CLINICAL INVESTIGATION

Physician Home Visit Patterns and Hospital Use Among Older Adults with Functional Impairments

*Aaron Jones, MSc,** *Susan E. Bronskill, PhD,†‡* *Hsien Seow, PhD,*§* *David Feeny, PhD,¶* *Lauren Lapointe-Shaw, MDCM, PhD,‖** *Fabrice Mowbray, MScN,** *and Andrew P. Costa, PhD*††*

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: We 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: The setting was Ontario, Canada, from October 2014 to September 2016.

PARTICIPANTS: Older adults (aged ≥65 years) with extensive functional impairments receiving publicly funded home care.

MEASUREMENTS: We measured the provision of home visits by a patient's most responsible primary care physician 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 6 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. A total of 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 0.057% to 3.19% across quartiles. Patients whose physicians were in the highest home visit provision quartile had lower rates of emergency department visits (incidence rate ratio [IRR] = 0.93; 95% confidence interval [CI] = 0.90–0.96) and hospital admissions (IRR = 0.89; 95% CI = 0.85–0.93) compared with patients whose physician 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. **J Am Geriatr Soc 00:1-8, 2020.**

Keywords: primary health care; home visits; house calls; 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

From the *Department of Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, Ontario, Canada; †ICES, Toronto, Ontario, Canada; ‡Institute of Health Policy, Management & Evaluation, Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada; §Department of Oncology, McMaster University, Hamilton, Ontario, Canada; ¶Department of Economics, McMaster University, Hamilton, Ontario, Canada; ‖Department of Medicine, University of Toronto, Toronto, Ontario, Canada; **University Health Network, Toronto, Ontario, Canada; and the ††Department of Medicine, McMaster University, Hamilton, Ontario, Canada.

Address correspondence to Aaron Jones, MSc, Department of Health Research Methods, Evidence, and Impact, McMaster University, 1280 Main St W, Hamilton, Ontario, Canada L8S 4K1.
E-mail: jonesa13@mcmaster.ca; Twitter: @aaronjonesstats

Previous Presentation: A prepublication version of this study was shared at the World interRAI Conference in Leuven, Belgium, in February 2020.

DOI: 10.1111/jgs.16639

0002-8614/20/$15.00

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 6 months of life were less likely to die in the 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 13.5 million residents, including over 2 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 years and older.

Study Design and Data Sources

We 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 to 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, have 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 make them an ideal population in which to study the effects of primary care physician home visits.

We 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. Data sets 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 6 to 12 months, depending on the patient's condition.[28] The RAI-HC is a comprehensive, valid,

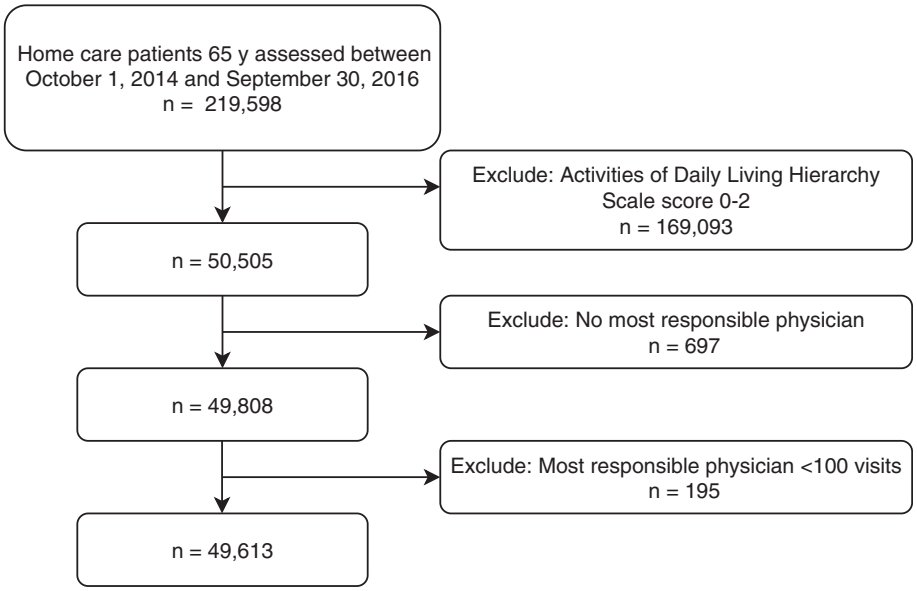

Figure 1. Cohort selection diagram.

and reliable clinical assessment that covers domains of health, function, cognition, social support, diagnoses, and health service use.[29-31] We selected all RAI-HC assessments for publicly funded home care patients 65 years of age and older completed in Ontario between October 1, 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). We restricted our cohort to only those patients with an Activities of Daily Living (ADLs) 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] We 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 2 years before the reference date.[35] Patients who could not be linked to a physician were excluded (n = 697) as were those whose assigned physician had few billings in a year (<100) (n = 195).

Measures

Primary Care Physician Home Visits

In Ontario, primary care physicians 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] We identified primary care physician home visits from a list of billing codes used in previous research[25] (Supplementary Table S2). We 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. We 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, we examined the home visit practice pattern of each patient's assigned physician in the calendar year before the reference assessment.

Outcomes

Counts of emergency department visits and hospital admissions within 6 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 6-month follow-up period. We did not include scheduled or

Table 1. Baseline Characteristics of Long-Stay Home Care Patients with Extensive Functional Impairments in Ontario, Canada, 2014 to 2016

Patient characteristics	No. (%) (n = 49,613)
Demographics	
Age, median (Q1, Q3), y	85 (77, 90)
Sex, male	19,764 (40)
Lived alone	20,370 (41)
Rurality	
Urban	37,541 (76)
Semiurban	9,413 (19)
Rural	2,686 (5)
Health	
ADL impairment[a]	
Extensive	23,814 (48)
Maximal/dependent	25,799 (52)
Cognitive impairment[b]	
Intact/borderline intact	9,124 (18)
Mild/moderate	27,775 (56)
Severe	12,714 (26)
Count of impaired ADLs, median (Q1, Q3)[c]	6 (4, 7)
No. of concurrent medications	
0–4	6,744 (14)
5–8	13,231 (30)
≥9	28,152 (57)
Any mood symptom	27,569 (56)
Bladder incontinence	33,906 (68)
Fall in last 90 d	23,461 (47)
Congestive heart failure	7,868 (16)
Chronic obstructive pulmonary disease	8,529 (17)
Dementia	21,247 (43)
Count of chronic conditions, median (Q1, Q3)	4 (3, 5)
Baseline health service use	
Home nursing at baseline	19,025 (38)
ED visits in prior 4 mo, mean (SD)	1.0 (1.51)
ED visits in prior 5–12 mo, mean (SD)	1.3 (1.84)
Hospital admissions in prior 4 mo, mean (SD)	0.5 (0.77)
Hospital admissions in prior 5–12 mo, mean (SD)	0.4 (0.84)

Note: Data are given as number (percentage) unless otherwise indicated.
Abbreviations: ADL, activity of daily living; ED, emergency department; Q1, quartile 1; Q3, quartile 3.
[a]ADL Hierarchy Scale: Includes personal hygiene, locomotion, eating, and toileting.
[b]Cognitive performance scale.
[c]At least limited assistance required. Includes bed mobility, transfer, locomotion, dressing, eating, toileting, personal hygiene, and bathing.

Table 2. Distribution of Primary Care Physician Home Visits Across Provision Groups

Home visit provision group	Physician-years	% of Total visits that were home visits[a]	Annual volume of home visits
0	4,695	0 (0, 0)	0 (0, 0)
Q1 (least)	2,629	0.058 (0.035, 0.090)	4 (3, 7)
Q2	2,629	0.25 (0.18, 0.34)	18 (11, 27)
Q3	2,629	0.81 (0.61, 1.07)	57 (38, 84)
Q4 (most)	2,629	3.19 (2.06, 6.23)	228 (131, 455)

Note: All measures were calculated per physician, per year, among all of a physician's patients.
Abbreviations: Q1, quartile 1; Q2, quartile 2; Q3, quartile 3; Q4, quartile 4.
[a]Data are given as median (Q1, Q3).

Table 3. Adjusted IRRs and 95% CIs from Negative Binomial Regression Models

	Adjusted IRR (95% CI)[a]		
Variable	Count of emergency department visits	Count of hospital admissions	Count of days spent in hospital
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 (0.78–0.90)
Sex, male	1.17 (1.14–1.19)	1.24 (1.21–1.28)	1.40 (1.33–1.47)
Age, y			
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 (0.96–1.02)	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 mo)	1.19 (1.18–1.20)		
Emergency department visits (prior 5–12 mo)	1.05 (1.04–1.06)		
Hospital admissions (prior 4 mo)		1.23 (1.21–1.25)	1.20 (1.16–1.23)
Hospital admissions visits (prior 5–12 mo)		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)

Abbreviations: CI, confidence interval; IRR, incidence rate ratio; Q1, quartile 1; Q2, quartile 2; Q3, quartile 3; Q4, quartile 4; ref, reference.
[a]Also adjusted for physician sex, years of practice, type of practice, international medical education, and board certification in family medicine.

prearranged emergency departments visits or elective hospital admissions as these are not related to acute medical conditions.

Covariates

We 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 to 4 and 5 to 12 months. Physician-level variables included sex, years of practice, type of practice, international medical education, and board certification in family medicine.

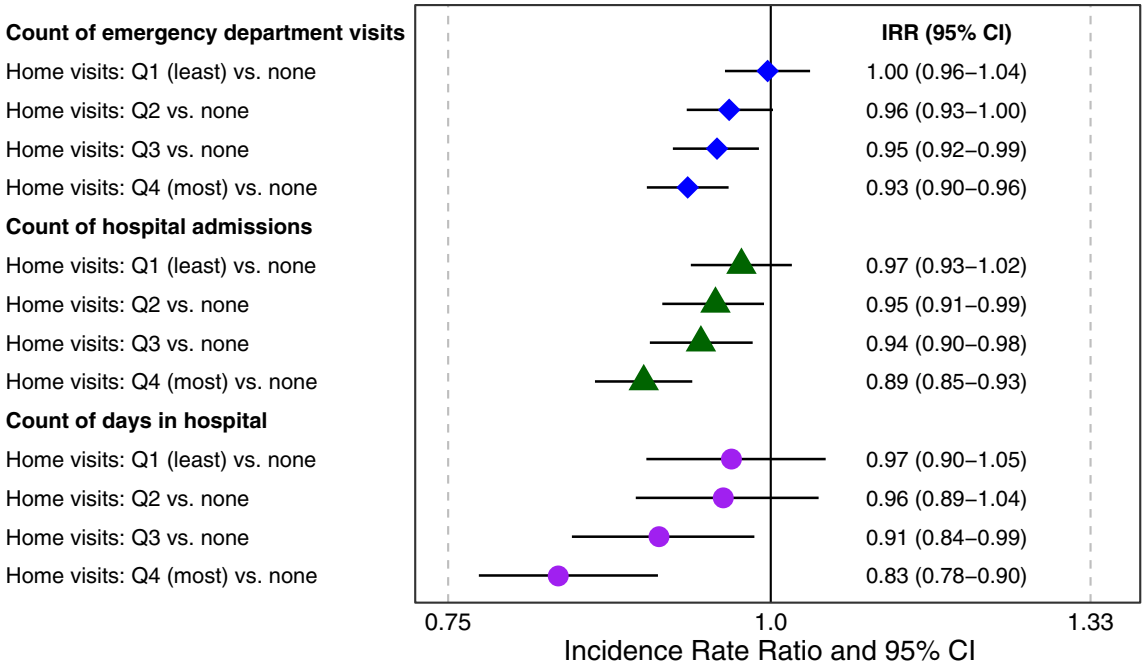

Figure 2. Associations between physician-level provision of primary care home visits and use of hospital care within 6 months of a home care assessment. The incidence rate ratio (IRR) is adjusted. CI, confidence interval; Q1, quartile 1; Q2, quartile 2; Q3, quartile 3; Q4, quartile 4.

Statistical Analysis

We examined the descriptive characteristics of all patients in the cohort and their assigned physicians. We 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 was 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).

Sensitivity Analysis

We repeated our analysis, categorizing physicians based on the annual absolute count of home visits provided rather than the proportion of home visits to total visits. We 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 to 11 visits, 12 to 23 visits (minimum of 3 patients), 24 to 67 visits (minimum of 6 patients), 69 to 127 visits (minimum of 17 patients), and 128 or more visits (minimum of 32 patients). We 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

Our 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 (quartile 1–quartile 3 [Q3] = 77–90 years), 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 cutpoints of the proportion of home visits 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 and a Canadian medical graduate (Supplementary Table S3). Physicians in the highest quartile were more likely to be palliative specialists, whereas physicians in the no visit group had practiced for fewer years and were less likely to be board certified in family medicine.

Association Between Provision of Home Visits and Use of Hospital-Based Care

During the 6-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 with patients assigned to physicians who had not provided any home visits, with an evident dose-response relationship (quartile 4 [Q4] vs none: adjusted incidence rate ratio [IRR] = 0.93 [95% confidence interval {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 [95% CI = 0.85–0.93]; Q3 vs none: IRR = 0.94 [95% CI = 0.90–0.98]) and days spent in hospital (Q4 vs none: IRR = 0.83 [95% CI = 0.78–0.90]; 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 with 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

Although approximately 70% of primary care physicians in this study provided at least one home visit in a year, the extent of provision varied widely. We found that home care patients with extensive functional impairments whose primary care physician had a higher historical provision of home visits had lower rates of emergency department visits and hospital admissions compared with 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.

Although primary care home visits have been frequently studied,[20-25] our study is novel in its examination of patterns of physician home visit provision and use of a population-based approach. Although our finding that higher provision of home visits was associated with less hospital use is broadly consistent with the literature, the effect sizes we observed were smaller than in many other studies. There are several possible explanations for this. First, we 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 with interventional studies in which every member of a treatment arm receives at least one home visit. Also, we examined all home visits in our study, whereas 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]

Our 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, although 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 we observed for days spent in hospital suggest 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, our results indicate that although most physicians did at least one home visit in a year, overall volumes are still low, particularly when compared with 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 we lacked specific data on home visits by nonphysicians 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] However, compared with the United States, 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

Our use of a physician-level exposure in this study is both a strength and a limitation. Because home visits tend to be provided to the most complex patients,[27] a patient-level measure would likely experience significant confounding by indication. By basing our analysis on historical physician practice patterns, we minimized this source of bias. However, this approach limits our ability to directly compare our results with studies performed using patient-level exposures. Another strength of our study is a population-based approach, by which we were able to analyze the effects of increasing provision of home visits across an entire health system rather than within a single program. Although this improves the generalizability of our findings, there may still be questions as to whether our results generalize outside of health systems similar to Ontario's. A limitation of our 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 we are unable to differentiate between home visits provided for acute needs and concerns and those that were routine. Finally, we are unable to

establish whether there is an ideal level of home visit provision, only concluding that, within the range observed in our 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.

ACKNOWLEDGMENTS

Financial Disclosure: This study was funded by the Canadian Institutes for Health Research Grant 148933. This study was also supported by ICES, which is funded by an Ontario Ministry of Health and Long-Term Care Annual Grant.

Conflict of Interest: The authors have no conflicts.

Author Contributions: A.J. and A.C. conceived the study and developed the design in collaboration with S.B., H.S., D.F., and L.L.S. A.J. performed data curation and analysis and wrote the first draft. All authors contributed to the interpretation of the data and revision of the manuscript. A.C. provided supervision and funding. Everyone who contributed significantly to this article has been listed.

Sponsor's Role: The opinions and conclusions expressed in this article are those of the authors and do not necessarily reflect the views of the contributing centers or funders. No endorsement by ICES or the Ontario Ministry of Health and Long-Term Care is intended or should be inferred. Parts of this material are based on data and/or information compiled and provided by the Canadian Institute for Health Information (CIHI). However, the analyses, conclusions, opinions, and statements expressed in the material are those of the author(s) and not necessarily those of CIHI. The sponsors had no role in the design, methods, analysis, interpretation, or preparation of this article.

REFERENCES

1. Kao H, Conant R, Soriano T, McCormick W. The past, present, and future of house calls. Clin Geriatr Med. 2009;25(1):19-34, v. https://doi.org/10.1016/j.cger.2008.10.005.
2. Chan BTB. The declining comprehensiveness of primary care. CMAJ. 2002;166(4):429-434.
3. Meyer GS, Gibbons RV. House calls to the elderly—a vanishing practice among physicians. N Engl J Med. 1997;337(25):1815-1820.
4. Walkinshaw E. Back to black bag and horse-and-buggy medicine. CMAJ. 2011;183(16):1829-1830. https://doi.org/10.1503/cmaj.109-3995.
5. Beck RA, Arizmendi A, Purnell C, Fultz BA, Callahan CM. House calls for seniors: building and sustaining a model of care for homebound seniors. J Am Geriatr Soc. 2009;57(6):1103-1109. https://doi.org/10.1111/j.1532-5415.2009.02278.x.
6. Stall N, Nowaczynski M, Sinha SK. Back to the future: home-based primary care for older homebound Canadians. Can Fam Physician. 2013;59(3):243-245.
7. Leff B, Burton JR. The future history of home care and physician house calls in the United States. J Gerontol A Biol Sci Med Sci. 2001;56(10):M603-M608. https://doi.org/10.1093/gerona/56.10.M603.
8. Ornstein KA, Leff B, Covinsky KE, et al. Epidemiology of the homebound population in the United States. JAMA Intern Med. 2015;175(7):1180-1186. https://doi.org/10.1001/jamainternmed.2015.1849.
9. Schuchman M, Fain M, Cornwell T. The resurgence of home-based primary care models in the United States. Geriatrics (Basel). 2018;3(3):41. https://doi.org/10.3390/geriatrics3030041.
10. Leff B, Carlson CM, Saliba D, Ritchie C. The invisible homebound: setting quality-of-care standards for home-based primary and palliative care. Health Aff. 2015;34(1):21-29. https://doi.org/10.1377/hlthaff.2014.1008.
11. Starfield B, Shi L, Macinko J. Contribution of primary care to health systems and health. Milbank Q. 2005;83(3):457-502. https://doi.org/10.1111/j.1468-0009.2005.00409.x.
12. Hwang U, Shah MN, Han JH, Carpenter CR, Siu AL, Adams JG. Transforming emergency care for older adults. Health Aff. 2013;32(12):2116-2121. https://doi.org/10.1377/hlthaff.2013.0670.
13. Aminzadeh F, Dalziel WB. Older adults in the emergency department: a systematic review of patterns of use, adverse outcomes, and effectiveness of interventions. Ann Emerg Med. 2002;39(3):238-247. https://doi.org/10.1067/mem.2002.121523.
14. Émond M, Grenier D, Morin J, et al. Emergency department stay associated delirium in older patients. Can Geriatr J. 2017;20(1):10-14. https://doi.org/10.5770/cgj.20.246.
15. Unwin BK, Iii PET. House calls. Am Fam Physician. 2011;83(8):925-938.
16. Department of Family and Community Medicine. *A new model for home-based primary care*. Department of Family and Community Medicine. https://www.dfcm.utoronto.ca/news/new-model-home-based-primary-care. Published August 21, 2017. Accessed December 13, 2019.
17. The Commonwealth Fund. *Home-based primary care learning from the field*. https://www.commonwealthfund.org/publications/issue-briefs/2017/jun/overview-home-based-primary-care-learning-field. Accessed December 13, 2019.
18. Akhtar S, Loganathan M, Nowaczynski M, et al. Aging at home: a portrait of home-based primary care across Canada. Healthc Q. 2019;22(1):30-35.
19. Boling PA, Yudin J. Home-based primary care program for home-limited patients. In: Malone ML, Capezuti EA, Palmer RM, eds. Geriatrics Models of Care: Bringing "Best Practice" to an Aging America. Cham, Switerland: Springer International Publishing; 2015:173-181. https://doi.org/10.1007/978-3-319-16068-9_15.
20. Stall N, Nowaczynski M, Sinha SK. Systematic review of outcomes from home-based primary care programs for homebound older adults. J Am Geriatr Soc. 2014;62(12):2243-2251. https://doi.org/10.1111/jgs.13088.
21. Kramer BJ, Creekmur B, Mitchell MN, Saliba D. Expanding home-based primary care to American Indian reservations and other rural communities: an observational study. J Am Geriatr Soc. 2018;66(4):818-824. https://doi.org/10.1111/jgs.15193.
22. Edwards ST, Prentice JC, Simon SR, Pizer SD. Home-based primary care and the risk of ambulatory care–sensitive condition hospitalization among older veterans with diabetes mellitus. JAMA Intern Med. 2014;174(11):1796-1803. https://doi.org/10.1001/jamainternmed.2014.4327.
23. Ruiz S, Snyder LP, Rotondo C, Cross-Barnet C, Colligan EM, Giuriceo K. Innovative home visit models associated with reductions in costs, hospitalizations, and emergency department use. Health Aff (Millwood). 2017;36(3):425-432. https://doi.org/10.1377/hlthaff.2016.1305.
24. Mattke S, Han D, Wilks A, Sloss E. Medicare home visit program associated with fewer hospital and nursing home admissions, increased office visits. Health Aff (Millwood). 2015;34(12):2138-2146. https://doi.org/10.1377/hlthaff.2015.0583.
25. Tanuseputro P, Beach S, Chalifoux M, et al. Associations between physician home visits for the dying and place of death: a population-based retrospective cohort study. PLoS One. 2018;13(2):e0191322. https://doi.org/10.1371/journal.pone.0191322.
26. Statistics Canada. Census profile, 2016 census - Ontario [province] and Canada [country]. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Published February 8, 2017. Accessed January 28, 2020.
27. 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;7(2):E360-E370. https://doi.org/10.9778/cmajo.20190038.
28. Poss J. Mind the gap? looking at reassessment patterns among Ontario long-stay home care clients. In: 2009 Canadian InterRAI Conference, Halifax, NS, Canada, 2009.
29. Landi F, Tua E, Onder G, et al. Minimum data set for home care: a valid instrument to assess frail older people living in the community. Med Care. 2000;38(12):1184-1190.
30. Hirdes JP, Ljunggren G, Morris JN, et al. Reliability of the interRAI suite of assessment instruments: a 12-country study of an integrated health

information system. BMC Health Serv Res. 2008;8:277. https://doi.org/10.1186/1472-6963-8-277.
31. Poss JW, Jutan NM, Hirdes JP, et al. A review of evidence on the reliability and validity of minimum data set data. Healthc Manage Forum. 2008;21(1):33-39. https://doi.org/10.1016/S0840-4704(10)60127-5.
32. Morris JN, Fries BE, Morris SA. Scaling ADLs within the MDS. J Gerontol A Biol Sci Med Sci. 1999;54(11):M546-M553.
33. Green M, Gozdyra P, Frymire E, Glazier R. Geographic Variation in the Supply and Distribution of Comprehensive Primary Care Physicians in Ontario, 2014/15. Toronto, ON, Canada: Institute for Clinical Evaluative Sciences; 2017.
34. Government of Ontario Ministry of Health and Long-term Care. Primary care payment models in Ontario - health care professionals - MOHLTC. http://www.health.gov.on.ca/en/pro/programs/pcpm/. Accessed October 22, 2019.
35. Schultz SE, Glazier RH. Identification of physicians providing comprehensive primary care in Ontario: a retrospective analysis using linked administrative data. CMAJ Open. 2017;5(4):E856-E863. https://doi.org/10.9778/cmajo.20170083.
36. Ministry of Health and Long-Term Care. Schedule of Benefits: Physician Services Under the Health Insurance Act. Toronto, ON, Canada: Queen's Printer for Ontario; 2015.
37. Ontario Ministry of Health. Home Visits Special Premium Payment and Reporting (CCM, FHG, FHN, FHO). Toronto, ON, Canada: Queen's Printer for Ontario; 2013.
38. Costa AP, Hirdes JP, Bell CM, et al. Derivation and validation of the detection of indicators and vulnerabilities for emergency room trips scale for classifying the risk of emergency department use in frail community-dwelling older adults. J Am Geriatr Soc. 2015;63(4):763-769. https://doi.org/10.1111/jgs.13336.
39. Kralj B. Measuring Rurality - RIO2008 BASIC: Methodology and Results. Toronto, ON, Canada: Ontario Medial Association; 2008.
40. Barbera L, Hwee J, Klinger C, Jembere N, Seow H, Pereira J. Identification of the physician workforce providing palliative care in Ontario using administrative claims data. CMAJ Open. 2015;3(3):E292-E298. https://doi.org/10.9778/cmajo.20150005.
41. Jasinarachchi KH, Ibrahim IR, Keegan BC, et al. Delayed transfer of care from NHS secondary care to primary care in England: its determinants, effect on hospital bed days, prevalence of acute medical conditions and deaths during delay, in older adults aged 65 years and over. BMC Geriatr. 2009;9(1):4. https://doi.org/10.1186/1471-2318-9-4.
42. Palmer K, Konkin J, Michael N. *House calls on the rise in Ontario*: healthy debate. 2017. https://healthydebate.ca/2017/08/topic/house-calls-rise-ontario. Accessed January 31, 2019.
43. Boerma WG, Groenewegen PP. GP home visiting in 18 European countries adding the role of health system features. Eur J Gen Pract. 2001;7(4):132-137.
44. Yao NA, Rose K, LeBaron V, Camacho F, Boling P. Increasing role of nurse practitioners in house call programs. J Am Geriatr Soc. 2017;65(4):847-852. https://doi.org/10.1111/jgs.14698.
45. Collins D. Assessing the effectiveness of advanced nurse practitioners undertaking home visits in an out of hours urgent primary care service in England. J Nurs Manag. 2019;27(2):450-458. https://doi.org/10.1111/jonm.12680.
46. Maier CB, Barnes H, Aiken LH, Busse R. Descriptive, cross-country analysis of the nurse practitioner workforce in six countries: size, growth, physician substitution potential. BMJ Open. 2016;6(9):e011901. https://doi.org/10.1136/bmjopen-2016-011901.

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article.

Supplementary Table S1: Databases Used in the Study

Supplementary Table S2: Fee Codes Used to Identify Home Visits

Supplementary Table S3: Characteristics of Primary Care Physicians Assigned to Cohort Members

Supplementary Table S4: Adjusted Incidence Rate Ratios and 95% Confidence Intervals from Negative Binomial Regression Models

Supplementary Table S5: Adjusted Incidence Rate Ratios and 95% Confidence Intervals from Negative Binomial Regression Models, Sensitivity Analyses