PRIMARY CARE AND EMERGENCY DEPARTMENT USE AMONG HOME CARE PATIENTS

QUALITY IN PRIMARY CARE AND USE OF THE EMERGENCY DEPARTMENT AMONG HOME CARE PATIENTS

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A Thesis Submitted to the School of Graduate Studies in Partial Fulfilment of the Requirements for the Degree Doctor of Philosophy

McMaster University DOCTOR OF PHILOSOPHY (2020)

Hamilton, Ontario (Health Research Methodology)

TITLE: Quality in primary care and use of the emergency department among home care patients

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NUMBER OF PAGES: xii, 136

Lay Abstract

Older adults receiving home care are a growing population of individuals with complex care needs and high rates of emergency department use. This thesis seeks to characterize the primary care use of home care patients in Ontario and examine to what degree better quality of primary care is associated with less use of the emergency department. My findings indicate that increased access to afterhours primary care, higher levels of primary care home visits, and better continuity of both primary and specialty physician care were associated fewer emergency department visits. In conjunction with other sectors, primary care plays a central role managing older adults with complex care needs in the community. Better quality of primary care, particularly advanced access, can help keep older adults safely at home and out of hospitals as they age.

Abstract

Background

Population aging has led to an increasing number of older adults living in the community with complex care needs such as functional limitations, cognitive impairment, and multimorbidity. These individuals may need help to remain in their homes, which has created a growing demand for home care. Strategies to manage complex older adults such as home care patients safely in the community typically emphasize robust and integrated primary care. The objective of this thesis is to explore how specific measures of quality in primary care are associated with emergency department use among home care patients in Ontario.

Methods

I conducted four studies on varying subsets of the same population-based retrospective cohort of long-stay home care patients assessed in Ontario from 2014-2016. The first study was a descriptive examination of the entire cohort that characterized their primary care and other health system use. The second was a case-crossover study among home nursing patients examining whether access to afterhours care modifies the association between home nursing visits and same-day emergency department visits. The third study looked at physician-level provision of primary care home visits and its association with emergency department visits among home care patients with extensive functional impairments. The final study examined and compared associations between continuity of primary and specialty physician care.

Results

Long-stay home care patients in Ontario are high users of both primary care and the emergency department. Better access to afterhours care reduced the likelihood of an emergency department visit

on the same day as a home nursing visit. Patients with extensive functional impairments whose primary care physician who provided higher levels of home visits had lower rates of emergency department use. Finally, better continuity of both primary and specialty physician care were similarly associated with lower emergency department use.

Conclusion

Better quality primary care integrated with other sectors of the health system is crucial to enabling home care patients to age safety in the community. Access to care is particularly important and can be improved though enhancing the availability of afterhours care and increasing the provision of home visits for those who have difficulty reaching primary care offices. Improving continuity of specialty physician care should be a health system objective alongside improving continuity of primary care.

Acknowledgements

I am very grateful to have been supervised by Dr. Andrew Costa, without whose support I would have never even started my doctoral program. I have learned an incredible amount from him over the past four years. I would also like to thank my supervisory committee members, Dr. Hsien Seow, Dr. David Feeny, and Dr. Susan Bronskill for their guidance and direction. They have been an invaluable resource and have greatly improved my research. Finally, I would like to thank my wife Sarah for her unending support during this adventure, and my children Eden, Craig, and Zoe for simultaneously keeping me sane and driving me crazy.

This thesis is dedicated to the personal support workers and nurses in Ontario who died after contracting COVID-19 while serving in home care and long-term care homes.

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List of Abbreviations

ADL = Activities of Daily Living

CI = Confidence Interval

COPD = Chronic Obstructive Pulmonary Disease

CPS = Cognitive Performance Scale

ED = Emergency Department

HR = Hazard Ratio

HUI3 = Health Utilities Index Mark 3

IRR = Incidence Rate Ratio

LTCH = Long-term Care Home

OHIP = Ontario Health Insurance Plan

OR = Odds Ratio

RAI-HC = Resident Assessment Instrument – Home Care

Q1 = Quartile 1

Q2 = Quartile 2

Q3 = Quartile 3

Q4 = Quartile 4

Declaration of Academic Achievement

This is a “sandwich” thesis consisting of four independent research studies with a shared introduction and conclusion. Under the supervision of Dr. Andrew Costa, I developed the research questions and methodology for each study. My supervisory committee, Dr. Hsien Seow; Dr. David Feeny; and Dr. Susan Bronskill, contributed to the refinement of research objectives and methods for each study. I performed all data curation, analysis, drafting of tables and figures, and writing of initial manuscripts. All authors reviewed the initial manuscripts and provided critical feedback, including interpretation of data. I incorporated all feedback into the final version of each manuscript and submitted them to their respective journals as first and corresponding author. Additionally, Dr. Costa provided funding and Dr. Bronskill served as my ICES supervisor. All work took place between the Summer of 2018 and Spring 2020.

Chapter 1: Introduction

Population aging is a global occurrence. Longer life expectancies, lower fertility rates, and the advancement of the "baby boomer" generation to retirement age is shifting the global age distribution higher. The proportion of the global population aged 65 years or older is predicted to double from 8% in 2015 to 16% by 2050, while the proportion aged 80 years and older will increase from 1.7% to 4.4%[1]. Biological effects of aging, such as a decrease in muscle mass and decline in immune function, put older adults at increased susceptibility to disease and disability and at a greater likelihood of developing multiple chronic conditions[2,3]. Older age is also marked by the emergence of geriatric syndromes such as dementia, delirium, frailty, and functional impairment, which are complex health states not typically present in younger patients[4]. Health care systems that were designed for younger populations tend to be entrenched in acute and episodic paradigms of care and may be ill-prepared to address the more complex care needs of people with chronic diseases and/or disabilities[5,6]. The need for health systems, internationally, to transform themselves to better meet the changing care needs of an aging population has been widely recognized[7–10]

As individuals age, changes in health can make it challenging for them to continue to live in the community. At the extreme, functional decline can result in need for support in performing activities of daily living such as bathing, dressing, toileting, and locomotion[11]. At the same time however, numerous surveys have shown that older adults have a strong preference to remain in the community for as long as possible[12,13]. One health system response to these conflicting realities has been to increase in the provision of health and social care that is available in the home[14]. Home care supports older adults by providing the care they need at home to enable them stay in the community and out of hospitals or long-term care homes for as long as possible[15]. The types of home care services available vary across

jurisdictions but may include nursing, personal care, home-making support, caregiver respite, physiotherapy, occupational therapy, speech language pathology, and social work.

Canadian home care

In 2016, 10% of the adults 65 and older in Canada, and 30% of those 80 and older received some form of home care, whether publicly or privately funded[16]. Public home care in Canada can be provided on a short-term or long-term basis depending on the needs of the patient. Short-term care tends to be provided for patients recovering from surgery or other acute conditions, while long-term care is provided to patients with on-going care needs for chronic conditions and/or functional and cognitive impairments[17]

Every Canadian province and territory provides public funding for home care, although policies vary widely with regard to what services are available, who is eligible, and how they are delivered[18]. For example, public funding may be restricted to professional services such as care coordination and nursing, with personal care and/or homemaking delivered under contract or subsidized with the patient responsible for ordering. Eligibility for services, particularly personal care and homemaking, can vary widely even within the same province due to regional differences in funding and service guidelines[19]. In addition, some jurisdictions incorporate income tests for personal care services, which can result in ineligibility and/or co-payments for higher-income patients[20]. In some provinces, home care providers are government employees that provide care directly while in others the services are contracted out to independent (not-for-profit and for-profit) agencies.

Privately-funded home care is also an option for individuals who are not eligible for public services or who would like to supplement the public services they receive. Private home care is

unregulated and data on utilization is sparse, but estimates from 2010 suggest that approximately 25% of publicly-funded home care recipients in Ontario supplemented with private care[21]. Other estimates indicate that close to 1/3 of all home care in Ontario is privately-funded[22]. Given the significant out-of-pocket costs of private home care and the high prevalence of unmet home care needs, there are concerns that the current system creates inequitable access to home care for those of low socioeconomic status, which could lead to negative health consquences[16,21,23]

The home care sector provides services critical to enabling older adults to age well in the community but is coming under increasing capacity pressures due to aging populations. Projections indicate that the demand for home care in Canada will more increase by 120% by 2050, even as there will be 30% fewer close family members who could potentially provide unpaid care.[22] Already, challenges in the availability or coordination of home and community care have been linked to over a quarter of delayed discharges of patients from inpatients settings[24]. Despite this, home care funding in Ontario in recent years has consistently been around 5% of the total health care budget, while hospitals account for 35% [19,25]. Accordingly, enhancing the funding and availability home care services is a key component of aging strategies in Canada.[5,26,27]

Population of Interest

The population of interest for this thesis are patients receiving long-term home care ("long-stay"). As community-dwelling older adults who require support to remain in their homes, they represent a growing population that will challenge health systems in future decades. The clinical characteristics, health service use patterns, and excellent availability of data for long-stay home care patients make them an ideal population in which to study the capacity of health systems to keep patients with complex care needs safely at home and out of institutions as they age. My chief interest is in the primary care of home care patients as primary care is the main source of medical care in the

community and ideally operates in conjunction with home care. I will examine the emergency department use of home care patients as my primary outcome as they are costly, disruptive, and may be an indicator of poorly controlled chronic conditions and suboptimal primary care.

Primary care for home care patients

According to the Institute of Medicine,

> "Primary care is the provision of *integrated, accessible health care services* by clinicians who are *accountable* for addressing a large *majority of personal health care needs*, developing a *sustained partnership* with *patients*, and practicing in the *context of family and community."*[28]

Primary care includes diagnosis and treatment of acute and chronic conditions, health promotion, disease prevention, counselling, and rehabilitation.[29] In Canada, primary care is chiefly, though not solely, delivered by physicians operating in family practice settings.[30] Nurse practitioners also provide independent primary care and multidisciplinary primary care models can include social workers, dietitians, physiotherapists, and other health and social care professionals. Primary care can be thought of as "primary" in several senses. First it is generally intended to be the location of first contact with the health care system[31]. Second, it is foundational to the rest of the health care system. Finally, for most patients it is where the majority of care needs can be met.[32] In Canada, primary care also functions as the gatekeeper to specialty physician care.

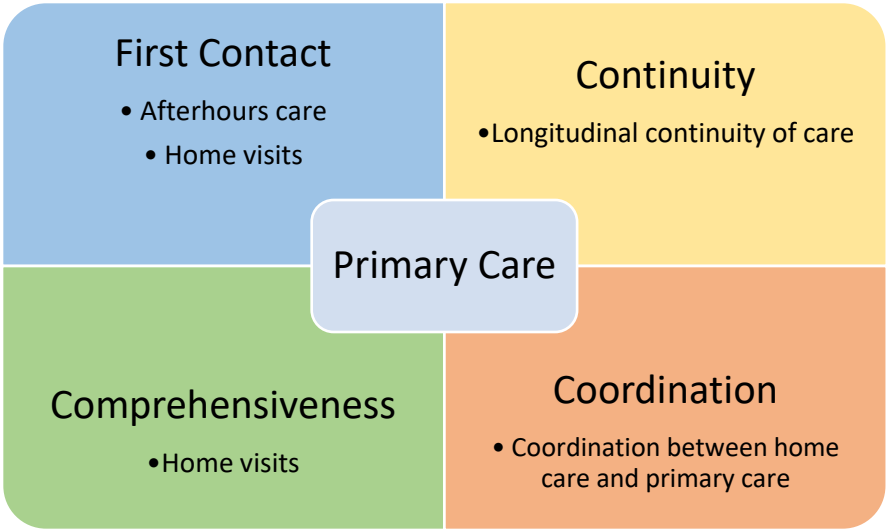
The overall value of primary care to health systems is well established, with research consistently finding that greater investments in primary care are associated with improved access, better outcomes, and reduced cost in health systems[33,34]. Chronic disease management models frequently emphasize the centrality of primary care to effectively managing older adults with multimorbidity in the community and avoiding costly inpatient settings[35,36]. With a continuous and person-centered, rather than disease-centered nature, primary care is well-suited to be a focus of

investment and innovation as health systems transform to meet the challenge of the growing burden of non-communicable diseases[37].

The four pillars of primary care first described by Starfield in 1992 endure as a basic framework for the quality of primary care delivery[38,39]. The pillars describe the essential attributes of primary care can be summarized as the 4 C's: 1) first Contact, 2) Continuity, 3) Comprehensiveness, and 4) Coordination[40]. First contact includes both the ability of patients to access primary care and the propensity of patients to seek their primary care provider initially for new health concerns[41]. Continuity of care spans several related concepts, but in the four pillars construct it refers primarily to consistency in seeing the same provider over time and to a positive relationship between provider and patient. Comprehensiveness is the provision of a broad enough range of services to meet most common health needs, and coordination primarily involves information sharing and collaborative care planning across multiple sectors of the health system[42]. Methods of achieving the goals of each of the pillars and to what degree they are effective at improving patient outcomes remains a focus of primary care research.[43]

In this thesis, I will be examining the primary care use of home care patients and its association with emergency department visits. In particular, there are several aspects of primary care that align with Starfield's pillars that I expect to be particularly relevant to patients receiving home care (Figure 1). These aspects include: availability of afterhours primary care, longitudinal continuity of care, primary care home visits, and coordination between home care and primary care.

Figure 1. Four pillar framework



Afterhours primary care

Better access to primary care is part of the pillar of first contact and is generally associated with better patient satisfaction, reduced mortality and disease rates, and less use of hospital-based care[44,45]. The ability to identify, seek, and obtain health care is a complex function of health systems, providers, individuals[46]. Strategies to improve access to primary care vary widely and may include practice reorganization, scheduling innovations, financial incentives for providers, and telemedicine[47]. In recent years, increasing the availability of primary care services outside of normal business hours has become a topic of interest for health systems globally[48]. Increased access to afterhours primary care could theoretically reduce emergency department visits, particularly less urgent visits that can be appropriately seen in a primary care setting.[49] However, the literature on the effects of afterhours primary care is conflicting, with some studies finding greater afterhours primary care is associated with fewer emergency departments visits[50,51] while others finding no effect.[52,53]

Evening and weekend primary care availability could improve the ability of home care patients to visit their usual provider rather than the emergency department or other available source of health care for emerging health issues such as exacerbations of chronic conditions. In particular, home care

patients have been shown to have a greater risk of visiting the emergency department afterhours on the same day as they had home nursing visit.[54] This was hypothesized to be due to the home care nurse referring the patient for further care for a health issue that the nurse was unable to address during the visit. In this thesis I will examine the ability of increased access to afterhours care to reduce the association between home nursing visits and same-day emergency department visits.

Longitudinal continuity of care

Continuity of care is a complex construct with multiple facets. The aspects of continuity are frequently decomposed into informational continuity, managerial continuity, and interpersonal (or relational continuity).[55] Longitudinal continuity of care is a sub-aspect of interpersonal continuity that refers specifically to the consistency with which a patient visits the same health care provider(s) over time[56]. Good longitudinal continuity supports a positive, continuous patient-physician relationship that has been traditionally highly valued within primary care.[57] A consistent, longitudinal relationship between a patient and a physician fosters comfort, familiarity, and trust, which can yield multiple benefits. [55] For the patient, increased continuity has been linked to better adherence to treatment plans, greater confidence in primary care, and more comfort in sharing health concerns.[58] Research also suggests that primary care providers believe that better continuity allows them to offer higher quality care[59].

Better longitudinal continuity of primary care has been associated with more consistent preventive care, higher patient satisfaction, and reduced hospitalizations.[60] Improving longitudinal continuity has been a chief goal of widely implemented models of primary care such as patient-centered medical homes and patient enrollment models[61,62]. But while longitudinal continuity of primary care has been a topic of research and innovations for decades, continuity of care with specialty care physicians has been rarely considered. However, recently several studies have examined associations between

patient outcomes and better continuity of physician specialty care, including psychiatry, internal medicine, and general surgery[63–65].

Home care patients are an ideal population in which to compare and contrast the benefits of continuity of primary and specialty physician care as many patients have multiple chronic diseases and a significant proportion are likely to see both primary and specialty care physicians[66]. Continuity of care is important for home care patients as it is thought to be a key factor in managing patients with multimorbidity in the community[67]. Continuity has also been shown to be more important to patients who have multiple chronic conditions.[68] In this thesis I will examine and compare the effects of longitudinal continuity of primary care and the continuity of specialty care among long-stay home care patients.

Physician home visits

A comprehensive primary care practice is one that offers a range of services broad enough to cover most needs. While definitions vary, common types of care include: urgent care, chronic care, preventative care, prenatal/maternal/neonatal care, perioperative care, mental health, geriatric care, palliative care, and general procedures.[69,70] One widely recognized element of comprehensiveness is offering primary care home visits, which provides access to care for patients with difficulty reaching primary care offices.

Home visits were a traditional part of the practice of family medicine[71]. Although they became less common in North America during the second half of the 20th century[72,73], there has been a recent resurgence of interest in physician home visits, particularly for homebound or frail older adults[74–77]. Individuals with difficulty reaching traditional office-based care are less likely to receive preventive care or early management of new health issues, which can result in future emergency department visits and hospital admissions[11]. Home visits represent a way to provide access to primary care for these patients,

potentially avoiding unnecessary use of hospital-based care. In addition to improving access, home visits allow a physician to observe patients in their home environment, providing an opportunity to assess factors such as medication adherence, dietary habits, and risk of falling.[78]

Previous research has found that multidisciplinary home-based primary care programs can delay institutionalization and reduce emergency department visits and hospital admissions among homebound patients[79], while home visits in general are associated with greater patient satisfaction[80]. However, population-based studies on the general provision of home visits as a physician practice pattern are lacking. Many home care patients live with functional impairments, which make them an ideal population to receive physician home visits. In this thesis I will examine the home visit practice patterns of the primary care physicians of home care patients with significant functional impairments.

Coordination between home care and primary care

Care coordination "involves deliberately organizing patient care activities and sharing information among all of the participants concerned with a patient's care to achieve safer and more effective care".[81] In addition to being one of the pillars of primary care, coordinated and integrated care is a cornerstone of chronic disease management models[82]. Among patients who see multiple health care providers, coordinated care can result in increased access to care, less duplication of services, better medication management, and early detection of disease exacerbations.[83] Ultimately this can improve clinical outcomes, prevent complications, and reduce emergency department visits and hospital admissions among complex older adults[84,85]

Home care patients typically live with complex care needs, see multiple health care providers, and experience transitions in care, all of which make them likely to receive fragmented care. Efforts to increase coordination between home care and primary care having included establishing

interdisciplinary teams, attaching primary care caseloads to individual primary care physicians, and embedding home care coordinators within primary care offices[86,87]. In this thesis I will examine coordination between home care and primary care by studying the use of physician billing codes that can be used when a primary care physician in Ontario provides advice, information, or direction to a home care provider.

Emergency department visits as an outcome for home care patients

While the impact of primary care can be assessed in numerous ways, emergency department visits are a frequently examined outcome. Emergency departments in Canada provide continuous, universal access to diagnosis and treatment of illness and injury. Despite being primarily indicated for urgent or life-threatening conditions, nearly half of the emergency department visits in Ontario are classified as less-urgent or non-urgent by the Canadian Triage Acuity Scale[88,89]. This is partially a result of patients using the emergency department in place of primary care when they cannot access their regular primary care provider or do not have a regular provider.[90,91]

Intensity of emergency department use increases with age, and home care patients have been noted to have particularly high utilization of the emergency department.[92,93] However, the episodic, disease-centric approach typical of emergency departments is often ill-suited to meet the complex, multifaceted care needs of home care patients[94]. Patients may present with numerous symptoms stemming from multiple etiologies, a complex history, and geriatric syndromes such as functional and cognitive impairments. Appropriate assessment and treatment of these conditions requires greater time and coordination than the efficiency-driven nature of emergency departments characteristically permits.[95]

While emergency departments provide essential care, there are also well-established risks for older adults in the emergency department. As time spent in the emergency department increases, older adults are at an increasing risk of missing medications, skipping meals, and of acquiring infections or delirium[96,97]. Furthermore, continuity of care is disrupted. Older adults are also at greater risk for adverse events post-discharge from the emergency department[94]. In addition, excess emergency department use can be a marker of poorly managed chronic diseases.[98,99] Given the crowded and expensive (relative to primary care) nature of emergency departments, health systems worldwide have made reducing emergency department visits, particularly less urgent visits, a priority[100,101].

I will examine emergency department visits as the primary outcome for all studies in this thesis. Depending on the research question, I will also examine how aspects of primary care differentially effect "avoidable" and "non-avoidable" emergency department visits. There is no agreed upon definition of an "avoidable" emergency department visit, and definitions in the literature incorporate diagnoses, discharge dispositions, triage scores, and self-reported data, each with their own shortcomings[102]. I will compare results across less and more urgent subsets of emergency department visits, as defined by whether the patient was admitted to hospital from the emergency department, to get a sense of whether a particular aspect of primary care more strongly affects emergency departments visits that are potentially replaceable by primary care or visits for which hospital-based care is likely necessary.

Thesis objective and components

The objective of the thesis is to examine associations between several measures of primary care delivery and use that are related to better quality of care and subsequent visits to the emergency department among long-stay home care patients in Ontario. The thesis includes four independent studies contained in chapters 2 through 5.

Chapter 2: "The primary care and other health system use of home care patients: a retrospective cohort analysis"[103]

Little is known about the primary care use of home care patients, in particular the prevalence of billable coordination codes, afterhours primary care, and physician home visits. The objective of this study is to examine the primary care use of home care patients, including utilization of the components of primary care examined in later thesis chapters such as home visits and afterhours care, and to explore associations between primary care use and clinical and demographic characteristics of patients.

Chapter 3: "Access to afterhours primary care as an effect modifier of same-day emergency department use: a case-crossover study"[104]

Previous work has found that home care patients are at a higher risk of visiting the emergency department during the afterhours period on the same day they had a nursing visit[54], but the ability of increased access to afterhours primary care to reduce this risk has not been explored. The objective of the second study is to examine the extent to which access to afterhours primary care modifies the associations between home care nursing visits and same-day emergency department visits.

Chapter 4: "Physician home visit patterns and hospital use among older adults with functional impairments"[105]

Research on programs of home-based primary care have found benefits in terms of reduced emergency department visits and hospitalizations among homebound patients. However, the provision of home visits as a general physician practice pattern has not been examined using a population-based approach. The objective of the third study is to examine whether having a regular primary care physician who historically provides higher levels of home visits is associated with fewer emergency department visits and hospitalizations among home care patients with extensive functional impairments.

Chapter 5: "Associations between continuity of primary and specialty physician care and use of hospital-based care among community-dwelling older adults with complex care needs"

While longitudinal continuity of care is a long-studied topic within primary care, continuity within other physician specialties has recently become a topic of interest. However, little research has jointly considered associations between continuity of primary care and specialty care. The objective of the final study is to concurrently examine and compare the associations between better continuity of primary and specialty physician care and emergency department use and hospital admissions among home care patients who use both primary and specialty physician care.

Chapter 2: The primary care and other health system use of home care patients: a retrospective cohort analysis

Summary:

The second chapter of this thesis descriptively examines the health system use of long-stay home care patients in Ontario, including primary and specialist physician care, home care, and hospital-based care. In additional to building a descriptive profile, I examined associations between specific measures of primary care (coordination between home care and primary care, afterhours primary care, and primary care home visits) and the clinical and demographic characteristics of the patient.

The findings of this chapter provide important context and inform the analysis of later chapters of the thesis. Primary care, specialty care, and emergency department use were all very common in my cohort. However, billing codes for coordination between home care and primary care were rare. While this was likely due to lack of physician awareness of the specific billing codes, difficulty integrating home care with other sectors of the health system has been previously noted. The very low use of the codes raises questions as to their usefulness as a method to increase coordination. Ultimately, uncertainty around accuracy of the codes precluded a thesis chapter focusing on coordination between primary care and home care.

Citation:

Jones A, Bronskill SE, Agarwal G, Seow H, Feeny D, Costa AP. The primary care and other health system use of home care patients: a retrospective cohort analysis. *CMAJ open*. 2019 Apr;7(2):E360.

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Abstract

Background

Robust and integrated primary care and home care are core components of effective chronic disease management in the community. However, primary care use by home care patients is not well studied. I described the primary care and other health system use by a cohort of home care patients.

Methods

I conducted a population-based retrospective cohort study of publicly-funded home care patients in Ontario, Canada from October 2014 to September 2016. Primary outcomes were primary care physician visits including coordination with home care, home visits, and afterhours/weekend visits within six months of a home care assessment. Secondary outcomes included specialist physician visits, emergency department use, home care visits, and long-term care home placement. Multivariable models examined associations between patient characteristics and subsequent primary care use.

Results

My cohort identified 226,054 home care patients with a median age of 81 years. Following assessment, home care patients visited primary care physicians at a rate of 0.78 visits per month. Physician-based home care coordination codes were billed for 3.9% of patients. Primary care home visits were received by 13.1% of patients, and 15.1% of patients utilized afterhours/weekend primary care.

Interpretation

Publicly-funded home care patients frequently visited a primary care physician. Physician billings for coordination between primary care and home care were infrequent but were more common in interprofessional primary care practices. Physician home visits were more likely to be received by the

oldest and most functionally impaired patients, suggesting that home visits are responsive to the needs of home care patients.

Background

Chronic disease management models frequently emphasize the importance of quality primary care for effective chronic disease management in the community.[1–3] Various aspects of the delivery of primary care have been shown to improve outcomes in older adults. For example, coordination between primary care and other health sectors can reduce depressive symptoms and improve the functional status of older adults with multimorbidity.[4] Home-based primary care has been shown to reduce emergency department visits and hospitalizations in homebound older adults.[5] Access to timely primary care and afterhours primary care could reduce emergency department visits.[6,7] However, research suggests that older adults with complex care needs frequently experience fragmentation of care and difficultly accessing primary care.[8]

Home care patients are a population of complex community-dwelling older adults characterized by multiple chronic conditions, need for support in activities of daily living, and a high risk of adverse outcomes.[9,10] Aging strategies have frequently called for robust and responsive primary care and home care to enable seniors to live well in the community as long as possible.[11,12] However, primary care use by home care patients has not been well studied.

The objective of this study was to describe the utilization of primary care physician services by publicly-funded home care patients in Ontario, including coordination between home care and primary care and advanced access to primary care such as home visits and afterhours/weekend care. I examined associations between patient characteristics and subsequent primary care use and also described the use of other health sectors to contextualize my findings.

Methods

Study Design and Data Sources

This study identified a population-based, retrospective cohort of adults in Ontario, Canada who received a comprehensive home care assessment and used multiple population-based health administrative databases to capture health system use following the assessment. Home care patients were identified through the Home Care Database, which captures client and service records for publicly-funded home care programs in Ontario. Physician visits were extracted from the Ontario Health Insurance Plan claims database, which contains information on inpatient and outpatient physician billings, including "shadow billings" for physicians in primarily capitated payment models. As the Home Care Database and the Ontario Health Insurance Plan database form the basis for payments to health care providers, they have good completion and are regularly used in research.[13] Other databases used include administrative records of hospitalizations, emergency department visits, and placement in long-term care homes. A description of all data sources can be found in Appendix 1. These datasets were linked using unique encoded identifiers and analyzed at ICES. This study was a granted an exemption of formal ethics review from the Hamilton Integrated Research Ethics Board as the use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board.

Study Cohort

Publicly-funded home care services are available in Ontario to individuals who require support to remain in their homes, typically seniors with functional impairments or other complex medical conditions.[14] All publicly-funded home care patients who are receiving on-going care are periodically assessed with the Resident Assessment Instrument for Home Care (RAI-HC), a comprehensive clinical assessment[15]. I selected all RAI-HC assessments of adult (19+), home care patients completed in Ontario between October 1, 2014 and September 30, 2016. If an individual was assessed more than once during the

period, their most recent assessment was selected. The assessment date was considered the index date for a six-month follow-up window. Patients receiving palliative home care at baseline were excluded from the cohort as their health utilization and outcomes vary greatly from other home care patients.

Baseline Characteristics

Patient characteristics were identified from the baseline assessment and included demographic, health and functional characteristics, frailty[10], health-related quality of life[16], and three key conditions known to be primary drivers of home care: congestive health failure, chronic obstructive pulmonary disease, and dementia.[17–19] Similar to other studies,[20] I also classified each patient's primary care enrollment model at baseline. The three main model types are: a) Family health teams, which are team-based, interprofessional primary health care organizations funded primarily through capitation payments; b) Other blended capitation models that are funded similarly but lack the explicit interprofessional approach; and c) Enhanced fee-for-service models which are funded primarily through billing claims. A few rural and specialty models were grouped together in an "Other" category and patients not rostered to a physician were considered a distinct category.

Primary care use among home care patients

I linked the index assessment records to other health administrative databases to identify health service use within six months (182 days) of the assessment date. A six-month follow-up was chosen as it aligns with the standard RAI-HC assessment interval and at least three-quarters of patients can be expected to experience a meaningful clinical change within six months.[21] Primary care physician visits were defined as all office, home, or phone-based services provided by a general practice/family practice physician or community medicine physician with a maximum of one visit per patient per physician per day. I identified primary care coordination with home care using billing codes specific to primary care supervision of home care or participation of a primary care physician in a case conference concerning a

home care patient. For measures of advanced access, I identified primary care physician visits to a patient's home and primary care visits that occurred afterhours or on a weekend or holiday. Details of the calculation of each physician measure can be found in Appendix 2.

Other health system use among home care patients

To contextualize the primary care use, I also measured other health sector use of patients and their transitions between care settings. Specialist physician visits were defined similarly to primary care and included all physicians other than general practice/family practice, community medicine, and pediatrics. Home care use was measured as hours of personal support and number of home nursing visits. Other measures included: unplanned emergency department visits, unplanned acute hospital admissions, long-term care home admission, and death. I also tracked the care setting of the patient (community, hospital, long-term care, dead) across the six-month follow-up period and calculated the total number of transitions in care settings.

Descriptive analysis

I reported the proportion of patients with each type of primary care physician visit, the rate of primary care physician visits per month, the proportion of patients with any specialist physician visit, the average number of specialties seen, and the rate of specialist physician visits per month. I also reported the proportion of patients who received or were authorized at baseline for personal support and home nursing as well as the rate of visits/hours per month among patients with the service. Other measures reported included the proportion of patients with an unscheduled emergency department visit, acute hospital admission, and long-term care home admission, the rate of emergency department visits per month, the number of transitions of care settings, and the proportion of patients who died during the follow-up window.

All rates were based on the number of days during follow-up that the patient spent in the community, i.e. not dead, in a long-term care home, or in hospital. The calculation of home care rates excluded any days after home care services were discharged. Monthly rates were produced by multiplying the daily rate by 30. Additionally, the proportion of patients who received a primary care physician home visit was reported by functional impairment strata and I stratified the proportion of patients with primary care coordination with home care by Ontario's 14 health regions to explore variation in the rates based on regional initiatives to promote coordination. All descriptive measures were reported both for the entire cohort as well as the important subpopulations with congestive heart failure, chronic obstructive pulmonary disease, and dementia.

Multivariable analysis

I fit multivariable regression models to examine associations between patient characteristics and four measures of primary care use. The rate of primary care physician visits was fit with a quasi-poisson generalized linear model[22] with an offset term for days spent in the community. Primary care coordination with home care, primary care physician home visits, and primary care physician afterhours/weekend visits were each separately fit with logistic regression models. I included independent variables that I believed may be associated with primary care utilization based on previous research and my own judgement.[23,24] These included demographics (sex, age, region, rurality), health characteristics (functional impairment, cognitive impairment, mood symptoms, comorbid conditions, number of concurrent medications), and health services (primary care patient enrollment model type, home care services received or authorized at baseline). Results were reported as incidence rate ratios (IRR) or odds ratios(OR) with 95% confidence intervals. All analyses were performed using SAS 9.4.

Results

My cohort identified 226,054 adult home care patients with an assessment between October 1, 2014 and September 30, 2016. The median age of patients in the cohort was 81 years and just under two-thirds (63%) were female (Table 1). Over 40% of patients needed at least limited assistance with personal hygiene, locomotion, eating, or toileting, and over 60% had at least a mild cognitive impairment. Around 13% of patients had a diagnosis of congestive heart failure at baseline, 20% had chronic obstructive pulmonary disease, and 25% had a diagnosis of dementia. Roughly 30% of patients were enrolled in each of the three broad types of primary care patient enrollment models at baseline. Transitions between care settings across the follow-up period were common (Figure 1). At the end of six months, 71% of the patients were still living in the community, 13% were in long-term care homes, 4% were in hospitals, and 13% had died.

Primary care use among home care patients

The overall primary care physician visit rate during the follow-up period was 0.78 visits per month (Table 2), with 84% of patients having at least one visit during the follow-up period. Primary care coordination with home care codes were billed for 3.9% of patients. Primary care physician home visits were received by 13.1% of patients and 15.1% of patients used after hours/weekend primary care. Patients with congestive health failure and chronic obstructive pulmonary disease had somewhat higher primary care use than the overall population. Among the most functionally impaired patients, just over one-quarter (27.5%) received a primary care physician home visit (Table 3). Stratifying primary care coordination with home care by health regions revealed significant regional variation in the use of the codes, particularly in the differential between family health teams and other patient enrollment models (Appendix 3).

Other health system use among home care patients

Around three-quarters of patients (71.8%) received personal support while just over a third received home nursing (35.7%). Nearly half of patients (46.9%) visited the emergency department and over a quarter (27.2%) had an unplanned hospital admission across the six-month follow-up. Patients with congestive heart failure or chronic obstructive pulmonary disease had higher rates of emergency department visits, hospitalizations, and death. Patients with dementia had similar emergency department and hospital utilization as the overall population but were significantly more likely to be admitted to a long-term care home.

Multivariable analysis

Given the number of associations examined and the power of the study to detect small effects, only statistically significant IRRs and ORs with point estimates greater than 1.25 or less than 0.8 are reported in the text. All results can be found in the tables.

Rate of primary care physician visits

Receiving home care nursing (IRR: 1.34 (1.31-1.36)) and having 9 or more prescription medications at baseline (IRR: 1.38 (1.34-1.42) was associated with greater primary care use (Table 4). Compared to enhanced fee-for-service models, patients enrolled in family health teams (IRR: 0.77 (0.76-0.79), other capitated models (IRR: 0.80 (0.78-0.82), other models (IRR: 0.66 (0.62-0.71) and patients not rostered to a physician (IRR 0.79 (0.75-0.83) used less primary care.

Primary care coordination with home care

Residing in southern Ontario (OR: 1.41 (1.34, 1.48), being enrolled in a family health team (OR: 2.73 (2.57, 2.90) and receiving home care nursing (OR 3.21 (3.07, 3.36) all increased the likelihood of primary

care coordination with home care (Table 5). Patients not rostered to a physician (OR: 0.66 (0.55, 0.79) were less likely to have coordination.

Primary care physician home visits

Patients in their 60's (OR 1.34 (1.25, 1.44), 70's, (OR 1.80 (1.69, 1.92), 80's (OR: 2.63 (2.47, 2.79), and 90 years of age and greater (OR: 3.89 (3.65, 4.14) were all more likely to receive a primary care home visit than younger patients (Table 6). Both personal support (OR: 1.46 (1.41, 1.51)) and home nursing (OR: 2.02, 2.13) were also associated with a greater likelihood of a primary care home visit, as was mild/moderate (OR: 1.39 (1.35, 1.43) and severe (OR: 2.69 (2.59 – 2.80) functional impairments.

Afterhours/weekend primary care visits

Patients living in eastern (OR: 0.55 (0.53, 0.58) or northern Ontario (OR: 0.50 (0.47, 0.53) or in rural locations (OR: 0.63 (0.60, 0.65) were less likely to use afterhours primary care (Table 7). Compared to enhanced fee-for-service models, enrollment in family health teams (OR: 0.40 (0.39-0.41), other capitated models (RR: 0.64 (0.63, 0.66), other models (OR: 0.32 (0.28-0.37) or not being rostered to a physician (OR 0.44 (0.41-0.47) reduced the likelihood of an afterhours visit. Patients with severe functional impairments (OR: 1.27 (1.22, 1.32) were more likely to use afterhours care while patients with dementia (OR 0.80 (0.78-0.83) were less likely.

Interpretation

Main Findings

Publicly-funded home care patients with continuing care needs frequently utilized primary care and other health services within six months of assessment. Nearly all the patients visited a primary care physician at least once, however just under 4% had a billing for home care coordination, 13% had a primary care physician home visit, and 15% used primary care afterhours or on a weekend or holiday. Coordination codes were more common in interprofessional primary care practices while afterhours

care was more prevalent in non-capitated practices. Physician home visits were more likely to be received by the oldest and most functionally impaired patients.

Explanation and comparison with other studies

A previous study with similar primary care definitions reported a primary care physician visit rate of 0.52 visits per month among all older adults in Ontario.[25] Comparing this to the 0.78 visits per month observed in this study suggests that home care patients had around 50% higher primary care use than a general older adult population. Comparisons to the same study also suggest home care patients had twice the specialist physician use and 3.5 times the emergency department visits of an older adult population. However, the billing codes specific to primary care coordination with home care were rarely used. This could suggest low levels of coordination possibly due to noted difficulties in communication and lack of integration between home care and primary care.[26] It may also be the result of lack of awareness of the codes or a sense that the codes are not worth the effort of claiming. Family health teams were considerably more likely than other enrollment models to bill the coordination codes, which could be due to their interprofessional orientation, or that regional planning organizations specifically target family health teams in initiatives to promote coordination.

Older patients with severe functional impairments were much more likely to receive a primary care home visit than those without impairments, which suggests physician home visits are responsive to the functional needs of patients. The proportion of home care patients with severe functional impairments who received a physician home visit (27.5%), is similar to the proportion of palliative patients in Ontario reported to have received a physician home visit in the last six months of life (22%).[27] Historically part of general practice, physician home visits in Canada have become more frequent recently after falling in previous decades.[28–31] Finally, home care patients enrolled in non-capitated primary care models were considerably more likely than those enrolled in capitation-based models to use afterhours or weekend

primary care. This effect has been previously noted, including in a study done in 2005-2006, shortly after the implementation of the first capitation models in Ontario.[32] My results suggest that the effect has persisted over time and that primary care model types may be influencing access to afterhours care.

Limitations

My study has a number of strengths, including having a large, population-based sample and ability to measure health service use across multiple sectors. There are also some important limitations. Despite the rich clinical data available in my index assessment, I am not able to determine the specific clinical reason(s) a patient is receiving home care or the focus of coordination between primary care and home care. The degree to which my billing code-based measure of coordination between primary care and home care underrepresents the true level of coordination cannot be ascertained by this study and would require qualitative, primary data collection. Given the overall low prevalence of the codes and the low likelihood that these codes would be billed in the absence of coordination, misclassification of coordination would likely move in the direction of reducing sensitivity while maintaining a high specificity and positive predictive value. Finally, findings around Ontario-specific primary care models or billing codes may have lower generalizability.

Conclusion and implications for practice and future research

I found that home care patients with continuing care needs in Ontario frequently visited a primary care physician. Billing codes specific to coordination between primary care and home care were rarely utilized, although this may underrepresent the true level of coordination, but were more common in interprofessional primary care practices. Physician home visits were more likely to be received by the oldest and most functionally impaired patients, suggesting responsiveness to patient needs. Afterhours primary care was more commonly received among patients enrolled in non-capitated primary care models, suggesting models of physician payment may be impacting access to afterhours care. These

findings provide important insight on the primary care use of home care patients and can inform future research on how patterns of primary care and home care can influence the health outcomes of home care patients.

Table and Figures

Figure 1: Transitions between care settings, adult home care patients, Ontario, September 2014 to October 2016. Note LTC = long-term care home.

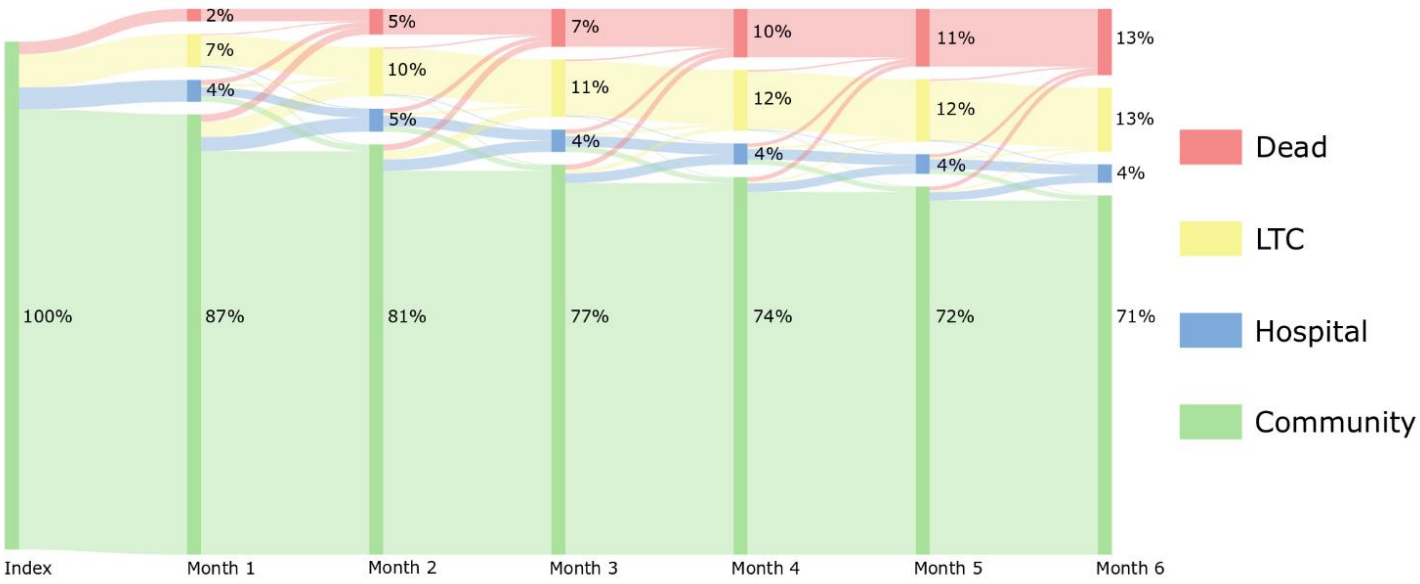

Table 1: Baseline characteristics of adult home care patients in Ontario, September 2014 to October 2016

Patient Characteristics	No. (%) of patients n=226,054
Demographics	
Age, yrs (Median (Q1-Q3))	81 (71-88)
Sex, female	83978 (62.9)
Lived Alone	110137 (48.7)
Health	
Activities of Daily Living (ADL) impairment[1]	
Independent/Supervision	127725 (56.5)
Limited/Extensive	72220 (32.0)
Maximal/ Dependent	26109 (11.6)
Cognitive impairment[2]	
Intact / Borderline intact	85613 (37.9)
Mild / Moderate	121081 (53.6)
Severe	19360 (8.6)
Mood symptoms[3]	
No symptoms	108918 (48.2)
Some symptoms	59684 (26.4)
Daily symptoms	57452 (25.4)
Bladder incontinence	94535 (41.8)
Fall in last 90 days	91962 (40.7)
Five or more concurrent medications	189760 (83.9)
Congestive heart failure	29875 (13.2)
Chronic obstructive pulmonary disease	44209 (19.6)
Dementia	58413 (25.8)
Frailty Index[4]	
Robust (0-0.19)	46043 (20.4)
Pre-frail (0.2-0.29)	68562 (30.3)
Frail (>= 0.3)	111449 (49.3)
Health-related quality of life (Median (Q1-Q3))[5]	0.19 (-0.01-0.42)
Patient Enrollment Model Type	
Enhanced fee-for-service	73150 (28.7)
Family health team	75031 (32.4)
Other capitation	64908 (33.2)
Other	8403 (2.0)
Not enrolled	4562 (3.7)

1 ADL Hierarchy Scale: Includes personal hygiene, locomotion, eating and toileting

2 Cognitive Performance Scale

3 Depression Rating Scale

4. Campitelli et al. (2016). Ranges from 0-1.

5 HUI3 scores are based on a scale where 1 represents perfect health and 0 represents dead The range of the values is -0.36 to 1 with scores less than 0 representing states worse than dead

Table 2: Primary care physician and other health system use by adult home care patients in Ontario, September 2014 to October 2016

Health Utilization Measure	All n=226,054	Chronic Conditions		
		Heart Failure n=29,875	COPD n=44,209	Dementia n=58,413
Primary Care				
Any primary care physician visit (%)	190777 (84.4)	25596 (85.7)	37867 (85.7)	47872 (82.0)
Rate of primary care physician visits per month	0.78	0.94	0.86	0.79
Any primary care coordination with home care (%)	8918 (3.9)	1509 (5.1)	2079 (4.7)	2048 (3.5)
Any primary care physician home visit (%)	29532 (13.1)	4873 (16.3)	5953 (13.5)	8623 (14.8)
Any afterhours/weekend primary care visit (%)	34071 (15.1)	4542 (15.2)	6705 (15.2)	7690 (13.2)
Other Health Sectors				
Any specialist physician visit (%)	154007 (68.1)	21163 (70.8)	31109 (70.4)	32433 (55.5)
Rate of specialist visits per month	0.60	0.70	0.64	0.42
Average count of specialties seen	1.50	1.64	1.62	1.00
Any personal support (%)	162276 (71.8)	23213 (77.7)	32643 (73.8)	45845 (78.5)
Any home nursing (%)	80636 (35.7)	13836 (46.3)	18334 (41.5)	14284 (24.5)
Rate of personal support hours per month	22.3	23.4	20.4	29.3
Rate of home nursing visits per month	6.8	6.3	6.1	5.1
Any emergency department visit (%)	105909 (46.9)	17461 (58.4)	24316 (55.0)	27263 (46.7)
Any acute care hospitalization (%)	61598 (27.2)	12011 (40.2)	15148 (34.3)	16154 (27.7)
Long-term care home admission (%)	35484 (15.7)	4631 (15.5)	5909 (13.4)	19896 (34.1)
Death (%)	29843 (13.2)	6930 (23.2)	7633 (17.3)	8577 (14.7)
Rate of emergency department visits per month	0.17	0.25	0.23	0.15
Transitions of care settings (%)[1]				
0	136627 (60.4)	14923 (50.0)	24876 (56.3)	27728 (47.5)
1-2	64222 (28.4)	10053 (33.7)	12980 (29.4)	23792 (40.7)
3+	25205 (11.2)	4900 (16.4)	6353 (14.4)	6893 (11.8)

1 Includes transfers between any of the following: community, acute hospital, rehab hospital, mental health hospital, continuing care hospital, or long-term care home

Table 3: Receipt of home visits from a primary care physician, by functional impairment stratum

ADL Impairment	n	Primary care physician home visit n (%)
Independent/Supervision	127725	11883 (9.3)
Limited/Extensive	72220	10471 (14.5)
Maximal/ Dependent	26109	7178 (27.5)

Table 4: Multivariable quasi-poisson regression of primary care physician visits

Variable		n	Unadjusted		Adjusted	
			Incidence Rate Ratio	95% CI	Incidence Rate Ratio	95% CI
Sex	Female	83978	0.97	(0.96, 0.99)	0.97	(0.95, 0.98)
Age	19-59	23520	(ref)	(ref)	(ref)	(ref)
	60-69	25957	1.07	(1.03, 1.11)	1.02	(0.98, 1.05)
	70-79	47410	1.11	(1.07, 1.15)	1.08	(1.05, 1.12)
	80-89	86717	1.14	(1.10, 1.17)	1.15	(1.11, 1.18)
	90+	42450	1.17	(1.13, 1.21)	1.20	(1.16, 1.25)
Region[1]	Central	93217	(ref)	(ref)	(ref)	(ref)
	East	42276	0.94	(0.91, 0.96)	0.96	(0.94, 0.99)
	North	19392	0.82	(0.79, 0.85)	0.84	(0.81, 0.87)
	South	71169	1.09	(1.06, 1.11)	1.07	(1.05, 1.09)
Rurality[2]	Rural	30584	0.88	(0.86, 0.91)	0.96	(0.94, 0.99)
Patient enrollment model type[3]	Enhanced fee-for-service	73150	(ref)	(ref)	(ref)	(ref)
	Family health team	75031	0.78	(0.76, 0.79)	0.77	(0.76, 0.79)
	Other capitation	64908	0.81	(0.79, 0.82)	0.80	(0.78, 0.82)
	Other	8403	0.60	(0.56, 0.65)	0.66	(0.62, 0.71)
	Not enrolled	4562	0.77	(0.73, 0.81)	0.79	(0.75, 0.83)
Home care services	Personal support	162276	1.00	(0.89, 1.02)	0.98	(0.96, 1.00)
	Nursing	80636	1.33	(1.31, 1.35)	1.34	(1.31, 1.36)
Function	Independent/Supervision	127725	(ref)	(ref)	(ref)	(ref)
	Mild/Moderate impairment	72220	1.05	(1.03, 1.07)	1.01	(0.99, 1.03)
	Severe impairment	26109	1.15	(1.12, 1.19)	1.05	(1.02, 1.08)
Cognition	Independent/Supervision	85613	(ref)	(ref)	(ref)	(ref)
	Mild/Moderate impairment	121081	1.01	(0.99, 1.03)	0.98	(0.97, 1.00)
	Severe impairment	19360	1.00	(0.96, 1.04)	0.97	(0.93, 1.01)
Mood	No symptoms	108918	(ref)	(ref)	(ref)	(ref)
	Some symptoms	59684	1.11	(1.09, 1.13)	1.10	(1.08, 1.13)
	Daily symptoms	57452	1.23	(1.20, 1.25)	1.22	(1.19, 1.24)
	Congestive health failure	29875	1.24	(1.21, 1.27)	1.12	(1.09, 1.14)

Chronic conditions	Chronic obstructive pulmonary disease	44209	1.14	(1.11, 1.16)	1.07	(1.05, 1.09)
	Dementia	58413	1.02	(0.99, 1.04)	1.04	(1.02, 1.07)
Number of medications	0-4	36294	(ref)	(ref)	(ref)	(ref)
	5-8	70698	1.21	(1.17, 1.24)	1.17	(1.14, 1.21)
	9+	119062	1.45	(1.41, 1.49)	1.38	(1.34, 1.42)

1: Region is defined by the first letter of a postal code: P - North, K - East, M,N - Central, L - South

2: Rural is defined as having a postal code with a Rurality Index of Ontario 2008 score >= 40

3: EFS - Enhanced fee-for-service, FHT - Family Health Team

Table 5: Multivariable logistic regression of primary care coordination with home care

Variable		n	Unadjusted		Adjusted	
			Odds Ratio	95% CI	Odds Ratio	95% CI
Sex	Female	83978	0.92	(0.88, 0.96)	1.01	(0.96, 1.06)
Age	19-59	23520	(ref)	(ref)	(ref)	(ref)
	60-69	25957	1.03	(0.94, 1.12)	0.94	(0.86, 1.03)
	70-79	47410	1.02	(0.94, 1.10)	1.01	(0.93, 1.10)
	80-89	86717	0.94	(0.88, 1.02)	1.02	(0.95, 1.11)
	90+	42450	0.93	(0.86, 1.01)	1.02	(0.93, 1.12)
Region[1]	Central	93217	(ref)	(ref)	(ref)	(ref)
	East	42276	1.07	(1.01, 1.14)	0.95	(0.89, 1.01)
	North	19392	1.23	(1.14, 1.33)	1.11	(1.02, 1.20)
	South	71169	1.38	(1.31, 1.45)	1.41	(1.34, 1.48)
Rurality[2]	Rural	30584	1.29	(1.22, 1.37)	1.06	(1.00, 1.13)
Patient enrollment model type[3]	Enhanced fee-for-service	73150	(ref)	(ref)	(ref)	(ref)
	Family health team	75031	2.81	(2.66, 2.98)	2.73	(2.57, 2.90)
	Other capitation	64908	1.23	(1.16, 1.32)	1.24	(1.16, 1.32)
	Other	8403	0.90	(0.74, 1.10)	0.87	(0.70, 1.07)
	Not enrolled	4562	0.66	(0.55, 0.79)	0.66	(0.55, 0.79)
Home care services	Personal support	162276	1.01	(0.97, 1.06)	1.18	(1.12, 1.25)
	Nursing	80636	3.18	(3.04, 3.32)	3.21	(3.07, 3.36)
Function	Independent/Supervision	127725	(ref)	(ref)	(ref)	(ref)
	Mild/Moderate impairment	72220	1.11	(1.06, 1.16)	1.06	(1.01, 1.12)
	Severe impairment	26109	1.27	(1.19, 1.35)	1.06	(0.98, 1.14)
Cognition	Independent/Supervision	85613	(ref)	(ref)	(ref)	(ref)
	Mild/Moderate impairment	121081	0.88	(0.84, 0.92)	0.94	(0.90, 0.99)
	Severe impairment	19360	0.90	(0.83, 0.97)	1.00	(0.91, 1.09)
Mood	No symptoms	108918	(ref)	(ref)	(ref)	(ref)
	Some symptoms	59684	1.13	(1.07, 1.19)	1.12	(1.06, 1.18)
	Daily symptoms	57452	1.19	(1.13, 1.25)	1.17	(1.11, 1.24)

Chronic conditions	Congestive health failure	29875	1.36	(1.28, 1.44)	1.08	(1.01, 1.14)
	Chronic obstructive pulmonary disease	44209	1.26	(1.20, 1.33)	1.06	(1.04, 1.12)
	Dementia	58413	0.85	(0.81, 0.89)	0.99	(0.93, 1.05)
Number of medications	0-4	36294	(ref)	(ref)	(ref)	(ref)
	5-8	70698	1.12	(1.04, 1.20)	1.06	(0.98, 1.13)
	9+	119062	1.46	(1.36, 1.56)	1.21	(1.13, 1.29)

1: Region is defined by the first letter of a postal code: P - North, K - East, M,N - Central, L - South

2: Rural is defined as having a postal code with a Rurality Index of Ontario 2008 score >= 40

3: EFS - Enhanced fee-for-service, FHT - Family Health Team

Table 6: Multivariable logistic regression of home visits from primary care physicians

Variable		n	Unadjusted		Adjusted	
			Odds Ratio	95% CI	Odds Ratio	95% CI
Sex	Female	83978	1.06	(1.04, 1.09)	1.05	(1.02, 1.08)
Age	19-59	23520	(ref)	(ref)	(ref)	(ref)
	60-69	25957	1.29	(1.21, 1.39)	1.34	(1.25, 1.44)
	70-79	47410	1.73	(1.63, 1.84)	1.80	(1.69, 1.92)
	80-89	86717	2.50	(2.37, 2.65)	2.63	(2.47, 2.79)
	90+	42450	3.94	(3.71, 4.17)	3.89	(3.65, 4.14)
Region[1]	Central	93217	(ref)	(ref)	(ref)	(ref)
	East	42276	0.76	(0.73, 0.79)	0.82	(0.79, 0.85)
	North	19392	0.54	(0.51, 0.57)	0.61	(0.58, 0.65)
	South	71169	1.03	(1.00, 1.06)	1.00	(0.97, 1.03)
Rurality[2]	Rural	30584	0.74	(0.71, 0.77)	0.88	(0.84, 0.92)
Patient enrollment model type[3]	Enhanced fee-for-service	73150	(ref)	(ref)	(ref)	(ref)
	Family health team	75031	0.75	(0.72, 0.77)	0.78	(0.76, 0.81)
	Other capitation	64908	0.84	(0.81, 0.86)	0.81	(0.79, 0.84)
	Other	8403	0.79	(0.72, 0.86)	1.03	(0.93, 1.14)
	Not enrolled	4562	1.00	(0.94, 1.07)	1.03	(0.96, 1.10)
Home care services	Personal support	162276	1.94	(1.88, 2.00)	1.46	(1.41, 1.51)
	Nursing	80636	1.84	(1.79, 1.88)	2.08	(2.02, 2.13)
Function	Independent/Supervision	127725	(ref)	(ref)	(ref)	(ref)
	Mild/Moderate impairment	72220	1.65	(1.61, 1.70)	1.39	(1.35, 1.43)
	Severe impairment	26109	3.70	(3.58, 3.82)	2.69	(2.59, 2.80)
Cognition	Independent/Supervision	85613	(ref)	(ref)	(ref)	(ref)
	Mild/Moderate impairment	121081	1.40	(1.36, 1.44)	1.09	(1.06, 1.13)
	Severe impairment	19360	2.06	(1.97, 2.14)	1.15	(1.10, 1.22)
Mood	No symptoms	108918	(ref)	(ref)	(ref)	(ref)
	Some symptoms	59684	1.02	(0.99,1.05)	1.02	(0.99, 1.06)
	Daily symptoms	57452	1.10	(1.06, 1.13)	1.10	(1.07, 1.14)
	Congestive health failure	29875	1.36	(1.31, 1.40)	1.03	(0.99, 1.07)

Chronic conditions	Chronic obstructive pulmonary disease	44209	1.04	(1.01, 1.08)	1.08	(1.04, 1.12)
	Dementia	58413	1.22	(1.18, 1.25)	0.91	(0.88, 0.94)
Number of medications	0-4	36294	(ref)	(ref)	(ref)	(ref)
	5-8	70698	1.19	(1.14, 1.23)	1.06	(1.02, 1.10)
	9+	119062	1.38	(1.33, 1.43)	1.16	(1.11, 1.21)

1: Region is defined by the first letter of a postal code: P - North, K - East, M,N - Central, L - South

2: Rural is defined as having a postal code with a Rurality Index of Ontario 2008 score >= 40

3: EFS - Enhanced fee-for-service, FHT - Family Health Team

Table 7: Multivariable logistic regression of primary care visits after hours and on weekends or holidays

Variable		n	Unadjusted		Adjusted	
			Odds Ratio	95% CI	Odds Ratio	95% CI
Sex	Female	83978	1.09	(1.06, 1.11)	1.08	(1.04, 1.1)
Age	19-59	23520	(ref)	(ref)	(ref)	(ref)
	60-69	25957	0.95	(0.90, 1.00)	0.91	(0.86, 0.95)
	70-79	47410	1.00	(0.96, 1.05)	0.98	(0.94, 1.03)
	80-89	86717	1.02	(0.98, 1.06)	1.00	(0.96, 1.05)
	90+	42450	1.01	(0.97, 1.06)	1.00	(0.95, 1.05)
Region[1]	Central	93217	(ref)	(ref)	(ref)	(ref)
	East	42276	0.48	(0.46, 0.50)	0.55	(0.53, 0.57)
	North	19392	0.41	(0.39, 0.43)	0.50	(0.47, 0.53)
	South	71169	1.13	(1.10, 1.16)	1.10	(1.07, 1.13)
Rurality[2]	Rural	30584	0.45	(0.43, 0.47)	0.63	(0.60, 0.65)
Patient enrollment model type	Enhanced fee-for-service	73150	(ref)	(ref)	(ref)	(ref)
	Family health team	75031	0.35	(0.34, 0.36)	0.40	(0.39, 0.41)
	Other capitation	64908	0.62	(0.60, 0.64)	0.64	(0.63, 0.66)
	Other	8403	0.22	(0.19, 0.25)	0.32	(0.28, 0.37)
	Not enrolled	4562	0.41	(0.38, 0.44)	0.44	(0.41, 0.47)
Home care services	Personal support	162276	1.19	(1.16, 1.23)	1.12	(1.09, 1.15)
	Nursing	80636	1.14	(1.12, 1.17)	1.22	(1.19, 1.26)
Function	Independent/Supervision	127725	(ref)	(ref)	(ref)	(ref)
	Mild/Moderate impairment	72220	1.05	(1.03, 1.08)	1.00	(0.97, 1.03)
	Severe impairment	26109	1.48	(1.43, 1.53)	1.27	(1.22, 1.32)
Cognition	Independent/Supervision	85613	(ref)	(ref)	(ref)	(ref)
	Mild/Moderate impairment	121081	0.91	(0.89, 0.93)	0.95	(0.93, 0.98)
	Severe impairment	19360	1.04	(1.00, 1.09)	1.05	(0.99, 1.10)
Mood	No symptoms	108918	(ref)	(ref)	(ref)	(ref)
	Some symptoms	59684	1.04	(1.02, 1.07)	1.05	(1.02, 1.08)
	Daily symptoms	57452	1.13	(1.10, 1.16)	1.12	(1.09, 1.16)
	Congestive health failure	29875	1.01	(0.98, 1.05)	0.97	(0.93, 1.00)

Chronic conditions	Chronic obstructive pulmonary disease	44209	1.01	(0.89, 1.04)	1.05	(1.02, 1.08)
	Dementia	58413	0.81	(0.79, 0.83)	0.80	(0.78, 0.83)
Number of medications	0-4	36294	(ref)	(ref)	(ref)	(ref)
	5-8	70698	1.10	(1.07, 1.15)	1.11	(1.07, 1.16)
	9+	119062	1.17	(1.13, 1.21)	1.18	(1.14, 1.23)

1: Region is defined by the first letter of a postal code: P - North, K - East, M,N - Central, L - South

2: Rural is defined as having a postal code with a Rurality Index of Ontario 2008 score >= 40

3: EFS - Enhanced fee-for-service, FHT - Family Health Team

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Appendices

Appendix 1: Databases used in the study

ICES Databases	Description
Discharge Abstract Database(DAD)	The DAD is compiled by the Canadian Institute for Health Information and contains administrative, clinical (diagnoses and procedures/interventions), demographic, and administrative information for all admissions to acute care hospitals, rehab, chronic, and day surgery institutions in Ontario. At ICES, consecutive DAD records are linked together to form 'episodes of care' among the hospitals to which patients have been transferred after their initial admission.
Ontario Health Insurance Policy Claims (OHIP)	The OHIP claims database contains information on inpatient and outpatient services provided to Ontario residents eligible for the province's publicly funded health insurance system by fee-for-service health care practitioners (primarily physicians) and "shadow billings" for those paid through non-fee-for-service payment plans. The main data elements include patient and physician identifiers (encrypted), code for service provided, date of service, associated diagnosis, and fee paid.
National Ambulatory Care Reporting System (NACRS)	The NACRS is compiled by the Canadian Institute for Health Information and contains administrative, clinical (diagnoses and procedures), demographic, and administrative information for all patient visits made to hospital- and community-based ambulatory care centres (emergency departments, day surgery units, hemodialysis units, and cancer care clinics). At ICES, NACRS records are linked with other data sources (DAD, OMHRS) to identify transitions to other care settings, such as inpatient acute care or psychiatric care.
Home care Database(HCD)	The HCD is a clinical client centric database that captures all services that are provided by or coordinated by Community Care Access Centres (CCACs). The data elements captured include information on: client, intake, assessment, admission & discharge, diagnosis and surgical procedure, and care delivery. ICES receives home care data from the Ontario Ministry of Health and Long-Term Care (MOHLTC). The primary purpose of the information collected through the HCD is to aid in planning and better clinical insight into clients who encounter service through CCACs.
Resident Assessment Instrument (RAI)-Home care source (OACCAC)	The RAIHC database is managed by the Community Care Access Centres (CCACs) and is a standardized clinical assessment to all long-stay home care clients in Ontario defined as clients receiving ongoing support for at least 60 consecutive days. Data collected include comprehensive clinical, functional and resource utilization information that are used to inform client needs. When used over time, it provides the basis for an outcome-based assessment of the person's response to care or services.
Ontario Mental Health Reporting System (OMHRS)	The OMHRS is compiled by the Canadian Institute for Health Information and contains administrative, clinical (diagnoses and procedures), demographic, and administrative information for all admissions to adult designated inpatient mental health beds. This includes beds in general hospitals, provincial psychiatric facilities, and specialty psychiatric facilities. Clinical assessment data is ascertained using the Resident Assessment Instrument for Mental Health (RAI-MH), but different amounts of information are collected using this instrument depending on the length of stay in the mental health bed. Multiple assessments may occur during the length of a mental health admission.

National Rehabilitation Reporting System(NRS)	The NRS is compiled by the Canadian Institute for Health Information and contains client data collected from participating adult inpatient rehabilitation facilities and programs across Canada. Main data elements contain socio-demographic information, administrative data (e.g. referral, admission and discharge), health characteristics, activities and participation (e.g. ADL, communication, social interaction), and interventions.
Continuing Care Reporting System(CCRS)	The CCRS database is compiled by the Canadian Institute for Health Information and contains demographic, clinical, functional, and resource utilization information for individuals receiving facility-based continuing care (also known as extended, auxiliary, or complex chronic care) in Ontario hospitals and residential care providing 24 hour nursing services (i.e. nursing home). Clinical assessment data (on the physical, functional, cognitive, and social domains of health) is ascertained using the Resident Assessment Instrument Minimum Data Set (RAI-MDS) version 2.0 which is administered by trained healthcare professionals.
The Corporate Provider Database (CPDB)	The Corporate Provider Database (CPDB) contains information on all physician and some non-physician (such as chiropractors, physiotherapists, and optometrist) providers funded by the Ministry, either through OHIP or other funding arrangements. The data includes demographic, eligibility, specialty, practice location, (encrypted) provider billing number, limited demographic information (year of birth, gender, year of graduation, specialty, and location of practice).
Registered Persons Database(RPDB)	The RPDB provides basic demographic information (age, sex, location of residence, date of birth, and date of death for deceased individuals) for those issued an Ontario health insurance number. The RPDB also indicates the time periods for which an individual was eligible to receive publicly funded health insurance benefits and the best known postal code for each registrant on July 1st of each year.

Appendix 2: Definitions of physician utilization measures

Measure	**Database**	**Field**	**Values**
PCP Visit	OHIP	Spec	00 - FP/GP
			05 - Community Medicine
	OHIP	Feecode	Any feecode with location of Office, Home, or Phone
			G202
			G212
			G372
			G373
			G365
			G538
			G539
			G590
			G591
PCP coordination with home care	OHIP	Spec	00 - FP/GP
			05 - Community Medicine

	OHIP	Feecode	K071
			K072
			K124
PCP home visit	OHIP	Spec	00 - FP/GP
			05 - Community Medicine
	OHIP	Feecode	A900
			A901
			B960
			B961
			B962
			B963
			B964
			B966
			B990
			B992
			B993
			B994
			B996
			B997
			B998
PCP afterhours/ weekend visit	OHIP	Spec	00 - FP/GP
			05 - Community Medicine
	OHIP	Feecode	Q012
			Q016
			Q017
			B962
			B963
			B964
			B994
			B993
			B996
			A962
			A963
			A964
			A994
			A998
			A996
			A888
Physician specialist visits	OHIP	Spec	**Not** 00 - FP/GP, 05 - Community Medicine, or 26 - Pediatrics
	OHIP	Feecode	Any feecode with location of Office, Home, or Phone

Note: Visits were limited to 1 per patient per physician per day

Note: Visits were excluded if patient was in LTCH at time of billing

Appendix 3. Proportion of patients with a primary care coordination with home care billing code by LHIN and FHT vs. non-FHT

	Primary care - home care coordination (%)	
LHIN	**FHT**	**non-FHT**
Erie St. Clair	3.7	3.7
South West	6.6	6.2
Waterloo Wellington	5.3	1.5
Hamilton Niagara Haldimand Brant	12.5	3.2
Central West	23.1	6.2
Mississauga Halton	1.7	1.7
Toronto Central	3.0	2.3
Central	3.5	2.4
Central East	3.0	1.7
South East	12.6	3.7
Champlain	2.4	1.1
North Simcoe Muskoka	4.8	2.6
North East	4.0	4.2
North West	9.0	1.2

Chapter 3: Access to afterhours primary care as an effect modifier of the relationship between same-day emergency visits and home nursing visits

Summary:

This chapter contains the first of three studies investigating the associations between selected measures of primary care use and/or delivery and subsequent visits to the emergency department. In particular, chapter 3 focuses on access to afterhours primary care, operationalized on the patient and practice level. This study builds on previous work showing that home care patients were more likely to visit the emergency department afterhours on the same day they received a home nursing visit. I replicated the case-crossover design of the previous study and incorporated access to afterhours care into it as an effect modifier to see whether greater access to afterhours primary care could reduce the likelihood of a same-day emergency department visit.

I found that patients with a history of afterhours primary care use were at a reduced risk of same-day less urgent emergency department visits following home care nursing visits. This finding contributes evidence to the frequently conflicted literature on the ability of afterhours primary care to reduce emergency visits. In particular, this study is novel in that it tests access to afterhours primary care as an effect modifier within a specific situation particularly relevant to home care patients, and does so using a study design that is more resistant to confounding than traditional cross-sectional or cohort studies.

Citation:

Jones A, Bronskill SE, Schumacher C, Seow H, Feeny D, Costa AP. Access to afterhours primary care as an effect modifier of the relationship between same-day emergency visits and home nursing visits. *The Annals of Family Medicine*. (In Press) (Accepted February 5th, 2020)

Abstract

Purpose

Previous work has demonstrated that home care patients have an increased risk of visiting the emergency department afterhours on the same day as a home nursing visit. I investigated whether this association is modified by greater access to afterhours primary care.

Methods

I conducted a population-based case-crossover study among home care patients in Ontario, Canada between 2014 and 2016. Emergency department visits after 5pm were selected as case periods and matched, within the same patient, to control periods within the previous week. The association between home nursing visits and same-day emergency department visits was estimated with conditional logistic regression. Access to afterhours primary care measured on the patient and practice-level was tested for effect modification using an interaction term approach. Analysis was performed separately for all emergency department visits and a less urgent subset not admitted to hospital.

Results

11,840 patients contributed cases to the analysis. Patients with a history of afterhours primary care use had a smaller increased risk of a same-day afterhours emergency department visit (OR: 1.18, 95% CI 1.06 - 1.30) compared to patients with no afterhours care (OR: 1.31, 95% 1.25- 1.39). The modifying effect was stronger among emergency department visits not admitted to hospital (OR: 1.11, 95% CI 0.97 - 1.28; vs. OR 1.41, 95% 1.31- 1.51).

Conclusion

Greater access to afterhours primary care reduced the increased risk of less urgent emergency department use associated with home nursing visits. These findings suggest increasing access to afterhours primary care could prevent some less urgent emergency department visits.

Keywords: Primary care, afterhours care, emergency department use

Introduction

In recent decades, health systems around the world have sought to increase access to primary care outside of traditional business hours. In theory, greater access to afterhours primary care can divert less urgent visits away from the emergency department, which is crowded, disrupts continuity of care, and is typically not designed to meet the care needs of complex, older adults[1,2]. However, the existing literature testing this hypothesis has produced conflicting results, with some studies showing that increased access to afterhours primary care is associated with fewer emergency department visits[3,4] and others finding no difference[5,6].

Older adults receiving home care services are a growing, frail population with particularly high rates of emergency department use[7,8]. Previous research has found that home nursing patients in Ontario, Canada have an increased risk of visiting the emergency department after 5pm on the same day they receive a home nursing visit[9]. This effect is presumed to be the result of the nurse identifying a health issue that they are unable to appropriately address during the visit and referring the patient for further care. Home care nursing in Ontario operates within a task-focused, visit-oriented model that limits a nurse's flexibility to move beyond pre-arranged tasks, hindering comprehensive practice, and likely contributing to the increased risk of a same-day emergency department visit[10]. The increased risk was considerably higher for less urgent emergency department visits, suggesting that many of the same-day visits could be more appropriately seen in a primary care setting. For visits of this nature, increased access to afterhours primary care could plausibly reduce the risk of a same-day emergency department visit.

My objective was to examine whether greater access to afterhours primary care modifies the association between nursing visits and same-day emergency department visits. I hypothesized that increased access to afterhours primary care, measured on both the patient and provider-level, would reduce the likelihood that a patient would visit the emergency department on the same day as a home

nursing visit, and that the modification would be stronger among less urgent emergency department visits.

Methods

Study design and data sources

This study extends a smaller case-crossover study previously conducted by my team[9]. In the current study, I identified a population-based, retrospective cohort of publicly-funded adult, home care patients in Ontario, Canada using multiple, linked, health administrative databases (Appendix 1). Home care patients and services were identified through the Home Care Database, which captures client and service records for publicly-funded home care programs in Ontario. Physician visits were extracted from the Ontario Health Insurance Plan claims database, which contains information on inpatient and outpatient physician billings, including "shadow billings" for physicians in primarily capitated payment models. Emergency department visits were extracted from the National Ambulatory Care Reporting System, which captures all hospital and community-based ambulatory care in Ontario. These datasets were linked using unique encoded identifiers and analyzed at ICES. This study was granted an exemption from formal ethics review by the Hamilton Integrated Research Ethics Board as the use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a research ethics board.

Participants

Individuals receiving on-going publicly-funded home care in Ontario are regularly assessed with the Resident Assessment Instrument for Home Care, a comprehensive clinical assessment[11]. I selected all assessments for home care patients 19 years or age and older that were completed in Ontario between October 1, 2014 and September 30, 2016. If an individual was assessed more than once during the accrual period, their most recent assessment was used. The assessment date was the index date for

a six-month follow-up period. Patients receiving palliative home care were excluded from the cohort as they receive specialized nursing care.

Case-crossover design

The case-crossover design is a self-matched, case-only design in which cases act as their own controls. The design can be used to determine whether an event was caused by something that happened just before and is immune to confounding by subject characteristics[12]. For each subject in a case-crossover study, a case period during which the subject experiences the event of interest is matched with control periods (commonly the previous day(s)) during which the subject did not experience the event. An exposure of interest is measured immediately prior to each case and control period[13]. The design enables researchers to determine whether there is transient association between the exposure and event by examining whether exposures were more likely to precede the case period rather than the control period(s).

In this study, the event of interest was an emergency department visit between 5pm and midnight. I identified case periods by selecting all weekdays within 182 days following the index date on which a patient had an active home nursing referral (i.e. able to receive a home nursing visit) and visited the emergency department after 5pm. Weekends and holidays were excluded as the availability of both home nursing and primary care differ significantly between weekends and weekdays. The earliest case period was utilized if a patient had more than one eligible case period during the follow-up period.

Control periods were identified by selecting all weekdays evenings within the seven days preceding the case period on which the patient did not have an emergency department visit. Control periods were matched to the case period within each patient. The exposure measured before each case or control period was whether a routine, pre-scheduled home nursing visit was received during the day. The identification and matching of case and control periods was performed separately for all emergency

department visits and for the subset of visits that were not admitted to hospital. The non-admitted visits represent lower acuity cases in which I expect both a stronger overall association and stronger effect modification.

Access to afterhours primary care

I operationalized access to afterhours primary care at both the patient and practice-level. In Ontario, primary care physicians can receive premiums for services provided outside of traditional office hours. I used afterhours premium billing codes (Appendix 2) to identify primary care visits that occurred after 5pm on weekdays. These codes include both care that took place during scheduled clinic hours after 5pm, as well as unscheduled care for urgent issues that took place afterhours, either in a physician office or in a patient's home.

The patient-level measure was based on an individual's use of afterhours primary care in the year preceding the case period and was split into any care versus no care. This definition is rooted in the concept that historical utilization provides evidence of health system access, and that past use of ambulatory care is a strong predictor of subsequent use[14]. However, since a lack of utilization does not necessarily indicate lack of access, I also created a measure to capture the relative amount of afterhours care provided by a patient's primary care practice. Following the approach of Glazier et al[15], I calculated the proportion of all weekday care provided by a patient's primary care practice that could be identified as afterhours care. This was measured using visits among Ontario residents 65 older during the year in which the case occurred. As there was no theoretical basis for any specific cut points in this continuous measure, I categorized the practice-level provision of afterhours care by quartiles.

Effect modification

The objective of this study is to examine the potential modifying effect of access to afterhours primary care on the increased risk of same-day emergency department visits following home nursing

visits, i.e., whether patients with greater access to afterhours primary care have a lower risk of an emergency department visit following a home nursing visit compared to patients with less access. This is accomplished by using the case-crossover design to estimate the effect of home nursing visits on same-day emergency department visits, and then testing the interaction between access to afterhours care and home nursing visits. This approach inherits the robustness of the case-crossover design to general confounding but is potentially at risk of bias if there are effect modifiers unaccounted for that are correlated with afterhours care.

Statistical Analysis

The association between home nursing visits and same-day emergency department visits was estimated with conditional logistic regression, where each set of within-patient matched case and control periods formed separate strata. Effect modification by access to afterhours primary care was examined using an interaction term approach. Analysis was performed separately for all emergency department visits and for the less urgent subset of visits that were not admitted to hospital. I reported the odds ratios and 95% confidence intervals of the association between home nursing and emergency department visits overall and within each category of the effect modifiers, as well as the p-value of the interaction term.

Sensitivity Analysis

I repeated the analyses including additional potential effect modifiers that may be correlated with access to afterhours care. These other modifiers were chosen based on previous research[8] and included primary care practice type, rurality, ADL hierarchy score (a measure of function impairment)[16], and presence of a live-in caregiver. I reported the odds ratio and 95% confidence interval of the association between home nursing and emergency department within each category of access to

afterhours care, fixing the other effect modifiers at their most common value for categorical variables and mean value for continuous variables.

Results

The final cohort contained 11,840 home care nursing patients with an emergency department visit who contributed a case period to the analysis. These case periods were matched to 55,210 control periods. For emergency department visits that were not admitted to hospital there were 6,703 patients with case periods matched to 31,538 control periods. Patients contributing case periods to the analysis had a median age of 77 and were balanced between males and females (Table 1). Just under half (46%) needed at least limited assistance with activities of daily living and over half (54%) had at least a mild cognitive impairment. Nearly all (88%) of the patients had five or more concurrent medications, a third (35%) were at least occasionally incontinent, and over 40% had a fall recently.

Main effect: Association between nursing home visits and same-day afterhours emergency department use

Similar to previous work, receiving a home nursing visit was significantly associated with a greater likelihood of a same-day afterhours emergency department visit (OR: 1.28, 95% CI 1.22 – 1.35) with a slightly larger effect in visits not admitted to hospital (OR: 1.34, 95%CI 1.26 – 1.43). (Figure 1.)

Effect modification: Access to afterhours primary care

Just over one-fifth (21.5%) of patients had least one afterhours weekday primary care visit in the previous year. These patients had a smaller increase in the risk of a same-day afterhours emergency department visit (OR: 1.18, 95% CI 1.06 – 1.30) compared to patients with no afterhours care (OR:1.31, 95% 1.25- 1.39). The difference in risk was noticeably larger among emergency department visits not admitted to hospital (OR: 1.11, 95% CI 0.97 – 1.28; vs. OR 1.41, 95% 1.31- 1.51). (Figure 1)

The practice-level provision of afterhours primary care could not be calculated for 771 patients (6.5%) who were not rostered to a primary care physician. Among the remaining cases, the quartile cutpoints for the practice-level proportion of care that was afterhours care were 3.2%, 5.6%, and 9.4%. While the observed associations in the second and fourth quartiles were lower than the first, I did not observe a monotonic trend towards a smaller risk of a same-day afterhours emergency department visit. (Figure 1).

Sensitivity analysis

Including additional effect modifiers increased the magnitude of the modifying effects of afterhours care and increased the standard errors of the main nursing effect but not the interaction effects. The result was greater significance for the interaction effects along with wider stratum-specific confidence intervals of the main nursing effect. (Figure 2).

Discussion

I found that home care patients were more likely to visit the emergency department after 5pm on the same day as a nursing visit, but that this association was smaller among patients who had a history of afterhours primary care use. This effect modification was stronger for the less urgent set of emergency department visits that did not result in a hospital admission. I did not find a consistent effect related to the practice-level provision of afterhours primary care.

Some cross-sectional and survey studies have suggested that an increase in access to primary afterhours could reduce emergency department visits[4,17–19] while other cohort studies and systematic reviews of interventions found no reduction.[5,6] My study is novel in that it tests the effectiveness of afterhours primary care in terms of its ability to reduce the risk of an emergency department visit following an event known to increase risk and does so within a self-matched study design. In contrast to

other studies, my study does not seek to determine whether afterhours primary care can reduce emergency department use overall, but rather if it can prevent visits that would otherwise occur shortly after a home nursing visit.

My results suggest that better access to afterhours primary care could prevent less urgent emergency department visits following home nursing visits. While my study only examines the ability of afterhours primary care to reduce a short-term increased risk of an emergency department visit, the findings represent a novel contribution to the frequently conflicted literature on this topic. Reducing less urgent emergency department visits is a priority of health systems globally as a means of improving continuity of care and reducing adverse outcomes such as emergency department-associated infections or delirium.[20,21] Consequently, governments around the world have put policies in place to increase the availability of afterhours primary care.[22] While the effectiveness of these policies have been called into question[5], my results contribute evidence to the argument that there is substantial benefit. Increasing the provision and use of afterhours primary care at individual practices or system-wide through policy tools such as regulations or incentives could yield benefits for complex, community-dwelling older adults such as home care patients.

While my results suggest expanding access to afterhours primary care would be beneficial, they also give rise to more questions. When examining the practice-level provision of afterhours care, I did not observe a consistent dose-response relationship that is typical of causal effects. This lack of consistency on the provider-level may be due to the importance of patient level-factors such as preference and awareness of the availability of afterhours primary care. In addition, I observed a smaller, more tenuous, modification of risk among all among all emergency department visits than the less urgent subset of visits. Although this algins with my original hypothesis, it raises questions as to what type and how many emergency department visits can be prevented by better access to afterhours care. Future research should further examine the influence of practice-level measures of afterhours care

provision on emergency department use as well as the types of emergency department visits that can be most successfully diverted to afterhours primary care.

Limitations

My study has a number of strengths, including use of population-based data and a self-matched design, but also notable weaknesses. First, there is no precise method to determine which emergency department visits could be more appropriately seen in primary care. Additionally, as the case-crossover study is a case-only design, only the patients who visited the emergency department after 5pm contributed to the analysis. Also, as I used claims-based data, my measures of access to afterhours primary are utilization-based proxies. Finally, my study examines a very specific question concerning emergency department visits following home care nursing visits. This is a strength in that it allows for clarity in interpretation, but also means that my findings cannot be generalized to overall emergency department use. However, it may be reasonable to assume that my findings generalize to emergency department visits following other visits to other health care providers where emerging health issues may be identified.

Conclusion

Home care patients were more likely visit emergency department following a home nursing visit, but patients with a history afterhours primary care use had a smaller risk, particularly for less urgent emergency department visits. This suggests better access to afterhours primary care can reduce certain specific, short-term risks of less urgent emergency department visits. These findings contribute evidence to the literature supporting the benefits of increasing the availability of afterhours primary care.

Tables and Figures

Figure 1: Association between home nursing and emergency department visits, overall and within each category of access to afterhours care

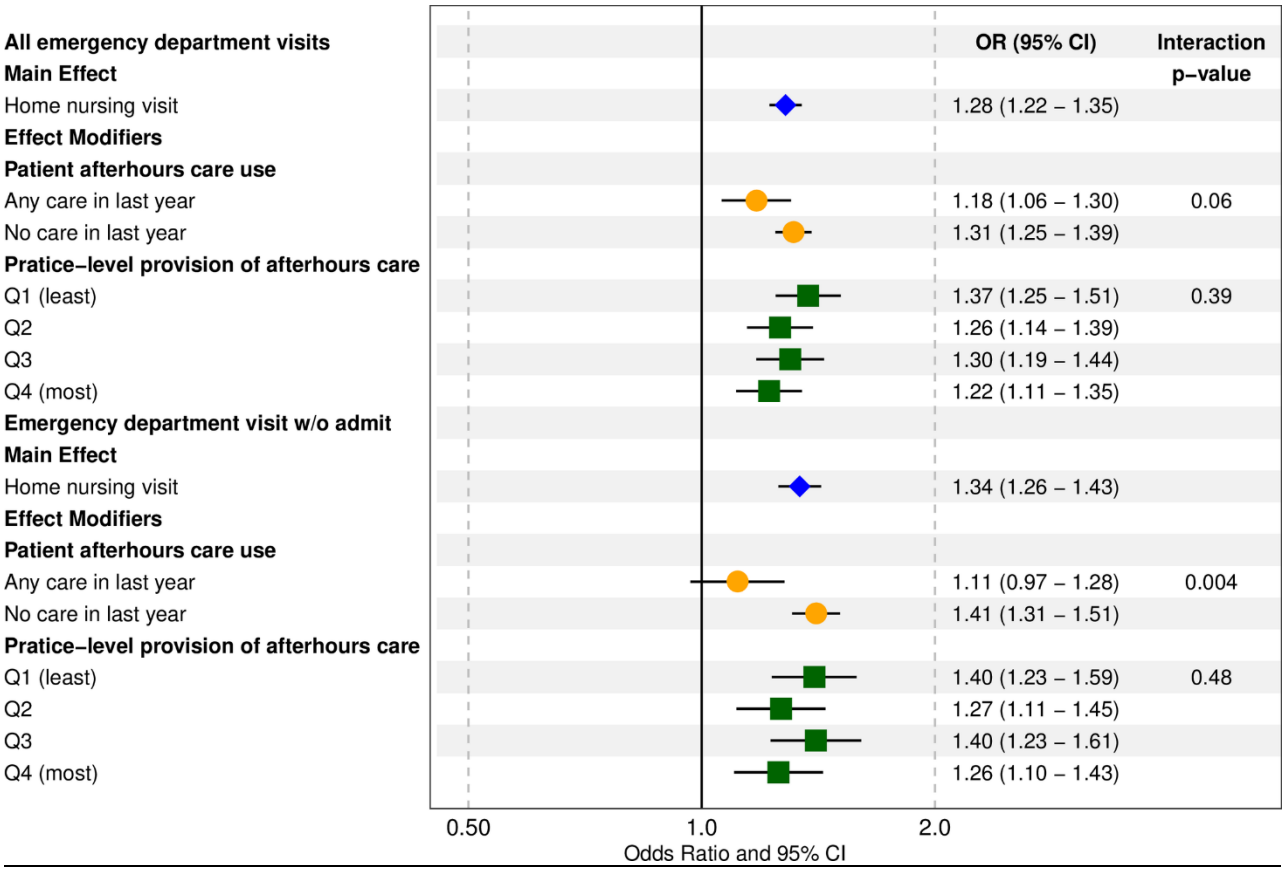
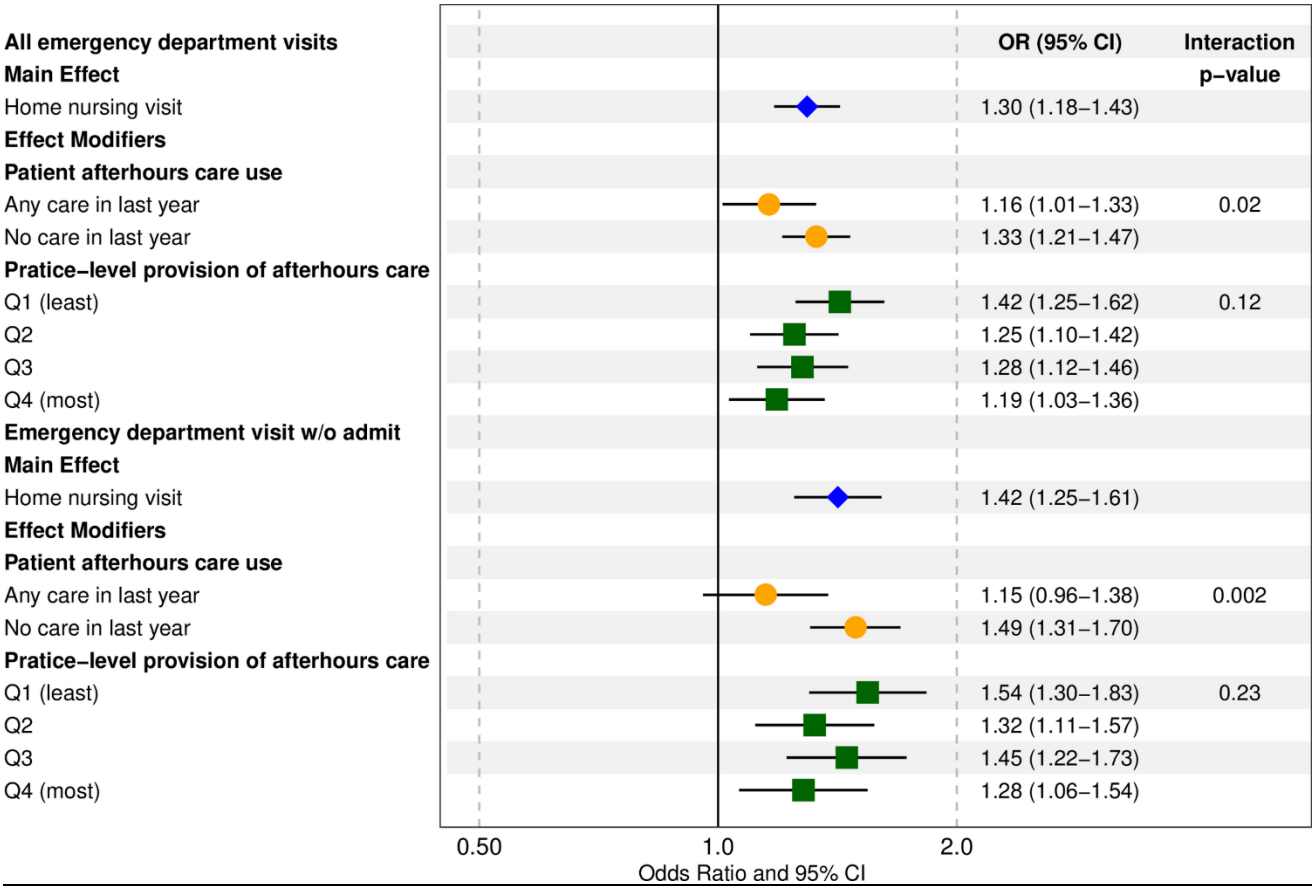


Figure 2: Association between home nursing and emergency department visits, overall and within each category of access to afterhours care, adjusted for other potential effect modifiers



Note: Adjusted for potential modifying effects of primary care practice type, rurality, functional impairment, and presence of a live-in caregiver

Table 1. Characteristics of home care patients contributing case periods

Patient Characteristics	All Patients no. (%) n=11,840	History of afterhours care use no. (%) n=2,550	No history of afterhours care use no. (%) n=9,290
Demographics			
Age, yr (Median (Q1, Q3))	77 (65-86)	77 (66-87)	76 (64-85)
Sex, female	6048 (51)	1356 (53)	4692 (51)
Lived Alone	4432 (37)	886 (35)	3546 (38)
Health			
ADL Impairment1			
Independent/Supervision	6345 (54)	1208 (47)	5137 (55)
Limited/Extensive	3624 (31)	774 (30)	2850 (31)
Maximal/ Dependent	1871 (16)	568 (22)	1303 (14)
Cognitive Impairment2			
Intact / Borderline intact	5438 (46)	1117 (44)	4321 (47)
Mild / Moderate	5687 (48)	1213 (48)	4474 (48)
Severe	715 (6)	220 (9)	495 (5)
Frailty Index3			
Robust (0-0.19)	2420 (20)	450 (18)	1970 (21)
Pre-frail (0.2-0.29)	3106 (26)	593 (23)	2513 (27)
Frail (>= 0.3)	6314 (53)	1507 (59)	4807 (52)
Depressive symptoms	6615 (56)	1477 (58)	5138 (55)
Aggressive behaviors	1144 (10)	276 (11)	868 (9)
Fall in last 90 days	4823 (41)	1008 (40)	3815 (41)
Bladder incontinence	4147 (35)	1009 (40)	3138 (34)
Five or more medications (%)	10399 (88)	2265 (89)	8134 (88)
Dementia	1832 (15)	445 (17)	1387 (15)
Clinical need indicators			
Wound care	5338 (45)	1177 (46)	4161 (45)
Intravenous medications	1116 (9)	206 (8)	910 (10)
Indwelling urinary catheter	2029 (17)	422 (17)	1607 (17)
Congestive heart failure	2262 (19)	498 (20)	1764 (19)
Chronic obstructive pulmonary disease	3096 (26)	652 (26)	2444 (26)

Note: ADL= Activities of daily living, Q1 = Quartile 1, Q3 = Quartile 3

1 ADL Hierarchy Scale: Includes personal hygiene, locomotion, eating and toileting

2 Cognitive performance scale

3 Scores on the frailty index range from 0 to 1, where 0 represents no health deficits

and 1 represents all possible health deficits

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Appendices

Appendix 1: Databases used in the study

ICES Databases	Description
Discharge Abstract Database(DAD)	The DAD is compiled by the Canadian Institute for Health Information and contains administrative, clinical (diagnoses and procedures/interventions), demographic, and administrative information for all admissions to acute care hospitals, rehab, chronic, and day surgery institutions in Ontario. At ICES, consecutive DAD records are linked together to form 'episodes of care' among the hospitals to which patients have been transferred after their initial admission.
Ontario Health Insurance Policy Claims (OHIP)	The OHIP claims database contains information on inpatient and outpatient services provided to Ontario residents eligible for the province's publicly funded health insurance system by fee-for-service health care practitioners (primarily physicians) and "shadow billings" for those paid through non-fee-for-service payment plans. The main data elements include patient and physician identifiers (encrypted), code for service provided, date of service, associated diagnosis, and fee paid.
National Ambulatory Care Reporting System (NACRS)	The NACRS is compiled by the Canadian Institute for Health Information and contains administrative, clinical (diagnoses and procedures), demographic, and administrative information for all patient visits made to hospital- and community-based ambulatory care centres (emergency departments, day surgery units, hemodialysis units, and cancer care clinics). At ICES, NACRS records are linked with other data sources (DAD, OMHRS) to identify transitions to other care settings, such as inpatient acute care or psychiatric care.
Home care Database(HCD)	The HCD is a clinical client centric database that captures all services that are provided by or coordinated by Community Care Access Centres (CCACs). The data elements captured include information on: client, intake, assessment, admission & discharge, diagnosis and surgical procedure, and care delivery. ICES receives home care data from the Ontario Ministry of Health and Long-Term Care (MOHLTC). The primary purpose of the information collected through the HCD is to aid in planning and better clinical insight into clients who encounter service through CCACs.

Resident Assessment Instrument (RAI)-Home care source (OACCAC)	The RAIHC database is managed by the Community Care Access Centres (CCACs) and is a standardized clinical assessment to all long-stay home care clients in Ontario defined as clients receiving ongoing support for at least 60 consecutive days. Data collected include comprehensive clinical, functional and resource utilization information that are used to inform client needs. When used over time, it provides the basis for an outcome-based assessment of the person's response to care or services.
The Corporate Provider Database (CPDB)	The Corporate Provider Database (CPDB) contains information on all physician and some non-physician (such as chiropractors, physiotherapists, and optometrist) providers funded by the Ministry, either through OHIP or other funding arrangements. The data includes demographic, eligibility, specialty, practice location, (encrypted) provider billing number, limited demographic information (year of birth, gender, year of graduation, specialty, and location of practice).
Registered Persons Database(RPDB)	The RPDB provides basic demographic information (age, sex, location of residence, date of birth, and date of death for deceased individuals) for those issued an Ontario health insurance number. The RPDB also indicates the time periods for which an individual was eligible to receive publicly funded health insurance benefits and the best known postal code for each registrant on July 1st of each year.

Appendix 2: List of afterhours feecodes

OHIP Fee Codes
Q012
Q016
Q017
B962
B964
B994
B996
A962
A964
A994
A996

Note: Visits were limited to 1 per patient per physician per day

Chapter 4: Physician home visit patterns and hospital use among older adults with functional impairments

Summary

This chapter investigates another type of enhanced access to primary care, the home visit. Once a traditional part of the practice of family medicine, home visits declined in frequency in North America across the 20th century, before receiving a more recent resurgence of interest. Home visits can provide access to continuous, comprehensive primary care for patients who have difficulty reaching office-based care. I characterized the home visit practice patterns of primary care physicians and examined how historical provision was associated with emergency room visits and hospital admissions by their home care patients with extensive functional impairments.

I found that around two-thirds of primary care physicians did at least one home visit in a year and that, among those who provided at least one home visit, there was wide variation in the yearly number of home visits provided. Patients whose most responsible primary care physician historically provided higher levels of home visits had lower rates of emergency department visits and hospital admissions. These findings contribute additional evidence to the literature of the importance of access to primary care and the benefits of home visits for functionally-impaired patients. Significantly, my results demonstrate the benefits of promoting the provision of home visits generally among physicians, apart from the multidisciplinary home-based primary care programs that have been more broadly studied in the literature.

Citation:

Jones A, Bronskill SE, Seow H, Feeny D, Lapointe-Shaw L, Mowbray F, Costa P. Physician home visit patterns and hospital use among older adults with functional impairments. *Journal of the American*

Geriatrics Society. 2020 Jun. (Epub head of print).

Abstract

Background

Home-based primary care has been associated with reductions in hospital use among homebound older adults, but population-based studies on the general home visit patterns of primary care physicians are lacking.

Objective

I examined the association between the provision of home visits by primary care physicians and subsequent use of hospital-based care among their older adult patients with extensive functional impairments.

Design

Population-based retrospective cohort study.

Setting

Ontario, Canada**,** October 2014 to September 2016.

Participants

Older adults (65+) with extensive functional impairments receiving publicly-funded home care.

Measurements

I measured the provision of home visits by a patient's most responsible primary care provider during the year before a comprehensive home care assessment. Physician home visit patterns were measured as the proportion of the total outpatient visits in a year that were home visits, categorized with quartiles.

Multivariable, multilevel negative binomial regression models examined the associations between physician-level home visit provision and patient emergency department visits and hospital admissions over the six months following the home care assessment.

Results

There were 49,613 patients in the cohort who were linked to 8,096 unique primary care physicians. 69.1% of physicians provided at least one home visit in a year, with the median proportion of home visits to total visits ranging from 0.063% to 6.46% across quartiles. Patients whose physicians were in the highest home visit provision quartile had lower rates of emergency department visits (IRR: 0.93 (95% CI: 0.90-0.96) and hospital admissions (IRR: 0.89 (95% CI: 0.85-0.93)) compared to patients whose physicians did not do home visits.

Conclusion

Home care patients with extensive functional impairments whose physicians provided higher levels of home visits had fewer emergency department visits and hospital admissions**.** Expanding home visits by primary care physicians could reduce hospital use by older adults living with functional impairments in the community.

Keywords

Primary health care, home visits, home visits, home care services

Introduction

Primary care home visits were historically part of the typical practice of family medicine[1]. In North America, the frequency of home visits and the proportion of physicians performing them declined dramatically in the second half of the 20th century[2,3]. However, the globally growing population of frail older adults with difficulty accessing primary care offices has sparked a resurgence of interest in physician home visits[4–7]. Older adults who experience difficulty leaving their homes are less able to access primary care services, forcing a greater reliance on care provided in the emergency department[8–10]. Patients with less access to primary care are also less likely to receive preventive care and early management of emerging health problems, resulting in higher subsequent use of hospital-based care[11]. Furthermore, the efficiency-driven approach of conventional emergency departments is ill-suited for older adults with complex care needs[12] and emergency department visits present well-established risks for older adults[13,14]. Home visits offer a way to potentially avoid excess hospital use by providing access to continuous, comprehensive primary care. In addition, home visits enable physicians to observe patients in their typical environment, providing the opportunity to assess factors such as medication adherence, dietary habits, and risk of falling[15]. Recently, there has been an increase in the availability of home-based primary care in many jurisdictions accompanied by calls to further expand home visits[16–19].

Several multidisciplinary home-based primary care programs have been shown to reduce emergency department visits and hospital admissions among homebound older adults[20–23]. Other programs have also demonstrated effectiveness, including a Medicare program involving a single comprehensive geriatric assessment at home that was associated with fewer hospital and nursing home admissions[24]. In Canada, a study among end-of-life patients found that patients receiving at least one physician home visit in the last six months of life were less likely to die in hospital[25]. Although there has been considerable research regarding specific models of home-based primary care, population-based studies examining the general home visit practice patterns of primary care physicians and their

association with patient outcomes are lacking. The objective of this study is to determine whether higher historical provision of home visits by primary care physicians is associated with lower rates of subsequent emergency department visits and hospital admissions within community-dwelling older adults with extensive functional impairments.

Methods

Setting

Ontario is Canada's largest province with a 2016 population of 13 million residents, including over two million residents aged 65 years or older[26]. Most residents are covered by Ontario's universal publicly-funded health insurance program, which includes medically necessary services such as physician care, hospital care, home care, and prescribed medications for those 65 and older.

Study design and data sources

I conducted a population-based retrospective cohort study of older adults with extensive functional impairments receiving publicly-funded home care services in Ontario, Canada from 2014-2016. In Ontario, long-stay home care patients are those who are expected to receive home care services for at least 60 days. These patients are community-dwelling older adults who typically live with functional and/or cognitive impairment, multiple chronic conditions, and experience high rates of emergency department use[27]. The clinical characteristics, health service use patterns, and frequent clinical assessments of long-stay home care patients makes them an ideal population in which to study the effects of primary care physician home visits.

I used multiple linked health administrative databases to create the study cohort. These included the Home Care Database, the Ontario Health Insurance Plan database for physician billings, the National Ambulatory Care Reporting System for emergency department visits and the Discharge Abstract Database for hospital admissions. A description of all the databases used in the study can be

found in Supplementary Table S1. Datasets were linked using unique encoded identifiers and analyzed at ICES. This study was exempted from formal ethics review by the Hamilton Integrated Research Ethics Board as the use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a research ethics board.

Participants

All long-stay home care patients in Ontario are assessed with the Resident Assessment Instrument for Home Care (RAI-HC) at intake and every six to twelve months depending on the patient's condition[28]. The RAI-HC is a comprehensive, valid, and reliable clinical assessment that covers domains of health, function, cognition, social support, diagnoses, and health service use[29–31]. I selected all RAI-HC assessments for publicly-funded home care patients 65 years of age and older completed in Ontario between October 1st, 2014 and September 30, 2016. If an individual had more than one assessment during the accrual window the last assessment was used and that assessment date became the reference date for the follow-up and look-back windows (n=219,598) (Figure 1). I restricted my cohort to only those patients with an Activities of Daily Living (ADL) Hierarchy scale of 3 or higher, which indicates that extensive assistance is required in at least one of the activities of locomotion, personal hygiene, toilet use, and eating. (n=50,505)[32]. I focused on home care patients with this level of ADL impairment as they would likely have the most difficulty reaching office-based primary care and prior work has indicated that these individuals are considerably more likely to receive a primary care home visit than home care patients with less or no functional impairment[27].

Patients in the cohort were assigned to a most responsible primary care physician via a multistep approach that has been used previously[33]. Most primary care physicians in Ontario operate within models that enroll patients in "medical homes" that are intended to become a patient's sole source of primary care. These models reimburse physicians through a mixture of capitation payments,

fee-for-service payments, and bonuses for achieving certain benchmarks[34]. Patients who were enrolled with a physician on the reference date were assigned to that physician. Patients not enrolled with a physician were assigned to the primary care physician with whom they had the most core primary care billings in the two years prior to the reference date[35]. Patients who could not be linked to a physician were excluded (n=697) as well as those whose assigned physician had very few billings (<100) (n=195).

Measures

Primary care physician home visits

In Ontario, primary care physicians can use specific billing codes for assessments provided in a patient's home, which are remunerated at a higher rate than assessments done in an office[36]. Physicians can also qualify for additional financial incentives by surpassing certain annual volumes of home visits[37]. I identified primary care physician home visits from a list of billing codes used in previous research[25] (Supplementary Table S2). I characterized physician home visit patterns by calculating the proportion of all outpatient visits by an individual physician that were home visits. This was done for each physician in each year of the cohort (e.g. a physician-year). This approach has the advantage over a simpler volume-based approach of accounting for differences in physician roster size. I used the proportion of outpatient visits that were home visits to categorize each physician-year into one of five groups. Physicians with no home visits within a year were categorized into a "None" group. The remaining physician-years were split into four groups of increasing provision of home visits using quartiles of the distribution of proportion of home visits to total visits. For analysis, I examined the home visit practice pattern of each patient's assigned physician in the calendar year prior to the reference assessment.

Outcomes

Count of emergency department visits and hospital admissions within six months of the reference date were the primary outcomes for this study. A secondary outcome was the number of days spent in hospital during the six-month follow-up period. I did not include scheduled or pre-arranged emergency departments visits or elective hospital admissions as these are not related to acute medical conditions.

Covariates

I identified additional variables to account for potential confounding[2,27,38]. These included baseline patient-level variables: age, sex, chronic conditions, count of concurrent medications, severity of functional impairment, active home care nursing , rurality[39], and count of emergency department visits or hospital admissions in the previous 0-4 months and 5-12 months. Physician-level variables included sex, years of practice, type of practice, international medical education, and board certification in family medicine.

Statistical analysis

I examined the descriptive characteristics of all patients in the cohort and their assigned physicians. I calculated summary statistics on the home visit practice patterns of primary care physicians. The association between physician-level provision of home visits and rate of emergency department visits and hospital admissions were examined with multivariable, multilevel negative binomial generalized linear models, controlling for all identified confounders. A gaussian-distributed random effect was included to account for clustering among patients assigned to the same physician. Analysis was preformed using SAS 9.4 (SAS Institute, Inc., Cary, NC).

Sensitivity analysis

I repeated my analysis categorizing physicians based on the annual absolute count of home visits provided rather than the proportion of home visits to total visits. I used the incentive tiers implemented by the Ontario Ministry of Health and Long-Term Care that combine volume of home visits with a minimum number of patients served per year[37]. These categories are 0-11 visits, 12-23 visits (min. 3 patients), and 69+ visits (min. 12 patients), and 128+ visits (min. 24 patients). I performed two additional sensitivity analyses, one excluding palliative specialist physicians who were identified using methods previously described and validated[40], and a second excluding physicians whose roster included less than the average proportion of home care patients.

Results

My cohort contained 49,613 home care patients with extensive functional impairments assigned to 8,096 unique primary care physicians. The median age of patients was 85 years (Q1, Q3: 77-90) and 60% were female. Over half (52%) had severe functional impairments and the median number of ADLs with which patients needed at least limited assistance was six. Cognitive impairment was common (82%), as was a history of falls (47%) and mood symptoms (56%). The median number of chronic conditions was four and 57% of the population used nine or more concurrent medications (Table 1).

Primary care physician home visit patterns

No home visits were provided within 4,695 (30.9%) of physician-years (Table 2). The quartile cut points of the proportion of home visit to total visits used to divide the remaining physician-years into groups of increasing provision were 0.13%, 0.46%, and 1.48%. The median proportion of total visits that were home visits and the annual volume of home visits increased monotonically across the groups. Physicians in higher home visit provision groups were more likely to be male, a Canadian medical graduate, and board certified in family medicine (Supplementary Table S3). Physicians in the highest

quartile were more likely to be a palliative specialist while physicians in the no visits group had practiced for fewer years.

Association between provision of home visits and use of hospital-based care

During the six-month follow-up window, 51% of patients visited the emergency department and 34% had a hospital admission. Patients assigned to physicians in higher home visit provision groups had lower rates of emergency department visits when compared to patients assigned to physicians who had not provided any home visits, with an evident dose-response relationship (Q4 vs. None: adjusted incidence rate ratio (IRR)=0.93 (95%CI 0.90-0.96); Q3 vs. None: IRR=0.95 (95% CI 0.92-0.99)) (Table 3, Figure 2). A similar pattern with larger differences across groups was observed for hospital admissions (Q4 vs. None: IRR=0.89 (0.85-0.95); Q3 vs. None: IRR=0.94 (95% CI 0.90-0.98)) and days spent in hospital (Q4 vs. None: IRR=0.83 (0.78-0.91); Q3 vs. None: IRR=0.91 (95% CI 0.84-0.99)).

Sensitivity analysis

Groups defined by the volume-based incentive tiers produced generally similar results to the main analysis with smaller differences observed between the highest two incentive tiers compared to the highest two quartile groups used in the main analysis. (Supplementary Table S4). Excluding palliative care specialist physicians did not meaningfully alter any results (Supplementary Table S5). Analysis among only physicians with higher proportions of home care patients on their roster also produced similar results to the main analysis, with slightly larger differences observed between the highest and lowest quartile groups (Supplementary Table S5).

Discussion

While approximately 70% of primary care physicians in this study provided at least one home visit in a year, the extent of provision varied widely. I found that home care patients with extensive functional impairments whose primary care physician had higher historical provision of home visits had

lower rates of emergency department visits and hospital admissions compared to patients whose physician did not provide home visits. The observed differences were small but exhibited a dose-response relationship and were robust to variations in how the provision of home visits and outcomes were measured.

While primary care home visits have been frequently studied[20-25], my study is novel in its examination of patterns of physician home visit provision and use of a population-based approach. While my finding that higher provision of home visits was associated with less hospital use is broadly consistent with the literature, the effect sizes I observed were smaller than in many other studies. There are several possible explanations for this. First, I examined home visits as a physician-level exposure, not a patient exposure. As such, there may have been patients assigned to physicians in higher home visit provision groups who did not receive a home visit although they may have benefited from it. This would produce a smaller effect when compared to interventional studies in which every member of a treatment arm receives at least one home visit. Also, I examined all home visits in my study, while much of the published research has focused specifically on home-based primary care programs. These programs tend to incorporate multicomponent interventions delivered by interdisciplinary teams, which may yield additional benefits[18].

My results support the utility of primary care physician home visits as a tool to mitigate unnecessary or excessive hospital use in older adults with functional impairments. These patients have high rates of hospital admissions and are at increased risk of delayed discharge from hospital[41]. Thus while a 10% decrease in risk may appear small on the patient level, the impact of a system-wide 10% reduction in hospital admissions among functionally-impaired older adults would be significant. In addition, the stronger associations I observed for days spent in hospital suggests there may also be a benefit from home visits on hospital length of stay.

In Ontario, the provincial government added financial incentives in 2011 to encourage greater provision of home visits by primary care physicians to frail, older adults, which resulted in yearly increases in the volume of home visits[42]. However, my results indicate that while most physicians did at least one home visit in a year, overall volumes are still low, particularly when compared to some European nations[43]. This suggests that additional incentives or other means of encouraging home visits may be necessary to further increase home visit provision. For example, although I lacked specific data on home visits by non-physicians in this study, the important role that nurse practitioners play in offering primary care home visits has been recognized in other jurisdictions and may produce similar benefits at a reduced cost[44,45]. Compared to the United States however, Canada has 75% fewer nurse practitioners per capita despite having introduced nurse practitioners at a similar time[46]. Future research should compare the benefits of alternate models of home-based primary care, including home visits by nurse practitioners, geriatrician-led models, and interdisciplinary primary care programs.

Strengths and Limitations

My use of a physician-level exposure in this study is both a strength and limitation. Since home visits tend to be provided to the most complex patients[27] , a patient-level measure would likely suffer from significant confounding by indication. By basing my analysis on historical physician practice patterns, I minimized this source of bias. However, this approach limits my ability to directly compare my results to studies carried using patient-level exposures. Another strength of my study is a population-based approach, by which were able to analyze the effects of increasing provision of home visits across an entire health system rather than within a single program. While this improves the generalizability of my findings, there may still be questions as to whether my results generalize outside of health systems similar to Ontario's. One limitation of my study is that the proportion of home visits to total visits is a crude measure, adjusted only for a physician's roster size. Another limitation is that I am unable to differentiate between home visits provided for acute needs and concerns and those that were

routine. Finally, I am unable to establish whether there is an ideal level of home visit provision, only concluding that within the range observed in my study, higher provision was associated with better patient outcomes.

Conclusion

Greater home visit provision by primary care physicians was associated with lower rates of emergency department visits and hospital admissions among community-dwelling older adults with functional impairments. Expanding home visits by primary care physicians could potentially reduce the use of hospital-based services and help enable community-dwelling older adults to age safely and well at home.

Tables and Figures

Figure 1. Cohort selection diagram

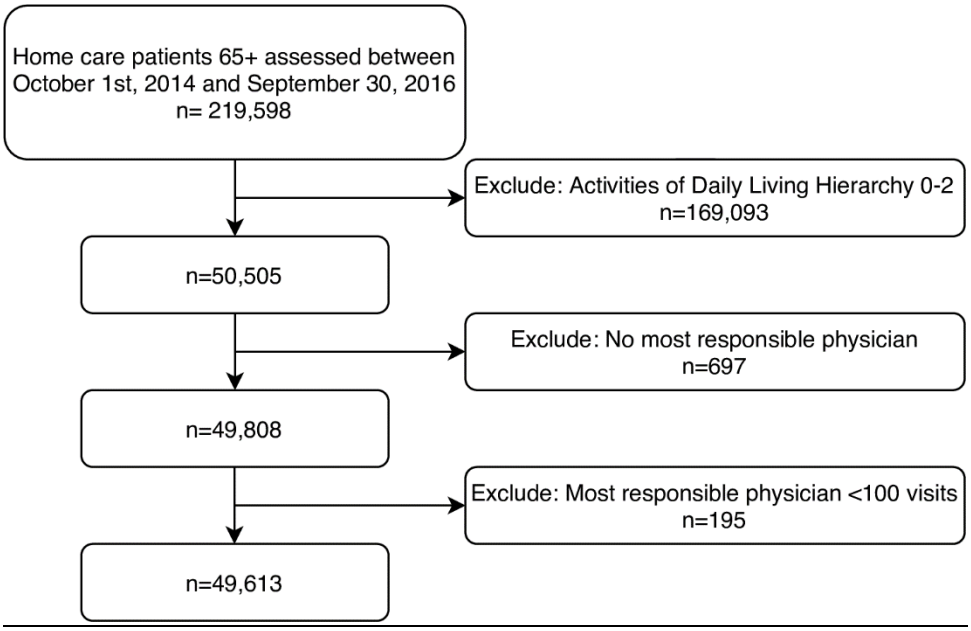

Figure 2: Associations between physician-level provision of primary care home visits and use of hospital care within six months of a home care assessment (IRR = Adjusted Incidence Rate Ratio; CI = Confidence Interval)

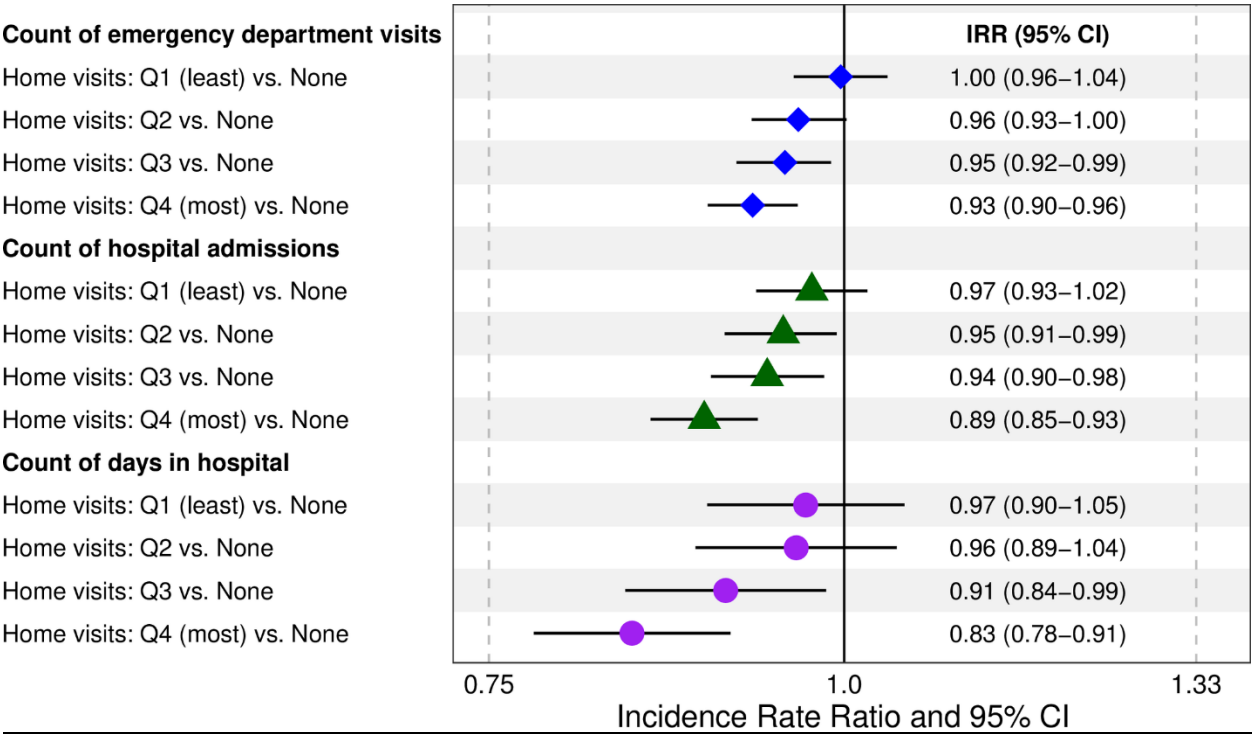

Table 1. Baseline characteristics of long-stay home care patients with extensive functional impairments in Ontario, 2014-2016

Patient Characteristics	no. (%) n=49,613
Demographics	
Age, yr (Median (Q1, Q3))	85 (77, 90)
Sex, male	19764 (40)
Lived Alone	20370 (41)
Rurality	
Urban	37541 (76)
Semiurban	9413 (19)
Rural	2686 (5)
Health	
ADL Impairment[1]	
Extensive	23814 (48)
Maximal/ Dependent	25799 (52)
Cognitive Impairment[2]	
Intact / Borderline intact	9124 (18)
Mild / Moderate	27775 (56)
Severe	12714 (26)
Count of impaired ADLs[3] (Median (Q1, Q3))	6 (4, 7)
Number of Concurrent Medications	
0-4	6744 (14)
5-8	13231 (30)
9 or more	28152 (57)
Any mood symptom	27569 (56)
Bladder incontinence	33906 (68)
Fall in last 90 days	23461 (47)
Congestive heart failure	7868 (16)
Chronic obstructive pulmonary disease	8529 (17)
Dementia	21247 (43)
Count of chronic conditions (Median (Q1, Q3))	4 (3, 5)
Baseline Health Service Use	
Home nursing at baseline	19025 (38)
ED visits in prior 4 months (Mean (SD))	1.0 (1.51)
ED visits in prior 5-12 months (Mean (SD))	1.3 (1.84)
Hospital admissions in prior 4 months (Mean (SD))	0.5 (0.77)
Hospital admissions in prior 5-12 months (Mean (SD))	0.4 (0.84)

Note: ADL= Activities of daily living, Q1 = Quartile 1, Q3 = Quartile 3
ED = Emergency department
1 ADL Hierarchy Scale: Includes personal hygiene, locomotion, eating and toileting

2 Cognitive performance scale
3 At least limited assistance required. Includes bed mobility, transfer, locomotion, dressing, eating, toileting, personal hygiene, bathing

Table 2. Distribution of primary care physician home visits across provision groups

Home visit provision group	Number of phyisican-years[1]	% of total visits that were home visits (Median (Q1, Q3))	Annual volume of home visits (Median (Q1, Q3))
None	4,695	0% (0%, 0%)	0 (0, 0)
Q1 (least)	2,629	0.063% (0.0035%, 0.090%)	4 (3, 7)
Q2	2,629	0.27% (0.18%, 0.34%)	18 (11, 27)
Q3	2,629	0.86% (0.61%, 1.07%)	57 (38, 84)
Q4 (most)	2,629	6.46% (3.20%, 20.63%)	228 (131, 455)

Note: All measures were calculated per-physician, per-year, among all a physician's patients.
Q1=Quartile 1, Q3=Quartile 3

Table 3. Adjusted incidence rate ratios and 95% confidence intervals from negative binomial regression models

Variable	Count of emergency department visits IRR (95%CI)[1]	Count of hospital admissions IRR (95%CI)[1]	Count of days spent in hospital IRR (95%CI)[1]
Home visit provision groups			
None (ref)	-	-	-
Q1 (lowest)	1.00 (0.96-1.04)	0.97 (0.93-1.02)	0.97 (0.90-1.05)
Q2	0.96 (0.93-1.00)	0.95 (0.91-0.99)	0.96 (0.89-1.04)
Q3	0.95 (0.92-0.99)	0.94 (0.90-0.98)	0.91 (0.84-0.99)
Q4 (Highest)	0.93 (0.90-0.96)	0.89 (0.85-0.93)	0.83 (0.78-0.91)
Sex, male	1.17 (1.14-1.19)	1.24 (1.21-1.28)	1.40 (1.33-1.47)
Age			
65-74 (ref)	-	-	-
75-84	1.03 (0.99-1.07)	1.02 (0.98-1.07)	1.03 (0.95-1.11)
85-94	0.96 (0.93-1.00)	0.98 (0.94-1.02)	0.95 (0.88-1.02)
95+	0.93 (0.88-0.98)	0.95 (0.89-1.01)	0.91 (0.81-1.02)
Functional impairment			
Extensive (ref)	-	-	-
Severe	0.90 (0.86-0.94)	0.99 (0.86-1.02)	0.99 (0.94-1.04)
Rurality			
Urban (ref)	-	-	-
Semiurban	0.94 (0.91-0.96)	0.98 (0.94-1.02)	0.99 (0.92-1.06)
Rural	1.09 (1.04-1.16)	1.09 (1.03-1.17)	1.19 (1.06-1.34)
Congestive heart failure	1.10 (1.06-1.14)	1.15 (1.11-1.20)	1.19 (1.11-1.27)
Chronic obstructive pulmonary disease	1.06 (1.03-1.10)	1.13 (1.09-1.18)	1.05 (0.98-1.11)
Dementia	0.93 (0.90-0.95)	0.91 (0.89-0.94)	1.00 (0.95-1.05)
Count of concurrent medications	1.03 (1.02-1.03)	1.02 (1.02-1.03)	1.00 (0.99-1.02)
Count of chronic conditions	1.02 (1.01-1.02)	1.02 (1.02-1.02)	1.02 (1.00-1.03)
Emergency department visits (prior 4 months)	1.19 (1.18-1.20)	-	-
Emergency department visits (prior 5-12 months)	1.05 (1.04-1.06)	-	-
Hospital admissions (prior 4 months)	-	1.23 (1.21-1.25)	1.20 (1.16-1.23)
Hospital admissions visits (prior 5-12 months)	-	1.15 (1.14-1.17)	1.15 (1.12-1.18)
Active home care nursing at baseline	1.10 (1.10-1.11)	1.17 (1.14-1.21)	1.15 (1.09-1.21)

Note: IRR = adjusted incidence rate ratio; CI = Confidence Interval

1. Also adjusted for physician sex, years of practice, type of practice, international medical education, and board certification in family medicine

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Appendices

Supplementary Table S1: Databases used in the study

ICES Databases	Description
Discharge Abstract Database(DAD)	The DAD is compiled by the Canadian Institute for Health Information and contains administrative, clinical (diagnoses and procedures/interventions), demographic, and administrative information for all admissions to acute care hospitals, rehab, chronic, and day surgery institutions in Ontario. At ICES, consecutive DAD records are linked together to form 'episodes of care' among the hospitals to which patients have been transferred after their initial admission.
Ontario Health Insurance Policy Claims (OHIP)	The OHIP claims database contains information on inpatient and outpatient services provided to Ontario residents eligible for the province's publicly funded health insurance system by fee-for-service health care practitioners (primarily physicians) and "shadow billings" for those paid through non-fee-for-service payment plans. The main data elements include patient and physician identifiers (encrypted), code for service provided, date of service, associated diagnosis, and fee paid.
National Ambulatory Care Reporting System (NACRS)	The NACRS is compiled by the Canadian Institute for Health Information and contains administrative, clinical (diagnoses and procedures), demographic, and administrative information for all patient visits made to hospital- and community-based ambulatory care centres (emergency departments, day surgery units, hemodialysis units, and cancer care clinics). At ICES, NACRS records are linked with other data sources (DAD, OMHRS) to identify transitions to other care settings, such as inpatient acute care or psychiatric care.
Home care Database(HCD)	The HCD is a clinical client centric database that captures all services that are provided by or coordinated by Community Care Access Centres (CCACs). The data elements captured include information on: client, intake, assessment, admission & discharge, diagnosis and surgical procedure, and care delivery. ICES receives home care data from the Ontario Ministry of Health and Long-Term Care (MOHLTC). The primary purpose of the information collected through the HCD is to aid in planning and better clinical insight into clients who encounter service through CCACs.

Resident Assessment Instrument (RAI)-Home care source (OACCAC)	The RAIHC database is managed by the Community Care Access Centres (CCACs) and is a standardized clinical assessment to all long-stay home care clients in Ontario defined as clients receiving ongoing support for at least 60 consecutive days. Data collected include comprehensive clinical, functional and resource utilization information that are used to inform client needs. When used over time, it provides the basis for an outcome-based assessment of the person's response to care or services.
The Corporate Provider Database (CPDB)	The Corporate Provider Database (CPDB) contains information on all physician and some non-physician (such as chiropractors, physiotherapists, and optometrist) providers funded by the Ministry, either through OHIP or other funding arrangements. The data includes demographic, eligibility, specialty, practice location, (encrypted) provider billing number, limited demographic information (year of birth, gender, year of graduation, specialty, and location of practice).
Registered Persons Database(RPDB)	The RPDB provides basic demographic information (age, sex, location of residence, date of birth, and date of death for deceased individuals) for those issued an Ontario health insurance number. The RPDB also indicates the time periods for which an individual was eligible to receive publicly funded health insurance benefits and the best known postal code for each registrant on July 1st of each year.

Supplementary Table S2: Fee codes used to identify home visits

Fee codes
A900
A901
B960
B961
B962
B963
B964
B966
B990
B992
B993
B994
B996
B997
B998

Note: More than one billing on a single day by the same physician to the same patient was considered a single visit

Supplementary Table S3: Characteristics of primary care physicians assigned to cohort members

	Home visit provision groups				
Measure	**None n=4,695**	**Q1 (least) n=2,629**	**Q2 n=2,629**	**Q3 n=2,629**	**Q4 (most) n=2,629**
Age, yr (Median (Q1, Q3))	50 (41,59)	53 (45,61)	53 (44,61)	54 (45,61)	56 (47,64)
Sex, male (%)	52.4%	67.0%	62.6%	63.4%	70.9%
Years in practice (Median (Q1, Q3))	14 (5,28)	23 (10,31)	23 (9,31)	24 (11,32)	26 (13,34)
International Medical Education (%)	31.9%	25.9%	18.8%	15.0%	11.1%
Certificate in Family Medicine (%)	37.7%	36.1%	47.7%	49.6%	47.6%
Palliative specialist (%)	3.2%	3.4%	2.7%	3.3%	9.1%
Mean proportion of roster that are home care clients (%)	3.2%	3.6%	3.8%	4.2%	5.5%
Volume Tiers (%)[1]					
0-11 visits (%)	100.0%	92.8%	35.1%	4.3%	0.6%
12-23 visits (%)	0.0%	6.7%	43.1%	19.5%	1.7%
24-67 visits (%)	0.0%	0.5%	21.3%	59.5%	24.5%
68-127	0.0%	0.0%	0.6%	13.9%	28.0%
128+ (%)	0.0%	0.0%	0.0%	2.8%	45.2%

1. Column percentages add to 100%

Supplementary Table S4. Adjusted incidence rate ratios and 95% confidence intervals from negative binomial regression models

	Count of emergency department visits	**Count of hospital admissions**	**Count of days spent in hospital**
Variable	**IRR (95% CI)**	**IRR (95% CI)**	**IRR (95% CI)**
Incentive tiers			
0-11 visits (ref)	-	-	-
12-23 visits	0.99 (0.95-1.03)	0.98 (0.94-1.03)	0.96 (0.88-1.05)
24-67 visits	0.97 (0.94-1.01)	0.96 (0.92-0.99)	0.94 (0.98-1.01)
68-127 visits	0.93 (0.89-0.97)	0.92 (0.87-0.97)	0.91 (0.92-0.99)
128+ visits	0.93 (0.89-0.97)	0.89 (0.85-0.94)	0.82 (0.75-0.89)

Note: IRR = adjusted incidence rate ratio; CI = Confidence Interval
All models adjusted for: sex, age, severity of functional impairment, rurality, chronic conditions, count of medications, home nursing, count of emergency department visits and hospital admissions in past 0-4 months and 5-12 months, physician sex, physician age, physician years of practice, physician practice type, international medical education, and board certification in family medicine

Supplementary Table S5. Adjusted incidence rate ratios and 95% confidence intervals from negative binomial regression models, sensitivity analysis

Analysis	Variable	Count of emergency department visits IRR (95% CI)	Count of hospital admissions IRR (95% CI)	Count of days spent in hospital IRR (95% CI)
Main Analysis	Home visit provision groups			
	None (ref)	-	-	-
	Q1 (lowest)	1.00 (0.96-1.04)	0.97 (0.93-1.00)	0.97 (0.89-1.05)
	Q2	0.96 (0.93-1.00)	0.95 (0.91-0.98)	0.96 (0.88-1.04)
	Q3	0.95 (0.92-0.99)	0.94 (0.90-0.97)	0.92 (0.84-1.00)
	Q4 (Highest)	0.93 (0.90-0.96)	0.89 (0.85-0.94)	0.83 (0.77-0.90)
No Palliative specialist physicians	Home visit provision groups			
	None (ref)	-	-	-
	Q1 (lowest)	1.00 (0.96-1.04)	0.98 (0.93-1.02)	0.97 (0.89-1.05)
	Q2	0.97 (0.96-1.01)	0.95 (0.90-0.99)	0.95 (0.88-1.04)
	Q3	0.96 (0.92-0.99)	0.94 (0.90-0.98)	0.91 (0.84-0.99)
	Q4 (Highest)	0.93 (0.89-0.96)	0.89 (0.85-0.93)	0.84 (0.77-0.91)
Only physicians whose roster had greater than the median proportion of home care patients	Home visit provision groups			
	None (ref)	-	-	-
	Q1 (lowest)	1.00 (0.95-1.05)	0.99 (0.93-1.06)	0.99 (0.89-1.11)
	Q2	0.95 (0.90-1.00)	0.94 (0.89-1.00)	0.97 (0.87-1.08)
	Q3	0.93 (0.88-0.97)	0.92 (0.87-0.98)	0.89 (0.80-0.99)
	Q4 (Highest)	0.91 (0.87-0.96)	0.89 (0.84-0.94)	0.83 (0.85-0.92)

Note: IRR = adjusted incidence rate ratio; CI = Confidence Interval
All models adjusted for: sex, age, severity of functional impairment, rurality, chronic conditions, count of medications, home nursing, count of emergency department visits and hospital admissions in past 0-4 months and 5-12 months, physician sex, physician age, physician years of practice, physician practice type, international medical education, and board certification in family medicine

Chapter 5: Associations between continuity of primary and specialty physician care and use of hospital-based care among community-dwelling older adults with complex care needs

Summary:

The final aspect of primary care that I am examining is continuity of care, which is a longstanding topic of interest within health service research. Specifically, I am examining longitudinal continuity, which is the degree to which a patient sees the same provider(s) over time. While continuity of primary care has been well-studied, continuity of care with specialist physicians has only recently become a topic of interest. I examined associations between the continuity of primary and specialty care concurrently to determine whether they have independent effects, the relative magnitude of those effects, and whether those effects vary by increasing multimorbidity, greater use of specialty care, and degree of impairment. I developed and employed a novel modification of the Bice-Boxerman continuity of care index to ensure that continuity of specialty care was independent of the number specialties seen.

I found that higher continuity of both primary care and specialty care had protective effects of generally similar size against emergency department use. This is a novel finding as it has not been previously established that the two types of continuity have independent associations. The similar size of the associations is also informative as it suggests that promoting continuity of specialty care should be of similar priority to continuity of primary care.

Citation:

Jones A, Bronskill SE, Seow H, Junek M, Feeny D, Costa AP. Associations between continuity of primary and specialty physician care and use of hospital-based care among community-dwelling older adults with complex care needs. *PLOS ONE*. 2020 Jun; 15(6):e0234205.

Abstract

Objective

While research suggests that higher continuity of primary and specialty physician care can improve patient outcomes, their effects have rarely been examined and compared concurrently. I investigated associations between continuity of primary and specialty physician care and emergency department visits and hospital admissions among community-dwelling older adults with complex care needs.

Methods

I conducted a retrospective cohort study of home care patients in Ontario, Canada, from October 2014 to September 2016. I measured continuity of primary and specialty physician care over the two years prior to a home care assessment and categorized them into low, medium, and high groups using terciles of the distribution. I used cox regression models to concurrently test the associations between continuity of primary and specialty care and risk of an emergency department visit and hospital admission within six months of assessment, controlling for potential confounders. I examined interactions between continuity of care and count of chronic conditions, count of physician specialties seen, functional impairment, and cognitive impairment.

Results

Of 178,686 participants, 49% had an emergency department visit during follow-up and 27% had a hospital admission. High vs. low continuity of primary care was associated with a reduced risk of an emergency department visit (HR=0.90 (0.89-0.92)) as was continuity of specialty care (HR=0.93 (0.91-0.95)). High vs. low continuity of primary care was associated also with a reduced risk of a hospital admission (HR=0.94 (0.82-0.96)) as was continuity of specialty care (HR=0.92 (0.90-0.94)). The effect of continuity of specialty care was moderately stronger among patients who saw four or more physician specialties.

Conclusion

Higher continuity of primary physician and specialty physician care had independent, protective effects of similar magnitude against emergency department use and hospital admissions. Improving continuity of specialty care should be a priority alongside improving continuity of primary care in complex, older adult populations with significant specialist use.

Introduction

Global population aging has resulted in a growing number of older adults living in the community with complex care needs such as multimorbidity, functional impairment, and frailty[1,2]. Global estimates of multimorbidity among older adults exceeds 50%[3], with estimates as high 81% in the United States[4], and figures are expected to continue to rise in the future[5–7]. The intensity of emergency department visits, hospitalizations, and overall health care expenditure increases with older age, and are further exacerbated by factors such as multimorbidity and frailty[4,8–10]. The growing challenge of multimorbidity and other complex care needs among older adults have spurred calls for a larger interdisciplinary physician workforce of both primary care and specialty care physicians, and greater continuity of physician care[7,11,12]

Continuity of care has been studied within health services research for decades as a method of examining how patients interact with their health care providers. Continuity is a complex construct with multiple aspects, including information continuity, management continuity, and interpersonal (or relational) continuity, the last of which is concerned with characterizing the on-going relationship between patient and provider[13]. A necessary component of interpersonal continuity is longitudinal continuity, which refers to the consistency with which a patient visits the same health care providers over time[14]. A continuous, longitudinal relationship between a provider and patient has been shown to

foster trust and familiarity, which can yield multiple benefits such as increased adherence to care plans, more effective communication, and greater satisfaction in care[15,16]. Higher continuity of care with physicians has been consistently linked to positive outcomes such as fewer emergency department visits, fewer hospital admissions, and lower mortality[17–19]. Consequently, improving continuity of care is a frequently sought objective of health care systems[20–22].

The development of the patient-physician relationship through longitudinal continuity has traditionally been highly valued within primary care[13,23]. More recently, the measurement and assessment of continuity within other physician specialties has become a topic of interest, although research is still limited[24–26]. Additionally, some researchers have examined continuity across all specialties (including primary care), particularly for multimorbid or otherwise complex patients who are expected to receive a significant portion of their care from specialist physicians[27–30]. In general, research suggests that continuity of both primary care and specialty physician care improve health utilization and mortality outcomes[17,31]. However, there has been little research that has concurrently examined and compared the effects of continuity of primary and specialty physician care in populations that are significant users of both types of care. Knowledge of the relative effectiveness of continuity of primary and specialty care can help inform strategies to promote continuity of care for older adults with complex care needs.

The objective of this study is to examine and compare the associations between continuity of primary and specialty physician care and emergency department use and hospital admissions and to explore potential modification of the effects of continuity. Within a cohort of community-dwelling older adults with complex care needs, I will determine whether continuity of primary and specialty care have independent effects, the relative magnitude of those effects, and examine interactions between continuity of care and increasing multimorbidity, use of physician specialties, functional impairment, and cognitive impairment.

Methods

Setting

Ontario is Canada's most populous province, with an estimated population of 13.7 million in 2015, including 3 million residents aged 60 years or older. Most residents are covered by Ontario's universal, publicly-funded, health insurance program that covers medically necessary services, including physician care, hospital and emergency department care, home care, and other services. Ontario operates a "gatekeeper" system in which access to specialist physicians requires a referral from primary care physician. Ontario offers publicly-funded home care for eligible residents which may include nursing, personal support and homemaking, physiotherapy, occupational therapy, and other services. Eligibility is based on need and criteria typically include difficulty in performing activities of daily living (such as bathing or toileting) or need for frequent nursing for reasons such as wound care, catheter/ostomy care, intravenous medications, or chronic disease monitoring.

Study design, population, and data sources

I conducted a population-based, retrospective cohort study of older adults receiving home care on an on-going basis in Ontario, Canada. Home care patients in Ontario are typically community-dwelling older adults characterized by multiple chronic conditions and/or functional and cognitive impairments. I focused on home care patients as the availability of accurate clinical measures, significant use of primary and specialist physicians, and frequent emergency department visitation make them an ideal population in which to examine the simultaneous influence of continuity of primary and specialty physician care[32]. I used multiple, linked, health administrative databases to identify a cohort of older adult home care patients who received a comprehensive home care assessment. Home care patients were identified using the Home Care Database. Physician billing claims were extracted from

the Ontario Health Insurance Plan database. The National Ambulatory Reporting System was used to identify emergency department visits and the Discharge Abstract Database was used to capture hospital admissions Patient deaths were identified with the Registered Persons Database and admission to long-term care homes with the Continuing Care Reporting System. Datasets were linked using unique encoded identifiers and analyzed at ICES (S1 Appendix). This study was granted an exemption from formal ethics review by the Hamilton Integrated Research Ethics Board as the use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a research ethics board.

Participants

Home care patients receiving on-going home care in Ontario are frequently assessed with the Resident Assessment Instrument for Home Care (RAI-HC)[33], which is a comprehensive clinical assessment. The reliability and validity of the RAI-HC assessment is well documented.[34–36] I selected all RAI-HC assessments for publicly-funded home care patients aged 60 years or older that were completed in Ontario between October 1, 2014 and September 30, 2016. If an individual was assessed more than once during the accrual period, their most recent assessment was used. This assessment date was used as the reference date for cohort entry. To ensure that both continuity of primary and specialty care could be calculated for all participants, I included only patients with at least two primary care physician visits and two specialist physician visits (within the same specialty) in the two years prior to the assessment.

Measures

<u>Modified Bice-Boxerman continuity of care index</u>

The Bice-Boxerman continuity of care index measures the dispersion of health care visits among providers, reaching a maximum value of one when all visits are within one provider and a minimum

value of zero when all visits are to different providers[37]. The index is one of the most commonly used measures of longitudinal continuity and has been employed within single physician specialties as well as across multiple specialties[38]. However, using the Bice-Boxerman index across multiple physician specialties results in lower continuity for patients who see more than one specialty as the physicians operating within the different specialties will naturally be different. The more physicians from different specialties a patient sees, the lower their continuity will be. Moreover, patients with complex care needs may benefit from regularly seeing physicians from multiple specialties, meaning that higher continuity when measured in the traditional manner may neither be desirable or optimal for these patients[39]. This complicates the interpretation of the Bice-Boxerman index, as higher continuity may no longer be expected to be associated with improved patient outcomes

To address these limitations and preserve the expectation that higher continuity should be associated with improved outcomes, I modified the Bice-Boxerman index to focus on fragmentation of care within each specialty rather than across specialties. My modified version divides the original Bice-Boxerman index by the maximum value of the index each patient could achieve assuming that each visit within each specialty was to the same physician. The resulting modified index reaches a maximum value of one when all visits *within each specialty* are to the same physician and a value of zero when each visit is to a different physician. The modified index is identical to the original index when only one specialty considered and is otherwise equivalent to a weighted average of specialty-specific Bice-Boxerman indices, assuming that specialty included has least two visits. The formulae for the original and modified Bice-Boxerman indices, along with an empirical example and proof can be found in S2 Appendix.

I used the modified Bice-Boxerman index to calculate continuity of care separately for primary care and specialty care. For primary care physician continuity, I included all ambulatory physician visits in the two years prior to the baseline assessment within family practice/general practice and community medicine (Fig 1). For specialty physician continuity I included all ambulatory visits in the two years prior

to the baseline assessment from all remaining physician specialties. For use in statistical analysis I split the continuity indices into high, medium, and low groups based on terciles of the sample distribution.

Outcomes

Associations between continuity of care and use of hospital-based care are among the frequently tested hypotheses in the literature on continuity of care[18]. Home care patients have been previously noted to have high rates of emergency department visits and hospital admissions, which contribute to health system overcrowding may lead adverse events such as delirium and deconditioning[40,41]. I followed patients for six months after the baseline assessment and calculated the number of days until the first emergency department visit and number of days until the first hospital admission as my primary outcomes. The outcomes were censored at date of death, admission to a long-term care home, and at the end of the six-month follow-up window.

Covariates

I identified important covariates to adjust for confounding in statistical models based on previous research[27,42]. These covariates included age, sex, rurality, count of chronic conditions, count of physician specialties seen in the previous two years (including primary care), congestive heart failure, chronic obstructive pulmonary disease, count of concurrent medications, count of outpatient physician visits in previous two years, count of emergency department visits in the previous two years, and hospital admission in the previous two years. Chronic diseases and medications were measured using the baseline RAI-HC assessment. All other covariates were extracted from administrative data sources. I focused on congestive heart failure and chronic obstructive pulmonary disease in particular as they have been shown to be major risk factors for use of hospital-based care in home care patients[43]. My broader count of chronic conditions included: stroke, congestive heart failure, hypertension, dementia,

Parkinsonism, multiple sclerosis, arthritis, osteoporosis, any psychiatric condition, cancer, chronic obstructive pulmonary disease, diabetes, and renal failure. The count of physician specialties only included those specialties in which a patient had a least two visits in the past two years to align with my calculation of continuity of care.

Count of chronic conditions, count of physician specialties, functional impairment, and cognitive impairment were identified as potential modifiers of the relationship between continuity of care and emergency department use. To examine modification across count of chronic conditions and count of physician specialties, I categorized each variable into three groups, as equally-sized as possible, based on the sample distribution. Functional impairment was measured using the ADL Hierarchy Scale (ADL)[44] and split into 3 categories, 0-1, 2-3, 4-6. Cognitive impairment was measured by the Cognitive Performance Scale [45](CPS) and also split into 3 categories: 0-1, 2-3, 4-6.

Analysis

I reported the demographic and health characteristics my of cohort. I further described the distribution of each continuity index, physician use within the two years prior to the baseline assessment, and proportion patients with an emergency department visit and hospital admission during follow-up. I used multivariable cox regression models to examine the associations between continuity of primary care and continuity of specialty care and risk of each outcome, controlling for identified confounders. To examine effect modification, I fit additional models with interaction terms between the continuity of care measures each of my potential effect modifiers. I reported the hazard ratios and 95% confidence intervals of an emergency department visit and hospital admission for all variables in the initial cox models. For the effect modification models, I reported the hazard ratios and 95% confidence intervals for high vs. low continuity of primary and specialty care within each category of the effect modifiers and the p-value of the interaction term.

Results

Of the 232,694 unique older adults home care patients with a RAI-HC assessment, 178,686, patients had at least two primary care physician visits and at least two specialist physician visits (within the same specialty) during the two years prior to the assessment. The median age of the population was 82 years and 61% were female (Table 1). Over half (59%) of the patients had at least a mild cognitive impairment (CPS >=2) and 42% needed at least limited assistance with the activities of daily living (ADL >=2). The most common chronic conditions were hypertension (66%), arthritis (54%) and diabetes (30%). The median number of chronic conditions was three. The proportion of patients with an emergency department visit during the six-month follow-up was 49% while 27% had a hospital admission.

Distribution of continuity indices and baseline physician use

The median value of continuity of primary care was 0.73 (Table 2). The 33th and 66th percentiles used to define the low, medium, and high continuity of primary care groups were 0.54, and 0.88 respectively. The median value of the continuity of specialty care was 0.89 and the 33th and 66th percentiles used to define the low, medium, and high continuity of specialty care groups were 0.68, and 1. The median count of physician visits in the two years prior to the baseline assessment was 27, with a median of 14 visits within primary care and 10 visits within specialty care.

Association between continuity of care and emergency department visits

Both continuity of primary and specialty physician care were associated with small reductions of generally similar size in the risk of an emergency department visit (Table 3). High vs. low continuity of primary care was associated with a hazard ratio (HR) of 0.90 (95% CI 0.89-0.92) while medium vs. low

continuity was associated with an HR of 0.96 (95% CI 0.94-0.98). High vs. low continuity of specialty care was associated with a HR of 0.93 (0.91-0.95) while medium vs. low continuity was associated with HR of 0.97 (0.95-0.99).

Association between continuity of care and hospital admissions

Continuity of primary and specialty physician care were also both associated with small reductions in the risk of a hospital admission (Table 3). High vs. low continuity of primary care was associated with an HR of 0.94 (95% CI 0.92-0.96) while medium vs. low continuity was associated with an HR of 0.96 (95% CI 0.94-0.98). High vs. low continuity of specialty care was associated with a HR of 0.92 (0.90-0.94) while high vs. medium continuity was associated with an HR of 0.96 (0.94-0.99).

Effect modification of associations between continuity and emergency department use and hospital admissions

Count of chronic conditions was categorized into groups of 0-2, 3, and 4+ conditions while count physician specialties seen was categorized into 2, 3 and 4+ specialties. Significant modification of the effect of high vs. low continuity of specialty physician care occurred across categories of the number of specialties seen for both outcomes (Figs 2 and 3). The HR of an emergency department visit associated with high vs. low continuity of specialty care was 0.94 (0.91-0.97) for two specialties, 0.96 (0.93-0.99) for three specialties and, 0.90 (0.88-0.93) for four or more specialties. For hospital admissions, the HR associated with high vs. low continuity of specialty care was 0.96 (0.93-1.00) for two specialties, 0.94 (0.90-0.98) for three specialties, and 0.87 (0.84-0.90) for four or more specialties.

Significant modification also occurred in the association between high vs. low continuity of primary care and emergency department visits across categories of cognitive impairment, with the

effect of continuity being stronger among patients with a CPS of 0-1 (HR: 0.89 (0.86-0.91)) than those with a CPS of 2-3 (HR: 0.93 (0.91-0.95)) and CPS of 4-6 (HR: 0.93 (0.87-0.99)). However, there was no significant modification for hospital admissions. Finally, there was modification in the association between high vs. low continuity of specialty care and hospital admissions across count of chronic conditions, but this is the result of a substantively weaker association in the middle category of chronic conditions (HR: 0.97 (0.93-1.01) compared to the higher (HR: 0.91 (0.88-0.94)) and lower categories (HR: 0.90 (0.87-0.94)). The lack of a dose-response relationship limits interpretation of this effect.

Discussion

I found that higher longitudinal continuity of primary physician care and specialty physician care were independently associated with lower risks of emergency department visits and hospital admissions in a population of community-dwelling older adults with complex care needs. The observed risk reductions were small and of generally similar size across continuity measures and outcomes. While there was no consistent modification of the effect of either continuity of primary or specialty care with increasing multimorbidity, the effect of continuity of specialty care was moderately stronger in patients who saw four or more physician specialties. There was also some support for a stronger effect of continuity of primary care among patients without cognitive impairment.

While research suggests that both primary care and specialty physician care are effective at improving patient outcomes, few studies have examined both in the same population in a way that would allow for an assessment of the relative magnitude of their effects. One study by Bayliss et al [31] examined the effects of both primary and specialty physician care in a group of seniors with chronic conditions and concluded that continuity of primary care, but not specialty care, was associated with a reduction in the risk of an emergency department visit. While my finding of similar, independent, effects stands in contrast to the findings of this previous study, my study was conducted in a different

population within a different health system and benefited from a considerably larger study size. The previous study also recorded a substantially lower continuity of specialty care than I observed, a difference which is likely related to my use of a modified Bice-Boxerman index that aggregates continuity within each specialty rather than across multiple specialties. my modified continuity index provides a clearer interpretation when measuring continuity across multiple specialties as it only discounts continuity due to inconsistency in seeing the same physicians within a specialty, rather than being influenced by the overall number of physician specialties seen.

It is reasonable to expect that the associations between continuity of primary and specialty physician care and use of hospital-based care could change with increasing multimorbidity and use of physician specialties. Multimorbidity presents significant challenges to effectively managing care, and better continuity of care has often been cited as a partial remedy[46,47]. Additionally, it is plausible to imagine that the influence of continuity of specialty care would increase along with the number of physician specialties a patient sees. At the same time, however, it can be beneficial for patients that see many physicians to have a designated primary care physician at the center that can operate within a patient-centric rather than disease-centric approach and connect with all the other providers[48]. Ultimately, the only significant modification I found was with respect to the effect of continuity of specialty care among patients who saw four or more physician specialties.

While it is intuitive that higher continuity of specialty care is more effective among patients who see more physician specialties, it is intriguing that I found no meaningful modification of the effect of continuity by the count of chronic conditions. Considerable attention has been given to promoting continuity among patients with multimorbidity and research has shown that continuity matters more to patients with more chronic conditions.[49] However, a study by Mondor et al[27] among home care patients with dementia in Ontario found that the association between multimorbidity and emergency department visits did not vary across categories of continuity of care. Another study by Weir et al[30]

found that multimorbidity did not meaningfully modify the effect of continuity on hospitalizations and mortality among US patients with incident diabetes. It is also possible that there is a ceiling effect to the influence of multimorbidity on continuity, and that by virtue of being a home care recipient, my population was already in poor enough health to have reached it.

I found no evidence of effect modification of continuity of care across categories of functional impairment, but there was some support for greater effectiveness of continuity of primary care among patients with intact cognition. This modification was only significant in one of my outcomes but the observed hazard ratios trended in the same direction for both measures of continuity in both outcomes. It is intuitive that the relational benefits of increased continuity of care could be lessened for patients with significant cognitive impairments and future research should explore this topic further.

My findings support the value of consistency in seeing the same specialist physicians alongside consistency in seeing the same primary care physician. While the importance of explicitly considering specialty physicians in informational and management continuity measures has been recognized, much of the attention directed towards improving longitudinal continuity has remained focused on primary care[50,51]. My results suggest that for complex, older adult populations, efforts to improve the continuity of specialty care should be a priority alongside continuity of primary care. Furthermore, I found that it was not among patients with more chronic conditions, but rather among those who saw more physician specialties, in which continuity of specialty care had a stronger effect[12]. While there is a clear connection between multimorbidity and use of more physician specialties[52], it may be that the additional benefit of continuity of specialty care only incurs when the growing burden of chronic diseases results in visits to a substantial number of physician specialties. Therefore, patients who see numerous physician specialties in additional to their primary care physician should be recognized as key population in which to promote continuity of specialty care.

Limitations

My study has several key strengths, including use of population-based data and a large study size. There are, however, notable weaknesses. I used claims-based data to examine longitudinal continuity of care, which is only one aspect of continuity. While the consistency with which a patient sees the same provider is a critical aspect of continuity of care, I was unable to consider other aspects such as informational or management continuity. While in individual practices, drops in informational and managerial continuity may always co-occur with drops in longitudinal continuity, in collaborative practices, which are now the standard, information and managerial continuity can be maintained even when a different primary care provider is seen.

Furthermore, in complex patients who see multiple physician specialties, interaction between physicians is clearly of vital importance[50,53]. However, my data sources, similar to other as claims databases, did not contain information on quantity or quality of communication between physicians. Also, I only examined patients who had at least two primary care and two specialty care physician visits. While this was necessary in order to examine the relative effects of primary and specialty physician care, I cannot generalize some of the other findings, such as the lack of modifying effect by increasing multimorbidity, to a population that does not have any specialist physician use.

Conclusion

Among community-dwelling older adults with complex care needs, higher longitudinal continuity of primary physician care and specialty physician care had similar, independent, protective effects against emergency department use and hospital admissions. These effects did not vary with increasing multimorbidity, but continuity of specialty physician care was more effective in patients who saw four or more physician specialties. Continuity of specialty physician care should be considered of similar value to continuity primary care among complex, community-dwelling older adults with

significant specialist physician use. Patients who see physicians within numerous specialties should be recognized as a group in which continuity of specialty care is of particular importance.

Tables and Figures

Figure 1: Study timeline

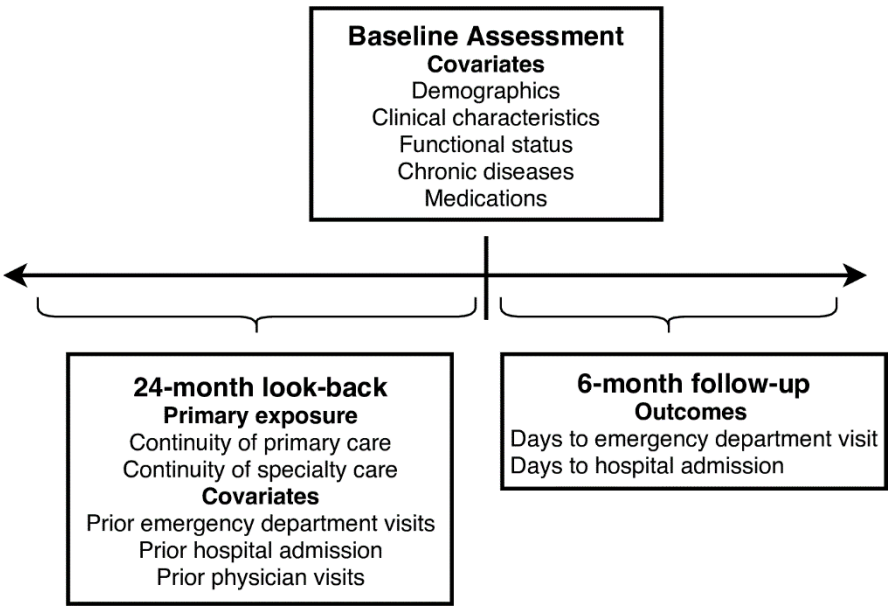

Figure 2. Associations between continuity of care and risk of an emergency department visit across effect modifiers

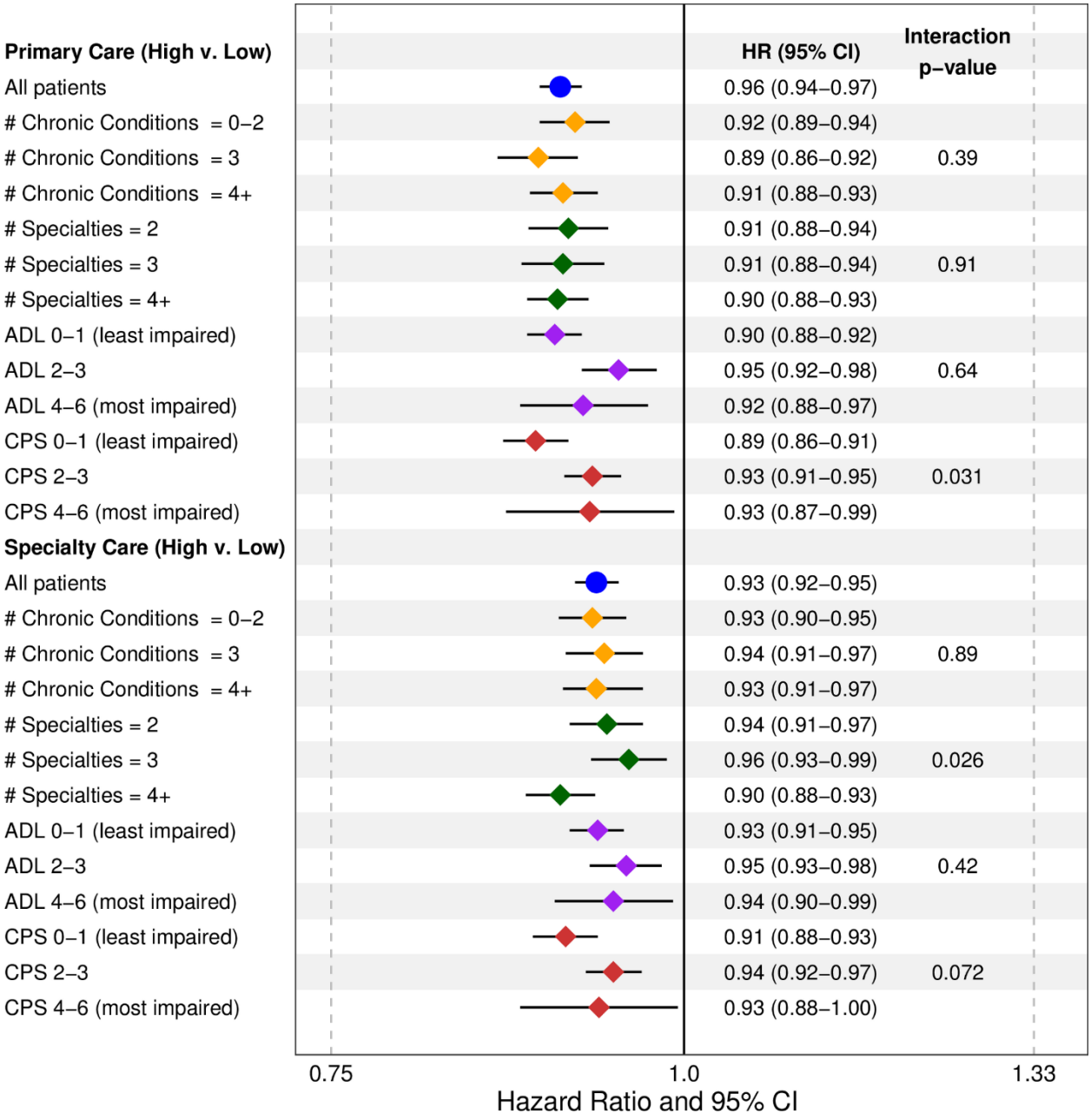

Figure 3. Associations between continuity of care and risk of a hospital admission across effect modifiers

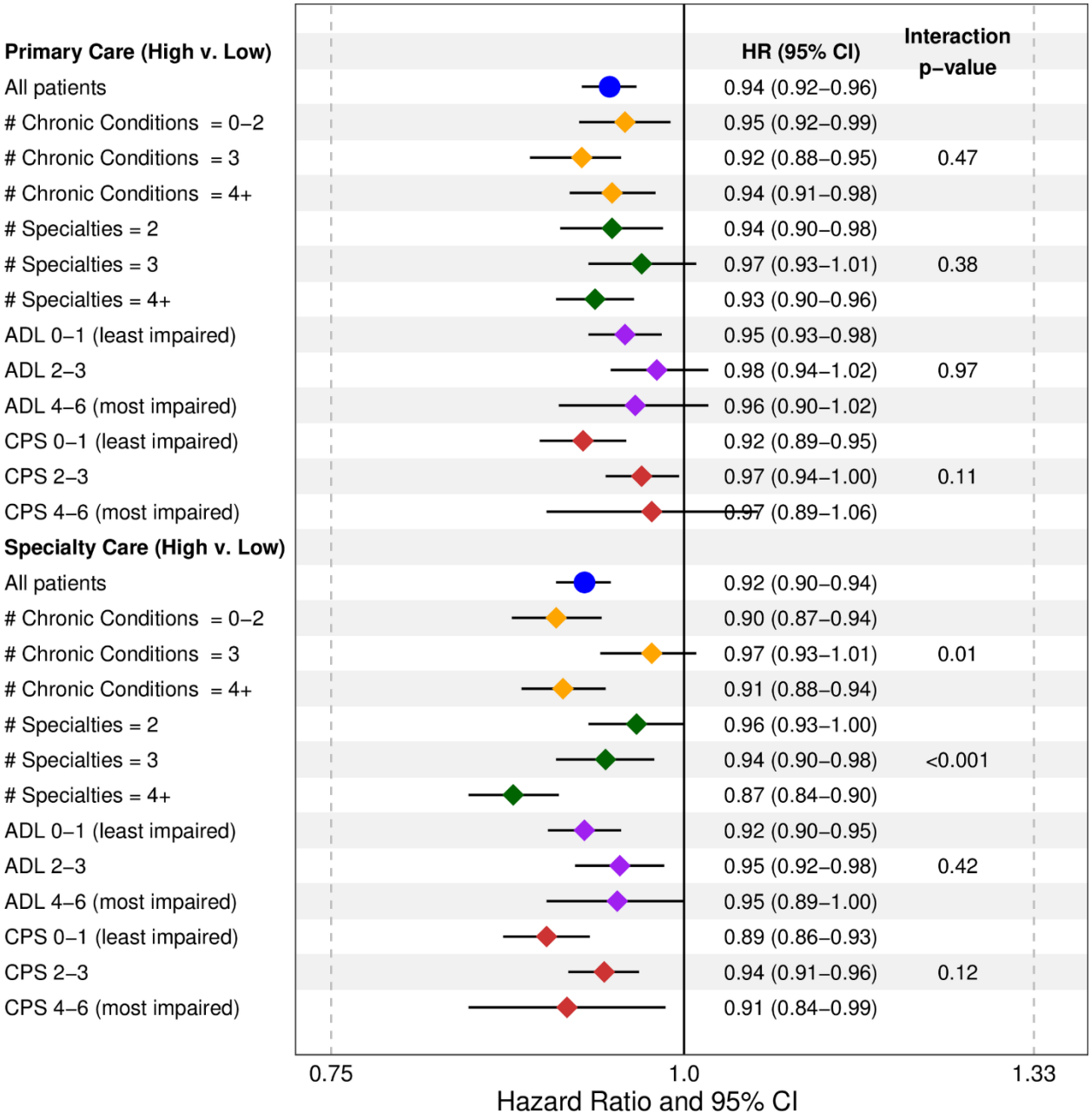

Table 1. Baseline characteristics of cohort members

Patient Characteristics	no. (%) n=178,686
Demographics	
Age, yr (Median (Q1, Q3))	82 (75, 88)
Sex, female	109620 (61)
Lived Alone	80436 (45)
Rurality	
Urban	121161 (71)
Semiurban	38584 (22)
Rural	13763 (8)
Health	
ADL Impairment[a]	
Independent/Supervision	104872 (59)
Limited/Extensive	54468 (31)
Maximal/ Dependent	19168 (11)
Cognitive Impairment[b]	
Intact / Borderline intact	72910 (41)
Mild / Moderate	93527 (52)
Severe	12071 (7)
Number of Medications	
0-4	21754 (12)
5-8	54722 (31)
9 or more	102032 (57)
Any mood symptom	92340 (52)
Bladder incontinence	71017 (40)
Fall in last 90 days	75309 (42)
Chronic Conditions	
Congestive heart failure	27043 (15)
Stroke	31319 (18)
Hypertension	117952 (66)
Chronic obstructive pulmonary disease	36681 (21)
Diabetes	53990 (30)
Dementia	43211 (24)
Multiple Sclerosis	1609 (1)
Parkinsonism	9674 (5)
Arthritis	96309 (54)
Osteoporosis	42713 (24)
Psychiatric diagnosis	34061 (19)
Cancer	31221 (17)

Renal failure	17854 (10)
Count of chronic conditions (Median (Q1, Q3))	3 (2, 4)

Note: ADL= Activities of daily living, Q1 = Quartile 1, Q3 = Quartile 3

[a] ADL Hierarchy Scale: Includes personal hygiene, locomotion, eating and toileting

[b] Cognitive performance scale

Table 2. Distribution of continuity indices and baseline physician utilization

Measure	**Median (Q1, Q3)**
Continuity of primary care	0.73 (0.47, 1)
Continuity of specialty care	0.89 (0.57,1)
Count of physician visits	27 (17, 40)
Count of primary care physician visits	14 (8, 22)
Count of specialty care physician visits	10 (6, 18)
Count of physician specialties seen	3 (2, 5)

Note: Covers two years prior to cohort entry

Table 3. Hazard ratios and 95% confidence intervals from multivariable cox models

Variable	Emergency Department Visit HR (95%CI)	Hospital Admission HR (95%CI)
Continuity of primary care		
High	0.90 (0.89-0.92)	0.94 (0.92-0.96)
Medium	0.96 (0.94-0.98)	0.96 (0.94-0.98)
Low (ref)	-	-
Continuity of specialty care		
High	0.93 (0.91-0.95)	0.92 (0.90-0.94)
Medium	0.97 (0.95-0.99)	0.96 (0.94-0.99)
Low (ref)	-	-
Sex, F	0.92 (0.81-0.84)	0.75 (0.74-0.77)
Age		
60-69 (ref)	-	-
70-79	1.01 (0.98-1.03)	1.04 (1.01-1.07)
80-89	1.04 (1.02-1.06)	1.09 (1.06-1.12)
90+	1.18 (1.15-1.20)	1.30 (1.26-1.34)
Rurality		
Urban (ref)	-	-
Semiurban	1.21 (1.19-1.23)	1.14 (1.11-1.16)
Rural	1.41 (1.38-1.45)	1.23 (1.20-1.28)
Count of comorbid conditions		
0-2 (ref)	-	-
3	1.04 (1.02-1.06)	1.05 (1.02-1.07)
4+	1.12 (1.10-1.14)	1.13 (1.10-1.16)
Count of physician specialties seen		
2 (ref)	-	-
3	1.02 (1.00-1.04)	1.00 (0.97-1.03)
4+	1.09 (1.07-1.12)	1.07 (1.04-1.10)
Congestive heart failure	1.19 (1.17-1.21)	1.34 (1.31-1.37)
Chronic obstructive pulmonary disease	1.13 (1.11-1.15)	1.18 (1.15-1.21)
Count of concurrent medications	1.01 (1.01-1.02)	1.02 (1.02-1.03)
Outpatient physician visits in past two years	1.00 (1.00-1.01)	1.00 (1.00-1.00)
Emergency department visits in past two years	1.03 (1.03-1.03)	1.01 (1.01-1.02)
Hospital admission in past two years	1.45 (1.43-1.47)	1.75 (1.72-1.78)

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Appendices

S1 Appendix: Databases used in the study

ICES Databases	Description
Ontario Health Insurance Policy Claims (OHIP)	The OHIP claims database contains information on inpatient and outpatient services provided to Ontario residents eligible for the province's publicly funded health insurance system by fee-for-service health care practitioners (primarily physicians) and "shadow billings" for those paid through non-fee-for-service payment plans. The main data elements include patient and physician identifiers (encrypted), code for service provided, date of service, associated diagnosis, and fee paid.
National Ambulatory Care Reporting System (NACRS)	The NACRS is compiled by the Canadian Institute for Health Information and contains administrative, clinical (diagnoses and procedures), demographic, and administrative information for all patient visits made to hospital- and community-based ambulatory care centres (emergency departments, day surgery units, hemodialysis units, and cancer care clinics). At ICES, NACRS records are linked with other data sources (DAD, OMHRS) to identify transitions to other care settings, such as inpatient acute care or psychiatric care.

Home care Database(HCD)	The HCD is a clinical client centric database that captures all services that are provided by or coordinated by Community Care Access Centres (CCACs). The data elements captured include information on: client, intake, assessment, admission & discharge, diagnosis and surgical procedure, and care delivery. ICES receives home care data from the Ontario Ministry of Health and Long-Term Care (MOHLTC). The primary purpose of the information collected through the HCD is to aid in planning and better clinical insight into clients who encounter service through CCACs.
Resident Assessment Instrument (RAI)-Home care source (OACCAC)	The RAIHC database is managed by the Community Care Access Centres (CCACs) and is a standardized clinical assessment to all long-stay home care clients in Ontario defined as clients receiving ongoing support for at least 60 consecutive days. Data collected include comprehensive clinical, functional and resource utilization information that are used to inform client needs. When used over time, it provides the basis for an outcome-based assessment of the person's response to care or services.
Registered Persons Database(RPDB)	The RPDB provides basic demographic information (age, sex, location of residence, date of birth, and date of death for deceased individuals) for those issued an Ontario health insurance number. The RPDB also indicates the time periods for which an individual was eligible to receive publicly funded health insurance benefits and the best known postal code for each registrant on July 1st of each year.
Discharge Abstract Database(DAD)	The DAD is compiled by the Canadian Institute for Health Information and contains administrative, clinical (diagnoses and procedures/interventions), demographic, and administrative information for all admissions to acute care hospitals, rehab, chronic, and day surgery institutions in Ontario. At ICES, consecutive DAD records are linked together to form 'episodes of care' among the hospitals to which patients have been transferred after their initial admission.

S2 Appendix: Formulae, empirical example, and proof regarding the Bice-Boxerman and modified Bice-Boxerman continuity of care indices

Let $n_i$be the number of visits to ith provider and n_j be the number of visits within the jth specialty. The overall number of visits, number of providers, number of specialties are given by n, p, and s respectively.

The Bice-Boxerman continuity of care index is given by:

$$\frac{\left(\sum_{i=1}^{p} n_i^2\right) - n}{n^2 - n}$$

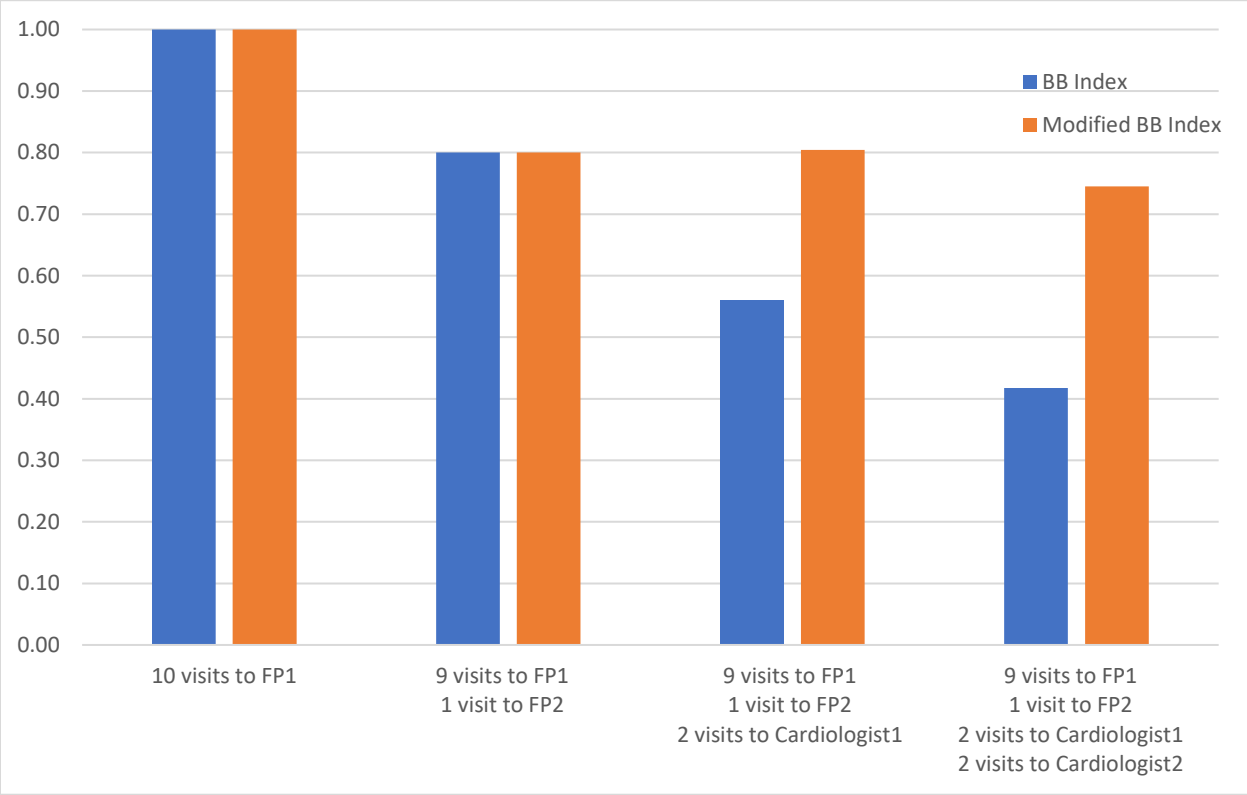
The modified Bice-Boxerman continuity of care index used in this study is defined as:

$$\frac{\left(\sum_{i=1}^{p} n_i^2\right) - n}{\left(\sum_{j=1}^{s} n_j^2\right) - n}$$

The modified Bice-Boxerman continuity of care index assumes that providers belong to one and only one specialty.

Empirical Example

Figure S1: Behavior of the original and modified Bice-Boxerman indices with increasing visits to multiple specialties



The above figure displays the value of the Bice-Boxmeran and modified Bice-Boxerman continuity indices under several scenarios involving visits to family physicians (FP) and cardiologists. The first set of bars representing a patient visiting the same family physician 10 times while the second set of bars represents a patient visiting one family physician 9 times and a different family physician once. The third set of bars represents a patient visiting one family physician 9 times, a different family physician once, and the same cardiologist twice, and the last set of bars represents the patient visiting one family physician 9 times, a different family physician once, and two different cardiologists twice each. The original Bice-Boxerman index drops in value across every scenario, including when then patient sees

only a single cardiologist, while the modified Bice-Boxerman index only drops in value when visits within a specialty are dispersed among multiple providers.

Proof

Let $n_i$be the number of visits to ith provider, $n_j$be the number of visits within the jth specialty, and n_{jk} be the number of visits to kth provider within the jth specialty. The overall number of visits, number of providers, number of specialties, and number of providers within each specialty j are given by n, p, s, and r_j respectively.

Proof that the modified Bice-Boxerman (MBB) index is a weighted averaged of specialty-specific unmodified Bice-Boxerman indices (BB) where each specialty has the weight $(n_j^2 - n_j)/(\sum_{j=1}^{s}(n_j^2) - n_j)$:

Assuming that each provider exists within only one specialty and that each $n_j \geq 2$ then:

$$\boldsymbol{BB = \frac{\left(\sum_{i=1}^{p} n_i^2\right) - n}{n^2 - n}}$$

$$\boldsymbol{BB_j = \frac{\left(\sum_{k=1}^{r} n_{jk}^2\right) - n_j}{n_j^2 - n_j}}$$

$$\boldsymbol{MBB = \frac{\left(\sum_{i=1}^{p} n_i^2\right) - n}{\left(\sum_{j=1}^{s} n_j^2\right) - n}}$$

$$\boldsymbol{= \frac{\left(\sum_{j=1}^{s}\left(\sum_{k=1}^{r} n_{jk}^2\right)\right) - \sum_{j=1}^{s} n_j}{\left(\sum_{j=1}^{s} n_j^2\right) - n}}$$

$$= \frac{\left(\sum_{j=1}^{s}\left(\sum_{k=1}^{r} n_{jk}^2\right) - n_j\right)}{\left(\sum_{j=1}^{s} n_j^2\right) - n}$$

$$= \frac{\sum_{j=1}^{s}\left(\left(\left(\sum_{k=1}^{r} n_{jk}^2\right) - n_j\right)\left(\frac{n_j^2 - n_j}{n_j^2 - n_j}\right)\right)}{\left(\sum_{j=1}^{s} n_j^2\right) - n}$$

$$= \frac{\sum_{j=1}^{s}\left(\frac{\left(\left(\sum_{k=1}^{r} n_{jk}^2\right) - n_j\right)\left(n_j^2 - n_j\right)}{n_j^2 - n_j}\right)}{\left(\sum_{j=1}^{s} n_j^2\right) - n}$$

$$= \frac{\sum_{j=1}^{s}\left(BB_j\left(n_j^2 - n_j\right)\right)}{\left(\sum_{j=1}^{s} n_j^2\right) - n}$$

$$= \frac{BB_1\left(n_1^2 - n_1\right)}{\left(\sum_{j=1}^{s} n_j^2\right) - n} + \frac{BB_2\left(n_2^2 - n_2\right)}{\left(\sum_{j=1}^{s} n_j^2\right) - n} + \cdots + \frac{BB_s\left(n_s^2 - n_s\right)}{\left(\sum_{j=1}^{s} n_j^2\right) - n}$$

Chapter 6: Discussion

This thesis examined the extent to which several aspects of primary care were associated with emergency department use among long-stay home care patients. I examined access, continuity, comprehensiveness, and coordination of primary care in ways that I expected to be particularly relevant for a home care population. Overall, I found that better quality of primary care in terms access to afterhours primary care, primary care physician home visits, and continuity of care, was associated with fewer emergency department visits.

The first study found that home care patients were significant users of primary care as well as other types of ambulatory care, including specialist physician care and the emergency department. Billing claims for coordination between home care and primary care were rarely utilized, which could indicate difficulty in communication and/or integration, but limited awareness of the codes among physicians suggests that their use likely underestimates the true prevalence of coordination.

In the second study I found that patients who had used afterhours primary care in the previous year were less likely to have a non-urgent same-day emergency department visit, but did not find a consistent effect when access was operationalized on the level of the primary care practice. The third study found that patients with extensive functional impairments whose most responsible primary care physician provided higher levels of home visits had lower use of emergency department visits and hospital admissions.

The final study found that increased continuity of both primary care and specialty care had similarly sized protective effects against emergency department visits while controlling for the influence of the other. These effects did not change meaningfully across increasing multimorbidity but the association with continuity of specialty care became slightly stronger when more specialists were seen.

A common thread across my findings is that better quality of primary care was associated with fewer emergency department visits. However, there are differences among my results in terms of the strength of the associations on less and more urgent subsets of emergency departments visits. Afterhours primary care was associated with a stronger reduction in risk for the less urgent visits, while physician home visits patterns had a greater effect among more urgent visits. This could be interpreted as differences in how the aspects of primary care that I examined influence "avoidable" and "non-avoidable" emergency department visits. Better access to afterhours primary care can potentially allow a primary care visit to replace a less urgent emergency department visit while regular physician home visits enables early management of emerging health issues that prevents them from becoming serious enough to warrant an urgent emergency department visit that leads to a hospital admission.

Comparison of findings with research literature

The published research literature is generally consistent with regards to the overall value of primary care and to the relevance of the four C framework as a means to describe quality in primary care.[33,34,39,106–108] However, within the literature there is conflicting evidence, uncertainty, and gaps in knowledge around how the specific primary care interventions and features I examined affect outcomes, particularly in a specialized population such as home care patients.[109–111]. Taken in aggregate, my findings agree with the literature as to the general value of primary care. Specifically, they advance the field by investigating new research questions around the value of primary care, exploring the influence of primary care in novel contexts, and advancing health research methods.

The degree of coordination between home care and primary care in Ontario is understudied and my study was the first examine it using physician billing codes. Although I was unable to reliably established the level of coordination, the probable underreporting of the codes has policy implications in its own right. The investigation of access afterhours primary care is situated in a novel context and

answers an original question by testing whether afterhours primary care can act as an effect modifier, i.e., reducing the risk of an emergency department visit following an event known to risk. Using a study design that is at less risk of bias than traditional cohort and cross-sectional studies, my findings contribute new evidence to the frequently conflicted research on the topic.[52,53,112,113]

The study on continuity of care examined a novel question around the relative associations between continuity of primary and specialty physician care and emergency department use. These results expand our general knowledge of with whom and by how much continuity of care matters. The study also contributed to the health research methods literature by introducing a modification of a common measure of continuity of care that is designed for use in calculating continuity across multiple physician specialties. Finally, my population-based analysis of the home visit practice patterns of primary care physician represents a novel approach to a topic that has been largely dominated by evaluations of specific home-based primary care programs. The findings are particularly relevant to health systems seeking to increase physician provision of home visits through incentives or other policy tools.

Implications of findings

My findings have several important implications for clinicians and policy-makers interested in bolstering the capacity of primary care to better support community-dwelling older adults with complex care needs. First, improving universal, timely, access to primary care for home care patients should remain a priority. It is self-evident that primary care cannot be effective if patients cannot access it, yet Canada performs poorly on measures of access to timely primary care when compared to other developed countries and has not been improving over time[114]. In this thesis, both increased access to afterhours care and home visits for functionally impaired patients were associated with lower risks of emergency department visits. Although there have been on-going efforts within Ontario and other

jurisdictions[115,116] to increase access to primary care, my results suggest there is room for improvement and that additional endeavors to increase access will likely yield benefits among home care patients and other community-dwelling older adults with similar care needs. Potential innovations to improve access could include advanced access scheduling models[117] or greater involvement of nurse practitioners and community pharmacists in primary care[118]. In addition, funding to expand multidisciplinary home-based primary care programs could augment general financial incentives for home visits to improve care for older adults with functional impairments or other complex care needs. Additionally, telemedicine and community paramedicine programs could provide access to primary care for older adults with complex care needs in rural and remote locations[119,120].

A second implication of my findings is that while continuity of care is a core pillar of quality in primary care, continuity of care with specialist physicians is of potentially equal relevance. Decades of research touting the benefits of continuity of primary care have made it common a health system objective[121,122]. Yet my findings suggest that continuity with specialty physicians may be similarly effective and therefore worthy of similar priority. The independence of the observed effects suggests that interventions or reforms that increase both the continuity of both primary and specialty care would have the greatest impact. For example, continuity in both areas could be encouraged through the development of primary care – specialty care networks, or co-location of specialty care within primary care.[123] Within Ontario, the recently formed Ontario Health Teams[124] present an opportunity to encourage continuity, in all of its aspects, across hospital and community sectors, including both primary and specialty care.

Finally, my findings suggest that improving integration between home care with other health care sectors is challenging. The utilization of home care-primary coordination codes in my research was very low, although their use may understate the true provision of coordination. Nonetheless the billing codes I examined were introduced as an incentive to increase coordination and their lack of use

indicates they are not achieving their purpose. Difficulty integrating home care and other sectors of the health system has been previously identified and solutions are needed that extend beyond simple financial incentives[125]. Embedding of home care coordinators in primary care practices is an encouraging trend but we must ensure that care coordinators operate as an integrated part of the primary care team and not as a separate entity that happens to share office space. Implementing integrated care models in accountable care organizations that have responsibilities across care settings also has the potential to increase coordination[126].

In general, my findings affirm the value of primary care and the key role it plays in managing older adults with complex care needs in the community. However, it is certainly notable that the magnitude of the effects observed were not particularly large (typically odds ratios, hazard ratios, or incidence rate ratios between 0.85 and 0.95). This highlights the challenge in designing and implementing interventions or reforms that significantly reduce the use hospital-based care by home care patients. In the broader literature, there are a number of community-based interventions that attempted to reduce emergency department visits among older adults with complex care needs that did not produce any meaningful benefits[125,127–130]. Studies with positive results have typically achieved risk or rate reductions of around 20%[131–133], suggesting that even the most successful interventions are unlikely to dramatically lower the emergency department use of home care patients. In in the light of the broader context, I can conclude that while robust, quality primary care is clearly of significant value, it cannot be considered a solution to the high use of hospital-based care by home care patients in its own right.

Strength and limitations

Each study in the thesis has its own set of strengths and limitations that have been noted in their respective chapters. In addition, there are strengths and limitations inherent in the data sources and population shared across the studies that are worth noting. Each study in the thesis uses administrative health data from Ontario. Administrative data are generated by the normal operation of the health system and are not collected specifically for research purposes. The use of these data has the key advantage of allowing for a population-based approach that permits analysis across everyone with access to an entire health system over time. The population-based nature of these data improves the generalizability of results and reduces some selection biases. Inference to policy is more robust when a large, heterogeneous, jurisdiction such as Ontario can be studied in its entirety rather than relying on convenience samples or single site studies. Administrative data also has the benefit of enabling long follow-up and look back periods and avoiding recall biases and other concerns with self-reported data.

There are also significant limitations to the use of administrative data. A chief limitation is that administrative data is not collected specifically for research purposes and therefore may not contain all variables desired. In this sense it is often referred to as broad but not deep. While this limitation was minimized by my use of the RAI-HC clinical assessment data, there were still limits to data availability. For example, measures of individual-level social determinants of health were minimal. Also, I have limited information as to why individuals did or did not receive services, for example, the reasons for which home care patients sought afterhours primary care.

The administrative nature of the data collection also puts limitations on cohort creation as data is only collected at certain intervals, which may not be ideal for research purposes. For example, I used a RAI-HC assessment as the cohort entry event. However, the RAI-HC in Ontario does not occur at the time of first enrollment into home care, as would be most desirable, but tends to between 2 to 6 weeks later. This gives an opportunity for some patients to be discharged from home care (i.e. death, admission to hospital) before they could enter the cohort.

There may also be concerns about accuracy and completeness of administrative data sources. The primary database I used was the Ontario Health Insurance Plan (OHIP) database, which is extensively used in research and whose physician billing data is considered relatively complete[70,134]. A limitation in completeness is that the OHIP database does not differentiate the activities of nurse practitioners in primary care or capture physician encounters in community health centres. My clinical data was based off the RAI-HC assessment, which has been shown to be a valid and reliable[135,136]. The databases used to define my outcomes, the Discharge Abstract Database and National Ambulatory Care Services database, are regularly checked for validity and are commonly used in research.[137,138]

A final limitation of the data sources is that they only contain quantitative data, which limits insight the ability the understand the patient experience. This precludes investigating such questions as why patients do or not seek out certain types of primary care or why physicians may or may not offer certain types of care. Future research should involve mixed methods designs to explore the mechanisms behind the examined associations more fully.

The generalizability of my thesis findings to other jurisdictions depend on the similarity their primary care systems to Ontario's. I believe that this similarity is high enough for other Canadian provinces such that there is good pan-Canadian generalizability. All provinces have publicly-funded health care systems with foci on primary care for first contact and continuous on-going care. Generalizability outside of Canada, i.e. to the United States, is more challenging. Primary care systems in the United States vary widely, but there are some HMOs and other systems (i.e. Kaiser Permanente, the VA) that implement primary care policies that are similar enough to allow for reasonable generality.

Next step in research

This thesis raises several questions that should be addressed in future work. One area of research would be around the provision and quality of coordination between home care and primary

care. Future studies could take the form of a survey of physicians to help determine the true level of coordination with home care and the sensitivity and specificity of the billing codes, as well as qualitative work to understand the barriers to improving coordination between home care and primary care. My lack of finding on the practice-level measure of afterhours care is also an area of potential future work. Additional quantitative studies could be done in different populations to establish whether this discrepancy exists more broadly. There is also an opportunity for qualitive work around patient awareness of the availability afterhours primary care, particularly for urgent unscheduled visits, and any barriers to accessing it. Finally, a key area of research on home visits would be to compare the outcomes of patients who are enrolled in multidisciplinary home-based primary care programs to patients whose physicians do home visits but are not part of a broader program. This could be done by combining existing administrative data sources with primary data collection to identify patients who are enrolled in one of the programs.

Conclusion

Home care patients in Ontario are high users of primary care physician services, specialty care physician services, and the emergency department. I measured quality of primary care in terms of access to afterhours care, physician practice patterns of house visits, and longitudinal continuity of care. Across all the measures, higher quality was associated with fewer emergency department visits and hospitals admissions, although the differences tended to be small. Better quality primary care has a central role to play in keeping older adults out of the emergency room and hospitals as they age but is limited in what it can achieve as a separate system. Robust, quality primary care fully integrated into systems of home care, specialty care, and hospital care, will be integral to health systems as they adapt to address the changing health needs of aging populations.

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