prior hospitalisation.¹⁹ The present study aimed to investigate the associations between polymedicated older inpatients' sociodemographic and clinical characteristics, drug data and their interactions, and their unplanned nursing home admission following an acute care hospital stay.

METHODS

Study design

The present population-based hospital registry study was conducted with close regard to the REporting of studies Conducted using Observational Routinely collected health Data statement.

Population and data collection

Our 4-year, longitudinal, population-based hospital registry of electronic health records included polymedicated (five and more drugs prescribed) home-dwelling older adults admitted and readmitted to the Valais Hospital, a multisite public teaching hospital (1074 beds) in southern Switzerland with a mean annual number of hospitalisations of approximately 39 000. This registry continues to be analysed as part of a larger project.²⁰ Our study defined 'unplanned nursing home admission' as the impossibility for a formerly home-dwelling older adult inpatient to return there after hospital discharge, and this included any new admission to a nursing home following an acute care admission.² All the patients included in the study followed a home to hospital to nursing home pathway. Nursing homes do not expect their residents to return to independent living in the community. The extracted patient data contained sociodemographic characteristics, medical and surgical diagnoses, routinely assessed clinical data (such as gait, falls risk, hearing or pain) and the drugs prescribed. The medical and surgical diagnoses encoded diagnostic data using the WHO International Classification of Diseases, 10th version (ICD-10), and the Swiss Classification of Surgical Interventions (CHOP).²¹ The hospital dataset showed that discharged patients had been prescribed 2370 different medicines. The Anatomical Therapeutic Chemical (ATC) classification system's 14 top-level codes were used to structure that dataset of prescribed medicines.²² The extracted data, from multiple dataset sources, were transformed and synthesised using best practices.²³ Our dataset was composed of 14 705 hospital admissions from home settings between 2015 and 2018. Data were without missing values, and there were similar numbers



of annual hospital admissions: 3777, 3534, 3724 and 3670, respectively.

Patient and public involvement

Patients were not involved in the development of the research questions, study design, outcome measures or the conduct of the study.

Dataset customising for predictive analysis

Synthesising the extracted data

Since where patients had arrived from and where they were discharged to were two distinct variables, the dataset was recoded and customised to identify the number of older adult inpatients admitted straight from their homes and then discharged to a nursing home ($n=903$) or returning to their homes ($n=13802$), as presented in a previous paper.²⁴ Therefore, older adults who died during hospitalisation (as assessed by the Valais Hospital's healthcare staff) were automatically excluded ($n=131$). Each subject's unique identifier was used to distinguish between different observations from 2015 to 2018 and to account for hospital readmissions. Cases involved 9430 different older adults, with an average of 1.56 hospital stays per person. Sociodemographic and clinical data were considered independent variables and used to compute the predictive models.²⁴ Unplanned nursing home admission after discharge from our participating hospital between 2015 and 2018 was identified by the difference between the original abode (home) and the destination at discharge (a nursing home or their own home), and this was used as the dependent variable of interest.

Sociodemographic and hospital variables

The analysis included two sociodemographic control variables: age and sex. Age was considered a continuous variable; its progressive impact was conclusive in preliminary investigations and previous studies.²⁵

Health variables

Numerous variables were used to describe older adults' health status at the end of their hospital stay. The modelling analysis included three of the six hierarchical clusters preliminarily computed as being variables significantly associated with more unplanned nursing home admissions in the descriptive analysis: mobility, dependency in the ADL and cognitive status.²⁴ Cognitive status was measured at an ordinal level using five categorical variables (perception–alertness, orientation, attention, decision-making process and ability to learn). Finally, the year of hospitalisation was introduced as a control variable, based on the fact that hospital admissions occurring earlier in the 4-year study were associated with a higher probability of unplanned nursing home admission.²⁴

Drugs

The WHO ATC classification system²² was used to select frequently prescribed drugs at discharge as independent variables for the predictive model. The selection of drug

class interactions was based on a literature review and expert opinions.²⁶ A cut-off point of at least 30 subjects per drug category prescribed was necessary to have a critical mass of data for computing robust statistics. The number of drugs prescribed at hospital discharge was considered continuous.

Data analysis strategy

Data were extracted into a Microsoft Excel spreadsheet (Microsoft, Redmond, Washington, USA) and subsequently imported into SPSS software, V.26.0 (IBM Corp). Associations with unplanned nursing home admission were examined based on previous studies: patient age and sex, hospital length of stay, the principal and secondary ICD-10 diagnoses, surgical interventions (CHOP) and prescribed drugs. No causality analyses were possible because data analysis was retrospective and based on routine data: there was no way of knowing medication regimens or functional status before hospitalisation and how these might be associated with unplanned nursing home admission. A series of unadjusted bivariate analyses using cross-tabulations were conducted to investigate whether the sociodemographic, health and drugs data (more than one independent variable) were statistically significantly associated with unplanned nursing home admission from 2015 to 2018 (our single dichotomous outcome). In a second stage, a series of generalised estimating equations (GEE or population-averaged logistic regression models) were computed to predict how sets of predictors influenced the probability of unplanned nursing home admission. The variables entered at the first stage were derived from the significant associations between sociodemographic characteristics, clinical and medical conditions and unplanned nursing home admission (table 1). The multivariable analysis model included 52 level 2 ATC drug classes, respecting the good practices for logistical regressions involving large population-based samples.²⁷ This adjusted baseline model was then completed by adding drugs that were found to be significantly associated with unplanned nursing home admissions in the previous analysis. Lastly, based on our literature review, known drug–drug interactions between different ATC drug classes were added to the baseline model. The model estimated each predictor's impact, other things being equal, by estimating its net impact controlling for confounding factors (adjusted ORs). Since the data are based on a whole population, not a sample, the ORs' CIs and statistical tests were used to indicate the robustness of relationships since they normally only make sense for statistical inference.

RESULTS

Population description

Fifty-five per cent of the population sample were men, and the total sample's mean age was 78.16 years old ($SD=7.65$). Mean hospital length of stay was 8.63 days ($SD=7.58$). The mean number of drugs prescribed at hospital discharge

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Table 1 Prevalence of unplanned nursing home admissions with regard to associations with sociodemographic characteristics and clinical and medical conditions among polymedicated hospitalised older adults (N=14 705)

Variables	Unplanned nursing home admission, n (%)	P value
Overall sample of older adults (n=14 705)	903 (6.1)	
Sex		<0.001
Female/male	575 (8.8)/328 (4.0)	
Age in years		<0.001
65–69	49 (2.2)	
70–79	192 (3.2)	
80–89	437 (8.3)	
90 or more	225 (19.7)	
Mobility		<0.001
Full ability (0)/impairment (1)	214 (2.0)/689 (16.7)	
Dependence in the activities of daily living		<0.001
Full ability (0)/impairment (1)	472 (3.4)/431 (44.8)	
Mental status		<0.001
Full ability (0)/impairment (1)	531 (3.8)/372 (41.3)	
ICD-10 principal diagnosis: circulatory problems		<0.001
No (0)/yes (1)	752 (6.7)/151 (4.3)	
ICD-10 principal diagnosis: infection		0.003
No (0)/yes (1)	892 (6.2)/11 (2.7)	
ICD-10 principal diagnosis: respiratory problems		0.226
No (0)/yes (1)	797 (6.1)/106 (6.8)	
ICD-10 principal diagnosis: traumatic injuries		<0.001
No (0)/yes (1)	720 (5.3)/183 (14.9)	
ICD-10 principal diagnosis: tumour		0.001
No (0)/yes (1)	835 (6.4)/68 (4.3)	
Number of ICD-10 diseases		<0.001
1	5 (1.8)	
2	17 (2.9)	
3	37 (3.9)	
4	47 (3.9)	
5 or more	797 (6.8)	
Number of surgical interventions (CHOP)		<0.001
0	379 (7.8)	
1	187 (6.4)	
2	135 (5.8)	
3	79 (5.2)	
4	39 (3.5)	
5 or more	84 (4.2)	
Year of hospitalisation		0.002
2015	276 (7.3)	
2016	216 (6.1)	
2017	194 (5.2)	
2018	217 (5.9)	
Number of drugs at hospital discharge	10.91 (SD=3.89)	<0.001*

*Mann-Whitney U test.
CHOP, Swiss Classification of Surgical Interventions; ICD-10, International Classification of Diseases, 10th version.

was 9.07 (SD=3.32), with means of 10.91 (SD=3.89) drugs for patients discharged to a nursing home vs 8.95 (SD=3.24) for those discharged home. Online supplemental tables 1 and 2 present descriptive statistics of the older adult inpatients' health statuses and drugs prescribed at discharge.

Associations between unplanned nursing home admission, sociodemographic characteristics, and the prevalence of clinical and medical conditions

We found a prevalence of older adults discharged to unplanned nursing home admission of 6.1% (n=903/N=14 705) over the whole time period, with a slight decrease in prevalence going forward (7.3% (n=276) in 2015 to 5.9% (n=217) in 2018). Bivariate associations showed that men had a lower prevalence of unplanned nursing home admission than women (4.0% (n=328) vs 8.8% (n=575)), as did subjects aged 65–69 years old (2.2%; n=49) compared with those 70–79 years old, 80–89 years old, and especially the oldest group, aged 90 or more (3.2% (n=192), 8.3% (n=437) and 19.7% (n=225), respectively).

Being concomitantly affected by several diseases increased the prevalence of unplanned nursing home admission, from 1.8% (n=5) for older adults with a single disease (ICD-10) to 6.8% (n=797) for those with five or more diseases. Furthermore, the number of surgical interventions was negatively associated with the prevalence of unplanned nursing home admission. Patients who had not undergone surgery showed a higher probability of unplanned nursing home admission (7.8%; n=379) than those who had undergone several interventions (3.5% (n=39) for four interventions, 4.2% (n=84) for five interventions) (table 1). The number of drugs prescribed at hospital discharge showed a positive linear relationship with unplanned nursing home admission (gamma=0.368) (figure 1).

Associations between unplanned nursing home admission and drugs

Bivariate associations showed that drugs were also related to unplanned nursing home admission (table 2). On average, home-dwelling older adults discharged to a

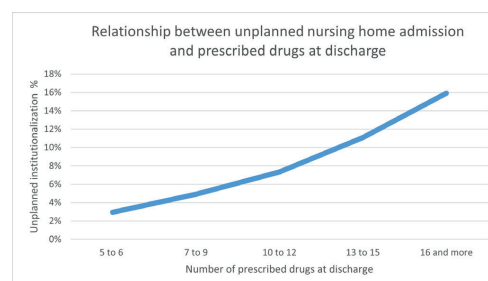


Figure 1 Relationship between unplanned nursing home admission and number of prescribed drugs at discharge.



Table 2 Prevalence of unplanned nursing home admission among polymedicated hospitalised older adults (N=14 705) with regard to associations with different classes of prescribed drugs

Drugs (ATC code)	Unplanned nursing home admission		P value
	No drugs in this class n (%)	Drugs in this class n (%)	
First level, main anatomical group			
Blood and blood-forming organ drugs (B)	180 (5.4)	723 (6.4)	0.050
Dermatologicals (D)	828 (5.8)	75 (14.1)	<0.001
Genitourinary system and sex hormones (G)	737 (6.1)	166 (6.3)	0.699
Systemic hormonal preparations, excluding sex hormones and insulins (H)	737 (6.1)	166 (6.5)	0.403
Anti-infectives for systemic use (J)	736 (6.4)	167 (5.3)	0.020
Antineoplastic and immunomodulating agents (L)	881 (6.3)	22 (3.5)	0.005
Drugs for the musculoskeletal system (M)	815 (6.4)	88 (4.3)	<0.001
Antiparasitic products, insecticides and repellents (P)	893 (6.2)	10 (4.0)	0.144
Respiratory system drugs (R)	771 (6.3)	132 (5.5)	0.147
Sensory organ drugs (S)	752 (5.5)	151 (13.4)	<0.001
Second level, therapeutic subgroup			
Stomatological preparations (A01)	899 (6.1)	4 (7.5)	0.669
Drugs for acid-related disorders (A02)	384 (5.8)	519 (6.4)	0.136
Drugs for functional gastrointestinal disorders (A03)	805 (5.9)	98 (9.8)	<0.001
Antiemetics and antinauseants (A04)	884 (6.1)	19 (18.6)	<0.001
Bile and liver therapy drugs (A05)	900 (6.1)	3 (7.9)	0.652
Drugs for constipation (A06)	605 (4.8)	298 (13.5)	<0.001
Antidiarrhoeals, intestinal anti-inflammatory/anti-infective agents (A07)	863 (6.0)	40 (9.4)	0.005
Digestives, including enzymes (A09)	883 (6.1)	20 (8.4)	0.148
Diabetes drugs (A10)	804 (6.6)	99 (3.9)	<0.001
Vitamins (A11)	801 (6.2)	102 (5.9)	0.629
Mineral supplements (A12)	513 (4.8)	390 (9.6)	<0.001
Other alimentary tract and metabolism products (A16)	901 (6.1)	2 (5.9)	0.950
Cardiac therapy drugs (C01)	792 (6.1)	111 (6.3)	0.792
Antihypertensives (C02)	888 (6.2)	15 (4.6)	0.237
Diuretics (C03)	621 (5.5)	282 (8.1)	<0.001
Peripheral vasodilators (C04)	901 (6.1)	2 (4.2)	0.568
Vasoprotectives (C05)	884 (6.1)	19 (7.2)	0.471
Beta-blocking agents (C07)	588 (7.2)	315 (4.8)	<0.001
Calcium channel blockers (C08)	762 (6.1)	141 (6.1)	0.964
Agents acting on the renin-angiotensin system (C09)	472 (7.2)	431 (5.3)	<0.001
Lipid-modifying agents (C10)	720 (8.2)	183 (3.1)	<0.001
Anaesthetics (N01)	898 (6.1)	5 (13.5)	0.061
Analgesics (N02)	158 (3.6)	745 (7.2)	<0.001
Antiepileptics (N03)	753 (5.7)	150 (10.3)	<0.001
Drugs against Parkinson's disease (N04)	814 (5.7)	89 (18.1)	<0.001
Psycholeptics (N05)	201 (2.4)	702 (11.0)	<0.001
Psychoanaleptics (N06)	565 (4.8)	338 (11.9)	<0.001
Other nervous system drugs (N07)	881 (6.1)	22 (5.9)	0.813

ATC, Anatomical Therapeutic Chemical.

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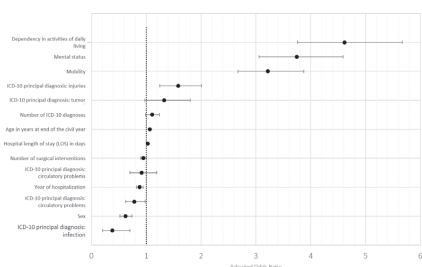


Figure 2 Baseline GEE logistic regression model with unplanned nursing home admission as the dependent variable associated with sociodemographic, hospitalisation, and independent clinical and medical variables (N=14 705 observations for 9430 different subjects). GEE, generalised estimating equations; ICD-10, International Classification of Diseases, 10th version.

nursing home had more prescribed drugs than those returning to their home (10.9 (SD=3.9) drugs vs 8.9 (SD=3.2)). Psycholeptics (antipsychotics, anxiolytics, hypnotics and sedatives) and psychoanaleptic drugs (antidepressants, psychostimulants, nootropics and anti-dementia drugs), antiemetics and antinauseants, anti-Parkinson's disease drugs, and drugs treating constipation and the sensory organs were significantly associated with unplanned nursing home admission. On the contrary, patients taking lipid-modifying agents were less prone to unplanned nursing home admission.

Multivariate baseline model

A baseline, GEE logistic regression model, including sociodemographic information, clinical data and diseases, was computed to predict unplanned nursing home admission among discharged polymedicated older adult patients (figure 2 and online supplemental table 3); prescribed drugs at hospital discharge were not included. If the 95% CI does not overlap the null value (eg, OR=1), then the higher the OR, the more the variable contributes to unplanned nursing home admission. Men had a lower probability of unplanned nursing home admission than women (OR=0.62; 95% CI 0.52 to 0.73). Patients' probability of unplanned nursing home admission increased with age (OR=1.07 for each additional year of age; 95% CI 1.05 to 1.08). Impaired mobility, dependency in the ADL and cognitive impairment revealed their substantial impacts on unplanned nursing home admission (OR=3.22; 95% CI 2.67 to 3.87; OR=4.62; 95% CI 3.76 to 5.67; and OR=3.75; 95% CI 3.06 to 4.59, respectively). Circulatory and infectious diseases were related to lower probabilities of unplanned nursing home admission (OR=0.78; 95% CI 0.63 to 0.98, and OR=0.38; 95% CI 0.20 to 0.70, respectively), whereas traumatic injuries were related to higher probabilities (OR=1.58; 95% CI 1.25 to 2.01). The number of ICD-10 diagnoses alone had no significant impact on the odds of unplanned nursing home admission (OR=1.11; 95% CI 0.98 to

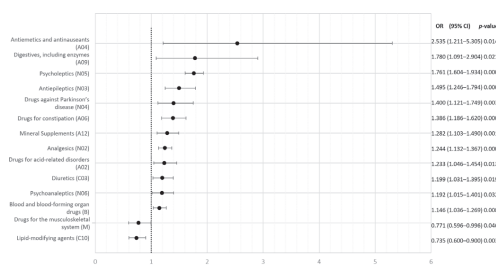


Figure 3 The GEE logistic regression model of the drugs prescribed to older adults at discharge with significant predictive values (ORs) for unplanned nursing home admission (N=14 705 observations for 9430 different subjects)—controlled for the parameters of the baseline model. GEE, generalised estimating equations.

1.24), in contrast to the number of surgical interventions undergone (CHOP), which was a protective factor against unplanned hospitalisation (OR=0.95; 95% CI 0.90 to 0.99). The year of hospital stay also had a significant impact, with more recent stays having lower probabilities of unplanned nursing home admission (OR=0.88; 95% CI 0.82 to 0.94, per ensuing year).

Prediction of unplanned nursing home admission and drug prescription

A higher number of prescribed drugs were associated with a higher probability of unplanned nursing home admission (OR=1.17; 95% CI 1.15 to 1.19). Figure 3 and online supplemental table 4 present the baseline GEE logistic regression model shown in figure 2 completed with those drugs prescribed to older adults at discharge that had a significant statistical association ($p<0.05$) with unplanned nursing home admission. Drugs without a significant statistical association are not presented in figure 3 for simplification purposes. Antiemetics and antinauseants (OR=2.53; 95% CI 1.21 to 5.30 for each additional unit), digestives (OR=1.78; 95% CI 1.09 to 2.90), psycholeptics (OR=1.76; 95% CI 1.60 to 1.93), antiepileptics (OR=1.49; 95% CI 1.25 to 1.79) and anti-Parkinson's disease drugs (OR=1.40; 95% CI 1.12 to 1.75) were strongly linked to unplanned nursing home admission after controlling for other parameters. On the contrary, taking lipid-metabolism-modifying agents was associated with lower probabilities of unplanned nursing home admission (OR=0.73; 95% CI 0.60 to 0.90, for each extra drug from this class prescribed).

Combined drug intake and probabilities of unplanned nursing home admission

To reduce collinearity and simplify the results, the combined intake of different ATC drug classes was recorded as a dichotomised variable for each drug pairing and added to the previous model.²² Only the drugs and drug combinations prescribed to older adults at discharge that had significant associations ($p<0.05$)



with unplanned nursing home admission are presented. The combined intake of cardiac therapy and psychoanaesthetic drugs was significantly associated with unplanned nursing home admission (OR=1.87; 95% CI 1.11 to 3.16), as were psychoanaesthetics and diabetes drugs combined (OR=1.75; 95% CI 1.03 to 2.98), and psycholeptic drugs and vitamins combined (OR=1.71; 95% CI 1.03 to 2.84). On the contrary, the combined intake of beta-blocking agents and antiepileptics strongly diminished the odds of unplanned nursing home admission (OR=0.39; 95% CI 0.23 to 0.67).

We also investigated the risk of unplanned nursing home admission for combined drug intake within the same drug class. The combined intake of two or more antiemetic and antinauseants (OR=2.65; 95% CI 1.26 to 5.58), psycholeptics (OR=1.64; 95% CI 1.46 to 1.85), antiepileptics (OR=1.55; 95% CI 1.23 to 1.96) or anti-Parkinson's disease drugs (OR=1.44; 95% CI 1.13 to 1.83) was strongly associated with a higher probability of unplanned nursing home admission.

Online supplemental table 5 summarises the main findings from our predictive analysis.

DISCUSSION

This population-based hospital registry study used longitudinal data to examine the unplanned nursing home admission of hospitalised polymedicated older inpatients, revealing a 6.1% prevalence rate over the 4-year dataset, in agreement with previous work by Luppa *et al* (men: 5.4%; women: 6.0%) and Goodwin *et al* (5.5%).^{7 28} The slight decrease in prevalence over the 4 years of the study may be explained by improvements in the regional home care services' contribution to maintaining older adults at home, but also to planned nursing home admissions without the requirement for intermediate hospitalisation.²⁹ Furthermore, the number of places in the region's nursing homes increased in that period,³⁰ allowing people for whom care at home became impossible to be admitted to a nursing home more promptly.

Our predictive analysis revealed that the group of the oldest adults, presenting functional mobility impairments, dependency in the ADL and cognitive impairment, was also at a high risk of unplanned nursing home admission, which is consistent with previous retrospective and prospective studies.^{31 32} Very old inpatients (≥ 90 years old) were much more likely to have an unplanned nursing home admission than those aged 65–69 years (19.7% vs 2.2%). This finding was expected and matched with previous research,³³ bearing in mind that the very oldest group presented with a high prevalence of multimorbidity and advanced functional and cognitive impairments. Unexpectedly, regardless of age, our results showed that older women had a higher prevalence and probability of unplanned nursing home admission than men.³⁴ Yet, our data could not entirely explain this result. Previous publications have indicated that social and life expectancy factors may play roles in the different rates of

nursing home admission between older adult men and women.³⁴

Our findings highlighted that functional and cognitive impairments were strong risk factors for unplanned nursing home admission, which is in line with the studies by Luppa *et al* and Goodwin *et al*.^{28 34} Likewise, our results emphasised a high risk of unplanned nursing home admission among non-surgically treated and trauma patients. This could be explained by the relationship between orthopaedic guidelines on traumatic injuries among older adults that suggest avoiding surgery, for several medical reasons (number and severity of multimorbidities), and which may lead to increased functional impairment and unplanned nursing home admission, as suggested by Gardner *et al* and Cutugno.^{35 36}

As might be expected, older adults who underwent an unplanned nursing home admission had more prescribed drugs than those returning home. Our results were in line with the retrospective study by Lucchetti *et al*, which demonstrated a relationship between the prescription of cardiovascular, gastrointestinal, and metabolic drugs and unplanned nursing home admission.³⁷

Our findings indicated that patients prescribed more than one drug from the same class of drugs—from the classes of antiemetics and antinauseants, psycholeptics, antiepileptics or anti-Parkinson's disease drugs—had a higher risk of discharge to a nursing home. Although this phenomenon is still underinvestigated, our findings are not in line with the few existing studies in this area, which have presented no significant relationships between drug interactions and unplanned nursing home admission.³⁸ However, in hospital settings, a recent systematic review reported drug–drug interactions among 80% or more of older inpatients.³⁹ Since polymedicated older inpatients should be considered as a population at a high risk of adverse outcomes, further studies should investigate how drug–drug interactions might predict the risks of nursing home admission.

Our findings undeniably mirrored existing evidence that chronic conditions and debilitating comorbidities are significant risk factors for unplanned nursing home admission.^{3 7} However, they also raised questions regarding hospitalisation's effects on the individual ageing process, which likely interact to produce a cascade of factors towards functional decline and dependency.¹ The adverse effects of hospitalisation begin immediately and progress rapidly.¹ Harrison *et al* and Haaksma *et al* described ways in which acute and exacerbated acute and chronic disorders, reinforced by existing undiagnosed geriatric syndromes (frailty, delirium, pressure sores, functional incontinence), contributed to hospitalised older patients being unable to return home and needing to be discharged to a nursing home.^{2 16} Previous studies suggested that silent geriatric syndromes such as frailty and functional decline, together with polypharmacy, are not only clinically characteristic of older adults but also potential predictors of being at risk of a further loss of independence and subsequent nursing home admission.

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Montes *et al* pointed out the dramatic rise in numbers of frail, hospitalised older adults. This increase generates concerns about whether nursing homes—already suffering from long admission waiting lists of home-dwelling older adults—will be able to cope with older adults' complex care needs.⁴⁰

Although some of the predisposing predictors identified cannot be treated (ie, sex, age), they may still contribute to an older adult's risk of being discharged to a nursing home and subsequently exacerbate their situation there. Given that hospitalisation introduces stressors that may increase the chances of unplanned nursing home admission,^{41 42} using patients' electronic hospital data could help identify the high-risk older adults who would benefit from specific preventive interventions. Being able to rapidly identify inpatients at a high risk of unplanned nursing home admission may help professional caregivers to provide them with the appropriate community health resources, such as community-based rehabilitation programmes. This would help older people to remain in their community for longer.

Study strengths and limitations

Although our population-based study's findings could be generalised to other regions of Switzerland, any interpretations should be made with caution. The Swiss Federal Statistical Office collects minimal annual data from public and private hospitals (number of hospitalisations, ICD diagnoses, length of stay, place of discharge, age and sex), but these indicated that our data were similar to those from other cantons with analogous healthcare structures.⁴³ However, we did not have access to more detailed data with which to compare with our dataset and explore potential biases or significant differences. Nevertheless, the Valais Hospital is the third largest hospital in Switzerland with more than 1000 beds and over 35 000 hospitalisations per year. Therefore, our findings could provide information to help better define which integrated healthcare approaches could be implemented to attenuate the risk factors associated with unplanned nursing home admission following an acute hospital admission or readmission. The numerous predictors revealed in our study enabled us to conceptualise an overview of hospitalised older adults' health conditions before their unplanned nursing home admission. As healthcare moves towards ever-more personalised medicine, this result could help create more refined, tailored, future interventions via 'risk profiles' defined using each older adult's personal predictors.

Our study had some limitations. The absence of data on patients' functional status before hospital admission meant that we could not assess changes to that status during hospitalisation, such as the influence of the development or deterioration of functional and cognitive impairment. We did not compute analysis on specific disorders such as neurodegenerative diseases like dementia and Parkinson's disease because this was beyond the scope of our study protocol. However, further

analyses could confirm earlier studies showing that these diseases significantly affect a person's risk of nursing home admission after hospitalisation, with almost 90% of patients with dementia being admitted into a nursing home before dying.^{15 16} Additionally, our dataset was based on routinely collected data, and we were unable to control for potential data assessment errors made by the Valais Hospital's healthcare staff at discharge. Moreover, we were unable to assess deceased patients' death certificates as these were unavailable and beyond the scope of our study. Although the study considered statistical associations between drugs and unplanned nursing home admission, it did not use clinically diagnosed drug-drug interactions. Lastly, our data were unable to identify hospitalisations that might have been triggered by limited care options at home or hospitalisations that were necessary while awaiting a place in a nursing home. These cases of planned nursing home admissions could not be distinguished from the unplanned nursing home admissions considered in the study. In addition, some patients may not have been transferred directly from hospital to nursing homes and may have had to stay in an intermediate structure while awaiting a place. These patients were not included in the study due to the unavailability of this information in the database.

CONCLUSION

The sociodemographic characteristics of hospitalised older inpatients, together with their clinical and medical conditions and their prescribed drugs, can provide us with a significant set of risk factors for unplanned nursing home admission, sustaining our stated hypotheses. Identifying these risk factors for unplanned nursing home admission could be of great assistance in developing predictive tools and tailored intervention programmes aimed at reducing the number of older adults placed in nursing homes. Our results showed that the patient-related risk factors leading to nursing home admission were based on declines in physical and cognitive function. Treatment with single drugs and combinations of drugs was also associated with unplanned nursing home admission, indicating that multiple chronic health conditions are important risk factors of a non-return home. Our findings may help to identify those older inpatients at the greatest risk of unplanned nursing home admission, enabling their care to be optimised by counterbalancing those risk factors. Further research is required across large samples of older inpatients to investigate whether tailored interventions at early stages in chronic diseases could delay physical and cognitive dysfunction and reduce unplanned nursing home admissions among this growing segment of the population.

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Patient consent for publication Not required.

Ethics approval This study involves human participants and ethical approval was obtained from the Human Research Ethics Committee of the Canton of Vaud (CER-VD, 2018-02196), and this permitted the partnering hospital's data warehouse to provide the appropriate dataset. Given the retrospective data source, obtaining consent from the patients concerned was impossible or posed disproportionate difficulties. The present study respects the legal requirements for research projects involving data reuse without consent, as set out in Article 34 from the Swiss Human Research Act (HTA).

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Supplementary Table 1. Descriptive statistics of the older adult inpatients' health status (N = 14,705 observations for 9,430 different subjects).

Variables	Population description (N = 14,705)
Sex	
Men n (%)	8,088 (55)
Women n (%)	6,617 (45)
Age (years)	
Mean (SD)	78.16 (7.65)
Hospital length of stay (days)	
Mean (SD)	8.63 (7.58)
Mobility	
Full ability n (%)	6,825 (63.2)
Impairment n (%)	7,880 (36.8)
Activities of Daily Living	
Full ability n (%)	12,131 (87.4)
Impairment n (%)	2,574 (12.6)
Cognitive status	
Full ability n (%)	12,622 (89.8)
Impairment n (%)	2,083 (10.2)
ICD-10 diseases (number) ¹	
Mean (SD)	4.59 (0.91)
Surgical interventions performed (CHOP)	
Mean (SD)	1.80 (1.77)
Most prevalent ICD-10	
Circulatory diseases n (%)	4,788 (23.4)
Infectious n (%)	559 (2.7)
Respiratory diseases n (%)	2,111 (10.3)
Traumatic injuries n (%)	2,385 (11.7)
Tumours n (%)	2,041 (10.0)

¹ Each older adult's number of ICD-10 diseases was entered into the model as a proxy for multimorbidity.

Supplementary Table 2. Descriptive statistics of prescribed drugs at discharge based on the ATC among the polymedicated older inpatients (N = 14,705 observations for 9,430 different subjects).

Drugs by ATC, level 2	Number of drugs per patient	
	Min-Max	Mean (SD)
<i>First level, anatomical main group</i>		
Blood and blood-forming organ drugs (B)	0–6	1.16 (0.86)
Dermatologicals (D)	0–3	0.04 (0.22)
Genito urinary system and sex hormones (G)	0–4	0.21 (0.47)
Systemic hormonal preparations, excl. sex hormones and insulins (H)	0–4	0.20 (0.46)
Anti-infective for systemic use (J)	0–4	0.23 (0.46)
Antineoplastic and immunomodulating agents (L)	0–5	0.05 (0.23)
Musculo skeletal system drugs (M)	0–3	0.15 (0.39)
Antiparasitic products, insecticides and repellents (P)	0–2	0.02 (0.13)
Respiratory system drugs (R)	0–7	0.27 (0.72)
Sensory organ drugs (S)	0–6	0.10 (0.40)
<i>Second level, therapeutic subgroup</i>		
Stomatological preparations (A01)	0–1	0.01 (0.06)
Drugs for acid related disorders (A02)	0–3	0.56 (0.52)
Drugs for functional gastrointestinal disorders (A03)	0–3	0.07 (0.28)
Antiemetics and antinauseants (A04)	0–1	0.01 (0.08)
Bile and liver therapy drugs (A05)	0–1	0.01 (0.05)
Drugs for constipation (A06)	0–4	0.17 (0.42)
Anti-diarrhoeal, intestinal anti-inflammatory/anti-infective agents (A07)	0–2	0.03 (0.18)
Digestives, incl. enzymes (A09)	0–2	0.02 (0.13)
Drugs used in diabetes (A10)	0–5	0.25 (0.63)
Vitamins (A11)	0–4	0.15 (0.44)
Mineral supplements (A12)	0–3	0.30 (0.51)
Other alimentary tract and metabolism products (A16)	0–1	0.01 (0.05)
Cardiac therapy drugs (C01)	0–4	0.14 (0.41)
Antihypertensives (C02)	0–2	0.02 (0.17)
Diuretics (C03)	0–3	0.28 (0.54)
Peripheral vasodilators (C04)	0–1	0.01 (0.06)
Vaso-protectives (C05)	0–3	0.02 (0.14)
Beta-blocking agents (C07)	0–2	0.45 (0.51)
Calcium channel blockers (C08)	0–2	0.16 (0.37)
Agents acting on the Renin-Angiotensin system (C09)	0–3	0.63 (0.62)
Lipid Modifying agents (C10)	0–3	0.41 (0.52)
Anaesthetics (N01)	0–1	0.01 (0.05)
Analgesics (N02)	0–7	1.03 (0.91)
Antiepileptics (N03)	0–5	0.11 (0.36)
Anti-Parkinson drugs (N04)	0–5	0.04 (0.25)
Psycholeptics (N05)	0–7	0.57 (0.77)
Psychoanaleptics (N06)	0–3	0.21 (0.45)
Other nervous system drugs (N07)	0–3	0.03 (0.19)
Total number of drugs	5–32	9.07 (3.32)
N valid - listwise		14.70

Supplementary Table 3. Baseline, GEE logistic regression model with unplanned nursing home admission as the dependent variable associated with sociodemographic, hospitalisation, and independent clinical and medical variables (N = 14,705 observations for 9,430 different subjects).

Variables	Odds Ratio	$p > z$	95% Confidence Interval
Sex ¹	0.62	< 0.000	0.52–0.74
Age in years	1.07	< 0.000	1.05–1.08
Hospital length of stay (LOS) in days	1.02	< 0.000	1.02–1.03
Mobility ²	3.22	< 0.000	2.67–3.87
Dependency in the activities of daily living ²	4.62	< 0.000	3.76–5.67
Mental status ²	3.75	< 0.000	3.06–4.59
ICD-10 principal diagnosis: circulatory problems ³	0.78	0.030	0.63–0.98
ICD-10 principal diagnosis: infection ³	0.38	0.002	0.20–0.70
ICD-10 principal diagnosis: respiratory problems ³	0.91	0.511	0.70–1.19
ICD-10 principal diagnosis: injuries ³	1.58	< 0.000	1.25–2.01
ICD-10 principal diagnosis: tumour ³	1.33	0.071	0.98–1.80
Number of ICD-10 diagnoses	1.11	0.090	0.98–1.24
Number of surgical interventions (CHOP)	0.95	0.042	0.90–0.99
Number of prescribed drugs	1.17	0.000	1.15–1.19
Year of hospitalisation: 2015 to 2018	0.88	< 0.000	0.82–0.94

Note. 1: 0 = woman, 1 = man; 2: 0 = normal status, 1 = poor status; 3: 0 = no, 1 = yes

Supplementary Table 4. GEE logistic regression model of the drugs prescribed to older adults at discharge with significant predictive values (odds ratios) for unplanned nursing home admission (N = 14,705 observations for 9,430 different subjects).

Drugs	Odds Ratio	$p > z$	95% Confidence Interval
Antiemetics and antinauseants (A04)	2.53	0.014	1.21–5.30
Digestives, including enzymes (A09)	1.78	0.021	1.09–2.90
Psycholeptics (N05)	1.76	0.000	1.60–1.93
Antiepileptics (N03)	1.49	0.000	1.25–1.79
Anti-Parkinson drugs (N04)	1.40	0.003	1.12–1.75
Drugs for constipation (A06)	1.39	0.000	1.19–1.62
Mineral Supplements (A12)	1.28	0.001	1.10–1.49
Analgesics (N02)	1.24	0.000	1.13–1.37
Drugs for acid-related disorders (A02)	1.23	0.013	1.05–1.45
Diuretics (C03)	1.20	0.019	1.03–1.39
Psychoanaleptics (N06)	1.19	0.032	1.01–1.40
Blood and blood-forming organ drugs (B)	1.15	0.008	1.04–1.27
Drugs for the musculoskeletal system (M)	0.77	0.046	0.60–0.99
Lipid-modifying agents (C10)	0.73	0.003	0.60–0.90

Supplementary Table 5. Factors associated with a higher and lower probability of unplanned nursing home admission among polymedicated hospitalised older adults (N = 14,705): summary of the predictive analysis.

Risk factors for a higher probability of unplanned nursing home admission	
- Dependency in the activities of daily living (OR = 4.62, 95% CI: 3.76–5.67)	
- Cognitive impairment (OR = 3.75, 95% CI: 3.06–4.59)	
- Functional mobility impairment (OR = 3.22, 95% CI: 2.67–3.87)	
- Antiemetics/antinauseants (OR = 2.53, 95% CI: 1.21–5.30)	
- Digestives (OR = 1.78, 95% CI: 1.09–2.90)	
- Psycholeptics (OR = 1.76, 95% CI: 1.60–1.93)	
- Injuries (OR = 1.58, 95% CI: 1.25–2.01)	
- Antiepileptics (OR = 1.49, 95% CI: 1.25–1.79)	
- Anti-Parkinson's drugs (OR = 1.40, 95% CI: 1.12–1.75)	
- Number of drugs prescribed (OR = 1.17, 95% CI: 1.15–1.19)	
- Older age (OR = 1.07, 95% CI: 1.05–1.08)	
Combined intake of:	
- cardiac and psychoanaleptic drugs (OR = 1.87, 95% CI: 1.11–3.16)	
- psychoanaleptic and diabetes drugs (OR = 1.75, 95% CI: 1.03–2.98)	
- psycholeptic drugs and vitamins (OR = 1.71, 95% CI: 1.03–2.84)	
Combined intake of two or more:	
- antiemetics and antinauseants (OR = 2.65, 95% CI: 1.26–5.58)	
- psycholeptics (OR = 1.64, 95% CI: 1.46–1.85)	
- antiepileptics (OR = 1.55, 95% CI: 1.23–1.96)	
- anti-Parkinson's drugs (OR = 1.44, 95% CI: 1.13–1.83)	
Protective factors for a lower probability of unplanned nursing home admission	
- Surgical interventions (OR = 0.95, 95% CI: 0.90–0.99)	
- Circulatory diseases (OR = 0.78, 95% CI: 0.63–0.98)	
- Lipid metabolism modifying agents (OR = 0.73, 95% CI: 0.60–0.90)	
- Male sex (OR = 0.62; 95% CI: 0.52–0.73)	
- Combined intake of beta-blocking agents and antiepileptics (OR = 0.39, 95% CI: 0.23–0.67)	
- Infectious diseases (OR = 0.38, 95% CI: 0.20–0.70)	

OTHER SCIENTIFIC OUTPUTS RELATED TO THIS CHAPTER

Contributions in related publications

Taushanov Z, Verloo H, Wernli B, Di Giovanni S, von Gunten A, **Pereira F**. Transforming a Patient Registry Into a Customized Data Set for the Advanced Statistical Analysis of Health Risk Factors and for Medication-Related Hospitalization Research: Retrospective Hospital Patient Registry Study. *JMIR Medical Informatics*. 2021;9(5):e24205. doi:10.2196/24205.

Abstract accepted in a peer-reviewed journal

Pereira F, Wernli B, von Gunten A, Santiago-Delefosse M, del Rio Carral M, Martins M, Verloo H. Polymedicated home-dwelling older adults' risk factors for hospital readmission and unplanned institutionalization: preliminary results from the retrospective study phase of the PNR74 ME@home project. (Accepted by *Primary and Hospital Care*, publication scheduled for September 2022).

Oral presentations in scientific meetings

Pereira F, Taushanov Z, Wernli B, Verloo H. Longitudinal data analysis of a regional hospital register to explore the profiles of polymedicated older inpatients with multiple chronic conditions: a multiple-cluster model strategy. Presented at the 10th International Conference of Panel Data Users. 2019. Lausanne, Switzerland.

Pereira F, Verloo H., Wernli B. Methodological considerations and outcomes from an analysis of routinely collected, highly sensitive health data from a hospital register. Presented at a Seminar of the Foundation for Research in Social Sciences (FORS), University of Lausanne. 2021. Lausanne, Switzerland.

**CHAPTER 5 – PROSPECTIVE QUALITATIVE
PHASE: MEDICATION MANAGEMENT AT HOME**

PROSPECTIVE QUALITATIVE PHASE: MEDICATION MANAGEMENT AT HOME

This chapter concerns the project's prospective qualitative phase conducted from October 2019 to November 2020 and focuses on how polymedicated home-dwelling older adults perceived their hospital discharge home and how they dealt with the new reality of their subsequent medication management there. The perceptions of their informal and professional caregivers on these issues are also described. This chapter includes two qualitative papers. Article 7 (submitted) describes the perceived needs for collaborative medication management for older adults taking several different medications at home after hospital discharge. Article 8 aimed to identify and categorize the stressors experienced and the reconstitution strategies adopted by older adults, their informal caregivers, and their healthcare professionals as they manage older adults' medications after hospital discharge. English translations of the interview guides used with these three groups of participants can be found in Article 7 or 8's appendices (same interview guides). Participants' information and consent form templates are provided in Appendix 4.

We plan to conduct further analyses soon of other data collected using the Resident Assessment Instrument-Home Care (RAI-HC) [35], participants' medication journals (Appendix 5), and photographs of their medication practices and routines.

ARTICLE 7

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**Collaborative Medication Management for Older Adults after Hospital Discharge: A
Qualitative Descriptive Study**

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Abstract

Background: Safe medication management for older adults after hospital discharge requires a well-coordinated, interprofessional, patient-centered approach. This study aimed to describe the perceived needs for collaborative medication management for older adults taking several different medications at home after hospital discharge.

Methods: A qualitative descriptive study was conducted using semi-structured interviews with older adults (n = 28), informal (n = 17), and professional caregivers (n = 13).

Results: Findings revealed four main needs: older adults and informal caregivers' perceived needs for greater involvement in discharge planning; older adults' perceived needs to be informed, listened to, and to be actively involved in decision-making; informal caregivers' perceived needs for help in supporting and coordinating medication management; and older adults' and informal and professional caregivers' perceived needs for better communication and coordination between professional caregivers.

Conclusions: This study revealed two underutilized pathways towards improving collaborative medication management: medication follow-up involving a community healthcare professional taking an overarching responsibility and empowering older adults and their informal caregivers in medication management after hospital discharge.

Keywords: older adults, home-dwelling, informal caregivers, polypharmacy, collaborative medication management, discharge planning, qualitative descriptive research, Switzerland.

Background

Medication safety is the core theme of the third Global Patient Safety Challenge Programme developed by the World Health Organization [1]. Unsafe medication practices and medication errors are considered inevitable and primarily caused by ineffective health systems [1]. Medication errors can occur at many steps in the medication management process, from ordering/prescribing the medication, documenting, transcribing, and dispensing it to when the drug is administered to the patient or during the monitoring of its effects [2]. One of the most common sources of error is poor interprofessional communication and, consequently, poor collaborative medication management [2].

Safe medication management is particularly challenging among older adults due to their increased prevalence of multiple chronic noncommunicable diseases requiring complex multi-drug pharmacotherapy. This is known as polypharmacy when patients take five or more medications daily [3]. Due to age-related changes in pharmacokinetics and pharmacodynamics [4], polypharmacy is particularly problematic in older adults and often leads to potentially inappropriate medications and medication-related harm [5, 6]. Unsafe medication management predisposes patients to adverse health outcomes, which deviate from the original intention of therapeutic benefit and can result in the patient's physical and cognitive decline and avoidable health costs [7, 8]. Because of its risk for medication-related harm, polypharmacy requires optimal professional communication and collaborative medication management [9]. Effective collaborative medication management occurs when the process of selecting and managing medications results in optimal patient outcomes [10]. It involves an interprofessional patient-centered approach to optimizing medication management and treatment decisions, minimizing medication-related harm, promoting medication adherence, and enhancing medication safety [1, 9].

Collaborative medication management for older adults taking several different medications at home was described by Roughead *et al.* [11] in their coordinated, integrated, multidisciplinary, patient-centered model of care. This theoretical framework suggested that the medication management of home-dwelling older adults required a patient-centered approach that optimized two-way communication and coordination between professional caregivers and patients, between professional caregivers and informal caregivers, and finally among professional caregivers themselves. This framework also incorporated older adults' treatment planning and decision-making preferences, despite their different individual profiles, potential willingness to participate, or understanding of their treatment complexity.

Poor collaborative medication management is heightened during care transitions, such as discharge home after hospitalization [1, 8, 12]. Care transitions are a critical period, as revealed by Parekh *et al.* [13] when exploring older adults' lived experiences of medication-related harm during the hospital discharge period. Participants felt vulnerable and evoked their reduced capacity to comprehend information, the pressure surrounding the circumstances of their discharge, and a lack of integrated care in the community. In addition, Tomlinson *et al.* [14] explored older adult patients' and their informal caregivers' experiences of post-discharge medication management. Their participants evoked how hospital discharge and changed medication was experienced as a disruption to knowledge, routine, and their ability to manage their medication prescriptions. Various strategies have been used to support medication use, such as creating checklists, seeking advice, or supporting primary care providers to ensure the right medications are supplied on time [14].

Interventions supporting successful care transitions have been developed. The systematic review and meta-analysis by Tomlinson *et al.* [15] evaluated interventions to support successful transitions of care through enhancing medication continuity. They suggested that interventions bridging the care transition period should continue for at least 90 days after discharge. These

were more likely to support successful transitions than those focusing solely on hospital admission or short post-discharge periods. Self-management activities, telephone follow-up, and medication reconciliation were statistically associated with fewer hospital readmissions [15].

Holmqvist *et al.* [16] explored physicians' and nurses' experiences of evaluating older adults' medications from their perspectives as professional caregivers. According to their findings, working conditions and cooperation with colleagues, older adults, and their professional and informal caregivers, all emerged as important factors related to medication evaluation. Nurses from community healthcare centers (CHCs) described speaking with the older adults and their informal caregivers about continuing treatments and undergoing medication reconciliation so that their medication lists only included medications relevant to the older adult. Communicating with colleagues involved active communication between professional caregivers about how to proceed with an older adult's medication. This included asking for instructions when information about continuing treatments was missing, and this often involved older adults seeing several healthcare providers [16].

In Switzerland, CHCs provide support for older adults unable to manage their medications by themselves or with the help of informal caregivers (even if they are autonomous for their activities of daily living). Nurses, usually employed by a municipality, provide CHC services to individuals living in their own homes. Pharmacists are ever more commonly involved in primary care [17].

Previous work on safe medication management has relied on clinician-focused or patient-focused perspectives. However, because safe medication management implies collaborative practices using interprofessional, patient-centered approaches, research with a single focus may not have provided a comprehensive description of the phenomenon. The present study therefore

relies on a multi-perspective description of older adults' and their informal and professional caregivers' needs for collaborative medication management after hospital discharge.

This study explored how home-dwelling older adults with polypharmacy, and their informal and professional caregivers, perceived collaborative medication management after hospital discharge. The research questions were:

- 1) What do older adults living at home with polypharmacy and their informal and professional caregivers perceive they needs for effective collaborative medication management after hospital discharge?
- 2) How is collaborative medication management for older adults implemented after hospital discharge, and what could be improved?

Methods

Study design

This study was conducted using a qualitative descriptive design. This naturalistic approach is often used in healthcare research to inform practice by providing a comprehensive, descriptive summary of the perspectives of participants directly experiencing a phenomenon [18, 19]. These different perspectives were captured through individual semi-structured interviews with older adults and professional caregivers and joint interviews with older adults and their informal caregivers and were then analyzed using inductive thematic analysis [20]. Our research team included perspectives from the fields of nursing (FP, MMM, and HV) and health psychology (MB and MdRC).

Participants and recruitment

Older adults were recruited in collaboration with nurses from the canton of Valais regional hospital and a CHC, both in French-speaking Switzerland. We used purposive sampling to ensure that older adults returning home after hospital discharge with a polypharmacy

prescription were well represented. This sampling technique provides diversity and a comprehensive summary of an event in everyday terms [18]. Eligible older adults fulfilling our inclusion criteria (Table 1) were asked for permission to give their names to the researchers. Nonetheless, for ethical reasons, their identities have been coded. There was no previous relationship between the participants and researchers. Based on the systematic review and meta-analysis by Tomlinson *et al.* [15] suggesting that interventions bridging the care transition should continue for at least 90 days after discharge, FP and MB contacted eligible older adults by telephone between one week and 90 days after their hospital discharge and asked for their consent to participate in the study. To explore a comprehensive, descriptive summary of perspectives about collaborative medication management, older adults without an informal caregiver or support from the CHC were not excluded.

After recruiting an older adult, FP or MB also asked an informal caregiver to participate if the older adult had identified them as the person most involved in their medication management. We defined informal caregivers as any family member, neighbor, or friend assisting a dependent older adult with certain activities in their daily life. That assistance, help, care, or physical presence had to have been given regularly, for at least two of the basic or instrumental activities of daily living (ADL or IADL) or to ensure patient safety, for at least the past six months [21]. Based on our clinical experience, being involved in an older adult's medication management entails at least one of the following activities: accompaniment to healthcare consultations, assistance in obtaining medication, providing medication, assistance in providing and/or taking medication, monitoring drug effectiveness and side effects, assistance in adhering to medication schedules, and organizing home-care support.

Lastly, FP or MB also recruited a professional caregiver involved in each older adult's medication management and employed to provide professional community healthcare services (i.e., home-care nurses, general practitioners [GPs], pharmacists). They were invited to

participate after an older adult had identified them as the professional most involved in their medication management. The inclusion and exclusion criteria for each group of participants are shown in Table 1. No exclusions were made relative to sex, gender identity, socioeconomic status, or marital status. The enrolment process is schematized in Supplementary File 1.

Table 1. Inclusion and Exclusion Criteria for Different Types of Participants

Participants	Inclusion criteria	Exclusion criteria
Older adults	- Aged 65 or above - Hospitalized within the last 90 days - Managing at least five different medications daily	Unable to speak and understand French
Informal caregivers	- Aged 18 or above - Designated by the older adult as the most significant informal caregiver involved in their medication management	Unable to speak and understand French
Professional caregivers	- Designated by the older adult as playing a key role in their medication management	- Student - Apprentice - Unable to speak and understand French

Data Collection

Data collection in qualitative descriptive research uses minimally-to-moderately structured open-ended individual and/or focus group interviews [18, 22]. Therefore, we used individual semi-structured and joint interviews with older adults and their informal and professional caregivers. We created four interview guides—one for each interview type. Each consecutive interview was based on data collected in the former interviews. The interview guides (Supplementary File 2) were inspired by our literature review and were tested in a preliminary study [23]. Data were collected by two of the research team members (FP and MB).

Older adults

Two semi-structured interviews performed two or three weeks apart, each lasting about an hour, were carried out by FP or MB at each older adult's home. Interviewing participants twice made it possible to analyze any evolution in medication management or collaborative practices

following the hospital discharge. However, eight older adults only underwent one interview because the first interview occurred a long time after their hospital discharge date and the data collected in the first interview was sufficiently complete to cover the two planned interviews. We also collected sociodemographic, health, and comorbidity data using the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) [24] and information on prescribed medications taken daily.

The first semi-structured interview collected data on older adults' perspectives on their transition from hospital to home, the information they had received about their treatment and its possible modifications, and whether their experiences and preferences had been considered in the prescription of their medications.

The second interview essentially focused on medication management at home, the informal and professional caregivers involved in their medication practices, and, finally, how collaborative medication management was implemented after hospital discharge and what could be improved. Older adults were interviewed alone or with their informal caregiver, if necessary. Health restrictions related to the SARS-CoV-2 virus were implemented towards the end of data collection, thus the last two older adult participants were interviewed by telephone, as were their professional caregivers.

Informal Caregivers

If an informal caregiver designated by the older adult was involved in medication management and had given consent to participate, a joint, third interview with the older adult and their informal caregiver was organized at the older adult's home one to two weeks after the second interview. Joint interviews provided access to interactions between older adults and their informal caregivers concerning medication management, and to the informal caregiver's specific tasks in collaborative medication management [25, 26].

The aim of joint interviews was not to triangulate information and arrive at the closest possible ‘picture of reality’, but rather to investigate how each participant’s perspectives intertwined to give a comprehensive summary of their perceptions about collaborative medication management after hospital discharge [27]. Although informal caregivers sometimes expressed themselves more than older adults, this allowed us to better understand their daily interactions and roles in medication management vis-à-vis the older adult and professional caregivers.

Sociodemographic data were also collected. Despite the health restrictions mentioned above, no informal caregivers were interviewed by telephone as the two older adults interviewed this way had not named a significant informal caregiver involved in their medication management.

Professional caregivers

When professional caregivers designated by older adults gave their consent to participate, they underwent a semi-structured interview of about one hour. This explored their types of medication management interventions (e.g., prescribing, preparation, administration, monitoring), their frequency, the information received prior to the first visit/consultation after hospitalization (including any changes to usual treatment), how treatment adjustments were being carried out, and the barriers to and facilitators of effective medication management they encountered.

To facilitate the recruitment, and in agreement with the study’s field partners, these interviews took place in professionals’ workplaces (CHC, medical practice, or pharmacy), during working hours, and one to two weeks after the joint, third interview. Sociodemographic and professional data were also collected. Although the primary professional caregivers contacted were interested in participating in the study, their intense workloads made planning appointments for interviews difficult. Five refused to participate and two were unreachable (Supplementary File 1). Therefore, for feasibility reasons, joint interviews involving older adults and their designated healthcare professionals were not planned.

Data analyses

Fifty-three audio-recorded individual and joint interviews were shared among four members of our team (including the two interviewers) and fully transcribed. The analysis was conducted in French, the data's original language, although the quotes used to illustrate our findings have been translated into English. Each full transcript underwent an inductive thematic analysis by the same four team members to identify common patterns in the full dataset [20, 28]. Individual and joint interviews were considered equally important to capture different perspectives of the phenomenon. Data not focused on an older adult's medication management and their most recent hospitalization were not considered useful for answering our research questions and were not coded. The four researchers met regularly to check whether patterns matched the coded extracts across the entire data set and until a consensus was reached. This analysis procedure enabled a systematic classification of all the descriptions into distinct themes, framed by the similarities and differences in participants' accounts. The entire corpus of interviews was then reviewed to validate the themes that had emerged. The analytical process was completed when *patterns of shared meaning* were reached regarding participants' accounts and our research questions [28]. Preliminary results were then discussed with the other authors. This widely acknowledged method of qualitative descriptive research fitted well with the study's aims as the topic emerged from a clinical concern and the participants were those directly affected by the condition [22].

Trustworthiness

The four key components of trustworthiness identified by Lincoln and Guba [29]—credibility, dependability, confirmability, and transferability—can readily be applied to qualitative descriptive research [22]. In the present study, credibility was ensured by reviewing the interview data collected by MB and FP, by each interviewer writing notes on the interview process to ensure that each aspect followed the interview guidelines, and by conducting a

briefing before each interview. Confirmability was ensured by the team members evaluating the research process during meetings and reading and analyzing the data together, by describing participants' demographic data, and by including their direct quotations. Dependability was ensured by defining clear study stages, keeping research diaries, having regular weekly coordination meetings, and ensuring accurate data coding. Strategies to support transferability included purposeful sampling according to our inclusion and exclusion criteria and providing a description of participants and the context of their perceptions.

Results

After completing 28 interviews with older adults, no new information emerged, suggesting that data saturation had been reached [22]. Consequently, no further participants were included. The sociodemographic characteristics of the three types of participants are presented in Table 2. The median older adult had 12 ICD-10 diagnoses when in hospital (range 3–27) and eight prescribed medications at hospital discharge (range 5–21). Only 17 informal caregivers participated in the study because not every older adult had an informal caregiver, not every informal caregiver was involved in medication management, and not all of them consented to participate. Thirteen of the 17 informal caregivers interviewed lived with the older adult, three lived in the same town or village, and one lived outside the canton. Most ($n = 11$) provided daily assistance in multiple activities (IADL or ADL). Older adults' levels of autonomy in medication management were very heterogeneous. Whereas some prepared and took their medications independently, others needed their informal caregivers and/or health professionals (a nurse or pharmacist) to prepare and administer them. The types of medication management assistance provided were also variable and depended on coordination between the different stakeholders involved. Older adults designated three types of healthcare professionals involved in their medication management: nurses, pharmacists, and GPs. More information on participants' characteristics is provided in Supplementary Files 3 and 4.

Table 2. Participants' Sociodemographic and Professional Characteristics and Older Adults' Polypharmacy and Medical Status (ICD-10 Diagnoses)

Sociodemographic and professional characteristics	Older adults (n = 28)	Informal caregivers (n = 17)	Professional caregivers (n = 13)
Sex (number)			
Female	11	15	10
Male	17	2	3
Age (years)			
Median	83 [66–94]	67 [48–86]	45 [28–58]
Relationship with the older adult			
Spouse/partner		10	
Child		6	
Daughter-in-law		1	
Profession (number)			
Retired	28	9	
Employed	0	7	
Unemployed	0	1	
Nurse			5
Pharmacist/Pharmacy Assistant			4
General Practitioner/Specialist			4
Number of drugs			
Median	8 [5–21]		
Number of ICD-10 diagnoses			
Median	12 [3–27]		

Our qualitative descriptive analysis revealed four main themes about collaborative medication management:

- older adults' and informal caregivers' perceived needs for greater involvement in discharge planning;
- older adults' perceived needs to be informed, to be listened to, and to be actively involved in decision-making;
- informal caregivers' perceived needs for help in supporting and coordinating medication management;

- d) older adults' and informal and professional caregivers' perceived needs for better communication and coordination between professional caregivers.

Older adults' and informal caregivers' perceived needs for greater involvement in discharge planning

All older adults and informal caregivers perceived hospital discharge as a desirable but distressing moment. Discharge planning was organized by physicians, ward and liaison nurses, and involved setting up or reactivating the medication management services (deliveries, weekly pill-box preparation, and administration) provided by CHCs. However, the older adults and informal caregivers interviewed did not always appreciate how discharge home was organized by the hospital's healthcare professionals. Indeed, some refused medication management by their CHC after hospital discharge despite the recommendations and prescriptions written by hospital professionals.

Other participants felt that they had been insufficiently listened to and consulted when decisions were made during hospital discharge. They described episodes of poor communication between hospital departments and few opportunities to discuss things with hospital healthcare staff. For example, OA20, living alone and hospitalized following a pulmonary embolism, complained about the lack of explanations he received at the hospital when the medication that he had been taking for many years was changed.

"They could have talked to me about it before stopping it [Zoldorm®]. (...) They're all assistants, lots of them... There's some big professor on each floor, the rest are all assistants with their computers on wheeled stands and they type as they walk along. That's it, eh. They don't say much (...). They don't communicate with anyone. They talk among themselves. They come in together; they leave together."

Other older adults described having experienced the process of their hospital discharge as being too rapid or even happening too early. This was described by OA01's two informal caregivers. They were surprised by the decision to discharge their mother, who lived alone, to her home when she presented with significant functional impairments. Furthermore, the speed with which hospital healthcare professionals made that difficult decision left no time for the informal caregivers to discuss it or ask questions about changes to their mother's medication.

IC01b: *"Honestly, I found it all a bit strange because... with, umm, her doctor, she said that at a certain age, you shouldn't unsettle them too much. When they are used to a certain medicine, you shouldn't make too many changes, because you often, you know? And then, suddenly, I said to myself, 'Why are there all these changes when she's used to certain things.' "*

Interviewer: *"And you never had the opportunity to talk about it?"*

IC01b: *"No. No, because in fact... at the same time, we didn't expect her [OA01] to be out so soon. And so, all of a sudden, huh, it was all done rapidly."*

Some informal caregivers expressed their fears about older adults' discharges home occurring too early. They developed strategies to mediate this and prevent potential health complications, including reorganizing their families to ensure a more frequent or regular presence with their older adult relative, especially regarding mealtimes and medication schedules. As in OA18's case, hospitalized following a stroke, an intermediary stay in a rehabilitation clinic was sought. His wife (IC18) did not actively assist him with his medication management, but they seemed to provide each other with mutual support and took their medication at the same time in the same place. According to IC18, her husband was discharged from hospital too soon and should have been prescribed an intermediary stay in a rehabilitation clinic.

In summary, this theme pulled together older adults' and informal caregivers' descriptions of discharge planning dysfunctions after hospitalization. Several older adults and informal

caregivers described not feeling sufficiently involved in the decisions concerning their transition from hospital to home.

Older adults' perceived needs to be informed, to be listened to, and to be actively involved in decision-making

Many older adults described their needs to be listened to and to be involved in decisions concerning their medication management after hospital discharge. This theme pointed to two extreme attitudes along a continuum. At one extreme, we found older adults who wished to control their own medication, and at the other, we found some who described themselves as having lost their ability to manage it. Older adults with the former profile strived to maintain control over their medication, often able to remember what they had already taken and what they had to take next, even if they could not always name all their prescribed medications. They felt it was crucial to maintain autonomy in their medication management, and any loss in independence would be difficult to accept.

OA22 explained her need to be informed about her medication during her last hospitalization, following pneumonia, and she compared herself to other patients.

"(...) I said to my son, 'Bring everything to the hospital.' And I even had him bring the box that was in the refrigerator. I said they had to put it in the fridge there, because I don't want to be changing my medication 36,000 times. Maybe I'm a pain, but that's the way it is. You see, I want to manage things depending on whether they're any use. I don't want to take anything just for the sake of it. You understand? (...) So, there are some people who don't worry about that. They... they swallow their pills any old way. No, me, I want to know what I'm taking. And why. (...) So, I don't know why they change my medication without telling me. They just give you the prescription, and that's it. No, me, I want to know the whys and wherefores."

Nevertheless, most of the participants only realized that their medication had changed, or that new medication had been added while they were in hospital, once they had got home. This was the case with OA05, hospitalized following a diagnosis of rectorrhagia. She received one new medication in hospital, but only learned about its contraindications on her return home; she decided that one of them matched her profile and decided to stop taking it without consulting her GP.

“She’d given me some sleeping pills [Distraneurin®]. Then I had a look. And it was written that if you had a cough, and all that, then you shouldn’t take it. So, me, because I had asthma and I was coughing, I didn’t dare take it.”

In addition, OA22 explained her efforts to maintain control of her medication preparation at home and how this was not always well understood by professional caregivers—in this case, by an independent home-care nurse caring for her after her discharge.

“(…) I’d laid it all out here, and I said to her, ‘You can ask me which medication is which.’ Then she [the independent home-care nurse] said to me, ‘Give it all to me.’ I said, ‘No. I won’t let you put your hands in my medication drawer because they’re...’ You see, they are always set out in the same way: Lisinopril®, Plavix®, Atorvastatin®, Trajenta®. Everything’s set. I don’t want anyone sticking their hands in there and moving it about. So, I said, ‘You ask me, and I’ll give it to you.’”

Older adults who wished to control their own medication sometimes sought to prove, from the outset, that their cognitive faculties, such as their decision-making capacities, were intact. OA10—hospitalized for lower back pain—underlined his need to control his medication management, which he did by deliberately not adhering to some medications given to him in hospital and after discharge home.

“No, because even at the hospital, I refused to take any medication, eh! (...) I want to have some control. (...) Yesterday, nothing. Today, nothing [Dafalgan®]. (...) I took that

decision. Why? I've already got a patch. It's the patch I've got against pain. If I've then got to take the Dafalgan® too, then I'll intensify these analgesics. What's the good of that? If it put me in a state of... No! (...) No, I'm not bedridden, me. Even if I was in that state, I wouldn't take that. (...) she [the CHC nurse] was supposed to change the patch for me, and I said that I don't want it. We'll see how it's going on Friday."

At the other extreme of the continuum, some older adults talked about being resigned to their health status, accepting decisions made about their medications, and obeying the professional recommendations made to them. For example, IC15 underlined her husband's continued acceptance and passivity.

"(...) He's a very agreeable patient, because he'll never contradict, never... He lets himself be cared for. I think that's also part of the reason that he's still here. (...) He's brave, but he's passive too. That's to say, he may get annoyed inside, but he doesn't show it. I can't do it, but he listens to what he's told and then he does what he's told. He accepts it—that's why he's still here."

Resignation seemed to be built on trust in professional caregivers, as described by OA01 with regards to her medication management.

"They did what they were supposed to, huh. I couldn't say, 'No, I don't want those particular pills.' Why? Because I was in their hands. I had to do what they wanted, you know?"

To different degrees, these older adults all let go of any active participation in their medication management and they handed over the responsibility to their informal and professional caregivers. Informal caregivers noticed these changes in attitude, as IC01a (daughter of OA01) described.

“(...) she’s come to a stage where she doesn’t give a damn. (...) She’s arrived at a stage in her life where she tells herself, ‘Well, I don’t have any choice, do I?’”

Other participants with this sort of profile had a rather obedient attitude but nevertheless retained an interest in their medication. One example was OA18, who very frequently solicited his pharmacist (Prof18) to ask him questions about his treatment, probably to progressively regain control in the same rigorous way he took his medication.

To summarize, despite some extreme attitudes along a continuum, most older adults described, at different levels, their desire to be informed, to be listened to, and to be involved in decision-making about their medication management at home after hospital discharge.

Informal caregivers’ perceived needs for help in supporting and coordinating medication management

Informal caregivers described the diverse tasks they carried out to ensure optimal medication management and their older adult’s safety following discharge home. They also described the negotiations they took part in regarding medication management coordination. These elements ensured effective medication management and the older adult’s safety, helping to prevent possible adverse health outcomes. Some informal caregivers, like IC12, equated institutionalization to a failure of the coordination system in place.

“Me, I say, he’s lucky, because if we weren’t here, he’d be in a care home.”

Another informal caregiver (IC11) went to the hospital to collect a prescription for Tramal® on realizing that their older adult relative had not been discharged with it. On discharge home, other informal caregivers (IC25, IC04, IC17b) went to pick up medication at the pharmacy, prepared pill-boxes, or drew a visually pleasing medication schedule. They also administered medication, accompanied older adults to medical consultations, and participated in ADL. This was also emphasized by older adults, as when OA01 explained that because she “*can’t do*

anything anymore", her two daughters had to do lots of things for her instead. Meanwhile, after discharge, other informal caregivers stopped performing certain tasks for safety reasons: as their older adult relative was less autonomous, some tasks simply became more dangerous, both for their relative and themselves.

Numerous descriptions of negotiations with professional caregivers revealed the central role informal caregivers played in older adults' day-to-day medication management. The informal caregivers interviewed tended to support the wishes of their older adult relatives, often playing an active role in sharing out tasks across the older adult's care network, in addition to completing tasks themselves. Although informal caregivers took on some functions, they described needing professional help with others. OA01's two daughters took care of remembering and administering medication, but they asked the pharmacy to prepare the pill-box in advance and the CHC for daily monitoring and support in the ADL and IADL. Furthermore, some informal caregivers set limits to their roles, as OA08's daughter explained. OA08 had been initially hospitalized for surgery on a cerebral tumor and then rehospitalized soon afterwards following a night-time fall.

"(...) Then I told myself, 'Listen. They can detect if suddenly there's something that's not quite right. (...) Me, I'm not a nurse. (...)".

IC15, for example, decided to stop managing her husband's medication and ask for professional help.

"So then I said, 'I'm not taking care of that. I've got other things to do, and that's too delicate', and then because I'm anti-medication, I don't want to touch it."

IC15 nevertheless remained an extremely involved informal caregiver through her involvement in the IADL, ADL, and the coordination of care.

"Oh, yes, I manage it all. Me, I don't let anything get by me. No way."

Some informal caregivers, like IC02, IC04, and IC07, spontaneously spoke about how they were overloaded and of the burden of ensuring that care transitions and home-care services functioned properly. As IC04 described:

“I’m exhausted from having to coordinate with all the different professions who don’t do things the same way—with all those people, and it’s not my field, etc. And then, at the same time, you have to try and make a good impression. Give them a big smile. ‘How are you? Is everything all right?’ etc. And then continue making meals, etc.”

To summarize, this theme highlighted the complexity of the support informal caregivers provide to medication management and their needs for help to keep supporting their older adult relatives and coordinating the different professional caregivers involved. Informal caregivers’ expectations of the role of professional caregivers in medication management after discharge from hospital did not always correspond to the care actually provided.

Older adults’ and informal and professional caregivers’ perceived needs for better communication and coordination between professional caregivers

According to the professional caregivers interviewed, an effective medication management transition from hospital to home began before hospital discharge and was dependent on communication between the health and social care professionals involved in discharge planning. This involved exchanges between the liaison nurse and home-care services about the treatments prescribed at hospital discharge. After discharge home, several professional caregivers were involved in medication management: GPs, home-care nurses (from the CHC, free-lance, or in protected accommodation), and sometimes, depending on the older adult’s needs, pharmacists, physiotherapists, CHC occupational therapists, dieticians, and specialist physicians.

Older adults placed GPs and home-care nurses at the center of their support networks for medication management and assigned them the role of coordinating and collecting all the

relevant information, especially information coming from the hospital. Because they knew the older adult before their hospitalization and were easily available to respond to problems or questions, they could verify whether new medication interfered with or affected an old one and whether any medication should be suspended, stopped, or replaced. Several participants cited home-care nurses as the professional caregivers most involved in their medication management, assuming a coordination role. We noted that this was often the case among the more functionally impaired older adults, whether living alone or with an aged partner, such as OA15, who was hospitalized following a stroke. His wife, IC15, was central to his health management, as evidenced in their two interviews, in which her husband participated only minimally. Given OA15's level of dependence, IC15 asked for assistance from the CHC following her husband's hospitalization, notably to prepare his weekly pill-box.

“(…), but we have to have a nurse come around. I don't want to take care of the medication anymore. They [the CHC nurses] prepare the weekly pill-box (…). They order the medication; they do everything. (…). Oh, yes, and its [the nurse] who checks it. When anything's missing, it's her who makes the order for new medication. (…).”

Collaboration between GPs or CHC nurses and community pharmacists were only occasionally mentioned. Prof01 was a pharmacist designated by OA01's two daughters as the healthcare professional who contributed most to their mother's day-to-day medication management. Prof01 explained that the hospital or the liaison nurse faxed or sent a secure email in advance so that the community pharmacy could order and prepare particular medications that might not be in stock; in cases of doubt, they contacted OA01's GP.

IC12 was the daughter of OA12, hospitalized following decompensated chronic obstructive pulmonary disease. She explained the reasons why she solicited the help of a pharmacy for the preparation of OA12's weekly pill-box.

“(...) because before we did it ourselves as there were not too many quarter- or half-pills. And then it changed. One day it’s so many pills and so many half-pills and quarter-pills, and after that, the next day, it changes. It’s so we don’t get it wrong. We wouldn’t want to get it wrong.”

IC12 also described the complex day-to-day coordination between the professional caregivers involved in OA12’s medication management.

“So, it’s the pharmacy [that prepares the medications]; we have the sheet. Every time we leave the hospital, they provide us with the sheet with which medications to take. And then afterwards, there’s the nurse who comes once a week to give the Sintrom® as well. To check on the Sintrom®—and on us, really—the nurses come twice a week to check his weight, blood pressure, and report to the doctors. (...) She [the GP] does home visits if it’s really necessary.”

According to Prof01 (a pharmacist) and Prof03 (a CHC nurse), the collaboration between pharmacists and home-care nurses was recently strengthened thanks to a regional pilot project on the prevention of adverse drug events. As Prof03 explained, this offered patients with polypharmacy the chance to have their weekly pill-boxes prepared in a pharmacy instead of in the older adult’s home by a home-care nurse, with the aim of promoting medication reviews and double-checking by professionals:

“Yeah, in fact, we put that in place so that we could delegate the preparation of weekly pill-boxes to pharmacies. So, when the pill-boxes are simple and they don’t change too much—because the situations at home aren’t too complex—then we ask the pharmacies to prepare the pill-boxes and deliver them to the CHC. And we take them to people if they can’t collect their pill-boxes. We deliver them directly to their homes. But we’ve got fewer and fewer weekly preparations to do; we only keep the complex weekly pill-boxes—those with frequent changes and unstable situations.”

Although collaboration during care transitions seemed to work well for some participants, others raised points of concern. From the professional perspective, one GP (Prof21) and one home-care nurse (Prof04) considered it potentially harmful that there was often a long delay between when they were called upon to intervene in care transitions after a hospitalization and the moment when they received the paperwork informing them of discharges. This was particularly relevant when there were changes in medication treatments, as for OA04. At her discharge, following hospitalization for a fall at home, OA04 and Prof04 recalled that there was a lack of coordination. Prof04, a nurse in the protected accommodation where OA04 lived, described the difficulties experienced when the hospital failed to transmit new prescription and discharge documents to the GP. After OA04 had an adverse reaction to her medication, she explained:

“(...) I called the doctor and he said to me, ‘But I haven’t received any paperwork.’ There was no information on her... (...) I find that there is often a lack of communication, or sometimes the hospital tells us that they are sending us the discharge documents, but we don’t receive anything.”

Indeed, communication by post sometimes seemed less effective than wished for, as one GP (Prof21) confirmed. He wanted discharge letters or consultation notes to be transmitted earlier because delays could lead to misunderstandings and errors.

Poor communication could also occur between professional community caregivers like home-care nurses and GPs, compromising the quality of medication management and perhaps even the older adult’s safety. This was described by OA28, living alone and hospitalized for abdominal adhesions with obstruction.

“(...) I said to [the CHC staff], ‘But if I get something like I got last time, what good does it do if the information doesn’t go any further? You should inform my GP. That’s the least you could do.’ I always thought that those sorts of reports got made. (...) So, I

said, 'Listen, now. At all costs, when something special occurs, like last time, you come by on Tuesday morning, and in the afternoon, I should go to the emergency department. Have you noted that down? You're writing lots down, but...' (...) So, I said that it wasn't normal that my doctor wasn't informed. I had to inform her myself. Yes!'

IC04 also described her dissatisfaction with the CHC staff's communication and coordination and the need for more effective medication management of her mother's pain.

"(...) And, in fact, when we looked, we noticed that quite a few errors had been made by people all along the chain of care. (...) We've got a table where we note which day we have to put which patch on [Fentanyl®]. Every 72 hours, they've got to be changed. (...) There was this mismatch where, in fact, she found herself changing the patch every 24 hours, and then later, there was no patch for 4 days until I called up the CHC. The person in charge said to me, 'But Madame, you just asked for assistance, not for a ...' (...) They knew we had to put on a patch, but she couldn't authorize it. She didn't do it. I said to her, 'So you can see a person suffering right in front of you, you know that they need to put on a patch, and you don't do it. Do you find that normal?' 'Well, yes. You asked for a home-help, not a home-nurse, etc.' So, it's been an ordeal getting this accepted, etc., getting them to accept it."

These organizational difficulties, just for changing a Fentanyl® patch, were reiterated by Prof04, the nurse working in the protected accommodation where OA04 lived.

"(...) So, there were often problems like that. I think that because there are several of us... (...) It's true that collaboration is so important, that information gets transmitted from the hospital to the CHC, to doctors and to us. Even if we are not a medical care institution, it's still important that we get the documents."

In summary, several actors—both professional and informal—were involved in different ways depending on the complexity of the older adult's clinical picture and the informal care resources

at their disposal. However, all the interviews pointed to a perpetual search for better communication and coordination between professional caregivers for more effective collaborative medication management.

Discussion

Our findings provided a description of older adults' and informal and professional caregivers' needs with regards to collaborative medication management after hospital discharge. Four main needs emerged from our analysis. Whereas some of those needs were common to all the actors involved (e.g., better communication and coordination between professional caregivers; more collaborative involvement in discharge planning), others were specific to just one group (e.g. older adults' perceived needs to be informed, listened to and to be involved in decision-making; informal caregivers' perceived needs for help in supporting and coordinating medication management).

Both older adults and their informal caregivers expressed a need for more involvement in discharge planning. Not only was discharge planning often considered unsatisfactory or absent, and discharge home inadequately organized, but older adults also felt insufficiently listened to or involved in discharge planning, corroborating recent findings in Switzerland [30]. Following their discharge from hospital, older adults and their informal caregivers perceived medication management at home to be complex during this period of instability, where existing strategies to support care coordination came under pressure. From our interviews, there was no *usual* procedure for ensuring optimal medication management for older adults after hospital discharge (e.g., being called in for a medication review by a GP). Older adults and their informal caregivers were confronted with more functional impairments during these transition periods and the uncertainty of whether they would be able to manage their medication and remain in their homes in the future. This was in line with Parekh *et al.* [13] findings about older adults' lived experiences of medication-related harm during the hospital discharge period. These

revealed that care transitions were a critical period, when older adults felt vulnerable and less confident about understanding information. Tomlinson *et al.* [14] found that older adult patients and their informal caregivers evoked how hospital discharge and changed medication was experienced as a disruption to knowledge, routines, and capability. Even if older adults' and informal caregivers' perceived needs for greater involvement in discharge planning have been revealed in previous studies, our findings emphasized that patients were still not sufficiently involved, despite discharge planning's importance for successful care transitions [1, 8, 12]. This may be explained, although not justified, by the current worldwide trend towards shorter lengths of stay, which places care transitions under increased pressure [31]. In Switzerland—where the healthcare system combines public and private funding—the cantons cover 55% of inpatient treatment costs and health insurance companies cover 45%, whereas for outpatient care, the health insurance companies cover 100% of costs. Cantonal authorities, therefore, are trying to shorten hospital lengths of stay as much as possible and favor outpatient treatment [32], although this overstretches community services.

Our findings also underlined that unsafe medication management was an important issue in care transitions. This was in line with the results of Lee *et al.* [33], who identified medication as one of the five principal themes influencing care transitions. From their multi-method qualitative study examining several perspectives, they designed a framework for a multidisciplinary, coordinated, collaborative *Care Circle* to ensure patient safety and a patient-centered approach to the care transition process. Moreover, there have also been recent advances in the development and application of innovative care pathways and multidimensional discharge planning [34, 35]. Nevertheless, inadequate patient assessment in acute care settings—leading to a lack of knowledge about patients' social circumstances—followed by poor communication between hospitals and community care providers remains a cause of discontinued, fractionated care [34, 35]. Hospital to home discharge planning by a collaborative interprofessional team,

including service referral and education for patients and informal caregivers, has been shown to be effective at providing safe care transitions for older adults with multiple chronic conditions [15]. The advantage of an interprofessional approach is linked to different professionals' abilities to identify and meet the older adult's medication management needs.

Older adults described their needs to be informed, to be listened to, and to be involved in decision-making. While some older adults strived to retain, regain, or consolidate control over their medication management and decisions (sometimes leading to confrontations with professional caregivers), others were resigned and adopted recommendations passively. The need to be proactively involved in their medication management may represent an underexplored resource in the pursuit of medication safety among older adults living at home with polypharmacy. For some participants, maintaining control over their own medication management was a means of displaying their autonomy and cognitive capacities, reinforcing their ability to live at home and thus removing the risk of institutionalization in a nursing home. Still being able to manage one's medication was, therefore, a way for some older adults to legitimize them remaining at home. Holmqvist *et al.* [36] described similar findings in their study about home-dwelling older adults' experiences of evaluations of their medication treatments. Their participants revealed that they were willing to be actively involved in their medication evaluations. Even though older adults trust that their physicians will regularly undertake these evaluations, that is not necessarily the case [36], which contributes to an increased risk of medication-related harm. This is in line with Roughead *et al.*'s coordinated, integrated, multidisciplinary, patient-centered model of care, which states that patient safety can benefit from a co-production approach to medication management, with professional caregivers explicitly sharing information with older adults and agreeing on responsibilities related to ongoing medication treatment [11]. Our findings add knowledge by revealing two types of obstacles to older adults' involvement in their medication management: those of an

individual nature, such as a loss of autonomy or cognitive faculties, and those to do with collaborative practices, such as difficulties communicating within and across the care network or the absence of a healthcare professional with an overarching responsibility for the patient. Professional caregivers should consider the obstacles to older adults being involved in their medication management, including the patient's personal preferences and values regarding discharge planning [30].

Informal caregivers described their needs for help in supporting and coordinating medication management, including complex negotiations to optimize care coordination. They also emphasized their work overload and the burden of ensuring that the healthcare network functioned properly to ensure safe medication management. The present study showed that informal caregivers played a vital role in ensuring safe and appropriate medication use by home-dwelling older adults, especially those who may also have a cognitive impairment. Some participants, however, reported complications related to this activity, including the time spent, anxiety about making mistakes, and solving communication problems or disagreements with professional caregivers regarding medication practices and care coordination. Previous studies showed that informal caregivers could also face uncooperative behavior from their older adult relative, difficulties maintaining continuous supplies of medication, problems administering drugs, and the need to make clinical judgements (e.g., in response to side effects or about over-the-counter medication) [37, 38]. Whereas some informal caregivers in our study expressed their worries about their older adult relative's health and the day-to-day efforts made to ensure effective care transitions and medication management, older adults themselves rarely brought up their relational and affective links with their informal caregivers. Although this finding went beyond our research questions, other studies have revealed that the frequency with which gratitude was expressed was significantly associated with caregiver burden [39] and that greater perceived gratitude was positively associated with informal caregivers' psychological well-

being [40]. Interventions by professional caregivers to improve informal caregivers' mental health might not only reduce the burdens of their role but also enhance their perceived gratitude and support their involvement in medication management.

Older adults, informal caregivers and healthcare professionals all expressed the perceived needs for better communication and coordination between professional caregivers. They described how numerous healthcare actors were involved in medication management after hospital discharge, with GPs and home-care nurses being at the center of the healthcare team. Home-care nurses were more involved in medication management with the most dependent older adults. They also described how dysfunctional communication within healthcare teams compromised the quality and safety of medication management. Medication management was put at risk by the long delays before professional community caregivers received notifications about hospital discharge, particularly if there were changes in medication treatments. Our findings also revealed, perhaps unsurprisingly, that the more actors were involved, the more complex interactions became and the more difficult they were to coordinate, which is in line with Cramm et al. [41] and Bindels et al. [42]. There were diverging points of view, for example, on when and why the preparation of weekly pill-boxes should be delegated to community pharmacies. Whereas pharmacists considered that they only dealt with more complex treatments, two nurses interviewed mentioned that pharmacies took care of "simple" treatments. The notion of what constitutes complexity clearly seemed to differ between pharmacists and nurses. Pharmacists seemed to focus on the complexity of the medication regimen, whereas nurses looked at the complexity of the medication management that would have to take place in older adults' homes (including functional limitations, values and preferences, and the availability of informal caregivers).

As argued by Roughead et al. [11], communication between the different actors involved in older adults' care—both professional and informal—was considered a key element of well-

functioning medication management, particularly during care transitions. However, our findings showed that, in certain situations, communication was clearly lacking, putting effective medication management at risk and, consequently, the quality and safety of older adults' care. Collaborative practices for recently discharged older adults should entail safe medication management and attention to communication, education, competency development, clinical support systems, and policy and regulatory decisions [10, 15]. Interventions that foster communication and collaboration between multiple stakeholders, particularly during care transitions between hospital and home, have been shown to reduce the worsening of chronic conditions and the significant costs of hospital readmission [43]. These interventions include bundled, multi-stakeholder approaches to best meet patients' needs.

Our findings also suggested that once an older adult has returned home with a polypharmacy prescription, follow-up by a community healthcare worker skilled in care management and with established community links to various other services could be a more efficient way to manage the complex medication required for multiple chronic conditions [34, 44]. This role could be performed by a primary care nurse manager, as our findings emphasized that nurses were the professional caregivers who interacted most with all the actors involved in medication management. Nurses' essential role in providing collaborative medication management, given their direct patient contact and their collaborative relationship with physicians, has been documented previously [10]. In addition, our findings revealed older adults' perceived needs to participate in medication decision-making, which requires empowering patients and their informal caregivers [43, 45-47]. By facilitating older adults' empowerment, healthcare providers promote collaborative medication management and shared-decision making, which could encourage them to take control of their own health, with the endpoints of safe medication management and better patient outcomes [48]. Older adults could benefit from a joint empowerment and monitoring approach, with a community healthcare professional taking on

the essential overall responsibility for sharing information and tasks related to medication management (see Figure 1).

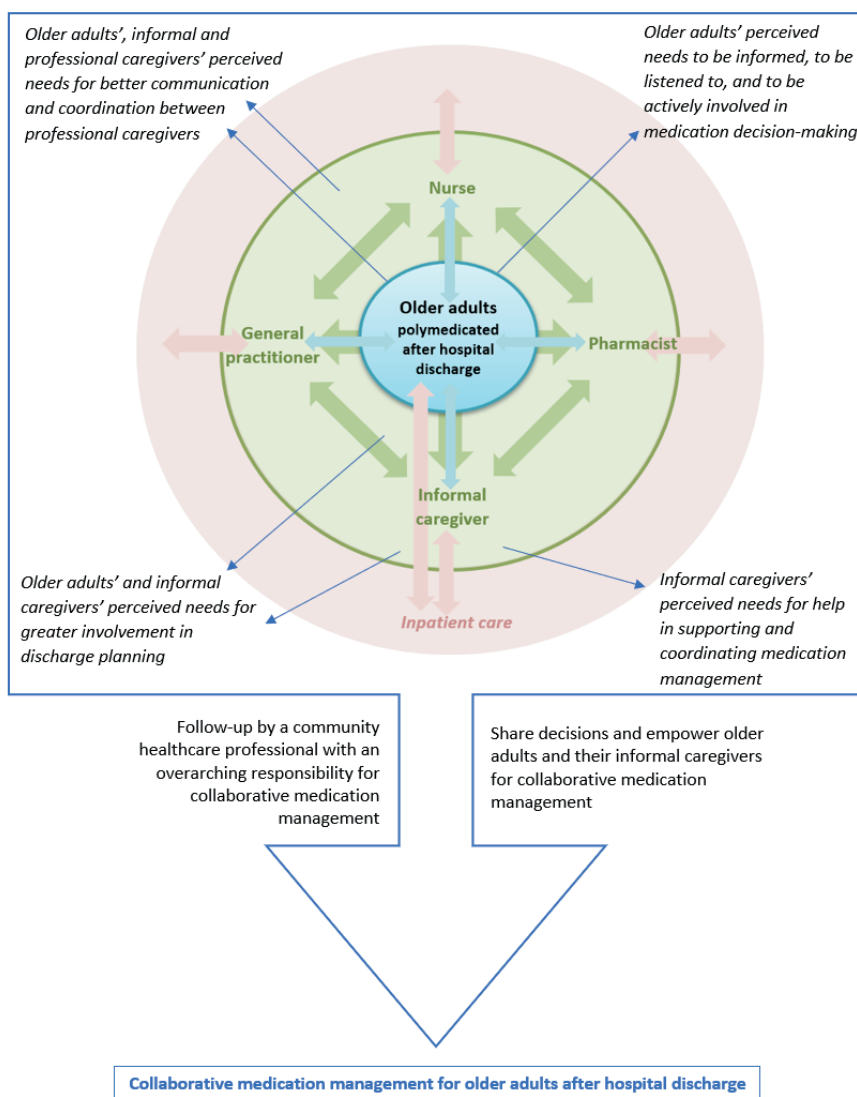


Figure 1. Overlap between older adults' and informal and professional caregivers' perceived needs for collaborative medication management after hospital discharge.

Study strengths and limitations

To the best of our knowledge, scarce qualitative descriptive studies have analyzed the needs for effective, collaborative medication management after hospital discharge expressed by older adults taking several different medications at home and their informal and professional caregivers. According to this multi-perspective description, safe medication management requires collaborative practices aimed at patient-centered care. The present paper adds to the increasing evidence about the importance of collaborative practices for ensuring safe medication management among home-dwelling older adults with polypharmacy after hospital discharge.

Our study had some limitations, however. Data collection had to be suspended at the beginning of March 2020 due to the older adults' and informal caregivers' vulnerability to the COVID-19 pandemic. Data collection was also suspended among professional caregivers because their skills were in such high demand during this crisis. Given the study's longitudinal nature, follow-up data from four of the older adults recruited were lost. Adjusting our qualitative methodology by collecting data via an online platform was unfeasible since our research population was mostly unfamiliar with information and communication technologies.

Another limitation noted during interviews was the difficulty keeping older adults and their informal caregivers focused on the theme of medication management rather than on other IADL and ADL. It was also difficult to maintain focus on the most recent care transition and ignore previous hospitalizations. Planning joint interviews between older adults and their professional caregivers was infeasible, although this could have enhanced our data through this direct access to their interactions. Despite our efforts at methodological rigor, we cannot exclude a risk of social desirability bias among study participants. It is thus possible that medication management was, in fact, less effective and collaborative than its portrayal in the interviews.

Conclusions

Describing the perceived needs of older adults taking several different medications at home, and those of their informal and professional caregivers, for collaborative medication management after hospital discharge revealed several opportunities for improving safety and effectiveness and preventing medication-related harm. Four primary needs were revealed, pointing to two main pathways for improving medication management: firstly, post-discharge medication follow-up by a community healthcare professional skilled in care management, and secondly, empowering older adults and their informal caregivers and sharing decision-making with them regarding medication management.

Further research, applying different research methods, will be required to identify how to meaningfully engage with older adults and their informal and professional caregivers in order to best support safe post-discharge medication management. Moreover, further research involving joint professional interviews or focus groups (bringing together nurses, GPs, and pharmacists) would be needed to continue to improve our knowledge of and interventions for safer collaborative medication management.

List of abbreviations

ADL : Basic activities of daily living

CHC : Community healthcare center

GP: General practitioner

IADL : instrumental activities of daily living

IC: Informal caregiver

ICD-10: 10th revision of the International Statistical Classification of Diseases and Related Health Problems

OA: Older adults

Prof: Healthcare professionals

Declarations

Ethics approval and consent to participate

The study was approved by the Human Research Ethics Committee of the Canton of Vaud (2018-02196, 01.02.2019) and by our field partners' institutional review board. All participants gave their written informed consent and, to maintain their anonymity, sociodemographic data, interview recordings, transcripts, and files containing identities were securely stored using passwords. Only research team members had access to them.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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Authors' contributions

All authors conceptualized and designed the study. HV secured the grant to conduct the study. FP and MB organized data collection, carried out the interviews and data analysis. MdRC and HV supervised data analysis. FP and HV wrote the manuscript. All authors read and approved the final manuscript.

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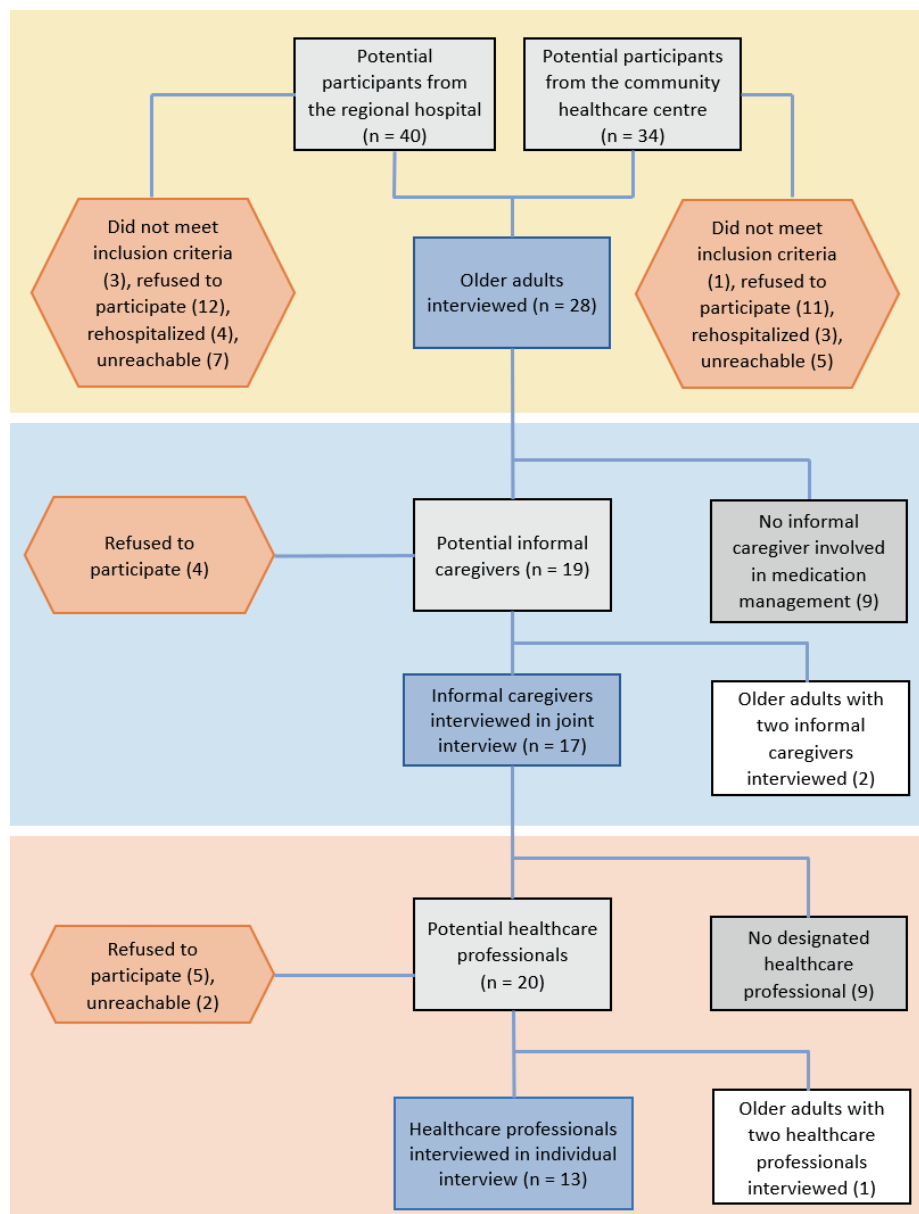
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Supplementary File 1

Description of the Enrolment Process



Supplementary File 2*Interview guides*

The interview guides were inspired by our literature review and tested in a preliminary study [1]. The original French versions were approved by the Human Research Ethics Committee of the Canton of Vaud on 5 July 2017 (2017-01025) and on 1 February 2019 (2018-02196), as well as by the institutional review board of our study's field partners. The guides have been translated into English for publication.

Interview 1: Older adult

Topics	Items
1) Presentation	Presentation of the study Presentation of the interview's objectives Details of the ethics measures taken
2) Experience of hospitalization and hospital discharge	General experience of the hospital stay Experience with medication received in hospital: - Changes to usual treatment in hospital - Information received in hospital about medication changes - People involved - Tools received in hospital to help manage medication at home
3) Experience of the return home	General experience and process of return home Experience with medication since returning home: - Management of medicines (and any changes made in hospital) since return home - People involved in medication management at home - Perceptions/experiences of taking several medications per day - Methods put in place to avoid forgetting to take medication, keep to the right schedule, and avoid taking the wrong medication - Taking other health or wellness products
5) Socio-demographic data	
6) End of the interview	Reminder of the ethical requirements for using the data collected in the interview

Medication Management in Older Adults Discharged Home

Interview 2: Older adult

Topics	Items
1) Presentation	Presentation of the interview's objectives Reminder of the details of the ethics measures taken
2) Daily medication management	Description of daily medication management: - Medication management locations (taking, storing) - Schedules - Routines
4) Support at home for medication management	People involved in the day-to-day management of medicines: - Who (people involved) - Frequency of assistance - Type of assistance
3) Experiences with medication	Medication habits and changes: - Time of onset of medication (before, during and after hospitalization) Knowledge about medications: - Indication for each medication - Effects of each medication - Possible precautions - Most important medication Satisfaction with information received about each medication Wish to ask questions about a particular medication
4) End of the interview	Reminder of the ethical requirements for using the data collected in the interview

Medication Management in Older Adults Discharged Home

Interview 3: Joint interview with the older adult and their informal caregiver

Topics	Items
1) Presentation	Presentation of the study Presentation of the interview's objectives Details of the ethics measures taken
2) Older adult–informal caregiver relationship	The relationship between them Assistance provided in ADL and IADL
3) Experience of the return home	Process of hospital discharge and return home: - Experience with medication changes - Information received - Experience with medication since returning home - Support for medication management
4) Involvement in medication management	Activities where the informal caregiver is involved in medication management How it happens Example
5) Sociodemographic data	
6) End of the interview	Reminder of the ethical requirements for using the data collected in the interview

Medication Management in Older Adults Discharged Home

Interview 4: Professional caregiver involved in medication management

Topics	Items
1) Presentation	Presentation of the study Presentation of the interview's objectives Details of the ethics measures taken
2) Experience with the older adult in relation to medication management	Since when has Mr./Mrs. X been followed Type of intervention(s) for medication management (prescription, preparation, administration, monitoring, etc.) Frequency of intervention Process of hospital discharge and the return home: - Information received before the first visit after hospitalization - Possible changes in usual medication Progress of the medication adjustment Any difficulties encountered with Mr./Mrs. X regarding medication management
3) Sociodemographic and professional data	
4) End of the interview	Reminder of the ethical requirements for using the data collected in the interview

1. Roux P, Verloo H, Santiago-Delefosse M, Pereira F. The spatial dimensions of medication management by home-dwelling older adults after hospital discharge. *Health Place*. 2019;60:102230.

Supplementary File 3

Older Adult Participants' Characteristics

Older adult ID	Age	Sex	Marital status	Living with	Hospital length of stay (days)	Number of ICD-10 diagnoses	Number of medications	Principal ICD-10 diagnosis for hospitalization
OA01	92	F	widow	alone	6	7	12	M80.88 Other osteoporosis with current pathological fracture, vertebra(e)
OA02	66	M	married	spouse	112	27	21	B25.80 Cytomegaloviral disease of the digestive system
OA03	73	F	married	spouse	39	12	8	C16.3 Malignant tumor: pyloric antrum
OA04	82	F	divorced	alone	20	25	14	S70.0 Contusion of hip
OA05	71	F	widow	alone	60	12	6	K92.1 Melena
OA06	86	M	married	spouse	14	10	9	J18.0 Bronchopneumonia, unspecified
OA07	94	F	widow	alone	12	10	8	I50.01 Right ventricular failure (secondary to left heart failure)
OA08	73	F	widow	children	12	3	10	N30.0 Acute cystitis
OA09	83	F	widow	alone	37	14	8	T84.04 Mechanical complication of internal joint prosthesis: hip joint
OA10	85	M	widower	alone	18	18	7	M80.98 Unspecified osteoporosis with pathological fracture
OA11	82	M	married	spouse	41	18	13	D64.8 Other specified anemias
OA12	82	M	widower	children	14	17	8	I50.01 Right ventricular failure (secondary to left heart failure)

OA13	75	M	widower	alone	14	9	7	I63.0 Cerebral infarction due to thrombosis of precerebral arteries
OA14	88	F	widow	alone	17	10	7	S22.4 Multiple fractures of ribs
OA15	85	M	married	spouse	34	16	13	I63.4 Cerebral infarction due to embolism of cerebral arteries
OA17	87	M	married	spouse/ children	47	22	11	K80.30 Calculus of bile duct with cholangitis
OA18	86	M	married	spouse	13	5	5	I63.8 Other cerebral infarction
OA19	84	M	married	spouse	5	9	6	G45.0 Vertebrobasilar artery syndrome
OA20	69	M	divorced	alone	13	14	13	I74.3 Embolism and thrombosis of arteries of lower extremities
OA21	75	F	married	spouse	13	16	6	R26.8 Other and unspecified abnormalities of gait and mobility
OA22	83	F	widow	alone	8	5	7	J13 Pneumonia due to Streptococcus pneumoniae
OA23	87	F	widow	alone	5	8	11	A08.1 Acute gastroenteropathy due to Norwalk agent
OA24	74	M	married	spouse	8	13	9	J18.1 Lobar pneumonia, unspecified
OA25	88	M	married	spouse	12	18	7	I50.01 Left ventricular failure
OA26	76	M	married	spouse	1	4	4	C22.0 Liver cell carcinoma
OA27	77	M	married	spouse	12	11	8	C20 Malignant neoplasm of rectum
OA28	89	M	widower	alone	14	9	14	K56.5 Intestinal adhesions [bands] with obstruction (post-infection)
OA29	81	M	married	spouse	4	9	8	K80.20 Calculus of gallbladder without cholecystitis without obstruction

Supplementary File 4*Informal and professional caregivers' characteristics*

Older adult ID	Informal caregiver ID	Age	Sex	Relationship	Healthcare Professional ID	Profession	Age	Sex
OA01	IC01a	59	F	Daughter	Prof01a	Pharmacist	40	F
	IC01b	67	F	Daughter	Prof01b	Pharmacy assistant	28	F
OA02	IC02	58	F	Wife	No designated healthcare professional			
OA03	IC03	71	M	Husband	Prof03	Nurse	30	F
OA04	IC04	54	F	Daughter	Prof04	Nurse	43	F
OA05	Not involved in medication management				No designated healthcare professional			
OA06	Refused to participate				No designated healthcare professional			
OA07	IC07	52	F	Daughter-in-law	Prof07	Nurse	31	M
OA08	IC08	55	F	Daughter	Prof08	Pharmacist	56	F
OA09	Not involved in medication management				No designated healthcare professional			
OA10	Not involved in medication management				Refused to participate			
OA11	IC11	57	F	Wife	Refused to participate			
OA12	IC12	48	F	Daughter	No designated healthcare professional			
OA13	Not involved in medication management				Refused to participate			

OA14	Refused to participate			No designated healthcare professional		
OA15	IC15	84	F	Wife	Prof15	Nurse 58 F
OA17	IC17a	85	F	Wife	Prof17	GP 54 F
	IC17b	52	F	Daughter		
OA18	IC18	86	F	Wife	Prof18	Pharmacist 54 M
OA19	Refused to participate			No designated healthcare professional		
OA20	Refused to participate				Prof20	Nurse 46 F
OA21	IC21	80	M	Husband	Prof21	GP 39 M
OA22	Not involved in medication management			Refused to participate		
OA23	Not involved in medication management			No designated healthcare professional		
OA24	Not involved in medication management			Refused to participate		
OA25	IC25	76	F	Wife	Unreachable	
OA26	IC26	75	F	Wife	No designated healthcare professional	
OA27	IC27	80	F	Wife	Unreachable	
OA28	Not involved in medication management				Prof28	GP - F
OA29	Not involved in medication management				Prof29	Oncologist 47 F

ARTICLE 8

Pereira F, Bieri M, Martins MM, del Río Carral M, Verloo H. Safe Medication Management for Polymedicated Home-Dwelling Older Adults after Hospital Discharge: A Qualitative Study of Older Adults, Informal Caregivers and Healthcare Professionals' Perspectives. *Nursing Reports*. 2022;12(2):403-423. doi:10.3390/nursrep12020039.

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Article

Safe Medication Management for Polymedicated Home-Dwelling Older Adults after Hospital Discharge: A Qualitative Study of Older Adults, Informal Caregivers and Healthcare Professionals' Perspectives

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Abstract: Safe medication management is particularly challenging among polymedicated home-dwelling older adults after hospital discharge. This study aimed to identify and categorise the stressors experienced and reconstitution strategies adopted by older adults, their informal caregivers, and healthcare professionals as they manage older adults' medications after hospital discharge. A primary study collected the perspectives of 28 older adults, 17 informal caregivers, and 13 healthcare professionals using a qualitative descriptive design. The Neuman Systems Model was used as the basis for a secondary deductive content analysis. Findings revealed that post-discharge medication management at home involved numerous stressors, often including dysfunctions in communication, collaboration, and coordination between the multiple stakeholders involved. Reconstitution strategies for safe medication management were not always successful or satisfactory and were sometimes identified as stressors themselves. Older adults, informal caregivers, and healthcare professionals' perspectives highlighted several potential opportunities for improving safe medication management through nurse-led, interprofessional, patient-centred practices.

Keywords: safe medication management; home-dwelling older adults; hospital discharge; informal caregivers; interprofessional collaboration; Neuman Systems Model; stressors; reconstitution; secondary deductive content analysis

1. Introduction

Inappropriate medication management can put older adults dependent on complex medication regimens at risk of medication-related problems (MRPs) [1,2]. These risks are increased in cases of polypharmacy (commonly defined as five or more medications daily) due to the pharmacokinetic and pharmacodynamic changes inherent in ageing [3,4]. MRPs include adverse medication reactions, medication errors, and potentially inappropriate prescriptions [2].

A quantitative descriptive study on the knowledge, attitudes, and behaviours surrounding medication use by home-dwelling older adults with chronic conditions revealed several dysfunctions that might trigger MRPs [5]: 75% of participants stated that they had received no information on medication use; 82% did not know about potential side effects; 68% did not take some medication doses; 46% discontinued their medication without asking their physician; 19% did not take their medicines regularly; 82% used other

medicines without their physician's advice; and only 7% appreciated using their medication. Inadequate explanations about medication result in omissions and incorrect dosages but can also lead to anxiety and confusion among older adults [6], increasing the risk of MRPs [7]. Nicosia et al. [8] conducted a qualitative study among older adults, primary care physicians, and pharmacists to identify MRPs from the perspective of patients and healthcare professionals. Their findings were grouped into four broad categories: obtaining medications, taking medications, medication effects, and communication and care coordination related to medications. Moreover, older adults often described MRPs with regards to their socioemotional effects on their lives, which contrasted with existing taxonomies for categorising MRPs [8].

Without preventative measures, MRPs can lead to physical and cognitive decline, exacerbated chronic medical conditions, rehospitalisations, avoidable health costs [9–11], and, sometimes, unplanned institutionalisation [12]. Nurses can play a crucial preventative role in ensuring safe medication management for polymedicated home-dwelling older adults [13,14]. Nursing interventions in medication management can help prevent unnecessary hospitalisations, emergency department visits, and admissions to assisted living facilities, as well as improve patients' quality of life [15]. A recent systematic review explored nurses' roles in medication management during transitional care, identifying three main contributions: (i) involvement in the medication reconciliation process through obtaining medication histories, performing medication reviews, and identifying medication discrepancies; (ii) involvement in interprofessional teamwork, highlighting nurses' roles in clarifying worries about medication, interdisciplinary communication and consultation, and discharge planning and monitoring; (iii) and involvement in supporting patients, emphasising nurses' responsibilities in communication with patients, education about medications and simplifying medication regimens, and symptoms management during transitional care [13].

In addition to nurses' contributions, informal caregivers are also considered key partners in safe medication management for home-dwelling older adults with multiple chronic conditions, notably those who may suffer cognitive impairment or psychopathological disorders [16–18]. They accompany patients to health consultations, help obtain, prepare, and administer medication, monitor adherence, effectiveness, and side effects, and organise home care support [17].

Managing medication requires interprofessional, patient-centred, collaborative practices across different healthcare and social care providers, organisations, and departments [7]. Orchard [19] defined this concept as a partnership between a team of healthcare professionals and a patient, where the patient retains control over their care and has access to the team members' knowledge and skills and thus arrives at a realistic shared plan of care with access to the resources to achieve that plan. Care coordination problems, associated with poor medication management, are even more frequent in the sensitive period of care transitions, such as discharge home from the hospital [5,6].

Different interventions have been tested to support medication management and prevent MRPs, such as pharmacist-led medication reviews [20] and nurse-led interventions to improve medication adherence [14]. Because such top-down interventions have shown limited long-term effectiveness, there is a need to consider complementary bottom-up approaches, exploring modifiable patient-centred determinants. A deeper understanding of older adults' needs and the barriers to safe medication management might enable the development and testing of patient-centred, bottom-up interventions.

To help bridge this gap, this study aimed to use the perspectives of older adults, their informal caregivers, and healthcare professionals to identify and categorise the difficulties experienced by polymedicated home-dwelling older adults trying to manage their medication after hospital discharge (*stressors*). A second aim was to identify and categorise the response patterns adopted to overcome these difficulties and prevent MRPs (*reconstitution strategies*).

2. Materials and Methods

2.1. Study Design

This study was conducted using a qualitative descriptive design. This approach is often used in healthcare research to inform practice by providing a comprehensive, descriptive summary of the perspectives of participants directly experiencing a phenomenon [21,22]. These different perspectives were captured through semi-structured individual interviews with older adults and healthcare professionals and joint interviews with older adults and their informal caregivers. Using secondary, deductive content analysis, this study analysed data collected in a mixed-methods study supported by Switzerland's National Research Programmes [23]. The primary study had documented the state of medication management practices among polymedicated, home-dwelling older adults after hospital discharge and had made proposals to prevent MRPs and support collaborative medication management [23,24]. Because the nature of the data collected had revealed the existence of difficulties (*stressors*) and response patterns (*reconstitution strategies*), the research team developed a secondary analysis guided by the NSM. The Consolidated Criteria for Reporting Qualitative studies (COREQ) guidelines were followed [25].

2.2. Theoretical Framework

The Neuman Systems Model (NSM) was used as a framework for identifying and categorising the difficulties and response patterns experienced by polymedicated home-dwelling older adults trying to manage their medication after hospital discharge and their impacts on client system stability. As per the NSM, those difficulties were considered *stressors* and response patterns were considered *reconstitution strategies* [26–28]. This framework also guided the study's implications for clinical practice to support safe medication management and prevent MRPs as part of nurse-led, interprofessional, collaborative practices [29,30].

The NSM perceives the individual as a “client system”, illustrated as a series of concentric circles surrounding a basic structure [28]. The basic structure consists of factors common to all persons (such as genetic features or the strengths and weaknesses of their organ systems). The concentric circles surrounding this basic structure—the flexible line of defence, normal line of defence and lines of resistance—have a protective function for the client system's integrity. They act as protective buffers preventing stressors from invading the client system. Stressors are described as tension-producing stimuli occurring in the client system's internal and external environments and having the potential to cause system instability. Environmental stressors are classified as intrapersonal (when occurring inside the client system's boundary), interpersonal (occurring outside but proximal to the client system's boundary), and extrapersonal (occurring outside but distal to the client system's boundary).

In the NSM, health corresponds to optimal system stability, which is “the best possible state of wellness at any given time” (p. 23). In a robust person, the flexible line of defence is strong enough to maintain system stability and prevent stressors from penetrating it. Once a stressor has overcome the normal line of defence and the lines of resistance and symptoms are being treated, the client system attempts to recover system stability. This process is called *reconstitution* and can result in higher or lower levels of system stability and wellness than before the stressor hit.

Three types of nursing interventions are proposed for retaining or returning to client system stability: primary, secondary, and tertiary interventions [28,29]. Primary preventive interventions aim to protect and reinforce the client system's normal defences to prevent stressors from overcoming them and retaining system stability. Secondary preventive interventions aim to protect the client system's basic structure when it has been penetrated by a stressor. Secondary interventions are essential to detecting stressors, reducing or eliminating their impact, treating symptoms, and strengthening lines of resistance. Tertiary prevention aims to protect the reconstitution of the client system's stability after treatment/secondary prevention.

2.3. Participants and Recruitment

We purposefully sampled participants for recruitment with help from research nurses at the regional hospital and community healthcare centre (CHC) in the French-speaking canton of Valais, Switzerland. CHCs are patients' first contact point with primary healthcare professionals and Switzerland's healthcare services system. They are tasked with being patient-focused (not disease-focused) and coordinating and integrating care over time [31]. Home-dwelling older adults receive their first-line healthcare services from CHC nurses (involving case and care management, health promotion, detection, prevention, interventions, and treatments), who also play key roles in decision-making and enhancing communication and collaboration between professional and family caregivers [31,32].

Research nurses identified and recruited 28 polymedicated, home-dwelling older adults who had been discharged from hospital in the last 90 days. Ninety days was chosen because Tomlinson et al.'s systematic review and meta-analysis regarded this as a period susceptible to MRPs [33]. Older adults who met the study inclusion criteria (Table 1) had the study described to them and were asked for permission to be contacted by the researchers. Between 7 and 90 days after their discharge, investigators contacted the home-dwelling older adults by telephone and requested their consent to participate in the study. If they agreed, an initial meeting was organised in the older adult's home in the ensuing days.

Next, an informal caregiver ($n = 17$), identified by a successfully recruited older adult as the person most involved in their medication management, was also asked for their written informed consent to participate. Informal caregivers were defined as family members, neighbours, or friends assisting dependent older adults with at least two of the basic or instrumental activities of daily living (ADLs or IADLs) or helping to ensure patient safety [34]. Our local clinical experience has shown that involvement in an older adult's medication management involves one or more of the following activities: attending healthcare consultations, assisting with acquiring or taking medication, monitoring effectiveness and side effects, supervising adherence to medication schedules, and coordinating home care.

Older adults also identified the professional caregiver ($n = 13$) most involved in their medication management, and they were invited to participate if they were providers of community healthcare services (i.e., general practitioners (GPs), pharmacists, nurses, nursing assistants). Table 1 shows the inclusion and exclusion criteria for each group of participants, and Supplementary Figure S1 shows a diagram representing the enrolment process.

Table 1. Inclusion and exclusion criteria for different groups of participants.

Participants	Inclusion Criteria	Exclusion Criteria
Older adults	Aged 65 or above Hospitalised within the last 90 days [33] Managing at least five different medications daily	Unable to speak and understand French
Informal caregivers	Aged 18 or above Designated by the older adult as the most significant informal caregiver involved in their medication management	Unable to speak and understand French
Healthcare professionals	Designated by the older adult as playing a key role in their medication management	Student Apprentice Unable to speak and understand French

2.4. Data Collection

Data were collected from the mixed-methods study previously mentioned [23]. That primary study used semi-structured individual and joint interviews with older adults, their informal caregivers, and healthcare professionals. Figure 1 presents the data collection process. In total, four interview guides were constructed, one for each interview, inspired from a literature review about medication management and tested in a preliminary study [35,36]. The interview guides are available in Appendix A. This section describes the collection of the parent data set.



Figure 1. Data collection process.

2.4.1. Home-Dwelling Older Adults

At the first meeting in the older adult's home, the investigators described the study in detail, including its two semi-structured interviews (each lasting about an hour)—one to start immediately and the other in two to three weeks. Depending on the participant's tiredness or their clinical condition's complexity, sometimes only one interview was needed. Older adults deciding to participate signed a written informed consent form permitting the investigators to record pertinent personal sociodemographic, health, and comorbidity data based on the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). They also noted numbers of ICD-10 conditions and prescribed medicines taken daily.

The initial semi-structured interview gathered older adult participants' perspectives on their transition from the hospital to home, the treatment information given to them, possible modifications to that treatment, and whether prescribers had considered their experiences and preferences when prescribing their medications.

The second interview concentrated on patients' medication management at home, the care network assisting their medication practices, and their lived experiences of all these interactions. Older adults were interviewed alone or, if needed, with their informal caregiver. COVID-19 health restrictions were coming into force near the end of the data collection period, resulting in the last two older adult participants and their designated healthcare professionals being interviewed by telephone.

2.4.2. Informal Caregivers

When possible and appropriate, joint third interviews were organised [37] with the older adult and their informal caregiver [6], at the older adult's home, soon after the second interview. Joint interviews enabled investigators to observe interactions concerning medication management between that dyad. Caregivers' sociodemographic data were also collected. No informal caregivers had to be interviewed by telephone because of COVID-19 pandemic health restrictions, as the two older adults interviewed this way did not name informal caregivers involved in their medication management.

2.4.3. Healthcare Professionals

Each professional caregiver participated in a roughly one-hour semi-structured interview exploring their perspectives on their interactions with home-dwelling older adults and their informal caregivers on medication management after hospital discharge. These interviews took place in professionals' usual working environments (CHC, medical practice, or pharmacy) and during normal working hours, one to two weeks after the joint, third interview. Primary healthcare professionals' intense workloads made arranging interview appointments more difficult. Sociodemographic and professional data were also collected.

2.5. Data Analyses

Participants' sociodemographic and health characteristics were summarised and analysed using descriptive statistics. The investigators performed separate deductive content analyses of the qualitative data collected in the parent study, as per the method developed by Elo and Kyngäs [38]. Deductive content analysis was chosen because its structure was operationalised using the NSM's theoretical framework [38]. Interviews were transcribed verbatim. Researchers read transcriptions several times to become familiar with their contents. A categorisation matrix was developed using concepts from the NSM (intrapersonal, interpersonal, and extrapersonal stressors, and reconstitution strategies). Every medication management-related quote from the parent study was coded according to these categories. Given that a structured analysis matrix was used, only aspects that fitted that matrix were chosen from the data [38]. An example of coding the data to the categorisation matrix is provided in Table 2.

Individual and joint interviews were considered equally important for capturing different perspectives of the phenomenon. In addition, data analysis was not separated by participating groups (older adults, informal caregivers, and healthcare professionals) because our focus was on the perspectives of the triad and not on each group separately. Indeed, the informal caregivers and healthcare professionals recruited were designated by the older adults.

Investigators' data codes incorporating similar content were compared and combined into subcategories. Similar subcategories were merged by abstraction into the generic categories defined in the categorisation matrix and then separated into the main categories derived from the NSM. The investigators analysed and discussed the data until they reached a consensus. Following this data analysis, the entirety of the interview manuscripts was reviewed to validate the subcategories revealed.

Table 2. An example of coding the data to the categorisation matrix through deductive content analysis within the NSM.

Participants	Intrapersonal	Interpersonal	Extrapersonal
Stressors experienced in medication management after hospital discharge	"I don't take the Brufen® [Ibuprofen] anymore. Because I think it's [the Brufen®] the reason I'm in my current situation." (OA03)	"I don't know why they change my medication without telling me." (OA22)	"Too fast. Yes, yes. I should have stayed a week longer." (OA09)

2.6. Study Rigour

The present study's rigour was ensured by using the four principles identified by Lincoln and Guba [39]: credibility, dependability, confirmability, and transferability.

Credibility was supported by having two researchers (MB and FP) review the data collected. Each interviewer wrote notes on the interview process to ensure that every aspect was appropriately covered as per the interview guidelines and gave a briefing before data were collected.

Confirmability was ensured by meetings to evaluate the research process and the reading and analysis of the data together as a team, by describing the participants' demographics and by including direct quotations from them.

Dependability was ensured by defining clear study stages, keeping research diaries, having regular weekly coordination meetings, and making certain data coding was accurate.

Ensuring transferability included purposefully sampling participants according to the inclusion/exclusion criteria and providing a description of them and the context of their perceptions.

2.7. Ethical Considerations

The primary study was approved by the Human Research Ethics Committee of the Canton of Vaud (2018-02196, 1 February 2019) and by our study field partner's institutional review board. All participants gave their written informed consent, and confidentiality, sociodemographic data, interview recordings, transcriptions, and files containing IDs were stored and secured using passwords. Only members of the research team have access to them.

3. Results

3.1. Sample

Following 28 interviews with older adults, no new information emerged, and we concluded that data saturation had been attained. No further participants were included. Table 3 presents the sociodemographic characteristics of our three groups of participants. Older adult patients had an average of 13 ICD-10 diagnoses when in hospital (range 3–27) and nine prescribed medications at discharge home (range 5–21). Not all the older adults designated an informal caregiver, and not every informal caregiver was involved in medication management. Indeed, only 17 participated in the study, as not all those designated agreed to do so. Thirteen of those interviewed shared the older adult's home, three lived in the same town or village, and one lived outside the canton. Most ($n = 11$) provided daily assistance for multiple ADLs or IADLs.

Autonomy in medication management was very heterogeneous. Whereas some older adults prepared and took their medicines on their own, others needed help from their informal caregivers or health professionals (nurse or pharmacist) for medication preparation and administration. Types of help in medication management also varied and depended on stakeholders coordinating with each other. Supplementary Tables S1 and S2 provide more information on each participant.

Table 3. Participants' sociodemographic and professional characteristics and older adults' numbers of prescribed medications and ICD-10 diagnoses.

Sociodemographic and Professional Characteristics	Older Adults ($n = 28$)	Informal Caregivers ($n = 17$)	Healthcare Professionals ($n = 13$)
Sex (number)			
Female	11	15	10
Male	17	2	3
Age (years)			
Mean/median	81/83	68/67	44/45
Range	66–94	48–86	28–58
Relationship with the older adult			
Spouse/partner		10	
Child		6	
Daughter-in-law		1	
Profession (number)			
Retired	28	9	-
Employed	0	7	13
Unemployed	0	1	-
Nurse			5
Pharmacist/Pharmacy Assistant			4
General Practitioner/Specialist			4
ICD-10 diagnoses (number)			
Mean/median	13/12		
Range	3–27		
Medications (number)			
Mean/median	9/8		
Range	5–21		

3.2. Qualitative Findings

The deductive content analysis of older adults, informal caregivers, and healthcare professionals' perspectives enabled us to identify the stressors experienced by polymedicated home-dwelling older adults attempting to manage their medication after hospital discharge. We also identified the reconstitution strategies adopted to overcome these stressors, restore system stability, and optimise medication management (see Figure 2).

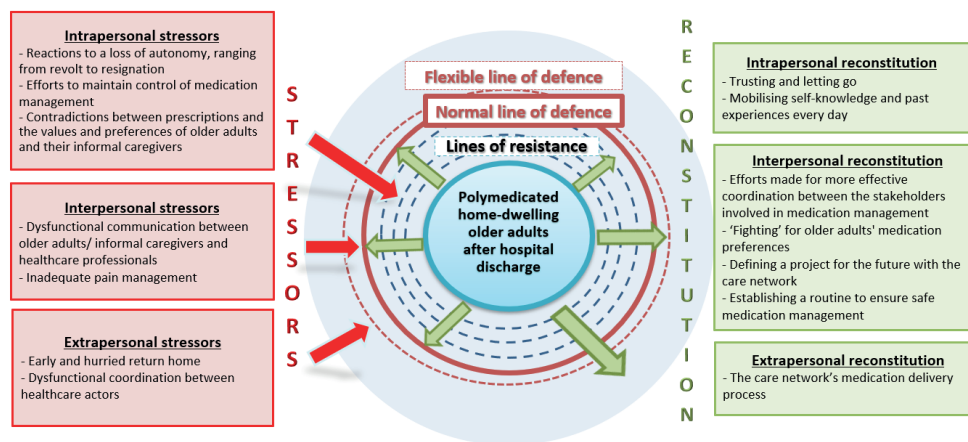


Figure 2. Stressors experienced and reconstitution strategies adopted by polymedicated home-dwelling older adults managing their medication after hospital discharge—inspired by the NSM [28].

3.2.1. Intrapersonal Stressors Affecting Safe Medication Management

Three intrapersonal stressors were identified: *reactions to a loss of autonomy, ranging from revolt to resignation; efforts to maintain control of medication management; and contradictions between prescriptions and the values and preferences of older adults and their informal caregivers.*

The *reactions to a loss of autonomy* were described by the triad of older adults, their informal caregivers, and healthcare professionals as the emotional and identity-related difficulties that older adults lived through with regards to their inability to perform the ADLs or IADLs independently, including medication management. Some, indeed, were quite frustrated, as older adult (OA)09 expressed:

“Yes, because, they... I’m so used to doing everything myself that now it’s very hard not to, that is, to be just sitting here, that’s what hurts me the most.”

Others revealed their resignation to this loss of autonomy, as OA01 noted about their hospital stay:

“They [the hospital] did their duty, right? I couldn’t say, ‘No. I don’t want those tablets.’ Why? Because I was in their hands. I had to do what they wanted, you know?”

This stressor revealed some older adults’ ambivalence about ‘letting go’—letting others take over—most readily seen in the implementation of home care or delegating medication management.

The stressor of *efforts to maintain control of medication management* was described by older adults and their informal caregivers, and it demonstrated older adults’ attempts to manage their daily medication despite the difficulties engendered by frequent changes to their prescriptions. About half of the older adults interviewed expressed their wish to understand their medication better, as OA22 explained:

"I don't want to take drugs for the sake of it. So, some people, they don't worry. They... they swallow pills any old way. No, me, I want to know what I'm taking. And why."

Not being able to understand one's new prescription is not without its consequences. Indeed, for some older adults, their lack of understanding led to non-adherence to treatment:

"Yeah, I don't take the Brufen® [ibuprofen] anymore. Because I think it's [the Brufen®] the reason I'm in my current situation." (OA03)

"She'd given me some sleeping pills [Distraneurin®—clomethiazole]. Then I took a look at the box. So, it was written that, if you've got a cough, you shouldn't take them. So for me, because I had asthma and I was coughing, I didn't dare to take them." (OA05)

The stressor of the contradictions between prescriptions and the values and preferences of older adults and their informal caregivers created tension when older adults and/or their informal caregivers were unhappy with the prescription, especially among those who self-identified as being "anti-medication". Indeed, this can lead to resistance to treatment in opposition to the adhesion to treatment sought and recommended by healthcare professionals. This stressor was described by older adults and their informal caregivers (IC):

"So, I said to myself, I'll keep taking the [Atorvastatin®]. But as soon as I get the stent—in a little while—I'll tell the doctor, 'Well, I can stop that now.' You see, I'm anti-medication." (OA22)

"(...) they changed his medications, for sure, yes, yes, clearly, and he's got far more now, which bothered me because I'm anti-medication, but I have to get used to it." (IC15)

"No, because even in hospital, I refused to take any medications, eh? (...) I want to have some control over it." (OA10)

3.2.2. Interpersonal Stressors Affecting Safe Medication Management

Two interpersonal stressors affecting safe medication management were described by older adults and their informal caregivers, but not by healthcare professionals: *dysfunctional communication between older adults/informal caregivers and healthcare professionals*; and *inadequate pain management*. Regarding dysfunctional communication, inadequate explanations about changes to treatments carried out during older adults' hospital stays were extensively evoked by the majority of the older adults and informal caregivers interviewed:

"They could have talked to me about it before dropping it [Zoldorm®—zolpidem tartrate]. They don't say much, though, eh? They don't communicate with anyone, eh? They speak amongst themselves. They come in together; they leave together." (OA20)

"But over there, you've no, you've got no say in it. They do stuff and that's the way it is. That's the problem. (...) I simply obeyed." (OA10)

"So, I don't know why they change my medications without telling me. They give you the prescription, and there you go. No, I want to know the whys and wherefores." (OA22)

In addition to communication difficulties in hospital settings, communication difficulties and misaligned healthcare goals between the older adult/informal caregiver dyad and healthcare professionals were also highlighted, but far less frequently. Indeed, OA22 described an episode of conflict with her free-lance nurse when she decided—on her own initiative—to reduce the number of times per day she would check her glycaemia level:

"(...) when I saw that I couldn't touch anything anymore, I stopped. I only did it in the mornings. (...) So, she didn't agree. She told me, 'Seeing as you're doing things your way, you don't need me anymore,' and she left. So, that made me a bit... I was sad. I couldn't understand why, because me, I didn't want to prick every one of my fingers. I wouldn't be able to touch anything anymore." (OA22)

Another interpersonal stressor was *inadequate pain management*, mentioned by four older adults and their informal caregivers. They all thought that the pain older adults

suffered was insufficiently considered and that healthcare professionals could manage this better, particularly nurses, if they were more attentive to older adults' wishes:

"There's the problem of pain... That might be the problem with the nurses. So, I think that, on discussing it with lots of patients, pain is rarely sorted out, after all. And then, the nurses... Well, they're not... All in all, that's always it. 'Take this. The pain will pass.' The nurses are a bit, simplistic, I'd say, in their relationship to patients and pain." (OA02)

3.2.3. Extrapersonal Stressors Affecting Safe Medication Management

Two extrapersonal stressors were identified: early and hurried return home and dysfunctional coordination between healthcare actors.

Many older adults and informal caregivers considered that their discharge home had occurred too early and that their recovery would have benefitted from a few more days in hospital or a rehabilitation centre. Furthermore, some informal caregivers complained that discharge was organised too rapidly, with no time to organise their care network to support the older adult's medication management.

Dysfunctional coordination between healthcare actors (professional and informal caregivers) was mentioned by all three groups of participants as a stressor that affected the quality of care and medication management. It was also sometimes associated with professional constraints, such as the unavailability of nurses, the disequilibrium between the time spent on administrative tasks, and the time dedicated to the patient, or hospital or community healthcare staff turnover. This stressor also included the problems informal caregivers often faced coordinating with community care networks:

"I'm exhausted from having to coordinate with all the different professions that don't do things the same way—with all those people, and it's not my field. And then, at the same time, you have to try and make a good impression. Give them a big smile. 'How are you? Is everything all right?' etc. And then continue making meals and so on." (IC04)

From the professional perspective, one GP (Prof21) and one home-care nurse (Prof04) considered it potentially harmful for there to be a long delay between being called upon to intervene in care transitions after a hospitalisation and receiving the paperwork informing them of discharges. This was particularly relevant when there were changes in medication treatments. Prof04, a nurse in the protected accommodation where OA04 lived, described the difficulties experienced when the hospital failed to transmit new prescription and discharge documents to the GP. After OA04 had an adverse reaction to her medication, she explained:

"I called the doctor and he said to me, 'But I haven't received any paperwork.' There was no information on her... I find that there is often a lack of communication, or sometimes the hospital tells us that they are sending us the discharge documents, but then we don't receive anything." (Prof04)

To overcome these stressors and enable the reconstitution of older adults' client systems after hospitalisation, a variety of intra-, inter-, and extrapersonal strategies were adopted.

3.2.4. Intrapersonal Reconstitution Strategies

Two intrapersonal reconstitution strategies for older adults' client systems were identified: *trusting and letting go* of medication management; and *mobilising self-knowledge and past experiences every day* in order to maintain control of one's medication management.

After hospitalisation, one reconstitution strategy adopted by several older adults and described by all three members of their triads was to *trust others and let go* of certain tasks and responsibilities—including medication management—that they had endeavoured to control in the past. Our interviewees either sought professional help with their medication management (home care services or pharmacists) or reactivated services that they had used previously by expanding them or increasing their frequency. Confiding tasks to their care networks (healthcare professionals and informal caregivers) allowed older adults to lessen

their involvement in their own medication management. This was expressed in terms of obedience, resignation, and loss of interest but also in terms of trusting relationships.

"She was very careful. Whereas now, she has reached a stage where she doesn't care. I think that she has reached a stage in her life where she says to herself, 'Well, I have no choice. I can't manage anything anymore.' " (IC1a); "Yes, it's better that they [IC] prepare it [the medication]. Otherwise, I wouldn't be able to do it." (OA01)

"They [healthcare professionals] know more about drugs than I do." (OA27); "We know nothing. We can't keep up..." (IC27)

"I think it suited Mrs [OA03] to have a simpler tool [pillbox] than she had had before, with big boxes, so that she didn't have to worry about that. She just took what we had prepared. I think she trusted us too, and then they [OA03 and her husband] were very collaborative, actually."

(Prof03 (CHC nurse))

The second intrapersonal reconstitution strategy described by older adults, their informal caregivers, and healthcare professionals was mobilising their knowledge and the results of their past experiences to better organise and manage their medication day to day, especially for monitoring treatment dosages. For example, Prof07 (CHC nurse) described how OA07 took her diuretic later when she planned to go out so as not to be bothered by going to public toilets, which are not always nearby.

3.2.5. Interpersonal Reconstitution Strategies

Four interpersonal reconstitution strategies were identified: *efforts made for more effective coordination between the stakeholders involved in medication management; 'fighting' for older adults' medication preferences; defining a project for the future with the care network; and establishing a routine to ensure safe medication management.*

The efforts made by older adults and their informal caregivers to improve the effectiveness of coordination between the stakeholders involved in medication management was one of the reconstitution strategies used to stabilise older adults' client systems.

"Prof04 sends me the medical report with the prescription so that we have something too. And we also check with the pharmacy. So, in fact, I'm now starting to be the hub distributing things left and right. So, for each group of people, I've really broken down their tasks and what they've got to do." (IC04)

In certain situations, however, if coordination reverts to dysfunction, this strategy can become a stressor too.

The strategy of 'fighting' for older adults' medication preferences sometimes implied older adults not adhering to their medical prescription. This was particularly evident with regards to the management of painkillers and insulin:

"Yesterday, nothing. Today, nothing [Dafalgan®—paracetamol]. I made that decision. Why? I've already got a patch. It's an analgesic patch. If I've got to take the Dafalgan too, I'd be amplifying those painkillers, so what's the good of that? Just so they put me in some sort of state of... No! No, I'm not bedridden, me. Even in that state. So, I'm not taking it." (OA10)

"The Trajenta [linagliptin], that's been since November. When I came out, they recommended taking 14 units. And me, when I saw my blood sugar level—because at home, I regulate my own blood sugar—it was still below ten. I told myself that I wasn't going to put 14 units into me. I only put 6 units in. Because I said to myself, if I go on like this, I'll be at under 5. And I don't want that. I'd be scared of that." (OA22)

Moreover, some older adults contested changes to their prescriptions, believing that their newly prescribed medications would be ineffective:

"I'm not even exactly certain what the change involved. It was stuff for sleeping that they took away from me, and they'd given me something else. But I wasn't sleeping with

that. So, I telephoned my GP, and the CHC's head nurse to explain it to her, to ask if I could have the Dalmadorm® [flurazepam] back again. I don't know. I can sleep with that, whereas with the other one, I had to wait two hours before falling asleep." (OA20)

The strategy of defining a project for the future with the care network—one with the older adult's preferences clearly established—seemed to facilitate coordination between the different stakeholders involved in medication management. This strategy was described by all three types of participants.

"And it's true that with OA03 we had, huh, we were on the same wavelength. You see? We told her what she wanted to hear—and that was that she could stay at home longer, because that's what she wanted. And that we'd be helping her with that; that we'd be putting things in place [about medication management]. It was really so she could stay at home, and we were going to do everything possible. As a result, she agreed to lots of things." (Prof03 (nurse))

The reconstitution strategy of establishing a routine to ensure safe medication management helped to put in place sustainable habits, almost becoming part of older adults' daily traditions or rituals—this often involved ways of storing and taking medications day to day. Indeed, the older adults interviewed wanted the minimum possible changes to their medication regimens. However, they were open to experimenting with approaches or tools that made things safer for them (such as new home care services or new types of pillbox).

3.2.6. Extrapersonal Reconstitution

Extrapersonal interventions helping with reconstitution all involved the care network's medication delivery processes and were described by all three groups of the triad. Our findings showed that these included several components: prescribing, transcribing, dispensing, administering, and monitoring. Nurses were particularly involved in the transcription and dispensing phases with home-dwelling older adults and sometimes with the administration phase too. Their role in monitoring was less explicit, as shown by some difficulties in interpreting clinical signs/symptoms and transmitting information to the rest of the interdisciplinary team. These reconstitution strategies, therefore, had the potential to become stressors at some point.

"And they [CHC nurses] are very nice and everything, but after they've written heaps and heaps with a special pen, it's recorded back there. But it all stays back there. I said, 'But when something happens like last time, what good does it do to have it all back there? You should send it to my GP. That's the least you could do.' I always thought that's what they did with all those reports. So, I said, 'Listen here. It's essential that when something special happens, like last time, when you come by on Tuesday morning and I have to go to the emergency department in the afternoon. You note it all down, you write chapters... ' It's not normal that the doctor's not informed. I had to tell her myself." (OA28)

Because these stressors and reconciliation strategies were not always identified by all three groups of participants (older adults, informal caregivers, and healthcare professionals), Table 4 presents who described them.

Table 4. Contributions to identifying and describing stressors and reconstitution strategies made by each participant group.

Stressors and Reconstitution Strategies Identified		Described by
Intrapersonal stressors	Reactions to a loss of autonomy, ranging from revolt to resignation	Older adults
		Informal caregivers
		Healthcare professionals
	Efforts to maintain control of medication management	Older adults
		Informal caregivers
	Contradictions between prescriptions and the values and preferences of older adults and their informal caregivers	Older adults
	Informal caregivers	

Table 4. Cont.

Stressors and Reconstitution Strategies Identified		Described by
Interpersonal stressors	Dysfunctional communication between older adults/informal caregivers and healthcare professionals	Older adults Informal caregivers
	Inadequate pain management	Older adults Informal caregivers
Extrapersonal stressors	Early and hurried return home	Older adults Informal caregivers
	Dysfunctional coordination between healthcare actors	Older adults Informal caregivers Healthcare professionals
Intrapersonal reconstitution	Trusting and letting go	Older adults Informal caregivers
	Mobilising self-knowledge and past experiences every day	Older adults Informal caregivers Healthcare professionals
Interpersonal reconstitution	Efforts made for more effective coordination between the stakeholders involved in medication management	Older adults Informal caregivers
	‘Fighting’ for older adults’ medication preferences	Older adults Informal caregivers
	Defining a project for the future with the care network	Older adults Informal caregivers Healthcare professionals
	Establishing a routine to ensure safe medication management	Older adults Informal caregivers
Extrapersonal reconstitution	The care network’s medication delivery process	Older adults Informal caregivers Healthcare professionals

4. Discussion

Exploring the perspectives of older adults, their informal caregivers, and healthcare professionals allowed us to identify the difficulties experienced by polymedicated home-dwelling older adults trying to manage their medication after hospital discharge and to categorise them as stressors within the NSM. Our findings revealed that these older adults were particularly exposed to a variety of intra-, inter-, and extrapersonal stressors that affected their medication management. We also observed that response patterns—or reconstitution strategies—for ensuring safe medication management were not always successful or satisfactory. Indeed, some participants’ reconstitution strategies were identified as stressors as well.

The NSM contributed to describing and understanding these difficulties (stressors) and their response patterns (reconstitution strategies). Prior to recruitment, our older adult participants were exposed to negative stressors that disrupted their lines of defence, destabilised their client system, and pushed them towards hospitalisation. Hospital admission led them towards the reconstitution process through secondary prevention measures that required the client system to alter itself in order to preserve and protect its basic structure. Discharge home occurred when some degree of system stability had been reached. However, in our study, this degree of stability was not perceived from the point of view of older adults and their informal caregivers (the extrapersonal stressor of “early and hurried return home”). According to the NSM, reconstitution after hospital discharge depends upon a successful mobilisation of the older adult’s resources to prevent further regression or reaction to stressors.

There is a greater risk of MRPs at hospital discharge because the client system is less well protected by its recently disrupted lines of defence—there is a state of entropy where older adults have less energy available than they need [28]. Thus, when one or

more stressors related to medication management cross the lines of defence, the instability triggered in the client system could result in MRPs and adverse health outcomes.

Our findings revealed that the stressors on safe medication management often concerned dysfunctions in the communication, collaboration, and coordination between the multiple stakeholders involved in it. This was concordant with the findings of Nicosia, Spar [8] about MRPs as seen from patients' and healthcare professionals' perspectives. Their participants identified communication and care coordination related to medication as an MRP; they also identified insufficient information about medications. The latter, however, was not corroborated by our findings, which revealed that older adults did not necessarily want to know more about their medication but did want to be properly informed of any changes and participate in decisions. The other MRPs described in the Nicosia, Spar [8] study—obtaining medications (e.g., problems of cost and insurance coverage), taking medications (e.g., organisation and remembering to take pills), and medication effects (including side effects and concerns about effectiveness)—were not identified by our participants as stressors on safe medication management. This might be explained by differences in the studies' inclusion criteria. The older adults in the Nicosia, Spar [8] study were not necessarily polymedicated (they were taking at least one medication) and had not been discharged from hospital. Furthermore, the clinical situations in our study were more complex: older adults were receiving considerable support for certain medication-related activities, such as obtaining medications or organising and taking medications, either from informal caregivers, healthcare professionals, or even both. For example, the majority of older adults in our study had a pillbox prepared by the CHC's nurse or the community pharmacy, and their informal caregiver reminded them when to take their medication. In relation to medication effects, the older adults and their informal caregivers in our study described their trust in healthcare professionals. Because they trusted them, they considered the prescribed medications to be appropriate. Trust was described by the members of all three groups and was categorised within the reconstitution strategy of "trusting and letting go".

Despite older adults and their informal caregivers frequently evoking the trust they placed in their care network, our findings showed that they were rarely integrated into decision-making about returns home, discharge planning, or changes to medication. Care networks' decisions concerning older adults failed to consider their values and preferences, as evidenced in other studies [40,41]. Indeed, according to our findings, older adults were the recipients of care rather than partners in the care networks involved in their medication management. This was in line with Holmqvist et al.'s [42] findings about home-dwelling older adults' experiences of medication-use evaluations. Even though older adults trusted that their physicians would regularly undertake medication-use evaluations and they were willing to be actively involved in it, that did not always occur, potentially contributing to an increased risk of MRPs.

Our findings showed that not being involved in medication-related decisions introduced two potential concerns into older adults' medication management. One was the wish to be 'in control', an attitude that was sometimes responsible for patient discord with healthcare professionals and deliberate non-adherence to treatment. The second attitude was one of 'letting go', passively obeying instructions, losing interest, participating less, and handing over full control of medication management to the care network. Letting go contributed to older adults' difficulties understanding their medication regimens and the changes made to them. We also noted that older adults who no longer thoroughly understood their medication situation reported trusting more and participating less.

These findings, however, could not tell us whether older adults 'let go' because they trusted in their care network or whether they learned to trust their care network because they had had to 'let go' (due to problems of comprehension or health literacy). Whatever the case, our findings revealed the paradox of the mutual trust between patients and professional caregivers (the foundation of any therapeutic relationship) and lessening participation and understanding: older adults should benefit from that trust by being

given better information and being allowed to participate more actively in decision-making concerning them [43,44].

Although the data collected from older adults and their informal caregivers allowed us to identify and categorise three types of stressors and reconstitution processes, professional perspectives remained focused on extrapersonal stressors and extrapersonal reconstitution. This was congruent with the findings of Nicosia et al. [8], in which older adults described MRPs from the socioemotional effects they had on their lives, in contrast to professional taxonomies for categorising MRPs (adverse medication reactions, medication errors, and potentially inappropriate prescriptions). These misaligned perspectives between older adults/informal caregivers and their healthcare professionals may have revealed a misalignment of their medication management goals and values and a failure of patient-centeredness. However, in a shared-decision making approach, patients should be considered pro-active partners and co-decision-makers [40,41]. When they are not, the risks of MRPs, such as non-adherence to treatment or medication errors, are higher [45,46]. A systematic review about the relationship between patient empowerment and medication adherence suggested that patient empowerment could promote medication adherence, but this required a co-constructed feeling of control in the professional caregiver–patient dyad induced by a “joint empowerment” approach [47].

Our findings suggested that older adults’ medication management after hospital discharge could benefit from a more nurse-led, empowering approach, with nurses sharing information on best practices in medication management and agreeing on responsibilities with older adults and their informal caregivers. Although patient empowerment has been promoted for safe medication management during hospital transitions [33], our results showed that this practice was not yet sufficiently implemented in practice among polymedicated home-dwelling older adults.

Because our older adult participants’ lines of defence had recently been disrupted and they presented with a greater risk of MRPs, nurse-led, interprofessional, collaborative practices could have helped to strengthen those lines of defence through secondary and tertiary prevention interventions. According to the *NSM Perspective of Nurse-Led Interprofessional Collaborative Practice* developed by Montano [30], nurses can clarify and share decision-making processes and facilitate discussions between interprofessional caregivers and older adults. The role of nurses in medication management during care transitions include: (i) medication reconciliation (obtaining medication histories, performing medication reviews, identifying medication discrepancies); (ii) collaboration with other healthcare providers in clarifying medication concerns, interdisciplinary communication and consultation, and discharge planning and monitoring; and (iii) provision of support to healthcare recipients, as professionals responsible for interpersonal communication with patients, medication education, the simplification of medication regimens, and symptoms management during transitional care [13]. Since the stressors on medication management and the reconstitution strategies identified for dealing with them mostly involved communication and coordination issues, our findings suggested that nurses’ responsibilities in medication management should be better defined, especially in hospitals, during care transitions, and in community healthcare settings after hospital discharge.

Furthermore, polymedicated, home-dwelling older adults at a high risk of MRPs should systematically be assigned a geriatric community-care nurse manager from a nearby CHC. Among a nurse manager’s tasks are fulfilling patients’ needs regarding medication management and preventing MRPs [48]. Using an interprofessional, evidence-based approach, co-constructed with older adults and informal caregivers, community-care nurse managers could contribute significantly to preventing hospital admissions, readmissions, institutionalisation in long-term care facilities, and early death, thus also helping to limit costs to the healthcare system [49].

Study Strengths and Weaknesses

The present paper provides a timely contribution to the growing body of evidence offering multiple perspectives on the difficulties, response patterns, and nurse-led, inter-professional, collaborative practices surrounding safe medication management for home-dwelling older adults after hospital discharge. The paper also introduces a categorisation of those difficulties into different types of stressors and of those response patterns into different types of reconstitution strategies, all within a globally recognised nursing model for community healthcare. Moreover, performing a secondary content analysis allowed us to take advantage of and benefit from existing research data to find answers to a question that was not asked in the primary study [49]. In the current trend towards open data, which encourages the repurposing of research information, this study's design was a good example of how to transpose existing data to a nursing model's perspective.

The study had some limitations. Although we considered the secondary analysis to be a strength, the interview guides were constructed based on a literature review on medication management, not the NSM; however, they did follow the philosophy of the NSM. We believe a data collection approach inspired directly by the NSM would have provided more exhaustive information, especially regarding extrapersonal stressors and reconstitution strategies. Secondly, in March 2020, data collection halted due to the risks that the COVID-19 pandemic posed to older adults and their often relatively old informal caregivers. Data collection also ceased with community healthcare professionals as their time and skills were in great demand during this health crisis. One limitation of our interviews was the difficulty maintaining older adults' and their informal caregivers' focus on medication management and not on other ADLs or IADLs. Maintaining a focus on the older adult's most recent care transition and ignoring earlier hospitalisations was also difficult. It is also possible, despite our best efforts at methodological rigour, that some of our participants' answers were influenced by social desirability bias and that their medication management was less effective than described in the interviews. Finally, despite our study's multiple perspectives on safe medication management, our participants were limited to one Swiss canton. Drawing conclusions for other cantons and countries should be done with care.

5. Conclusions

This paper provides a useful and original standpoint regarding bottom-up nursing approaches to improve safe medication management among polymedicated, home-dwelling older adults with multiple chronic conditions. Older adults, informal caregivers, and healthcare professionals' perspectives revealed several potential opportunities for improving safe medication management through nurse-led, interprofessional, collaborative, patient-centred practices. The majority of older adults wish to be and have the capacity for being actively involved in their medication management. Their willingness to participate may represent a poorly used resource in medication management processes. Polymedicated, home-dwelling older adults might benefit significantly from an approach that empowers their participation in safe medication management. Nurses should be encouraged to share information on best practices on that topic with older adults and their informal caregivers, and care networks should agree on sharing responsibilities with them.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/nursrep12020039/s1>. Figure S1: Enrolment Process; Table S1: Older Adult Participants' Characteristics; Table S2: Informal caregivers and healthcare professionals' characteristics.

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Appendix A. Interview Guides

The interview guides from the primary study were inspired by our literature review and tested in a preliminary study [35,36]. The original French versions were approved by the Human Research Ethics Committee of the Canton of Vaud on 5 July 2017 (2017-01025) and 1 February 2019 (2018-02196).

Table A1. Interview guide 1 with the older adult.

Topics	Items
(1) Presentation	Presentation of the study Presentation of the interview's objectives Details of the ethics measures taken
(2) Experience of hospitalisation and hospital discharge	General experience of the hospital stay Experience with medication received in hospital: • Changes to usual treatment in hospital • Information received in hospital about medication changes • People involved • Tools received in hospital to help manage medication at home
(3) Experience of the return home	General experience and process of return home Experience with medication since returning home: • Management of medicines (and any changes made in hospital) since return home • People involved in medication management at home • Perceptions/experiences of taking several medications per day • Methods put in place to avoid forgetting to take medication, keep to the right schedule and avoid taking the wrong medication • Taking other health or wellness products

Table A1. *Cont.*

Topics	Items
(4) Socio-demographic data	
(5) End of the interview	Reminder of the ethical requirements for using the data collected in the interview

Table A2. Interview guide 2 with the older adult.

Topics	Items
(1) Presentation	Presentation of the interview's objectives Reminder of the details of the ethics measures taken
(2) Daily medication management	Description of daily medication management: • Medication management locations (taking, storing) • Schedules • Routines
(3) Support at home for medication management	People involved in the day-to-day management of medicines • Who (people involved) • Frequency of assistance • Type of assistance
(4) Experiences with medication	Medication habits and changes: • Time of onset of medication (before, during and after hospitalisation) Knowledge about medications: • Indication for each medication • Effects of each medication • Possible precautions • Most important medication Satisfaction with information received about each medication Wish to ask questions about a particular medication
(5) End of the interview	Reminder of the ethical requirements for using the data collected in the interview

Table A3. Joint interview with the older adult and their informal caregiver.

Topics	Items
(1) Presentation	Presentation of the study Presentation of the interview's objectives Details of the ethics measures taken
(2) Older adult–informal caregiver relationship	The relationship between them Assistance provided in ADL and IADL
(3) Experience of the return home	Process of hospital discharge and return home: • Experience with medication changes • Information received • Experience with medication since returning home • Support for medication management
(4) Involvement in medication management	Activities where the informal caregiver is involved in medication management How it happens Example
(5) Sociodemographic data	
(6) End of the interview	Reminder of the ethical requirements for using the data collected in the interview

Table A4. Professional caregiver involved in medication management.

Topics	Items
(1) Presentation	Presentation of the study Presentation of the interview's objectives Details of the ethics measures taken
(2) Experience with the older adult in relation to medication management	Since when has Mr/Mrs X been followed Type(s) of medication management intervention (prescription, preparation, administration, monitoring, etc.) Frequency of intervention Process of hospital discharge and the return home: - Information received before the first visit after hospitalisation - Possible changes in usual medication Progress of the medication adjustment Any difficulties encountered with Mr/Mrs X regarding medication management
(3) Sociodemographic and professional data	
(4) End of the interview	Reminder of the ethical requirements for using the data collected in the interview

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OTHER SCIENTIFIC OUTPUTS RELATED TO THIS CHAPTER

Contributions in related publications

Bieri M, del Río Carral M, Santiago-Delefosse M, Miano G, Rosset F, Verloo H, **Pereira F**. Beliefs about Polypharmacy among Home-Dwelling Older Adults Living with Multiple Chronic Conditions, Informal Caregivers and Healthcare Professionals: A Qualitative Study. Multidisciplinary Digital Publishing Institute; 2021:1204. doi:10.3390/healthcare9091204.

Oral presentations in scientific meetings

Pereira F, Martins M, del Río Carral M, Verloo H. Optimizing medication management for polymedicated home-dwelling older adults. Presented at the EANS Virtual Summer School. 2021. Cologne, Germany.

**CHAPTER 6 – A COLLABORATIVE, PATIENT-
CENTERED MEDICATION MANAGEMENT
MODEL: FROM THE DIAGNOSTIC TO THE
SOLUTION-DESIGN PHASE**

A COLLABORATIVE, PATIENT-CENTERED MEDICATION MANAGEMENT MODEL: FROM THE DIAGNOSTIC TO THE SOLUTION-DESIGN PHASE

This chapter presents the results of the overall mixed-methods study, i.e. the combined findings from the two preceding chapters. Older adults', informal caregivers', and healthcare professionals' perceptions about medication management at home after hospital discharge supported and completed our quantitative findings describing the health profiles of older adults presenting with greater risks of adverse health outcomes related to MRPs. Furthermore, these combined findings enabled us to develop a collaborative, patient-centered model to optimize medication management and prevent adverse health outcomes related to MRPs among polymedicated home-dwelling older adults after hospital discharge. Article 9 presents the combined findings and the medication management model. This is currently under review and has been presented at different scientific events.

Further research perspectives and potential collaborations have emerged throughout the evolution of this thesis project. One example is the Joint Swiss–Portuguese Academic Program, whose objectives are to intensify interaction and scientific cooperation between Swiss and Portuguese scientists from the University of Applied Sciences and Arts Western Switzerland (HES-SO) and from Portugal's Polytechnic Institutes, establish research partnerships of mutual interest and benefit, and finally, connect existing but separately funded research projects in the two countries. As part of this program, we established a partnership with the Polytechnic of Leiria's School of Health Sciences and obtained a grant from September 2020 to December 2022 for the OptiMed project (grant number 105 995), in which the candidate is the principal Swiss investigator. This project consists of a pre–post, multi-site pilot and feasibility study of an intervention program to reduce MRPs among polymedicated home-dwelling older adults; it is based on the Medical Research Council Framework

for Complex Interventions (protocol presented in Article 10). In addition, this project included the psychometric validation, in Portuguese and in French, of the doMESTIC risk tool, as used by an interprofessional home care team in a German-speaking region of Switzerland, for the detection of MRPs among polymedicated home-dwelling individuals [36]. Although the results of the thesis' "diagnostic process" contributed to the development of OptiMed, the latter evolved before the "solution-design" phase was completed and, therefore, the model presented in Article 9 is not being fully tested in OptiMed (Article 10). OptiMed's ethical approvals by Swiss and Portuguese ethics commissions are presented in Appendix 6.

ARTICLE 9

Pereira F, Meyer-Masseti C, del Río Carral M, von Gunten A, Wernli B, Martins M, Verloo H. A collaborative, patient-centered medication management model for poly-medicated home-dwelling older adults after hospital discharge: results of a mixed-methods study (Submitted to BMC Geriatrics on June 10th, 2022).

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A collaborative, patient-centered medication management model for polymedicated home-dwelling older adults after hospital discharge: results of a mixed-methods study

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ABSTRACT

Background: Safe medication management is one of the necessary basic conditions for enabling polymedicated home-dwelling older adults to remain in their homes and maintain their quality of life after hospital discharge.

Objectives: This study aimed to develop a model to optimize medication management and prevent adverse health outcomes associated with medication-related problems (MRPs).

Methods and analysis: We used an explanatory, sequential, mixed-methods study to investigate medication management among polymedicated, home-dwelling older adults after discharge from a local hospital in French-speaking Switzerland. The quantitative strand retrospectively examined three years of that hospital's electronic patient records (N = 105,243) to identify the different profiles of such patients at risk of 30-day hospital readmission and unplanned nursing home admission. The qualitative strand explored the perspectives of older adults (n = 28), their informal caregivers (n = 17), and healthcare professionals (n = 13) on medication management after hospital discharge.

Results: Quantitative results from older adults' profiles affected by similar patient-, medication-, and environment-related factors were enhanced and supported by qualitative findings. The combined findings enabled us to design an interprofessional, collaborative medication management model to prevent MRPs among home-dwelling older adults after hospital discharge. The model was composed of four interactive fields of action: giving voice to polymedicated home-dwelling older adults and their informal caregivers; involving older adults and their informal caregivers in shared, medication-related decision-making; empowering older adults and their informal caregivers for safe medication self-management; optimizing collaborative medication management practices.

Conclusions: Connecting retrospective and prospective findings, using an explanatory sequential design and involving multiple stakeholders' perspectives contributed to a deep understanding of the difficulties and challenges regarding safe medication management of polymedicated, home-dwelling older adults after hospital discharge. This led to the design of an innovative, collaborative, patient-centered model to optimize medication management and prevent MRPs among this population.

Keywords

Polypharmacy; home-dwelling; older adults; medication management; hospital discharge; care transitions; mixed-methods research; medication-related problems; hospital registry; patient-centered model.

BACKGROUND

Maintaining medication safety—the core initiative of the third WHO Global Patient Safety Challenge Programme—is particularly burdensome for older adults due to their increased prevalence of multiple, chronic, non-communicable diseases requiring complex multi-drug pharmacotherapy [1], which is commonly known as polypharmacy when patients take five or more medications daily [2]. Due to age-related changes in pharmacokinetics and pharmacodynamics [3], polypharmacy is particularly problematic among older adults and often associated with medication-related problems (MRPs) [4, 5]. According to the Pharmaceutical Care Network Europe, an MRP is “an event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes” [6]. A recent systematic review about MRPs among home-dwelling older adults reported an average of 4.16 MRPs per patient (95% CI: 1.37–10.00), including inappropriate prescription (51.41%), inappropriate dose (11.62%), and patient-related problems (10.70%) (such as non-adherence or inability to use the drug or form as prescribed) [7]. MRPs deviate from the originally intended therapeutic benefit and may predispose patients to adverse health outcomes, including hospital admissions, prolonged hospital stays, reduced quality of life, nursing home admission, increased mortality, and greater healthcare costs [8–10].

The risk of MRPs is heightened during care transitions, such as discharge home after hospitalization [1, 9, 11]. An integrative review by Valente et al. reported that the main MRPs among older adults during care transitions between hospital and home were related to the absence of medication reconciliation (40%), medication adherence (30%), and adverse drug events (30%) [12]. Those MRPs were related to the greater number of medications prescribed during hospitalization, modifications to the therapeutic regimen, incomplete, inaccurate, or illegible prescriptions, and older adults’ lack of knowledge about their prescribed medications.

Older adults and informal caregivers often experience medication changes as disruptions to knowledge, routines, and medication self-management [13]. Older adults may feel vulnerable, have difficulties understanding information, and lack integrated community care [14].

High occurrences of MRPs among older adults after hospital discharge could be reduced by improved care transitions based on discharge planning processes combining hospital discharge medication-management plans and follow-up strategies at home [15-17]. Discharge planning is the in-hospital process of developing an individually tailored plan to facilitate a return home (or to a care facility) following an inpatient admission [18]. Comprehensive discharge planning for older inpatients effectively reduces unplanned readmissions (roughly three fewer readmissions per 100 patients) [18]. Many existing discharge planning models include different hospital and community healthcare professionals, older adults, and their informal caregivers. The systematic review and meta-analysis by Tomlinson et al. suggested that interventions to support successful transitions of care through better medication continuity should continue for at least 90 days after discharge [19]. These were more likely to aid successful transitions than those focusing solely on hospital admission or short post-discharge periods. Medication self-management activities, telephone follow-up, and medication reconciliation were all statistically associated with fewer hospital readmissions [19]. Creating checklists, seeking advice, or supporting primary care providers to ensure the right medications are supplied on time are also strategies used to support safe medication management after hospital discharge [13]. Overall, safe medication management requires interprofessional collaboration across different health and social care providers in inpatient and outpatient care, regular monitoring for potential MRPs, and medication reconciliation at every transition of care, including changes in the clinical setting, treating physician, or level of care [1, 17].

In Switzerland, community healthcare centers provide support for older adults unable to manage their medications by themselves or only with the help of informal caregivers, often in their own homes. Community pharmacists are ever more commonly involved in primary care [20]. The current trend in Switzerland's healthcare system is to attempt to reduce hospital length of stay as much as possible and promote outpatient treatment, but this may lead to the "medication-intensive hospital discharge" of geriatric inpatients [21]. This is a major concern for public health, and it calls for a robust, integrated, multi-stakeholder model embedding medication management into the context of where and how older adults live, thus preventing the onset or progression of MRPs. A medication management model like this needs to be rigorously structured, using a care model process embracing development, implementation, and sustainability milestones [22].

Aim and Objectives

The study aims were: 1) to explore how older adults', their informal caregivers', and healthcare professionals' perspectives on medication management at home after hospital discharge explained or complemented quantitative results about the health profiles of older adults presenting with greater risks of adverse health outcomes, and 2) to develop a model to optimize medication management and prevent adverse health outcomes related to MRPs.

METHODS

Study design

We ran an explanatory, sequential, mixed-methods study from February 2019 to January 2022 [23]. The quantitative strand involved a retrospective analysis of three years of a local hospital's electronic patient records (N = 105,243) to identify the profiles of polymedicated, home-dwelling older adults at risk of adverse health outcomes. These profiles were extracted from the

hospital data and allowed us to take a purposive sample for the qualitative strand, focused on older adults' (n = 28), informal caregivers' (n = 17), and professional caregivers' (n = 13) perspectives on medication management at home after hospital discharge. The analysis of the results from the retrospective quantitative strand was integrated with the data collected from the prospective qualitative strand.

The rationale for this design was that previous studies had explored medication management from a quantitative or qualitative perspective, but rarely both. Furthermore, to the best of our knowledge, no study on medication management had attempted to connect data from hospital registers with qualitative data. Finally, qualitative studies on medication management have relied on clinician-focused or patient-focused perspectives. However, because safe medication management implies interprofessional, patient-centered approaches, research using a single focus may not have provided a comprehensive description of the phenomenon. Therefore, our qualitative strand relied on a multi-perspective description of older adults', their informal caregivers', and their healthcare professionals' perceptions of medication management after hospital discharge.

Phase 1, Retrospective Quantitative Strand

The quantitative strand sought to identify profiles affected by similar patient-, medication-, and environment-related factors among polymedicated, home-dwelling older adults at risk of hospital readmission [24] or unplanned nursing home admission [25]. Patient-related factors included sociodemographic characteristics and the International Classification of Diseases 10th version (ICD-10) diagnostics (main diagnosis and co-morbidities). Supplementary filters were added to discriminate 'polypharmacy' and 'home-dwelling'. Medication-related factors

included their number and the Anatomical Therapeutic Chemical (ATC) classification of the prescribed medication. Environment-related factors included the length of stay.

Data were derived from a large, longitudinal, electronic patient dataset extracted from a public general hospital in the French-speaking part of Switzerland—the Valais Hospital. The hospital register's electronic health records included all inpatients aged 18 years old or more admitted or readmitted between January 1, 2015, and December 31, 2017 (N = 105,243 hospitalization records).

The dataset of polymedicated, home-dwelling older adults was analyzed between February 2019 and March 2020 using descriptive and multivariate regression analysis to identify the patient-, medication-, and environment-related factors that increased the risk of 30-day readmissions [24] and unplanned nursing home admission [25] (Supplementary File 1). Furthermore, the profiles of polymedicated, home-dwelling older adults hospitalized and identified via multi-cluster analysis [26] guided the qualitative strand and led to a purposive sampling of those presenting with more risk factors. A flow-chart in Supplementary File 2 gives an overall view of the retrospective data analysis strategy used on the raw hospital register data.

Phase 2, Prospective Qualitative Strand

The qualitative strand consisted of a qualitative descriptive study of the medication practices and experiences of older adults presenting with the risk factors identified in the first strand (Supplementary File 1). This qualitative phase used purposive sampling from within our Swiss sample to better explain our retrospective quantitative findings. Besides the qualitative interview data collected from older adults, we also collected, analyzed and cross-referenced the perspectives of their informal caregivers and healthcare professionals involved in medication management at home.

From October 2019 to November 2020, nurses research partners identified and recruited 28 home-dwelling older adults, using the following inclusion criteria: aged 65 or older, managing at least five different medications daily, discharged from hospital in the 90 days prior to recruitment, and estimated to retain a significant risk of adverse health outcomes (hospital readmission or unplanned nursing home admission). The 90-day timeframe was defined based on Tomlinson *et al.*'s systematic review and meta-analysis, which regarded this period as the most susceptible to MRPs [19]. For each older adult, an informal caregiver, aged 18 or above, if available, was also invited to participate in the investigation. Finally, a healthcare professional designated by each older adult and involved in their daily medication management at home was also integrated into the investigation.

Semi-structured individual and joint interviews were conducted with each of these three populations. Four interview guides were constructed, one for each interview, based on our retrospective quantitative strand and a literature review about medication management and tested in a preliminary study [27, 28].

The first semi-structured interview gathered older adults' perspectives on their transition from hospital to home, the treatment information given to them, possible modifications to that treatment, and whether prescribers had considered their experiences and preferences when prescribing their medications. Each participant was asked to complete a week-long medication journal [29] [30], either alone or helped by their informal or professional caregivers, about daily medication routines, all the medications taken (prescribed or self-medication), and their perceptions of and satisfaction with their treatment. This provided information on the daily routines associated with the participant's medication and formed the basis of the second interview. The second interview was a walking interview allowing older adults to better explain their daily medication practices and routines [31]. It focused on their medication self-

management, the care network assisting their medication practices at home, and their lived experiences of all these interactions.

The third interview was a joint interview of about one hour organized with the older adult and their informal caregiver at the older adult's home, one to two weeks after the walking interview [29, 32]. These enabled investigators to observe interactions concerning medication management within each dyad.

Moreover, a fourth semi-structured interview of about one hour was conducted with each healthcare professional to explore their perspectives on the older adult's medication management after hospital discharge. These took place in professionals' usual working environments (community healthcare center, medical practice, or pharmacy), during normal working hours, one to two weeks after the joint, third interview.

Participants' sociodemographic and health characteristics were summarized and analyzed using descriptive statistics. Fifty-three audio-recorded individual and joint interviews were distributed among four investigators (including the two interviewers) and fully transcribed. Each full transcript underwent an inductive thematic analysis by the same four members of the research team to identify patterns shared across the full dataset [33, 34]. They met regularly, under the principal investigator's supervision, to check whether patterns of meaning matched the coded extracts across the entire dataset and until a consensus was reached. This analysis procedure enabled the systematic organization and classification of the qualitative data into distinct themes, framed by the similarities and differences in participants' accounts. The entire corpus of interviews was then reviewed by the team to validate the final thematic classification. The analytical process was complete when *patterns of shared meaning* in participants' accounts were agreed upon in relation to our research objectives [34]. Preliminary qualitative results

were then discussed with the other authors. Finally, the content of each older adult's medication journal was also analyzed and categorized according to the same principles as the interviews.

Phase 3, Integration of Quantitative and Qualitative Results and Development of a Medication Management Model

As per Creswell and Clark [35], the integration of the quantitative and qualitative results occurred at two distinct moments. First, the retrospective quantitative strand's data analysis was integrated with the prospective qualitative strand's data collection: we collected accounts of the experiences of older adults presenting with the risk factors identified in the first strand, and the interview guides for the qualitative strand were designed based on the retrospective quantitative findings. Second, once the qualitative strand was complete, we integrated the two sets of connected results and developed integrated conclusions about how the qualitative findings explained and extended quantitative findings.

Our connected results documented the 'diagnostic process' (Phases 1 and 2) and contributed to the 'solution design' (Phase 3) of our Medication Management Model, which was guided by the Agency for Clinical Innovation (ACI) framework—a project management methodology comprising five stages for reviewing and developing Models of Care (ACI, 2013) (Figure 1). These solutions were inspired by the quadruple-aim of enhancing the patient's experience, improving population health, reducing costs, and improving healthcare professionals' working lives [36].

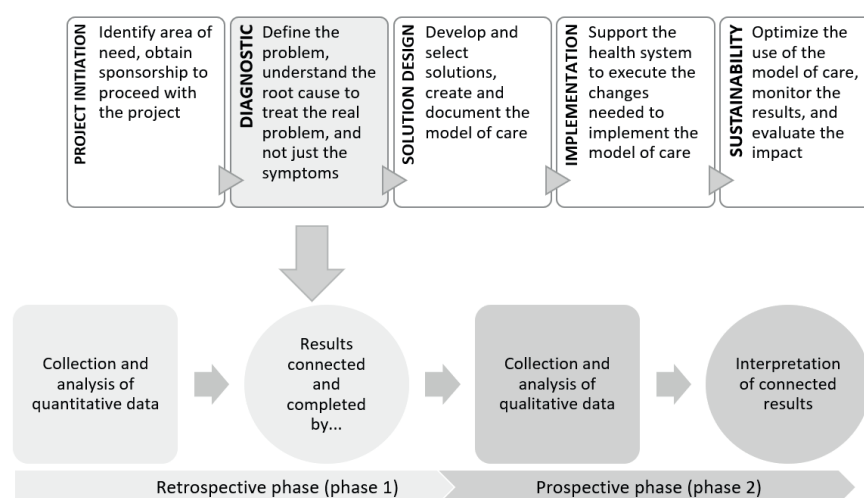


Figure 1: Methodological framework to develop our Medication Management Model: mixed-methods research with an explanatory sequential design [22, 35].

RESULTS

Overview of quantitative findings

The total dataset comprised 105,243 hospitalization records. After applying the inclusion criteria for older adult inpatients aged 65 or more, our analysis included 53,690 hospitalizations (51% of the dataset) from 2015–2017 [21]. Mean age was 78.4 (SD = 7.9), the median age was 78 [IQR 25–75 = 72–84], and potential participants ranged from 65–106 years old, with 28,018 (52.2%) female geriatric inpatients (Supplementary File 3).

Overview of qualitative findings

A total of 28 older adults, 17 informal caregivers, and 13 healthcare professionals participated in the study. Their sociodemographic characteristics are presented in Supplementary File 4. The median number of ICD-10 diagnoses was 12 (range 3–27), and the median number of

prescribed medications at hospital discharge was 8 (range 5–21). Only 17 informal caregivers participated in the study because not every older adult had an informal caregiver involved in medication management. Thirteen of the 17 informal caregivers interviewed lived with the older adult. Most ($n = 11$) provided daily assistance in multiple activities. Older adults' levels of autonomy in medication self-management were very heterogeneous: while some prepared and took their medications independently, others needed their informal caregivers and/or health professionals (a nurse or pharmacist) to prepare and administer them. Older adults designated three types of healthcare professionals involved in their medication management: nurses, pharmacists, and general practitioners.

Mixed-methods findings

Detailed quantitative [21, 24] and qualitative [37] findings have been published in previous papers. Therefore, this section connects and integrates both sets of findings (Table 1) and draws conclusions on how the qualitative results help to explain and extend specific quantitative results.

Table 1. Joint display of quantitative and qualitative findings regarding medication management.

<i>Sociodemographic and hospitalization data</i>	Retrospective quantitative findings	Prospective qualitative findings
Polypharmacy at hospital discharge	67.5% of geriatric inpatients were polymedicated at hospital discharge (N = 36,266 (67.5%) vs. N = 17,424 (32.5%)) [21].	Older adults did not feel sufficiently listened to or involved in medication-related decisions Discharge planning was often unsatisfactory or non-existent Contradiction between the prescription and the values and preferences of older adults and their informal caregivers
Polypharmacy and length of stay	Hospital lengths of stay were five days longer among polymedicated geriatric inpatients ($\mu = 13.8$; SD = 15.1 vs. $\mu = 8.6$; SD = 12.4; $p < 0.001$).	Discharge home was rapid and sometimes too early Older adults' and informal caregivers' perceived needs for greater involvement in discharge planning
Number of medications prescribed and age	The older the patients were, the more medications they were prescribed ($\mu = 78.75$; SD = 7.7 vs. $\mu = 77.58$; SD = 8.3; $p < 0.001$).	Efforts to maintain control of medication management Loss of autonomy: from revolt to resignation Contradiction between the prescription and the values and preferences of older adults and their informal caregivers Older adults did not feel sufficiently listened to or involved in medication-related decisions
Medical conditions		
Number of comorbidities (ICD-10 diagnoses)	The median number of comorbidities was twice as high among polymedicated ($\mu = 5.7$; SD = 2.2; Med = 6; IQR 25–75 = [4–8]) than among non-polymedicated patients ($\mu = 4.4$; SD = 2.2; Med = 3; IQR 25–75 = [3–6]).	Efforts to maintain control of medication management Contradiction between the prescription and the values and preferences of older adults and their informal caregivers ‘Fighting’ for older adults’ medication preferences
Physical impairments	Polymedicated inpatients had proportionally more physical impairments to general mobility (43.2% vs. 41.9% in non-polymedicated inpatients; $p < 0.001$), gait (46.2% vs. 43%; $p < 0.001$), fatigue (48.6% vs. 43.4%; $p < 0.001$), and lower body care (49.7% vs. 47.6%; $p < 0.001$).	Loss of autonomy: from revolt to resignation Trusting and letting go Informal caregivers’ perceived needs for help in supporting and coordinating medication management
Cognitive impairments	Geriatric inpatients with severe cognitive impairments had fewer medications at hospital discharge ($p < 0.001$) for all of the cognitive variables: alertness/consciousness disorders (N = 591; 1.7% among polymedicated inpatients vs. N = 577; 12.0% among non-polymedicated inpatients), orientation space, time, people disorders (N = 6686; 19.2% vs. N = 3463; 26.3%); concentration (N = 3410; 9.8% vs. N = 2433; 18.5%); verbal expression (N = 2392; 6.9% vs. N = 1980; 15.0%); capacity and skills to react to the demands of daily life (N = 9294; 26.8% vs. N = 4010; 30.5%); ability to learn disorders (N = 9675; 27.8% vs. N = 4149; 31.5%).	Efforts to maintain control of medication management Mobilizing self-knowledge and past experiences every day Efforts made for more effective coordination between the stakeholders involved in medication management
Pain medication management	One third of all geriatric inpatients (n = 17,895; 33.3%) reported acute pain at hospital discharge. A greater proportion of polymedicated inpatients reported acute pain than did non-polymedicated patients (N = 13,189; 38% vs. N = 4706; 35.8%; $p < 0.001$), whereas the reports of chronic pain were similar (N = 4029; 11.6% vs. N = 1463; 11.1%; $p = 0.153$).	Inadequate pain management Dysfunctional coordination between healthcare actors Older adults did not feel sufficiently listened to or involved in medication-related decisions Discharge planning was often unsatisfactory or non-existent

	Older adults with analgesic prescriptions had a higher probability of unplanned nursing home admission (OR = 1.244; 95% CI: 1.132–1.367). No association was found with 30-day hospital readmission.	
Adverse health outcomes 30-day hospital readmission	The overall 30-day hospital readmission rate was 7.8%. Thirty-day hospital readmission risks were associated with longer hospital length of stay (OR = 1.014 per additional day; 95% CI: 1.006–1.021), impaired mobility (OR = 1.218; 95% CI: 1.039–1.427), multimorbidity (OR = 1.419 per additional ICD-10 condition; 95% CI: 1.282–1.572) and polypharmacy (OR = 1.043 per additional medication prescribed; 95% CI: 1.028–1.058).	Discharge home was rapid and sometimes too early Discharge planning was often unsatisfactory or non-existent Contradiction between the prescription and the values and preferences of older adults and their informal caregivers Older adults' and informal caregivers' perceived needs for greater involvement in discharge planning
Unplanned nursing home admission	The prevalence of unplanned nursing home admission after hospital discharge was 6.1%. The oldest adults (OR = 1.07 for each additional year of age; 95% CI 1.05–1.08) presenting with impaired functional mobility (OR = 3.22; 95% CI 2.67–3.87), dependency in the activities of daily living (OR = 4.62; 95% CI 3.76–5.67), cognitive impairment (OR = 3.75; 95% CI 3.06–4.59), and traumatic injuries had a higher probability of unplanned nursing home admission (OR = 1.58; 95% CI 1.25–2.01). The number of ICD-10 diagnoses had no significant impact on institutionalization, contrarily to the number of prescribed medications (OR = 1.17; 95% CI 1.15–1.19).	Dysfunctional coordination between care actors Defining shared medication management goals Establishing personal routines to ensure safe medication
Medication-related problems (medications statistically associated with 30-day hospital readmission and unplanned nursing home admission, controlled for other parameters)	Adjusted multivariate analyses revealed an increased risk of hospital readmission for patients with polypharmacy (OR = 1.043 per additional drug prescribed; 95% CI 1.028–1.058) and certain specific medications, including antiemetics and antinauseants (OR = 3.216 per additional medication unit taken; 95% CI 1.842–5.617), antihypertensives (OR = 1.771; 95% CI 1.287–2.438), medication for functional gastrointestinal disorders (OR = 1.424; 95% CI 1.166–1.739), systemic hormonal preparations (OR = 1.207; 95% CI 1.052–1.385), and vitamins (OR = 1.201; 95% CI 1.049–1.374), as well as concurrent use of beta-blocking agents and medication for acid-related disorders (OR = 1.367; 95% CI 1.046–1.788) [24]. Antiemetics/antinauseants (OR = 2.53; 95% CI 1.2–5.30), digestives (OR = 1.78; 95% CI 1.09–2.90), psycholeptics (OR = 1.76; 95% CI 1.60–1.93), antiepileptics (OR = 1.49; 95% CI 1.25–1.79), and anti-Parkinson's medication (OR = 1.40; 95% CI 1.12–1.75) were strongly linked to unplanned nursing home admission [25].	The medication review of participants' medication lists showed that Beers and STOPP/START criteria were not often respected. The least frequently met criteria were STOPP-A1, STOPP-A2, and STOPP-A3: any drug prescribed without a clinical indication, any drug prescribed beyond the recommended duration, and any dual prescriptions from the same drug class, respectively. For example, proton pump inhibitors (PPIs) prescribed for more than 8 weeks without indication (Beers and STOPP-F2); benzodiazepines for more than 4 weeks (Beers and STOPP-D5 and K1); non-selective beta-blocker with a history of asthma requiring treatment (STOPP-G4); a loop diuretic as first-line therapy for hypertension (STOPP-B6, B7); long-term aspirin at doses greater than 160 mg per day (STOPP-C1).

DISCUSSION

Diagnostic step: defining the problem and understanding the root cause

This mixed-methods study described the current state of polymedicated, home-dwelling older adults' medication management practices and experiences after discharge from the Valais hospital. Both the quantitative and qualitative phases reported on the complexity of their medication lists during hospital-to-home transitions. Quantitative results concerning profiles affected by similar patient-, medication-, and environment-related factors among polymedicated, home-dwelling older adults were enhanced and supported by the qualitative findings. The qualitative strand conducted among a purposive sample of older adults provided a better understanding of the challenges and needs in their daily medication management that may be responsible for MRPs and adverse health outcomes.

Our quantitative findings revealed that a majority of geriatric inpatients were polymedicated at hospital discharge and that their mean hospital lengths of stay were five days longer than their non-polymedicated peers. Prolonged lengths of stay are considered an indicator of clinical complexity and geriatric inpatients' functional decline [38, 39]. Despite longer lengths of stay, our qualitative findings showed that planning for discharge home was often considered unsatisfactory, unsuitable, or non-existent, and discharges were experienced as rapid and sometimes too early. Even when polymedicated older adults had longer hospital stays, they did not feel sufficiently prepared for medication self-management at home. This is in line with the Knight *et al.* (2013) study, which explored older adults' and informal caregivers' experiences of hospital discharge in relation to medication plans and management. Inadequate explanations about medications at discharge were commonly reported and led to medication omission, incorrect dosages, anxiety, and confusion [29].

Our quantitative findings revealed that the older the patients were, the more medications they were prescribed, in line with previous studies in which the rate of polypharmacy among home-dwelling older adults was also associated with age and comorbidities [39, 40]. Although the qualitative strand did not enable us to explain this result, the qualitative analysis provided information on older adults' daily attempts to self-manage their medication, despite their advanced age and the difficulties arising from continual changes to their prescriptions. Considering that advanced age and polypharmacy are the main risk factors for MRPs [41-43] and that MRPs have a major impact on functional outcomes [44], the number of medications that geriatric inpatients have to manage after hospital discharge, more or less autonomously, deserves further attention from the healthcare professionals involved in discharge planning.

The median number of comorbidities was twice as high among polymedicated than among non-polymedicated patients. Although it is understandable (but not always justifiable) that the more different medical diagnoses a patient has, the more medications they are likely to be prescribed, the opposite—the impact of the number of medications on the number of diagnoses—remains unclear [45]. Qualitative results showed us that polymedicated home-dwelling older adults were confronted with the burdens of not only their comorbidities but also complex medication self-management. Moreover, they had to juggle their loss of autonomy after hospital discharge and their efforts to maintain control of a complex medication regimen. Contradictions also emerged between prescriptions and older adults' and their informal caregivers' values and preferences. Medication changes were rarely discussed with patients and, therefore, not always well accepted and integrated into their daily lives. Even if older adults had multiple conditions, they were not always in favor of extending their treatment list and often found it necessary to fight for their medication preferences and medication self-management.

Polymedicated inpatients had proportionally more physical impairments—general mobility, gait, and fatigue problems—than did non-polymedicated inpatients. Previous studies had positively associated physical impairments with polypharmacy [40]. In our qualitative phase, these conditions were reflected in patients' inability to perform some medication management tasks independently, as they had done before hospitalization. Their reactions to this loss of autonomy after hospital discharge ranged from resistance to resignation. Indeed, some older adults revealed their daily efforts to self-manage their medication despite their advanced age, physical impairments, and continual changes to their prescriptions. Establishing an individual routine was one of the strategies used to ensure safe medication self-management. However, some older adults with more functional impairments felt less involved in medication management and had withdrawn from certain tasks and responsibilities that they had endeavored to control in the past. We noted that older adults who 'let go' of medication self-management reported greater difficulties understanding their medication regimens and comprehending changes. This agreed with Diedrich *et al.* [46], who reported that home care clients who had reached their physical, psychological, and social limits felt relieved when a community healthcare center took over the coordination of medication management, and they no longer perceived themselves as active partners in maintaining medication safety. In line with Mortelmans *et al.* [47], our research showed that regardless of their functional impairments or level of involvement in medication management, polymedicated older adults experienced a variety of struggles during the process of medication self-management after hospital discharge. These included finding the physical strength to take medication, a lack of medication knowledge, non-adherence, and/or disrupted continuity of medication self-management. Our quantitative findings showed that geriatric inpatients with severe cognitive impairments had fewer medications at hospital discharge. This might be explained by clinicians'

contemporary concerns about potentially inappropriate prescribing and deprescribing practices among geriatric populations presenting with cognitive disorders and about the risks of non-adherence to prescribed medication due to omitted or repeated medication intake [48, 49]. It may also be that current recommendations on deprescribing medications for older adults with a limited life expectancy have shifted clinicians' focus away from disease prevention and towards maximizing the patient's quality of life [50]. Indeed, the medication management tasks highlighted in our qualitative phase revealed the complexity that polymedicated home-dwelling older adults face in their daily lives and the impracticability of safe, effective management by individuals with severe cognitive impairments—at least without the presence of a robust social network. A prerequisite for older adults managing their own polypharmacy at home was the ability to use their knowledge and past experiences daily and make efforts towards more effective coordination within their healthcare network. Our interviews showed that the more cognitively impaired a polymedicated older adult was, the more they required highly coordinated family and professional support to manage their medication. This was in line with previous findings revealing that cognitive impairment was associated with noncompliance and medication management difficulties, thus increasing the risk of MRPs [51].

In our retrospective quantitative phase, a statistically significant greater proportion of polymedicated inpatients reported acute pain than did non-polymedicated patients, whereas their reports of chronic pain were similar. Although pain assessments were carried out, the medications prescribed did not seem to entirely address pain outcomes. Although we found no statistically significant associations between the prescription of analgesics at discharge and hospital readmission [24], discharge-day pain scores have previously been associated with 30-day hospital readmissions [52]. Indeed, our logistic regression analysis revealed that older adults with analgesic prescriptions had a higher probability of unplanned nursing home

admission (adjusted for age, sex, number of comorbidities, and functional status) [25]. Four participants and their informal caregivers described inadequate pain management during our qualitative phase, which might be explained by poor discharge planning and older adults' complaints of not feeling sufficiently listened to or involved in medication-related decisions. In addition, the dysfunctional coordination between healthcare actors disclosed by all three groups of participants, may contribute to and exacerbate inadequate pain management in the critical hospital discharge period. Deficient pain medication management is of significant concern considering the well-known functional and psychological impacts of pain on older adults, not to mention the great healthcare costs [53].

In our retrospective quantitative phase, 30-day hospital readmission risks were associated with longer hospital length of stay, impaired mobility, multimorbidity, and polypharmacy. Regarding unplanned nursing home admission after hospital discharge, the oldest adults presenting with impaired functional mobility, dependency in the activities of daily living, cognitive impairment, traumatic injuries, and polypharmacy had a higher probability of nursing home admission. In addition, adjusted multivariate analyses revealed an increased risk of hospital readmission and unplanned nursing home admission for patients prescribed certain specific drugs. This might be explained by potentially inappropriate medications, particularly among geriatric inpatients. Indeed, the medication prescription reviews for our qualitative phase participants showed that the Beers and STOPP criteria [54, 55] were rarely fulfilled. Potentially inappropriate medications have been associated with MRPs and adverse health outcomes, such as hospital readmission and mortality [56]. According to our qualitative findings, these adverse health outcomes and inappropriate prescriptions might have been the result of dysfunctional discharge planning: many older adults and informal caregivers considered that discharges home had occurred too rapidly, with no time to organize a care network to support the older adult's

medication management. In addition, several older adults and informal caregivers revealed not feeling sufficiently listened to or involved in medication-related decisions during hospital discharge, despite them being the most important stakeholders in the decision-making process. Thus, they described contradictions between prescriptions and their medication preferences. Research into older adults' experiences of post-discharge medication management, by Tomlinson *et al.* [13] and Parekh *et al.* [14], documented similar findings. Participants felt vulnerable, evoking their difficulties understanding information, pressures surrounding the circumstances of their discharge, and a lack of integrated community care. Our qualitative phase revealed that not being involved in medication-related decisions led three of our participants to deliberate non-adherence. Losi *et al.* [57] suggested that medication adherence was influenced by multiple factors, including polypharmacy, psychological and social issues, and a patient's motivation and health literacy. Given that medication adherence is closely associated with MRPs and that polymedicated older adults are particularly vulnerable to these, medication adherence and continuity require an evaluation of patient preferences and adequate patient education [57].

The lack of patient-centeredness revealed in our study was exacerbated by dysfunctional coordination between healthcare actors, which affected the quality of care and medication management. Older adults and informal caregivers described poor communication between healthcare professionals and few opportunities to discuss new prescriptions with hospital healthcare staff. Our results were in line with the cross-sectional studies by Mabire *et al.* [58] and Meyer-Massetti *et al.* [59], which revealed wide gaps in discharge planning processes for geriatric inpatients, and the qualitative findings of Holmqvist *et al.* (2019) describing home-dwelling older adults' eagerness to be actively involved in their own medication evaluations. In addition, the healthcare professionals involved in our qualitative phase considered that the

long delay between being tasked to intervene in a care transition after hospital discharge and receiving the paperwork was potentially harmful. Communication failures between hospitals and community healthcare professionals have been described in previous studies (Knight et al., 2013). Tomlinson *et al.* [19] demonstrated that successful care transitions implied not only medication reconciliation and review but also patient education, collaboration within the care team, timely cross-sector communication (between hospital and community healthcare or between other healthcare services), and a patient-centered discharge document. Concerning discharge documentation, our qualitative research revealed no standardized, systematic interprofessional collaborative interfaces—such as software or other tools—that might help to optimize collaborative medication management.

Solution design step: development of the medication management model

Our combined findings helped us design an interprofessional, collaborative medication management model to prevent MRPs among home-dwelling older adults after hospital discharge. It is composed of four interacting fields of action (Figure 2).

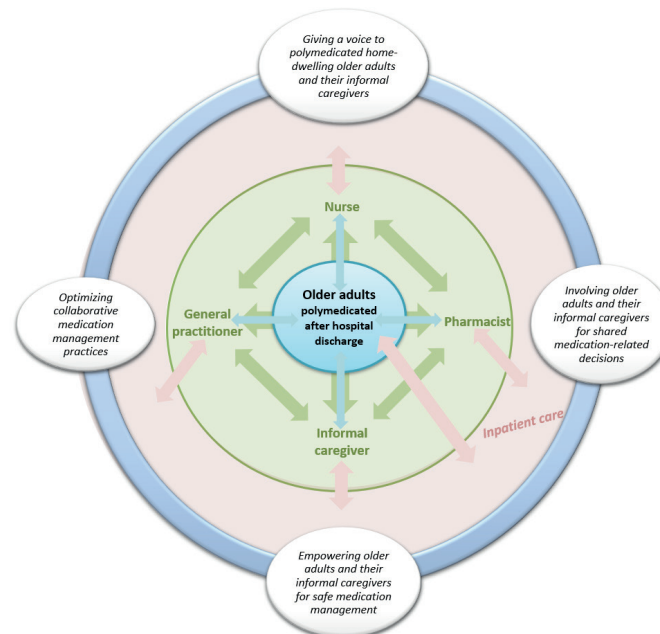


Figure 2. A collaborative, patient-centered, medication management model for polymedicated home-dwelling older adults after hospital discharge, based on mixed-methods research using an explanatory sequential design.

Giving a voice to polymedicated home-dwelling older adults and their informal caregivers

Our findings suggested that hospital and community healthcare professionals should explore older adults' values and preferences—and those of their informal caregivers involved in medication management—before and after hospital discharge. Although this is a common concern in research [57, 60], our results showed that it is still not sufficiently implemented in the Valais hospital and local community clinical settings. Previous studies have argued for regular reassessments of their values and preferences and for integrating them into each change in treatment [61, 62]. Our findings also suggested the need to ensure more adequate responses

to pain assessments. Not only should older adults' and informal caregivers' needs be considered and addressed, but collaborative pain management plans should be developed in conjunction with them and the healthcare professionals involved in their medication management [63]. Our study evidenced the misaligned perspectives between older adults, informal caregivers, and their healthcare professionals; they may also have revealed a misalignment between their medication management goals and values. Moreover, they suggested healthcare institutions' failure to be patient-centered. Collaborative medication management could be strengthened by fully sharing stakeholders' goals and creating a well-defined project about the older adult's health and quality of life trajectory [61]. Healthcare professionals should verify that medication management goals are up to date (corresponding to the current reality) and ensure that all the partners in the care network have been informed and that information has been duly documented and can be consulted [64].

Involving older adults and their informal caregivers in shared medication-related decisions

Regardless of older adults' age, comorbidities, or functional impairment, they wished to be involved in decision-making concerning them, such as medication changes or discharge planning. The meta-analysis by Hunt-O'Connor *et al.* [65] noted a reduced risk of readmission among older adults who had benefitted from discharge planning (RR = 0.78; 95% CI: 0.72–0.84; $p < .001$). Older adults should benefit from being given better, more appropriate, personalized information and being allowed to participate more actively in medication-related decisions at a technical or clinical level adapted to their preferences and capabilities [66–68]. In approaches using shared medication-related decision-making, patients should be considered pro-active partners and co-decision-makers in a manner adapted to their values, preferences, and capabilities [60, 68]. When they are not, the risks of non-adherence to treatment or medication errors are higher, as supported by our qualitative findings and previous studies [61,

69]. Therefore, it is important to support and encourage older adults' remaining autonomy in medication management [61].

Empowering older adults and their informal caregivers for safe medication self-management

Because our participants often reported misunderstanding the changes in their medication that took place in hospital and their difficulties in dealing with them at home, our findings emphasized that older adults' safety should benefit from a more empowering approach. This could involve healthcare providers sharing information on medication management best practices and agreeing on responsibilities with older adults and their informal caregivers [70]. A patient-centered medication empowerment plan, based on older adults' and informal caregivers' needs in terms of medication knowledge and skills, should be initiated in the hospital and followed up by community healthcare professionals. Healthcare professionals should be able to determine the extent to which an older adult and their informal caregivers have understood the changes in their medication that took place in hospital [71]; they should give them the means, tools, and tips to optimize day-to-day medication self-management [72, 73]; and they should monitor each older adult's level of medication adherence and any potential barriers to this [74, 75]. By facilitating medication empowerment for older adults and informal caregivers, healthcare professionals promote shared-decision making, which may encourage them to take control of their own health, with the endpoints of safe medication management and better patient outcomes [76].

Optimizing collaborative medication management practices

According to our results, collaborative practices between the different actors involved in older adults' care were considered key elements of safe medication management, particularly during care transitions. However, our findings showed that, in certain situations, communication was

clearly missing, putting effective medication management at risk and, consequently, the quality and safety of older adults' care. Interventions that foster communication and collaboration between multiple stakeholders, particularly during the care transitions between hospital and home, have been shown to best meet older adults' needs, prevent MRPs, reduce the worsening of chronic conditions, and cut the significant costs of hospital readmission [19, 64, 77]. Proper communication channels should be established to facilitate medication information sharing among the multiple stakeholders. For example, adopting a validated interprofessional collaborative tool able to detect and identify the physiological, clinical, psychosocial, and pharmacological risk factors for MRPs could improve interprofessional teamwork and promote safe medication management [78, 79]. In addition, each stakeholder's independent, joint, and overlapping responsibilities regarding medication management should be clearly defined so that they can better contribute to the different stages of the medication administration process [71]. Moreover, each older adult at a high risk of MRPs should systematically be assigned a *patient-centered geriatric care manager* from a nearby community healthcare center, with the overarching responsibility of fulfilling the older adult's needs and ensuring their safety [80-82]. These managers could contribute significantly to preventing hospital admissions, rehospitalizations, institutionalizations, and early death, as well as limiting the economic impact on the healthcare system [83]. They could ensure that medication reconciliations are performed whenever there is a change in health status or a care transition, ask an older adult's general practitioner or pharmacist to perform a medication review whenever there is a new prescription, as well as document and date all medication reconciliations or reviews and distribute that information to the care network [84].

Strengths and limitations

This study contributes to the growing body of knowledge and multiple perspectives on the barriers, challenges, and opportunities for improving the safe medication management of polymedicated older adults at home after hospital discharge. We used an innovative mixed-methods approach involving an explanatory sequential design that connected retrospective and prospective findings, including the many perspectives of the study's participants. Older adults', informal caregivers', and healthcare professionals' perspectives on medication management at home after hospital discharge helped explain and complete quantitative results describing the health profiles of older adults presenting with greater risks of adverse health outcomes related to MRPs. Our connected findings enabled us to develop a collaborative, patient-centered model to optimize medication management and prevent adverse health outcomes related to MRPs among polymedicated home-dwelling older adults after hospital discharge. The model proposes four interacting fields of action with tangible, collaborative recommendations.

The study, nevertheless, had some limitations. Regarding its retrospective quantitative strand, our dataset was based on routinely collected data, and we were unable to control for their quality or any potential assessment errors made by the hospital's healthcare staff at discharge. In addition, patients' medication datasets at admission and during hospitalization were often incomplete or unknown, which meant that we were unable to explore changes in the number of prescriptions during hospitalization. It would be interesting to explore whether hospitalization tends to increase or decrease the number of medications prescribed to geriatric inpatients. Additionally, although the study considered statistical associations between medications and adverse health outcomes, it did not consider clinically diagnosed drug–drug interactions. This would have involved inputting the multiple possible interactions or analyzing the prescriptions of a sample of the 105,243 hospitalization records. Regarding the study's prospective qualitative strand, one limitation was the difficulty keeping older adults and their informal

caregivers' interviews focused on the theme of medication management rather than on other instrumental activities of daily living. It was also difficult to maintain focus on the most recent care transition and ignore previous hospitalizations. Another limitation was the interruption of data collection at the beginning of March 2020 due to the COVID-19 pandemic restrictions. Given the study's longitudinal nature, follow-up data from four of the older adults recruited were lost. Adjusting our qualitative methodology by collecting data via an online platform was unfeasible since our research population was mostly unfamiliar with information and communication technologies. Despite our efforts at methodological rigor, we cannot exclude a risk of social desirability bias among study participants. It is thus possible that medication management was, in fact, less effective and collaborative than was portrayed in the interviews. Although it had no impact on the methodological rigor of this mixed-methods research, the qualitative phase started a few months before the end of the quantitative phase in order to meet planned project deadlines. Consequently, some of the results obtained in the retrospective phase (not presented in this paper) could have been explored further if the two phases had been conducted in a perfectly sequential manner. Concretely, the interview guides could have targeted some of the quantitative phase's results more deeply to explain or complete them. Nevertheless, this remains challenging when adopting an explanatory sequential design in a study that involves conciliating different data sources, field partners, research sub-teams, and time constraints.

CONCLUSIONS

Exploring polymedicated home-dwelling older adults' medication management after hospital discharge, using mixed-methods research, revealed several opportunities for improving that management's safety and effectiveness and preventing adverse health outcomes associated with medication-related problems. Healthcare professionals should consider not only the individual

barriers to older adults' involvement in medication management, triggered by their advanced age, multimorbidity, and physical impairments, but also older adults' and informal caregivers' preferences and values regarding their involvement in medication decision-making. Two-way communication and coordination between patients and healthcare professionals, between healthcare professionals and informal caregivers, and among healthcare professionals themselves should be broadly promoted. Our collaborative, patient-centered medication management model is innovative and could prove a tangible strategy for improving medication management safety in the canton of Valais and Switzerland. Future studies should be conducted to explore the effectiveness of combining these fields.

List of abbreviations

ACI: Agency for Clinical Innovation

ATC: Anatomical Therapeutic Chemical classification

ICD-10: International Classification of Diseases 10th version

MRPs: Medication-Related Problems

DECLARATIONS

Ethics approval and consent to participate

Ethics approval was granted by the Human Research Ethics Committee of the Canton of Vaud (CER-VD) (2018-02196). All participants gave their informed consent before participating in the qualitative phase. Given the quantitative phase's retrospective data source, obtaining patients' consent was impossible or posed disproportionate difficulties. The quantitative phase respected the legal requirements for research projects involving data reuse without consent, as set out in Art. 34 of the Swiss Human Research Act (HTA).

Consent for publication

Not Applicable.

Availability of data and materials

Data will be shared following a request made to the corresponding author and the permission of the Swiss National Science Foundation.

Competing interests

The authors declare that they have no potential conflicts of interest concerning the publication of this study.

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Authors' contributions

FP: project design, data analysis, methodology, writing original draft. HV: supervision, project design, data analysis, methodology, writing original draft. CM, MdRC, AvG, BW, MMM: project design, writing review, and editing. All authors read and approved the final manuscript.

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Supplementary File 1: Profiles of polymedicated, home-dwelling older adults at risk of adverse health outcomes (30-day readmissions and unplanned nursing home admission).

Patient-related factors
- age (OR = 1.07 for each additional year of age; 95% CI 1.05–1.08) [25]; - multimorbidity (OR = 1.419 per additional ICD-10 condition; 95% CI 1.282–1.572) [24]; - impaired mobility (OR = 1.218; 95% CI: 1.039–1.427) [24]; (OR = 3.22; 95% CI 2.67–3.87) [25]; - dependency in the activities of daily living (OR = 4.62; 95% CI 3.76–5.67) [25]; - cognitive impairment (OR = 3.75; 95% CI 3.06–4.59) [25]; - traumatic injuries (OR = 1.58; 95% CI 1.25–2.01) [25].
Medication-related factors
- number of prescribed medications (OR = 1.043 per additional medication prescribed; 95% CI: 1.028–1.058) [24]; (OR = 1.17; 95% CI 1.15–1.19) [25].
Environment-related factors
- longer hospital length of stay (OR = 1.014 per additional day; 95% CI: 1.006–1.021) [24].

Supplementary File 2. Sociodemographic characteristics of geriatric inpatients from the quantitative strand (n = 53,690) and a comparison between those who were polymedicated (n = 36,266) and those who were non-polymedicated (n = 17,424).

Variables		Geriatric inpatients aged 65 or more (n = 53,690)			P-value
		Total n (%) 53,690	Polymedicated 36,266 (67.5)	Non-polymedicated 17,424 (32.5)	
Sex	Male	25,672 (47.8)	17,357 (67.6)	8,315 (32.4)	0.763 ^a
	Female	28,018 (52.2)	18,909 (67.5)	9,109 (32.5)	
Age (years)	Mean (SD)	78.37 (7.9)	78.75 (7.7)	77.58 (8.3)	< 0.001 ^b
	Min–Max	65–106	65–106	65–106	
	Med [IQR-75]	78.00 [72–84]	79.00 [72–84]	77.00 [70–84]	< 0.001 ^a
	65–74	18,882 (35.2)	11,753 (62.2)	7,129 (37.8)	
	75–84	21,818 (40.6)	15,485 (71.0)	6,333 (29.0)	
	85 or more	12,990 (24.2)	9,028 (69.5)	3,962 (30.5)	
Admitted from	Home	38,324 (71.4)	24,740 (64.6)	13,584 (35.4)	< 0.001 ^a
	Other locations ^d	15,366 (28.6)	11,526 (75.0)	3,840 (25.0)	< 0.001 ^a
Discharged to	Home	33,771 (62.9)	23,747 (70.3)	10,024 (29.7)	< 0.001 ^a
	Other locations ^d	17,273 (32.2)	12,302 (71.2)	4,971 (28.8)	
	Died in hospital	2,646 (4.9)	217 (8.2)	2,429 (91.8)	
Length of stay (days)	Mean (SD)				< 0.001 ^c
	Min–Max				
	Med [IQR-75]				
65–74		12.1 (14.5)	13.8 (15.1)	8.6 (12.4)	< 0.001 ^b
		1–197	1–197	1–192	
		8 [4–15]	10 [5–17]	4 [1–11]	
75–84	Mean (SD)	10.3 (14.7)	12.4 (16.0)	6.8 (11.4)	< 0.001 ^b
	Min–Max	1–197	1–197	1–192	
	Med [IQR-75]	6 [13]	8 [4–15]	3 [1–7]	
85 or more	Mean (SD)	12.4 (14.0)	13.9 (14.4)	8.8 (12.2)	< 0.001 ^b
	Min–Max	1–194	1–194	1–189	
	Med [IQR-75]	9 [13]	10 [1]	5 [10]	
	Mean (SD)	14.3 (14.6)	15.5 (14.8)	11.6 (13.9)	< 0.001 ^b
	Min–Max	1–192	1–192	1–170	
	Med [IQR-75]	11 [14]	12 [18]	8 [15]	

Note. ^a Chi-square test; ^b ANOVA; ^c Wilcoxon–Mann–Whitney; ^d Other locations: hospitals and nursing homes

Supplementary File 3. Sociodemographic and professional characteristics of participants from the qualitative strand and older adults' numbers of prescribed medications and ICD-10 diagnoses.

Sociodemographic and professional characteristics	Older adults (n = 28)	Informal caregivers (n = 17)	Healthcare professionals (n = 13)
Sex (number)			
Female	11	15	10
Male	17	2	3
Age (years)			
Mean	81	68	44
Range	66–94	48–86	28–58
Relationship with the older adult			
Spouse/partner		10	
Child		6	
Daughter-in-law		1	
Profession (number)			
Retired	28	9	-
Employed	0	7	13
Unemployed	0	1	-
Nurse			5
Pharmacist/Pharmacy Assistant			4
General Practitioner/Specialist			4
ICD-10 diagnoses (number)			
Mean	13		
Range	3–27		
Medications (number)			
Mean	9		
Range	5–21		

ARTICLE 10

Pereira F, Coelho Rodrigues Dixe M, Santos Gonçalves Pereira, S, Meyer-Masseti C, Verloo, H. Intervention programme to reduce medication-related problems among polymedicated home-dwelling older adults (OptiMed): a pre–post multi-site pilot and feasibility study protocol (Submitted to JMIR Protocols on April 30th, 2022).

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Intervention programme to reduce medication-related problems among polymedicated home-dwelling older adults (OptiMed): a pre-post multi-site pilot and feasibility study protocol

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Abstract

Background: Effective medication management is one of the essential preconditions for polymedicated home-dwelling older adults with multiple chronic conditions to remain at home and preserve their quality of life and autonomy.

Objective: This study aims to explore the feasibility and acceptability of an evidence-based, multi-component, interprofessional intervention programme supported by informal caregivers to decrease medication related problems among polymedicated, home-dwelling older adults with multiple chronic conditions.

Methods: This quasi-experimental pre-post multi-site pilot and feasibility study will use an open-label design, where participants know what they are signing up for and will take place in primary healthcare settings in Portugal and Switzerland. The research population will comprise 30 polymedicated home-dwelling adults aged 65 years old or more, at risk of medication related problems and receiving community-based healthcare.

Results: Previous to a full-scale study, this pilot and feasibility study will focus on the recruitment and collaboration of participants and piloting the feasibility of the evidence-based, multi-component, interprofessional intervention programme. It will also be an essential part of follow-up research programmes on the multiple roles of informal caregivers, as it will put their coordination tasks into perspective with their own needs.

Trial registration: Swiss National Clinical Trials Portal (SNCTP) 000004654. Registered 1 November 2021, <https://www.kofam.ch/en/snctp-portal/searching-for-a-clinical-trial/?sid=140048>

Keywords: protocol; pilot study; feasibility; medication safety; medication-related problems; medication management; home-dwelling older adults; informal caregivers; interprofessional collaboration; patient-centred care; quasi-experimental pre-post study.

Introduction

Background

Older adults with multiple chronic health conditions—particularly those with cognitive impairment—frequently depend on complex medication regimens (1). Although the use of five or more medications, known as polypharmacy (2), may be clinically appropriate in many cases, inappropriate prescriptions may put older adults at a greater risk of medication-related problems (MRPs) and adverse health outcomes (3, 4). MRPs can lead to degradation in a patient's acute clinical condition, physical and cognitive decline, an exacerbation of chronic medical conditions, and avoidable health costs (5, 6). This public health issue has been highlighted in various European countries, including Portugal and Switzerland (7, 8).

Nonetheless, MRPs have been demonstrated to be preventable or reducible by using well-coordinated, patient-centred, interprofessional primary care (4, 5, 9). Current evidence-based strategies for medication safety and the prevention of MRPs include medication reconciliation, the systematic, comprehensive review of prescribed medications (including deprescribing), and electronic medication management systems (10, 11). Medication reconciliation is a well-documented, evidence-based practice involving the process of creating and updating a single list for an older adult's medication (12), followed by a systematic, comprehensive review of all that patient's currently prescribed medicines. Prior research has shown that the hospital discharge documents received by primary-care professionals are frequently inaccurate and lack key information (13). Regular medication reconciliation reduces medication errors thanks to consistent communication during transitions of care, including changes in clinical settings, medical practitioners or the level of care (14). Regularly and systematically reviewing prescribed medications is a straightforward, effective means of reducing inappropriate prescribing and, therefore, a preventive strategy for avoiding MRPs (15). Inappropriate prescribing includes potentially inappropriate medications and potential prescribing omissions (15). Existing assessment tools—such as the STOPP/START criteria (Screening Tool of Older Persons' Prescriptions/Screening Tool to Alert to Right Treatment)—recognise the dual nature of inappropriate prescribing by including a list of potentially inappropriate medications (STOPP criteria) and potential prescribing omissions (START criteria) (16). Complementary to this, the regularly updated American Geriatrics Society Beers Criteria is a list of potentially inappropriate

medications that older adults should avoid in most situations or in connection with particular health conditions (17).

Implementing effective primary-care management for home-dwelling older adults with multiple chronic conditions should be a priority to address and prevent adverse health outcomes, avoid hospital admissions, promote and maintain autonomy in their daily lives, and, consequently, help them remain at home (18). Primary-care management requires interprofessional collaboration across different healthcare and social care providers, organisations and departments (19). Indeed, the complexity of dealing with home-dwelling older adults with multiple chronic conditions and needs leads them to be significant users of health services and to consult many different healthcare professionals (20). Besides prescribers—usually general practitioners (GPs) and different specialist physicians—pharmacists, nurses and other allied health professionals may also be involved in medication management (19). Collaborative home medication reviews (i.e. involving a GP and a pharmacist) have demonstrated their effectiveness at preventing, detecting and resolving MRPs among home-dwelling older adults (19). Furthermore, adherence to prescribed medication can be improved by pharmacist- and nurse-led interventions (21-24). However, the number of healthcare professionals consulted by home-dwelling older adults has been directly associated with fragmented and uncoordinated care (19). Moreover, different healthcare professionals may have different treatment preferences, leading to differing prescriptions. Thus, home-dwelling older adults with multiple chronic conditions often receive inefficient and ineffective care (25), or uncoordinated care, even though they are more likely to benefit from that care (26). Failure to coordinate care contributes to MRPs (19). Older adults who consult three or more healthcare professionals report receiving conflicting advice, making it difficult for them to know whose guidance they should follow. Inadequate explanations about medication result in omissions and incorrect dosages, but it can also lead to anxiety and confusion among older adults (27). Older adults' safety could benefit from a more empowering approach, with healthcare providers sharing information on best practices in medication management and agreeing on responsibilities with older adults and their informal caregivers (28). The WHO defines empowerment as “a process in which patients understand their role, are given the knowledge and skills by their health-care provider to perform a task in an environment that recognizes community and cultural differences and encourages patient participation”(29). Four components have been reported as being fundamental to the process of patient

empowerment: 1) they understand their own role; 2) they acquire sufficient knowledge to be able to engage with their healthcare provider; 3) they develop skills; and 4) there is a facilitating environment (30). To the best of our knowledge, these four components have never been explored with regards to empowering older adults and informal caregivers' medication management skills and promoting their active engagement in reducing the risk of MRPs.

To close these gaps, which are mostly due to communication issues, older adults at a high risk of MRPs should systematically be assigned a *geriatric patient-centred community-care manager* from a nearby primary healthcare centre (PHC). The manager's aims are fulfilling patients' needs regarding medication management and preventing MRPs (31). Using an evidence-based, multi-component, interprofessional intervention, co-constructed with older adults and informal caregivers, community care managers could contribute significantly to preventing hospital admissions, rehospitalisations, institutionalisations in long-term care facilities, and early death, as well as limiting economic impacts on the healthcare system (32). PHCs are a first point of contact with primary healthcare professionals and entire healthcare services systems; they are patient-focused (not only disease-oriented) and coordinate and integrate care over time (33). Services provided by PHCs include health promotion, prevention and diagnosis, detection, intervention, treatment, and case and care management. PHC staff provide first-line healthcare services to home-dwelling older adults and play a crucial decision-making role, strengthening communication and collaboration between community and specialised healthcare professionals (33, 34).

In addition to healthcare professionals' contributions to effective medication management and identifying the risks of MRPs, informal caregivers could help ensure the safe and appropriate use of medication at home by older adults with multiple chronic conditions, notably among those who may also have a cognitive impairment or psychopathological disorders (35-37). More interventional studies are required to explore how informal caregivers can be efficiently supported in their roles as medication managers, notably through the use of up-to-date, accurate and easily understandable medication plans. Primary healthcare professionals should be assigned the task of cooperating with informal caregivers and integrating their shared decision-making experiences (35-37). Previous research has shown the effectiveness of evidence-based, multi-component, interprofessional intervention programmes for reducing MRPs. These programmes included risk assessment, health education for older adults and their informal

caregivers, digital applications, and specialised counselling services or interventions provided by pharmacists and advanced practice nurses (35-37). These elements should be tested to prevent any adverse outcomes due to polypharmacy before their implementation in daily practice.

Improving medication management for home-dwelling older adults with multiple chronic conditions requires eliminating discrepancies in their medication therapy through medication reconciliation during transitions of care, the monitoring of MRPs through regular medication reviews to deal with over- and under-prescribing, coordinating care by different healthcare and social services providers, and empowering older adults and informal caregivers to manage older adults' medications (38-40). This calls for a tailored intervention programme, based on a clear allocation of roles, to reduce the risk of MRPs among home-dwelling older adults with multiple chronic conditions. Such a medication management programme should be underpinned by a multi-component model of care including development, implementation and sustainability milestones. It should also consider the four-fold aim of enhancing the patient's experience, improving population health, reducing costs, and improving healthcare professionals' working lives (41). Such an intervention programme should be able to detect and identify the physiological, clinical, psychosocial and pharmacological risk factors of MRPs early on. A standardised, evidence-based, multi-component, interprofessional intervention programme, which embeds care into the context of where and how older adults with multiple chronic conditions live, needs to be developed to prevent the onset or progression of MRPs.

Objectives

Before conducting a full-scale study with sufficient statistical power, a pilot and feasibility study is a critical step in the process of developing and testing the intervention. It is "a small-scale test of the methods and procedures to be used on a larger scale" (42). Thus, our pilot and feasibility study's goal is not to test hypotheses about our intervention's impact but rather to assess the feasibility and acceptability of our approach (43).

Pilot study design

This quasi-experimental pre-post multi-site pilot and feasibility study will focus on the feasibility components using an open-label design where participants know what they are signing up for. It

will support the development of a standardised, evidence-based, multi-component, interprofessional intervention programme to reduce MRPs.

The OptiMed pilot study's framework

Intervention studies in primary care are typically complex, multi-component, interprofessional, and standardised, requiring considerable planning if they are to be conducted successfully (44). Thus, in accordance with the Medical Research Council Framework, we carefully planned the different steps required for the successful execution of this project, having sufficient statistical power and the necessary number of participants in both countries (Figure 1). Designing the OptiMed pilot and feasibility study protocol is part of the development phase, which includes developing all of the study's different components: identifying research gaps and the risks of MRPs, describing relevant concepts and designing the intervention. Whereas the OptiMed pilot study (phase 2) will let us explore and test the feasibility of conducting the OptiMed full-scale study (phase 3), the latter will assess the effectiveness of the evidence-based, multi-component, interprofessional medication-management intervention programme for polymedicated home-dwelling older adults. As a secondary endpoint, we also expect to develop and implement a Swiss–Portuguese interprofessional education training course about optimising medication management among polymedicated home-dwelling older adults receiving community-based healthcare (phase 4).

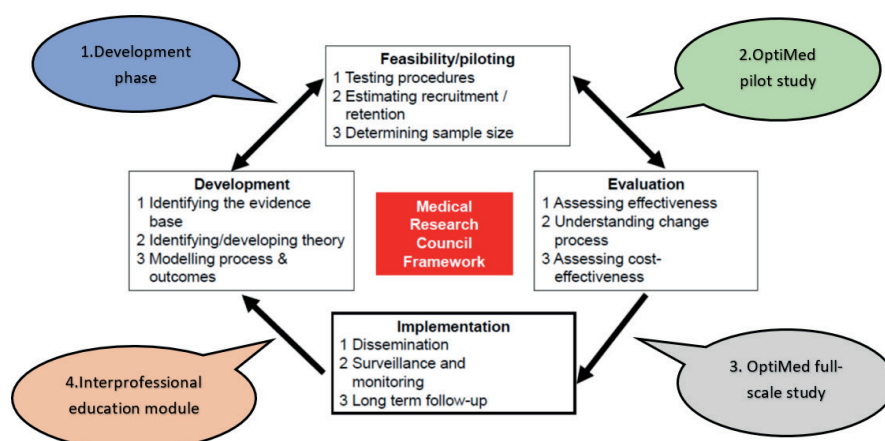


Figure 1: The four phases of OptiMed pre-post multi-site study and their relationships with the Medical Research Council's framework for complex interventions (44, 45).

Furthermore, four concurrently interacting components that improve the primary care of home-dwelling older adults with multiple chronic conditions—previously identified by Boulton and Wieland (46)—will help to operationalise and implement the intervention programme: 1) appropriate tools to comprehensively assess the risks associated with MRPs; 2) evidence-based, multi-component, interprofessional care planning, interventions and monitoring; 3) the promotion of active engagement in that care by patients and informal caregivers, and 4) coordination between professionals to ensure the best patient care. All four concurrent interacting components are tailored to the patient's goals and preferences. In the present pilot study, these four components will be integrated into a medication-management programme focused on the context surrounding polypharmacy. Assigning roles and respecting the competencies of each member of the programme's interprofessional team is key to ensuring optimal coordination and a systematic team approach.

Methods: Participants, interventions, and outcomes

Study setting

The OptiMed pilot study will take place in PHCs in the French-speaking Switzerland and the USF Santiago-Marrazes in Leiria, Portugal.

Eligibility criteria

The research population will include polymedicated home-dwelling adults aged 65 years old or more, both men and women, at risk of MRPs and receiving community-based healthcare. Purposive sampling will recruit older adults taking four or more medicines per day and presenting with a risk of an MRP, as assessed using the doMESTIC risk tool, currently in psychometric validation. The criterion of four or more drugs is based on the Delphi study that developed this tool (47). Older adult participants at risk of MRPs will be integrated into our investigation if their informal caregiver is involved in medication management and they too agree to participate.

We defined informal caregivers as any family member, neighbour or friend who assists a dependent older adult. That assistance, help, care or physical presence must have been given regularly, for six months or more, for at least two basic or instrumental activities of daily living or to ensure patient safety (48). The informal caregiver will be included in the study if the recruited older adult identifies them as being significant in their medication management and if they give informed written consent to participate. Based on our clinical experience, being significant in an older adult's medication management involves at least one of the following activities: accompanying the patient to health consultations, assistance in obtaining medication, collecting

or delivering medication, assistance with preparing or taking medication, monitoring effectiveness and side effects, assistance in maintaining the medication schedule and organising home care support.

Furthermore, throughout the investigation, each participant will be accompanied by the healthcare professional(s) designated as the professional most involved in their medication management. Table 1 presents the specific inclusion and exclusion criteria for each group of participants.

Table 1. Inclusion and exclusion criteria of the OptiMed pilot study participants.

	Participants	Inclusion criteria	Exclusion criteria
Study participants	Polymedicated home-dwelling older adults	- Aged 65 or older for both men and women - Suffering from multiple chronic conditions (two or more) - Managing at least four prescribed medications daily for more than 90 days (2) (explored during recruitment) - At risk of MRPs identified using the doMESTIC RISK tool - Living alone or with a partner, in a rural or urban area - Supported by a Primary Healthcare Centre - An informal caregiver is involved in medication management - Gives written informed consent	- Unable to speak and understand French (Swiss site) or Portuguese (Portuguese site) - Moderate or severe dementia criteria (≥ 10 on the Six-item Cognitive Impairment Test, 6-CIT) - No risk of MRPs (doMESTIC RISK tool score < 5) - No informal caregiver
	Informal caregivers	- Designated by the older adult as the most significant informal caregiver involved in medication management - Aged 18 or above - Gives written informed consent	
Collaborating participants	Nurse primary care manager	- Working for a Primary Healthcare Centre - Designated by the older participant as playing a key role in medication management - Gives written informed consent	- Student - Apprentice
	Community pharmacist	- Working in a community pharmacy - Designated by the older participant as playing a key role in medication management - Gives written informed consent	
	Physician	- Older adult's GP or specialist physician - Designated by the older participant as playing a key role in medication management - Gives written informed consent	

Primary and secondary feasibility outcomes

The pilot study's primary objective is to explore the feasibility and acceptability of an evidence-based, multi-component, interprofessional intervention programme, supported by informal caregivers, to decrease MRPs among polymedicated, home-dwelling older adults with multiple

chronic conditions. The pilot study will gather information about the feasibility and acceptability of recruitment, participant retention, adherence, fidelity, acceptability and satisfaction, intervention dose, and the intervention programme's overall credibility (42, 49) (Table 2). The secondary objective is to test the different data collection tools planned for use in the full study.

Table 2. Outcomes and measurements of the OptiMed pilot study's feasibility based on the *US National Center for Complementary and Integrative Research* recommendations (50).

Outcomes	Measurements of feasibility
Target population is recruited	Number screened per month; number enrolled per month; average time delay from screening to enrolment
Study participants are retained	Treatment-specific retention rates for study measurements; reasons for drop-outs
Study participants adhere to their instructions	Treatment-specific rates of adherence to study protocol (in-person session attendance, homework, home sessions, etc.); treatment-specific measurements of competencies
Medication review is successful	Treatment-specific fidelity rates; time invested; number of discrepancies between professional sources; number of discrepancies between patient-reported medication use and professional sources; number of questions; number of items needing clarification; number of recommendations made by the pharmacist; number of pharmacist's recommendations adopted by the physician
Assessments are not considered too burdensome	Proportion of planned assessments that are completed; duration of assessment visits; reasons for drop-outs; ease of use of doMESTIC RISK tool; ease of use of structured medication review template
All interventions are rated as acceptable	Acceptability ratings; qualitative assessments; reasons for drop-outs; treatment-specific preference ratings (pre-and post-intervention)
Credibility of each component of the interprofessional intervention programme is assessed as positive	Ratings for treatment-specific expectations of benefit
Relationship between dose of nursing (51) and response to the programme is measured	Amount, frequency, intensity and duration
Study displays clinical relevance	How participants perceive the intervention programme (patient-reported outcomes), PROMS (52). Identify what is relevant for participants (such as quality of life or remaining at home). Enables a choice of which final outcomes from the pilot study will go into the intervention.

As per the COSMIN recommendations (53), if the pilot study is conclusive, then the OptiMed full-scale study will adopt the standardised Core Outcome Set (COS) for clinical trials of a medication review for multi-morbid older patients with polypharmacy, as previously reported by Beuscart, Knol (54) in 2018.

Study intervention

After the older participant has been recruited via their nurse primary-care manager, working for their PHC, the intervention's first component (t0) involves a baseline assessment of them at a

meeting conducted by a research nurse. The research is explained to the older participant in detail, both orally and in writing, and the consent form is signed. Following this, the older participant is asked to answer some sociodemographic and health-related questions and provide a complete list of their current medication prescription. The research nurse completes a questionnaire on the risk of MRPs—doMESTIC risk. A first meeting also takes place individually with the informal caregiver (who will also answer some sociodemographic and health-related questions and describe their role in medication management). The older participant is asked to identify the healthcare professional(s) (GP or specialist, nurse primary-care manager and/or community pharmacist) most involved in their medication management.

The second component (t1) involves a review of the prescribed medications in week 1, including a medication reconciliation and a structured medication analysis by the pharmacist study partner, to identify drugs with a high risk of MRPs among older adults. This will use the STOPP/START criteria, and undertreated indications or missed therapies will use the START criteria (16). The older participant's physician will be invited to participate in the review of prescribed medications in collaboration with the pharmacist study partner. They will discuss validated, evidence-based, internationally recognised guidelines to reconsider beneficial or non-beneficial therapies or to simplify and focus on specific care goals and adjust medications to be consistent with guidelines. If the older participant's physician adopts no changes despite the medication review (t1) highlighting their relevance, the research team will inform the older participant of their physician's decision and will invite them to proceed with the study.

Based on the baseline assessment (t0), the research nurse will use a joint consultation in week 2 to explore the needs and care goals of the older participant and their informal caregiver so as to reduce the risk of MRPs (t2). The research nurse will then design a target patient-centred education plan—in collaboration with the designated healthcare professional(s)—to empower the older participant's medication management and reduce the risk of MRPs (t2). This is based on a four-step patient empowerment process: 1) the patient understands their role; 2) the patient acquires sufficient knowledge to be able to engage with their healthcare professionals; 3) the patient improves their skills; and 4) there is a facilitating environment (30). Each older participant's plan will be unique and consider their preferences, medication literacy and treatment adherence.

During weeks 3 and 4 (t3), the research nurse will help the older participant and their informal caregiver to implement their target education plan (t2) aimed at empowering their medication

management and promoting their active engagement in reducing the risks of MRPs. Two joint consultations will be organised between the older participant, their informal caregiver and the research nurse (once each week). During planned home visits, the nurse will periodically evaluate older participant' medication status (primary and secondary outcomes) and promote communication between the different professional and non-professional actors involved in medication management.

The research nurse will carry out a final assessment (t4) of each older participant's risks of MRPs in week 5 (35–40 days after t0) in collaboration with the study partner pharmacist. The occurrence of MRPs and medication-related hospital admissions will be investigated. Finally, the acceptability of the interprofessional intervention programme to reduce MRPs will be assessed by the healthcare professionals designated by the older participant in a final questionnaire.

As already described, the medication-management intervention programme guiding OptiMed's pilot study comprises four components based on concurrent interacting processes previously identified by Boult and Wieland (46) (Table 3). The pilot study will explore possible biases so that they can be correctly addressed in the full study (42, 44).

Table 3. Overview of the OptiMed pre-post multi-site pilot and feasibility study: an intervention programme to optimise medication management and prevent MRPs among polymedicated home-dwelling older adults with multiple chronic conditions.

Participant recruitment	Contact with study and collaborating participants (t-1)	Baseline assessment after written consent (pre-intervention)	Medication-management intervention programme to reduce the risks of MRPs			Final assessment (post-intervention) Week 5 = Measurement 2 (t4) Measurement 1 + 35–40 days
		Week 0 = Measurement 1 (t0)	Week 1 (t1)	Week 2 (t2)	Weeks 3 and 4 (t3)	
Study participants: <u>Risk of MRPs</u> Sample pilot study (n = 30) Inclusion criteria: - Aged 65 or older, both for men and women - Suffering from multiple chronic conditions (2 or more) - Managing at least four prescribed medications daily - At risk of MRPs (score ≥ 5) - Living alone or with a partner, in a rural or urban area - Supported by a Primary Healthcare Centre - An informal caregiver is involved in medication management Collaborating participants: <u>Informal caregivers</u> - Designated by the older adult as the most significant informal caregiver involved in medication management - Aged 18 or above Nurse primary-care manager - Working in a Primary Healthcare Centre - Already knows the participant Community pharmacist - Study partner or works in a community pharmacy Physician - Older adult's GP - Designated by the older adult as having a key role in medication management	Nurse primary-care manager working for a Primary Healthcare Centre, already knows the participant professionally and explains the study to them In collaboration with the Primary Healthcare Centre: (1) Recruitment of participants (2) First meeting, within 3 to 4 days, at participant's home (3) Oral and written information and explanation about the study (4) Written consent	Older participants: - Sociodemographic data - Health status: - 6-CIT - Tilburg Frailty Indicator (TFI) - ICD-10 diagnosis - Risk of MRPs: - Medication list(s) - Previous MRPs - doMESTIC risk tool* * <i>Assessment carried out by two research nurses collaborating with two community pharmacist study partners.</i> Informal caregiver: - Sociodemographic data - Role in medication management Pharmacist: - Sociodemographic and professional data Nurse primary-care manager: - Sociodemographic and professional data Physician: - Sociodemographic and professional data <i>All data will be accessed using securiTrial®</i>	Reviewing prescribed medications using the STOPP/START criteria (16): - By the pharmacist study partner in close collaboration with the older adult's physician- For older participants at risk of MRPs detected using the doMESTIC risk tool (t0) Exploring older participant and informal caregiver's needs and care goals to reduce the older adult's risks of MRPs: - One joint consultation between the older participant, their informal caregiver and the research nurse. Designing a target education plan to empower the older participant and informal caregiver's medication management and to promote their active engagement in reducing the risks of MRPs (Items 9 and 10 from doMESTIC risk tool): - By the research nurse - In collaboration (if available) with the designated healthcare professional(s) Implementing the target plan to empower older participant and informal caregiver's medication management and promote their active engagement to reduce risks of MRPs - Two joint consultations (once a week) between the older participant, the informal caregiver and the research nurse	Older participant at risk of MRPs: - Risk of MRPs with doMESTIC risk tool* - Number and type of medication changes made (by the physician) - Acceptability assessment Collaborating participants: Acceptability assessment Pilot study: Feasibility outcomes (Table 2) assessment		

Participant timeline

The schedule of enrolment, interventions and assessments is presented in Table 4. The pilot study will be carried out over a period of 12 months, including the recruitment phase.

Table 4. OptiMed schedule of enrolment, interventions and assessments based on *Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT)* (55).

		STUDY PERIOD					
		Enrolment	Allocation	Post-allocation			Final endpoints
TIMEPOINT		-t ₁	t ₀	t ₁	t ₂	t ₃	t ₄
ENROLMENT	Eligibility screening	X					
	Informed consent	X					
	Other procedures (to complete)						
	Allocation	NA in the pilot study					
INTERVENTIONS	Medication review process examining the risks of MRPs			↔			
	Target education plan to empower older adults' and informal caregivers' medication management to reduce the risks of MRPs				↔		
	Implementing the target plan to reduce the risks of MRPs					↔	
ASSESSMENTS	Baseline variables:						
	Older participants' sociodemographic data, health status and risks of MRPs		X				
	Informal caregivers' sociodemographic data		X				
	Healthcare professionals' sociodemographic and professional data		X				
	Final assessment of older participants' risks of MRPs						X
	Medication reconciliation ¹						
	Number of discrepancies			X			
	Number of clarifications needed			X			
	Medication analysis ¹						
	Overuse			X			X
	Underuse			X			X
	Potentially inappropriate medications			X			X
	Clinically significant drug–drug interactions			X			X
	Monitoring requirements			X			X
	Adverse events ¹						
	Medication-related hospital admissions						X
	Medication-related problems (MRPs)						X

Patient-reported outcomes² (will be defined by the pilot study)						X
Feasibility outcomes						
Target population recruitment						X
Retaining study participants						X
Participants' adherence to what they are asked to do						X
Medication reconciliation						X
Burden of assessments						X
Acceptability of each intervention						X
Credibility of each intervention						X
Relationship between dose of nursing(51) and response to the programme						X

¹ Primary outcomes. ² Secondary outcomes.

Sample size and recruitment

Based on Hogg, Tanis (56) we plan to recruit 30 older participants (15 men and 15 women) in collaboration with PHCs in French-speaking Switzerland and the USF Santiago–Marrazes PHC in Leiria, Portugal. Nurse primary-care managers partnering with the project will briefly explain the study to polymedicated home-dwelling older adults who meet the inclusion criteria. Eligible participants will be asked for permission to give their names to the researchers, and a research team member will telephone them to ask for their agreement to participate in the study. If they agree, a first meeting with a research team member will be organised at the older participant's home or the PHC in the next few days. Given the two countries' different primary healthcare practices, eligible participants in Switzerland will be met at home, whereas participants in Portugal will be met at the PHC. Consenting older participants will be asked to designate their most significant informal caregiver, aged 18 or older, involved in their medication management, and the research team will invite them to participate in the study too. The older participant will be asked to designate those healthcare professionals (GP or specialist physician, nurse primary care manager and/or community pharmacist) who are most prominently involved in their medication management. During this first meeting, the research nurse will explain the study's nature, purpose and procedures to the older participant, along with its expected duration, the potential risks and benefits, and any discomfort it may entail. Each older participant will be informed that participation in the study is voluntary, that they may withdraw from it at any time, and that withdrawal will in no way affect their subsequent medical assistance and treatment.

Methods: Data collection, management, and analysis

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Data collection methods

Data on older participants' health status will be collected using the Six-item Cognitive Impairment Test (6-CIT), the Tilburg Frailty Indicator (TFI) and the diagnosis list based on the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). Current medication, previous MRPs and the doMESTIC RISK tool will provide data on the risks of future MRPs and will be collected, when possible, through PHCs' routinely collected data or directly from older participants and their informal caregivers.

For informal caregivers, sociodemographic data and information about their contribution to their relative's medication management will be collected. For healthcare professionals (GPs, nurse primary-care managers and community pharmacists), we will collect sociodemographic and professional data, information about medication monitoring and follow-up information, teaching and training provided on medication management, assessing cognitive capacity to manage medication, stakeholder collaboration, and medication management.

The study will also collect participants' opinions on the acceptability of each intervention, reasons for drop-outs, and treatment-specific preference ratings (pre-and post-intervention).

Except for the doMESTIC risk tool—whose psychometric validation is currently being conducted—all the other study's instruments have demonstrated their reliability and validity in previous studies. Table 5 describes the measurements taken, the instruments used for data collection, and their respective purposes. To promote data quality, the nurses and study partner pharmacists will receive two one-hour sessions of assessment training.

Table 5. Measurements and instruments used for data collection.

	Participants	Measurements and instruments	Purpose
Study participants	Home-dwelling older adults	Sociodemographic data (baseline assessment, t0)	Describe older participants' profiles (birth date, sex, household size, number of hospitalisations, date of last hospitalisation, etc.)
		Six-item Cognitive Impairment Test (6-CIT) (t0)	Perform brief cognitive screening recommended for use in primary care settings (57)
		Tilburg Frailty Indicator (TFI) (self-administered or at t0)	Assess multidimensional frailty among older participants via a self-administered questionnaire (58)
		10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10 diagnosis list) (t0)	Describe older participants' morbidities based on the ICD-10 (59); The list is useful when doing a medication analysis and evaluating prescription adequacy

		Current medication list(s) (t0)	Perform medication analysis (overuse, underuse, potentially inappropriate medications, clinically significant drug–drug interactions) and medication reconciliation (number of discrepancies and clarifications needed)
		Previous MRPs (t0)	Describe history of past MRPs
		doMESTIC RISK tool (t0 and final assessment, t4)	Identify older participants' at a high risk of MRPs (47)
		Acceptability of the intervention (60) (t4)	Collect older participants' opinions on the acceptability of the medication-management intervention programme
	Informal caregivers	Sociodemographic data (t0)	Describe the profiles of informal caregivers and their relationships with older participants
		Involvement in medication management (t0)	Describe types, frequencies and intensity of informal caregivers' support activities
		Acceptability of the intervention (60) (t4)	Collect informal caregivers' opinions on acceptability of the medication-management intervention programme
	Healthcare professionals (nurse primary-care manager, community pharmacist, physician)	Sociodemographic and professional data (t0)	Describe professional caregivers' profiles and baseline involvement in medication management
		Acceptability of the intervention (60) (t4)	Collect professional caregivers' opinions on acceptability of the medication-management intervention programme

Study instruments

Six-item Cognitive Impairment Test (6-CIT)

6-CIT was selected for the cognitive screening of older participants because it is brief and simple to apply and do not need special education. Originally called the Six-Item Orientation–Memory–Concentration Test, and developed by Katzman *et al.* (61) by shortening Blessed *et al.*'s Mental Status Test, 6-CIT involves three tests of temporal orientation (year, month, time), two tests of attention (counting backwards from 20 to 1, reciting the months of the year in reverse), and one of short-term memory (5-item address). Scored out of 28, higher scores indicate greater impairment. 6-CIT has been used in a broad range of settings, including screening for dementia in primary care, cognitive screening in acute care, in large population-based studies and in Alzheimer's disease studies (57). In primary care, the English version's internal consistency (Cronbach's alpha), stability over time (Pearson's *r*) and agreement between successive tests (Cohen's kappa) reached values of 0.58, 0.62 and 0.45, respectively.

Sensitivity and specificity reached values of 0.49 and 0.92 at the 7/8 cut-off and of 0.32 and 0.98 at the 10/11 cut-off, respectively (62). The Portuguese version of the 6-CIT (6-CIT-P) presented a high test–retest reliability coefficient ($r = 0.95$, $p = 0.00$; $n = 54$), indicating good temporal stability (63). 6-CIT-P also showed strong internal consistency ($\alpha = 0.88$), and the corrected item-total correlations ranged between 0.32 and 0.90, representing a moderate-to-strong correlation between the items and total score. 6-CIT-P and mini-mental state examination (MMSE) scores were strongly negatively correlated ($r = -0.90$) because of the polarity of the tests, indicating acceptable convergent validity. The Global 6-CIT showed good sensitivity and specificity (82.78% and 84.84%, respectively) based on comparisons with the MMSE (63). The French version is currently being explored in a validation study.

Tilburg frailty indicator (TFI)

Because polypharmacy has been associated with a higher incidence of frailty (64, 65), the TFI will be used to assess multidimensional frailty among home-dwelling older adults (58). Unlike other frailty assessment instruments, the TFI does not focus exclusively on the physical dimension of frailty and does not include disability and diseases in its assessment. This contributes to a holistic perspective of human functioning in the community (including the physical, psychological and social domains). The TFI consists of two parts: part A contains ten questions on the determinants of frailty and multimorbidity, whereas part B examines three domains of frailty (physical, psychological and social) with a total of 15 questions (58). Each question results in a score of 1 or 0. A total score ≥ 5 suggests that a person is frail, and the greater the score, the more the degree of frailty is considered to be significant. The original English version's internal coherence demonstrated a satisfactory Cronbach's α coefficient of 0.73. Construct validity between the different domains revealed significant Pearson's correlation coefficients ($p \leq 0.05$): $r = 0.42$ between the physical and psychological domains, $r = 0.19$ between the physical and social domains, and $r = 0.18$ between the psychological and social domains. Convergent and divergent validities were considered good. The TFI demonstrated good temporal-fidelity stability, with a frailty score of 0.90 after 2 weeks and 0.79 after 1 year (66). The Portuguese version of the TFI showed good internal consistency ($KR-20 = 0.78$) and test–retest reliability ($r = 0.91$), with kappa coefficients showing substantial agreement for most items (67). The French version is currently being validated.

doMESTIC RISK tool

The doMESTIC RISK tool is used to identify patients at a high risk of MRPs (47). It is based on home-care-specific risk factors for medication safety derived from the literature. Experts prioritised the tool's suggested items using a two-round Delphi study. The final tool was subsequently statistically validated via a systematic medication review involving 150 home care patients. The tool's subsequent weighting improved the model's overall quality and resulted in a final doMESTIC RISK tool with 10 risk factors. The tool's strengths are its specific focus on the home care setting and the interprofessional input necessary for its completion (47). French and Portuguese versions of the original tool will be used. The reliability, validity and responsiveness of the doMESTIC RISK tool are currently being measured based on a quantitative analysis of field tests (factor analysis and item response theory) (53, 68). In this pilot study, an older adult's risk of MRPs, and whether the medication-management intervention programme contributes to decreasing it, will be assessed by two nurse research assistants in collaboration with two pharmacists using the doMESTIC RISK tool during the baseline assessment (t0) and the final assessment (t4).

Participants retention and complete follow-up

Based on best practice guidance (69), the following strategies will be used to promote the retention of older participants and informal caregivers and to complete follow-up:

- Involving informal caregivers;
- Allowing rest between measurements and interviews, as needed;
- Visiting older participants at home during visits by the PHC's home care services (Switzerland);
- Arranging transport to the visit location or reimbursing transportation costs (Portugal);
- Keeping visits short (less than one hour);
- Providing opportunities to build social support through organised educational sessions within the target plan;
- Keeping in touch by scheduling appointments in advance and sending reminders to both the older participant and the informal caregiver;
- Providing regular feedback to study participants.

Study and collaborating participants can withdraw their consent to participate in the study at any time and without having to justify this. Participants who discontinue, drop out or deviate from the intervention programme will be briefly interviewed to learn when and why they did so, and an intention-to-treat analysis will be done. In case of withdrawal, the data collected will be anonymised using secuTrial® search software and stored on a secure server at the School of Health Sciences, HES-SO Valais/Wallis and ciTechCare, Polytechnic of Leiria.

Data management

All data will be entered into the secuTrial® electronic data capture system, either at the School of Health Sciences, HES-SO Valais/Wallis, or at ciTechCare, Polytechnic of Leiria. Original study forms will be scanned, stored electronically with limited access and kept on file at the HES-SO and ciTechCare sites. Data entry screens will resemble the paper forms approved by the ethics committees. Data consistency will be ensured through various mechanisms, including referential data rules, valid values, range checks and consistency checks against data already stored in the database (longitudinal checks). Checks will be applied when data are entered into a specific field and before they are committed permanently to the database. Modifications to data in the database will be documented via an audit trail. Data in the secuTrial® database will be retrievable through the data entry applications. The types of activity that individual users may undertake will be regulated by the privileges associated with their user identification code and password.

The two-country roll-out will allow greater standardisation of the evidence-based, multi-component intervention programme for a future, full-scale, quasi-experimental pre-poststudy. However, raw data will not be shared between countries and the results obtained will be discussed only after having been analysed in each country. A joint publication is planned using aggregated data from the pilot study results.

Statistical methods

The pilot study will compute descriptive statistics as distributions and central tendencies, and inferential statistics to provide power analyses for the pilot study's proposed sample size. The quantitative cut-off point for feasibility will be success with at least 70% of participants. The pilot study's results will help to provide a power analysis of the sample needed for a fully

powered pre-post study. Analyses will be conducted in collaboration with a biostatistician using an up-to-date version of SPSS software (Chicago, IL).

Handling missing data and drop-outs

We do not expect any missing data as the protocol is limited and well adapted to the potential subjects' characteristics. The OptiMed pilot study will consider missing data and drop-out rates as significant results for organising recruitment, intervention adherence, acceptability and subject retention in the full study. Nevertheless, to fully evaluate all of the pilot study's different components, we will replace drop-outs with new subjects until 30 have completed the study.

Methods: Monitoring

Data monitoring

SecuTrial® will be a great help in monitoring both the pilot study and the full-scale study. Data monitoring will inform us on aspects of the study's conduct, such as ongoing recruitment, and help to identify any needs for adjustment.

The Lausanne University Hospital's Clinical Trial Unit (CHUV-CTU) and Regional Health Administration (ARS) of Leiria will check the electronic case report forms (eCRFs) for consistency and completeness throughout the study. Should any issues be detected, the monitor will open queries in the secuTrial® software, and the investigator will be able to answer and correct the data in that software as needed. An overall data consistency check will be performed by the study monitor and the designated data manager. Any actions required to fix data issues will be reported in the eCRF. A final export of the dataset will enable us to completely remove participants' identities, and the database will be locked.

Risk-benefit assessment

The research team will not add or change any medications. However, based on a medication review (made following validated, evidence-based, internationally recognised guidelines), the study's partner pharmacist may make suggestions to older participants' GP or specialist physicians. Thus, by participating in the project, older participants may be exposed to minor

risks, such as a temporary alteration of their usual condition, if their treatment is modified by their physician after discussion with the study's partner pharmacist to avoid MRPs.

Medication management will be done using validated, internationally recognised, evidence-based guidelines for older adults. The medication-management intervention programme proposed to the older participants and their informal caregivers will be tailored (in intensity and duration) to each individual and will consider their health and medication literacy. This is important to avoid any lack of follow up, particularly among those with a possible undiagnosed mild cognitive impairment. Older participants, informal caregivers and prescribers should all benefit from a more empowering approach to medication management.

Insurance

In the event of any study-related damages or injuries, the School of Health Sciences, HES-SO Valais/Wallis and ciTechCare, Polytechnic of Leiria may be liable to provide compensation, except for claims that arise from misconduct or gross negligence.

Auditing

The CHUV-CTU and ARS of Leiria will conduct regular monitoring to ensure data quality and completeness. They will audit source documents in Switzerland and Portugal, with at least one research-site monitoring visit per six months in each country throughout the study. Monitors' primary objectives will be education, support and problem-solving. The monitors will discuss the protocol in detail and identify and clarify any areas of weakness. The investigators will practice entering data so that the monitors can assure themselves that they are proficient in all aspects of data entry, query response and communication with the CHUV-CTU and ARS. The monitors will audit overall data quality and completeness, examine source documents, interview investigators, and confirm that the research site has complied with the protocol's requirements. The monitors will verify that all adverse events were correctly documented and consistent with the protocol's definition. They will review source documents (ICD-10 diagnosis list, current medication lists, associated reports from PHCs) as needed to determine whether the data reported in secuTrial® are complete and accurate. They will confirm that the regulatory binder is complete and that all associated documents are up to date. The regulatory binder should include the protocol, informed consent forms, ethical approvals from both countries and investigators' agreements.

If a problem is identified during a visit (e.g. poor communication with the CHUV-CTU and ARS, inadequate or insufficient staff to conduct the study, missing study documents), the monitors will assist the research site in resolving its issues. Visits and electronic monitoring will focus on source document reviews and confirming adverse events. Monitors will verify the following variables for all study participants: date of birth, sex, signed informed consent, eligibility criteria, treatment assignment, adverse events and endpoints. All the parties involved will keep participants' data strictly confidential.

Ethics approval and consent to participate

Research ethics approval

Ethics approval has been obtained from the Human Research Ethics Committee of the Canton of Vaud (CER-VD), Switzerland (2021-01843), and the ARS of Leiria, Portugal (80-2021).

Protocol amendments

Any substantial changes made to the study setup or study organisation, the protocol or relevant study documents will be submitted to CER-VD and ARS for approval before implementation. Under emergency circumstances, deviations from the protocol may be taken to protect the rights, safety and well-being of human subjects, and these may proceed without prior approval of the Ethics Committee. Such deviations will be documented and reported to CER-VD and ARS as soon as possible.

Consent to participate

All the study participants will be provided with a participant information sheet and a consent form describing the study and providing sufficient information for them to make an informed decision about taking part. Participants will have up to two weeks to decide whether to participate or not. The participant's formal consent, using an approved consent form, will be obtained before the participant is submitted to any study procedure. The consent form will be signed and dated by the investigator at the same time as the participant. One copy of the signed informed consent form will be given to the study participant and the other will be retained in a secure location as part of the study records. Participants will also be requested to provide written consent for the re-use of data in encoded form.

The intervention programme will be pre-tested, before the pilot study, on three to four study participants to evaluate how long, intense and tiring it proves to be for them. Participants' autonomy will be respected, and study participation will be voluntary. They will be able to refuse further participation or drop out of the study. However, once collected, data will not be deleted. Throughout the process, the research team will tell the truth and ensure that it misleads neither its research partners nor participants.

The older participant, their informal caregivers and the collaborating healthcare professionals will receive no form of compensation for their involvement in this research project. However, study participants will benefit from the intervention programme and superior support in their medication management.

Confidentiality and access to data

Participant data will be handled with utmost discretion and will only be accessible to authorised personnel who require that data to fulfil their duties within the scope of the study. On the eCRFs and other study-specific documents, participants will only be identified using their unique participant number. Study subjects will be coded as follows: OPTIMED-01, OPTIMED-02, etc. Any links between that code and the subject's real identity will be protected by secuTrial®, and only the research team will have access to the data collected. The types of activity that individual users may undertake will be regulated by the privileges associated with their user identification code and password. Original study forms will be scanned, stored electronically with limited access, and kept on a secure server at the School of Health Sciences, HES-SO Valais/Wallis and ciTechCare, Polytechnic of Leiria for 20 years after the study's completion.

Dissemination policy

Knowledge transfer activities will promote this pilot study at professional and scientific conferences for primary healthcare providers, within hospital care units, and to informal caregivers' and older adults' associations. The pilot study's findings will be submitted to a peer-reviewed journal.

Discussion

Designing, constructing and exploring the effectiveness of an intervention programme to reduce the risk of MRPs among home-dwelling older adults in collaboration with all the

different actors involved in their medication management is an emerging and under-investigated issue. Current knowledge in this area has previously been developed in academic settings and acute and long-term care facilities, but hardly anything is known about this topic in home care settings. Regarding the prevention of MRPs, research to date has been unable to simultaneously integrate the roles and perceptions of polymedicated home-dwelling older adults with multiple chronic conditions, their informal caregivers and their healthcare professionals (70).

List of abbreviations

ARS: Regional Health Administration

CER-VD: Human Research Ethics Committee of the Canton of Vaud

CHUV-CTU: Lausanne University Hospital's Clinical Trial Unit

eCRFs: Electronic Case Report Forms

GPs: General Practitioners

ICD-10: International Statistical Classification of Diseases and Related Health Problems

MMSE: mini-mental state examination

MRPs: Medication related problems

PHC: Primary Healthcare Centre

6-CIT: Six-item Cognitive Impairment Test

TFI: Tilburg Frailty Indicator

Declarations

Consent for publication

Written informed consent for publication of study and collaborating participants' data was obtained from older participants, informal caregivers and healthcare professionals. A copy of the consent form is available for review by the Editor of this journal.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

FP and HV had the original idea. SR, MDD, CMM and HV provided conceptual and methodological expertise to the study design. CMM is the principal author of the doMESTIC risk tool. FP and HV were major contributors to writing the manuscript. All authors read, edited, and approved the final manuscript.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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OTHER SCIENTIFIC OUTPUTS RELATED TO THIS CHAPTER

Oral presentations in scientific meetings

Pereira F, Coelho Rodrigues Dixe M, Santos Gonçalves Pereira, S, Verloo, H. Intervention programme to reduce medication-related problems among polymedicated home-dwelling older adults: the OptiMed study. Oral presentation at the First International Seminar on CCISP–HES-SO Collaborative Research. 2021. Leiria, Portugal.

Pereira F, del Rio Carral M, Verloo H, Martins M. Optimizing medication management: contributions from an interdisciplinary approach. Oral presentation at the Interdisciplinary Research Seminar in Health and Clinical Psychology. 2022. Lausanne, Switzerland.

Poster presentations in scientific meetings

Pereira F, Martins M, del Río Carral M, Meyer-Masseti C, Verloo H. Optimising medication management for polymedicated home-dwelling older adults: the ME@HOME study. Poster presented on the Synthesis conference of the NRP 74, Smarter HealthCare. 2022. Luzern, Switzerland.

Pereira F, Martins M, del Río Carral M, Meyer-Masseti C, Verloo H. Optimising medication management for polymedicated home-dwelling older adults: the ME@HOME study. Poster presented on the EANS Summer Conference 2022. Vilnius, Lithuania.

CHAPTER 7 – CONCLUSIONS AND FUTURE PERSPECTIVES

CONCLUSIONS AND FUTURE PERSPECTIVES

This chapter presents the main conclusions that emerged from the thesis project, their relevance, and their implications for clinical practice, together with future perspectives for nursing education and research (Table 1). Because each article in Chapters 4, 5, and 6 presents its own discussion, conclusion, and implications for clinical practice and future research, this section focuses on the project as a whole.

Our overall aim was to develop a model to support medication management and prevent MRPs among polymedicated home-dwelling older adults after hospital discharge. The concepts defined by the NSM enabled us to fulfill that aim and develop nurse-led, interprofessional, collaborative intervention strategies. As explained in Chapter 3, this thesis documents the “diagnostic process” and the “solution design” for this Medication Management Model [30].

The first phase—the “diagnostic process” (phase zero)—included an ongoing systematic review. Although SR-M3 is not yet complete, our preliminary findings helped answer the third and fourth research questions about the actual state of knowledge on medication management optimization among polymedicated home-dwelling older adults and how nurses can contribute to optimizing medication management within interprofessional teams. Indeed, we were able to identify the existing literature about models used in research and clinical practice and about interventions and clinical pathways aimed at optimizing medication management at home. In addition, we noted the lack of descriptions of nurses’ roles in safe medication management and MRP prevention.

The retrospective quantitative phase (phase one of the “diagnostic process”) aimed to describe the profiles of polymedicated home-dwelling older adults and determine the risk factors facing them with regards to adverse health outcomes related to MRPs (first research question). Our findings showed that the majority of geriatric inpatients were indeed polymedicated at hospital discharge, experienced longer hospital lengths of stay, and were prescribed more medications the older they were.

Those inpatients presented with proportionally more impairments to their general mobility and gait, more dependence in lower body care, more fatigue, and a higher risk of malnutrition. Their 30-day hospital readmission rate was associated with longer hospital length of stay, impaired mobility, multimorbidity, and polypharmacy. Meanwhile, the oldest polymedicated adults presenting with impaired functional mobility, dependency in the activities of daily living, cognitive impairment, and traumatic injuries had a higher probability of unplanned nursing home admission. Certain specific medications were also associated with the risk of 30-day hospital readmission and unplanned nursing home admission. All these findings went to guiding the qualitative phase and led to a purposive sampling of potential interviewees presenting with similar profiles of risk factors. For clinical practice, these retrospective quantitative findings may help to identify and monitor the home-dwelling older inpatients most vulnerable to functional decline and present the greatest risk of MRPs. This could enable the design of targeted strategies for the prevention of functional impairment and related adverse health outcomes among polymedicated home-dwelling older adults during hospitalization and care transitions.

The prospective qualitative phase (phase two of the “diagnostic process”) aimed to describe older adults’, informal caregivers’, and professional caregivers’ perceptions about medication management after hospital discharge (second research question). Our qualitative findings revealed several potential opportunities for improving medication management and preventing MRPs through interprofessional and nurse-led interventions (third and fourth research questions, respectively). Concerning the hospital discharge period, older adults did not feel sufficiently listened to or involved in medication-related decision-making, reported contradictions between their prescriptions and their values and preferences, and sought—together with their informal caregivers—greater involvement in discharge planning. After hospital discharge, older adults revealed their efforts to maintain control of medication management, and this was related to their loss of autonomy following hospitalization. They also reported their efforts to more effectively coordinate between the stakeholders involved in their medication management, and their needs to define shared medication management goals and establish personal routines to ensure safe medication. With regards to informal caregivers, our findings highlighted their crucial role in ensuring safe medication management for home-dwelling older adults, especially those who might also have a cognitive impairment. However, some of them reported hindrances to their roles, such as anxiety about making mistakes and having to solve communication problems or disagreements about medication practices and care coordination with healthcare professionals. Finally, a medication review of participants’ medication lists showed that the Beers [37] and STOPP criteria [38] were rarely respected. In summary, our older adult participants’ LD had recently been disrupted, and, because of their MRPs, they presented with a greater risk of adverse health outcomes. Interprofessional, nurse-led collaborative practices could have helped strengthen those LD through secondary and tertiary prevention interventions [25, 39].

In light of the NSM, our “diagnostic phase” showed that polymedicated home-dwelling older adults were more exposed to different types of stressors because their FLD were closer to their NLD, with the inherent greater risks of their NLD being breached because they were less well protected by their FLD. Their loss of physiological reserves and declines in their functional status could lead to a state of entropy where the energy available is less than what is needed. Instability in the client system could be triggered in cases where one or more of those stressors cross the FLD and the NLD, which in turn may lead to MRPs and adverse health outcomes such as hospital admissions, readmissions, or nursing home admissions.

Once the “diagnostic phase” was completed, solutions were developed and selected in the “solution-design phase”. Our mixed-methods findings enabled us to develop a collaborative, patient-centered medication management model to prevent adverse health outcomes related to MRPs among polymedicated home-dwelling older adults after hospital discharge, thus answering the third and fourth research questions. According to the model proposed, medication management for home-dwelling older adults after hospital discharge requires a patient-centered approach that optimizes two-way communication and coordination between healthcare professionals and patients, between healthcare professionals and informal caregivers, and, finally, between healthcare professionals themselves. The model incorporates older adults’ preferences in treatment planning and medication-related decision-making, whatever their individual profiles and differences in willingness to participate or in understanding their treatment’s complexity.

In considering the NSM, healthcare professionals need to understand and offer support to polymedicated home-dwelling older adults after hospital discharge in the specific environments that they have created for themselves. This will help them guide older adults along a pathway to overcoming their present health status, either preserving or enhancing their wellness levels. Our findings suggest that nurses are the professional caregivers who interact the most with all the other stakeholders involved in medication management for polymedicated home-dwelling older adults. Therefore, nurses are the best-placed healthcare professionals to ensure that older adults and informal caregivers are involved in medication-related decision-making and that their values and preferences are considered throughout their care transitions. Once an older adult has returned home with a polypharmacy prescription, follow-up by a primary care nurse manager with established community links to various other services could be a more efficient way to manage the complex medication required for multiple chronic conditions. Additionally, as a frontline care provider, a primary care nurse manager is in a key position to intercept an MRP before it affects a patient. In brief, it is important for nurses to take control of developing and ensuring the quality of medication management instead of taking advice from professionals in other disciplines who do not always fully understand the complexity of the nurse’s profession [13].

Polymedicated home-dwelling older adult inpatients who are discharged home live through a care transition requiring secondary and tertiary preventive interven-

tions. Based on the NSM—presented in Chapter 2—and the four interactive fields of action (Article 9), Figure 9 presents findings from Article 8 and a summary of the secondary (at hospital) and tertiary (at home) interventions that should be carried out by hospital and community nurses so as to prevent MRPs and adverse health outcomes. Because they should be initiated while the patient is still in hospital and then followed up at home, we have not distinguished between these secondary and tertiary interventions. Interventions should protect the older adult's basic structure by detecting stressors early, reducing reactions to them, strengthening internal lines of resistance, and treating the symptoms, as well as avoiding or deflecting specific known stressors and strengthening existing resources to prevent further reactions to them.

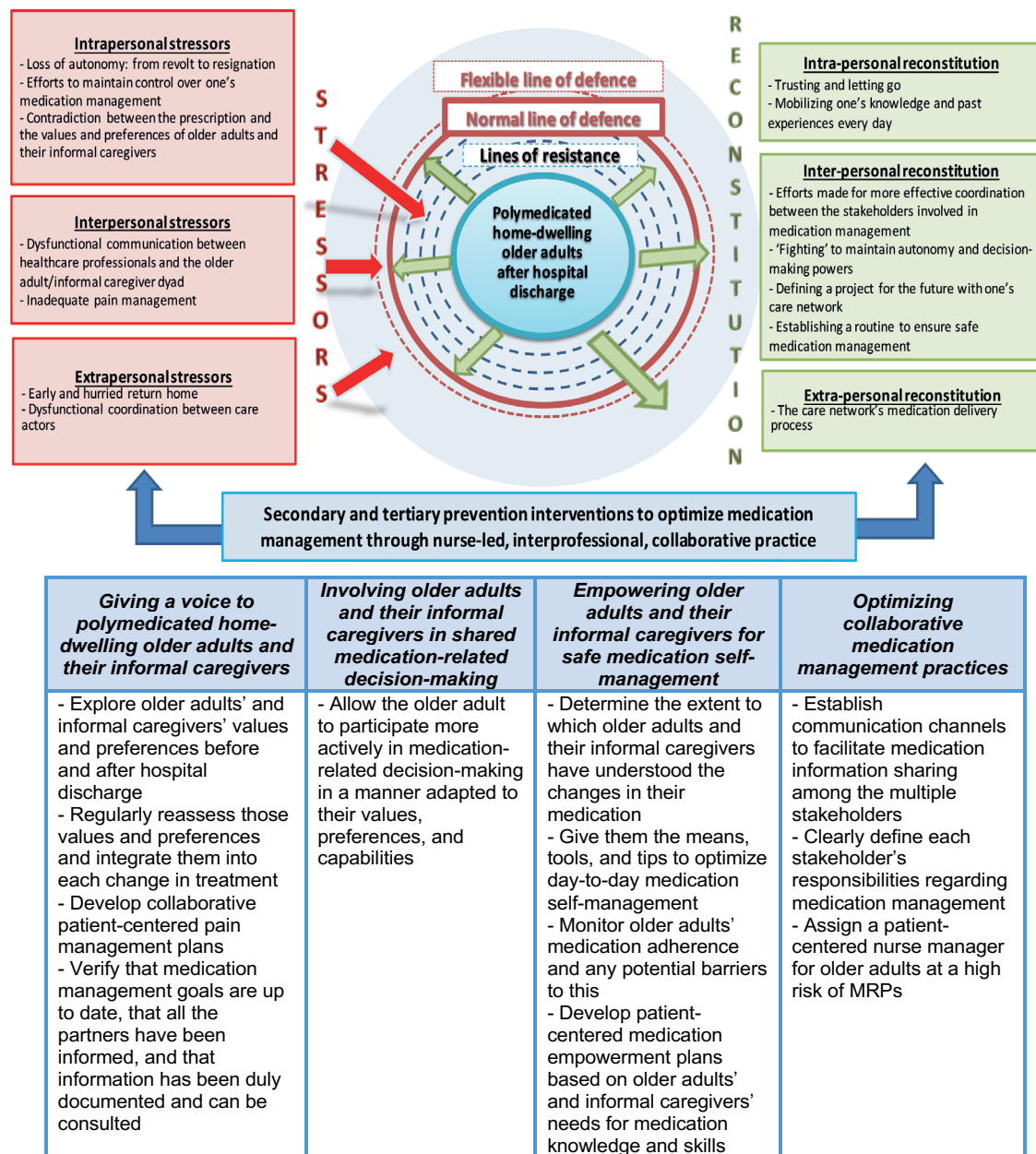


Figure 9: Summary of the main results (Article 9) and recommendations for nurses' preventive interventions to optimize medication management for polymedicated home-dwelling older adults discharged home.

The collaborative, patient-centered medication management model developed during this thesis project may prove to be a valuable strategy for improving medication management safety in the canton of Valais and could subsequently be shared with other Swiss cantons. Future research is being planned to explore the effectiveness of combining the proposed fields of action while fulfilling the ACI framework's "Implementation" and "Sustainability" steps [30]. Effectiveness outcomes will have to consider the quadruple healthcare aims of enhancing the patient's experience, improving population health, reducing costs, and improving healthcare professionals' working lives [32]. Based on our literature review, preventing MRPs and adverse health outcomes reduces costs, whereas healthcare professionals' working lives can be improved by facilitating collaborative practices and assigning well-defined responsibilities in the area of medication management [40]. A fifth aim of "health equity" has recently been proposed [41]. Although our findings did not reveal any healthcare disparities, this issue should be explored in future investigations dealing with home-dwelling older adults.

Deciding on the option of publishing all this thesis' articles in international scientific journals with significant impact factors led to valuable discussions with reviewers and editors, including criticisms, suggestions, and contributions from these various stakeholders that contributed to making our research process more transparent and robust. Therefore, we believe that the articles developed throughout this thesis project provide evidence that will help optimize medication management for polymedicated home-dwelling older adults after hospital discharge. Additionally, these articles highlight several opportunities to improve nurses' roles in medication management. Our findings should encourage further research exploring value-based outcomes that enhance nurses' roles as essential partners in interprofessional collaborative medication management. Finally, the ME@home project, of which this thesis forms a part, is the result of close collaboration between an international interdisciplinary research team. We also believe that this thesis highlights the nursing discipline's valuable contribution to interdisciplinary health research.

Table 1. The thesis project's main considerations.**What was already known about this topic**

- Safe medication management for polymedicated home-dwelling older adults after hospital discharge requires an interprofessional, patient-centered approach.
- Nursing interventions in medication management can help prevent unnecessary emergency department visits, hospitalizations, and admissions to assisted living facilities.

What this study added

- Described the patient-, medication-, and environment-related factors affecting polymedicated home-dwelling older adults that increase their risk of hospital readmission or unplanned nursing home admission.
- Detailed how post-discharge medication management at home involves numerous stressors, often including dysfunctions in communication, collaboration, and coordination between the multiple stakeholders involved.
- Revealed that reconstitution strategies for safe medication management were not always successful or satisfactory and were sometimes identified as stressors themselves.
- Developed a collaborative, patient-centered model based on a bottom-up approach to optimize medication management and prevent MRPs among this population.

Implications for clinical practice

- Observing the patient-, medication-, and environment-related factors that increase the risk of adverse health outcomes related to MRPs may help to identify and monitor home-dwelling older adult inpatients and develop preventative strategies.
- Interprofessional, collaborative practices with effective communication strategies will have to be developed for safer medication management for home-dwelling older adults after hospital discharge.
- Healthcare professionals should give greater weight to older adults' and informal caregivers' values and preferences in medication-related decision-making.
- Nurses' independent, joint, and overlapping responsibilities in medication management for home-dwelling older adults should be better defined, especially during care transitions.
- Nurses should share information on best practices for safe medication management and implement an empowering approach with older adults and their informal caregivers.

Implications for nursing education

- Undergraduate and post-graduate nursing programs should consider broadening nurses' and students' knowledge and skills with regard to safe medication management for older adults. This will help prevent MRPs, better share responsibilities across interprofessional teams, and empower older adults and informal caregivers.
- Nurses should also be trained to develop effective patient-centered discharge plans to improve medication safety during care transitions and therefore prevent MRPs.

Implications for future research

- Future studies should explore the effectiveness of our collaborative, patient-centered medication management model for polymedicated home-dwelling older adults after hospital discharge.

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APPENDICES

Appendix 1 – ME@home approval by the Human Research Ethics Committee of the Canton of Vaud (CER-VD)



COMMISSION CANTONALE
D'ÉTHIQUE DE LA RECHERCHE
SUR L'ÊTRE HUMAIN

CER-VD

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Lausanne, le 01/02/2019
Réf. PR/az

Décision de la Commission cantonale (VD) d'éthique de la recherche sur l'être humain (CER-VD)

No de projet	2018-02196
Titre du projet	Optimising medication management for polymedicated home-dwelling older adults with multiple chronic conditions
Investigateur principal	Prof Henk Verloo
Promoteur	Prof Henk Verloo
Centre	Prof Henk Verloo, School of Health Sciences HES-SO University of Applied Sciences and Arts Western Switzerland, Sion, Switzerland

Procédure de décision

☐ Procédure ordinaire
 ☐ Procédure simplifiée
 ☒ Procédure présidentielle

Décision

Prof Henk Verloo, School of Health Sciences HES-SO University of Applied Sciences and Arts Western Switzerland, Sion, Switzerland

☒ Autorisation accordée
☐ Autorisation avec charges
☐ En l'état, l'autorisation ne peut pas être accordée
☐ Autorisation non accordée
☐ Non entrée en matière

Classification

☒ Projet de recherche au sens de l'ORH
 Catégorie : A

- ☒ recherche sur des personnes
- ☐ réutilisation du matériel biologique ou des données personnelles liées à la santé
- ☐ sur des personnes décédées
- ☐ sur des embryons et des fœtus
- ☐ avec rayonnements ionisants
- ☐ changement de catégorie selon l'Art. 48, alinéa 2 de l'ORH

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N° de réf. de la CER-VD 2018-02196

Prof Henk Verloo

01/02/2019

- ☒ Le projet de recherche est une réutilisation de matériel biologique et de données personnelles liées à la santé à défaut de consentement (Art. 34 LRH, Art. 37-40 ORH)

a. But de réutilisation :

Le but du projet est de révéler l'état actuel des pratiques de gestion des médicaments des personnes âgées vivant à domicile avec des conditions chroniques multiples et une polymédication. Ensuite, faire des propositions pour améliorer les itinéraires cliniques et médicamenteux grâce à un modèle innovateur et intégré pour soutenir la gestion des médicaments et prévenir des complications liées à la polymédication.

b. Désignation du matériel biologique/données personnelles liées à la santé :

Phase 1 : Toutes les personnes âgées vivant à domicile avec des conditions chroniques multiples atteints de troubles somatiques et/ou cognitifs qui ont été hospitalisés, réhospitalisés ou ont consulté les urgences de l'hôpital du Valais entre 2015 et 2017 (N= 100 000) seront inclus.

c. Personnes habilitées à transmettre le matériel biologique et les données personnelles :

Phase 1 : Après approbation de la CER-VD, le service informatique médicale de l'Hôpital du Valais fournira les données appropriées sur la base d'un protocole d'extraction de données (cf. "List of the retrospective variables" dans la section 39. Miscellaneous / Varia).

d. Personnes habilitées à recevoir le matériel biologique et les données personnelles :

Prof. Henk Verloo
HES-SO Valais/Wallis
Haute école de santé Chemin de l'Agasse 5
1950-Sion
+41 78 769 89 90
henk.verloo@hevs.ch

Voies de recours

La présente décision peut faire l'objet d'un recours au Tribunal cantonal, Cour de droit administratif et public. L'acte de recours doit être déposé auprès du Tribunal cantonal dans les **30 jours** suivant la communication de la décision attaquée ; il doit être signé et indiquer les conclusions et motifs du recours. La décision attaquée est jointe au recours. Le cas échéant, ce dernier est accompagné de la procuration du mandataire.

Copie pour information à :

- ☐ OFSP
☐ Autre(s)

Signature


Prof. Patrick Ravussin
Vice-président

Annexes: -Obligations du requérant / Signification des décisions possibles
-Liste des documents soumis le 11.01 et 23.01.2019

Annexes

Obligations du requérant (promoteur ou investigateur) :

Soumission de documents : les documents modifiés et les nouveaux documents relatifs à l'étude/au projet de recherche sont soumis via le dossier de l'étude déjà existant dans le portail de soumission BASEC. Les documents qui ne sont plus valides sont effacés et remplacés par les nouveaux. Les documents révisés doivent être soumis une fois en mode « suivi des modifications » et une fois en mode « modifications acceptées » (« track changes » et « clean »). Les documents d'information et de consentement ainsi que le protocole doivent être transmis dans un format permettant la recherche (PDF navigable) ou scannés avec une fonction OCR (Optical Character Recognition). La lettre d'accompagnement, datée et signée, comprend les réponses aux questions posées. Le cas échéant, les documents révisés sont également mis à disposition des autorités compétentes pour approbation.

Remarque: La commission d'éthique compétente examine, dans le cadre du processus d'autorisation, les feuilles d'information et déclarations de consentement dans une des langues officielles suisses: allemand, français ou italien. La commission d'éthique ne fait qu'accuser réception des feuilles d'information et déclarations de consentement écrites dans d'autres langues. Le promoteur ou la direction du projet est responsable de la traduction correcte des documents.

Obligations d'annonce : Les obligations d'annonce (p.ex d'événements indésirables, d'interruption d'étude) et de soumission pour autorisation des modifications essentielles obligatoires s'appliquent (Ordonnances). Le rapport final est à remettre à la commission d'éthique compétente dans un délai d'une année à compter de la fin ou de l'arrêt de l'étude.

Devoir d'enregistrement : Le promoteur d'un essai clinique doit procéder à l'enregistrement dans un registre primaire reconnu par l'OMS ou dans le registre de la bibliothèque médicale nationale des Etats-Unis d'Amérique (clinicaltrials.gov) puis indiquer le numéro de l'étude sur le portail BASEC. Le transfert des données vers le Swiss National Clinical Trials Portal (SNCTP) est effectué automatiquement suite à l'autorisation de l'étude par la commission d'éthique, sous réserve de l'accord du requérant. Les données relatives à l'essai clinique figurant sur les deux registres sont accessibles au public. Swissethics publie également sur son site des informations (titre et type d'étude, commission compétente) sur chaque étude ayant reçu une autorisation, à l'exception des études de phase I.

La Commission certifie se conformer aux principes ICH GCP.

Remarque : Des instructions détaillées sur la soumission sur le portail BASEC sont disponibles sur le portail lui-même.

Signification des décisions possibles

Autorisation accordée : L'étude peut commencer selon le plan de recherche accepté. Elle doit être menée dans le cadre des dispositions légales en vigueur.

Les études cliniques avec produits thérapeutiques de catégorie B et C sont soumises aux conditions additionnelles:

1. les éventuelles remarques émises par les autorités fédérales (Swissmedic/OFSP/OFEV) ne suscitent pas de modifications des documents approuvés par la commission d'éthique;
2. l'autorisation des autorités fédérales (Swissmedic/OFSP/OFEV) est obtenue.

Autorisation avec charges : L'étude peut commencer selon le plan de recherche accepté. Elle doit être menée dans le cadre des dispositions légales en vigueur. Les charges doivent être remplies dans un délai de 30 jours et avant le recrutement du premier patient. Les documents modifiés seront réévalués en procédure présidentielle.

En l'état, l'autorisation ne peut pas être accordée : L'étude ne peut pas commencer. Prière de répondre point par point aux conditions de la commission d'éthique et de nous faire parvenir les documents révisés avec les modifications apparentes et la mention de la date de la nouvelle version.

Autorisation non accordée: L'étude ne peut pas commencer. Une nouvelle soumission reste possible.

Non entrée en matière : La commission d'éthique n'est pas juridiquement compétente pour accorder une autorisation. Un autre organe administratif peut entrer en matière ou l'étude ne nécessite pas d'autorisation.

N° de réf. de la CER-VD 2018-02196

Prof Henk Verloo

01/02/2019

Liste des documents soumis pour le centre principal

Prof Henk Verloo, School of Health Sciences HES-SO University of Applied Sciences and Arts Western Switzerland, Sion, Switzerland

nom du fichier	date du fichier	version
1. Cover Letter		
Cover Letter_10.01.2019.pdf	10/01/2019	
2018-02196-form-rep-20181218_10.01.2019.pdf	10/01/2019	
2. Synopsis of the study plan		
2.protokollsynopsis_10.01.2019_track changes.pdf	10/01/2019	2
2.protokollsynopsis_10.01.2019_clean.pdf	10/01/2019	2
3. Participant information sheet and informed consent (ICF)		
Feuille d'information_consentement_PAg_v3_23.01.2019_track changes.pdf	23/01/2019	3
Feuille d'information_consentement_PAg_v3_23.01.2019_clean.pdf	23/01/2019	3
Feuille d'information_consentement_PAI_v2_10.01.2019_track changes.pdf	10/01/2019	2
Feuille d'information_consentement_Prof_v2_10.01.2019_clean.pdf	10/01/2019	2
Feuille d'information_consentement_Prof_v2_10.01.2019_track changes.pdf	10/01/2019	2
Feuille d'information_consentement_PAI_v2_10.01.2019_clean.pdf	10/01/2019	2
4. Study plan (protocol), signed and dated		
4.HRO_Research_Plan_Template_23.01.2019_track changes.pdf	23/01/2019	3
4.HRO_Research_Plan_Template_23.01.2019_clean.pdf	23/01/2019	3
Protocol signature form_23.01.19.pdf	23/01/2019	3
39. Miscellaneous / Varia		
Données sociodémographiques_PAI_v2_10.01.2019_clean.pdf	10/01/2019	2
Données sociodémographiques et de santé_PAg_v2_10.01.2019_clean.pdf	10/01/2019	2
Données sociodémographiques_PAI_v2_10.01.2019_track changes.pdf	10/01/2019	2
Données sociodémographiques et de santé_PAg_v2_10.01.2019_track changes.pdf	10/01/2019	2

Appendix 2 – Research equations for each of the data sources used in the systematic review SR-M3

Appendix 2–Systematic literature research SR-M3

Research conducted by Filipa PEREIRA, HEdS, HES-SO Valais / Wallis and Joëlle ROSSELET AMOUSSOU, Psychiatry Library, Education and Research Department, Lausanne University Hospital and University of Lausanne.

Research reviewed by Cécile JACQUES and Jolanda ELMERS, BIUM

1. Database search - strategies	2
<i>Embase.com</i>	<i>2</i>
<i>Medline Ovid SP.....</i>	<i>3</i>
<i>PubMed.....</i>	<i>4</i>
<i>CINAHL EBSCO.....</i>	<i>5</i>
<i>Cochrane Library Wiley.....</i>	<i>6</i>
<i>Web of Science – Core collection</i>	<i>7</i>
<i>ProQuest – Dissertations and Theses.....</i>	<i>8</i>
<i>Dart Europe – European research theses.....</i>	<i>9</i>
<i>Agency for health care research and quality (AHRQ)</i>	<i>9</i>
<i>National institute for health and care excellence (NICE).....</i>	<i>9</i>
2. Results.....	10
3. Additional research	10

1. Database search - strategies

Embase.com

Strategy with adapted syntax to copy/paste into the database [here](#)

('aged'/de OR 'frail elderly'/de OR 'very elderly'/exp OR 'elderly care'/de OR 'geriatric care'/exp OR 'geriatric patient'/de OR 'geriatrics'/exp OR (elder* OR eldest OR geriatr* OR "old age*" OR "oldest old*" OR "very old*" OR (older NEXT/3 (patient* OR people OR subject* OR age* OR adult* OR man OR men OR male* OR woman OR women OR female* OR population* OR person* OR individual*)) OR aging OR ageing OR senior* OR "late life"):ab,ti,kw) AND ('polypharmacy'/de OR 'deprescription'/de OR (polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR poly-therap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR ((multi-drug* OR multidrug* OR "multiple drug*") NOT ((multidrug OR multi-drug OR "multiple drug") NEXT/1 resist*)) OR ((many OR multiple) NEXT/1 (medication* OR medicine* OR prescri*)) OR "multiple pharmacotherap*" OR "prescribing cascade*" OR "cascade prescribing" OR deprescri* OR de-prescri* OR "complex medication*"):ab,ti,kw) AND ('medication therapy management'/de OR 'drug utilization review'/de OR 'deprescription'/de OR 'drug surveillance program'/de OR 'drug monitoring'/exp OR 'treatment planning'/de OR 'screening'/de OR 'consensus'/de OR 'clinical decision making'/de OR 'decision support system'/exp OR 'inappropriate prescribing'/exp OR 'patient education'/de OR ((medication* OR medicine* OR drug* OR therap* OR treatment* OR polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR poly-therap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR multi-drug* OR multidrug* OR pharmacotherap* OR prescri*) NEAR/4 (manag* OR optimis* OR optimiz* OR improve* OR model* OR pattern* OR monitoring OR guide* OR protocol* OR review* OR revising OR revise OR revised OR evaluation* OR reduce* OR reduction* OR reducing OR minimi* OR decreasing OR plan OR plans OR planning OR strategy OR strategies OR approach* OR screening) OR (screening NEAR/3 (tool* OR program*)) OR "care model*" OR (intervention* NEAR/3 (improv* OR implementation)) OR "best practice*" OR (good NEXT/3 practice*) OR "clinical tool" OR deprescri* OR de-prescri* OR reconciliation OR "PIM List*" OR Beers OR STOPP OR STOPPs OR "START Criteria*" OR "STOPP/START" OR ("screening tool" NEAR/3 "inappropriate prescription*") OR "Medication Appropriateness Index" OR "potentially inappropriate medication list*" OR FORTA OR "clinical decision making" OR "decision support*" OR (patient* NEXT/2 education)):ab,ti,kw) NOT ([conference abstract]/lim AND [<1966-2016]/py)

6191	references found on	November 4, 2019
Comment(s):	We excluded conference abstracts (2016 and before) assuming that they would have been published as an article since then.	
	NOT ([conference abstract]/lim AND [<1966-2016]/py)	

Medline Ovid SP

Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily 1946 to November 01, 2019

Strategy with adapted syntax to copy/paste into the database [here](#) (remove case "Map Term to Subject Heading")

(exp aged/ OR "Geriatric Nursing"/ OR "Geriatrics"/ OR "Geriatric Psychiatry" OR (elder* OR eldest OR geriatr* OR "old age*" OR "oldest old*" OR "very old*" OR (older ADJ3 (patient* OR people OR subject* OR age* OR adult* OR man OR men OR male* OR woman OR women OR female* OR population* OR person* OR individual*)) OR aging OR ageing OR senior* OR "late life").ab,ti,kf.) AND (exp "Polypharmacy"/ OR (polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR poly-therap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR ((multi-drug* OR multidrug* OR "multiple drug*") NOT ((multidrug OR multi-drug OR "multiple drug") ADJ1 resist*)) OR ((many OR multiple) ADJ1 (medication* OR medicine* OR prescri*)) OR "multiple pharmacotherap*" OR "prescribing cascade*" OR "cascade prescribing" OR deprescri* OR de-prescri* OR "complex medication*").ab,ti,kf.) AND ("Medication Therapy Management"/ OR "Drug Utilization Review"/ OR "Deprescriptions"/ OR "Drug Monitoring"/ OR "Consensus"/ OR "Clinical Decision-Making"/ OR "Decision Support Systems, Clinical"/ OR "Inappropriate Prescribing"/ OR "Potentially Inappropriate Medication List"/ OR "Medication Reconciliation"/ OR "Patient Education as Topic"/ OR Patient education handout.pt OR ((medication* OR medicine* OR drug* OR therap* OR treatment* OR polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR poly-therap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR multi-drug* OR multidrug* OR pharmacotherap* OR prescri*) ADJ4 (manag* OR optimis* OR optimiz* OR improve* OR model* OR pattern* OR monitoring OR guide* OR protocol* OR review* OR revising OR revise OR revised OR evaluation* OR reduce* OR reduction* OR reducing OR minimi* OR decreasing OR plan OR plans OR planning OR strategy OR strategies OR approach* OR screening) OR (screening ADJ3 (tool* OR program*)) OR "care model*" OR (intervention* ADJ3 (improv* OR implementation)) OR "best practice*" OR (good ADJ3 practice*) OR "clinical tool" OR deprescri* OR de-prescri* OR reconciliation OR "PIM List*" OR Beers OR STOPP OR STOPPs OR "START Criteria*" OR "STOPP/START" OR ("screening tool" ADJ3 "inappropriate prescription*") OR "Medication Appropriateness Index" OR "potentially inappropriate medication list*" OR FORTA OR "clinical decision making" OR "decision support*" OR (patient* ADJ2 education)).ab,ti,kf.)

4392	references found on	November 4, 2019
Comment(s):		

PubMed

Strategy with adapted syntax to copy/paste into the database [here](#)

(elder*[tiab] OR eldest[tiab] OR geriatr*[tiab] OR old age*[tiab] OR oldest old*[tiab] OR very old*[tiab] OR "older patient"[tiab] OR "older patients"[tiab] OR "older people"[tiab] OR older subject*[tiab] OR older age*[tiab] OR older adult*[tiab] OR "older man"[tiab] OR "older men"[tiab] OR older male*[tiab] OR "older woman"[tiab] OR "older women"[tiab] OR older female*[tiab] OR older population*[tiab] OR older person*[tiab] OR older individual*[tiab] OR aging[tiab] OR ageing[tiab] OR senior*[tiab] OR "late life"[tiab]) AND (polymedicat*[tiab] OR poly-medica*[tiab] OR polipharma*[tiab] OR polypharma*[tiab] OR poly-pharma*[tiab] OR polypragm*[tiab] OR polymedicine*[tiab] OR polytherap*[tiab] OR poly-therap*[tiab] OR polytreat*[tiab] OR poly-treat*[tiab] OR multimedica*[tiab] OR multi-medica*[tiab] OR multitherap*[tiab] OR multi-therap*[tiab] OR multitreat*[tiab] OR multi-treat*[tiab] OR ((multi-drug*[tiab] OR multidrug*[tiab] OR multiple drug*[tiab]) NOT ((multidrug[tiab] OR multi-drug[tiab] OR "multiple drug"[tiab]) AND resistan*[tiab])) OR ((many[tiab] OR multiple[tiab]) AND (medication*[tiab] OR medicine*[tiab] OR prescri*[tiab])) OR multiple pharmacotherap*[tiab] OR prescribing cascade*[tiab] OR deprescri*[tiab] OR de-prescri*[tiab] OR complex medication*[tiab]) AND ((medication*[tiab] OR medicine*[tiab] OR drug*[tiab] OR therap*[tiab] OR treatment*[tiab] OR polymedicat*[tiab] OR poly-medica*[tiab] OR polipharma*[tiab] OR polypharma*[tiab] OR poly-pharma*[tiab] OR polypragm*[tiab] OR polymedicine*[tiab] OR polytherap*[tiab] OR poly-therap*[tiab] OR polytreat*[tiab] OR poly-treat*[tiab] OR multimedica*[tiab] OR multi-medica*[tiab] OR multitherap*[tiab] OR multi-therap*[tiab] OR multitreat*[tiab] OR multi-treat*[tiab] OR multi-drug*[tiab] OR multidrug*[tiab] OR pharmacotherap*[tiab] OR prescri*[tiab]) AND (manag*[tiab] OR optimis*[tiab] OR optimiz*[tiab] OR improve*[tiab] OR model*[tiab] OR pattern*[tiab] OR monitoring[tiab] OR guide*[tiab] OR protocol*[tiab] OR review*[tiab] OR revising[tiab] OR revise[tiab] OR revised[tiab] OR evaluation*[tiab] OR reduce*[tiab] OR reduction*[tiab] OR reducing[tiab] OR minimi*[tiab] OR decreasing[tiab] OR plan[tiab] OR plans[tiab] OR planning[tiab] OR strategy[tiab] OR strategies[tiab] OR approach*[tiab] OR screening[tiab]) OR (screening[tiab] AND (tool*[tiab] OR program*[tiab])) OR care model*[tiab] OR (intervention*[tiab] AND (improv*[tiab] OR implementation[tiab])) OR best practice*[tiab] OR (good[tiab] AND practice*[tiab]) OR "clinical tool"[tiab] OR deprescri*[tiab] OR de-prescri*[tiab] OR reconciliation[tiab] OR PIM List*[tiab] OR Beers[tiab] OR STOPP[tiab] OR START Criteria*[tiab] OR "STOPP/START"[tiab] OR ("screening tool"[tiab] AND inappropriate prescription*[tiab]) OR "Medication Appropriateness Index"[tiab] OR potentially inappropriate medication list*[tiab] OR FORTA[tiab] OR "clinical decision making"[tiab] OR decision support*[tiab] OR ((patient[tiab] OR patients[tiab]) AND education[tiab])) NOT medline[sb]

2001	references found on	November 4, 2019
Comment(s):	The research is limited to references not indexed for Medline: NOT medline[sb]	

CINAHL EBS CO

Strategy with adapted syntax to copy/paste into the database [here](#)

(MH "Aged" OR MH "Aged, 80 and Over" OR MH "Frail Elderly" OR MH "Gerontologic Nursing+" OR MH "Geriatrics" OR MH "Geriatric Psychiatry" OR TI (elder* OR eldest OR geriatr* OR "old age*" OR "oldest old*" OR "very old*" OR (older W2 (patient* OR people OR subject* OR age* OR adult* OR man OR men OR male* OR woman OR women OR female* OR population* OR person*)) OR aging OR ageing OR senior* OR "late life") OR AB (elder* OR eldest OR geriatr* OR "old age*" OR "oldest old*" OR "very old*" OR (older W2 (patient* OR people OR subject* OR age* OR adult* OR man OR men OR male* OR woman OR women OR female* OR population* OR person*)) OR aging OR ageing OR senior* OR "late life")) AND (MH "Polypharmacy" OR TI (polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR polytherap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR ((multi-drug* OR multidrug* OR "multiple drug*") NOT ((multidrug OR multi-drug OR "multiple drug") W2 resist*)) OR ((many OR multiple) W2 (medication* OR medicine* OR prescri*)) OR "multiple pharmacotherap*" OR "prescribing cascade*" OR "cascade prescribing" OR deprescri* OR de-prescri* OR "complex medication*") OR AB (polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR polytherap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR ((multi-drug* OR multidrug* OR "multiple drug*") NOT ((multidrug OR multi-drug OR "multiple drug") W2 resist*)) OR ((many OR multiple) W2 (medication* OR medicine* OR prescri*)) OR "multiple pharmacotherap*" OR "prescribing cascade*" OR "cascade prescribing" OR deprescri* OR de-prescri* OR "complex medication*")) AND (MH "Medication Management" OR MH "Utilization Review+" OR MH "Prescription Drug Monitoring Programs" OR MH "Drug Monitoring" OR MH "Consensus" OR MH "Decision Making, Clinical" OR MH "Decision Support Systems, Clinical" OR MH "Inappropriate Prescribing" OR MH "Medication Reconciliation" OR MH "Patient Education" OR TI ((medication* OR medicine* OR drug* OR therap* OR treatment* OR polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR polytherap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR multidrug* OR multidrug* OR pharmacotherap* OR prescri*) N5 (manag* OR optimis* OR optimiz* OR improve* OR model* OR pattern* OR monitoring OR guide* OR protocol* OR review* OR revising OR revise OR revised OR evaluation* OR reduce* OR reduction* OR reducing OR minimi* OR decreasing OR plan OR plans OR planning OR strategy OR strategies OR approach* OR screening) OR (screening N3 (tool* OR program*)) OR "care model*" OR (intervention* N4 (improv* OR implementation)) OR "best practice*" OR (good W4 practice*) OR "clinical tool" OR deprescri* OR de-prescri* OR reconciliation OR "PIM List*" OR Beers OR STOPP OR STOPPs OR "START Criteria*" OR "STOPP/START" OR ("screening tool" N4 "inappropriate prescription*") OR "Medication Appropriateness Index" OR "potentially inappropriate medication list*" OR FORTA OR "clinical decision making" OR "decision support*" OR (patient* W3 education)) OR AB ((medication* OR medicine* OR drug* OR therap* OR treatment* OR polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR polytherap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR multi-drug* OR multidrug* OR pharmacotherap* OR prescri*) N5 (manag* OR optimis* OR optimiz* OR improve* OR model* OR pattern* OR monitoring OR guide* OR protocol* OR review* OR revising OR revise OR revised OR evaluation* OR reduce* OR reduction* OR reducing OR minimi* OR decreasing OR plan OR plans OR planning OR strategy OR strategies OR approach* OR screening) OR (screening N3 (tool* OR program*)) OR "care model*" OR (intervention* N4 (improv* OR implementation))

OR "best practice*" OR (good W4 practice*) OR "clinical tool" OR deprescri* OR de-prescri* OR reconciliation OR "PIM List*" OR Beers OR STOPP OR STOPPs OR "START Criteria*" OR "STOPP/START" OR ("screening tool" N4 "inappropriate prescription*") OR "Medication Appropriateness Index" OR "potentially inappropriate medication list*" OR FORTA OR "clinical decision making" OR "decision support*" OR (patient* W3 education)))

2471	references found on	November 5, 2019
Comment(s):	During the CINAHL export a reference is lost. After many tests, we could not identify which one.	

Cochrane Library Wiley

Issue 11 of 12, November 2019

Strategy with adapted syntax to copy/paste into the database [here](#)

(elder* OR eldest OR geriatr* OR (old NEXT age*) OR (oldest NEXT old*) OR (very NEXT old*) OR (older NEXT/3 (patient* OR people OR subject* OR age* OR adult* OR man OR men OR male* OR woman OR women OR female* OR population* OR person* OR individual*)) OR aging OR ageing OR senior* OR "late life"):ab,ti,kw AND (polymedicat* OR (poly NEXT medicat*) OR polipharma* OR polypharma* OR (poly NEXT pharma*) OR polypragma* OR polymedicine* OR polytherap* OR (poly NEXT therap*) OR polytreat* OR (poly NEXT treat*) OR multimedic* OR (multi NEXT medic*) OR multitherap* OR (multi NEXT therap*) OR multitreat* OR (multi NEXT treat*) OR (((multi NEXT drug*) OR multidrug* OR (multiple NEXT drug*)) NOT ((multidrug OR (multi NEXT drug) OR (multiple NEXT drug)) NEXT/1 resistan*)) OR ((many OR multiple) NEXT/1 (medication* OR medicine* OR prescri*)) OR (multiple NEXT pharmacotherap*) OR (prescribing NEXT cascade*) OR "cascade prescribing" OR deprescri* OR (de NEXT prescri*) OR (complex NEXT medication*)):ab,ti,kw AND ((medication* OR medicine* OR drug* OR therap* OR treatment* OR polymedicat* OR (poly NEXT medicat*) OR polipharma* OR polypharma* OR (poly NEXT pharma*) OR polypragma* OR polymedicine* OR polytherap* OR (poly NEXT therap*) OR polytreat* OR (poly NEXT treat*) OR multimedic* OR (multi NEXT medic*) OR multitherap* OR (multi NEXT therap*) OR multitreat* OR (multi NEXT treat*) OR (multi NEXT drug*) OR multidrug* OR pharmacotherap* OR prescri*) NEAR/4 (manag* OR optimis* OR optimiz* OR improve* OR model* OR pattern* OR monitoring OR guide* OR protocol* OR review* OR revising OR revise OR revised OR evaluation* OR reduce* OR reduction* OR reducing OR minimi* OR decreasing OR plan OR plans OR planning OR strategy OR strategies OR approach* OR screening) OR (screening NEAR/3 (tool* OR program*)) OR (care NEXT model*) OR (intervention* NEAR/3 (improv* OR implementation)) OR (best NEXT practice*) OR (good NEXT/3 practice*) OR "clinical tool" OR deprescri* OR (de NEXT prescri*) OR reconciliation OR (PIM NEXT List*) OR Beers OR STOPP OR STOPPs OR (START NEXT Criteria*) OR "STOPP/START" OR ("screening tool" NEAR/3 (inappropriate NEXT prescription*)) OR "Medication Appropriateness Index" OR (potentially NEXT inappropriate NEXT medication NEXT list*) OR FORTA OR "clinical decision making" OR (decision NEXT support*) OR (patient* NEXT/2 education)):ab,ti,kw

474	references found on	November 5, 2019
Comment(s):	11 reviews	

Web of Science – Core collection

Strategy with adapted syntax to copy/paste into the database [here](#)

TS=(elder* OR "eldest" OR geriatr* OR "old age*" OR "oldest old*" OR "very old*" OR ("older" NEAR/3 (patient* OR "people" OR subject* OR age* OR adult* OR "man" OR "men" OR male* OR "woman" OR "women" OR female* OR population* OR person* OR individual*)) OR "aging" OR "ageing" OR senior* OR "late life") AND TS=(polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR poly-therap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR ((multi-drug* OR multidrug* OR "multiple drug*") NOT ((("multidrug" OR "multi-drug" OR "multiple drug") NEAR/1 resistan*)) OR ((("many" OR "multiple") NEAR/1 (medication* OR medicine* OR prescri*)) OR "multiple pharmacotherap*" OR "prescribing cascade*" OR "cascade prescribing" OR deprescri* OR de-prescri* OR "complex medication*") AND TS=((medication* OR medicine* OR drug* OR therap* OR treatment* OR polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR poly-therap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR multi-drug* OR multidrug* OR pharmacotherap* OR prescri*) NEAR/4 (manag* OR optimis* OR optimiz* OR improve* OR model* OR pattern* OR "monitoring" OR guide* OR protocol* OR review* OR "revising" OR "revise" OR "revised" OR evaluation* OR reduce* OR reduction* OR "reducing" OR minimi* OR "decreasing" OR "plan" OR "plans" OR "planning" OR "strategy" OR "strategies" OR approach* OR "screening") OR ("screening" NEAR/3 (tool* OR program*)) OR "care model*" OR (intervention* NEAR/3 (improv* OR "implementation")) OR "best practice*" OR ("good" NEAR/3 practice*) OR "clinical tool" OR deprescri* OR de-prescri* OR "reconciliation" OR "PIM List*" OR "Beers" OR "STOPP" OR "STOPPs" OR "START Criteria*" OR "STOPP/START" OR ("screening tool" NEAR/3 "inappropriate prescription*") OR "Medication Appropriateness Index" OR "potentially inappropriate medication list*" OR "FORTA" OR "clinical decision making" OR "decision support*" OR (patient* NEAR/2 "education"))

3287	references found on	November 5, 2019
Comment(s):		

ProQuest – Dissertations and Theses

Strategy with adapted syntax to copy/paste into the database

<https://search.proquest.com/pqdt/index>

(elder* OR "eldest" OR geriatr* OR "old age*" OR "oldest old*" OR "very old*" OR ("older" NEAR/3 (patient* OR "people" OR subject* OR age* OR adult* OR "man" OR "men" OR male* OR "woman" OR "women" OR female* OR population* OR person* OR individual*)) OR "aging" OR "ageing" OR senior* OR "late life") AND (polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR poly-pharma* OR polypragma* OR polymedicine* OR polytherap* OR poly-therap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR "multiple pharmacotherap*" OR "prescribing cascade*" OR "cascade prescribing" OR deprescri* OR de-prescri* OR "complex medication*") AND ((medication* OR medicine* OR drug* OR therap* OR treatment* OR polymedicat* OR poly-medicat* OR polipharma* OR polypharma* OR polypharma* OR polypragma* OR polymedicine* OR polytherap* OR poly-therap* OR polytreat* OR poly-treat* OR multimedic* OR multi-medic* OR multitherap* OR multi-therap* OR multitreat* OR multi-treat* OR multi-drug* OR multidrug* OR pharmacotherap* OR prescri*) NEAR/4 (manag* OR optimis* OR optimiz* OR improve* OR model* OR pattern* OR "monitoring" OR guide* OR protocol* OR review* OR "revising" OR "revise" OR "revised" OR evaluation* OR reduce* OR reduction* OR "reducing" OR minimi* OR "decreasing" OR "plan" OR "plans" OR "planning" OR "strategy" OR "strategies" OR approach* OR "screening") OR ("screening" NEAR/3 (tool* OR program*)) OR "care model*" OR (intervention* NEAR/3 (improv* OR "implementation")) OR "best practice*" OR ("good" NEAR/3 practice*) OR "clinical tool" OR deprescri* OR de-prescri* OR "reconciliation" OR "PIM List*" OR "Beers" OR "STOPP" OR "STOPPs" OR "START Criteria*" OR "STOPP/START" OR ("screening tool" NEAR/3 "inappropriate prescription*") OR "Medication Appropriateness Index" OR "potentially inappropriate medication list*" OR "FORTA" OR "clinical decision making" OR "decision support*" OR (patient* NEAR/2 "education"))

55	references found on	October 31, 2019
Comment(s):	Limits used in the "advanced search": - Doctoral theses only - All fields except full text - Segment removed from the basic strategy to lighten the equation (basic equation too heavy for ProQuest) : ((multi-drug* OR multidrug* OR "multiple drug*") NOT (("multidrug" OR "multi-drug" OR "multiple drug") NEAR/1 resistan*)) OR (("many" OR "multiple") NEAR/1 (medication* OR medicine* OR prescri*))	

Dart Europe – European research theses

Strategy with adapted syntax to copy/paste into the database

<http://www.dart-europe.eu/basic-search.php>

polymedicat* OR "poly-medication*" OR polipharma* OR polypharma* OR polytherap* OR multimedic* OR "multiple drug*" OR "multiple medication*" OR "multiple medicine"

175	references found on	November 1, 2019
Comment(s):		

Agency for health care research and quality (AHRQ)

Strategy with adapted syntax to copy/paste into the database

<https://search.ahrq.gov/>

(polymedicat* OR poly-medication* OR polipharma* OR polypharma* OR poly-pharma* OR polymedicine OR multimedic* OR multi-drug* OR multidrug* OR "multiple drug*" OR "multiple pharmacotherap*" OR "multiple medication*" OR "multiple medicine*" OR "multiple prescri*" OR "prescribing cascade*" OR "cascade prescribing") AND (elder* OR eldest OR geriatr* OR "old age*" OR "oldest old*" OR "very old*" OR older OR aging OR ageing OR senior* OR "late life")

963 with duplicates	references found on	November 1, 2019
Comment(s):	Many duplicates in the database.	

National Institute for health and Care Excellence (NICE)

Strategy with adapted syntax to copy/paste in database

<https://www.nice.org.uk/>

(polymedication OR poly-medication OR polipharmacy OR polypharmacy OR poly-pharmacy OR OR multi-drug OR multidrug OR multiple drug OR multiple pharmacotherapy OR multiple medication OR multiple medicines OR multiple prescriptions OR prescribing cascade OR cascade prescribing) AND (elder OR eldest OR geriatry OR geriatrics OR old OR oldest OR older OR aging OR ageing OR senior OR late life)

601	references found on	November 1, 2019
Comment(s):		

2. Results

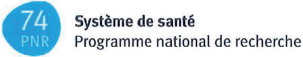
The order of import into Endnote was as follows:

Database	Date of research	Number of references...	
		...found...	...and after deduplication
Medline OVID SP	04.11.19	4392	4386
Embase.com	04.11.19	6191	2749
PubMed	04.11.19	2001	1379
CINAHL EBSCO	05.11.19	2471	826
Cochrane Library Wiley	05.11.19	474	203
Web of Science – Core collection	05.11.19	3287	664
Total		18,816	10,207

3. Additional research

Database	Date of research	Number of references found
ProQuest	31.10.19	55
DART Europe	01.11.19	175
Agency for Healthcare Research and Quality (AHRQ)	01.11.19	963
National Institute for health and Care Excellence (NICE)	01.11.19	601

Appendix 3 – Contract and contract extension for the transfer and use of Valais Hospital data



Amendement au contrat relatif au transfert et à l'utilisation des données de l'Hôpital du Valais dans le cadre du projet national de recherche PNR 74 (ID 407440-183434/1) du 12 juin 2019 : « Optimizing medication management for polymedicated Home-Dwelling older adults with chronic conditions »

Sion, le 22 novembre 2021



Système de santé
Programme national de recherche



1. Prolongation du contrat pour la mise à disposition des données d'hospitalisation et des admissions aux urgences anonymisées

Raison :

Dans le cadre du projet PNR 74 (ID 407440-183434/1), des analyses additionnelles sont demandées par le FNS pour documenter la fragilité dans le cadre du projet 407440-183434/1. En tenant compte que l'utilisation des données du CHVR prenait fin au 30.06.2020, une prolongation de la mise à disposition est nécessaire jusqu'au 30 juin 2022 afin de répondre à la demande du FNS et pour justifier l'utilisation des données auprès la CER-VD.

Prolongation :

Les données anonymisées d'hospitalisation et des admissions aux urgences du CHVR seront mises à disposition jusqu'au 30 juin 2022 :

- Patient de 65 ans et plus (pour chaque année d'hospitalisation)
- Sortie de l'hôpital vers le domicile
- Patient ayant une prescription de 5 ou plus médicaments à la sortie

Données anonymisées des admissions aux urgences :

- Patients de 65 ans et plus (pour chaque année admission)
- Patients provenant du domicile.

2. Modalités de conservation des données pendant la prolongation

Les données anonymisées de l'HVS (CHVR) seront conservées et sécurisées comme indiqué dans le contrat de base du 12 juin 2019, c'est-à-dire dans le serveur sécurisé à la HES-SO Valais/Wallis, sur la plateforme « Redcap » du projet PNR 74 (ID 407440-183434/1).

3. Toutes les autres modalités indiquées dans le contrat de base restent en vigueur et applicables

Sion, le 22 novembre 2021



Système de santé
Programme national de recherche



Signatures :

Prof. Eric BONVIN
Directeur général
Hôpital du Valais
Avenue Grand-Champsec 86
1951 Sion

Hélène HERTZOG
Directrice des soins
Centre hospitalier du Valais romand
Hôpital du Valais
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Prof. Redouane BOUALI
Directeur médical
Centre hospitalier du Valais romand
Avenue Grand-Champsec 86
1951 Sion

Prof. Henk Verloo
Professeur ordinaire HES
Haute Ecole de Santé (HES-SO Valais-Wallis)
Chemin de l'Agasse 5
1950 Sions 2

Appendix 4 – Participant information sheet and consent form



Système de santé
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Gestion des médicaments chez les personnes vivant à domicile avec des conditions médicales chroniques

Titre officiel complet :

Optimising medication management for polymedicated home-dwelling older adults with multiple chronic conditions

ME@home (Medication management for the Elderly at Home)

Ce projet est organisé par des chercheurs de la Haute École de Santé HES-SO Valais-Wallis (Prof. Henk Verloo), l'Université de Lausanne (Prof. Marie Santiago-Delefosse, Prof. Boris Wernli) et le Centre Hospitalier Universitaire Vaudois (Prof. Armin von Guten).

Madame, Monsieur,

Nous vous proposons de participer à notre projet de recherche. Cette feuille d'information décrit le projet de recherche.

Information détaillée destinée à la personne vivant à domicile avec des conditions médicales chroniques

1. Objectifs du projet de recherche

L'objectif de ce projet de recherche est d'étudier comment les personnes vivant à domicile avec des conditions médicales chroniques, âgées de 65 ans ou plus, qui rentrent à leur domicile après une hospitalisation, vivent cette période et gèrent leurs médicaments au quotidien. Nous nous intéressons également à l'implication des proches aidants et des soignants à domicile dans cette gestion des médicaments à domicile.

2. Sélection des personnes pouvant participer au projet

La participation est ouverte à toute personne âgée de 65 ans ou plus, vivant avec des conditions médicales chroniques, qui rentre à son domicile après une hospitalisation et qui, en outre, prend plus de 5 médicaments par jour.

3. Informations générales sur le projet

Ce projet est mis en œuvre par des chercheurs de la Haute École de Santé du Valais, l'Université de Lausanne et le Centre Hospitalier Universitaire Vaudois. Il se déroule en collaboration avec l'Hôpital du Valais et le Centre Médico-Social de Sion. Il durera un an et trois mois, à compter d'octobre 2019.

Ce projet reposera sur la réalisation d'entretiens de recherche avec des personnes vivant à domicile avec des conditions médicales chroniques, âgées de 65 ans ou plus, leurs proches aidants et leurs soignants à domicile, afin de mieux comprendre comment se passe la gestion des médicaments à domicile après une hospitalisation.

Au total, 30 personnes avec des conditions médicales chroniques participeront à l'étude, ainsi que 30 proches aidants et 30 soignants à domicile.

Nous effectuons ce projet dans le respect des prescriptions de la législation suisse. La commission cantonale d'éthique compétente a contrôlé et autorisé le projet.



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4. Déroulement pour les participants

À la fin de votre hospitalisation, et lors de votre retour à domicile, le chercheur vous proposera de participer à **trois entretiens** d'une heure environ, espacés de trois à quatre semaines. Le chercheur demandera également votre accord pour récupérer les données concernant votre santé auprès des soignants de l'hôpital ou du Centre Médico-Social. Enfin, il vous demandera de désigner le proche et le professionnel de santé les plus impliqués dans votre quotidien, afin de réaliser des entretiens avec eux, avec votre accord.

Le **premier entretien** aura lieu lors de cette première rencontre à votre domicile. En suivant un guide d'entretien, il vous questionnera sur votre séjour à l'hôpital, votre retour à domicile, les informations que vous avez reçues sur vos médicaments, les soignants et les proches impliqués auprès de vous. Vous serez interviewé seul à votre domicile.

Le chercheur vous proposera de compléter, au cours de la semaine suivant le premier entretien, un **journal de médication**, seul ou avec l'aide de vos proches ou soignants à domicile. Cet outil vous sera expliqué en détail par le chercheur ; il permettra d'obtenir des informations sur les routines quotidiennes associées à la médication, et sera une base pour le deuxième entretien.

Le **deuxième entretien** aura lieu deux à trois semaines après le premier. A partir du journal de médication que vous aurez rempli, le chercheur vous questionnera sur vos habitudes et routines avec vos médicaments, les espaces au sein de votre domicile dans lesquels vous disposez, rangez vos médicaments.

Avec votre accord, le chercheur photographiera les espaces où les médicaments sont conservés, les lieux où les contacts et informations médicales sont rangés, et les autres emplacements d'objets impliqués dans les pratiques de soin quotidiennes.

Vous serez interviewé seul, à votre domicile.

Dans le **troisième entretien**, vous serez présent avec le proche que vous aurez désigné comme étant le plus impliqué dans votre quotidien. Cet entretien aura lieu deux à trois semaines après le deuxième entretien. Vous échangerez sur la manière dont ce proche est impliqué dans votre quotidien, et dans l'organisation de vos soins et médicaments.

5. Bénéfices pour les participants

Votre participation au projet ne vous apportera aucun bénéfice.

Les résultats du projet pourraient contribuer à des améliorations dans la gestion des médicaments et de la santé des personnes âgées de 65 ans et plus, prenant plus de 5 médicaments par jour, qui rentrent à leur domicile après une hospitalisation. Les résultats du projet pourraient se révéler importants pour le maintien à domicile et l'évitement d'une réhospitalisation de ces personnes.

6. Droits des participants

Vous êtes libre d'accepter ou de refuser de participer au projet. Si vous choisissez de ne pas participer ou si vous choisissez de participer et revenez sur votre décision pendant le déroulement du projet, vous n'aurez pas à vous justifier. Cela ne changera rien à votre prise en charge médicale habituelle. Vous pouvez à tout moment poser toutes les questions nécessaires au sujet de l'étude. Veuillez-vous adresser pour ce faire à la personne indiquée à la fin de la présente feuille d'information.

7. Confidentialité des données

Pour les besoins de l'étude, nous enregistrerons vos données personnelles et médicales. Seul un nombre limité de personnes peut consulter vos données sous une forme non codée, et exclusivement afin de pouvoir accomplir des tâches nécessaires au déroulement du projet. Les données recueillies à des fins de recherche sont codées lors de leur collecte. Le codage signifie que toutes les données permettant de vous identifier (p. ex. le nom, la date de naissance, etc.)

Feuille d'information v1, 20.11.2018
Personnes vivant à domicile avec des conditions médicales chroniques

page 2/5



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sont remplacées par un code. Le code reste en permanence au sein de la Haute École de Santé. Les personnes ne connaissant pas ce code ne peuvent pas lier ces données à votre personne. Dans le cas d'une publication, les données agrégées ne vous sont donc pas imputables en tant que personne. Votre nom n'apparaîtra jamais sur Internet ou dans une publication. Parfois, les journaux scientifiques exigent la transmission de données individuelles (données brutes). Si des données individuelles doivent être transmises, elles sont toujours codées et ne permettent donc pas de vous identifier en tant que personne. Toutes les personnes impliquées dans l'étude de quelque manière que ce soit sont tenues au secret professionnel. Toutes les directives relatives à la protection des données sont respectées et vous avez à tout moment le droit de consulter vos données. Il se peut que vos données soient ultérieurement exploitées dans de futurs projets de recherche en accord avec le Fonds National Suisse. Ces éventuels projets doivent toutefois obéir aux mêmes normes et exigences que celles du présent projet.

Durant son déroulement, le projet peut faire l'objet d'inspections. Celles-ci peuvent être effectuées par la commission d'éthique qui s'est chargée de son contrôle initial et l'a autorisé, mais aussi être mandatées par l'organisme qui l'a initié. Il se peut que la direction du projet doive communiquer vos données personnelles et médicales pour les besoins de ces inspections. Toutes les personnes impliquées sont tenues au secret professionnel. Nous garantissons le respect de toutes les directives de la protection des données et ne ferons apparaître votre nom dans aucun rapport ou publication, imprimé ou en ligne.

8. Retrait du projet

Vous pouvez à tout moment vous retirer de l'étude si vous le souhaitez, sans produire de justification. Par ailleurs, en cas de révocation de votre consentement, les données ne seront pas utilisées dans le cadre de cette recherche et seront immédiatement détruites.

12 Rémunération des participants

Si vous participez à ce projet, vous ne recevrez pour cela aucune compensation.

13 Financement du projet

L'étude est majoritairement financée par le Fonds National Suisse de la Recherche Scientifique.

14 Interlocuteur(s)

En cas de doute, de craintes ou d'urgences pendant ou après l'étude, vous pouvez vous adresser à tout moment à l'un des interlocuteurs suivants :

Responsable du projet :

Prof. Henk Verloo
Haute École de Santé, HES-SO Valais – Wallis
Chemin de l'Agasse 5, 1950 Sion
henk.verloo@hevs.ch
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Collaborateurs :

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Dr. Maria del Rio Carral, Université de Lausanne
Quartier UNIL-Mouline - Bâtiment Géopolis CH – 1015 Lausanne
maria.delriocarral@unil.ch
Tel. +41 21 692 32 56



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Attestation de la personne assurant l'information :

Par la présente, j'atteste avoir expliqué au participant / à la participante la nature, l'importance et la portée du projet. Je déclare satisfaire à toutes les obligations en relation avec ce projet conformément au droit en vigueur. Si je devais prendre connaissance, à quelque moment que ce soit durant la réalisation du projet, d'éléments susceptibles d'influer sur le consentement du participant / de la participante à prendre part au projet, je m'engage à l'en informer immédiatement.

Lieu, date	Nom et prénom de la personne assurant l'information aux participants en caractères d'imprimerie.
	Signature de la personne assurant l'information



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Gestion des médicaments chez les personnes vivant à domicile avec des conditions médicales chroniques

Titre officiel complet :

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Madame, Monsieur,

Nous vous proposons de participer à notre projet de recherche. Cette feuille d'information décrit le projet de recherche.

Information détaillée destinée au proche aidant

1. Objectifs du projet de recherche

L'objectif de ce projet de recherche est d'étudier comment les personnes vivant avec des conditions médicales chroniques, âgées de 65 ans ou plus, qui rentrent à leur domicile après une hospitalisation, vivent cette période et gèrent leurs médicaments au quotidien.

Nous nous intéressons également à l'implication des proches aidants et des soignants à domicile dans cette gestion des médicaments à domicile.

2. Sélection des personnes pouvant participer au projet

La participation est ouverte à toute personne âgée de 65 ans ou plus, vivant avec des conditions médicales chroniques, qui rentre à son domicile après une hospitalisation et qui, en outre, prend plus de 5 médicaments par jour.

3. Informations générales sur le projet

Ce projet est mis en œuvre par des chercheurs de la Haute École de Santé du Valais, l'Université de Lausanne et le Centre Hospitalier Universitaire Vaudois. Il se déroule en collaboration avec l'Hôpital du Valais et le Centre Médico-Social de Sion. Il durera un an et trois mois, à compter d'octobre 2019.

Ce projet reposera sur la réalisation d'entretiens de recherche avec des personnes vivant à domicile avec des conditions médicales chroniques, âgées de 65 ans ou plus, leurs proches aidants et leurs soignants à domicile, afin de mieux comprendre comment se passe la gestion des médicaments à domicile après une hospitalisation.

Au total, 30 personnes avec des conditions médicales chroniques participeront à l'étude, ainsi que 30 proches aidants et 30 soignants à domicile.

Nous effectuons ce projet dans le respect des prescriptions de la législation suisse. La commission cantonale d'éthique compétente a contrôlé et autorisé le projet.



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4. Déroulement pour les participants

À la fin de l'hospitalisation de votre proche, et lors de son retour à domicile, le chercheur lui proposera de participer à **trois entretiens** d'une heure environ, espacés de trois à quatre semaines. Le chercheur demandera également de désigner le proche et le professionnel de santé les plus impliqués dans son quotidien, afin de réaliser des entretiens avec eux, avec son accord.

Dans le **troisième entretien**, vous serez présent en tant que proche aidant désigné comme le plus impliqué dans son quotidien. Cet entretien, **d'une heure** de durée environ, aura lieu deux à trois semaines après le deuxième entretien avec votre proche vivant à domicile avec des conditions médicales chroniques. Vous serez les deux ensembles dans son domicile et échangerez sur la manière dont vous vous impliquez dans son quotidien, et dans l'organisation de ses soins et médicaments.

5. Bénéfices pour les participants

Votre participation au projet ne vous apportera aucun bénéfice. Les résultats du projet pourraient contribuer à des améliorations dans la gestion des médicaments et de la santé des personnes âgées vivant à domicile avec des conditions médicales chroniques, âgées de 65 ans et plus, prenant plus de 5 médicaments par jour, qui rentrent à leur domicile après une hospitalisation. Les résultats du projet pourraient se révéler importants pour le maintien à domicile et l'évitement d'une réhospitalisation de ces personnes.

6. Droits des participants

Vous êtes libre d'accepter ou de refuser de participer au projet. Si vous choisissez de ne pas participer ou si vous choisissez de participer et revenez sur votre décision pendant le déroulement du projet, vous n'aurez pas à vous justifier. Cela ne changera rien à votre prise en charge médicale habituelle. Vous pouvez à tout moment poser toutes les questions nécessaires au sujet de l'étude. Veuillez-vous adresser pour ce faire à la personne indiquée à la fin de la présente feuille d'information.

7. Confidentialité des données

Pour les besoins de l'étude, nous enregistrerons vos données personnelles et médicales. Seul un nombre limité de personnes peut consulter vos données sous une forme non codée, et exclusivement afin de pouvoir accomplir des tâches nécessaires au déroulement du projet. Les données recueillies à des fins de recherche sont codées lors de leur collecte. Le codage signifie que toutes les données permettant de vous identifier (p. ex. le nom, la date de naissance, etc.) sont remplacées par un code. Le code reste en permanence au sein de la Haute École de Santé. Les personnes ne connaissant pas ce code ne peuvent pas lier ces données à votre personne. Dans le cas d'une publication, les données agrégées ne vous sont donc pas imputables en tant que personne. Votre nom n'apparaîtra jamais sur Internet ou dans une publication. Parfois, les journaux scientifiques exigent la transmission de données individuelles (données brutes). Si des données individuelles doivent être transmises, elles sont toujours codées et ne permettent donc pas de vous identifier en tant que personne. Toutes les personnes impliquées dans l'étude de quelque manière que ce soit sont tenues au secret professionnel. Toutes les directives relatives à la protection des données sont respectées et vous avez à tout moment le droit de consulter vos données. Il se peut que vos données soient ultérieurement exploitées dans de futurs projets de recherche en accord avec le Fonds National Suisse. Ces éventuels projets doivent toutefois obéir aux mêmes normes et exigences que celles du présent projet.

Durant son déroulement, le projet peut faire l'objet d'inspections. Celles-ci peuvent être effectuées par la commission d'éthique qui s'est chargée de son contrôle initial et l'a autorisé, mais aussi être mandatées par l'organisme qui l'a initié. Il se peut que la direction du projet doive communiquer vos données personnelles et médicales pour les besoins de ces inspections. Toutes les personnes



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impliquées sont tenues au secret professionnel. Nous garantissons le respect de toutes les directives de la protection des données et ne ferons apparaître votre nom dans aucun rapport ou publication, imprimé ou en ligne.

8. Retrait du projet

Vous pouvez à tout moment vous retirer de l'étude si vous le souhaitez, sans produire de justification. Par ailleurs, en cas de révocation de votre consentement, les données ne seront pas utilisées dans le cadre de cette recherche et seront immédiatement détruites.

12 Rémunération des participants

Si vous participez à ce projet, vous ne recevrez pour cela aucune compensation.

13 Financement du projet

L'étude est majoritairement financée par le Fonds National Suisse de la Recherche Scientifique.

14 Interlocuteur(s)

En cas de doute, de craintes ou d'urgences pendant ou après l'étude, vous pouvez vous adresser à tout moment à l'un des interlocuteurs suivants :

Responsable du projet :

Prof. Henk Verloo
Haute École de Santé, HES-SO Valais – Wallis
Chemin de l'Agasse 5, 1950 Sion
henk.verloo@hevs.ch
Tel. +41 27 606 84 24

Collaborateurs :

Prof. HES Assis. Filipa Pereira
Haute École de Santé, HES-SO Valais – Wallis
Chemin de l'Agasse 5, 1950 Sion
filipa.pereira@hevs.ch
Tel. +41 27 606 84 42

Dr. Maria del Rio Carral, Université de Lausanne
Quartier UNIL-Mouline - Bâtiment Géopolis - CH – 1015 Lausanne
maria.delriocarral@unil.ch
Tel. +41 21 692 32 56



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Déclaration de consentement du proche aidant

Déclaration de consentement écrite pour la participation à un projet de recherche

- Veuillez lire attentivement ce formulaire.
- N'hésitez pas à poser des questions lorsque vous ne comprenez pas quelque chose ou que vous souhaitez avoir des précisions.

Numéro BASEC du projet :

(après soumission à la commission d'éthique compétente) :

2018-02196

Titre de l'étude :

(titre scientifique et titre usuel)

Gestion des médicaments chez les personnes vivant à domicile avec des conditions médicales chroniques

Optimising medication management for polymedicated home-dwelling older adults with multiple chronic conditions
ME@home (Medication management for the Elderly at Home)

Institution responsable :

(adresse complète) :

Haute École de Santé
HES-SO Valais – Wallis
Chemin de l'Agasse 5, 1950 Sion

Lieu de réalisation du projet :

Sion

Directeur / directrice du projet sur le site :

(nom et prénom en caractères d'imprimerie) :

Verloo Henk

Participant / participante :

(nom et prénom en caractères d'imprimerie) :

Date de naissance :

☐ femme

☐ homme

- Je déclare avoir été informé, par la personne assurant l'information soussigné(e), oralement et par écrit, des objectifs et du déroulement du projet ainsi que des effets présumés, des avantages, des inconvénients possibles et des risques éventuels.
- Je prends part à cette étude de façon volontaire et j'accepte le contenu de la feuille d'information qui m'a été remise sur le projet précité. J'ai eu suffisamment de temps pour prendre ma décision.
- J'ai reçu des réponses satisfaisantes aux questions que j'ai posées en relation avec ma participation au projet. Je conserve la feuille d'information et reçois une copie de ma déclaration de consentement écrite.
- J'accepte que les spécialistes compétents de l'institution, du mandataire du projet, de la Commission d'éthique compétente pour cette étude, puissent consulter mes données brutes afin de procéder à des contrôles, à condition toutefois que la confidentialité de ces données soit strictement assurée.
- Je peux, à tout moment et sans avoir à me justifier, révoquer mon consentement à participer à l'étude, sans que cela n'ait de répercussion défavorable sur la suite de ma prise en charge médicale usuelle.

Lieu, date

Signature du participant / de la participante



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Attestation de la personne assurant l'information :

Par la présente, j'atteste avoir expliqué au participant / à la participante la nature, l'importance et la portée du projet. Je déclare satisfaire à toutes les obligations en relation avec ce projet conformément au droit en vigueur. Si je devais prendre connaissance, à quelque moment que ce soit durant la réalisation du projet, d'éléments susceptibles d'influer sur le consentement du participant / de la participante à prendre part au projet, je m'engage à l'en informer immédiatement.

Lieu, date	Nom et prénom de la personne assurant l'information aux participants en caractères d'imprimerie. Signature de la personne assurant l'information



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Gestion des médicaments chez les personnes vivant à domicile avec des conditions médicales chroniques

Titre officiel complet :

Optimising medication management for polymedicated home-dwelling older adults with multiple chronic conditions

ME@home (Medication management for the Elderly at Home)

Ce projet est organisé par des chercheurs de la Haute École de Santé HES-SO Valais-Wallis (Prof. Henk Verloo), l'Université de Lausanne (Prof. Marie Santiago-Delefosse, Prof. Boris Wernli) et le Centre Hospitalier Universitaire Vaudois (Prof. Armin von Guten).

Madame, Monsieur,

Nous vous proposons de participer à notre projet de recherche. Cette feuille d'information décrit le projet de recherche.

Information détaillée destinée au professionnel de la santé

1. Objectifs du projet de recherche

L'objectif de ce projet de recherche est d'étudier comment les personnes vivant avec des conditions médicales chroniques, âgées de 65 ans ou plus, qui rentrent à leur domicile après une hospitalisation, vivent cette période et gèrent leurs médicaments au quotidien.

Nous nous intéressons également à l'implication des proches aidants et des soignants à domicile dans cette gestion des médicaments à domicile.

2. Sélection des personnes pouvant participer au projet

La participation est ouverte à toute personne âgée de 65 ans ou plus, vivant avec des conditions médicales chroniques, qui rentre à son domicile après une hospitalisation et qui, en outre, prend plus de 5 médicaments par jour.

3. Informations générales sur le projet

Ce projet est mis en œuvre par des chercheurs de la Haute École de Santé du Valais, l'Université de Lausanne et le Centre Hospitalier Universitaire Vaudois. Il se déroule en collaboration avec l'Hôpital du Valais et le Centre Médico-Social de Sion. Il durera un an et trois mois, à compter d'octobre 2019.

Ce projet reposera sur la réalisation d'entretiens de recherche avec des personnes vivant à domicile avec des conditions médicales chroniques, âgées de 65 ans ou plus, leurs proches aidants et leurs soignants à domicile, afin de mieux comprendre comment se passe la gestion des médicaments à domicile après une hospitalisation.

Au total, 30 personnes avec des conditions médicales chroniques participeront à l'étude, ainsi que 30 proches aidants et 30 soignants à domicile.

Nous effectuons ce projet dans le respect des prescriptions de la législation suisse. La commission cantonale d'éthique compétente a contrôlé et autorisé le projet.



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4. Déroulement pour les professionnels de la santé participants

La personne vivant à domicile avec des conditions médicales chroniques participant à l'étude **identifiera le professionnel de santé le plus impliqué dans la gestion de son traitement médicamenteux**. Après la prise de contact et en cas de consentement de participation, un entretien semi-structuré d'**une heure environ** sera réalisé afin d'explorer les pratiques de médication de la personne du point de vue du professionnel de la santé, et les enjeux associés au retour à domicile après une hospitalisation. Il aura lieu dans son lieu de travail, deux à trois semaines après l'entretien rassemblant la personne avec des conditions médicales chroniques et son proche aidant.

5. Bénéfices pour les participants

Votre participation au projet ne vous apportera aucun bénéfice. Les résultats du projet pourraient contribuer à des améliorations dans la gestion des médicaments et de la santé des personnes âgées vivant à domicile avec des conditions médicales chroniques, âgées de 65 ans et plus, prenant plus de 5 médicaments par jour, qui rentrent à leur domicile après une hospitalisation. Les résultats du projet pourraient se révéler importants pour le maintien à domicile et l'évitement d'une réhospitalisation de ces personnes.

6. Droits des participants

Vous êtes libre d'accepter ou de refuser de participer au projet. Si vous choisissez de ne pas participer ou si vous choisissez de participer et revenez sur votre décision pendant le déroulement du projet, vous n'aurez pas à vous justifier. Cela ne changera rien à votre prise en charge médicale habituelle. Vous pouvez à tout moment poser toutes les questions nécessaires au sujet de l'étude. Veuillez-vous adresser pour ce faire à la personne indiquée à la fin de la présente feuille d'information.

7. Confidentialité des données

Pour les besoins de l'étude, nous enregistrerons vos données personnelles et médicales. Seul un nombre limité de personnes peut consulter vos données sous une forme non codée, et exclusivement afin de pouvoir accomplir des tâches nécessaires au déroulement du projet. Les données recueillies à des fins de recherche sont codées lors de leur collecte. Le codage signifie que toutes les données permettant de vous identifier (p. ex. le nom, la date de naissance, etc.) sont remplacées par un code. Le code reste en permanence au sein de la Haute École de Santé. Les personnes ne connaissant pas ce code ne peuvent pas lier ces données à votre personne. Dans le cas d'une publication, les données agrégées ne vous sont donc pas imputables en tant que personne. Votre nom n'apparaîtra jamais sur Internet ou dans une publication. Parfois, les journaux scientifiques exigent la transmission de données individuelles (données brutes). Si des données individuelles doivent être transmises, elles sont toujours codées et ne permettent donc pas de vous identifier en tant que personne. Toutes les personnes impliquées dans l'étude de quelque manière que ce soit sont tenues au secret professionnel. Toutes les directives relatives à la protection des données sont respectées et vous avez à tout moment le droit de consulter vos données. Il se peut que vos données soient ultérieurement exploitées dans de futurs projets de recherche en accord avec le Fonds National Suisse. Ces éventuels projets doivent toutefois obéir aux mêmes normes et exigences que celles du présent projet.

Durant son déroulement, le projet peut faire l'objet d'inspections. Celles-ci peuvent être effectuées par la commission d'éthique qui s'est chargée de son contrôle initial et l'a autorisé, mais aussi être mandatées par l'organisme qui l'a initié. Il se peut que la direction du projet doive communiquer vos données personnelles et médicales pour les besoins de ces inspections. Toutes les personnes impliquées sont tenues au secret professionnel. Nous garantissons le respect de toutes les



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directives de la protection des données et ne ferons apparaître votre nom dans aucun rapport ou publication, imprimé ou en ligne.

8. Retrait du projet

Vous pouvez à tout moment vous retirer de l'étude si vous le souhaitez, sans produire de justification. Par ailleurs, en cas de révocation de votre consentement, les données ne seront pas utilisées dans le cadre de cette recherche et seront immédiatement détruites.

12 Rémunération des participants

Si vous participez à ce projet, vous ne recevrez pour cela aucune compensation.

13 Financement du projet

L'étude est majoritairement financée par le Fonds National Suisse de la Recherche Scientifique.

14 Interlocuteur(s)

En cas de doute, de craintes ou d'urgences pendant ou après l'étude, vous pouvez vous adresser à tout moment à l'un des interlocuteurs suivants :

Responsable du projet :

Prof. Henk Verloo
Haute École de Santé, HES-SO Valais – Wallis
Chemin de l'Agasse 5, 1950 Sion
henk.verloo@hevs.ch
Tel. +41 27 606 84 24

Collaborateurs :

Prof. HES Ass. Filipa Pereira
Haute École de Santé, HES-SO Valais – Wallis
Chemin de l'Agasse 5, 1950 Sion
filipa.pereira@hevs.ch
Tel. +41 27 606 84 42

Dr. Maria del Rio Carral, Université de Lausanne
Quartier UNIL-Mouline - Bâtiment Géopolis CH – 1015 Lausanne
maria.delriocarral@unil.ch
Tel. +41 21 692 32 56



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Déclaration de consentement du professionnel de la santé

Déclaration de consentement écrite pour la participation à un projet de recherche

- Veuillez lire attentivement ce formulaire.
- N'hésitez pas à poser des questions lorsque vous ne comprenez pas quelque chose ou que vous souhaitez avoir des précisions.

Numéro BASEC du projet : (après soumission à la commission d'éthique compétente) :	2018-02196
Titre de l'étude : (titre scientifique et titre usuel)	Gestion des médicaments chez les personnes vivant à domicile avec des conditions médicales chroniques <i>Optimising medication management for polymedicated home-dwelling older adults with multiple chronic conditions</i> <i>ME@home (Medication management for the Elderly at Home)</i>
Institution responsable : (adresse complète) :	Haute École de Santé HES-SO Valais – Wallis Chemin de l'Agasse 5, 1950 Sion
Lieu de réalisation du projet :	Sion
Directeur / directrice du projet sur le site : (nom et prénom en caractères d'imprimerie) :	Verloo Henk
Participant / participante : (nom et prénom en caractères d'imprimerie) : Date de naissance :	 ☐ femme ☐ homme

- Je déclare avoir été informé, par la personne assurant l'information soussigné(e), oralement et par écrit, des objectifs et du déroulement du projet ainsi que des effets présumés, des avantages, des inconvénients possibles et des risques éventuels.
- Je prends part à cette étude de façon volontaire et j'accepte le contenu de la feuille d'information qui m'a été remise sur le projet précité. J'ai eu suffisamment de temps pour prendre ma décision.
- J'ai reçu des réponses satisfaisantes aux questions que j'ai posées en relation avec ma participation au projet. Je conserve la feuille d'information et reçois une copie de ma déclaration de consentement écrite.
- J'accepte que les spécialistes compétents de l'institution, du mandataire du projet, de la Commission d'éthique compétente pour cette étude, puissent consulter mes données brutes afin de procéder à des contrôles, à condition toutefois que la confidentialité de ces données soit strictement assurée.
- Je peux, à tout moment et sans avoir à me justifier, révoquer mon consentement à participer à l'étude, sans que cela n'ait de répercussion défavorable sur la suite de ma prise en charge médicale usuelle.

Lieu, date	Signature du participant / de la participante



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Attestation de la personne assurant l'information :

Par la présente, j'atteste avoir expliqué au participant / à la participante la nature, l'importance et la portée du projet. Je déclare satisfaire à toutes les obligations en relation avec ce projet conformément au droit en vigueur. Si je devais prendre connaissance, à quelque moment que ce soit durant la réalisation du projet, d'éléments susceptibles d'influer sur le consentement du participant / de la participante à prendre part au projet, je m'engage à l'en informer immédiatement.

Lieu, date	Nom et prénom de la personne assurant l'information aux participants en caractères d'imprimerie.
	Signature de la personne assurant l'information

Appendix 5 – Participants' medication journals



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Hes-SO
Haute Ecole de Santé
Hochschule für Gesundheit



Unil
UNIL | Université de Lausanne



CHUV
Hôpital du Valais
Spital Wallis



cms
Région de Stion

Journal de vos pratiques de médication

Gestion des médicaments chez la personne vivant à domicile avec des conditions médicales chroniques

Jour : Date :

Code du participant :

Cher participant, voici quelques questions auxquelles nous vous invitons à répondre lors de vos prises de médicaments :

Moment de la journée de prises de médicaments	Quels médicaments avez-vous pris ?	A quel endroit et à quel moment avez-vous pris vos médicaments ?	Qui était présent lors de votre prise de médicaments ?	Étiez-vous plutôt content de prendre vos médicaments ? Ou plutôt mécontent ?	Avez-vous d'autres commentaires ou sentiments à nous transmettre à propos de vos prises de médicaments ?
Matin					
Midi					
Après - midi					
Soir					
Nuit					

Basé sur les articles scientifiques suivants :
 Dew, K., Norris, P., Gabe, J., Chamberlain, K., & Hodgetts, D. (2015). Moral discourses and pharmaceuticalised governance in households. *Social Science & Medicine*, 131, 272-279
 Knight, D. A., Thompson, D., Mathie, E., & Dickinson, A. (2013). 'Seamless care? Just a list would have helped! Older people and their carer's experiences of support with medication on discharge home from hospital. *Health Expectations*, 16(3), 277-291

Journal de médication ME@home

v1, 20.11.2018

page 1/2



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Consignes :

- Chaque jour, pendant une semaine, vous pourrez compléter ce document aux moments où vous prendrez vos médicaments ;
- Vous pouvez indiquer les médicaments par leur nom, marque, forme/couleur, ou de tout autre façon qui fait sens pour vous ;
- Ce document sera consulté seulement par les membres de l'équipe de recherche ;
- Il est important que vous notiez tous les médicaments que vous avez pris, ceux prescrits par votre médecin, à l'hôpital, mais aussi les autres médicaments que vous êtes amené à prendre ;
- Vous pouvez demander de l'aide à un proche ou à un soignant pour remplir ce document ;
- Ce document n'a pas pour but de contrôler vos pratiques mais il sera un support pour notre discussion lors du deuxième entretien.

Vous pouvez contacter les membres de l'équipe de recherche en cas de question :

Responsable du projet :

Prof. Henk Verloo
Haute École de Santé, HES-SO Valais – Wallis
Chemin de l'Agasse 5, 1950 Sion
henk.verloo@hevs.ch
Tel. +41 27 606 84 24

Collaborateurs :

Prof. HES Ass. Filipa Pereira
Haute École de Santé, HES-SO Valais – Wallis
Chemin de l'Agasse 5, 1950 Sion
filipa.pereira@hevs.ch
Tel. +41 27 606 84 42

Dr. Maria del Rio Carral
Université de Lausanne
Quartier UNIL-Mouline - Bâtiment Géopolis - CH – 1015 Lausanne
maria.delriocarral@unil.ch
Tel. +41 21 692 32 56

Appendix 6 – OptiMed's ethics approvals by Portugal's and Switzerland's respective ethics commissions



COMMISSION CANTONALE
D'ÉTHIQUE DE LA RECHERCHE
SUR L'ÊTRE HUMAIN

CER-VD

Av. de Chailly 23
1012 Lausanne

Pr Henk Verloo
HES-SO Valais/Wallis
Haute Ecole de Santé
Chemin de l'Agasse 5
1950 Sion

Lausanne, le 26/10/2021
Réf. JMA/ne/cc

Décision de la Commission cantonale (VD) d'éthique de la recherche sur l'être humain (CER-VD)

Project-ID	2021-01843
Titre du projet	Effectiveness of an evidence-based, multi-component intervention programme to reduce medication-related problems among polymedicated home-dwelling older adults: a pilot study for the OptiMed clinical trial
Investigateur principal	Prof Henk Verloo
Promoteur	Prof Henk Verloo
Centres	Prof Henk Verloo, School of Health Sciences, Sion

Décision

☒ Autorisation accordée
☐ Autorisation avec charges
☐ En l'état, l'autorisation ne peut pas être accordée
☐ Autorisation non accordée
☐ Non entrée en matière

Classification

☒ Essai clinique au sens de l'OClin

☐ de médicament
☐ de transplants standardisés
☐ avec des organismes génétiquement modifiés ou pathogènes
☒ autres essais cliniques au sens du chapitre 4 de l'OClin

Catégorie : A

☐ de dispositifs médicaux
☐ de thérapie génique
☐ de transplantation
☐ avec rayonnements ionisants

Procédure de décision

☐ Procédure ordinaire
 ☐ Procédure simplifiée
 ☒ Procédure présidentielle

La Commission certifie se conformer aux principes ICH GCP.

Secrétariat administratif | Tél. +41 21 316 18 36 | Secretariat.CER@vd.ch | www.cer-vd.ch
Page 1 sur 4

N° de réf. de la CER-VD 2021-01843

Prof Henk Verloo

26/10/2021

Taxes et émoluments

Déjà facturé.

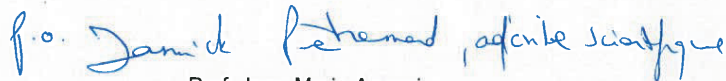
Voies de recours

La présente décision peut faire l'objet d'un recours au Tribunal cantonal, Cour de droit administratif et public. L'acte de recours doit être déposé auprès du Tribunal cantonal dans les **30 jours** suivant la communication de la décision attaquée ; il doit être signé et indiquer les conclusions et motifs du recours. La décision attaquée est jointe au recours. Le cas échéant, ce dernier est accompagné de la procuration du mandataire.

Copie pour information à :

- ☐ OFSP
- ☐ Autre(s)

Signature



Prof. Jean-Marie Annoni
Vice-président

Annexes: -Obligations du requérant
-Signification des décisions possibles
-Liste des documents soumis les 03.09.2021, 17.10.2021

Annexes

Obligations du requérant (promoteur ou investigateur principal) :

Soumission de documents : les documents modifiés et les nouveaux documents relatifs à l'étude/au projet de recherche sont soumis via le dossier existant. Les documents qui ne sont plus valides sont effacés et remplacés par les nouveaux. Les documents révisés doivent être soumis une fois en mode « suivi des modifications » et une fois en mode « modifications acceptées » (« track changes » et « clean »). Les documents d'information et de consentement ainsi que le protocole doivent être transmis dans un format permettant la recherche (PDF navigable) ou scannés avec une fonction OCR (Optical Character Recognition). Le cas échéant, les documents révisés sont également mis à disposition des autorités compétentes pour approbation.

Remarque: La commission d'éthique compétente examine, dans le cadre du processus d'autorisation, les feuilles d'information et déclarations de consentement dans une des langues officielles suisses: allemand, français ou italien. La commission d'éthique ne fait qu'accuser réception des feuilles d'information et déclarations de consentement écrites dans d'autres langues. Le promoteur ou la direction du projet est responsable de la traduction correcte des documents.

Obligations d'annonce : Les obligations d'annonce (p.ex d'événements indésirables, d'interruption d'étude) et de soumission pour autorisation des modifications essentielles obligatoires s'appliquent (**Ordonnances**). Le rapport final est à remettre à la commission d'éthique compétente dans un délai d'une année à compter de la fin ou de l'arrêt de l'étude.

Devoir d'enregistrement : Le promoteur d'un essai clinique doit procéder à l'enregistrement dans un registre primaire reconnu par l'OMS ou dans le registre de la bibliothèque médicale nationale des Etats-Unis d'Amérique (clinicaltrials.gov) puis indiquer le numéro de l'étude sur le portail BASEC. Le transfert des données vers le Swiss National Clinical Trials Portal (**SNCTP**) est effectué automatiquement suite à l'autorisation de l'étude par la commission d'éthique, sous réserve de l'accord du requérant. Les données relatives à l'essai clinique figurant sur les deux registres sont accessibles au public. Swissethics publie également sur son site des informations sur chaque étude ayant reçu une autorisation, à l'exception des essais cliniques de phase I.

Signification des décisions possibles

Autorisation accordée : L'étude peut commencer selon le plan de recherche accepté. Elle doit être menée dans le cadre des dispositions légales en vigueur. D'autres obligations d'autorisation (Swissmedic/OFSP) doivent être respectées.

Autorisation avec charges : L'étude peut commencer selon le plan de recherche accepté. Elle doit être menée dans le cadre des dispositions légales en vigueur. Les charges doivent être remplies dans un délai de 30 jours. Les documents modifiés seront réévalués en procédure présidentielle. D'autres obligations d'autorisation (Swissmedic/ OFSP) doivent être respectées.

En l'état, l'autorisation ne peut pas être accordée : L'étude ne peut pas commencer. Prière de répondre point par point aux conditions de la commission d'éthique et de nous faire parvenir les documents révisés avec les modifications apparentes et la mention de la date de la nouvelle version.

Autorisation non accordée : L'étude ne peut pas commencer dans sa forme actuelle. Une nouvelle soumission reste possible.

Non entrée en matière : Justification, voir ci-dessus, par exemple la commission d'éthique n'est pas juridiquement compétente pour accorder une autorisation ou l'étude ne nécessite pas d'autorisation.

N° de réf. de la CER-VD 2021-01843

Prof Henk Verloo

26/10/2021

Liste des documents soumis**Prof Henk Verloo, School of Health Sciences, Sion**

nom du fichier	date du fichier	version
1. Cover Letter		
1-coverletter-optimized.pdf	02/09/2021	
2021-01843-form-rep-211004.docx	16/10/2021	
2. Synopsis of the study plan		
see doc/cat: 4, page/ref: 4-6		
3. Participant information sheet and informed consent (ICF)		
4-information-et-consentement-personne-agee-v3.docx	11/10/2021	v3
5-information-et-consentement-proche-aidant-v3.docx	11/10/2021	v3
6-information-et-consentement-professionnel-v3.docx	11/10/2021	v3
4. Study plan (protocol), signed and dated		
optimized-clinicalprotocoltemplate-v6-track-changes-pop.pdf	11/10/2021	v6
optimized-clinicalprotocoltemplate-v6-clean.pdf	11/10/2021	v6
4a. Monitoring plan		
monitoring-plan-16-10-2021.pdf	16/10/2021	v2
5. CRF (Case Report Form)		
1-quest-older-adult-fr.docx	02/09/2021	v2
2-quest-informal-caregivers-fr.docx	02/09/2021	v2
3-quest-professionals-fr.docx	02/09/2021	v2
6. Investigator's CV, dated		
cv-hverloo-31-08-2021.pdf	31/08/2021	
7. Investigator's proof of GCP training		
scan-attestation-bonne-pratiques-essais-cliniques-05-09-2014.pdf	05/09/2014	
9. Agreement between sponsor/commissioned institution / grant provider or other third parties and the investigator		
clinical-study-agreement-optimized-pt-ch-v3-signed.pdf	12/10/2021	
clinical-study-agreement-optimized-carla-massetti.pdf	06/10/2021	
11. Other documents handed over to study participants		
No other documents handed over to study participants		
12. Details on nature and scope/value of compensation for participants		
There is no compensation for the participation in this study		
14. Information on secure handling of biological material and personal data, and in particular on the storage thereof		
see doc/cat: 4, page/ref: 20 /8.3		
39. Miscellaneous / Varia		
7-feasibility-questionnaire.docx	02/09/2021	v2

COMISSÃO DE ÉTICA PARA A SAÚDE

PARECER FINAL:
FAVORÁVEL

DESPACHO:

Rosa Reis Marques
04.11.2021

ASSUNTO:

Título: "Eficácia de um programa de intervenção para reduzir os problemas relacionados com a medicação em adultos idosos polimedicados. Estudo multicêntrico Suíça-Portugal.." (processo 80-2021).

Autores: Maria dos Anjos Coelho Rodrigues Dixe; Filipa Pereira; Sónia Gonçalves Pereira; Carla Meyer-Masseti; Henk Verloo.

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Conselho Diretivo

Rosa Reis Marques

Dr.ª Rosa Reis Marques
Presidente

João Rodrigues

Dr. João Rodrigues
Vice-Presidente

O objetivo principal do estudo baseia-se no pressuposto de que uma gestão eficaz da medicação constitui uma das condições prévias essenciais para que os idosos com múltiplas condições crónicas possam permanecer em casa e preservar a sua qualidade de vida.

Como objectivos, pretendem:

- Determinar os dados sociodemográficos, clínicos e determinantes da fragilidade de idosos com polimedicação;
- Avaliar a forma e a frequência com que o cuidador informal participa na gestão da medicação do seu familiar idoso;
- Identificar os dados de gestão da medicação e avaliação da capacidade cognitiva do idoso e/ou do cuidador informal para gerir a medicação;
- Avaliar a eficácia de uma intervenção junto de idosos, cuidadores informais e profissionais de saúde na área da gestão da medicação em idosos polimedicados.

Da população em estudos constam:

- Idosos polimedicados inscritos em unidades de saúde primários que cumpram os seguintes critérios de inclusão: idade igual ou superior a 65 anos, diagnóstico de múltiplas condições crónicas (2 ou mais); com prescrição e toma diária de pelo menos 5 medicamentos prescritos; em risco de problemas relacionados com a polimedicação (identificados através da escala doMESTIC) e com capacidade cognitiva para responder (identificada através da escala 6 CIT).
- Cuidadores informais de idosos polimedicados inscritos nos cuidados de saúde primários que cumpram os seguintes critérios de inclusão: designados pelos idosos como cuidador informal, idade igual ou superior a 18 anos.
- Profissional de saúde dos cuidados de saúde primários que cumpram os seguintes critérios de inclusão: disponibilidade para participar no estudo, independentemente da categoria profissional.



COMISSÃO DE ÉTICA PARA A SAÚDE

Estão garantidas todos os aspectos ético legais. No entanto, nos consentimentos informados deve figurar um contacto directo (telemóvel/telefone) do investigador e um local para assinatura do mesmo.

Solicita-se posteriormente o envio do relatório final do estudo, sendo que o cronograma deve ser ajustado.

Pelo exposto somos de parecer Favorável à realização do estudo

O Relator e Presidente da CES-ARS do Centro

Profª. Doutora Isabel Vitória Figueiredo