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Does the way we pay primary care providers influence emergency department use during after-hours?

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Abstract

In the early 2000s, Ontario introduced extensive primary care reforms to increase around-the-clock access to comprehensive primary care in response to inadequate access to primary care, including the way Ontario primary care physicians were paid. This thesis investigates the extent to which changes in physician payment could affect emergency department visits. First, a review evaluating the impact of access to primary care on primary care and emergency department utilization was conducted. Secondly, the impact of Ontario's after-hours premium on emergency department visits was investigated, first within Ontario, then compared to four control provinces. Finally, rates of primary care services and emergency department visits were compared between the two most popular physician remuneration models. Data sources include databases housed at ICES as well as the Canadian Community Health Survey linked to the National Ambulatory Care Reporting System. The review found that while improving access to primary care increased primary care visits, the effects on emergency department visits were often limited, and the effects depends on the intervention used to improve access to care and the context of the health care system. The introduction of Ontario's after-hours premium was associated with a reduction in less-urgent emergency department visits, particularly during after-hours; however, subsequent increases in the premium were found to have only a small further reduction in emergency department visits and comparisons to other provinces suggested that an increase in the premium was unlikely to be causal. Physicians paid by blended capitation were found to provide fewer primary care services than physicians paid by enhanced/blended fee-for-service model, especially outside regular working-hours. For most patients, having a physician paid by blended capitation was associated with making more emergency department visits; however, for patients with multiple chronic conditions, blended capitation was associated with a reduction in more urgent emergency department visits. The way primary care physicians are remunerated can influence the way patients receive care, in both the primary care and emergency department setting, as patients in the blended capitation model may receive fewer primary care services but make more less-urgent emergency department visits.

Keywords

Keywords: primary care; after-hours; physician remuneration; pay-for-performance incentives; fee-for-service; capitation

Summary for Lay Audience

The Ontario government changed the way primary care physicians are paid in response to many residents not being able to get appointments, especially outside of the regular working-hours. Many changes were applied to extend services outside the regular working-hours and this thesis investigates whether they may have reduced emergency department visits. A literature review of current evidence found that better access to primary during after-hours increased use of primary care services, but any reduction in emergency department visits depended on how access was improved and within what type of health care system. Ontario's after-hours premium, an incentive for primary care physicians to provide appointments outside the regular working-hours was found to lead to a reduction in less-urgent emergency department visits when it was introduced, but later increases in its value were found to lead to only small effects. When compared to other provinces, the increase in the after-hours premium from 20% to 30% did not lead to a reduction in less-urgent emergency department visits. Physicians who were paid based on the number of patients in the practice were found to deliver fewer primary care services compared to physicians who were paid based on the number of services provided, especially for services provided during after-hours. Physicians who were paid based on the number of patients in the practice also had patients who used the emergency department more, except for patients who had multiple chronic conditions, who made fewer urgent emergency department visits. The way primary care physicians are paid can lead to differences in how they deliver services to their patients and how accessible these services are outside of the regular working-hours. These changes in delivery can in turn affect how their patients use the emergency department, with patients in models paid based on the number of patients receiving fewer primary care services but making more visits to the emergency department.

Co-Authorship Statement

All chapters were written by Michael Hong in fulfillment of requirements of the Doctor of Philosophy of Epidemiology & Biostatistics at Western University. Michael Hong was responsible for drafting all proposals, conducting the literature review, analyzing all data, and drafting the manuscripts. Proposals and data creation plans were drafted under the supervision of Dr. Sarma. Dr. Sarma was involved in the design of the study, interpretation of the data, and revisions of the manuscript, while Dr. Thind and Dr. Zaric were involved in feedback regarding the study direction and revisions of the manuscripts.

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Table of Contents

Abstract ii

Summary for Lay Audience iv

Co-Authorship Statement v

Acknowledgments vi

Table of Contents vii

List of Tables xii

List of Figures xv

List of Abbreviations xvi

List of Appendices xx

1 Background 1

1.1 Primary Care 1

1.2 The Canadian Primary Care System 3

1.2.1 Canadian Primary Care Reform 4

1.2.2 Incentives for After-Hours Primary Care Across Canada 7

1.3 Primary Care Reform in Ontario 8

1.3.1 Patient Enrolment Models 10

1.3.2 After-Hours Primary Care in Ontario 13

1.4 The Impact of Health Care Reforms on Health Care Utilization and Health Status 15

1.4.1 Ontario's Primary Care Reforms on Health Care Utilization 16

1.4.2 The Impact of Primary Care Incentives 17

1.5 Emergency Department Utilization 18

1.5.1 Causes, Consequences, and Solutions for Emergency Department Overcrowding 19

1.5.2 Primary Care Avoidable Emergency Department Visits 20

1.5.3 Access to Primary Care and Emergency Department Visits 22

1.6 Objectives 23

1.7 References 32

2 The impact of improved access to after-hours primary care on primary care and emergency department utilization: A review of the literature 52

2.1 Introduction 52

2.2 Methods 53

2.3 Results 54

2.3.1 After-Hours Primary Care and Primary Care Utilization 55

2.3.2 After-Hours Primary Care and Emergency Department Utilization 56

2.4 Discussion 60

2.4.1 Patient Preference for the ED over Primary Care 61

2.4.2 Limitations 62

2.4.3 Future Directions 63

2.5 Conclusion 64

References 79

3 Emergency department use following an incentive to provide after-hours primary care: A retrospective cohort study 86

3.1 Introduction 86

3.2 Methods 88

3.2.1 Study Design 88

3.2.2 Study Data and Study Population 89

3.2.3 Study Variables 90

3.2.4 Statistical Analysis 91

3.2.5 Ethics Approval 96

3.3 Results 97

3.3.1 First Study Cohort 97

3.3.2 Second Study Cohort 101

3.4 Discussion 103

3.4.1 Limitations 104

3.4.2 Future Directions 105

3.5 Conclusion 105

3.6 References 129

4 After-hours premiums and emergency department visits: A difference-in-differences analysis 136

4.1 Introduction 136

4.2 Methods 138

4.2.1 Study Data 138

4.2.2 Study Population 141

4.2.3 Study Variables 141

4.2.4 Statistical Analysis 143

4.3 Results 147

4.3.1 The Impact of the Increase in the After-Hours Premium from 20% to 30% in Ontario 148

4.3.2 The Impact of the Increase in the After-Hours Premium from 20% to 30% in Ontario Relative to Control Provinces 150

4.4 Discussion 152

4.4.1 Limitations 154

4.4.2 Future Directions 155

4.5 Conclusion 156

4.6 References 182

5 Primary care payment model on provision of primary care services and emergency department visits in Ontario: a comparison of the Family Health Group and Family Health Organization models 189

5.1 Introduction 189

5.2 Methods 191
5.2.1 Study Design 191
5.2.2 Study Data and Study Population 192
5.2.3 Study Variables 194
5.2.4 Statistical Analysis 195
5.2.5 Ethics Approval 199
5.3 Results 199
5.3.1 Propensity Score Weighting 200
5.3.2 Effect of Physician Remuneration on Primary Care Services and Emergency Department Visits 200
5.3.3 Association between Primary Care Services and Emergency Department Visits 201
5.3.4 Effects of Physician Remuneration on Primary Care Services and Emergency Department Visits by Morbidity 202
5.3.5 Pairwise Comparisons between Family Health Group, Family Health Organization, and Family Health Team 203
5.3.6 Additional Subgroup Analyses 204
5.4 Discussion 205
5.4.1 Limitations 207
5.4.2 Future Directions 208
5.5 Conclusion 209
5.6 References 230
6 Conclusion 236
6.1 Summary of Findings 236
6.1.1 Evidence in the Literature on Access to After-Hours Primary Care and Primary Care and Emergency Department Utilization 236
6.1.2 Ontario's After-Hours Premium on Emergency Department Utilization 237
6.1.3 Remuneration Models and Primary Care and Emergency Department Use 238

6.2 Strengths and Limitations 239
6.3 Future Directions 241
6.4 Conclusion 242
6.5 References 244
Appendix 245
Curriculum Vitae 252

List of Tables

Table 1.1 Summary of after-hours premiums across the ten provinces in Canada 25

Table 1.2 Characteristics of the traditional FFS model and the patient enrolment models 28

Table 1.3 Services eligible to be billed with the after-hours premium 31

Table 2.1 Search strategy 65

Table 2.2 Characteristics and results of included studies 67

Table 3.1 Descriptive characteristics and outcomes of study sample between 2002/03 and 2005/06 108

Table 3.2 Impact of the introduction of the after-hours premium and increase in value from 10% to 15% on ED visits 110

Table 3.3 Impact of the introduction of the after-hours premium and increase in value from 10% to 15% on ED visits, stratified by timing 112

Table 3.4 Propensity score model diagnostics, before and after weighting by inverse probability weighting using the estimated propensity score and entropy balancing weights 115

Table 3.5 Impact of the introduction of the after-hours premium and increase in value from 10% to 15% on ED visits, using propensity score and entropy balancing weights 117

Table 3.6 Impact of the introduction of the after-hours premium and increase in value from 10% to 15% on ED visits for physicians who billed the premium 119

Table 3.7 Impact of the introduction of the after-hours premium and increase in value from 10% to 15% on ED visits for subgroups by sex, age group, comorbidity level, and area-level income 120

Table 3.8 Descriptive characteristics and outcomes of study sample between 2005/06 and 2015/16 123

Table 3.9 Impact of the increase in the after-hours premium from 15% to 20% and from 20% to 30% on ED visits 125

Table 3.10 Impact of the increase in the after-hours premium from 15% to 20% and 20% to 30% on ED visits for subgroups by sex, age group, comorbidity level, and area-level income 126

Table 4.1 Weighted descriptive characteristics and outcomes for the national sample by survey cycle 158

Table 4.2 Weighted descriptive characteristics and outcomes for the Ontario sample by survey cycle 162

Table 4.3 Effect of the increase in the after-hours premium on ED visits in Ontario 166

Table 4.4 Effect of the increase in the after-hours premium on ED visits in Ontario by timing 168

Table 4.5 Sensitivity and subgroup analyses for the effect of the increase in the after-hours premium in Ontario 169

Table 4.6 Weighted descriptive characteristics and outcomes for the control sample by survey cycle 171

Table 4.7 Effect of the increase in Ontario's after-hours premium on ED visits relative to control province under difference-in-differences framework 176

Table 4.8 Effect of the increase in Ontario's after-hours premium on ED visits relative to control province under the difference-in-differences framework by timing 178

Table 4.9 Sensitivity and subgroup analyses for the effect of the increase in Ontario's after-hours premium on ED visits relative to control provinces under the difference-in-differences framework 179

Table 5.1 Physician and aggregate physician-level patient descriptive characteristics and outcomes by fiscal year 210

Table 5.2 Propensity score model diagnostics, before and after CBPS weighting 214

Table 5.3 Effect of being in an FHO model compared to FHG model on primary care services and ED visits 216

Table 5.4 Absolute difference using marginal effects of being in an FHO model compared to FHG model on primary care services and ED visits 217

Table 5.5 Physician remuneration model and the association between the rate of primary care services on ED visits 218

Table 5.6 Effect of being in an FHO model compared to FHG model on primary care services and ED visits by number of chronic conditions 220

Table 5.7 Effect of being in an FHO model compared to FHG model on primary care services and ED visits by chronic condition 222

Table 5.8 Effect of physician model on primary care services and ED visits, comparing between FHG, FHO, and FHT 225

Table 5.9 Subgroup analyses for urban patients and by patient sex and area-level income, and physician sex 227

Table 6.1 Summary of key findings 243

List of Figures

Figure 2.1 Flow chart for inclusion and exclusion of studies into review 66

Figure 3.1 Flowchart of patients into study sample for both study periods 106

Figure 3.2 Monthly emergency department (ED) visits between April 2001 and March 2016, stratified by timing and urgency. 107

Figure 3.3 Distribution of propensity scores before and after weighting using propensity score weighting and entropy balancing methods 113

Figure 3.4 Standardized mean difference and variance ratio before and after weighting using propensity score weighting and entropy balancing 114

Figure 4.1 ED visit rates per 1,000 patients per year by intervention group, timing, and urgency 175

Figure 5.1 Distribution of propensity scores before and after CBPS weighting 213

Figure 5.2 Standardized mean difference and variance ratio before and after weighting using propensity score weighting and entropy balancing 215

List of Abbreviations

ACG: Adjusted Clinical Groups

ADG: Aggregated Diagnosis Groups

ASTHMA: Ontario Asthma Dataset

ATE: Average Treatment Effect

ATT: Average Treatment Effect Among the Treated

BC: British Columbia

CAD: Canadian Dollars

CAEP: Canadian Association of Emergency Physicians

CAPE: Client Agency Program Enrolment

CBPS: Covariate Balancing Propensity Score

CCHS: Canadian Community Health Survey

CCM: Comprehensive Care Model

CHC: Community Health Centre

CHF: Congestive Heart Failure

CI: Confidence Interval

CIHI: Canadian Institute for Health Information

CIHR: Canadian Institute of Health Research

CKD: Chronic Kidney Disease

COPD: Chronic Obstructive Pulmonary Disease

CPDB: Corporate Provider Database

CSC: Community-Sponsored Contracts

CTAS: Canadian Triage and Acuity Scale

CVD: Cardiovascular Disease

DAD: Discharge Abstract Database

DID: Difference-in-Difference

ED: Emergency Department

FFS: Fee-for-Service

FHG: Family Health Group

FHN: Family Health Network

FHO: Family Health Organization

FHT: Family Health Team

FP: Family Physician

FPSC: Family Practice-Sensitive Conditions

GHC: Group Health Centre

GP: General Practitioner

GPC: General Practitioner Cooperative

HIV: Ontario HIV Database

HSO: Health Service Organization

HYPER: Ontario Hypertension Dataset

IBD: Inflammatory Bowel Disease

ICD: International Classification of Disease

IMG: International Medical Graduate

IPDB: ICES Physician Database

IPW: Inverse Probability Weighting

IRR: Incidence Rate Ratio

NACRS: National Ambulatory Care Reporting System

NGFP: Northern Group Funding Planning

OCCC: Ontario Crohn's and Colitis Dataset

OCR: Ontario Cancer Registry

ODB: Ontario Drug Benefit Claims

ODD: Ontario Diabetes Dataset

OHIP: Ontario Health Insurance Plan Claims Databse

OMHRS: Ontario Mental Heart Reporting System

OMID: Ontario Myocardial Infarction Dataset

ORAD: Ontario Rheumatoid Arthritis Dataset

PCCF: Postal Code Conversion File

PCN: Primary Care Network

PEI: Prince Edward Island

PEM: Patient Enrolment Model

PHIPA: Personal Health Information Protection Act

RNPGA: Rural and Northern Physician Group Agreement

RPDB: Registered Persons Database

SDS: Same Day Surgery Database

SE: Standard Error

SEAMO: Southeastern Ontario Academic Medical Association

SJHC: St. Joseph's Health Care Centre - Toronto

THAS: Telephone Health Advisory Service

TIA: Transient Ischemic Attack

UK: United Kingdom

US: United States

WAHA: Weeneebayko Area Health Authority

List of Appendices

Appendix A Search strategy 245

Appendix B Family practice-sensitive conditions along with ICD-10 codes..... 246

Appendix C Data Sources for Chronic Conditions..... 251

1 Background

1.1 Primary Care

Primary care and primary health care have both been defined as "first-contact care," or a patient's first encounter with the health care system; however, primary health care refers to a broader term, encompassing all first-contact care, whereas primary care tends to refer to services commonly provided by family physicians (FPs) or general practitioners (GPs), the level of care that should act as the front of any health care system.[1] Starfield defined primary care as "the level of a health service system that provides entry into the system for all new needs and problems that provides person-focused care over time."[2] Primary care providers deliver person-centric care, providing care for most common health conditions and coordinating care provided elsewhere by other providers for other conditions. While primary care is typically delivered by FPs or GPs, it may be delivered by other physicians, including pediatricians and obstetricians, or non-physician health care providers, such as nurse practitioners, an increasingly popular alternative, especially in remote areas and areas with physician shortages.[1,3,4]

Strong primary care systems are defined by four main features: first-contact access for new health-related needs, long-term person-focused care rather than disease-focused care, comprehensive care for most health needs, and coordinated care when care must be provided elsewhere.[2,5,6] Stronger primary care systems are expected to be associated with improvements in patient outcomes.[5] This relationship between primary care and improved population health has been demonstrated extensively in the literature – areas in the United States (US) with a higher ratio of primary care physicians to population have lower rates of all-cause mortality, infant mortality, and poor self-reported health.[7–10] Similarly, having a primary care physician as a regular source of care was found to be associated with lower mortality.[11] The relationship between strong primary care systems and improved population health is consistent across high-income countries: an international comparison of 18 countries found that those with stronger primary care systems were associated with better health outcomes, including lower rates of all-cause mortality.[12]

In addition to being associated with improved patient outcomes, stronger primary care systems are associated with improved health system performance.[5] Better access to primary care services is associated with reduced likelihood of unnecessary secondary care utilization, including both unnecessary emergency department (ED) visits and avoidable hospitalizations.[13,14] Studies have found that US residents with better access to primary care clinics had lower rates of avoidable secondary care, including preventable ED utilization.[14–16] Primary care systems that provide person-focused care for common conditions and coordinate care provided elsewhere have been demonstrated to lower health care costs and improve the appropriateness of care.[12,17–21] International comparisons show that primary care systems that delivered care that was more accessible and more continuous had lower rates of ED visits and hospital admissions.[22,23] However, evidence on the relationship between strong primary care and health care costs is mixed. Early evidence found that strong primary care systems were associated with lower health care costs and that countries with better primary care systems were better able to handle rising health care costs.[5,24] In countries where primary care providers acted as gatekeepers for the health care system and secondary care could only be accessed through referrals, health care costs were lower.[24] However, some evidence suggests the opposite, with greater total health care expenditures among countries with stronger primary care systems.[23]

Primary care physicians are commonly paid through one of three basic payment schemes: fee-for-service (FFS), where a physician receives a fixed fee for each unit of health care service performed; capitation, where a physician receives a fixed fee for each patient in the roster, often with risk-adjustment; and fee-for-time, also known as salary, where a physician receives fixed income on a regular basis.[25–28] In FFS payment schemes, income is dependent on the volume of services, so in theory, these payment schemes promote the excess supply of services to maximize profits and physicians are incentivized to treat patients with greater need and provide more unnecessary services.[29] On the other end, capitation payment schemes encourage the undersupply of services as physicians are incentivized to enroll more patients but provide fewer services to each patient.[29,30] These issues with FFS and capitation schemes may be resolved through blended payment schemes, where physicians receive remuneration through some combination of FFS

payments, capitation, and/or salary, as well as pay-for-performance incentives for targeted care. In practice, findings are similar to the theoretical underpinnings of the relationship between payment schemes and performance: a systematic review found that patients of physicians paid through FFS had a higher number of primary care and specialist physician visits compared to patients of physicians paid predominantly through capitation, with no difference in the rate of ED visits or hospitalizations.[31]

1.2 The Canadian Primary Care System

Although the Canadian health care system, also known as Medicare, is publicly funded, it is divided into 13 individual provincial and territorial health care insurance plans rather than being a single national health insurance plan.[32] The federal government's role in the health care delivery is to set national standards through the Canada Health Act, provide funding support for provincial and territorial health care services and support delivery of health care services to specific groups (including First Nations residents living on reserves, Inuit, active Canadian Forces eligible veterans, inmates, and specific refugee claimants), while the provincial and territorial governments are responsible for the management, organization, and delivery of health care services for their respective residents. The Canada Health Act, enacted in 1984, includes five mandates: (i) public administration, the administration and operation of insurance plans on a non-profit basis; (ii) comprehensiveness, the insurance of medically necessary services provided by hospitals and physicians; (iii) universality, the coverage of all legal residents; (iv) portability, the coverage of all Canadians travelling within Canada; and (v) accessibility, the reasonable access to all medically necessary services, based on medical need.[33] Provinces and territories only receive funding from the federal government by adhering to the standards set by the Canada Health Act via the Canada Health Transfer. As of the 2014/15 fiscal year, funding from the Canada Health Transfer is divided equally between provinces and territories on a per-capita basis to provide comparable treatment for all Canadians regardless of geographic location.[34]

1.2.1 Canadian Primary Care Reform

Over the past 50 years, Canadian primary care has evolved slowly; however, there were two large changes to the Canadian primary care system: the revolutionary introduction of public medical insurance in 1966 and significant strides in primary care reforms in the early 2000s.[26] The federal government committed substantial funding towards improving primary care, including $36.8 billion over five years starting in 2003 under the 2003 First Ministers' Accord on Health Care Renewal to support primary care, home care, and catastrophic drug coverage.[35] In general, these primary care reforms benefit patients through renewed focus on health promotion, disease prevention, and chronic disease management, as well as improvements in continuity of care, access to care, and quality of care in the primary care setting. However, primary care reforms may also benefit the health care system by increasing the appropriate use of services and reducing the unnecessary use of hospital and ED services.

The context for primary care reforms in the early 2000s is based on a response to lack of access to care rather than a pre-emptive attempt to improve primary care in Canada before it worsened. In the early 1990s, access to high-quality primary care was problematic across many high-income countries, including Canada, despite its universal medical care coverage.[36–40] However, while other countries invested heavily in their primary care systems, Canada failed to do so, leading to the Canadian primary care system trailing behind other high-income countries. There was a clear lack of progress in the development of primary care in Canada, specifically regarding timely access to services.[41] Canada's poorly performing primary care system was brought on by major issues in the organization of the system, including: fragmentation of care due to lack of coordination; limited management and follow-up of vulnerable groups; access to care issues; low priority for health promotion and disease prevention activities; and issues regarding the quality, collection, and sharing of patient information between providers and with patients.[42,43] By the early 2000s, Canadians cited many issues with accessibility to primary care services, with 15% of Canadians reporting some difficulty accessing routine primary care and 23% of Canadians reporting difficulty accessing immediate primary care services.[44] Canadians were especially limited in access to primary care

outside the regular working-hours, with 41% of Canadians reporting some difficulty accessing primary care on nights and weekends.[45] Many Canadians instead turned to the emergency care setting, with 39% of Canadians who visited the ED considered their visit to have been avoidable had their primary care provider been more accessible.[46] Between 1990 and 1998, Canadians' views on their primary care system shifted and by 1998, 79% of Canadians believed that the Canadian primary care system required fundamental changes or complete restructuring, up from 44% in 1990.[45] By the early 2000s, it was clear that the Canadian primary care sector required substantive changes.

Primary care reforms began in the early 2000s, following recommendations of the Royal Commission on the Future of Health Care in Canada (also known as the Romanow Report) and the Standing Senate committee on Social Affairs, Science and Technology Report (also known as the Kirby Report).[47,48] There were five overarching objectives for primary health care reform established by the federal government: (i) increasing the proportion of the population with access to primary health care; (ii) increasing the emphasis on health promotion, disease and injury prevention, and chronic disease management; (iii) expanding all-day, every-day access to essential services; (iv) establishing multidisciplinary teams so that the most appropriate care is provided by the most appropriate provider; and (v) facilitating coordination with other health services, such as specialists and hospitals.[37,49] The federal government supported provinces and territories in meeting these objectives through the Primary Health Care Transition Fund and the First Ministers Health Accord, established in 2000 and 2003, respectively. The transition fund provided $800 million in support to provinces and territories in pilot and demonstration projects aimed to reform the primary health care system. The First Ministers Health Accord provided $17.3 billion in health care funding to provinces and territories, with $16 billion allocated to the Health Reform fund, solely dedicated to primary health care, home care, and catastrophic drug coverage, with a major focus on ensuring that at least half of all Canadians could access continuous multidisciplinary care by 2011.[50]

However, even after spending billions on primary care reforms, Canadians continue to face difficulties accessing primary care. In the Commonwealth Fund's 2015 International

Health Policy Survey of Primary Care Physicians, Canada fared poorly in terms of access to care, coordination of care, and various performance indicators compared to other high-income countries.[51] Only 53% of Canadian primary care physicians reported the availability of same- or next-day appointments compared to the Commonwealth Fund average of 72% and only 48% of Canadian physicians had an arrangement where patients could see a health care provider during after-hours without going to the ED compared to the Commonwealth Fund average of 75%. Canadian physicians reported more timely access than their patients did and a later survey found only 43% of adults reported having access to same- or next-day appointments and only 34% reported access to after-hours primary care in 2016.[52] Although Ontario physicians reported some of the highest access measures compared to other provinces, with 66% reporting access to same- or next-day appointments and 67% with after-hours arrangements,[51] adults reported access that was much lower, with only 44% of Ontario adults reported access to same- or next-day appointments and 40% reported access to after-hours appointments.[52]

Since each provincial and territorial government was responsible for their own set of reform objectives, the actual reforms implemented varied across provinces and territories. Ontario, Quebec, and Alberta focused on introducing newer organizational models, while British Columbia (BC), Manitoba, and Saskatchewan focused on quality improvement initiatives within existing models of primary care.[50] There were some overlaps in objectives across provinces and territories, including: to improve access to primary care services, to improve coordination and integration of care, to expand of team-based approaches, to improve quality and appropriateness of care, to improve patient engagement, and to increase the use of electronic medical records and information management systems.[58] Some common initiatives implemented include: interdisciplinary primary health care teams, group-based practice, patient enrolment with a primary care provider, and reformed payment mechanisms to include blended-payment schemes and pay-for-performance incentives.[50,53]

1.2.2 Incentives for After-Hours Primary Care Across Canada

Improving after-hours access to primary care was a common goal of primary care reform across the country.[58] Although there was a wide variation in measures implemented to improve after-hours access, including mandatory physician coverage and after-hours telephone helplines, all ten provinces adopted some form of an incentive for physicians who delivered primary care outside the regular working-hours (Table 1.1). Three provinces, Newfoundland and Labrador, Nova Scotia, and Ontario, offer incentives to physicians to extend office hours for existing clinics, in effort to expand access to primary care and possibly divert lower risk patients away from alternative care sites,[26,54–56] while two provinces, Alberta and BC, offer incentives to primary care physicians to practice outside the regular working-hours in alternative areas of care, such as nursing homes and active treatment hospitals, increasing staffing in areas that may require greater urgency.[57,58] Additionally, Quebec and Saskatchewan offer both types of incentives, with additional payments for physicians in both the primary care and alternative care settings.[59,60] Manitoba, New Brunswick, and Prince Edward Island (PEI) offer incentives during after-hours not based on location, but based solely on the urgency of the service, with additional payments for urgent and emergent services provided during after-hours.[58,61–63]

Differences are not restricted to location, with provinces and territories offering incentives that differed by value, timing eligibility, and incentivized services. While some provinces offer fixed dollar value payments for services, others offer incentives as a percentage of a fee-for-service payment billed. BC only offers a single payment to travel for a service provided outside the regular working-hours.[60] With one exception of Newfoundland and Labrador, which offers incentives only for specific hours on weekday evenings, weekends, and holidays, provinces offer incentives for services on weekday evenings and overnight and any timing on weekends and holidays; however, there is variation in the start timing of evenings and end timing of the overnight period. Additionally, some incentives differ in value depending on the timing, with larger payments for services rendered overnight, from midnight until the end of the incentivized period.

1.3 Primary Care Reform in Ontario

Ontario undertook several primary care reforms motivated by the lack of access to primary care services, especially during after-hours, and the fragmentation of care as patients moved across the health care system.[26] Keeping the federal initiatives in mind, the government of Ontario established four main objectives as part of primary care reform: (i) to improve patient access to care, (ii) to improve quality and continuity of care, (iii) to improve both provider and patient satisfaction with the health care system, and (iv) to increase the cost-effectiveness of health care services.[26,64] The most significant change to the primary care system during the primary care reform period was the introduction of newer primary care delivery models, which included features such as encouraged or required patient enrolment, blended payment schemes, group-based (and sometimes interdisciplinary team-based) care, after-hours availability, and the use of pay-for-performance incentives for targeted care.

In the late 1990s, the Ontario primary care system lagged further behind other provinces in timely access to care and patient-centredness.[37,65] By 2000, Ontario had one of the lowest ratios of family physicians to population, with only 85 physicians per 100,000 population.[66] Part of the limited access was thus caused by the low ratio of physicians to population, which was caused by medical program graduates' preference for specialization, due in no small part to the higher income of specialists.[67,68] Therefore, central to improving access to primary care was improving the number of primary care physicians in Ontario through newer payment schemes that increased their payments. Another major focus of Ontario primary care reform was to remodel the fragmented and unstructured primary care system into an integrated and coordinated health care system. The Health Services Restructuring Commission identified several issues with primary care in Ontario in 1999, including a shortage of primary care services in rural and northern regions, diminished quality of life for primary care providers, lack of coordination between primary care providers and other levels of care, and a lack of access to the appropriate provider, often leading to inappropriate utilization of the ED.[69,70]

Prior to the primary care reforms of the early 2000s, most primary care providers in Ontario were reimbursed through fee-for-service. Although several models prior to reforms experimented with capitation and group payment schemes, the traditional FFS model remained the predominant model. The Group Health Centre (GHC) was an early experimental model that opened in 1963 to provide care to the majority of Sault St. Marie residents, where primary care physicians were paid primarily through capitation with FFS payments for some services and pay-for-performance incentives.[26,71] Another early alternative payment model established in the 1970s were Community Health Centres (CHCs), comprised of salaried interdisciplinary teams of physicians working alongside other health care providers, such as nurses, nurse practitioners, nutritionists, and social workers. CHCs tend to serve underserved populations, including areas more vulnerable to illness, such as areas with higher proportions of immigrants, unhoused, or older adults, as well as areas with barriers to health care service access relative to the general population, such as rural and northern communities or areas with a higher proportion of non-English speakers.

Some experimental models were designed to fix various issues with access to care among the population, such as the introduction of newer models specific to rural and remote regions. Residents of rural and remote regions have been found to have poorer health status compared to residents of urban regions, with differences compounded by difficulties in attracting and retaining health care providers.[72,73] Community Sponsored Contracts (CSCs) and the Northern Group Funding Plan (NGFP) models were introduced in 1996 and 1998, respectively, and were designed to entice physicians to practice in rural and/or northern areas of the province. Physicians in the CSC and NGFP models were paid predominantly through salary with additional pay-for-performance incentives for targeted care. These two models were later converted into the Rural and Northern Physician Group Agreement (RNPGA) in 2004. The Health Service Organization (HSO) was introduced in 1973 and unlike the traditional FFS model, physicians had the option of practicing as a solo practitioner or within a group. Additionally, the HSO model allowed for integration of non-physician providers. HSO physicians were paid by capitation for a defined basket of services, adjusted based on the age and sex of the patient, while services outside the defined basket of services and services provided to

non-enrolled patients were paid by FFS. The HSO model was Ontario's first large-scale experiment with capitation models and was later converted into the Family Health Organization (FHO) during the primary care reform period.

Current estimates suggest Ontario primary care reforms led to moderate improvements in access to care, with the vast majority (94%) of residents aged 16 and older having a primary care provider by 2014.[74] While many Ontarians receive primary care from their primary care provider on a continuing basis, there are still unresolved issues regarding access to primary care. Many patients are unable to access same- or next-day appointments or primary care during after-hours, instead relying on walk-in clinics and the ED setting for care during after-hours.[52,75] Ontarians report similar ED utilization patterns as the Canadian population, with 40% of Ontarians reported having used an ED in the past 2 years compared to the Canadian average of 41% and additionally, 44% of Ontarians reporting their ED visit to have been avoidable had their primary care provider been more accessible compared to the Canadian average of 41%.[52] In 2017, approximately one-third of Ontario residents visited a walk-in clinic when they were sick and of those who visited, approximately half visited the walk-in clinic because their regular primary care provider was unavailable.[75] This suggests either a lack of availability by primary care providers or that their patients may be unaware of any access arrangements by their primary care provider. The proportion of patients who considered their ED visit avoidable had their primary care provider been accessible differs across geography and demographic characteristics, with rural patients and younger patients more likely to visit the ED for avoidable conditions.[75]

1.3.1 Patient Enrolment Models

The backbone of primary care reform in Ontario was the introduction of patient enrolment models (PEMs), which encouraged group practice, patient rostering with a specific primary care provider, provision of services during after-hours, blended payment schemes, and financial incentives for the delivery of targeted health care.[50] The four main PEMs were: the Family Health Network (FHN) introduced in April 2002, the Family

Health Group (FHG) introduced in July 2003, the Comprehensive Care Model (CCM) introduced in October 2005, and the FHO introduced in November 2006 (Table 1.2).[26]

Physicians currently have several options of practice: the traditional FFS model, being remunerated solely through FFS payments; under one of four PEMs, paid either through blended capitation (FHN or FHO) or enhanced/blended FFS (FHG or CCM); or under a set of specialized models that include CHCs, GHC, and RNPGA, as well as the Southeastern Ontario Academic Medical Association (SEAMO), the Weeneebayko Area Health Authority (WAHA), and the St. Joseph's Health Care Centre – Toronto (SJHC), that receive remuneration through a blend of FFS payments, capitation, and salary. CHCs are salaried models and tend to provide primary care, health promotion, and illness prevention services to specific marginalized patient populations facing barriers to accessing primary care, such as those with HIV-infection and unhoused patients, while other specialized models tend to serve a patient population in a central location. In addition to receiving remuneration through blended payment schemes, specialized models may also be eligible for additional bonuses and incentives available to physicians. For example, physicians working in the SEAMO model receive remuneration through an identical payment scheme to those in the FHN model, and physicians under the RNPGA model are remunerated through a blended salary model with additional pay-for-performance incentives.[26]

The FHN and FHO models are also known as blended capitation models, as physicians practicing in either model receive payment predominantly through capitation. FHN and FHO physicians receive additional FFS payments on services outside the defined basket of services and for those provided to non-enrolled patients subject to the hard cap limit, as well as pay-for-performance incentives for meeting various levels of targeted care. The FHN and FHO are group-based models, with a minimum of three physicians practicing within a group; however, physicians within a group may be geographically separated from one another. Capitation payments are adjusted for age and sex and provided to cover a core basket of services to enrolled patients. The core basket of services is larger in the FHO model has than the FHN model, and thus, FHO physicians receive a higher base capitation rate compared to FHN physicians. Physicians may claim a maximum

amount for in-basket services to non-enrolled patients per year up to a hard cap of $55,900 for FHO physicians in 2013/14.[56] Additionally, physicians also receive 10% of the FFS value of in-basket services provided to enrolled patients through the shadow-billing premium, initially aimed to encourage submission of claims for capitated or salaried services, but now used to support effective compliance with billing.[26] As of October 2010, the shadow-billing premium increased to a value of 15%. While there is no limit on the number of patients that may be enrolled, the comprehensive capitation payment will be reduced by 50% per patient for each patient enrolled beyond 2,400 patients. Physicians receive various incentives for providing targeted care to eligible patients, such as the cumulative preventive care bonus, for maintaining specified levels of preventive care to their enrolled patients. FHN and FHO physicians receive the access bonus to a maximum of 18.59% of the capitation rate, reduced by the FFS value of core services provided by other physicians with a maximum claw-back value equal to its maximum value.

The CCM and FHG models are commonly known as enhanced or blended FFS models with patient enrolment, as physicians are paid primarily through FFS payments with some similar incentives for preventive services and after-hours coverage as in the blended capitation models. While patient enrolment is voluntary for physicians practicing in CCM and FHG models, bonus payments and other incentives are tied to enrolled patients. By rostering patients, physicians are also eligible to receive comprehensive care capitation payments for enrolled patients on eligible services.[56] While the FHG requires group practice (though similar to blended capitation models, physicians may be geographically separated), physicians may practice solo in the CCM. Additionally, physicians practicing in the CCM are not required to provide on-call or triage services.

While most physicians practiced in the traditional FFS prior to primary care reform, many switched to a PEM during the primary care reform period. In the 2000/01 fiscal year, more than 98% of family physicians were paid predominantly through fee-for-service remuneration.[76,77] However, by 2010/11, only 35% of physicians continued to practice in the traditional FFS model, with 24% of physicians practicing in the FHG model, 24% of physicians in the FHO model, 3% in the FHN model, 2% in the CCM

model, and the remainder in one of the specialized models.[76] More recent estimates suggest that the popularity of the FHO model is continuing to increase, from 2,851 physicians in an FHO in 2010/11 to 5,494 physicians in 2017/18.[78] Between 2004 and 2008, the most popular PEM was the FHG model; however, by 2008, many were switching to the FHO model.[26,79] These reforms led to increased payments for many primary care physicians, with physicians in FHG and FHO models billing over 25% more than the average payment to physicians in the traditional FFS model.[26]

Although not a payment model, the Family Health Team (FHT) model is a physician-led interdisciplinary team-based practice introduced in April 2005 and is available to physician groups in a blended capitation (such as the FHO or FHN) model or salary models.[80] FHTs are composed of core health care professionals, such as physicians and nurses, and interdisciplinary health care providers, including those in mental health, nutrition, and social work to promote comprehensive and interdisciplinary provision of care for chronic disease management, counseling, health education and palliative care.[26,81] FHTs receive additional resources such as salary, sessional payment, or contractual agreements for allied health care providers from the Ministry of Health.

1.3.2 After-Hours Primary Care in Ontario

Physicians in PEMs and some specialized models are required to provide after-hours services to patients. Though the information on practice opening outside of the regular working-hours is not required to be publicly available, enrolled patients must be informed when the after-hours services are available, and the physicians must provide services for both scheduled and unscheduled patient visits. In Ontario, after-hours services are defined as services provided evenings and overnight (5:00 PM – 8:00 AM) on weekdays or any time on weekends and statutory holidays. Physicians in PEMs are required to provide a minimum number of three-hour blocks of after-hours services, with service blocks on Monday through Thursday starting between 5:00 PM and 7:00 PM. Initially practices were required to offer at least one three-hour block of after-hours services for each physician in the practice group to a maximum of five three-hour blocks of after-

hours services. However, under The Enhanced After-Hours Services requirement introduced in April 2013, the number of after-hours service blocks required for physician groups with ten or more physicians in the FHG, FHN, and FHO models increased to accommodate for larger roster size.[82] The Enhanced After-Hours Services requirement requires more three-hour blocks of service depending on the size of the group, with 7 blocks of after-hours services for 10-19 physicians, 8 blocks for 20-29 physicians, 15 blocks for 75-99 physicians, 20 blocks for 100-199 physicians, and 25 for a group size of 200 or more physicians. Physicians with a group size of five or more are required to offer at least four blocks of after-hours services on weekday evenings, as well as at least one block of services on weekends. Although the after-hours services requirement is mandatory, physicians in the FHG, FHN, and FHO models may be exempt from the enhanced after-hours requirement where at least half of all physicians in the group provide regular care of hospital inpatients, hospital on-call coverage, hospital anesthesia services, obstetrical deliveries outside of regular office hours, care to nursing home or long-term care patients, care to patients in hospice or palliative unit care, or active work as coroners.[82,83] Although provision of after-hours services is required for physicians in these models, there is insufficient evidence that contracted service elements such as the provision of after-hours services is actually undertaken. One study where physicians' offices were contacted after-hours found that many physicians provided little, if any, instruction on how to access the appropriate health care provider during after-hours based on the severity of their condition.[84]

Patients enrolled in a PEM also have access to Telephone Health Advisory Service (THAS), an after-hours telephone health advice and triage service. Prior to the 2012 Physician Service Agreement, primary care physicians in PEMs were required to be on-call for scheduled periods to the THAS to provide advice if required, with physicians paid a monthly salary for the on-call service.[85] However, due to the low volume of calls compared to the cost of the service, the requirement was dropped, and the THAS program is currently staffed by nurses and nurse practitioners. Although physicians may participate in the THAS program on a voluntary basis, they no longer receive a monthly salary for the on-call service. After-hours instructions provided by physician clinics were found to often recommend a patient visit the ED for treatment.[84] However, the study also

found that physicians in the reformed models were more likely to recommend their patient see an after-hours clinic compared to those continuing to practice in the traditional FFS model.

One incentive available to physicians practicing in a PEM or one of the specialized models is the after-hours premium (Q012A for physicians practicing in FHO, FHN, and FHG models and Q016A for physicians practicing under the CCM), an incentive on specific services provided for enrolled patients provided during after-hours. Initially upon introduction in July 2003, the after-hours premium was provided as a 10% incentive and later increased to 15% in April 2005, to 20% in April 2006, and to 30% in September 2011. The after-hours premium may be billed on specific services provided to patients enrolled to the physician or another physician in the same group for both scheduled and unscheduled services provided during after-hours. The after-hours premium is eligible to be billed with fourteen service codes as well as three service codes for virtual care made temporarily eligible during the COVID-19 pandemic (Table 1.3). [26,86]

1.4 The Impact of Health Care Reforms on Health Care Utilization and Health Status

Due to different objectives set by each provincial and territorial government and varying levels of funding from the federal government, strategies for primary care reform varied greatly. Ontario focused on reforming models of payment for physicians, while other provinces such as Alberta and Quebec focused on introducing non-physician health care professionals into interdisciplinary team-based models within fee-for-service. A systematic review of primary care reforms across Canada found that the introduction of team-based models led to reduction in ED visits and small improvements in processes of care.[53] In Alberta and Quebec, interdisciplinary team-based aspects of primary care reforms for chronically ill or elderly patients were associated with a reduction in ED visits, but not associated with any changes in the rate of hospitalizations.[87–89]

1.4.1 Ontario's Primary Care Reforms on Health Care Utilization

In Ontario, early evidence suggests that primary care reforms led to an improvement in physician attachment, with approximately 15% of the total population who were previously unattached to a physician rostered to a primary care physician between 2003 and 2010.[79] Patients rostered to PEMs had lower health care costs compared to patients with a physician in the traditional FFS model.[93] Comparisons of physicians who continued to practice in the traditional FFS model and those who practiced in a PEM found that reforms altered their behaviour: physicians in the enhanced FFS model were found to be more productive than physicians in the traditional model, providing more services and treating more patients.[79,94]

Physicians in the FHN model provided fewer services and visits per day compared to their FHG counterparts, despite limited evidence of risk selection.[95,96] Between the FHG and FHN models, patients in the FHN model had poorer access to care during after-hours and lower comprehensiveness of care but continuity of care was similar between groups.[67] Additionally, costs were found to be lower for patients in the FHG group compared to patients in the traditional FFS model, both in primary care and across the system.

The number of hours worked did not differ between models, instead, physicians modified how they delivered care. Physicians in the blended models allocated more hours to direct patient care outside the clinic and indirect patient care compared to FFS physicians, who allocated most time to direct patient care in the clinic.[79,97] The introduction of PEMs was associated with improved processes of care, including improved screening and preventive services.[79,90–92] Additionally, physicians in capitation and salary models dedicated more time to providing preventive care services.[98–101] Screening rates were higher among patients in the FHG and FHO model compared to patients in the traditional FFS models, with cervical cancer screening rates being the highest among patients in the FHG model.[102] Enrolled patients also receive better preventive care for specific chronic diseases and more recommended diabetes tests compared to non-enrolled patients.[90,91] However, physicians who switched to the FHO model increased the number of patient referrals to specialists compared to those who remained in the FHG model.[103] Patients in

the FHN model were more likely to visit the ED compared to patients in the FHG model, despite being less likely to have chronic conditions.[67] Thus, there may be trade-offs in access to care and quality of care between the enhanced FFS and capitation models.

1.4.2 The Impact of Primary Care Incentives

In theory, pay-for-performance financial incentives should reward high-performing physicians, while at the same time, motivating underperforming physicians to improve quality of care.[104,105] However, the evidence for the effectiveness of incentives in the literature is mixed. Reviews examining the effect of incentives on cancer screening for primary care providers have found inconclusive evidence for the effectiveness of incentives on improving rates of cancer screening.[106–108] One Cochrane review concluded that while financial incentives for primary care providers are becoming increasingly popular, there is insufficient evidence to demonstrate that financial incentives truly improve the quality of primary care and high-quality evidence on the effectiveness of financial incentives still limited.[109] Similarly, other studies have found mixed evidence for the effectiveness of these incentives on clinical indicators and measures of access to primary care.[110,111] A more recent systematic review similarly found that pay-for-performance incentives had little impact on processes of care and patient-relevant health outcomes, especially when considering the methodological quality of the studies reviewed; this review also demonstrated mixed evidence for the effect of incentives on health care utilization.[112] Differences across studies highlight the influence of contextual health system factors and the value of the incentive introduced. Therefore, when studying the effectiveness of a pay-for-performance incentive, it is important to consider the health care system in which an incentive is introduced and to use rigorous statistical methods when testing for a difference in effect.

The effectiveness of incentives in Ontario has also been found to be mixed. The Ontario provincial government introduced the cumulative preventive care bonuses during the primary care reform period, available to physicians practicing in PEMs who maintain certain standards of care for their enrolled patients in five preventive care categories:

influenza vaccine, Pap smear, mammography, childhood immunizations, and colorectal cancer screening. However, it is unclear whether the cumulative preventive care bonuses are truly effective. One study finds that the cumulative preventive care bonuses were responsible for moderate improvements in screening rates among PEMs.[92] However, another study over a ten-year period found no difference in the rate of cancer screening before and after the bonuses were introduced, finding that Ontario spends a substantial amount on these financial incentives for no effect.[113] Modest findings were also demonstrated when examining the effect of incentives for diabetes care among physicians, with small improvements in preventive monitoring tests for diabetes such as blood-glucose measures, cholesterol monitoring, and eye tests.[91] In some cases, the incentive implemented has been found to have little to no effect on primary care provider behaviour and may thus be costly on the health care system without any benefits for patients. For example, the access bonus, available to physicians in the FHN and FHO models, was designed to improve access and minimize the number of patient visits outside of their primary care provider group, but has been instead found to simply reward physicians whose patients make fewer health care visits to their own primary care provider.[114] Patients of physicians who received higher payments through the access bonus had poorer access to after-hours primary care, but made more ED visits and had higher adjusted ambulatory costs.[114] The introduction of various incentives during the primary care reform period in Ontario has been associated with modest, if any, improvements in primary care and warrants further investigation using rigorous statistical methods.

1.5 Emergency Department Utilization

The ED is typically to be used for care for emergency conditions. However, it is becoming increasingly difficult to seek care in the ED due to the issue of ED overcrowding, commonly defined as the scenario where the demand for emergency services exceeds the ability of an ED to provide quality care in the appropriate time frame.[115,116] Internationally, crowding has become one of the most significant public health concerns as ED utilization continues to grow at alarming rates.[117] Many countries,

including Canada, have reported significant increases in the number of ED visits that will further contribute to the levels of overcrowding seen, and cannot be explained solely by population growth.[118–123] In a survey of ED directors across Canada, 62% reported ED overcrowding to be a major or severe problem during the previous year, attributing overcrowding to issues such as a lack of admitting beds, a lack of acute beds, and the increased length of stay of patients admitted in the ED.[124]

1.5.1 Causes, Consequences, and Solutions for Emergency Department Overcrowding

Asplin et al. (2003) proposed one model of ED overcrowding known as the input-throughput-output model, where overcrowding is caused by three factors: i) the input factor, the volume of patients waiting to be seen; ii) the throughput factor, delays in assessing and treating patients already in the ED; and iii) the output factor, barriers to patients leaving the ED after receiving treatment.[125] In a recent systematic review, causes of ED overcrowding were identified and categorized into this input-throughput-output model.[118,125] The review found several studies that identified access block, or the inability to transfer a patient from the ED to an inpatient bed after receiving treatment in the ED, as a major cause of ED overcrowding; however, output factors did not appear to be the major cause of ED overcrowding.[124,126–130] Instead, many studies focused on input causes including an increase in presentations from older adults, patients with urgent and complex needs, and patients with low-acuity issues that could be treated elsewhere,[124,126,127,131–134] as well as limited access to appropriate care outside of the ED.[124,126,134,135] One study in the United Kingdom (UK) identified limited access to primary care as an input-phase cause of ED overcrowding and found that patients who were able to see a physician within two days were less likely to self-refer to the ED with low-acuity issues.[135] Similarly, a Canadian study reported that access to a primary care provider could potentially reduce non-urgent ED visits by 40%.[134]

ED overcrowding tends to lead to an increase in wait times within the ED,[118136] typically due to increases in time to treatment and delays in ED care, and an increase in length of

stay for patients admitted to the hospital.[137,138] In turn, these increases in length of stay are associated with increases in health systems costs due to costs of hospital beds and other associated factors.[137] Patients may also experience other consequences, including delays in assessment or receiving required care,[124,139] increased exposure to medical errors,[140,141] reduced patient satisfaction, increased length of stay in the ED and post-hospital admission,[137,138] and increased inpatient mortality during the stay in the hospital setting.[118,120] Finally, overcrowding may be detrimental to the health care system through consequences to health care staff, including increased stress and physical violence against providers.[124,142] It is clear that ED overcrowding is a cause for concern among healthcare policymakers from both provider and patient perspectives.[143–145]

Various solutions have been proposed to reduce ED overcrowding, including interventions targeted to improve access outside of the ED setting. These interventions include introducing primary care provider-led walk-in-clinics and primary care provider clinics within or adjacent to the ED,[146–148] as well as extending the availability of existing primary care provider practices.[149–152] Extending availability was demonstrated to be effective in reducing both low-acuity ED visits and the number of visits made by elderly patients in the UK and in Australia.[149–151] The Canadian Association of Emergency Physicians (CAEP) established several recommendations in limiting ED overcrowding in the Canadian context.[115] Although they focused on procedures to limit access block within the ED setting, one recommendation to limit overcrowding through the input phase included improving access to primary care, with the CAEP highlighting the need for extended access to a primary care provider during after-hours and the availability of semi-urgent appointments. Improving access to primary care may reduce less-urgent ED visits, and thus be one part of the solution to overcrowding.

1.5.2 Primary Care Avoidable Emergency Department Visits

One of the contributing causes of ED overcrowding is the inappropriate utilization of the ED by patients with primary care-treatable conditions; however, the definition of an inappropriate ED visit varies considerably in the literature. In the literature, the use of the

term ‘inappropriate’ ED visit is often erroneously used interchangeably with ‘avoidable,’ ‘non-urgent,’ or ‘unnecessary’ ED visit, but the definition may differ not only between these terms, but within the terms.[153] Inappropriate ED utilization may be defined using a variety of methods, including patient self-reported data, triage scores, such as the Canadian Triage and Acuity Scale (CTAS),[154] and using a list of avoidable conditions as developed by organizations such as the Canadian Institute for Health Information (CIHI).[155–157] Due to these varying and often broad definitions, estimates for the proportion of ED visits that are inappropriate vary vastly, with one review finding the prevalence of inappropriate ED visits to range from 10% to 90%.[158] Among studies that used standardized definitions such as the CTAS or the Hospital Urgencies Appropriateness Protocol, the prevalence of inappropriate ED utilization ranged from 25% to 65%.[158] In Canada, the prevalence of inappropriate ED use was estimated to be 25% when using the CTAS to define the occurrence of an inappropriate ED visit.[159]

Factors associated with inappropriate ED utilization include demographic characteristics, with older adults and women being more likely to use the ED for inappropriate reasons, socioeconomic characteristics, with lower education and income associated with greater likelihood of use of the ED for inappropriate reasons, and health needs, as individuals with chronic conditions or comorbidities were more likely to use the ED for inappropriate reasons.[158,160] However, there are several avoidable factors that may be associated with ED utilization, including limited access to primary care services, as inability to obtain an appointment with a primary care provider was a significant contributor to inappropriate use of the ED.[160,161] Although limited primary care access remains a major reason for use of the ED for inappropriate and potentially primary care treatable conditions, the evidence for the effectiveness of interventions expanding access to primary care has demonstrated a modest impact and further study is required to determine the impact of interventions implemented to improve access to primary care.[162–164]

While inappropriate ED use may contribute to ED overcrowding and thus expose patients to greater risk of medical errors and potential in-hospital mortality, inappropriate primary care treatable ED visits can also be burdensome on the health care system. The use of the ED for primary care-treatable conditions can contribute to increased health systems costs

as treatment costs for patients in the ED is more expensive compared to other treatment centers, such as in the primary care setting or a walk-in clinic.[165,166] One US study estimates that ED visits were approximately two to three times more costly than other treatment settings and in 1993, these inappropriate ED visits are estimated to have cost the US health care system $5-7 billion.[167] Additionally, the use of the ED for conditions treatable by a primary care physician may lead to poorer continuity of care, which in turn is associated with poorer patient satisfaction and greater health care utilization outside of the primary care setting.[168]

1.5.3 Access to Primary Care and Emergency Department Visits

In the Commonwealth Fund's 2016 International Health Policy Survey of Adults, Canadians visited the ED more often than adults of other high-income countries.[51] Not only do Canadians use the ED more, but 41% of Canadians believed their condition could have been treatable in a primary care setting had their primary care physician been available. Previous research has found that many survey respondents who used the ED indicated the lack of availability of same-day appointments to be a major driver of ED visits, despite preferring to be seen by their primary care physician.[169] Instead, patients opt for the convenience of the ED over their primary care providers, and research has demonstrated that while other factors may also play a role in the choice of the ED over a primary care physician, access tends to remain the greatest contributing factor.[170]

Access to care is commonly defined as the use of health care services in relation to an individual's need.[171] Under Andersen's health care utilization model, factors that influence access may be categorized as: 1) predisposing factors, or socioeconomic and cultural factors; 2) enabling factors, or the logistic factors involved in obtaining access to care; and 3) need factors, or the perceived and evaluated factors that generate need for health care services.[172,173] A later framework was centred around five dimensions of access to care, where access was defined as the opportunity to have health care needs fulfilled: 1) approachability, the ability to identify some form of services exists and can be reached; 2) acceptability, cultural and social factors determining possibility to accept

aspects of services; 3) availability and accommodation, the ability to reach health care services both physical and in a timely manner; 4) affordability, the economic capacity to use appropriate services; and 5) appropriateness, the suitability between the patient and the services.[174]

Under Andersen's health care utilization model, Ontario's primary care reforms may have altered physician behaviour to reduce barriers to accessing primary care under the enabling factors.[172] The after-hours premium incentivizes physician groups to open their practice beyond the regular working-hours, thus extending the duration and flexibility of hours of service.[174] As patients often opt for the emergency department due to limited primary care access and may prefer being seeing by their primary care physician, the extension of clinic hours may lead to the diversion of patients with conditions potentially treatable in the primary care setting.

1.6 Objectives

The overarching goal of this thesis is to investigate how reforms in primary care physician payment systems, including incentives and blended payment models, lead to improved access to primary care and reduction in less-urgent ED visits. Chapter 2 presents a review of the published literature, examining current evidence on the effect of interventions to improve access to primary care during after-hours on both primary care and ED visits. Chapter 3 uses empirical data from Ontario to examine whether the introduction of Ontario's after-hours premium was associated with a reduction in less-urgent ED visits and whether subsequent increases in the value of the premium were associated with further reductions in less-urgent ED visits. Chapter 4 builds on the study from Chapter 3, using linked survey and administrative data to first examine whether the increase in Ontario's after-hours premium was associated with a reduction in less-urgent ED visits, then secondly, whether this reduction is potentially causal by comparing to several control provinces. Chapter 5 examines the difference in rates of primary care services and ED visits between the FHG and FHO models in the post-reform period, specifically focusing on whether this difference persists across timing and urgency of

visits and by patient chronic conditions. Finally, Chapter 6 presents a summary of these four studies, the key strengths and limitations, and the implications and future directions of this research.

Table 1.1 Summary of after-hours premiums across the ten provinces in Canada

Province	Name	Description	Timing	Value
Alberta[59]	After-hours time premium	Incentive claimable for physician service provided to patients in alternative areas of care (active treatment hospitals, nursing homes, auxiliary hospitals, and urgent care centres)	Weekdays, 5:00 PM – 10:00 PM; weekends and statutory holidays, 7:00 AM – 10:00 PM	Fixed value of $22.79
			Weekdays, weekends, and holidays, 10:00 PM – 7:00 AM; designated holidays, 7:00 AM – 10:00 PM	Fixed value of $45.55
British Columbia[60]	Out-of-office premium	Call-out charge for where physician is called for emergency or non-elective services and physician must travel from one location to another to see patient; premium only billable for first patient seen	Weekdays, 6:00 PM – 11:00 PM; weekends and statutory holidays, 8:00 AM – 11:00 PM	Fixed value of $72.17
			Weekdays, weekends, and holidays, 11:00 PM – 8:00 AM	Fixed value of $101.35
Manitoba[61]	After-hours premium	Premium available for urgent and emergent medical services provided in any setting; however, physicians cannot bill on services provided where physician's office maintains regular hours during these periods	Weekdays, 5:00 PM – 12:00 AM; weekends and statutory holidays, 7:00 AM – 12:00 AM	50%
			Weekdays, weekends, and statutory holidays, 12:00 AM – 7:00 PM	75%
New Brunswick[62]	After-hours emergency premium	Premium for emergency services provided, where emergency services are defined as services that must be performed without delay because of the medical condition of the patient)	Weekdays, 6:00 PM – 12:00 AM; weekends and holidays 6:00 AM – 12:00 AM	50%
			Weekdays, weekends, and statutory holidays, 12:00 AM – 6:00 AM	100%
Newfoundland and Labrador[54]	Add-on fee for scheduled after-hours general practice clinics	Fee for specific set of services provided by primary care physicians who see patients in regularly scheduled after-hours clinics	Weekdays, 6:00 PM – 8:00 AM; weekends and holidays, any timing	Fixed value of $10
Nova Scotia[55]	GP enhanced hours premium	Incentive on specific set of services provided to patients on group roster	Weekdays, 6:00 PM – 10:00 PM; weekends, 9:00 AM – 5:00 PM	25%

Ontario[26,56]	After-hours premium	Incentive on specific set of services provided to patients on group roster	Weekdays, 5:00 PM – 8:00 AM; weekends and statutory holidays, any timing	30%
Prince Edward Island[63]	After-hours premium	Premium for services provided on emergency basis	Weekdays, 6:00 PM – 12:00 AM; weekends and statutory holidays, 8:00 AM – 12:00 PM	25%
Quebec[57]	Majorations en horaires défavorables	Incentive for specific set of services provided to patients at-home, in-clinic at a GMF-U, or in-clinic at a community health centre	Monday – Thursday (excluding statutory holidays), 6:00 PM – 10:00 PM	16%
			Friday, 6:00 PM – 10:00 PM; weekends and statutory holidays, 8:00 AM – 12:00 AM	26%
		Incentive for specific set of services provided to patients at-home, in-clinic at a Groupe de médecine de familiale universitaire, or in-clinic at a community health centre where patient visit does not have an appointment from a Groupe de médecine de famille-Réseau (super-clinique), provided at the clinic location	Weekends and statutory holidays, 8:00 AM – 12:00 AM	33%
		Incentive for emergency services provided in-hospital or in an integrated childcare network community health centre	Monday – Thursday, 8:00 PM – 12:00 AM; weekdays, weekends, and statutory holidays, 12:00 AM – 8:00 AM	16%
			Friday, 8:00 PM – 12:00 AM	26%
			Weekends, 8:00 AM – 12:00 AM	33%
		Incentive for patients admitted, services requiring immediate surgical attention, and services provided in an outpatient clinic requiring hyperbaric treatment	Monday – Thursday, 8:00 PM – 12:00 AM	13%
			Friday, 8:00 PM – 12:00 AM; weekends and statutory holidays, any timing	23%

		Incentive for patients admitted requiring intensive or coronary care	Weekends and statutory holidays, any timing	30%
Saskatchewan[58]	Out-of-hours premium	Premium for services in a non-office environment	Weekdays, 5:00 PM – 12:00 AM; weekends and statutory holidays 7:00 AM – 12:00 AM	50%
			Weekdays, weekends, and statutory holidays, 12:00 AM – 7:00 AM	100%
	After-hours-clinic premium	Premium for general practitioners when performing specific set of services in an office location; premium is restricted to certain cities	Weekdays 7:00 PM – 7:00 AM; weekends and statutory holidays, any timing	10%

Incentives available only on specific services; value as a fixed payment for each service provided or as a percentage of the fee-for-service value of the service.

Table 1.2 Characteristics of the traditional FFS model and the patient enrolment models

	Traditional Fee-For-Service	Comprehensive Care Model (CCM)	Family Health Group (FHG)	Family Health Network (FHN)	Family Health Organization (FHO)
Date of Introduction		April 2002	July 2003	October 2005	November 2006
Payment	Fee-for-service	Fee-for-service with additional incentives and bonuses	Fee-for-service with additional incentives and bonuses	Capitation, fee-for-service for non-enrolled patients and services outside the pre-specified basket of services and additional incentives and bonuses	Capitation, fee-for-service for non-enrolled patients and services outside the pre-specified basket of services and additional incentives and bonuses
Group Size	No minimum	Solo physician	Minimum 3 physicians	Minimum 3 physicians	Minimum 3 physicians
Availability	Unrestricted	Unrestricted	Unrestricted	Effective June 1, 2015, onward, monthly registration is limited to 20 physicians per month in areas of high need; physicians in existing groups may be replaced in all areas regardless of need	Effective June 1, 2015, onward, monthly registration is limited to 20 physicians per month in areas of high need; physicians in existing groups may be replaced in all areas regardless of need
Patient Enrolment	None	Optional	Optional	Required	Required
Basket of Services; FFS Billing	FFS billing per Schedule of Benefits for all services provided	FFS billing per Schedule of Benefits for all services provided	FFS billing per Schedule of Benefits for all services provided	Base capitation rate plus shadow billing (15%) on 64 codes for enrolled patients FFS billing per Schedule of Benefits for services outside the core basket of services and	Base capitation rate plus shadow billing (15%) on 130 codes for enrolled patients FFS billing per Schedule of Benefits for services outside the core basket of services and

				services provided to non-enrolled patients No hard cap ceiling in the first year of practice, but a hard cap ceiling of $55,900 per physician in the group for in-basket services to non-enrolled patients	services provided to non-enrolled patients No hard cap ceiling in the first year of practice, but a hard cap ceiling of $55,900 per physician in the group for in-basket services to non-enrolled patients
Annual Capitation Rate[26]	None	None	None	Capitation rate is age- and sex-adjusted; base rate of $126.48 in 2013/14	Capitation rate is age- and sex-adjusted; base rate of $139.12 in 2013/14
Access Bonus	None	None	None	Calculated at 18.59% of the base rate (20.65% for long-term care patients), paid semi-annually The access bonus is reduced if enrolled patient receives in-basket services from GP outside of group; access bonus cannot be negative	Calculated at 18.59% of the base rate (20.65% for long-term care patients), paid monthly The access bonus is reduced if enrolled patient receives in-basket services from GP outside of group; access bonus cannot be negative
After-Hours Requirement[a]	None	None	Number of after-hours blocks of services varies depending on number of physicians in the group based on the Enhanced After-Hours Requirement	Number of after-hours blocks of services varies depending on number of physicians in the group based on the Enhanced After-Hours Requirement	Number of after-hours blocks of services varies depending on number of physicians in the group based on the Enhanced After-Hours Requirement

			Exemption if more than 50% of group provides emergency, anesthesia coverage, or obstetrics coverage	Exemption if more than 50% of group provides emergency, anesthesia coverage, or obstetrics coverage; northern and rural groups that are required to have 50% of physicians maintain active hospital privileges do not have to provide more than 5 blocks per week	Exemption if more than 50% of group provides emergency, anesthesia coverage, or obstetrics coverage; northern and rural groups that are required to have 50% of physicians maintain active hospital privileges do not have to provide more than 5 blocks per week
After-Hours Premium[b]	None	Q016: Additional 30% premium for specific services provided to enrolled patients as of September 2011	Q012: Additional 30% premium for specific services provided to enrolled patients as of September 2011	Q012: Additional 30% premium for specific services provided to enrolled patients as of September 2011	Q012: Additional 30% premium for specific services provided to enrolled patients as of September 2011

All rates, number of services, and incentives listed effective as of June 2015 unless state otherwise. As of June 1st, 2015, several fee codes were eliminated including the new patient fee (Q013A), the new graduate-new patient fee (Q033A), the mother and newborn fee (Q054A), and the multiple newborn fee (Q055A). Additionally, fee codes for patient rostering, per patient rostering fee (Q200A), GHC per patient rostering fee (Q201A), and the LTC per patient rostering fee (Q202A) have been reduced to $0 but must be submitted to manage patient rostering.

[a]After-hours requirement is 3 after-hours services blocks for 3 physicians in a group, 4 blocks for 4 physicians, 5 blocks for 5-9 physicians, 7 blocks for 10-19 physicians, 8 blocks for 20-29 physicians, 10 blocks for 30-74 physicians, 15 blocks for 75-99 physicians, 20 blocks for 100-199 physicians, and 25 blocks for 200 or more physicians.

[b]After-hours premium (Q012 and Q016) may be billed for basic office visit codes: A001, A003, A004, A007, A008, A888, K005, K013, K017, K030, K130, K131, K132, K033, and Q050.

Table 1.3 Services eligible to be billed with the after-hours premium

Fee Code	Description	Date of Eligibility
A001	Minor Assessment	Jul 2003
A003[a]	General Assessment (K130, K131, and K132 replaced A003 as of January 2013)	Jul 2003 – Jan 2013
A004	General Re-Assessment	Jul 2003
A007	Intermediate Assessment/Well Baby Care	Jul 2003
A008	Mini Assessment	Jul 2003
A888	Emergency Department Equivalent – Partial Assessment	Jul 2003
K005	Primary Mental Health Care	Apr 2005
K013	Counselling – Individual Care per half-hour	Apr 2005
K017	Annual Health Examination – Child After Second Birthday	Apr 2005
K030	Diabetic Management Fee	Apr 2009
K033	Counselling Individual Care	Sep 2011
K080[b]	Minor assessment of a patient by telephone or video	Mar 2020
K081[b]	Intermediate Assessment of a patient by telephone or video, at least 10 min; or Psychotherapy, psychiatric, or primary mental health care, counseling or interview by telephone or video, at least 10 min	Mar 2020
K082[b]	Psychotherapy, psychiatric or primary mental health care by telephone or video per half-hour unit	Mar 2020
K130	Periodic Health Visit – Adolescent	Jan 2013
K131	Periodic Health Visit – Adult (18-64)	Jan 2013
K132	Periodic Health Visit – Adult (65 and older)	Jan 2013
Q050	Heart Failure Management Incentive (Annual)	Apr 2009

[a]Service codes K130, K131, and K132 replaced A003 in January 2013

[b]Service codes K080, K081, and K082 were temporarily added for eligibility to bill the after-hours premium during the COVID-19 pandemic

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2 The impact of improved access to after-hours primary care on primary care and emergency department utilization: A review of the literature

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2.1 Introduction

The strength of a primary care system can be characterized by four dimensions: first-contact access to care for new needs; long-term person-focused care; comprehensiveness care for most health needs; and coordinated care when it must be sought elsewhere.[1] Investing in primary care has been found to be beneficial – stronger primary care systems are expected to be associated with improved patient and system outcomes, including better access to health care services, lower cost of care, and a reduction in population health inequities.[1] The relationship between a strong primary care system and improved health outcomes holds both internationally, as cross-European comparisons find countries with more comprehensive primary care were associated with improved population health, lower rates of unnecessary hospitalization, and reduced socioeconomic inequality,[1–6] and at the individual-level, patients who had access to continuous and comprehensive primary care have better health status compared to those without such access.[1,7]

Although access to comprehensive primary care is crucial for a strong health care system, the Commonwealth Fund's 2016 International Health Policy Survey of Adults in 11 Countries found access to primary care is limited in many high-income countries.[8] The survey found that as many as 33% of adults in the United States (US) faced cost-related access barriers in the past year and as many as 53% of Canadians were unable to receive same- or next-day appointments. When surveyed on access to after-hours primary care (i.e., weekday evenings, weekends, and statutory holidays), more than 50% of adults from six countries reported difficulty accessing primary care on evenings and weekends

without having to visit the emergency department (ED). Seeking care in the ED for conditions treatable in the primary care setting is linked with lower continuity of care and increased health care system costs.[9–13] Moreover, lower continuity of care may in turn be associated with poorer satisfaction of care and subsequently increased health services utilization.[14]

Policymakers have introduced various interventions to improve after-hours access to primary care, including as part of reorganization of the primary care system and more targeted actions, like the expansion of existing clinic hours or the introduction of after-hours clinics. Across several European countries, including the United Kingdom (UK), Denmark, and the Netherlands, general practitioner cooperative (GPC) models have been developed, comprised of physicians and additional personnel to provide after-hours primary care through telephone triage and advice, office visits, and home visits.[15] Early evidence of these models suggested a reduction in ED visits and physician costs; however, a systematic review of primary care interventions in the UK on non-urgent ED utilization found conflicting evidence for the effectiveness of GPCs.[16] While this review examined the impact of GPCs on ED visits, no review has specifically evaluated the impact of interventions to improve access to primary care. Improving access to primary care during after-hours may be one potential strategy to reduce inappropriate ED visits. Thus, this study aims to review the evidence on the impact of improved access to after-hours primary care on both primary care and ED utilization.

2.2 Methods

A literature search examining the association between improved access to after-hours primary care and both ED visits and primary care visits was conducted using four databases: CINAHL, EMBASE, MEDLINE, and Scopus. Database searches were conducted by combining keywords to describe after-hours, including “after hour” and “out of hour,” and keywords to describe primary care, including “primary care,” “primary health care,” “family physician,” “family doctor,” and “general practitioner.” For CINAHL, EMBASE, and MEDLINE, searches were conducted using the keywords and

search term headings specific to each database (Table 2.1). Additional studies were identified by scanning the reference list of initial references included for review and forward citation tracking of studies using Google Scholar. The search was first conducted in May 2018, with an updated search conducted in May 2020 (Appendix A).

Observational studies that examined the impact of improved access to after-hours primary care on either ED visits or primary care visits were included if they included quantitative associations. After-hours was defined broadly as outside of the regular working-hours, which could include weekday evenings or any timing during weekends and/or holidays. Studies examining primary care services delivered by a non-physician health care professional, including nurse practitioners, physician assistants, or other health care providers, as well as services delivered in a walk-in clinic setting were excluded. During the screening of study title and abstract, no restrictions were placed on the date of publication or the study population; however, studies were restricted to the English language. Case studies, review articles, letters and editorials, descriptive studies, and observational studies where the exposure was unrelated to access to after-hours primary care were excluded from full-text screening. During full-text screening, studies that did not examine either primary care or ED utilization as an outcome were excluded.

Information extracted from studies included author, year published, country of study, study design, study population, intervention or exposure group, statistical methods, effect on rates of ED visits, and effect on rates of primary care visits.

2.3 Results

The literature search identified 1,795 unique articles (Figure 2.1). After exclusion of 359 letters and editorials, 60 case studies, 57 reviews, 798 descriptive studies, and 459 observational studies where the exposure was unrelated to after-hours primary case access, 63 articles were left for full-text screening. After full-text screening, 12 studies were included from the search strategy, with an additional 8 studies added after forward and backward citation checking of included articles, resulting in a total of 20 studies for

review. Six studies examined the association between after-hours access and primary care utilization, while all 20 studies examined the association between improved access to after-hours primary care and ED utilization.

Although after-hours primary care may be broadly defined as any primary care services provided outside of the regular working-hours, the exact definition of after-hours varies by region. Articles defined after-hours in their region as weekday evenings and overnight, starting as early as 5:00 PM and ending as late as 9:00 AM the following weekday, and any time during weekends and local holidays.

Included studies were: (i) cross-sectional studies, comparing patients with and without access to after-hours primary care or (ii) pre-post design studies, evaluating the impact of access to after-hours primary care before and after implementation of some intervention to improve after-hours primary care. Studies were conducted in the US (n = 5),[17–21] Canada (n = 3),[22–24] Australia (n = 2),[25,26] Belgium (n = 2),[27,28] England (n = 2),[29,30] Ireland (n = 2)[31,32], the Netherlands (n = 2),[33,34] Italy (n = 1),[35] and Scotland (n = 1).[36] Although most studies used a general population, two studies in the US focused specifically on pediatric populations.[20,21] Study characteristics and a summary of individual study findings are presented in Table 2.2.

2.3.1 After-Hours Primary Care and Primary Care Utilization

Six studies examined the impact of improved access to after-hours primary care on primary care services.[24,27,28,33,34,37] Of these studies, five focused on the impact of reorganizing primary care physicians, while one focused on the impact of a financial incentive for physicians during after-hours. Among the five studies examining reorganization of primary care, one examined on Patient Enrolment Models (PEMs) in Ontario, Canada, group-based models which were required to practice during after-hours, while the other four focused on GPCs in Belgium and the Netherlands. PEMs were found to be associated with a reduction in the total primary care visit rate; however, there was an increase in the proportion of primary care visits provided on weekends.[24] In Belgium,

GPCs, regardless of whether they were located within a local ED or between the two local EDs, were associated with an increase in primary care visits by 37%-38%.[27,28] Additionally, GPCs that were located between the two local EDs were found to be associated with an increase in home visits.[27] GPCs in the Netherlands were associated with an increase in primary care utilization ranging from 10% to 25%.[33,34] Finally, the study examining the impact of Ontario's after-hours premium, an incentive for physicians on some services provided during after-hours found that an increase in the value of the premium was associated with an increase in primary care visits during after-hours, but a reduction in visits during regular-hours.[22]

2.3.2 After-Hours Primary Care and Emergency Department Utilization

All studies included for review examined the impact of improved access to primary care during after-hours on ED visits; however, studies categorized ED visits differently. Several studies examined total ED visits while others categorized ED visits based on urgency, either stratifying visits on two levels, as non-urgent and urgent, or on three levels, as non-urgent, semi-urgent, and urgent. Urgency was classified differently between studies; however, generally, a non-urgent ED visit was defined as a visit for a condition of minor intensity, a potentially avoidable visit, or as low urgency on some triage scale. A semi-urgent visit was typically defined as a visit of moderate intensity or through some middle range on a triage scale and an urgent visit was defined as a visit for emergency conditions or of high urgency on a triage scale.

Five studies compared ED visits between patients with access to after-hours primary care against those without such access.[17–21] The remaining fifteen studies examined the impact of improved access to after-hours primary care on ED visits using pre-post study designs. Of these, four examined the impact of opening an after-hours primary clinic during evenings and/or weekends,[23,25,26,36] while two studies examined the impact of extending primary care clinic hours in the UK: one conducted a pilot project extending primary care offices to seven-day openings and another extended services into weekday evenings.[29,30]

Six studies examined the impact of reorganization of primary care from smaller groups to larger GPCs in the Netherlands, Belgium, and Ireland.[27,28,31–34] Additionally, another study examined the reorganization of physicians into PEMs in Ontario, Canada.[24] Finally, two studies examined the impact of financial incentives: Italian physician groups were incentivized to be available for at least ten hours per day on weekdays,[35] while physicians in Ontario were incentivized to provide services during evenings and overnight, weekends, and holidays.[22]

2.3.2.1 Results of Cross-Sectional Studies

The five cross-sectional studies that compared ED visits between patients with access to after-hours primary care versus those without such access were all conducted in the US. These studies found mixed results, with three studies finding access to after-hours primary care associated with reduced ED visits. In one study, patients with a physician who offered extended services on weekend and evenings were less likely to visit the ED by 2%.[18] Two other studies found a reduction in ED visits related to after-hours access, one conducted in a general population, another in a pediatric population.[19,21] This association was greatest for practices open for longer hours and more nights a week, with a reduction in ED visits for adult practices that offered at least 12 hours of weekday evening services (Risk Ratio: 0.80, 95% Confidence Interval [CI]: 0.67, 0.95) and for pediatric practices that offered weekday evening services at least five nights a week (Incidence Rate Ratio: 0.51; 95% CI: 0.28, 0.92). However, no association was found between extended weekend access and ED visits.[19] Finally, two studies found no association between after-hours access and ED use. One study found a similar likelihood of having a usual source of care who offered services on evenings and weekends among patients who used the ED for non-emergency conditions compared to those who did not use the ED,[17] while another study found that access to after-hours pediatric primary care was not associated with non-urgent ED visits.[20]

2.3.2.2 Results of Pre-Post Design Studies

Studies using a pre-post design to examine the impact of introducing an after-hours primary care clinic on ED visits were mixed. Two studies were conducted in Australia, the first of which found that introducing an after-hours clinic available during weekends was associated with a reduction in non-urgent ED visits, but no difference in semi-urgent ED visits.[26] The second found introduction of an after-hours primary care clinic to reduce non-urgent ED visits by 8% (95% CI: 6, 10) at any timing, but also found an increase in urgent ED visits by 2%.[25] A Canadian study that examined the impact of an evening after-hours clinic reported a 40% reduction in the number of semi-urgent ED visits per month, but found no difference in non-urgent and urgent ED visits.[23] In Scotland, the introduction of primary care emergency centres, after-hours primary care clinics implemented to divert patients away from the ED, did not lead to a difference in ED visits three-months or one-year after implementation; however, the study did find a reduction in the proportion of ED visitors who classified their visit as non-urgent.[36]

Although studies examining stand-alone after-hours clinics produced mixed findings, the extension of primary care services in the UK outside of regular working-hours was associated with a significant reduction in semi-urgent ED visits between 5% and 19%, but no statistically significant reduction in non-urgent ED visits.[29,30] Based on a pilot study that expanded primary care services into the weekend, the largest reduction in ED visits occurred in semi-urgent ED visits by 20% (95% CI: 13%, 27%); however, there was some evidence of a spill-over effect, with a smaller reduction in weekday semi-urgent visits by 13% (95% CI: 6%, 21%).[29] This study also found a reduction in hospitalizations and ambulance referrals. In the second study, where primary care clinic hours were expanded to evenings and weekends, there was a reduction in semi-urgent ED visits by 5% (95% CI: 1%, 10%), but again, no difference in non-urgent and urgent ED visits.[30]

Seven studies examined the impact of reorganization of primary care groups, finding conflicting results. Six looked at GPCs, which provided better coverage of after-hours services through the redistribution of physician hours,[27,28,31–34] while one examined the impact of mandatory after-hours services in PEMs in Ontario, Canada.[24] For GPCs in the

Netherlands and Ireland, after-hours services were available on both evenings and weekends; however, in Belgium, GPCs were available only on weekends. Both studies in the Netherlands reported a reduction in ED visits ranging from 8% during regular hours to 53% during after-hours.[33,34] Additionally, the proportion of self-referrals to the ED dropped along with hospital admissions. Although GPCs were effective in the Netherlands, GPCs were not associated with a reduction in ED visits in Belgium.[27,28] Despite this, the implementation of a GPC co-located within the local ED in Belgium was associated with fewer ambulance admissions and self-referrals. One study in Ireland found no difference in unnecessary ED visits,[31] while the second found a reduction in non-urgent ED visits, but an increase in urgent ED visits.[32] Opposite conclusions were found in Canada, with enrolment in a PEM associated with an increase in ED visits.[24]

Two studies examined the impact of financial incentives for primary care on ED visits. In Italy, a financial incentive scheme was implemented to provide additional payments to physician groups who provided services for at least ten hours per day and up to twelve hours per day. This incentive scheme was associated with a reduction of inappropriate admissions between 10% to 15%.[35] Similarly, increasing the value of payments to physicians by increasing the value of the after-hours premium in Ontario, Canada, from 10% to 20% for specific services provided during after-hours was associated with a small reduction in less-urgent ED visits.[37]

Three of five cross-sectional studies found access to after-hours primary care was associated with a reduction in ED visits, ranging from 2% to 50% when patients had weekday evening access; however, weekend access to primary care was not linked to ED visits. Nine of fifteen studies examining interventions to improve after-hours primary care found significant evidence of a reduction in either non-urgent or semi-urgent visits that ranged from 2% to 50%. Of the initiatives aimed to improve access to after-hours primary care, there was limited evidence for the effectiveness of opening after-hours clinics and reorganization of primary care groups; however, studies examining financial incentives and the extension of hours for established clinics demonstrated consistent reductions in non-urgent and semi-urgent ED visits.

For the six studies that examined the impact of access to primary care during after-hours on both primary care and ED visits, some studies suggest a link between the two settings. The Canadian study which focused on financial incentives found that the increase in primary care services itself was associated with a reduction in less-urgent ED visits.[37] Two studies from the Netherlands found increased access to primary care was associated with an increase in primary care utilization and a reduction in ED visits.[27,28] Despite the study examining enrolment in a PEM finding that ED visits increased, the study also found a reduction a reduction in primary care services.[24] These studies suggest that increased use of primary care through improved access to primary care could potentially lead to a reduction in ED visits.

2.4 Discussion

This review examined the link between improving access to primary care during after-hours and both primary care and ED visits. Six studies examined the impact of improved access to primary care during after-hours on primary care utilization, while twenty examined the effect on ED visits. Improved access to primary care during after-hours was found to generally lead to an increase in primary care utilization; however, the findings for ED visits were less conclusive. Studies that did find that improved access to primary care during after-hours was linked to a reduction in ED visits demonstrated a wide range of results, ranging from as small as 2% to as large as 50%. For the six studies that looked at both outcomes, three of these studies found an increase in primary care delivery and a reduction in ED visits, suggesting that by improving access to primary care during after-hours, health systems could divert some patients away from the ED and back towards the primary care setting.[22,33,34]

Surveys of staff and primary care patients have found that both the perceived and realized lack of access to primary care were associated with increased ED visits.[38,39] However, the effects of previous interventions to improve primary care access on ED visits have been inconclusive, and a previous systematic review on interventions, including telephone triage, GPCs, walk-in clinics, and urgent care centres, led to mixed findings.[16] While

these interventions led to mixed findings in this study, other interventions aimed to improve access to primary care during after-hours were found to be more effective, including extending hours of existing clinics and financial incentives for physicians who provided after-hours access. Similar to the two studies from the Netherlands included for review, a previous review of GPCs located within EDs found that GPCs were a safe and cost-effective alternative to emergency care.[40] However, GPCs in Belgium and Ireland did not demonstrate similar findings and these heterogenous results suggest that the impact of improved access to primary care during after-hours is dependent not only on the interventions to improve access to care but also the underlying contextual factors of a health care system.

For many studies included in this review, the effect on primary care or the uptake of the intervention are unknown. Previous research suggests that patients may choose to use the ED as they are unaware of any availability of after-hours primary care.[41] Poor uptake and lack of awareness of the availability of after-hours primary care services may be one reason several studies did not find a reduction in ED visits. Additionally, improved access to after-hours primary care may be linked to a reduction only for visits made during after-hours for conditions treatable in primary care settings. The diversion of patients away from the ED to the primary care setting may have been masked as many studies reviewed did not stratify ED visits by timing or severity of the visit.

2.4.1 Patient Preference for the ED over Primary Care

Patient preference may play a key role in the effectiveness of improved access to after-hours primary care on ED visits. Accessibility and convenience have been identified as two of the most important factors in non-urgent ED visits.[42] Although opening a new after-hours primary care clinic led to mixed findings,[23,25,26,36] extension of clinic hours for established primary care clinics demonstrated a more consistent reduction in ED visits.[29,30] This may indicate that while patients prefer seeing their own primary care provider, the convenience of the ED becomes preferable to a primary care provider with whom they do not have a continuous relationship. One survey found that while most

adults prefer to be seen by their primary care physician, almost half would seek care elsewhere if same-day appointments were available, opting for the convenience of the ED over their continuous relationship with a primary care provider.[43] Perceptions of wait times may also factor into the choice of an ED over a primary care physician.[41,44] The ED may be viewed as convenient due to its around-the-clock access, favourable for its ability to provide comprehensive evaluation in a single location, and the inability to be refused an appointment.[45–47]

The ED may also be chosen over the primary care setting due to the perceived urgency of a health condition. The perception of need for immediate care may be just as important as the actual realized urgency of the health condition, as many patients recognize that their health is not urgent but visit the ED for reassurance.[45,48] Some patients have reported strong beliefs that urgent care was required for their health condition, often stemming from the perception that their condition required hospital resources or was too complex to be treated by a primary care provider.[45,49,50] There is some disconnect between patient perceptions and actual urgency, with as many as 24% of patients triaged as non-urgent attending the ED because they believed they needed to be admitted into hospital.[51] Other factors related to preference for the ED over the primary care setting include trust, familiarity, and satisfaction with their previous ED experience.[52–55] Conversely, patients may avoid their primary care physician due to dissatisfaction with previous experiences or a lack of confidence in their abilities.[56] Although these factors may play a role in the choice of the ED over a primary care physician, access tends to remain the greatest factor, as most patients opt for the most convenient location for care.[57]

2.4.2 Limitations

Several limitations in the quality of evidence were found in the literature, with most evidence being cross-sectional or pre-post designs without a concurrent comparator group. Many of these studies employed statistical methodology that did not account for the biases in the relationship between after-hours primary care and ED visits. This is especially troublesome for studies involving policy interventions as it becomes difficult

to isolate the effects of the intervention to improve access to after-hours primary care from other interventions introduced during the same period. In several studies, additional policy interventions were enacted that may have influenced patient use of the ED, such as changes in the organization of the ED system. Additionally, some of the included pre-post design studies failed to account for seasonal variation that may influence ED visits, which may have biased results, especially in studies that focused only on short periods following the intervention to improve access to primary care during after-hours.

There are also some limitations in the scope of this review. Studies were restricted to the English language, resulting in the inclusion of studies only from high-income countries in Australia, Europe, and North America. The effects thus cannot be generalized to low- and middle-income countries. Due to high heterogeneity in the interventions and health care systems of each study, it was not possible to conduct a meta-analysis. The high heterogeneity also makes generalizing the impact of improving access to primary care during after-hours difficult, and the underlying contextual and institutional differences in primary care and emergency care systems should be taken into consideration when interpreting the results.

2.4.3 Future Directions

Future research in the form of controlled pre-post design studies or quasi-experimental studies is required to establish the impact of improved access to after-hours primary care on both primary care and ED visits. Future research should also place greater focus on the severity of ED conditions, focusing on primary care-treatable ED visits, as well as the timing of both ED visits and primary care visits.

Given the evidence of some reduced semi-urgent and non-urgent ED visits following improved access to after-hours primary care, one important policy question is whether improved access to primary care could lead to health system cost savings. Four studies have examined the impact of access to primary care during after-hours on some measure of cost.[18,22,30,58] All studies found a reduction in ED-related costs, with the reduction

primarily attributed to the diversion of patients away from the ED rather than a difference in the per-unit cost of ED visits, with savings ranging from 10% to 26%. Although studies found a reduction in ED-related costs, further research is required to examine the effects on primary care setting costs and total health systems costs. Future research could explore the potential cost-effectiveness and cost-savings of interventions to improve access to after-hours primary care.

2.5 Conclusion

This review focused on the impact of improved access to after-hours primary care on ED utilization and primary care utilization. Although improving access to after-hours primary care may lead to increased primary care utilization, the impact of such access on ED visits was mixed in the literature. Improved access to after-hours primary care may potentially shift patient care from the ED towards the primary care setting in some institutional settings; however, stronger evidence of the effectiveness of various interventions is required. Policymakers must recognize that prior to implementing policies that affect after-hours primary care provision, the organization of the primary care and ED system within the environment must be considered.

Table 2.1 Search strategy

Database	Search Strategy
CINAHL	("after hour*" OR "out of hour*") AND ((MH "Primary Health Care") OR (MH "Physicians, Family") OR "primary care" OR "primary health*" OR family doctor*" OR family physician*" OR general practitioner*")
EMBASE	("after hour".mp. or "out of hour*".mp.) and (exp primary medical care/ or exp primary health care/ or exp general practitioner/ or "primary care".mp. or "primary health*".mp. or "family doctor*".mp. or "family physician*".mp. or "general practitioner*".mp.)
MEDLINE	(exp After-Hours Care/ or "after hour*".mp. or "out of hour*".mp.) and (exp Primary Health Care/ or exp General Practitioners/ or exp Physicians, Family/ or "primary care".mp. or "primary health*".mp. or "family doctor*".mp. or "family physician*".mp. or "general practitioner*".mp.)
Scopus	("after hour*" OR "out of hour*") AND ("primary care" OR "primary health*" OR "family doctor*" OR "family physician*" OR "general practitioner*")

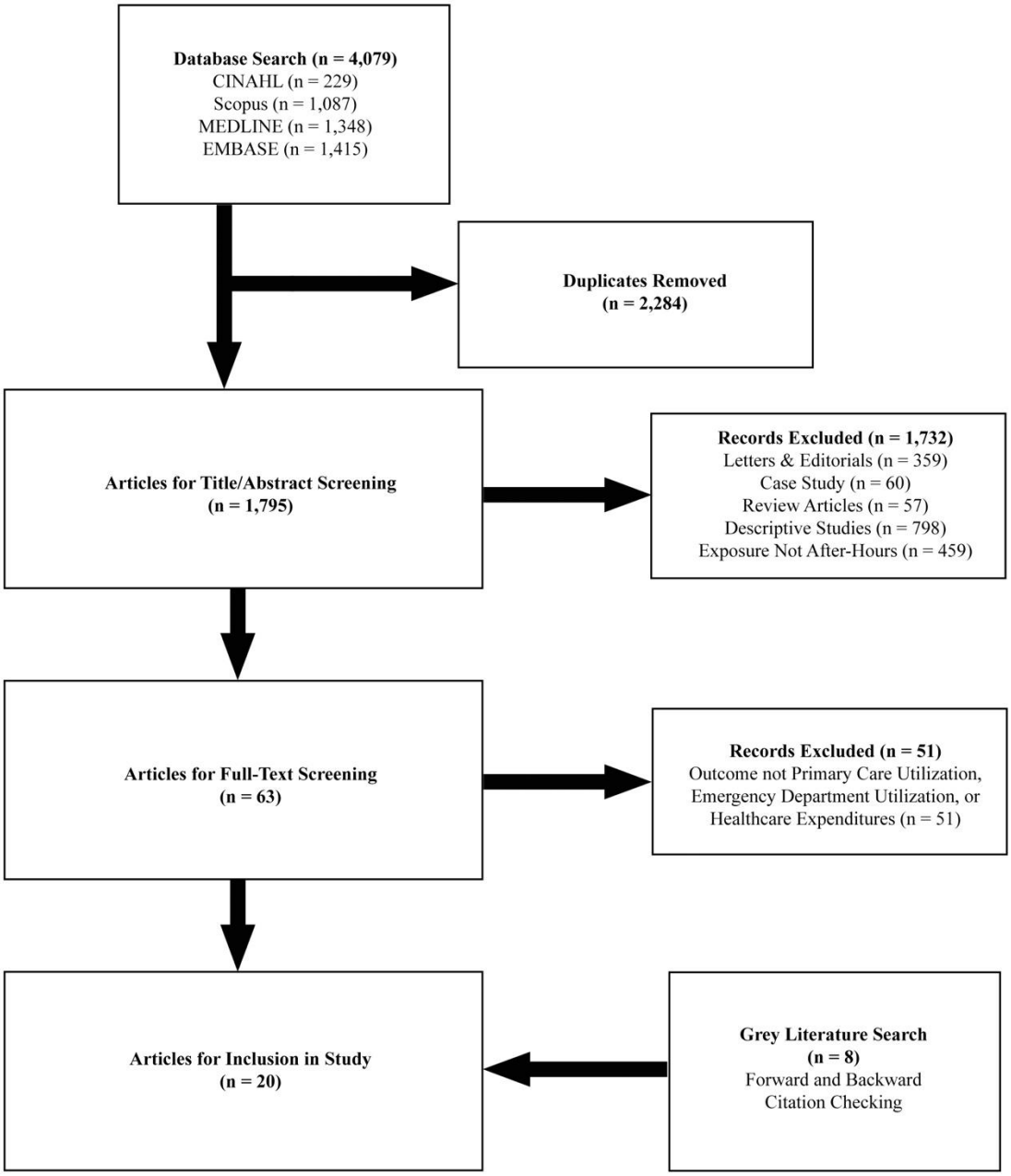

Figure 2.1 Flow chart for inclusion and exclusion of studies into review

Table 2.2 Characteristics and results of included studies

Author (Year) *Journal* Country	Access to After-Hours Primary Care Exposure Patient Population	Primary Care or ED Utilization Outcome	Statistical Methods	Results	Remarks
Villani & Mortensen (2013)[17] *Journal of the American Board of Family Medicine* US	Access to after-hours care measured using patient survey of whether respondent's usual source of care has office hours on nights and weekends Survey data from 2007-2009 MEPS, representative survey of health services utilization of approximately 15,000 households	Non-emergent ED visits; non-emergent visit defined as: patient not admitted as inpatient; patient did not receive surgical procedure radiograph, magnetic resonance imaging scan, computed axial tomography scan, electrocardiogram, electroencephalogram; patient did not report reason for visit was emergency	Bivariate chi-square test, hurdle model (count model with two processes: multivariate logistic regression, negative binomial regression) Potential confounders: usual source of care communication and access (mode of transportation, time to usual source of care, difficulty in travelling to care, difficulty in reaching care by phone or after-hours), patient demographics (age, sex, race, ethnicity, education, employment, marital status, English-speaking, health, health beliefs)	Patients who had at least one non-urgent ED visit were more likely to have a usual source of care provider that did not maintain office hours on nights or weekends compared to those who had no ED visit (35.1% vs. 38.5%); however, the result was not statistically significant Patients who had at least one non-urgent ED visit were significantly more likely to have difficulty contacting their usual source of care after hours compared to those without an ED visit Sensitivity analysis including emergent ED visits found after-hours access to primary care still a significant predictor of using the ED and the number of ED visits	Other access to primary care variables found significantly related to the number of ED visits were the time to usual source of care and difficulty getting to usual source of care Study subject to sampling bias as only respondents who visited a health care provider in the past 12 months were included, and MEPS may overestimate number of adults with usual source of care; study includes larger proportion of ethnic minorities Use of cross-sectional survey data subject to recall bias
Jerant et al. (2012)[18] *Annals of Family Medicine* US	Individuals 18 and older from the MEPS Household Component (2000-2008), respondents who had a usual source of care, comparing those whose usual source of	Cost information from MEPS Household Component health care use (hospitalizations, ED visits, outpatient hospital visits, office-based visits, dental visits, home health care, prescription	Cross-Sectional Design Linear regression; Cox proportional hazards survival model; logistic regression; generalized linear model (log-link, Poisson distribution)	Extended office hours associated with 1.9% (95% CI: 0.8, 3.7) fewer ED visits in the second year after extended access compared to the group without extended access; 9.1% (95% CI: 6.3, 11.8)	Control of covariates associated with increased use of health services and expenditures related to health care services MEPS relies on patient survey data, including

	care offered evening and weekend hours	medication, ancillary care); total health care costs, ED expenditures, prescription expenditures, office-visit-related expenditures ED visits and ED expenditures and inpatient expenditures over a two-year period Health status using Short Form-12, mortality from National Death Index	Covariates: sex, age, race/ethnicity, household income, education level, urban residence, US Census region of residence, health insurance status, chronic conditions	reduction in ED and inpatient expenditures Under multivariate model, access to extended office hours associated with 10.4% (95% CI: 7.2, 13.4) lower health expenditures in the second year Although not significant, not having extended office hours was associated with increased mortality (HR: 1.11, 95% CI: 0.92, 1.35)	self-reported health care utilization with standardized patient costs rather than total calculated costs; survey data for mortality has 98.5% reliability Calculation of outcomes after two years to reduce recall bias
Lowe et al. (2005)[19] *Medical Care* US	Comparison of primary care system characteristics that are related to higher ED visits After-hours accessibility measured as weekday evening office hours per week and weekend office hours per week Study conducted in one of four Health Maintenance Organizations serving Delaware region of Pennsylvania	ED visits per patient between August 1998 and July 1999 Stratified by potentially avoidable visits, high probability that appointment in primary care could have avoided ED visit, and probably unavoidable visits, condition was unlikely to be treatable in primary care Sensitivity analysis on respiratory-related visits	Cross-Sectional Design Mixed model Poisson regression, random effects model Analysis conducted at patient-level and practice-level Confounders: patient age, gender, race, Medicaid eligibility category, and chronic medical conditions likely to affect ED	Patients from practices with 12 or more evening hours a week used the ED 20% (RR: 0.80, 95% CI: 0.67, 0.95) less than patients in practices without evening office hours; greater reduction in potentially avoidable visits than probably unavoidable visits For patients from practices with weekend office hours, RR: 0.97 (95% CI: 0.93, 1.004) At practice-level, weekday evening hours associated with 13% reduction in ED use, while weekend office hours associated with 5% reduction in ED use	Medicaid patients, practices with higher ratios of active patients per clinician-hour, practices with nurse practitioners or physician assistants, and practices where at least one clinician made hospital rounds had higher rates of ED use Primary care characteristics were verified with each clinic, adjustment measures using patient characteristics that were found to be associated with ED visits Use of cross-sectional data, focusing on ED visits over one year at the patient-level

Sturm et al. (2010)[20] *Academic Pediatrics* US	Pediatric practice characteristics associated with ED use including after-hours availability defined as having Saturday hours or having some weekday hours after 5:00 PM Study examined characteristics of 35 pediatric practices in Atlanta	Visits from two tertiary care between November 2006 and October 2007 pediatric EDs were reviewed; non-urgent visit if initial triage category was non-urgent Triage category was defined using the Emergency Services Index triage system using standard 5-level triage system, non-urgent being the two lowest categories	Cross-Sectional Design Discriminant analysis via mixed integer programming; k-means clustering algorithm Covariates: physicians in practice, non-MD physician extenders in practice, practice patient population, patients per physician, patients per provider, percent of patients with Medicaid, office same-day turnaround of blood count, walk-in policy, after-hours nurse triage line, on-call physician	Practices that stayed open late during weekends or evening weekday hours, or used an after-hours nurse triage phone line were not significantly associated with non-urgent visitation to the ED	There was a high frequency of practices that had weekend office hours making analysis non-discriminatory using discriminant analysis Patient characteristics were not considered in the model and data was cross-sectional
Zickafoose et al. (2013)[21] *Journal of Pediatrics* US	Enhanced access was defined as whether there was telephone availability, same-day visits, after-hours telephone availability, email access and number of nights a week primary care office was open after 5:00 PM surveyed in December 2011 Internet-based survey of national sample of parents	ED utilization was obtained through survey as the number of times the child visited the ED in the prior 12 months	Cross-Sectional Design Chi-square test; negative binomial regression model Covariates: child age, special health care needs, insurance status and type, parent-reported child health, parental race/ethnicity, parental education, household poverty level, presence of usual source of care that was not an ED	Only 54% of parents reported access to phone advice after-hours while 47% had some weekend office hours access and 23% had some evening office hours access Availability after 5:00 PM on 5 nights a week was associated with reduced ED use (IRR: 0.51, 95% CI: 0.28, 0.92) in multivariate analyses, while weekend and all evening services were associated with reduced ED use in bivariate analyses	The effect of after-hours services was larger in the Hispanic and publicly insured groups, while lower in the Black, non-Hispanic groups Use of cross-sectional survey data subject to recall bias
Devlin et al. (2020)[22] *Canadian Public Policy*	Increases in the value of Ontario's after-hours	The rate of primary care visits stratified by timing	Single-Arm Pre-Post Design	Increases in the after-hours premium were	Further analyses demonstrate that while

Canada	premium, an incentive provided to physicians providing specific services provided during after-hours, from 10% to 15% and from 15% to 20% Sample consists of physicians who billed the after-hours premium, excluding those who work part-time 6,605 physician-year observations for 1,321 unique physicians across 2003-2007	as visits during regular-hours (9:00 AM – 5:00 PM weekdays) and after-hours (5:00 PM – 8:00 weekdays and any time holidays and weekends) The rate of ED visits stratified by urgency defined using the CTAS where level 1 and 2 visits are classified as very-urgent, level 3 visits are classified as urgent, and level 4 and 5 visits are classified as less-urgent	OLS Regression and physician fixed-effects regression Covariates: physician age, proportion of female physicians in practice, proportion of foreign graduates in practice, group size, average patient age, average patient ADG score using Johns Hopkins Adjusted Clinical Group software, proportion of patients living in deprived areas, and proportion of patients living in rural area	associated with a reduction in less-urgent ED visits Increases in the after-hours premium were associated with an increase in primary care physician services provided after-hours and a reduction in primary care physician services provided during regular-hours	there is no relationship between after-hours primary care services and overall ED visits, an increase in after-hours primary care services was associated with a reduction in the less-urgent ED visits Splitting the physicians by low and high mean patient ADG score demonstrates that changes in ED costs are driven by physicians with relatively healthy patients
Jones et al. (2011)[23] *Journal of Primary Care & Community Health* Alberta, Canada	Implementation of Leduc after-hours clinic, in August 2006 which operates from 6:00 PM – 10:00 PM Monday to Thursday Leduc, Alberta has a population of 20,000	Local hospital ED visits from January 2005 to February 2008 Visits were stratified by CTAS: level 3 (urgent), 4 (semi-urgent), and 5 (non-urgent)	Single-Arm Pre-Post Design Wilcoxon signed-rank tests Data were matched by month before and after the implementation of the after-hours clinic	During clinic hours, there was a reduction in 3.2 semi-urgent patient visits per month per 1,000 people, a 40% reduction in semi-urgent patient visits per 1,000 members of the population Significant reduction in total ED visits (38.1, 95% CI: 15.4, 60.9) and semi-urgent visits (49.3, 95% CI: 37.2, 61.4), non-significant increase in urgent visits (10.5, 95% CI: -1.3, 22.3) and reduction in non-urgent visits (-2.3, 95% CI: -7.0, 2.4) during clinic hours	Over 40% of users reported that had the clinic not been available, they would have attended the local ED Use of matching before and after introduction of clinic leads to loss of data from some months and cannot analyze time trends (level and slope change of interrupted time series analysis) No control of potential confounders associated with ED visits Unable to analyze whether patients received

				During daytime hours, significant reduction in semi-urgent visits (39.1, 95% CI: 4.0, 74.2); non-significant reduction in total visits and increase in urgent and non-urgent visits	care at other physician offices in the area Renovations to the local ED increased capacity which may have led to increases in visits during introduction of the clinic
Kiran et al. (2018)[24] *Annals of Family Medicine* Canada	Introduction of medical homes, which required physicians to provide a minimum number of after-hours evening and weekend sessions per week based on the number of physicians in the group Residents who were 19 years or older, and eligible for Ontario health insurance; subset of the population enrolled between 2005-06 and 2011-12, with a minimum of 3 years of outcome data before and after enrolment and rural residents were excluded 8.9 million adult patients and 6,813 physicians transitioned to a medical home; regression analysis performed on 2,945,087 individuals	ED visit rate calculated over a one-year period Also assessed the proportion of primary care visits on the weekend, the overall primary care visit rate, and primary care continuity	Two-Arm Pre-Post Design Segmented linear regression analysis Covariates: patient age, sex, area income quintile, rurality, and comorbidity using ADGs and resource utilization bands using Johns Hopkins Adjusted Clinical Group software	Crude number of emergency department visits increased for population both for weekdays and weekends Prior to enrolment, ED visit rate rose by 0.8% (95% CI: 0.7, 0.9) per year and post-enrolment, ED visit rate rose by 1.5% (95% CI: 1.4, 1.5); overall increase in trend of 0.7% (95% CI: 0.6, 0.8); increase in proportion of weekend visits and decrease in primary care visit rate and small increase in primary care continuity	Sensitivity analyses demonstrated that excluding physicians who were exempt from providing after-hours care had slightly lower ED visit rates, but similar secular trends Considered the total effect of enrolment in a medical home, which had other policy characteristics, including formal patient enrolment, blended physician payment, and physicians working together in teams (including in some cases, interdisciplinary teams)
Buckley et al. (2010)[25] *Medical Journal of Australia* Australia	Opening of an after-hours clinic in March 2003 After-hours clinic less than a kilometer from	Low-urgency ED utilization from January 1998 to October 2008 Urgency determined by ATS; Low-urgency	Single-Arm Pre-Post Design Time series regression analysis, multiple linear regression analysis	Daily low-urgency ED visits at any time of day fell by 7.04 (95% CI: 5.39, 8.70) patients per day; 8.2% (95% CI: 6.2%, 10.2%) reduction in visits	Prior to opening the after-hours clinic, there were limited after-hours GP services

	city's only ED (Wagga Wagga Base Hospital) After-hours clinic located in Wagga Wagga in New South Wales, with a population of 58,000	defined as ATS category 4 and 5 Outcomes were daily ATS category 4 and 5 visits any time of day; daily ATS category 4 and 5 during clinic hours; daily ATS category 1, 2 and 3 any time of day	Level and slope change were used for time-series analysis	Low-urgency ED visits during clinic hours declined by 2.07 (95% CI: 1.43, 2.72) patients per day Daily ED visits by patients triaged as ATS category 1, 2, or 3 increased by 1.36 (95% CI: 0.36, 2.35) patients per day; 1.6% (95% CI: 0.4%, 2.7%) increase in visits	Researchers did not control factors that may be related to ED visits such as age, sex, or socio-economic characteristics of patients
Payne et al. (2017)[26] *BMC Family Practice* Australia	Opening of an after-hours general practice clinic adjacent to the local hospital, open from 3:00 PM – 7:00 PM on weekends and holidays The Bathurst After Hours General Practice Clinic is located adjacent to the Bathurst Base hospital in Bathurst, New South Wales	ED presentations between 12:00 PM Saturday to 8:00 AM Monday were extracted for two years prior to opening (December 2010 – November 2012) and two years after (December 2012 – November 2014) Presentations were stratified by urgency, semi-urgent and non-urgent ED visits using ATS category 4 and 5	Single-Arm Pre-Post Design Independent *t*-test; chi-square tests for survey proportional data Covariates: age, sex	Significant reduction in non-urgent ED visits (418.5 vs. 245.5 visits per year) following opening of the after-hours clinic; non-significant reduction in semi-urgent visits (3984.5 vs. 3931.5) More males than females presented to the ED with non-urgent complaints after opening the after-hours clinic and more females visited the after-hours clinic in the same period	Data selected used timing where only the study clinic was available, no other GP clinics were open in the area; after-hours clinic open for a short time frame during study hours 76% of patients deemed visit to after-hours clinic as essential while 86% of GPs deemed the visit appropriate
Colliers et al. (2017)[27] *Acta Clinica Belgica* Belgium	Turnhout study: implementation of GPC halfway between hospitals in 2006 Antwerp study: implementation of GPC adjacent to hospital in 2011	Number of primary care and emergency care contacts during study periods (two months of surveillance prior to GPC reorganization and those same study months one-year post-reorganization)	Two-Arm Pre-Post Design Chi-square tests for categorical variables; odds ratios	Increase in the number of GPC contacts in Turnhout (OR = 1.37, 95% CI: 1.20, 1.56) and Antwerp (OR = 1.38, 95% CI: 1.23, 1.54) study; increase in GPC consultations in Turnhout and Antwerp study regions, decrease in home	Survey of four regions with control region for Turnhout study missing information on ED visits Study only conducted one year prior and one year after GPC

	Study conducted in Flanders, northern portion of Belgium; regions are comprised of 80-120 GPs serving 100,000-180,000 inhabitants	Turnhout study: data from nine weekends before and after implementation of the GPC Antwerp study: data from eight weekends before and after implementation of the GPC		visits for Antwerp (OR = 0.63, 95% CI: 0.49, 0.82) study No difference in ED visits for Antwerp study (OR: 0.96; 95% CI: 0.87, 1.06); fewer admissions by ambulance and self-referrals	implementation, may not detect long-term changes No control for other variables that may be associated with ED visits
Philips et al. (2010)[28] *BMC Health Services Research* Belgium	Opening of a GP cooperative allowing out-of-hours walk-in visits or home visits, but not telephone triage GP cooperative is open from 8:00 AM Saturday to 8:00 AM Monday and holidays in Turnhout, Flanders	ED visits and patient contacts with primary care cooperative from nine weekends before GP cooperative implementation and nine weekends after GP cooperative implementation (two months of surveillance in 2006 prior to GPC reorganization and those same study months one-year post-reorganization)	Two-Arm Pre-Post Design Univariate analyses; chi-square tests, Mann-Whitney tests	ED visits did not change during the study period 816 ED visits prior to implementation vs. 795 post-implementation The number of patient contacts at the GP cooperative increased significantly (OR: 1.65, 95% CI: 1.44, 1.88); larger than the increase in other regions	No control region for the ED as there was no other region with tight boundaries; no comparison of continuous longitudinal data No control over variables that may be associated with ED visits
Dolton & Pathania (2016)[29] *Journal of Health Economics* England	Pilot seven-day opening of clinics funded compared to other clinics in the region between April 2013 and February 2014 Pilot practices employ 312 GPs and serve over 190,000 patients in Central London	Weekend and weekly practice-level attendances to the emergency department over one year Admissions categorized as admission (hospitalized), minor (discharged without follow-up or left without treatment), moderate (discharged with GP follow-up), ambulance, and accident (physical trauma)	Two-Arm Pre-Post Design Difference-in-difference Poisson model; OLS regression Stratification of estimates by day of week, and age-group, and socioeconomic status Covariates: demographic, socioeconomic characteristics of patients, size of practice, patient/GP ratio,	Seven-day opening of clinics associated with 17.9% (SE: 3.9) reduction in total weekend visits; 9.9% (SE: 4.8) reduction in hospitalizations, 19.9% (SE: 3.5) reduction in moderate visits, 19.3% (SE: 7.5) reduction in ambulance reduction; non-significant reduction in minor visits (12.3, SE: 8.7) and accidents (4.8, SE: 32.6) Opening associated with 9.9% (SE: 3.8) reduction	Little evidence of temporal and spatial spillover, consistent with continuity of care preferences Explanation of greater increase in moderate cases than minor cases due to patients who frequently use health care services; a reduction in minor cases when examining low-frequency A&E visitors Significant difference in pilot project participant

			perception of GP accessibility and measures of practice level clinical quality	in weekly visits, with 13.1% (SE: 3.8) reduction in moderate cases Significant reduction in each age group of all A&E cases Among wealthier patients, there is a 15.3% (SE: 6.8) reduction in total ED visits and a 19.9% (SE: 7.4) reduction in moderate cases	and control patient/GP ratio which may affect access Use of longitudinal data in experimental setting, controlling for baseline characteristics is a notable strength
Whittaker et al. (2016)[30] *Plos Medicine* England	Four schemes that received funding to increase opening to evenings Monday to Friday (typically 5:00 PM – 9:00 PM with some deviations) and some weekend office hours implemented between January 2014 and December 2014 Primary care centres were in Greater Manchester area, with groups responsible for 200-300,000 patients	Patient-initiated visits to ED visits for minor problems Secondary analysis for total ED visits and stratified by intensity type (minor, standard, high) and referral type (GP-referral, patient-initiated, other referral)	Two-Arm Pre-Post Design Difference-in-difference regression analysis; OLS regression; propensity score matching Covariates: GP age, gender, country of qualification, size of registered patients per practitioner, patient age, gender, limited long-standing illness	Intervention practices had a 26.4% (95% CI: 14.2, 38.6) relative reduction in patient-initiated referrals to ED for minor problems and a 26.6% (95% CI: 14.1, 39.2) relative reduction in cost of these referrals or savings of $1,173.890 Non-significant total reduction in total ED visits (-3.1%; 95% CI: -6.4, 0.2) Non-significant reduction in minor (-4.5%; 95% CI: -9.2, 0.3) and high-intensity (-1.1%; 95% CI: -5.5, 8.0) visits, but significant reduction in standard visits by 5.4% (95% CI: 0.9, 9.9) Non-significant increase in GP referrals, significant	Cost savings for ED visits is less than funding provided with an incremental cost of $3.5 million Control for covariates associated with ED using propensity score matching, but exclusion of those with the highest and lowest probability of having a physician in the group The intervention was not standardized and was provided as a package of funding for set clinics, some variation in clinic after-hours provided Use of longitudinal data as well as a comparator group for clinics that did not have funding for

				reduction in self-referrals and significant increase in other referrals	increased after-hours services is a strength
O'Keeffe (2008)[31] *Irish Journal of Medical Science* Ireland	Introduction of GP co-operative in August 2005 providing out-of-hours coverage, replacing on-call rotas; larger area and more physicians Southdoc GP co-operative introduced to County Cork with local A&E seeing 9,000 attenders per year	Out-of-hours attenders to A&E in winter before co-operative was introduced (November 2004 – January 2005) to winter after co-operative was introduced (November 2005 – January 2006) Out-of-hours defined as 8:00 PM – 8:00 AM on weeknights, Saturday 2:00 PM – Monday 8:00 AM (weekends), and statutory holidays Unnecessary attender defined as registered with GP, not treated in A&E, not involved in injury, and discharged completely or referred to A&E	Single-Arm Pre-Post Design Chi-square test	Although not significant, unnecessary attenders were lower after co-operative introduction (6.2%) compared to before the co-operative was introduced (8.5%) Although not significantly different, admissions, transfers and paediatric surgeries were higher after introduction of the GP co-operative, while X-rays were the same between groups	Southdoc co-operative opens at 6:00 PM; however, decided to use 8:00 PM to as there may be overlap period Analysis only uses a three-month period ignoring three-quarters of the year and longitudinal trends (level and slope in time series analysis) associated with the change to the GP co-operative Analyzes out-of-hours attenders ignoring potential for spill-over effects Some patients attend surrounding hospitals, these data were not captured in the study
O'Kelly et al. (2010)[32] *Emergency Medicine Journal* Ireland	Introduction of Dubdoc, out-of-hours cooperative service Cooperative located by St. James's Hospital site in the Dublin city centre city centre	ED and cooperative attendances between 1999 and 2007 ED visits were stratified by acuity using Manchester Triage System, with high acuity defined as category 1, 2, and 3; and low acuity as category 4 and 5; low acuity attendances were stratified by hours	Single-Arm Pre-Post Design Linear regression	Low acuity attendances at the ED have decreased from 5,801 during the cooperative's hours to 2,683 (54% reduction) and 18,087 outside of the cooperative's hours to 8,703 (52% reduction); total attendances more than halved The attendances to the co-operative doubled from	In 2004, co-payments for ED attendance exceeded cost of GP cooperative visits Stable proportions of triage category admission over time No control of other variables that may be related to ED visits

				3,810 to 7,698 during the study period and higher acuity visits increased from 27,739 to 36,431	Use of longitudinal data, but no analysis of data prior to cooperative introduction or use of control region
van Uden et al. (2004)[33] *Emergency Medicine Journal* The Netherlands	Reorganization of out-of-hours primary care from 24 smaller rotas to three larger cooperatives Study region is province of Limburg, with a population of 400,000 inhabitants Out-of-hours care defined as between 5:00 PM -8:00 weekdays and 5:00 PM Friday – 8:00 AM Monday	ED visits and primary care patient contacts were compared before reorganization in four-week periods between May-June 2001 and after reorganization between May-June 2002	Single-Arm Pre-Post Design Chi-square test	There was an 8.2% decrease in demand for emergency care during regular hours and an 8.9% decrease in demand for emergency care during out-of-hours Increase in the number of patient contacts with primary care during out-of-hours by 9.8% After reorganization, there, the proportion of self-referrals decreased from 47.6% to 44.3%; absolute reduction of 13.7%	A 3.6% (95% CI: 2.5, 4.7) shift from patients utilising emergency care to primary care was observed No adjustment for time trends that may exist through interrupted time series analysis or control for variables potentially related to ED visits
van Uden et al. (2005)[34] *Journal of General Internal Medicine* The Netherlands	Reorganization of out-of-hours primary care from smaller rotas to larger cooperative groups established in January 2000 Study set in city of Maastricht with a population of 120,000	All patient contacts to primary care or ED in three weeks between January and February 1998 before cooperative reorganization and three weeks in March 2001 after cooperative reorganization were compared ED visits were stratified by type of referral and reason for encounter	Single-Arm Pre-Post Design Pearson's chi-square test Potential confounders (non-controlled): patient age, sex	Proportion of patients utilizing out-of-hours emergency care decreased by 52.6% while proportion utilizing out-of-hours primary care increased 25% Proportion of self-referrals reduced by 88.8% while GP referrals increased 45.0%; hospital admissions decreased by 34.2% and patients not receiving post-ED care dropped by 91.4%	Shift in patient flow from emergency care to primary care after establishing GP cooperative No control for potential confounders or use of control region Selected study periods were short, selected different seasons; but there were no other health care system changes between 1998 and 2001

Lippi Bruni et al. (2016)[35] *Journal of Health Economics* Italy	Voluntary policy that allows GPs to extend availability of primary care services between 10 and 12 hours/day Physicians who provide 10 hours coverage receive 4 € per patient; with addition 1 € per patient per additional hour (up to 12 hours) Panel covers 1,075 GPs composed of those GPs working in groups with more than 300 registered patients during the 2008-2010 period	ED visits over 3 years measured as inappropriate visits as triage system white codes and potentially inappropriate visits (white codes and episodes without diagnostic or specialist follow-up)	Two-Arm Pre-Post Design Standard *t*-test for mean comparison Instrumental variable approach to account for potential endogeneity problem; panel-data models accounting for time-invariant latent heterogeneity Covariates: GP's gender, seniority, nursing staff, practices in mountainous municipalities, distance between premises and closest ED, list size, share of male patients, patient's average age and share of foreign patients, hospital admission rate (list severity)	Average frequency of white codes is highest for GPs working alone (70 visits per 1000 patients), followed by GPs in groups not participating in program (55 visits per 1000 patients) and the lowest for GPs participating in program (44 visits per 1000 patients) Estimated effects are larger for white codes than potentially inappropriate admissions; estimated 10-15% reduction in inappropriate admissions No evidence of a weekend effect	Using Italian Ministry data estimated a savings of 1515 € in the most conservative estimate and 2560 € in the most favorable scenario Use of longitudinal data and control of covariates associated with ED visits at the physician level, but not at the patient level
Stoddart et al. (1999)[36] *Health Bulletin* Scotland	Establishment of six primary care emergency centres in the Glasgow city centre, three of these centres adjacent to A&E departments in March 1999 Emergency centres were open from 6:00 PM – 7:00 AM weekdays and 12:00 PM Saturday – 7:00 AM Monday on weekends	New attendance figures at the A&E departments located in the city were analyzed from one-week intervals at 1 week prior to introduction, 12 weeks after introduction and 1 year after introduction Reason for attendance was classified as either illness or injury	Single-Arm Pre-Post Design No detail provided on statistical methods used	During the study periods, there was no significant difference in the number of attendances to the A&E clinic; no differences in the reason for attendance Significant reduction in the number of patients classifying attendance as non-urgent (27% vs. 16%) and increase in those classifying attendance as urgent (33% vs. 44%) after one year	Awareness of the primary care emergency centres even one year after introduction was approximately 50% Study used patient surveys rather than physician information which may lead to some bias Use of three one-week periods rather than longitudinal data over the entire period and no

				Proportion of patients self-referred to A&E department fell from 85% to 65% one year after opening emergency centres	adjustment for characteristics that may be associated with ED visits

A&E: Accident & Emergency; ADG: Aggregated Diagnosis Group; ATS: Australasian Triage Scale; CI: Confidence Interval; CTAS: Canadian Triage and Acuity Scale; ED: Emergency Department; GP: General Practitioner; HR: Hazard Ratio; IRR: Incidence Rate Ratio; GPC: General Practitioner Cooperative; MEPS: Medical Expenditure Panel Survey; OLS: Ordinary Least Squares; OR: Odds Ratio; RR: Risk Ratio; SE: Standard Error

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3 Emergency department use following an incentive to provide after-hours primary care: A retrospective cohort study

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3.1 Introduction

One of the most prominent health policy issues in high-income countries is emergency department (ED) overcrowding, the scenario where ED resources and physical capacity are overwhelmed by the excessive number of patients who require care, leading to impaired function of the ED.[1,2] Overcrowding is associated with poorer patient outcomes, including longer wait times, reduced patient satisfaction, and increased mortality,[3–6] and may contribute to higher health system costs.[7,8] Although the consequences of overcrowding on patient and system outcomes have been well-established, questions about the causes of overcrowding remain. A recent systematic review of the causes of ED overcrowding identified several causes related to the input phase, including increases in presentations of less-urgent visits and poor access to primary care.[4] The review also identified improved extended access to primary care as a potential solution to ED overcrowding. Several interventions to improve access to primary care have demonstrated a reduction in ED visits, suggesting a link between the primary care and emergency care settings.[9–12] However, current evidence in the literature examining the link between improved access to after-hours primary care and ED visits is mixed.[13] While some studies identify a reduction in less-urgent and semi-urgent ED visits associated with improved after-hours access, others found no association. Furthermore, some studies find a reduction only when primary care was available at least four weekday evenings.[14,15] Some interventions were found to be more successful and two studies found incentives for physicians to improve access to after-hours primary care led to a reduction in less-urgent ED visits.[16,17]

In the early 2000s when the Canadian primary care system lagged behind other high-income countries, the federal government invested in primary care reforms. One of the main objectives of the reform was to promote access outside the regular working-hours. During this period, Ontario introduced new models of primary care delivery known as patient enrolment models (PEMs). These models are characterized by several features, including mandatory patient enrollment, minimum after-hours access requirements, group-based practice, and blended remuneration comprised of retrospective and prospective payments, as well as pay-for-performance incentives for targeted care.[18] One incentive was the after-hours premium, a pay-for-performance incentive for physicians to provide services during after-hours (5:00 PM – 8:00 AM on weekdays and during any time on weekends and statutory holidays) introduced in July 2003. Initially, physicians were paid an additional 10% for a specific basket of services; however, it has increased in value to 15% in April 2005, 20% in April 2006, and finally to 30% as of September 2011. Additionally, the basket of services has increased and currently, the after-hours premium is eligible to be billed on top of 14 basic service codes: A001, A004, A007, A008, A888, K005, K013, K017, K030, K033, K130, K131, K132, and Q050.[18]

Canada has performed poorly in terms of access to primary care outside the regular working-hours. In a survey of 11 high-income countries, Canada ranked second last in access to after-hours primary care, with only a third of adults reporting very easy or somewhat easy access outside the regular working-hours.[19] Ontario fares slightly better than other provinces in terms of access to primary care during after-hours; however, whether its reforms are effective requires further investigation. One study investigated the impact of enrollment in a PEM on ED visits and found enrolment to be associated with an increase in ED visits; however, the study did not stratify by the urgency of the ED visit, potentially masking the differential impact on urgent and less-urgent ED visits.[20] Another study investigated the change in ED visits related to the increase in the value of the premium from 10% to 20%, finding a reduction in less-urgent ED visits associated with the increase in the value of the after-hours premium.[16] However, this study did not examine the full range of the implementation of after-hours premium or include a control group of patients. This study examines the impact of the introduction of the after-hours premium on ED visits, focusing on less-urgent ED visits. Secondly, this study examines

whether the subsequent increases in the value of the premium were associated with further reductions in less-urgent ED visits.

3.2 Methods

3.2.1 Study Design

This retrospective cohort study follows a random sample of Ontario residents to investigate the impact of the introduction of the after-hours premium and its subsequent increases in value, using linked health administrative data available from April 2002 to March 2016. This time period captures the introduction of the after-hours premium in 2003, and the increases in the value of the after-hours premium in 2005, 2006, and 2011. During the later reform period between 2006 and 2008, several large-scale reforms were enacted, including other incentives for physicians practicing in PEMs, some of which overlapped with services incentivized by the after-hours premium, such as the diabetes management incentive and the heart failure management incentive. Due to these other components of reforms, it is not possible to completely disentangle the effects of increases in the value of the after-hours premium beyond 15% from these other reforms. Instead, the study is separated into two distinct time periods, the first period investigating the pure effect of the incentive and the second investigating the combined effect of the incentive with other reforms. In the first period, data from the full cohort of patients is used to investigate the effect of the introduction of the after-hours premium and the increase in the value of the premium from 10% to 15%, using data from April 2002 to March 2006. The effect of the incentive is investigated by comparing a cohort of patients enrolled to a physician in a PEM model to a cohort of patients whose physician continued to practice in the traditional fee-for-service (FFS) model throughout the study period. In the second period, the combined effects of the increases in value of the after-hours premium with other reforms from 15% to 20% and from 20% to 30% are investigated using a sub-cohort of patients who were continuously enrolled to a physician practicing in a PEM between April 2005 and March 2016.

3.2.2 Study Data and Study Population

The following seven health administrative databases were linked: 1) the Corporate Provider Database (CPDB) for physician practice characteristics and information on physician model type, 2) the ICES Physician Database (IPDB) for physician demographic characteristics, 3) the Client Agency Program Enrolment (CAPE) database used to link patients enrolled in a PEM to their responsible physician, 4) the Ontario Health Insurance Plan Claims Database (OHIP) for billings information of primary care physicians, 5) the Registered Persons Database (RPDB) for patient sociodemographic characteristics, 6) Census data for dissemination area-level income data, and 7) the National Ambulatory Care Reporting System (NACRS) database for information on ED visits. These datasets were linked using encoded identifiers and analyzed at ICES.

The study sample consisted of a 10% random sample of Ontario residents taken on April 1st, 2001. Although available, data for the 2001/02 fiscal year were not used due to potential issues in NACRS data coverage. Additionally, while the sample derived from the population is inherently unbalanced, balanced panel data was used by excluding patients who did not have full coverage over the study period, which included patients who died, moved out of province, or did not use health care services for at least two years during the study period. Patients who were enrolled to a physician practicing in the earlier Primary Care Network (PCN) model prior to primary care reform and the introduction of the PEMs were excluded. Additionally, patients living in rural areas at any time were excluded due to rural-urban differences in primary care practice that lead to rural EDs acting as a source of primary care for residents in these areas.[21] Patients were assigned to a Census subdivision based on their postal code using the RPDB and Statistics Canada's Postal Code Conversion File (PCCF) and living in a rural area was defined as living in a small town or rural area with a population of less than 10,000.[22]

The after-hours premium is eligible to be billed by any physician practicing in a PEM, including the blended FFS models, or the Family Health Group (FHG) and Comprehensive Care Model (CCM), the blended capitation models, or the Family Health Network (FHN) and Family Health Organization (FHO), and the specialized models that service a particular population, such as the Southeastern Ontario Academic Medical

Association. Physicians in the traditional FFS model were not eligible to bill the after-hours premium. Patients were categorized into the PEM group and the FFS group on a monthly basis. The CAPE database captures all rostering and de-rostering requests by a physician, allowing linkage of patients formally enrolled to a physician practicing in a PEM.[23] All other patients were informally rostered to a physician based on the ICES virtual rostering approach, where patients were attached to the physician with the highest billings in the previous two years of data.[24,25] This virtual rostering approach has been accepted by the Ontario Ministry of Health and Long-Term Care.[24] In the first study period, patients in both groups were compared to investigate the pure effect of the incentive, while in the second study period, only patients in the PEM group were followed to evaluate the combined effect of the incentive.

3.2.3 Study Variables

The outcome was the number of ED visits per patient per month, obtained from NACRS. Additionally, ED visits were stratified by timing and urgency. Visits were stratified into those made during regular-hours (i.e., 8:00 AM – 5:00 PM on weekdays, excluding statutory holidays) and visits made during after-hours, where after-hours was defined in agreement with the eligibility to bill the after-hours premium (i.e., visits 5:00 PM – 8:00 AM weekdays and any time on weekends and statutory holidays). ED visits were stratified by urgency using the Canadian Triage and Acuity Scale (CTAS),[26] where visits with a CTAS score of 1 or 2 were defined as very-urgent, visits with a CTAS score of 3 were defined as urgent, and visits with a CTAS score of 4 or 5 were defined as less-urgent ED visits.

Patient demographic characteristics included age and sex, obtained from the RPDB. To minimize the risk of identification of patients within the remote access dataset, patient age was categorized into five-year intervals. Patient area-level income was defined using the census dissemination area-level income using postal codes from the RPDB and Statistics Canada's PCCF.[22] Although census dissemination area-level income is categorized into quintiles, it was dichotomized, where low-income area was defined as

those living in the two lowest income quintiles. Patient comorbidity was measured using the number of Aggregated Diagnosis Groups (ADGs) from the Johns Hopkins Adjusted Clinical Groups (ACG)® Version 11.0.[27,28] The ACG system categorizes patients into one of thirty-two mutually exclusive diagnosis clusters or ADGs, using International Classification of Disease (ICD)-9/ICD-10 codes based on the duration, severity, diagnostic certainty, etiology, and speciality care involvement of the disease.[29,30] A patient is assigned into an ADG if they have a diagnosis that fits within that ADG and patients will have a number of ADGs from zero to thirty-two, with a larger number of ADGs representing higher morbidity. Patients within the same ADG cluster are expected to have similar health care utilization.[31]

Physician characteristics include physician age, sex, years since graduation as a measure of experience, and physician group size, the number of physicians sharing the same group number in the CPDB. Additionally, international medical graduate (IMG) status, defined as graduation outside of Canada or the United States, was taken from the IPDB.

3.2.4 Statistical Analysis

This study was conducted using individual patient-level longitudinal data. In each study period, descriptive characteristics are presented for each fiscal year, with descriptive characteristics presented separately for patients and physicians. Continuous variables are presented as mean (standard error [SE]) while categorical variables are presented as frequency (proportion).

The after-hours premium is treated as a categorical variable, with the value of the premium set to 0 for patients at any point in the study period who were in the FFS group as well as for all patients prior to the introduction of the after-hours premium in July 2003. From July 2003 onward, the after-hours premium variable was set to the value of the after-hours premium for all patients rostered to a physician in a PEM. Multivariable fixed-effects linear regression models were used to investigate the effect of the after-hours premium on ED visits, adjusting for patient and physician characteristics and

seasonal variation using monthly dummies. In addition to the patient and physician characteristics described above, quadratic terms were included for physician age and physician years since graduation variables. Separate models were estimated for each timing and urgency of ED visits. Additionally, two-way clustering of standard errors was implemented to ensure estimates of correct standard errors were obtained, with monthly observations clustered within patients and patients clustered within physicians.[32] Without clustering, the precision of standard errors is overestimated. For ease of interpretation, estimated β-coefficients were multiplied by 1,000, such that a β-coefficient may be interpreted as the impact of the after-hours premium on the number of ED visits per 1,000 patients per month.

Patient fixed-effects linear models were used to estimate the effect of the after-hours premium on ED visits, defined by:

$$Y_{it} = \beta \cdot AHP_{it} + \boldsymbol{\beta X}_{it} + \alpha_i + \epsilon_{it}, \quad (3.1)$$

where Y_{it} represents the number of ED visits for patient i at time t, AHP_{it} is a dummy variable that represents the value of the after-hours premium at time t for patients in the PEM group or 0 for those in the traditional FFS group, β represents the effect of the after-hours premium on ED visits, $\boldsymbol{X}$ represents the vector of time-varying patient and physician characteristics described previously, α_i represents the patient fixed-effect or the time-invariant patient factors, and ϵ_{it} represents the error term.

Fixed-effects regression models handle this time-invariant confounding by introducing a fixed-effect term, α_i, specific to each patient.[33] This term controls for both observed and unobserved time-invariant patient characteristics, such as sex or patient preferences for the ED. Regression analyses using fixed-effects methods reduce the risk of omitted variable bias, by using the variation in monthly ED visits within a patient to estimate regression coefficients and between-patient variation is not used.[33] The fixed-effects model effectively removes time-invariant confounding; however, an important assumption is that all time-varying observed confounders are controlled for within the analyses.

3.2.4.1 Propensity Score Weighting

Although the fixed-effects approach controls for patient-specific time-invariant confounding, confounding may remain, due to the characteristics of patients enrolled to a physician in a PEM being potentially different from patients whose physician continued to practice in the traditional FFS model. Inverse probability weighting based on the estimated propensity scores may be used to control for selection bias by rebalancing either one or both of the treatment groups. The propensity score is the probability of treatment assignment conditional on observed patient characteristics, and although unknown in non-randomized studies, may be estimated by fitting treatment status as the dependent variable and observed covariates as independent variables.[28] Conditional on the propensity score, the distribution of observed baseline characteristics will be identical between the intervention and control groups. Propensity score methods have been used extensively in the literature to balance treatment groups at baseline in longitudinal data and have been used in the Ontario context to investigate the impact of various primary care reforms on several outcomes.[34–37] The use of the weighted fixed-effects linear models accounts for confounding related to observed patient and physician characteristics through the propensity score weights and for unobserved patient-specific time-invariant confounding through the fixed-effects.

Inverse probability weighting may be used to measure two different measures of population effect, the average treatment effect (ATE) and the average treatment effect among the treated (ATT).[38] The ATE is the average effect of moving the entire population from untreated to treated, while the ATT is the average effect of the treatment only for those who received the treatment. Estimation of weights differs between the two groups. ATE weights are generated for both the intervention and control group, while ATT weights generated only for the control group. ATE weights create intervention and control pseudo-populations where the distribution of covariates is similar between them while ATT weights creates a control pseudo-population that has a similar distribution of covariates to the intervention group.

A sensitivity analysis was conducted using propensity score methods. Analyses for the first study period will be conducted in two stages, first generating a propensity score

model to estimate weights to balance covariates in the two groups, then the weighted fixed-effects linear regression model to estimate the effect of the after-hours premium on ED visits, additionally controlling for the time-invariant confounding factors. This weighted and adjusted estimator is considered doubly robust, meaning that the estimator is consistent if either the propensity score model or the outcome model is correctly specific and efficient if both models are correctly specified.[39] The first study period has a clear comparator group, comparing patients who became enrolled in a PEM with patients who were continuously treated by FFS physicians; however, the second study period was comprised solely of patients continuously enrolled in a PEM between April 2005 and March 2016. Therefore, weighting was only conducted for the first study period. The propensity score was estimated using a logistic regression model, fitted by regressing treatment status, or patient enrolment to a physician who switched into a PEM group between April 2002 to March 2006, on the observed patient and physician characteristics and the number of less-urgent, urgent, and very-urgent ED visits in the first month of analysis. ATT weights were used and estimated as:

$$w_{i,ATT} = Z_i + \frac{(1-Z_i)e_i}{1-e_i} \tag{3.2}$$

where $w_{i,ATT}$ is the weight for the average treatment effect among the treated, Z_i is a dummy indicator for treatment, or whether the *i*th patient had a physician who practiced in a PEM at any time during the first study period, and e_i is the estimated propensity score for the *i*th patient.[40] These weights simplify based on the treatment group, with $w_{i,ATT} = 1$ for those whose physician switched to a PEM and $w_{i,ATT} = \frac{e_i}{1-e_i}$ for patients whose physician remained in the traditional FFS model.

Balancing patients at baseline using the estimated propensity score ensures that patient characteristics between the PEM group and the FFS group were similar at baseline. The *t* test for equality of means, the standardized difference, and the variance ratio were calculated for each covariate to assess whether treatment groups were properly balanced. The *t* test for continuous variables was used to assess whether the means between groups are statistically different. The standardized difference, the difference in means of

continuous and binary variables divided by the pooled standard deviation, and variance ratio, the ratio between the variance in the intervention group compared to the control, were used to compare the balance.[38,41,42] The standardized difference is a useful statistic for comparing treatment groups as it is not influenced by sample size. A standardized difference less than 0.1 is typically used to indicate a negligible difference in the mean or proportion, suggesting that the two treatment groups are balanced.[38,43] A variance ratio of less than 2.0 indicates acceptable balance.[44]

Although conventional propensity score methods are useful in controlling for selection bias, propensity score models are sensitive to misspecification of the propensity score, and even slight misspecification of the model may result in substantial bias in the estimated treatment effect.[45–47] Conventional methods estimate the propensity score using logistic regression models, using the maximum likelihood to estimate the propensity score; however, under model misspecification or imbalance of covariates, the estimated effects may be biased.[48] The covariate balancing propensity score (CBPS) is another method of estimating the propensity score that uses the implied condition of mean independence between treatment and covariates after inverse probability weighting to optimize covariate balance at the expense of likelihood.[48] The CBPS is more robust to misspecification of the propensity score model and improves the balance of covariates. Another method of weighting is entropy balancing, which estimates weights such that the weighted treated and untreated groups satisfy a set of balance conditions, forcing balance between included covariates, even where there is misspecification of the propensity score model.[49] Analyses will be repeated using CBPS and entropy-balancing weights to assess whether the results differ when using these weighting techniques that improve balance between the two groups.

3.2.4.2 Subgroup Analyses

Although all physicians practicing in a PEM are eligible to bill the after-hours premium, the minimum number of required after-hours service blocks is imposed at the group-level and physician groups may be exempt from after-hours requirements, based

on coverage of services provided outside of the primary practice setting. In a subgroup analysis, the intervention group was restricted to include only patients in the PEM group whose physician consistently billed at least one after-hours premium code each month after its introduction.

Previous analyses have found that health care utilization differs by age, sex, income, and morbidity.[50–54] Subgroup analyses were conducted based on the patient characteristics at baseline to assess whether there may be important differences in the effects of the after-hours premium, stratifying patients by sex, income status (low-income area versus middle- or high-income area), comorbidity status stratified as above the median ADG score and below or equal to the median ADG score, and age group (19 years old or younger, 20 to 64 years old, or 65 years old or older).

3.2.4.3 Statistical Software

All analyses were conducted using Stata 15.1.[55] User written Stata programs were used to perform analyses – reghdfe was used to perform fixed-effects analyses with two-way clustering, psweight was used to conduct propensity score weighting at baseline and perform propensity score diagnostics, and ebalance for entropy balancing treatment groups at baseline.[56–58]

3.2.5 Ethics Approval

The use of the data in this project is authorized under Section 45 of the Ontario Personal Health Information Protection Act (PHIPA) and thus Research Ethics Board review was not.

3.3 Results

The initial 10% random sample of Ontario's residents from April 2001 consisted of 951,121 residents (Figure 3.1). After excluding 25,433 residents who were rostered to physicians practicing in the earlier PCN model, 106,800 residents living in a rural area at any point during the study period, 232,354 residents with incomplete follow-up (i.e., those who either died, moved out of province, or did not use health care services in Ontario for two consecutive years), and 2,987 residents with missing data, the study sample consisted of 586,534 residents with complete data between 2002/03 to 2015/16. The first study cohort was comprised of the full study sample, consisting of 586,534 residents with 28,153,632 person-months of data from April 2002 to March 2006. The second study cohort was restricted to residents who were continuously enrolled to a physician practicing in a PEM from April 2005 to March 2016, consisting of 201,594 residents with 26,610,408 person-months of data during the period.

The total number of ED visits for the study cohort increased from 28.2 ED visits per 1,000 patients per month in 2002/03 to 36.2 ED visits per 1,000 patients per month in 2015/16 (Figure 3.2). There was a larger increase in the number of ED visits during regular-hours by 5.6 ED visits per 1,000 patients per month compared to during after-hours where there was an increase of 3.5 ED visits per 1,000 patients per month. The increase in ED visits was driven by an increase in urgent and very-urgent ED visits, which increased by 6.7 and 6.5 ED visits per 1,000 patients per month, respectively; however, less-urgent ED visits decreased by 5.3 ED visits per 1,000 patients per month. This reduction in less-urgent ED visits was primarily due to the reduction in ED visits made during after-hours, with a reduction of 4.1 ED visits per 1,000 patients per month.

3.3.1 First Study Cohort

The first study cohort consisted of 586,534 patients followed from April 2002 to March 2006 (Table 3.1). Between 2002/03 and 2005/06, the proportion of patients 65 years old and older increased from 14% in 2002/03 to 17% in 2005/06, while the proportion of patients living in a low-income area remained relatively steady, fluctuating between 37%

to 39%. By 2005/06, 77% of patients were under a physician practicing in a PEM. The rate of ED visits increased from 28.2 ED visits per 1,000 patients per month in 2002/03 to 29.0 ED visits per 1,000 patients per month in 2005/06. This increase in ED visits was driven by an increase in very-urgent and urgent ED visits, from 2.4 to 4.4 very-urgent ED visits per 1,000 patients per month and 10.6 to 12.6 urgent ED visits per 1,000 patients per month, whereas less-urgent ED visits declined from 15.3 to 12.1 ED visits per 1,000 patients per month during the same period. Although ED visits increased from 9.9 to 10.9 ED visits per 1,000 patients during regular-hours, ED visits declined slightly from 18.3 to 18.1 ED visits per 1,000 patients per month during after-hours, driven by a large reduction in less-urgent ED visits during after-hours.

3.3.1.1 Impact of the Introduction of the After-Hours Premium and the Increase from 10% to 15% on Emergency Department Visits

The introduction of the after-hours premium was associated with a reduction of 1.26 less-urgent ED visits per 1,000 patients per month (95% Confidence Interval [CI]: -1.48, -1.04), after controlling for patient and physician characteristics as well as seasonal effects through monthly dummies (Table 3.2). The reduction in less-urgent ED visits was larger during after-hours compared to during regular-hours, with a reduction of 0.87 (95% CI: -1.03, -0.72) and 0.39 (95% CI: -0.51, -0.26) ED visits per 1,000 patients per month, respectively (Table 3.3). Although the introduction of the after-hours premium was associated with a reduction in less-urgent ED visits, small increases were found in very-urgent and urgent ED visits, with an increase of 0.65 very-urgent ED visits per 1,000 patients per month (95% CI: 0.55, 0.75) and an increase of 0.84 urgent ED visits per 1,000 patients per month (95% CI: 0.66, 1.02). The introduction of the after-hours premium was not associated with a change in total ED visits.

The increase in the value of the after-hours premium from 10% to 15% was not associated with a change in the total number of less-urgent ED visits. However, when stratified by timing, the increase in the value of the after-hours premium was associated

with a slight reduction in less-urgent ED visits during after-hours by 0.17 ED visits per 1,000 patients per month (95% CI: -0.32, -0.02) and a small increase in less-urgent ED visits during regular-hours by 0.13 ED visits per 1,000 patients per month (95% CI: 0.01, 0.25). The increase in the value of the premium to 15% was associated with an increase in total ED visits by 1.28 ED visits per 1,000 patients per month (95% CI: 0.95, 1.60), with increases in urgent ED visits (0.87 ED visits per 1,000 patients per month) and very-urgent ED visits (0.44 ED visits per 1,000 patients per month).

3.3.1.2 Propensity Score Diagnostics and Weighted Analyses

Propensity score weighting at baseline was conducted to create a control pseudo-population (Figure 3.3). After inverse probability weighting using the standard propensity score, the standardized difference in means between the FFS and PEM groups was reduced for all covariates except for the number of urgent ED visits in the first month (Figure 3.4). The largest differences between the FFS and PEM group prior to weighting were found in the proportion of patients living in a low-income area, mean physician age, mean physician years since graduation, and the proportion of physicians who were international medical graduates. The reduction in bias ranged from 3.7% for very-urgent ED visits to 99.6% for physician IMG status (Table 3.5). CBPS and entropy balancing methods were more effective at balancing treatment groups with 100% reduction in bias for almost all variables.

Applying standard propensity score and CBPS weights led to very slight attenuation of the effects of the after-hours premium, while entropy balancing weights led to larger attenuation of the effects (Table 3.6). The introduction of the after-hours premium was associated with a reduction of 1.24 less-urgent ED visits per 1,000 patients per month (95% CI: -1.46, -1.02) after weighting using inverse propensity score weights and a reduction of 1.16 ED visits per 1,000 patients per month (95% CI: -1.39, -0.94) after weighting using entropy weights. Entropy balancing also led to attenuation of the increase in urgent (0.79 ED visits per 1,000 per month) and very-urgent ED visits (0.61 ED visits per 1,000 patients per month) related to the introduction of the after-hours

premium. The after-hours premium was associated with a slightly smaller yet statistically significant reduction in less-urgent ED visits during after-hours after applying standard propensity score and CBPS weights; however, after applying entropy balancing weights, the effect was no longer significant.

3.3.1.3 Subgroup Results

The impact of the introduction of the after-hours premium was slightly smaller when comparing only patients whose physician consistently billed the after-hours premium to patients in the traditional FFS group (Table 3.7). The introduction of the after-hours premium was associated with a smaller reduction in less-urgent ED visits of 0.92 ED visits per 1,000 patients per month (95% CI: -1.19, -0.65). Additionally, the increase in the value of the after-hours premium was no longer associated with a significant reduction in less-urgent ED visits during after-hours.

Subgroup analyses demonstrated slightly larger absolute reductions in less-urgent ED visits for males compared to females and for those living in low-income areas compared to those in middle- or high-income areas (Table 3.7). By age group, the effect of the introduction of the after-hours premium was largest among those 19 years old and younger in 2002/03, with a reduction found for those ages 20-64, but no reduction among those 65 and older. However, these analyses found that the increase in the premium was associated with an increase in less-urgent ED visits for those 19 and younger. Finally, those with an ADG score higher than the median score of 3 saw a larger reduction in less-urgent ED visits following the introduction of the after-hours premium and a significant reduction in less-urgent ED visits associated with the increase in the premium whereas those with a score of 3 or lower had an increase in less-urgent ED visits associated with the increase in the premium.

3.3.2 Second Study Cohort

The second study cohort consisted of a subsample of 201,594 patients who were continuously enrolled to a physician practicing in a PEM between April 2005 and March 2016 (Table 3.8). Between 2005 and 2016, the proportion of patients who were 19 years old or younger decreased from 20% to 8%, while the proportion of patients who were 65 and older increased from 11% to 25%. The proportion of patients living in a low-income area and the mean ADG score were stable over the study period.

The rate of ED visits during the period increased from 23.9 ED visits per 1,000 patients per month in 2005/06 to 33.2 ED visits per 1,000 patients per month in 2015/16. The increase in ED visits was similar by timing, with ED visits during regular-hours increasing from 8.6 to 13.2 ED visits per 1,000 patients per month, while ED visits during after-hours increased from 15.3 to 20.0 ED visits per 1,000 patients per month. Less-urgent ED visits decreased by 1.5 ED visits per 1,000 patients per month, from 11.2 to 9.7 ED visits per 1,000 patients per month, whereas urgent and very-urgent ED visits increased by 6.2 and 4.8 ED visits per 1,000 patients per month, respectively. The reduction in less-urgent ED visits was primarily driven by a reduction in visits during after-hours, with a reduction of 0.1 less-urgent ED visits per 1,000 patients per month during regular-hours and a reduction of 1.4 ED visits per 1,000 patients per month during after-hours.

3.3.2.1 Impact of the Increase in the After-Hours Premium from 15% to 20% and 20% to 30% on Emergency Department Visits

The increase in the value of the after-hours premium from 15% to 20% was not associated with a change in less-urgent ED visits; however, the increase in the premium from 20% to 30% was associated with a small reduction in less-urgent ED visits by 0.22 ED visits per 1,000 patients per month (95% CI: -0.39, -0.06) (Table 3.9). Both increases in the premium were associated with a reduction in less-urgent ED visits during after-hours, by 0.17 ED visits (95% CI: -0.31, -0.02) and 0.13 ED visits (95% CI: -0.25, -0.02)

per 1,000 patients per month when the premium increased from 15% to 20% and from 20% to 30%, respectively.

The increase in the premium from 15% to 20% was not associated with urgent ED visits during regular-hours but was associated with a reduction in urgent ED visits during after-hours by 0.24 ED visits per 1,000 patients per month (95% CI: -0.42, -0.05). Additionally, this increase in the premium was associated with a reduction in total after-hours ED visits by 0.34 ED visits per 1,000 patients per month (95% CI: -0.57, -0.11). The increase in the premium from 20% to 30% was associated with large increases in ED visits of urgent and very-urgent nature during any timing, with an increase in total ED visits by 3.08 ED visits per 1,000 patients per month (95% CI: 2.78, 3.37).

3.3.2.2 Subgroup Results

Subgroup analyses found that only one group, those with an ADG score of 3 or lower experienced a reduction in less-urgent ED visits associated with the increase in the value of the premium from 15% to 20%; however, there was no reduction in less-urgent ED visits associated with the increase in the premium from 20% to 30% (Table 3.10). Despite this, there were reductions in less-urgent ED visits associated with the increase in the premium from 15% to 20% during after-hours for males, residents living in a middle- or high-income area, adults ages 20-64, and those with an ADG score of 3 or lower. The increase in the premium from 20% to 30% was associated with a reduction in less-urgent ED visits for four subgroups only: females, residents living in a low-income area, adults ages 20-64, and those with an ADG score greater than 3. These four groups also saw a reduction in less-urgent ED visits made during after-hours; however, there was an increase in less-urgent ED visits during after-hours for children and adolescents ages 0-19.

3.4 Discussion

The introduction of Ontario's after-hours premium led to a reduction in less-urgent ED visits, with most of the reduction in visits during after-hours. The most conservative estimate, the entropy balanced estimate, found that the introduction of the after-hours premium was associated with 1.16 fewer less-urgent ED visits per 1,000 patients per month (95% CI: -1.39, -0.94). Given that approximately 10 million Ontario residents were enrolled in a PEM in March 2011,[59] the introduction of the after-hours premium would be associated with a reduction of 139,600 fewer less-urgent ED visits per year (95% CI: 112,600, 166,700). Subsequent increases in the value of the after-hours premium were associated with smaller reductions in less-urgent ED visits during after-hours. Under sensitivity analyses where the groups were balanced, the results were similar, demonstrating that the effect of the introduction of the after-hours premium was similar when accounting for potential confounding factors that cause differences in selection of physician model. Subgroup analyses demonstrate that the impact of the after-hours premium was larger for certain subgroups, including females, residents of low-income areas, and patients with higher comorbidity.

These findings fall in line with previous literature, which found that interventions aimed to improve access to primary care during after-hours may be associated with a reduction in less-urgent ED visits.[9–11,60,61] The results are consistent with other studies that found incentivizing physicians to be available for longer hours to be associated with a small reduction in non-urgent ED visits.[17] The previous review of the literature on the effects of improved access to primary care during after-hours found a wide range of estimates in reductions in less-urgent ED visits from 2% to 50%, and Ontario's after-hours premium demonstrates a small effect on less-urgent ED visits.[13] Additionally, like another study comparing Ontario's after-hours premium from 10% to 20%, this study found a slight reduction in less-urgent ED visits associated with increases in the value of Ontario's after-hours premium. [16] Previous research in Ontario found enrolment in a PEM was associated with an increase in ED visits.[20] Differences in methodology may be responsible, as the study lacked a comparator group, did not control for patient-specific time-invariant confounding, and used overall ED visits rather than stratifying by urgency.

However, the conflicting results may also point to evidence of competing policies, with the after-hours premium leading to a reduction in less-urgent ED visits but enrolment in a PEM leading to an increase in urgent ED visits.

3.4.1 Limitations

This study used rigorous statistical methods to control for patient-specific time-invariant confounding using a large representative sample of patients from Ontario. However, it is subject to several limitations, some of which are inherent to observational data. First, while the analyses in the first period reflect the pure effect of the after-hours premium, the analyses in the second period capture the combined effect of the premium with other pay-for-performance incentives that were introduced in the post-2006 era, for example, the diabetes management and congestive heart failure incentives introduced in April 2006. There is no reasonable way to disentangle the effect of the increases in the value of the after-hours premium from other incentives. Although the analyses demonstrated that the after-hours premium was associated with an increase in urgent and very-urgent ED visits, further investigation is necessary to determine whether these are truly linked to the after-hours premium or other primary care reforms. Secondly, analyses were conducted using a balanced panel of data, which excludes those who died during the study period. Given the long follow-up period, this selects for a relatively healthier population that is unlikely to be representative of the Ontario population, and effects may not be similar among very sick or very old adults.

Third, the study was unable to account for the role of individual-level socioeconomic factors that may influence ED visits, instead relying on area-level income as a proxy for individual-level income. Fourth, although selection bias was controlled for in the analyses using the propensity score and entropy balancing methods, there may be some residual confounding if there is unobservable physician selection into PEMs not controlled for within the fixed-effects analyses. Finally, the datasets are only able to capture ED visits, they do not capture information on visits outside of the ED-setting and these analyses are therefore unable to account for whether patients attempted to seek care

from a primary care physician prior to seeking care in the ED and the role of walk-in clinics due to lack of geographic data of these clinics.

3.4.2 Future Directions

Further research is required to understand the effects of the after-hours premium across the health care system. The after-hours premium was initially developed to improve access to primary care outside of the regular working-hours for Ontario residents. Although research has demonstrated that access to primary care during after-hours is better in Ontario than other provinces, it is unclear whether this is solely due to the after-hours premium or other primary care reforms adopted or aspects of Ontario's health care system. Further research is required to examine whether the after-hours premium has improved after-hours access to primary care for those with unmet needs and patient satisfaction with their primary care provider. Finally, while the after-hours premium may be associated with a reduction in less-urgent ED visits, it is unclear whether this has led to cost-savings in the health care system and future research examining the cost-effectiveness of the after-hours premium is required.

3.5 Conclusion

The intended goal of the after-hours premium was to improve access to primary care during after-hours; however, benefits were demonstrated in the ED setting the introduction of the premium was related to a reduction in less-urgent ED visits within Ontario. Despite a reduction in less-urgent ED visits related to the introduction of the premium, subsequent increases in its value were associated with smaller reductions in less-urgent ED visits. As ED utilization continues to rise globally, interventions to divert patients with potentially avoidable ED visits are of increasing interest to policymakers and the use of low levels of incentives such as Ontario's after-hours premium to improve access to primary care may be one policy option worth considering.

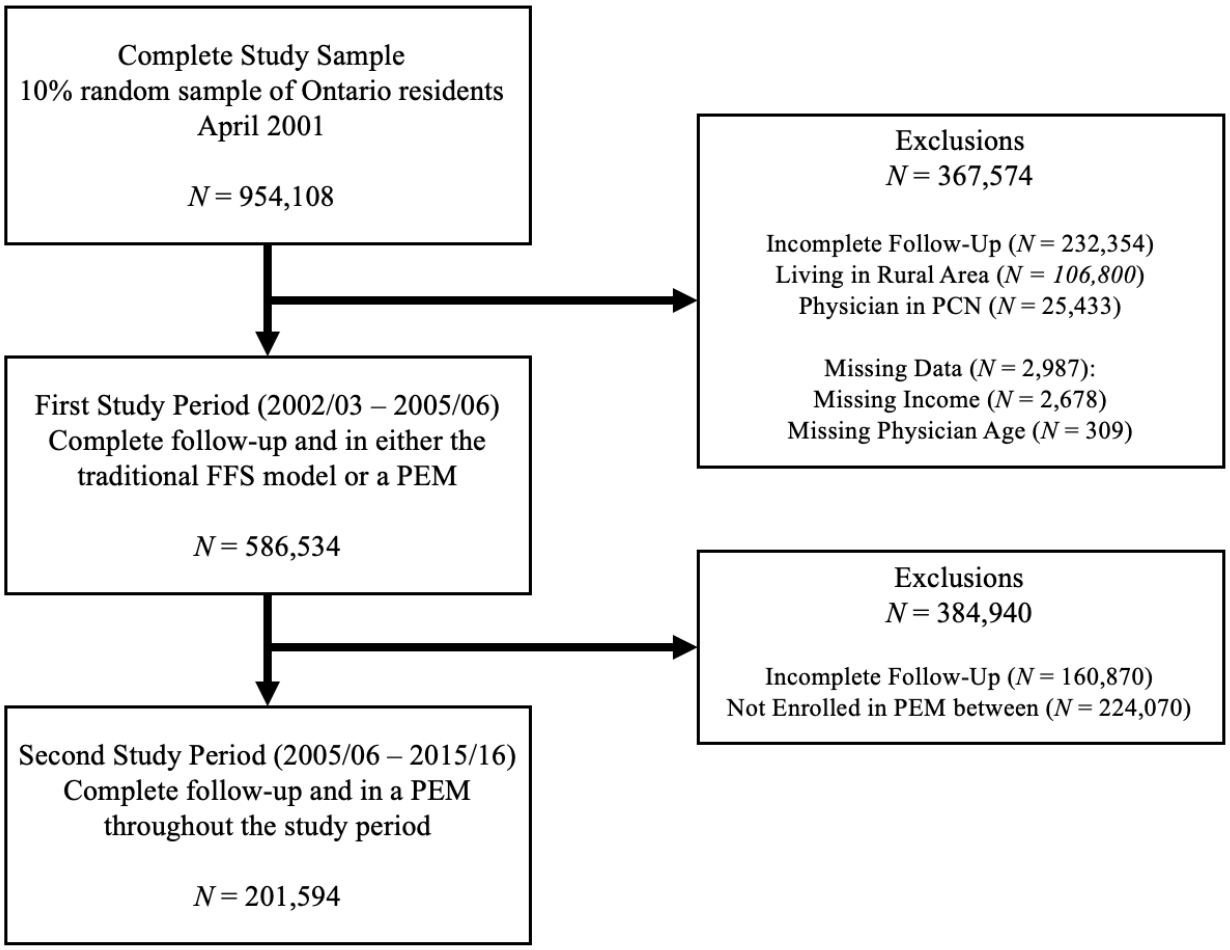

Figure 3.1 Flowchart of patients into study sample for both study periods. FFS: fee-for-service; PCN: Primary Care Network; PEM: Patient Enrolment Model.

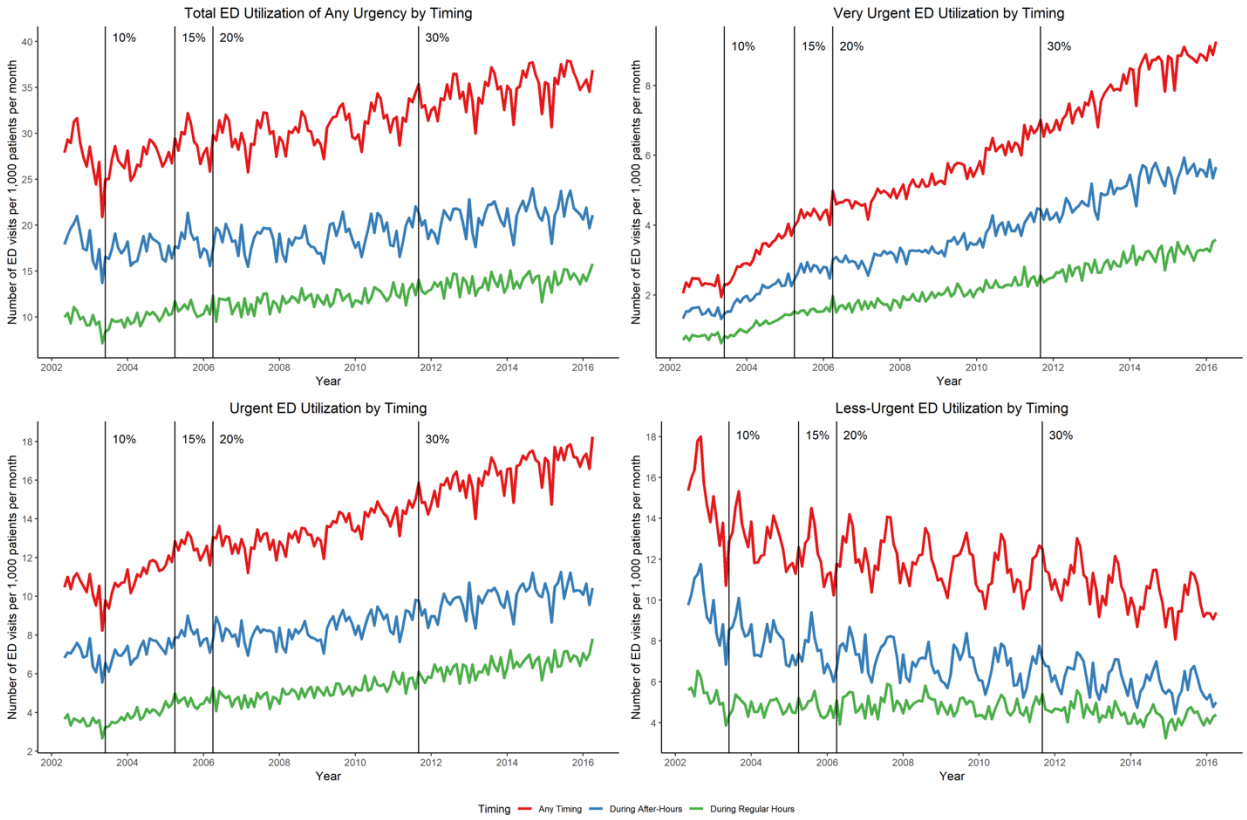

Figure 3.2 Monthly emergency department (ED) visits between April 2002 and March 2016, stratified by timing and urgency.

Table 3.1 Descriptive characteristics and outcomes of study sample between 2002/03 and 2005/06

	2002/03	2003/04	2004/05	2005/06
Patient Characteristics				
Number of Patients, *N*	586,534	586,534	586,534	586,534
Number Enrolled in PEM, *n* (%)	0 (0.00%)	167,400 (28.54%)	288,321 (49.16%)	449,481 (76.63%)
Age Group, *n* (%)				
0-19	123,634 (21.08%)	116,772 (19.91%)	109,830 (18.73%)	102,803 (17.53%)
20-64	378,955 (64.61%)	380,342 (64.85%)	381,595 (65.06%)	383,006 (65.30%)
65+	83,945 (14.31%)	89,420 (15.25%)	95,109 (16.22%)	100,725 (17.17%)
Female, *n* (%)	328,290 (55.97%)	328,290 (55.97%)	328,290 (55.97%)	328,290 (55.97%)
Low-Income Area, *n* (%)	223,160 (38.05%)	217,889 (37.15%)	230,563 (39.31%)	226,166 (38.56%)
ADG Score, mean (SE)	3.650 (0.003)	3.634 (0.003)	3.580 (0.003)	3.606 (0.003)
Physician Characteristics				
Number of Physicians, *N*	8,128	8,224	8,186	8,164
Physician Age, mean (SE)	48.71 (0.12)	49.08 (0.12)	49.63 (0.12)	50.10 (0.12)
Female Physician, *n* (%)	2,728 (33.56%)	2,822 (34.31%)	2,840 (34.69%)	2,888 (35.37%)
Years Since Graduation, mean (SE)	22.24 (0.13)	22.58 (0.13)	23.12 (0.13)	23.60 (0.13)
Group Size, mean (SE)	1.00 (0.00)	1.37 (0.03)	6.43 (0.15)	10.71 (0.22)
IMG Status, *n* (%)	1,032 (12.70%)	1,056 (12.84%)	1,099 (13.43%)	1,170 (14.33%)
ED visits per 1,000 patients per month, mean (SE)				
Total	28.19 (0.11)	25.98 (0.11)	27.88 (0.11)	28.99 (0.11)
Regular-Hours	9.87 (0.05)	9.23 (0.05)	10.26 (0.05)	10.90 (0.05)
After-Hours	18.33 (0.08)	16.75 (0.08)	17.62 (0.08)	18.09 (0.08)
Very-Urgent	2.35 (0.02)	2.68 (0.02)	3.62 (0.03)	4.35 (0.03)
Regular-Hours	0.82 (0.01)	0.93 (0.01)	1.31 (0.01)	1.58 (0.02)
After-Hours	1.53 (0.02)	1.75 (0.02)	2.31 (0.02)	2.77 (0.03)
Urgent	10.58	10.29	11.68	12.55

	(0.05)	(0.05)	(0.06)	(0.06)
Regular-Hours	3.56 (0.03)	3.57 (0.03)	4.17 (0.03)	4.58 (0.03)
After-Hours	7.02 (0.04)	6.72 (0.04)	7.51 (0.04)	7.97 (0.04)
Less-Urgent	15.27 (0.07)	13.01 (0.07)	12.58 (0.06)	12.09 (0.07)
Regular-Hours	5.48 (0.04)	4.73 (0.03)	4.78 (0.03)	4.74 (0.03)
After-Hours	9.78 (0.05)	8.28 (0.05)	7.81 (0.05)	7.35 (0.04)

ADG: Aggregated Diagnosis Groups; ED: Emergency Department; IMG: International Medical Graduate; PEM: Patient Enrolment Model

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays.

Table 3.2 Impact of the introduction of the after-hours premium and increase in value from 10% to 15% on ED visits (*N* = 586,534)

	Change in total ED visits per 1,000 patients per month (95% CI)	Change in very-urgent ED visits per 1,000 patients per month (95% CI)	Change in urgent ED visits per 1,000 patients per month (95% CI)	Change in less-urgent ED visits per 1,000 patients per month (95% CI)
After-Hours Premium (reference: 0%)				
10%	0.227 (-0.084, 0.536)	0.648*** (0.554, 0.742)	0.838*** (0.660, 1.016)	-1.259*** (1.459, -1.060)
15%	1.502*** (1.197, 1.807)	1.088*** (0.991, 1.185)	1.708*** (1.530, 1.886)	-1.294*** (-1.484, -1.104)
Change from 10% - 15%	1.276*** (0.961, 1.591)	0.440*** (0.335, 0.545)	0.870*** (0.684, 1.057)	-0.035 (-0.230, 0.161)
Month (reference: January)				
February	-1.255*** (-1.576, -0.932)	-0.179 (-0.285, -0.074)	-0.384*** (-0.584, -0.184)	-0.692*** (-0.906, -0.477)
March	1.287*** (0.951, 1.622)	0.277 (0.166, 0.388)	0.630*** (0.423, 0.836)	0.380*** (0.160, 0.601)
April	-0.934*** (-1.269, -0.600)	-0.466 (-0.571, -0.361)	-0.540*** (-0.742, -0.338)	0.072 (0.152, 0.296)
May	1.477*** (1.133, 1.821)	-0.153 (-0.260, -0.045)	0.225** (0.017, 0.432)	1.405*** (1.175, 1.635)
June	1.123*** (0.780, 1.467)	-0.242 (-0.349, -0.136)	-0.173* (-0.378, 0.031)	1.539*** (1.307, 1.771)
July	3.181*** (2.831, 3.531)	-0.159 (-0.267, -0.051)	0.457*** (0.248, 0.665)	2.884*** (2.646, 3.122)
August	3.269*** (2.918, 3.620)	-0.138 (-0.246, -0.031)	0.565*** (0.357, 0.772)	2.843*** (2.604, 3.081)
September	1.581*** (1.240, 1.922)	-0.019 (-0.127, 0.088)	0.206** (0.001, 0.411)	1.394*** (1.165, 1.623)
October	0.733*** (0.394, 1.071)	-0.085 (-0.193, 0.023)	0.069 (-0.136, 0.274)	0.749*** (0.524, 0.974)
November	-0.436** (-0.766, -0.105)	-0.136 (-0.243, -0.029)	-0.159 (-0.362, 0.044)	-0.140 (-0.360, 0.079)
December	1.011*** (0.681, 1.342)	-0.080 (-0.187, 0.027)	0.370*** (0.167, 0.574)	0.721*** (0.502, 0.940)
Patient Age (5 years)	0.182 (-0.082, 0.447)	0.838*** (0.761, 0.915)	0.796*** (0.646, 0.945)	-1.451*** (-1.624, -1.279)
Low-Income Area	-0.432** (-0.808, -0.056)	-0.000 (-0.106, 0.106)	-0.234** (-0.445, -0.023)	-0.198* (-0.437, 0.040)
ADG Score	-2.011*** (-2.080, -1.942)	-0.219*** (-0.240, -0.197)	-0.854*** (-0.894, -0.815)	-0.938*** (-0.980, -0.896)
Physician Age	0.026 (-0.372, 0.424)	0.042** (-0.071, 0.155)	-0.012 (-0.233, 0.210)	-0.004 (-0.263, 0.255)
Physician Age-Squared	-0.001 (-0.005, 0.003)	-0.000 (-0.001, 0.001)	-0.000 (-0.003, 0.002)	-0.000 (-0.003, 0.002)
Years Since Graduation	-0.087 (-0.282, 0.107)	-0.068** (-0.122, -0.013)	-0.026 (-0.133, 0.081)	0.007 (-0.121, 0.135)
Years Since Graduation-Squared	0.003 (-0.001, 0.007)	0.001* (-0.000, 0.002)	0.001 (-0.001, 0.004)	0.000 (-0.003, 0.003)

Female Physician	0.593** (0.066, 1.119)	0.098 (-0.036, 0.232)	0.348** (0.056, 0.640)	0.147 (-0.199, 0.492)
International Medical Graduate	0.049 (-0.645, 0.744)	0.155* (-0.029, 0.339)	0.092 (-0.293, 0.476)	-0.197 (-0.635, 0.240)
Group Size	0.005 (-0.002, 0.012)	0.006*** (0.004, 0.008)	-0.002 (-0.006, 0.003)	0.001 (-0.003, 0.005)

*P < 0.10, **P <0.05, *** P < 0.01

ADG: Aggregated Diagnosis Group; CI: Confidence Interval; ED: Emergency Department

Confidence intervals are based on standard errors clustered at the patient- and physician-level.

Table 3.3 Impact of the introduction of the after-hours premium and increase in value from 10% to 15% on ED visits, stratified by timing (*N* = 586,534)

	Change in total ED visits per 1,000 patients per month (95% CI)	Change in very-urgent ED visits per 1,000 patients per month (95% CI)	Change in urgent ED visits per 1,000 patients per month (95% CI)	Change in less-urgent ED visits per 1,000 patients per month (95% CI)
Regular-Hours				
0% - 10%	0.180** (0.018, 0.343)	0.207*** (0.156, 0.258)	0.362*** (0.265, 0.459)	-0.388*** (-0.500, -0.276)
10% - 15%	0.687*** (0.516, 0.857)	0.173*** (0.115, 0.230)	0.383*** (0.279, 0.487)	0.131** (0.017, 0.245)
After-Hours				
0% - 10%	0.046 (-0.187, 0.279)	0.441*** (0.367, 0.516)	0.476*** (0.339, 0.613)	-0.871*** (-1.020, -0.723)
10% - 15%	0.589*** (0.354, 0.824)	0.267*** (0.184, 0.350)	0.487*** (0.344, 0.631)	-0.165** (-0.310, -0.021)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; ED: Emergency Department

Controlled for patient (patient age, low-income area, and comorbidity using Aggregated Diagnosis Group [ADG] score) and physician characteristics (physician age, physician age-squared, years since graduation, years since graduation-squared, physician sex, international medical graduation status, and group size), monthly dummy variable, and patient fixed-effects term. Confidence intervals are based on standard errors clustered at the patient- and physician-level.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays.

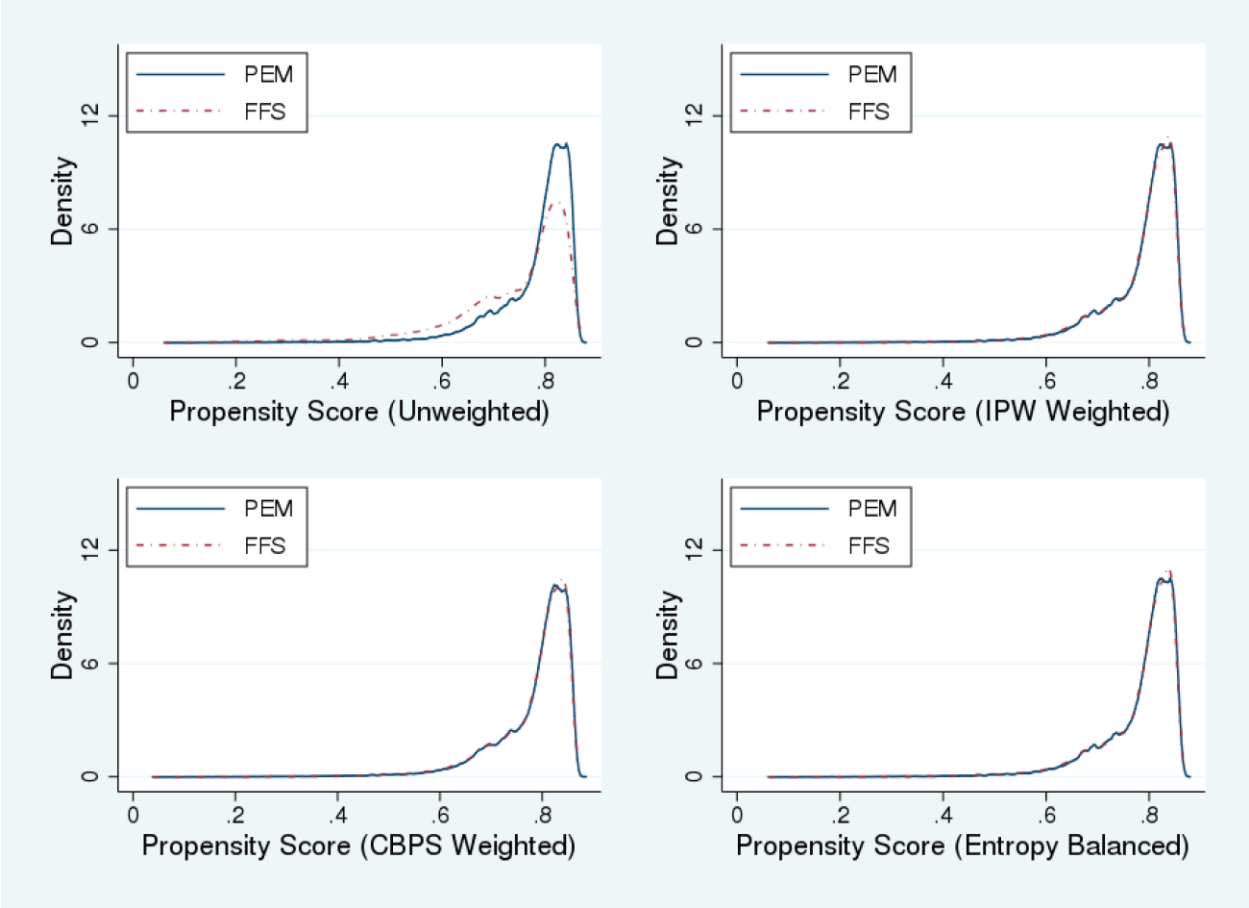

Figure 3.3 Distribution of propensity scores before and after weighting using propensity score weighting and entropy balancing methods

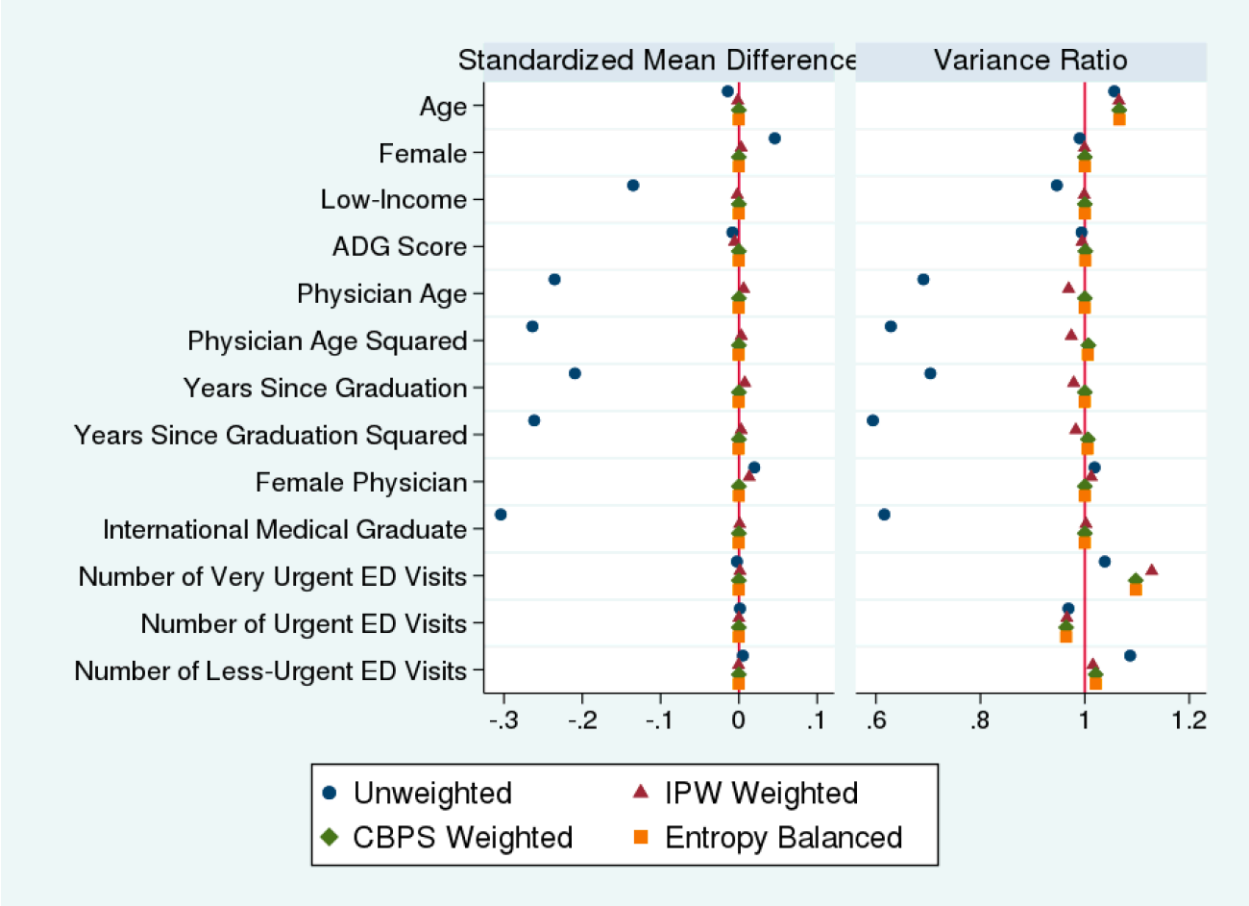

Figure 3.4 Standardized mean difference and variance ratio before and after weighting using propensity score weighting and entropy balancing. CBPS: Covariate Balancing Propensity Score IPW: Inverse Probability Weight

Table 3.4 Propensity score model diagnostics, before and after weighting by inverse probability weighting using the estimated propensity score and entropy balancing weights

Variable	Mean and Standardized Bias of Unweighted Sample				Means and Standardized Bias After Matching by Propensity Score (IPW)				
	PEM	FFS	P-value	% Bias	PEM	FFS	P-value	% Bias	% Reduction in |Bias|
Patient Characteristics									
Sample Size	453,929	132,605			453,929	132,605			
Age (5-year)	8.826	8.887	0.0000	-1.4	8.826	8.836	0.47	-0.2	83.8
Female (%)	0.565	0.562	0.000	4.6	0.565	0.563	0.25	0.4	92.3
Low-Income Area (%)	0.368	0.434	0.000	-13.7	0.368	0.368	0.66	-0.1	99.0
Number of ADGs	3.610	3.644	0.000	-1.3	3.610	3.622	0.11	-0.5	63.2
Number of Very-Urgent ED Visits	0.00322	0.00315	0.67	0.1	0.00322	0.00330	0.69	-0.1	3.7
Number of Urgent ED Visits	0.01133	0.01116	0.65	0.1	0.01133	0.01161	0.44	-0.2	-75.4
Number of Less-Urgent ED Visits	0.01326	0.1290	0.37	0.3	0.01326	0.01347	0.60	-0.2	40.1
Physician Characteristics									
Age	49.702	52.147	0.000	-24.0	49.702	49.644	0.04	0.6	97.6
Age-Squared	2555.3	2841..9	0.000	-26.8	2555.3	2552.1	0.28	0.3	98.9
Years Since Graduation	23.424	25.638	0.000	-21.4	23.424	23.352	0.01	0.7	96.7
Years Since Graduation-Squared	637.65	783.24	0.000	-26.5	637.65	636.13	0.31	0.3	99.0
Female (%)	0.292	0.284	0.000	1.7	0.292	0.286	0.000	1.3	25.2
IMG (%)	0.135	0.255	0.000	-30.6	0.135	0.134	0.69	0.1	99.6

	Means and Standardized Bias After Matching by Propensity Score (CBPS)					Means and Standardized Bias After Matching by Entropy Balancing Weights				
	PEM	FFS	P-value	% Bias	% Reduction in |Bias|	PEM	FFS	P-value	% Bias	% Reduction in |Bias|
Patient Characteristics										
Sample Size	453,929	132,605				453,929	132,605			
Age (5-year)	8.826	8.826	1.00	0.0	100.0	8.826	8.826	0.98	-0.0	99.7
Female (%)	0.565	0.565	1.00	0.0	100.0	0.565	0.565	0.99	0.0	100.0
Low-Income Area (%)	0.368	0.368	1.00	0.0	100.0	0.368	0.368	0.99	-0.0	100.0
Number of ADGs	3.610	3.610	1.00	0.0	100.0	3.610	3.610	1.00	-0.0	99.9

Number of Very-Urgent ED Visits	0.00322	0.00322	1.00	0.0	100.0	0.00322	0.00322	1.00	-0.0	100.0
Number of Urgent ED Visits	0.01133	0.01133	1.00	0.0	100.0	0.01133	0.01133	1.00	0.0	100.0
Number of Less-Urgent ED Visits	0.01326	0.01326	1.00	0.0	100.0	0.01326	0.01326	1.00	0.0	99.9
Physician Characteristics										
Age	49.702	49.702	1.00	0.0	100.0	49.702	49.706	0.86	-0.0	99.9
Age-Squared	2555.3	2555.3	1.00	0.0	100.0	2555.3	2555.6	0.84	-0.0	99.9
Years Since Graduation	23.424	23.424	1.00	0.0	100.0	23.424	23.427	0.87	-0.0	99.9
Years Since Graduation-Squared	637.65	637.65	1.00	0.0	100.0	637.65	638.85	0.84	-0.0	99.9
Female (%)	0.292	0.292	1.00	0.0	100.0	0.292	0.293	0.98	0.0	99.7
IMG (%)	0.135	0.135	1.00	0.0	100.0	0.135	0.135	0.92	-0.0	99.9

ADG: Aggregated Diagnosis Groups; CBPS: Covariate Balancing Propensity Score; ED: Emergency Department; IMG: International Medical Graduate; IPW: Inverse Probability Weight

Table 3.5 Impact of the introduction of the after-hours premium and increase in value from 10% to 15% on ED visits, using propensity score and entropy balancing weights (*N* = 586,534)

	Change in total ED visits per 1,000 patients per month (95% CI)			Change in very-urgent ED visits per 1,000 patients per month (95% CI)		
After-Hours Premium	IPW	CBPS	Entropy Balancing	IPW	CBPS	Entropy Balancing
0% - 10%	0.245 (-0.065, 0.556)	0.246 (-0.065, 0.556)	0.234 (-0.083, 0.552)	0.651*** (0.557, 0.745)	0.651*** (0.558, 0.745)	0.609*** (0.514, 0.705)
10% - 15%	1.288*** (0.973, 1.603)	1.289*** (0.973, 1.604)	1.265*** (0.945, 1.585)	0.441*** (0.336, 0.547)	0.442*** (0.337, 0.547)	0.407*** (0.301, 0.513)
Regular-Hours						
0% - 10%	0.190** (0.027, 0.353)	0.190** (0.027, 0.353)	0.165* (-0.002, 0.332)	0.208*** (0.157, 0.259)	0.208*** (0.157, 0.260)	0.197*** (0.145, 0.249)
10% - 15%	0.694*** (0.523, 0.865)	0.695*** (0.524, 0.866)	0.671*** (0.497, 0.844)	0.174*** (0.116, 0.231)	0.174*** (0.116, 0.231)	0.163*** (0.105, 0.221)
After-Hours						
0% - 10%	0.056 (-0.178, 0.289)	0.055 (-0.178, 0.289)	0.070 (-0.168, 0.308)	0.443*** (0.368, 0.517)	0.443*** (0.368, 0.517)	0.412*** (0.337, 0.488)
10% - 15%	0.593*** (0.358, 0.828)	0.594*** (0.359, 0.829)	0.594*** (0.356, 0.833)	0.268*** (0.185, 0.351)	0.268*** (0.185, 0.351)	0.244*** (0.160, 0.327)
	Change in urgent ED visits per 1,000 patients per month (95% CI)			Change in less-urgent ED visits per 1,000 patients per month (95% CI)		
After-Hours Premium	IPW	CBPS	Entropy Balancing	IPW	CBPS	Entropy Balancing
0% - 10%	0.838*** (0.660, 1.016)	0.838*** (0.660, 1.016)	0.788*** (0.606, 0.970)	-1.244*** (-1.443, -1.044)	-1.244*** (-1.444, -1.044)	-1.163*** (-1.368, -0.958)
10% - 15%	0.872*** (0.685, 1.058)	0.872*** (0.685, 1.059)	0.828*** (0.639, 1.018)	-0.253 (-0.221, 0.170)	-0.025 (-0.221, 0.170)	0.030 (-0.169, 0.228)
Regular-Hours						
0% - 10%	0.365*** (0.268, 0.462)	0.365*** (0.268, 0.463)	0.346*** (0.248, 0.446)	-0.384*** (-0.496, -0.272)	-0.383*** (-0.495, -0.272)	-0.379*** (-0.493, -0.264)
10% - 15%	0.386*** (0.282, 0.490)	0.386*** (0.282, 0.490)	0.368*** (0.263, 0.474)	0.135** (0.021, 0.249)	0.135** (0.021, 0.249)	0.139** (0.024, 0.254)
After-Hours						
0% - 10%	0.473*** (0.336, 0.611)	0.473*** (0.335, 0.610)	0.442*** (0.301, 0.582)	-0.860*** (-1.009, -0.710)	-0.860*** (-1.009, -0.711)	-0.784*** (-0.937, -0.632)
10% - 15%	0.486*** (0.342, 0.629)	0.486*** (0.342, 0.629)	0.460*** (0.315, 0.605)	-0.160** (-0.305, -0.015)	-0.160** (-0.305, -0.015)	-0.109 (-0.257, 0.038)

*P < 0.10, **P <0.05, *** P < 0.01

CBPS: Covariate Balancing Propensity Score; CI: Confidence Interval; ED: Emergency Department; IPW: Inverse Probability Weight

Controlled for patient (patient age, low-income area, and comorbidity using Aggregated Diagnosis Group [ADG] score) and physician characteristics (physician age, physician age-squared, years since graduation, years since graduation-squared, physician sex, international medical graduation status, and group size), monthly dummy variable, and patient fixed-effects term. Confidence intervals are based on standard errors clustered at the patient- and physician-level.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays.

Table 3.6 Impact of the introduction of the after-hours premium and increase in value from 10% to 15% on ED visits for physicians who billed the premium (*N* = 338,567)

	Change in total ED visits per 1,000 patients per month (95% CI)	Change in very-urgent ED visits per 1,000 patients per month (95% CI)	Change in urgent ED visits per 1,000 patients per month (95% CI)	Change in less-urgent ED visits per 1,000 patients per month (95% CI)
0% - 10%	0.408* (-0.008, 0.823)	0.619*** (0.486, 0.752)	0.709*** (0.460, 0.958)	-0.920*** (-1.177, -0.663)
10% - 15%	1.217*** (0.784, 1.651)	0.327*** (0.179, 0.476)	0.786*** (0.521, 1.050)	0.104 (-0.155, 0.363)
Regular-Hours				
0% - 10%	0.248** (0.029, 0.467)	0.234*** (0.160, 0.308)	0.286*** (0.151, 0.421)	-0.272*** (-0.416, -0.129)
10% - 15%	0.642*** (0.409, 0.875)	0.116** (0.032, 0.200)	0.358*** (0.213, 0.503)	0.168** (0.019, 0.317)
After-Hours				
0% - 10%	0.160 (-0.165, 0.475)	0.385*** (0.280, 0.490)	0.423*** (0.230, 0.616)	-0.647*** (-0.844, -0.452)
10% - 15%	0.576*** (0.249, 0.903)	0.212*** (0.096, 0.328)	0.428*** (0.223, 0.633)	-0.064 (-0.260, 0.133)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; ED: Emergency Department

Controlled for patient (patient age, low-income area, and comorbidity using Aggregated Diagnosis Group [ADG] score) and physician characteristics (physician age, physician age-squared, years since graduation, years since graduation-squared, physician sex, international medical graduation status, and group size), monthly dummy variable, and patient fixed-effects term. Confidence intervals are based on standard errors clustered at the patient- and physician-level.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays.

Table 3.7 Impact of the introduction of the after-hours premium and increase in value from 10% to 15% on ED visits for subgroups by sex, age group, comorbidity level, and area-level income

		Change in total ED visits per 1,000 patients per month (95% CI)	Change in very-urgent ED visits per 1,000 patients per month (95% CI)	Change in urgent ED visits per 1,000 patients per month (95% CI)	Change in less-urgent ED visits per 1,000 patients per month (95% CI)
Males (*N* = 258,224)					
Any Timing	0% - 10%	0.03 (-0.45, 0.51)	0.61*** (0.46, 0.76)	0.80*** (0.53, 1.07)	-1.38*** (-1.70, -1.07)
	10% - 15%	1.28*** (0.79, 1.76)	0.49*** (0.32, 0.65)	0.94*** (0.65, 1.22)	-0.15 (-0.46, 0.16)
Regular-Hours	0% - 10%	0.16 (-0.09, 0.41)	0.22*** (0.14, 0.30)	0.41*** (0.26, 0.55)	-0.46*** (-0.64, -0.29)
	10% - 15%	0.54*** (0.28, 0.79)	0.14*** (0.05, 0.22)	0.31*** (0.16, 0.47)	0.08 (-0.09, 0.26)
After-Hours	0% - 10%	-0.13 (-0.49, 0.23)	0.40*** (0.28, 0.51)	0.39*** (0.19, 0.60)	-0.92*** (-1.15, -0.69)
	10% - 15%	0.74*** (0.38, 1.11)	0.35*** (0.22, 0.49)	0.62*** (0.41, 0.84)	-0.23** (-0.46, -0.01)
Females (*N* = 328,290)					
Any Timing	0% - 10%	0.37* (-0.06, 0.80)	0.67*** (0.55, 0.80)	0.86*** (0.62, 1.10)	-1.17*** (-1.45, -0.88)
	10% - 15%	1.26*** (0.83, 1.68)	0.40*** (0.27, 0.53)	0.81*** (0.56, 1.06)	0.05 (-0.23, 0.32)
Regular-Hours	0% - 10%	0.19 (-0.04, 0.42)	0.20*** (0.13, 0.27)	0.32*** (0.19, 0.46)	-0.33*** (-0.49, -0.17)
	10% - 15%	0.80*** (0.57, 1.03)	0.20*** (0.12, 0.27)	0.43*** (0.30, 0.57)	0.16** (0.00, 0.32)
After-Hours	0% - 10%	0.18 (-0.14, 0.50)	0.48*** (0.38, 0.58)	0.54*** (0.35, 0.72)	-0.84*** (-1.04, -0.64)
	10% - 15%	0.46*** (0.14, 0.78)	0.20*** (0.10, 0.30)	0.38*** (0.18, 0.57)	-0.12 (-0.31, 0.08)
Middle- or high-income area at baseline (*N* = 362,365)					
Any Timing	0% - 10%	0.13 (-0.25, 0.50)	0.58*** (0.47, 0.69)	0.68*** (0.48, 0.89)	-1.14*** (-1.39, -0.89)
	10% - 15%	0.98*** (0.61, 1.36)	0.37*** (0.25, 0.49)	0.66*** (0.44, 0.88)	-0.04 (-0.28, 0.19)
Regular-Hours	0% - 10%	0.04 (-0.16, 0.23)	0.18*** (0.12, 0.25)	0.27*** (0.16, 0.390	-0.42*** (-0.56, -0.30)
	10% - 15%	0.58*** (0.38, 0.78)	0.14*** (0.07, 0.21)	0.29*** (0.17, 0.41)	0.14** (0.00, 0.28)
After-Hours	0% - 10%	0.09 (-0.19, 0.37)	0.40*** (0.31, 0.48)	0.41*** (0.25, 0.57)	-0.72*** (-0.90, -0.54)
	10% - 15%	0.41*** (0.13, 0.69)	0.23*** (0.14, 0.33)	0.36*** (0.19, 0.53)	-0.19** (-0.36, -0.01)
Low-income area at baseline (*N* = 224,169)					
Any Timing	0% - 10%	0.40 (-0.21, 1.01)	0.78*** (0.60, 0.96)	1.10*** (0.76, 1.44)	-1.48*** (-1.88, -1.08)
	10% - 15%	1.75*** (1.12, 2.37)	0.55*** (0.35, 0.74)	1.23*** (0.86, 1.59)	-0.03 (-0.42, 0.37)
Regular-Hours	0% - 10%	0.44***	0.25***	0.51***	-0.33***

		(0.12, 0.76)	(0.16, 0.35)	(0.33, 0.70)	(-0.55, -0.10)
	10% - 15%	0.85*** (0.52, 1.19)	0.22*** (0.11, 0.33)	0.53*** (0.34, 0.73)	0.10 (-0.13, 0.33)
After-Hours	0% - 10%	-0.04 (-0.49, 0.41)	0.53*** (0.38, 0.67)	0.59*** (0.32, 0.85)	-1.15*** (-1.43, -0.87)
	10% - 15%	0.89*** (0.44, 1.35)	0.32*** (0.16, 0.48)	0.70*** (0.42, 0.97)	-0.13 (-0.40, 0.15)
Age 0-19 at baseline (N = 113,312)					
Any Timing	0% - 10%	-2.17*** (-2.78, -1.56)	0.25*** (0.12, 0.38)	-0.21 (-0.54, 0.13)	-2.22*** (-2.68, -1.75)
	10% - 15%	1.34*** (0.74, 1.95)	0.20*** (0.59, 0.34)	0.69*** (0.34, 1.04)	0.45** (0.02, 0.88)
Regular-Hours	0% - 10%	-0.51*** (-0.82, -0.21)	0.08** (0.01, 0.14)	0.02 (-0.15, 0.18)	-0.61*** (-0.85, -0.37)
	10% - 15%	0.44*** (0.13, 0.75)	0.02 (-0.05, 0.10)	0.18** (0.00, 0.35)	0.24** (0.00, 0.47)
After-Hours	0% - 10%	-1.66*** (-2.14, -1.18)	0.17*** (0.07, 0.28)	-0.22 (-0.50, 0.05)	-1.61*** (-1.97, -1.25)
	10% - 15%	0.91*** (0.42, 1.39)	0.18*** (0.06, 0.30)	0.51*** (0.22, 0.81)	0.21 (-0.13, 0.56)
Age 20-64 at baseline (N = 380,991)					
Any Timing	0% - 10%	0.19 (-0.21, 0.58)	0.61*** (0.50, 0.73)	0.79*** (0.57, 1.01)	-1.22*** (-1.48, -0.95)
	10% - 15%	0.34* (-0.06, 0.74)	0.27*** (0.15, 0.40)	0.44*** (0.21, 0.67)	-0.37*** (-0.63, -0.11)
Regular-Hours	0% - 10%	0.09 (-0.12, 0.29)	0.18*** (0.12, 0.24)	0.29*** (0.17, 0.41)	-0.39*** (-0.53, -0.24)
	10% - 15%	0.34*** (0.13, 0.55)	0.11*** (0.04, 0.17)	0.21*** (0.09, 0.33)	0.02 (-0.12, 0.17)
After-Hours	0% - 10%	0.10 (-0.19, 0.39)	0.43*** (0.34, 0.52)	0.50*** (0.33, 0.66)	-0.83*** (-1.02, -0.64)
	10% - 15%	0.00 (-0.30, 0.30)	0.17*** (0.07, 0.27)	0.23** (0.05, 0.40)	-0.39*** (-0.58, -0.21)
Age 65+ at baseline (N = 92,231)					
Any Timing	0% - 10%	3.66*** (2.74, 4.59)	1.33*** (0.97, 1.69)	2.49*** (1.93, 3.06)	-0.16 (-0.69, 0.37)
	10% - 15%	4.68*** (3.70, 5.65)	1.38*** (0.99, 1.77)	2.77*** (2.15, 3.39)	0.52* (-0.01, 1.06)
Regular-Hours	0% - 10%	1.51*** (0.97, 2.05)	0.49*** (0.27, 0.70)	1.13*** (0.79, 1.46)	-0.10 (-0.44, 0.24)
	10% - 15%	2.38*** (1.80, 2.96)	0.63*** (0.40, 0.87)	1.35*** (0.99, 1.71)	0.40 (0.04, 0.76)
After-Hours	0% - 10%	2.15*** (1.50, 2.80)	0.84*** (0.58, 1.11)	1.37*** (0.95, 1.78)	-0.06 (-0.40, 0.28)
	10% - 15%	2.30*** (1.62, 2.98)	0.75*** (0.46, 1.04)	1.42*** (0.97, 1.87)	0.13 (-0.21, 0.46)
Less than or equal to median ADG (ADG $\leq$ 3) at baseline (N = 325,899)					
Any Timing	0% - 10%	-0.57*** (-0.88, -0.25)	0.25*** (0.16, 0.33)	0.29*** (0.11, 0.46)	-1.10*** (-1.33, -0.88)
	10% - 15%	2.98*** (2.64, 3.31)	0.57*** (0.47, 0.66)	1.48*** (1.29, 1.67)	0.93*** (0.70, 1.16)
Regular-Hours	0% - 10%	-0.22** (-0.39, -0.05)	0.05** (0.00, 0.10)	0.09* (-0.00, 0.19)	-0.36*** (-0.49, -0.24)
	10% - 15%	1.26*** (1.07, 1.44)	0.22*** (0.16, 0.27)	0.57*** (0.47, 0.67)	0.47*** (0.34, 0.60)

After-Hours	0% - 10%	-0.35*** (-0.58, -0.11)	0.20*** (0.13, 0.27)	0.19*** (0.06, 0.33)	-0.74*** (-0.91, -0.57)
	10% - 15%	1.72*** (1.47, 1.97)	0.35*** (0.28, 0.43)	0.91*** (0.76, 1.06)	0.46*** (0.29, 0.63)
Above median ADG (ADG > 3) at baseline (*N* =260,635)					
Any Timing	0% - 10%	1.33*** (0.71, 1.95)	1.19*** (0.99, 1.38)	1.60*** (1.24, 1.95)	-1.45*** (-1.85, -1.06)
	10% - 15%	-1.01*** (-1.63, -0.40)	0.24** (0.03, 0.44)	0.03 (-0.33, 0.39)	-1.28*** (-1.65, -0.91)
Regular-Hours	0% - 10%	0.73*** (0.40, 1.06)	0.42*** (0.31, 0.53)	0.73*** (0.54, 0.92)	-0.42*** (-0.64, -0.19)
	10% - 15%	-0.09 (-0.42, 0.24)	0.10* (-0.02, 0.21)	0.11 (-0.09, 0.31)	-0.30*** (-0.53, -0.08)
After-Hours	0% - 10%	0.60** (0.14, 1.05)	0.77*** (0.62, 0.92)	0.87*** (0.60, 1.13)	-1.04*** (-1.31, -0.76)
	10% - 15%	-0.92*** (-1.38, -0.47)	0.14 (-0.03, 0.30)	-0.08 (-0.36, 0.19)	-0.97*** (-1.23, -0.71)

*P < 0.10, **P <0.05, *** P < 0.01

ADG: Aggregated Diagnosis Group; CI: Confidence Interval; ED: Emergency Department

Controlled for patient (patient age, low-income area, and comorbidity using ADG score) and physician characteristics (physician age, physician age-squared, years since graduation, years since graduation-squared, physician sex, international medical graduation status, and group size), monthly dummy variable, and patient fixed-effects term. Confidence intervals are based on standard errors clustered at the patient- and physician-level.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays.

Table 3.8 Descriptive characteristics and outcomes of study sample between 2005/06 and 2015/16

	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Patient Characteristics											
Number of Patients, *N*	201,594	201,594	201,594	201,594	201,594	201,594	201,594	201,594	201,594	201,594	201,594
Age Group, *n* (%)											
0-19	40,689 (20.18%)	38,599 (19.15%)	36,544 (18.13%)	34,537 (17.13%)	32,341 (16.04%)	29,978 (14.87%)	27,274 (13.53%)	24,575 (12.19%)	21,855 (10.84%)	19,021 (9.44%)	16,180 (8.03%)
20-64	138,066 (68.49%)	138,084 (68.50%)	137,936 (68.44%)	137,556 (68.23%)	137,200 (68.06%)	137,051 (67.98%)	137,160 (68.04%)	136,562 (67.74%)	135,995 (67.46%)	135,750 (67.34%)	135,406 (67.17%)
65+	22,839 (11.33%)	24,911 (12.36%)	27,087 (13.44%)	29,501 (14.63%)	32,053 (15.90%)	34,565 (17.15%)	37,160 (18.43%)	40,457 (20.07%)	43,744 (21.70%)	46,823 (23.23%)	50,008 (24.81%)
Female, *n* (%)	112,968 (56.04%)	112,968 (56.04%)	112,968 (56.04%)	112,968 (56.04%)	112,968 (56.04%)	112,968 (56.04%)	112,968 (56.04%)	112,968 (56.04%)	112,968 (56.04%)	112,968 (56.04%)	112,968 (56.04%)
Low-Income Area, *n* (%)	69,278 (34.37%)	68,180 (33.82%)	67,192 (33.33%)	66,534 (33.00%)	66,218 (32.85%)	65,799 (32.64%)	65,563 (32.52%)	65,615 (32.55)	65,547 (32.51%)	65,776 (32.63%)	65,218 (32.35%)
ADG Score, mean (SE)	3.276 (0.005)	3.303 (0.005)	3.290 (0.005)	3.253 (0.005)	3.321 (0.006)	3.340 (0.006)	3.340 (0.006)	3.382 (0.006)	3.332 (0.006)	3.329 (0.006)	3.394 (0.006)
Physician Characteristics											
Number of Physicians, *N*	3,460	4,689	5,142	5,462	5,744	6,004	6,189	6,370	6,483	6,596	6,925
Physician Age, mean (SE)	49.14 (0.16)	49.83 (0.14)	50.33 (0.14)	50.61 (0.14)	51.07 (0.14)	51.37 (0.13)	51.73 (0.13)	51.99 (0.13)	52.46 (0.13)	53.18 (0.13)	53.25 (0.13)
Female Physician, *n* (%)	1,210 (34.97%)	1,701 (36.28%)	1,923 (37.40%)	2,123 (38.87%)	2,270 (39.52%)	2,457 (40.92%)	2,589 (41.83%)	2,713 (42.59%)	2,796 (43.13%)	2,796 (43.13%)	2,867 (43.47%)
Years Since Graduation, mean (SE)	22.75 (0.17)	23.45 (0.15)	23.94 (0.14)	24.19 (0.14)	24.64 (0.14)	24.91 (0.14)	25.26 (0.14)	25.47 (0.14)	25.91 (0.14)	26.64 (0.14)	26.66 (0.14)
Group Size, mean (SE)	22.54 (0.42)	46.21 (1.17)	47.26 (1.17)	55.88 (1.18)	56.62 (1.20)	51.57 (1.07)	46.15 (0.97)	42.60 (0.89)	41.57 (0.87)	37.73 (0.78)	36.90 (0.77)
IMG Status, *n* (%)	290 (8.38%)	599 (12.77%)	748 (14.55%)	877 (16.06%)	1,006 (17.51%)	1,141 (19.00%)	1,247 (20.15%)	1,351 (21.21%)	1,387 (21.39%)	1,428 (21.65%)	11,599 (23.09%)
ED visits per 1,000 patients per month, mean (SE)											
Total	23.86 (0.15)	24.04 (0.15)	24.60 (0.15)	24.61 (0.15)	25.58 (0.15)	26.44 (0.16)	27.93 (0.17)	29.46 (0.17)	30.33 (0.17)	31.38 (0.18)	33.23 (0.19)

Regular-Hours	8.55 (0.07)	8.83 (0.07)	9.08 (0.08)	9.60 (0.08)	9.70 (0.08)	10.29 (0.08)	10.77 (0.08)	11.40 (0.09)	11.89 (0.09)	12.26 (0.09)	13.24 (0.10)
After-Hours	15.31 (0.11)	15.21 (0.10)	15.52 (0.11)	15.01 (0.11)	15.88 (0.11)	16.15 (0.11)	17.16 (0.12)	18.05 (0.12)	18.43 (0.12)	19.12 (0.13)	19.99 (0.13)
Very-Urgent	2.94 (0.04)	3.06 (0.04)	3.43 (0.05)	3.72 (0.05)	4.06 (0.05)	4.57 (0.05)	5.05 (0.06)	5.64 (0.06)	6.33 (0.07)	7.06 (0.07)	7.68 (0.08)
Regular-Hours	1.02 (0.02)	1.11 (0.02)	1.17 (0.02)	1.36 (0.03)	1.49 (0.03)	1.67 (0.03)	1.80 (0.03)	2.05 (0.03)	2.35 (0.03)	2.62 (0.04)	2.87 (0.04)
After-Hours	1.92 (0.03)	1.95 (0.03)	2.26 (0.04)	2.36 (0.04)	2.57 (0.04)	2.90 (0.04)	3.25 (0.04)	3.60 (0.05)	3.99 (0.05)	4.44 (0.05)	4.80 (0.06)
Urgent	9.71 (0.08)	9.60 (0.08)	9.83 (0.08)	10.21 (0.08)	11.05 (0.09)	11.37 (0.09)	12.29 (0.09)	13.33 (0.10)	14.11 (0.10)	14.80 (0.11)	15.90 (0.11)
Regular-Hours	3.34 (0.04)	3.35 (0.04)	3.48 (0.04)	3.83 (0.04)	4.05 (0.05)	4.31 (0.05)	4.63 (0.05)	5.06 (0.05)	5.50 (0.06)	5.69 (0.06)	6.31 (0.06)
After-Hours	6.37 (0.06)	6.26 (0.06)	6.35 (0.06)	6.38 (0.06)	7.00 (0.06)	7.06 (0.07)	7.66 (0.07)	8.28 (0.06)	8.60 (0.07)	9.10 (0.08)	9.58 (0.08)
Less-Urgent	11.21 (0.09)	11.37 (0.09)	11.34 (0.09)	10.67 (0.09)	10.47 (0.09)	10.50 (0.09)	10.59 (0.09)	10.48 (0.09)	9.89 (0.08)	9.53 (0.08)	9.66 (0.08)
Regular-Hours	4.18 (0.05)	4.36 (0.05)	4.43 (0.05)	4.40 (0.05)	4.16 (0.05)	4.31 (0.05)	4.34 (0.05)	4.30 (0.05)	4.05 (0.05)	3.95 (0.05)	4.05 (0.05)
After-Hours	7.02 (0.06)	7.01 (0.07)	6.91 (0.06)	6.27 (0.07)	6.31 (0.06)	6.19 (0.06)	6.25 (0.06)	6.18 (0.06)	5.84 (0.06)	5.58 (0.06)	5.61 (0.06)

ADG: Aggregated Diagnosis Groups; ED: Emergency Department; IMG: International Medical Graduate Status; SE: Standard Error
Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays.

Table 3.9 Impact of the increase in the after-hours premium from 15% to 20% and from 20% to 30% on ED visits (*N* = 201,594)

	Change in total ED visits per 1,000 patients per month (95% CI)	Change in very-urgent ED visits per 1,000 patients per month (95% CI)	Change in urgent ED visits per 1,000 patients per month (95% CI)	Change in less-urgent ED visits per 1,000 patients per month (95% CI)
15% - 20%	-0.077 (-0.384, 0.231)	0.104** (0.001, 0.207)	-0.238** (-0.418, -0.058)	0.057 (-0.130, 0.245)
20% - 30%	3.076*** (2.788, 3.362)	1.310*** (1.203, 1.416)	1.990*** (1.820, 2.160)	-0.224*** (-0.382, -0.065)
Regular-Hours				
15% - 20%	0.266*** (0.103, 0.429)	0.038 (-0.016, 0.092)	0.004 (-0.094, 0.101)	0.224*** (0.116, 0.333)
20% - 30%	1.265*** (1.109, 1.420)	0.465*** (0.407, 0.523)	0.889*** (0.795, 0.984)	-0.090* (-0.184, 0.004)
After-Hours				
15% - 20%	-0.343*** (-0.572, -0.114)	0.066 (-0.017, 0.147)	-0.242*** (-0.380, -0.104)	-0.167** (-0.307, -0.027)
20% - 30%	1.811*** (1.605, 2.016)	0.845*** (0.763, 0.926)	1.100*** (0.974, 1.226)	-0.134** (-0.248, -0.020)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; ED: Emergency Department

Controlled for patient (patient age, low-income area, and comorbidity using Aggregated Diagnosis Group [ADG] score) and physician characteristics (physician age, physician age-squared, years since graduation, years since graduation-squared, physician sex, international medical graduation status, and group size), monthly dummy variable, and patient fixed-effects term. Confidence intervals are based on standard errors clustered at the patient- and physician-level.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays.

Table 3.10 Impact of the increase in the after-hours premium from 15% to 20% and 20% to 30% on ED visits for subgroups by sex, age group, comorbidity level, and area-level income

		Change in total ED visits per 1,000 patients per month (95% CI)	Change in very-urgent ED visits per 1,000 patients per month (95% CI)	Change in urgent ED visits per 1,000 patients per month (95% CI)	Change in less-urgent ED visits per 1,000 patients per month (95% CI)
Males (*N* = 88,628)					
Total	15% - 20%	-0.51** (-0.99, -0.04)	0.11 (-0.06, 0.28)	-0.56*** (-0.82, -0.29)	-0.07 (-0.37, 0.24)
	20% - 30%	2.74*** (2.30, 3.18)	1.08*** (0.91, 1.24)	1.77*** (1.52, 2.02)	-0.11 (-0.36, 0.14)
Regular-Hours	15% - 20%	0.16 (-009, 0.41)	0.04 (-0.05, 0.12)	-0.08 (-0.22, 0.07)	0.20** (0.02, 0.37)
	20% - 30%	1.18*** (0.95, 1.41)	0.35*** (0.26, 0.43)	0.83*** (0.69, 0.97)	0.00 (-0.14, 0.15)
After-Hours	15% - 20%	-0.67*** (-1.02, -0.31)	0.08 (-0.06, 0.21)	-0.48*** (-0.68, -0.28)	-0.26** (-0.48, -0.04)
	20% - 30%	1.57*** (1.25, 1.89)	0.73*** (0.61, 0.86)	0.94*** (0.76, 1.13)	-0.11 (-0.29, 0.07)
Females (*N* = 112,966)					
Total	15% - 20%	0.57*** (0.15, 0.98)	0.21*** (0.09, 0.34)	0.18 (-0.07, 0.44)	0.17 (-0.08, 0.43)
	20% - 30%	3.29*** (2.90, 3.69)	1.47*** (1.33, 1.62)	2.14*** (1.89, 2.38)	-0.32*** (-0.53, -0.10)
Regular-Hours	15% - 20%	0.50*** (0.29, 0.72)	0.10*** (0.03, 0.17)	0.16** (0.03, 0.29)	0.25*** (0.10, 0.39)
	20% - 30%	1.31*** (1.10, 1.53)	0.55*** (0.47, 0.63)	0.93*** (0.79, 1.06)	-0.16** (-0.29, -0.03)
After-Hours	15% - 20%	0.06 (-0.24, 0.37)	0.12** (0.02, 0.21)	0.02 (-0.17, 0.21)	-0.08 (-0.27, 0.11)
	20% - 30%	1.98*** (1.70, 2.26)	0.92*** (0.81, 1.04)	1.21*** (1.04, 1.39)	-0.15** (-0.30, -0.00)
Middle- or high-income area at baseline (*N* = 135,171)					
Total	15% - 20%	0.23 (-0.12, 0.58)	0.18*** (0.06, 0.29)	-0.03 (-0.24, 0.17)	0.09 (-0.14, 0.31)
	20% - 30%	2.93*** (2.60, 3.26)	1.18*** (1.06, 1.31)	1.81*** (1.61, 2.01)	-0.07 (-0.25, 0.12)
Regular-Hours	15% - 20%	0.38*** (0.19, 0.57)	0.05 (-0.01, 0.11)	0.06 (-0.05, 0.17)	0.27*** (0.14, 0.40)
	20% - 30%	1.24*** (1.06, 1.42)	0.45*** (0.38, 0.52)	0.80*** (0.69, 0.91)	-0.01 (-0.12, 0.10)
After-Hours	15% - 20%	-0.15 (-0.41, 0.11)	0.13*** (0.04, 0.22)	-0.10 (-0.26, 0.07)	-0.19** (-0.35, -0.02)
	20% - 30%	1.69*** (1.45, 1.93)	0.74*** (0.64, 0.83)	1.01*** (0.87, 1.15)	-0.05 (-0.19, 0.08)
Low-income area at baseline (*N* = 66,423)					
Total	15% - 20%	0.00 (-0.60, 0.61)	0.18* (-0.01, 0.38)	-0.27 (-0.63, 0.08)	0.09 (-0.28, 0.46)
	20% - 30%	3.29*** (2.71, 3.87)	1.54*** (1.34, 1.74)	2.31*** (1.97, 2.65)	-0.56*** (-0.88, -0.24)
Regular-Hours	15% - 20%	0.36**	0.13**	0.08	0.15

		(0.04, 0.68)	(0.03, 0.23)	(-0.11, 0.27)	(-0.06, 0.37)
	20% - 30%	1.28*** (0.97, 1.59)	0.49*** (0.38, 0.60)	1.05*** (0.86, 1.24)	-0.25*** (-0.44, -0.07)
After-Hours	15% - 20%	-0.36 (-0.80, 0.08)	0.05 (-0.11, 0.22)	-0.35*** (-0.62, -0.09)	-0.06 (-0.33, 0.21)
	20% - 30%	2.01*** (1.60, 2.41)	1.05*** (0.90, 1.21)	1.27*** (1.02, 1.51)	-0.31*** (-0.54, -0.09)
Age 0-19 at baseline (N = 29,205)					
Total	15% - 20%	-0.35 (-1.12, 0.43)	0.13 (-0.10, 0.36)	-0.57** (-1.00, -0.13)	0.09 (-0.42, 0.60)
	20% - 30%	3.89*** (3.12, 4.65)	1.12*** (0.86, 1.370	2.22*** (1.78, 2.66)	0.55** (0.10, 1.00)
Regular-Hours	15% - 20%	0.45** (0.07, 0.83)	0.05 (-0.05, 0.15)	0.07 (-0.14, 0.28)	0.33** (0.05, 0.62)
	20% - 30%	1.17*** (0.78, 1.56)	0.33*** (0.21, 0.45)	0.76*** (0.53, 0.99)	0.08 (-0.18, 0.33)
After-Hours	15% - 20%	-0.79** (-1.41, -0.18)	0.08 (-0.10, 0.26)	-0.63*** (-0.99, -0.27)	-0.24 (-0.64, 0.16)
	20% - 30%	2.72*** (2.14, 3.29)	0.78*** (0.59, 0.98)	1.46*** (1.12, 1.80)	0.48*** (0.13, 0.82)
Age 20-64 at baseline (N = 136,921)					
Total	15% - 20%	-0.17 (-0.55, 0.21)	0.16** (0.03, 0.28)	-0.23** (-0.45, -0.01)	-0.10 (-0.34, 0.14)
	20% - 30%	1.92*** (1.57, 2.26)	1.05*** (0.92, (1.18)	1.32*** (1.12, 1.52)	-0.45*** (-0.65, -0.26)
Regular-Hours	15% - 20%	0.20** (0.01, 0.40)	0.05 (-0.02, 0.11)	-0.00 (-0.12, 0.11)	0.16** (0.02, 0.29)
	20% - 30%	0.85*** (0.67, 1.04)	0.37*** (0.30, 0.44)	0.61*** (0.50, 0.72)	-0.13** (-0.24, -0.01)
After-Hours	15% - 20%	-0.37** (-0.66, -0.09)	0.11** (0.01, 0.21)	-0.23*** (-0.40, -0.06)	-0.25*** (-0.43, -0.07)
	20% - 30%	1.06*** (0.81, 1.31)	0.68*** (0.58, 0.78)	0.71*** (0.56, 0.86)	-0.33*** (-0.47, -0.19)
Age 65+ at baseline (N = 35,468)					
Total	15% - 20%	2.00*** (1.26, 2.76)	0.41*** (0.12, 0.70)	0.96*** (0.52, 1.40)	0.63*** (0.19, 1.08)
	20% - 30%	6.36*** (5.60, 7.12)	2.32*** (2.01, 2.64)	4.06*** (3.59, 4.53)	-0.02 (-0.40, 0.36)
Regular-Hours	15% - 20%	0.94*** (0.52, 1.37)	0.20** (0.03, 0.37)	0.36*** (0.10, 0.62)	0.39*** (0.12, 0.65)
	20% - 30%	2.73*** (2.28, 3.19)	0.89** (0.71, 1.07)	1.95*** (1.66, 2.24)	-0.11 (-0.36, 0.15)
After-Hours	15% - 20%	1.06*** (0.53, 1.59)	0.21* (-0.01, 0.44)	0.60*** (0.28, 0.92)	0.25 (-0.06, 0.56)
	20% - 30%	3.63*** (3.12, 4.15)	1.43*** (1.19, 1.67)	2.11*** (1.79, 2.44)	0.08 (-0.16, 0.33)
Less than or equal to median ADG (ADG $\leq$ 3) at baseline (N = 120,620)					
Total	15% - 20%	-0.89*** (-1.22, -0.55)	-0.05 (-0.15, 0.06)	-0.51*** (-0.60, -0.32)	-0.33*** (-0.55, -0.11)
	20% - 30%	2.12*** (1.82, 2.41)	0.79*** (0.69, 0.90)	1.38*** (1.21, 1.56)	-0.06 (-0.25, 0.13)
Regular-Hours	15% - 20%	-0.08 (-0.27, 0.10)	-0.00 (-0.05, 0.05)	-0.11** (-0.22, -0.01)	0.03 (-0.10, 0.17)
	20% - 30%	0.79*** (0.63, 0.96)	0.27*** (0.21, 0.32)	0.57*** (0.47, 0.67)	-0.04 (-0.15, 0.07)

After-Hours	15% - 20%	-0.80*** (-1.05, -0.55)	-0.05 (-0.13, 0.04)	-0.40*** (-0.55, -0.25)	-0.36*** (-0.53, -0.19)
	20% - 30%	1.32*** (1.11, 1.54)	0.52*** (0.44, 0.61)	0.81*** (0.68, 0.95)	-0.02 (-0.15, 0.12)
Above median ADG (ADG > 3) at baseline (*N* = 80,974)					
Total	15% - 20%	1.42*** (0.84, 2.01)	0.42*** (0.22, 0.62)	0.33* (-0.02, 0.68)	0.67*** (0.33, 1.02)
	20% - 30%	4.47*** (3.90, 5.04)	2.07*** (1.86, 2.29)	2.87*** (2.53, 3.22)	-0.48*** (-0.77, -0.18)
Regular-Hours	15% - 20%	0.94*** (0.63, 1.24)	0.15*** (0.04, 0.26)	0.27*** (0.09, 0.46)	0.52*** (0.32, 0.71)
	20% - 30%	1.95*** (1.64, 2.25)	0.76*** (0.64, 0.87)	1.36*** (1.16, 1.55)	-0.16* (-0.34, 0.01)
After-Hours	15% - 20%	0.49** (0.06, 0.92)	0.27*** (0.12, 0.42)	0.06 (-0.20, 0.32)	0.16 (-0.09, 0.41)
	20% - 30%	2.52*** (2.12, 2.92)	1.32*** (1.15, 1.48)	1.52*** (1.27, 1.76)	-0.31*** (-0.52, -0.11)

*P < 0.10, **P <0.05, *** P < 0.01

ADG: Aggregated Diagnosis Group; CI: Confidence Interval; ED: Emergency Department

Controlled for patient (patient age, low-income area, and comorbidity using ADG score) and physician characteristics (physician age, physician age-squared, years since graduation, years since graduation-squared, physician sex, international medical graduation status, and group size), monthly dummy variable, and patient fixed-effects term. Confidence intervals are based on standard errors clustered at the patient- and physician-level.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays.

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4 After-hours premiums and emergency department visits: A difference-in-differences analysis

4.1 Introduction

In the early 2000s, the Canadian government enacted primary care reform in response to many Canadians facing difficulty accessing high-quality primary care.[1–6] Five overarching objectives were set for primary care reform, including one goal to expand all-day every-day access to essential services; however, it was the responsibility of each provincial and territorial government to enact reforms, leading to variations in the implementation of reform objectives.[2,7] Different approaches were undertaken by different provinces – for example, British Columbia (BC), Manitoba, and Saskatchewan strengthened their primary care systems by improving existing infrastructure, whereas Alberta, Ontario, and Quebec introduced newer primary care delivery models in an effort to overhaul their primary care systems.[8] Differences in reform objectives across provinces have led to differences in the extent of offering primary care services outside of the regular working-hours (i.e., after-hours). Beyond access to after-hours telephone helplines, some provinces have mandated minimum required hours of opening practice during after-hours.[9]

Despite the lack of uniform after-hours coverage, each province adopted some form of an incentive for primary care physicians who provide services outside the regular working-hours. After-hours incentives provide an example of the variation in adoption of primary care reforms with differences in practice setting requirements, services incentivized, value, and the definition of after-hours. Three provinces, Newfoundland and Labrador, Nova Scotia, and Ontario, offer incentives for physicians to extend practice hours beyond the regular working-hours,[10–14] whereas BC and Alberta offer after-hours incentives for services provided in alternative practice settings such as nursing homes and active treatment hospitals.[15,16] Quebec and Saskatchewan offer both types of incentives, incentivizing services in the primary care setting, as well as those in alternative practice settings.[17,18] Finally, Manitoba, New Brunswick, and Prince Edward Island (PEI) offer incentives based solely on the urgency of the services, with additional payments for urgent or emergency services provided during after-hours.[18–21] Some provinces offer

fixed dollar value payments where others offer incentives as a percentage of a fee-for-service payment billed. Most provinces offer incentives for a defined basket of services provided during evenings, overnight, weekends, and statutory holidays; however, there are slight differences in the definitions of evenings and overnight across provinces. Additionally, some provinces also offer incentives that differ in value depending on the timing, with larger payments for services provided overnight, or from midnight until the end of the overnight period.

Ontario implemented some of the most expansive reforms in the country to improve access to primary care during after-hours. Apart from being the first province to offer an after-hours premium, physicians practicing in a patient enrolment model (PEM) are also required to keep practices open for a minimum number of hours during after-hours depending on the number of physicians within a group, as well as provide patients access to an after-hours telephone hotline. The 2016 Commonwealth Fund Survey found that Canada ranked second-last among 11 high-income countries in ease of access to after-hours primary care but Alberta and Ontario performed significantly better than the national average.[22] These differences in primary care access during after-hours may potentially be related to the primary care reforms undertaken by Alberta and Ontario.

Since its introduction in 2003, Ontario's after-hours premium has undergone several changes. The set of services eligible for the premium has expanded and the value of the premium has increased three times, first from 10% to 15% in April 2005, then to 20% in April 2006, and finally to 30% in September 2011. Previous studies that investigated the effect of the after-hours premium suggested that the introduction of the premium and subsequent increases in its value were associated with a reduction in less-urgent ED visits during after-hours.[13,23] However, studies have yet to examine the impact of these reforms in relation to other provinces. This study uses linked survey and administrative data to examine whether the increase in the after-hours premium from 20% to 30% was associated with a reduction in less-urgent ED visits in Ontario relative to four other provinces.

4.2 Methods

4.2.1 Study Data

This study uses linked survey and administrative data to examine whether the increase in the value of Ontario's after-hours premium from 20% to 30% in 2011 was associated with a reduction in less-urgent ED visits. Secondly, this study uses data from multiple provinces and a difference-in-differences (DID) framework to examine changes in ED visits in Ontario relative to control provinces. Analyses were conducted using total ED visits, as well as ED visits stratified by timing and urgency. Cross-sectional survey data from the 2010-2016 cycles of the Canadian Community Health Survey (CCHS) were linked to the National Ambulatory Care Reporting System (NACRS) database. The CCHS was used to obtain respondent demographic, socioeconomic, and health characteristics, while NACRS was used to obtain ED visit information. The study period was chosen to limit the influence of other primary care reforms adopted by Ontario and the control provinces in the early primary reform period of the 2000s that could potentially influence access to primary care during after-hours as well as limited coverage of NACRS data across provinces. Although NACRS coverage has been historically limited, coverage has improved over time, with a large increase in the estimated proportion of all ED visits in Canada reported to NACRS from 36% in 2009/10 to 52% in 2010/11 due to mandated reporting from Alberta, and increasing coverage in several other provinces.[24]

4.2.1.1 Canadian Community Health Survey

The CCHS is a cross-sectional survey of Canadians administered by Statistics Canada to collect information on demographic, socioeconomic, and health-related variables, primarily for health surveillance and population health research. The survey was first conducted in 2001, with each new cycle administered every two years to approximately 130,000 Canadians per cycle. However, as of 2007, the survey is administered on an annual basis to approximately 65,000 Canadians per cycle. The CCHS is designed to capture a sample of community-dwelling residents aged 12 and older and excludes those

living on reserve or other Aboriginal settlements, individuals living in the Quebec health regions of Région du Nunavik and Région des Terres-Cries-de-la-Baie-James, institutionalized populations, members of the Canadian Forces, and children living in foster care. Together, these exclusions represent less than 3% of the Canadian population.[25] Response to the CCHS is completely voluntary, and the response rates for the CCHS 2010 and 2016 cycles were 71.5% and 61.3%, respectively.[25,26] The CCHS may be administered in both English or French, with data collected directly from survey respondents using computer assisted personal and telephone interview software.

The CCHS uses a multi-stage sampling design, designed to provide representative data at the health region-level in each province. For the 2010-2014 cycles, study sample sizes were allocated to the provinces and territories based on the size of the population and the number of health regions within the province or territory. This study sample size is further allocated across health regions, proportional to the square root of the population size of each health region. Three sampling frames were used to select the sample of households: an area frame, a list frame of telephone numbers and a random digit dialling sampling frame.[26] The area frame used in the CCHS is the same area frame developed for the Labour Force Survey, which involves a two-stage stratified sampling design. Clusters are formed within strata and sampled using a probability-proportional-to-size sampling design, with a systemic sample taken within each sampled cluster. In the CCHS, these clusters are stratified by health region, and then a sample of households is randomly drawn within each region. The list frame and the random digit dialling frame are used as complements to the area frame. Among the 117 health regions, 4 health regions used the random digit dialling frame, while all other health regions used the list frame. Random digit dialling was used to select a random sample from 100-number banks (i.e., a bank of numbers that have the area code and first five digits in common), which are matched as closely to health regions as possible. Sampling from the random digit dialling list is conducted until the required sample size is reached. For the list frame, phone numbers are matched to health regions using a postal code conversion file and a random sample of phone numbers is taken within each health region. These three frames are used to develop the sample of households and the second step involves selecting a member among each

dwelling, by first listing the members aged 12 and older, then selecting one member, with the individual's selection probability based on age and household composition.

The sampling strategy was modified for the 2015 cycle and the modified strategy has been used since.[25] The population is first stratified into two age groups, those 18 and older and those ages 12-17. Study sample sizes are then allocated among the provinces, then health regions, according to power allocations and the population size. The CCHS then uses two sampling frames, based on age group, to select the study sample. The same area frame from the CCHS 2010-2014 cycles is used to select dwellings; however, when selecting a member of each household, only those 18 and older are considered. For potential respondents ages 12-17, a sampling frame is built using the Canadian Child Tax Benefit, where the sampling frame is stratified by health region and a simple random sample is selected within each health region.

4.2.1.2 National Ambulatory Care Reporting System Database

The NACRS database contains hospital-based and community-based ambulatory care data on day surgery, outpatient and community-based clinics and ED visits.[27] NACRS was used in this study to obtain information on ED visits, including the urgency, date, and timing of the visit. The database is managed by the Canadian Institute for Health Information (CIHI), with data received either directly from reporting facilities or from regional health authorities or ministries. Coverage of NACRS varies heavily across provinces and in the 2010/11 fiscal year, coverage was mandated only in Alberta and Ontario, with partial coverage across several other provinces.[24] CIHI estimated that in the 2010-11 fiscal year, 52% of all ED visits in the country were reported to NACRS; however, by the 2019/20 fiscal year, it is estimated that 84% of all ED visits in the country were reported to NACRS.[24,27] Data coverage in NACRS is currently evolving and continuing to improve to obtain more comparable and standardized data. In the 2019/20 fiscal year, ED visit information was mandated in Quebec, Ontario, Alberta, and Yukon, and partially mandated in PEI, Nova Scotia, Manitoba, Saskatchewan, and BC. In 2019, Statistics Canada linked CCHS survey data to several administrative databases,

including NACRS, as part of a project to create an integrated dataset to allow researchers to study the effects of behavioural, socioeconomic, and environmental factors on hospital services and health outcomes.

4.2.2 Study Population

CCHS data were linked to NACRS on an annual basis, with each survey cycle linked to the same fiscal year of NACRS data. For example, CCHS respondents in the 2010 cycle were linked to corresponding ED visit data from the 2010/11 fiscal year (April 2010 to March 2011). This study uses seven cross-sectional samples from the CCHS, the 2010-2016 cycles, and is restricted to respondents residing in Ontario or in one of the four control provinces. Respondents residing in the three territories were excluded. Manitoba and Saskatchewan were not included in the control group due to changes in their after-hours premiums during the study period, while New Brunswick, Newfoundland and Labrador, and Quebec lacked sufficient coverage in NACRS for inclusion. Accordingly, the control group was only composed of four provinces: Alberta, BC, Nova Scotia, and PEI. Respondents living in rural regions were excluded from the study sample due to rural-urban differences in primary care practices since EDs act as a source of primary care for those patients living in rural regions.[28] Rurality was defined based on the population size of the geographic location using the respondent's postal code, where a rural area was defined as a Census Division with a population size less than 10,000.[29] Given the limited coverage of NACRS data, the study population was restricted to respondents residing within 10 km of an ED that reported their ED visit information to NACRS.

4.2.3 Study Variables

The outcome of interest was the number of ED visits per patient per year, stratified by timing and urgency. Timing was defined using the eligibility criteria of Ontario's after-hours premium, where regular-hours was defined as 8:00 AM – 5:00 PM on weekdays

and after-hours was defined as between 5:00 PM – 8:00 AM on weekdays and any timing during weekends and Ontario statutory holidays. ED visits were stratified by urgency based on the Canadian Triage and Acuity Scale (CTAS),[30] where ED visits with a CTAS score of 4 or 5 were classified as less-urgent, ED visits with a CTAS score of 3 were classified as urgent, and visits with a CTAS score of 1 or 2 were classified as very-urgent.

Respondent characteristics included demographic, socioeconomic, and health-related variables. Demographic and socioeconomic characteristics included province, age, sex, marital status, household size, presence of minors living in the household, immigrant status, education, and household income. Age was treated as a spline variable, calculated using the survey date and the respondent's date of birth, with two cut-offs at 18 and 65 years old, while sex was a dichotomous variable. Six categories of marital status were collapsed into three groups: (i) single, (ii) married or in a common-law relationship, and (iii) separated, divorced, or widowed. Household size was defined as a count variable, the number of individuals living in the same residence, while the presence of minors was a dichotomous variable based on whether the respondent was living in the same residence as any person under the age of 18. Immigrant status was captured using two survey items from the CCHS, the immigrant flag variable and the time since immigrant variable, to create a three-level categorical variable: (i) non-immigrant; (ii) recent immigrants, defined as those who immigrated less than 5 years before the survey date; and (iii) long-term immigrants, defined as those who immigrated 5 or more years before the survey date.[31] Education was treated as a three-level categorical variable: (i) less than secondary school education; (ii) secondary school graduation; and (iii) post-secondary certificate, diploma, or university degree. Income was based on household income, categorized into quintiles within each province. Although the CCHS 2010-2015 cycles provided education as a four-level categorical variable and provided deciles for household income, education and household income were collapsed into a three-level categorical variable and quintiles, respectively, to be consistent with the 2016 cycle of the CCHS.

Physician status and morbidity were also included in the multivariable models. Physician status was included as a dichotomous variable based on whether a respondent had a physician as a usual source of care. Morbidity was treated as a three-level categorical

variable, based on the number of comorbidities from a list of nine conditions developed by an expert working group under the Public Health Agency of Canada: (i) no morbidities, (ii) one morbidity, and (iii) multimorbidity, defined as two or more chronic conditions.[32] This list of chronic conditions included: Alzheimer's disease and related dementias, arthritis, asthma, cancer, chronic obstructive pulmonary disorder, diabetes mellitus, heart disease, mental disorder (defined as having either or both a mood disorder and/or anxiety), and stroke.

4.2.4 Statistical Analysis

This study uses respondent-level cross-sectional data. All analyses are conducted by applying survey-weights to produce estimates that are representative of the respective provincial populations. Weighted descriptive characteristics are presented for each cycle of data, with continuous variables presented as mean (standard error [SE]) and categorical variables presented as a proportion. All unweighted sample sizes were rounded to nearest 5, while all weighted counts were rounded to the nearest 1,000 as per Statistics Canada protocols for CCHS linked to NACRS data.

Due to the count nature of ED visits and the skewness of the distribution of ED visits, negative-binomial regression models were used to model the effect of the increase in the premium on ED visits. Multivariable models were used, controlling for the patient demographic, socioeconomic, and health characteristics as described above. As the CCHS uses a multi-stage cluster sampling design, survey weights and clustered bootstrap errors were used in models. Sample weights were used to produce estimates representative of the five provinces included in the study sample. As the standard estimator for variance would be biased downwards from the true variance, clustered bootstrap standard errors were used to account for the correlation between respondents within a cluster.[33]

To investigate whether Ontario's after-hours premium caused a reduction in ED visits, the full study sample including Ontario and the four control provinces was used. A DID

analysis was conducted to examine the impact of the increase in the value of the after-hours premium in Ontario compared to control provinces. [34] DID methodology has been used extensively in health research for policy evaluation, including to evaluate policy changes in Ontario.[35–39] DID methodology, compared to simple pre-post analyses, can be powerful as it can control for similar changes that occur over time in both the intervention and control group and can control for time-invariant confounding characteristics.[35] However, the DID framework relies on two important assumptions: 1) the parallel trend assumption, that trends in the outcome would have been identical in the absence of the policy change; and 2) the common shocks assumption, that any other policy changes outside of the given policy change under study affect both the intervention and control groups equally.[40,41]

Under the DID framework, two differences are taken – first, the difference in the rate of ED visits before and after the increase in the value of the after-hours premium from 20% to 30% is taken separately for Ontario and for the control group. The second difference is the difference-in-differences, or the difference in the pre-post rate of ED visits in Ontario compared to the difference in the pre-post rate of ED visits in the control provinces. Although the after-hours premium increased in September 2011, the outcome was measured on an annual basis, and thus a lagged intervention was used. The pre-increase period was from April 2010 to March 2012, and the post-increase period was from April 2012 to March 2017. The use of the lagged intervention additionally allows for this model to account for delays in the effect of the after-hours premium due to gradual uptake of the increased value of the after-hours premium. The DID model estimates the effect of the increase in the value of the after-hours premium on ED visits in Ontario, relative to the control group, removing background changes in the outcome. The DID model using negative-binomial regression is specified as:

$$\ln(Y_i) = \beta_0 + \beta_1 \cdot AHP + \beta_2 \cdot t + \beta_3 \cdot AHP \cdot t + \boldsymbol{\beta X} + v_i + \epsilon_i \qquad (4.1)$$

where Y_i is the number of ED visits for respondent i during the year of survey, AHP represents the time-period, captured as a binary variable where $AHP = 0$ represents the period before the increase in the value of the after-hours premium (i.e., where the

premium was 20%) and $AHP = 1$ represents the period after the increase in the value of the premium (i.e., where the premium was 30%), t represents the treatment variable, where $t = 0$ for control provinces and $t = 1$ for Ontario, β_3 thus represents the difference-in-differences term, $\boldsymbol{X}$ represents a vector of demographic, socioeconomic, and health-related characteristics for control, and v_{it} allows for modelling of the overdispersion in the negative-binomial regression model, such that $e^{v_{it}}$ has a mean of 1 and a variance of the overdispersion parameter α, and ϵ_i represents the standard error term.

4.2.4.1 Sensitivity Analyses

Sensitivity analyses were conducted to test the robustness of the inclusion criteria, specifically, the criterion related to the road distance of a respondent to the nearest ED. Due to limited coverage of NACRS, not all ED visits were reported in some provinces. By using the inclusion criteria of 10 km road distance to the nearest ED, an artificial boundary could be created to ensure that the population within these artificial boundaries made ED visits to EDs responsible for reporting information to NACRS. Previous research in Canada suggests that the majority of residents live within 5 km aerial distance to the nearest hospital.[42] The inclusion criteria using a road distance of 10 km to the nearest ED should sufficiently cover the majority of urban populations serviced by any one particular ED; however, to test the robustness of this criteria, sensitivity analyses were conducted by altering the inclusion criteria, expanding to respondents within a road distance of 20 km to the nearest ED and shrinking to a road distance of within 5 km to the nearest ED.

Less-urgent ED visits for family practice-sensitive conditions (FPSC) or ED visits with a CTAS score of 4 or 5 for conditions resulting in less than 1% probability of requiring hospitalization were captured as a sensitivity analysis (Appendix B).[43,44] These codes are based on the International Classification of Disease, 10th Revisions (ICD-10) codes and due to high levels of missingness in BC and PEI, analyses involving less-urgent ED visits

for FPSCs were conducted only for analyses within Ontario and in cross-provincial comparisons with Alberta and Nova Scotia.

4.2.4.2 Subgroup Analyses

Subgroup analyses were conducted to examine the impact of the increase in the after-hours premium on various subpopulations. Subgroup analyses were performed in three groups expected to benefit most from the after-hours premium: respondents who reported having a regular source of care, respondents who worked full-time, and respondents who reported having at least one chronic condition. As Ontario's after-hours premium is eligible to be billed only by physicians practicing in PEMs on select services provided to patients enrolled either to that physician or a physician practicing under the same group, the increase in the after-hours premium is likely to have a larger effect among respondents with a regular source of care, as these respondents are more likely to be enrolled with a PEM physician compared to those without a regular source of care.[13,14] The increase in the value of the after-hours premium may also be larger for respondents with full-time employment as the increased flexibility of after-hours services is likely to be more advantageous to those with full-time employment compared to those without. Finally, individuals with a chronic condition have been found to both use more health services and use those health services more intensely than those without chronic conditions and so improvements in access to primary care may likely have a larger impact among this group than among respondents without chronic conditions.[45–47]

Additional subgroup analyses were conducted to compare the effect of the increase in the after-hours premium from 20% to 30% by province, sex, and household income quintile. Each of the four control provinces was used as a separate control group under the DID analysis. As sex and income are both known to be associated with an increase in health care utilization, subgroup analyses were conducted for these variables to assess whether there may be any important inequalities that may be present with respect to the after-hours premium.[48,49] Separate regression models were estimated for males and females, and for respondents in the highest income quintile and in the lowest income quintile.

4.2.4.3 Statistical Software

All analyses were conducted using Stata 17.0.[50] Analyses involving bootstrapping to create clustered bootstrap errors used 500 bootstrap samples provided by Statistics Canada.

4.3 Results

Across the 2010-2016 cycles of the CCHS, 345,140 respondents were surveyed, of which, 266,860 respondents resided in Ontario or one of the four control provinces. Of these respondents, 73,255 respondents living in rural areas were excluded and 76,460 respondents were excluded as they lived outside of the 10 km road distance to the nearest ED. Finally, 14,370 respondents with missing data were excluded, including 195 with missing marital status (<1%), 615 missing immigrant status (<1%), 1,315 missing education status (1%), 1,800 missing any of the eight chronic conditions (2%), and 5,445 (5%) missing information on household income. The final sample consisted of 107,775 respondents across all cycles for analysis, representing 86,970,000 Canadian-years (Table 4.1). The sample was mostly comprised of Ontario residents, ranging from 73% of the sample in the 2010 cycle to only 58% in the 2014 and 2015 cycles. Mean age was consistently between 42 and 44 years old, while the proportion of female respondents was between 49% and 51%. The proportion of single respondents increased from 30% in 2010 to 33% in 2016, while the proportion of respondents who were married or in a common-law relationship decreased from 58% to 56%. The proportion of non-immigrants decreased from 71% in 2010 to 62% in 2016, while the proportion of long-term immigrants increased from 25% to 34% over the same period. The proportion of respondents with chronic conditions was stable, with the proportion with a single chronic condition ranging from 24% to 26% while the proportion with two or more ranged from 11% to 13%.

The rate of ED visits for the sample ranged from 360 to 384 ED visits per 1,000 patients per year. Trends in ED visits were found after stratifying by urgency, the rate of less-urgent ED visits decreased from 181 ED visits per 1,000 patients per year in 2011 to 124

ED visits per 1,000 patients per year in 2016, whereas slight increases in the rates of very-urgent and urgent ED visits were observed. Similar trends were found during regular-hours and after-hours for ED visits of very-urgent and less-urgent nature, while an increase in urgent ED visits was only found in visits during after-hours as regular-hours urgent ED visits remained consistent over the study period.

4.3.1 The Impact of the Increase in the After-Hours Premium from 20% to 30% in Ontario

Demographic characteristics in the Ontario sample were consistent over time, with mean age ranging from 43 to 45 years old and the proportion of female respondents ranging from 50% to 52% (Table 4.2). Trends in ED visits followed similar patterns: a decrease in less-urgent ED visits was found from the highest rate of 164 ED visits per 1,000 patients per year in 2011 to 109 ED visits per 1,000 patients per year in 2016. Very-urgent and urgent ED visits increased over the study period.

The increase in Ontario's after-hours premium from 20% to 30% was associated with a 15% reduction in less-urgent ED visits per year (95% CI [Confidence Interval]: 6%, 24%) after controlling for respondent demographic, socioeconomic, and health-related characteristics (Table 4.3). When stratified by timing, the increase in the after-hours premium was not significantly associated with a reduction in less-urgent ED visits during regular-hours (Incidence Rate Ratio [IRR]: 0.89; 95% CI: 0.78, 1.02) but only during after-hours (IRR: 0.82; 95% CI: 0.71, 0.93) (Table 4.4). While the increase in the after-hours premium was not associated with a change in total ED visits, both during regular- and after-hours, the increase in the premium was associated with an increase in total very-urgent ED visits by 24% (95% CI: 7%, 43%), although only significant during after-hours (IRR: 1.31; 95% CI: 1.12, 1.54).

4.3.1.1 Sensitivity Analyses

Despite a reduction in less-urgent ED visits, the after-hours premium was not associated with a reduction in less-urgent ED visits for FPSCs during regular- or after-hours (Table 4.5). Variations in the inclusion criteria of road distance to the nearest ED yielded similar results for ED visits by any urgency and timing. However, expanding the inclusion criterion to within 20 km of the nearest ED demonstrated a larger effect of the increase in the after-hours premium on very-urgent ED visits (IRR: 1.33; 95% CI: 1.16, 1.52) compared to when the inclusion criterion was restricted to within 5 km of the nearest ED (IRR: 1.21; 95% CI: 1.01, 1.45).

4.3.1.2 Subgroup Analyses

Subgroup analyses of respondents with a physician as a regular source of care and respondents with at least one chronic condition yielded similar results to the main analyses (Table 4.5). Respondents with full-time employment had a slightly larger effect of a 20% reduction in less-urgent ED visits (95% CI: 6%, 32%). Despite no difference in the effect of less-urgent ED visits, for respondents with at least one chronic condition, the increase in the after-hours premium was no longer associated with a change in very-urgent ED visits during any timing and a smaller increase in very-urgent ED visits during after-hours.

The increase in the after-hours premium was associated with a reduction in less-urgent ED visits among females (IRR: 0.80; 95% CI: 0.70, 0.91) but not among males (IRR: 0.91; 95% CI: 0.77, 1.07). For females, there was a reduction during both regular- and after-hours; however, no reduction was found for males even when stratifying by timing. Additionally, there was an increase in very-urgent ED visits only among males and not among females; but similar increases in very-urgent ED visits during after-hours for both groups. When stratified by income, the effects on less-urgent ED visits were not significant, likely due to small sample size; however, a 23% reduction in less-urgent ED visits during after-hours was found for those in the lowest income quintile. No other significant associations were found for the income subgroups.

4.3.2 The Impact of the Increase in the After-Hours Premium from 20% to 30% in Ontario Relative to Control Provinces

Compared to Ontario, respondents from control provinces were less likely to be immigrants and less likely to have a physician as a regular source of care (Table 4.6). Like in Ontario, there was a reduction in the rate of less-urgent ED visits over the study period from a high of 227 ED visits per 1,000 patients per year in 2010 to 145 ED visits per 1,000 patients per year in 2016; however, there were increases in the rates of urgent and very-urgent ED visits. Similar to Ontario, there was a larger reduction in less-urgent ED visits during after-hours compared to during regular-hours. The rates of total ED visits between Ontario and control provinces were similar prior to the increase in the after-hours premium; after the increase in the premium, the rate of total ED visits in control provinces dropped below the rate of ED visits in Ontario (Figure 4.1). There was a larger reduction in less-urgent ED visits for the control provinces compared to Ontario, but slightly smaller increases in very-urgent and urgent ED visits for Ontario.

In Ontario, the post-period was associated with a reduction in less-urgent ED visits for all provinces, while Ontario was associated with a lower rate of less-urgent ED visits compared to the four control provinces (Table 4.7). Despite these associations, the increase in the after-hours premium was not associated with a reduction in less-urgent ED visits (IRR: 1.02, 95% CI: 0.87, 1.21). Instead, reductions were found in very-urgent and urgent ED visits in Ontario relative to the control provinces. When stratified by timing, the reduction in urgent ED visits was not found to be statistically significant during regular- or after-hours; however, the reduction in very-urgent ED visits was statistically significant during both, with a slightly larger reduction in visits during regular-hours compared to during after-hours (Table 4.8).

4.3.2.1 Sensitivity Analyses

The increase in the after-hours premium was not associated with a reduction in less-urgent ED visits for FPSCs during either regular- or after-hours (Table 4.9). When the inclusion criterion was modified to respondents living within 5 km road distance to the

nearest ED, similar results were found for very-urgent and less-urgent ED visits; however, the increase in the after-hours premium was no longer associated with urgent ED visits. Conversely, when the inclusion criteria included respondents within 20 km road distance to the nearest ED, the increase in the premium was associated with a significant reduction in urgent ED visits during any timing and during after-hours in addition to the reduction in very-urgent ED visits.

Sensitivity analyses were conducted using each province as a control group. For each separate analysis, the increase in Ontario's after-hours premium was not associated with a reduction in less-urgent ED visits and was even associated with a 67% increase in less-urgent ED visits (95% CI: 1%, 177%) per year compared to PEI. Relative to PEI, there was also an increase in total ED visits, as well as both very-urgent and urgent ED visits over the same period. However, relative to Alberta and Nova Scotia, there was a reduction in very-urgent ED visits over the study period by 32% (95% CI: 8%, 50%) and 65% (95% CI: 36%, 81%), respectively. While there was no difference in urgent ED visits compared to Alberta and PEI, there was a reduction in urgent ED visits compared to BC over the same period by 41% (95% CI: 5%, 64%).

4.3.2.2 Subgroup Analyses

The increase in Ontario's after-hours premium was not associated with a reduction in less-urgent ED visits for any of the subgroups (Table 4.9). Reductions in very-urgent ED visits were found in Ontario relative to control provinces for respondents with a physician as a regular source of care and respondents with at least one chronic condition, while reductions in urgent ED visits were found for respondents with a regular source of care and respondents with full-time employment. Between males and females, similar effects were observed; however, there was a reduction in very-urgent ED visits in Ontario relative to control provinces only among males with no significant difference among females. No reductions were found for either urgent or less-urgent ED visits for both males and females. Finally, a reduction in very-urgent ED visits in Ontario relative to

control provinces was found only for respondents in the lowest income quintile, with no significant difference found for respondents in the highest income quintile.

4.4 Discussion

The increase in Ontario's after-hours premium from 20% to 30% was associated with a reduction in less-urgent ED visits within Ontario and when stratified by timing, the reduction was found only during after-hours. However, when compared to the four control provinces, the association between the increase in the premium and less-urgent ED visits disappeared. This lack of association persisted even when comparing separately to each of the four control provinces, examining subgroups expected to benefit most from the premium, stratifying by timing, and examining conditions most likely to be treatable in the primary care setting. Despite not finding a reduction in less-urgent ED visits in Ontario relative to any of the four control provinces, there was some reduction in very-urgent and urgent ED visits relative to control provinces.

Previous evidence examining the relationship between access to primary care during after-hours and ED use is mixed; however, one study found incentives to extend primary care practice hours resulted in a reduction of inappropriate ED visits by 10-15%.[51,52] Similarly, another study examining Ontario's after-hours premium found that increases in its value from 10% to 20% were associated with more patients receiving care from their primary care physicians and making fewer less-urgent ED visits.[23] While the evidence is consistent with these results, w examining the changes to Ontario's after-hours premium, the largest reduction in less-urgent ED visits was found for the introduction of Ontario's after-hours premium.[13] Subsequent increases in the value of the premium were marginally associated with further reduction in less-urgent ED visits and therefore it is also possible that the increase in the premium from 20% to 30% may simply not lead to a further reduction in less-urgent ED visits. Combined with results from this study, it suggests that the increase in the premium from 20% to 30% was unlikely to be causally associated with a reduction in less-urgent ED visits.

Compared to other provinces, Ontario has introduced some of the most expansive policy reforms to improve access to primary care outside the regular working-hours. In addition to the after-hours premium, Ontario implemented a mandatory minimum number of hours to open practice outside the regular working-hours by physicians and a telephone health advisory service staffed by nurses and nurse practitioners.[14] However, despite these reforms, many Ontario residents continue to lack access to primary care during after-hours.[22] Evaluation of the effectiveness of these reforms has been mixed and although one study finding enrolment in a PEM was associated with an increase in ED visits,[53] two others found the after-hours premium was associated with a reduction in less-urgent ED visits before the premium was increased to 30%.[13,23] Despite finding a reduction in less-urgent ED visits in Ontario, this association disappears when compared to four control provinces. Attempts to bolster access to after-hours primary care have been demonstrated with the increase in the value of the premium in 2011 and the 2013 Enhanced After-Hours Requirement, which increased the minimum number of service blocks for larger groups. Yet despite this, adults in Ontario continue to report poor access to care, with one survey in 2016 finding only 40% of adults found it easy to receive primary care services during after-hours without going to the ED.[22] The increase in the after-hours premium then may not have been causally linked to a reduction in less-urgent ED visits as it was not associated with improvements in after-hours access to primary care.

Perhaps one possible explanation for the lack of an association is that two aspects of Ontario primary care reform may be driving less-urgent ED visits in opposite directions: the after-hours premium promotes access leading to a reduction in less-urgent ED visits, while enrolment in a capitated PEM is associated with greater use of the ED. Despite being incentivized to improve access to after-hours primary care through the after-hours premium, some PEM physicians may be motivated to refer patients to the ED. Physicians in the blended capitation models receive the access bonus, an incentive intended to improve access to in-basket services for enrolled patients, but this may instead encourage ED visits.[14,54] Physicians are eligible to receive the access bonus for all rostered patients, with the value clawed back on services provided by primary care physicians outside the physician group. Physicians are not penalized for patient ED use, so while it may limit outside use of primary care physicians, the access bonus may also drive physicians to

refer their patients to the ED to maximize their bonus, potentially leading to an increase in ED visits. In addition to the change in the after-hours premium, many physicians transitioned from the traditional FFS model to a PEM during the study period and it is possible that these transitions masked any association between the after-hours premium and less-urgent ED visits.[55]

Despite not finding a reduction in less-urgent ED visits under the DID framework, a reduction was somewhat consistently found in very-urgent ED visits relative to the four control provinces. Differences by provinces in upcoding, the practice of coding a condition as more severe than warranted, may be a concern, that the reduction in less-urgent ED visits may have been masked by concurrent increases in very-urgent ED visits.[56] However, while upcoding may be partially responsible for the reduction in less-urgent ED visits seen for both Ontario and the control provinces, it is unlikely that the effect was masked by differences in practices between Ontario and the control provinces given the similar lack of statistically significant findings on less-urgent ED visits for FPSCs. Additional subgroup analyses focused on populations most likely to benefit from improvements in access to after-hours primary care, including respondents with a physician as a regular source of care, with full-time employment, or with a chronic condition, found slightly larger reduction in Ontario, but similarly, no associations when compared to other provinces. Similarly, these subgroup results point to the absence of a truly causal association between the increase in the after-hours premium from 20% to 30% and less-urgent ED visits.

4.4.1 Limitations

Several survey cycles were linked with NACRS data to form a pooled cross-sectional study design and thus, this study is subject to the limitations of cross-sectional research designs. First, due to the cross-sectional nature of the study design, important time-varying confounders could not be controlled for in analyses. Secondly, as the CCHS is based on survey response, it is subject to response bias and several variables may be subject to response bias, including non-response bias due to differences between non-

respondents and respondents of sensitive characteristics such as household income. This study is also subject to additional biases due to linking of data. NACRS coverage is incomplete for several control provinces and three provinces were excluded from analysis due to little to no reporting to NACRS. Due to limited coverage, ED visit rates may be underestimated in three of the four control provinces, upwardly biasing the effects in Ontario relative to control provinces. Sensitivity analyses demonstrated that the effects were somewhat sensitive to the road distance inclusion criteria which may be due to bias related to NACRS coverage.

The CCHS does not collect information on physician characteristics. As the after-hours premium is only available for physicians in PEMs, the effect of the premium may be biased as not all respondents within Ontario had a physician eligible to bill the after-hours premium. Similarly, NACRS only captures ED visits and does not capture information related to how patients access the ED, such as whether they were referred by their primary care physician. Finally, while this study period was chosen to compare ED visits before and after the increase in the after-hours premium across several provinces, this study was unable to completely isolate the effect of the increase in the premium from other for changes in Ontario, such as the increase in the number of physicians switching to PEMs over the study period. Although provinces with changes to their after-hours premium over the same study period were excluded, other policies may have been enacted that affected ED visits and led to differences in trends that were not controlled for in this analysis. As exploratory analyses, separate analyses between Ontario and each of the four control provinces corroborate that the increase in the premium was not associated with less-urgent ED visits. It is unlikely that each of the four provinces adopted policies that masked an effect of the after-hours premium in Ontario.

4.4.2 Future Directions

While this study is one of the first to use CCHS data linked with health administrative data, and these linked datasets can be powerful, especially for future research, it demonstrates the need for caution when using these linked datasets. Issues of coverage in

NACRS limit the analysis of this study and the coverage and quality across study groups should be considered within other health administrative databases prior to their use, otherwise unaccounted selection bias and bias due to missing data may limit generalizability and validity of results.

Given the reduction in very-urgent ED visits in Ontario relative to other provinces, future research should investigate whether Ontario primary care or emergency care policies may be driving a difference in very-urgent ED visits compared to other provinces. Additionally, while the increase in the value of Ontario's after-hours premium was not found to be associated with a reduction in less-urgent ED visits, further research in after-hours premiums is still warranted. Other provinces developed after-hours incentives that incentivized different services, for example, Manitoba incentivized emergency conditions, while Alberta incentivized primary care within hospitals and urgent care centres. Future research should be conducted to evaluate the effectiveness of after-hours premiums in each province on both access to primary care and its impact on ED utilization. Research exploring the cost-effectiveness of various premiums should be evaluated and may prove invaluable to policymakers looking to adopt an after-hours premium to distinguish the benefits of different models of incentives.

4.5 Conclusion

Despite a reduction in less-urgent ED visits in Ontario over the last decade, the increase in the after-hours premium from 20% to 30% does not appear to be responsible for a further reduction in ED visits when compared to four control provinces. Although the increased value of the after-hours premium may have been valuable in other respects, such as improving access to primary care during after-hours and/or addressing unmet primary care, benefits in the ED setting were not found. While the introduction of the premium was associated with a reduction in less-urgent ED visits in the previous study, further reduction in less-urgent ED visits were not apparent with an increase in the premium. Evaluation of the after-hours premiums should also be examined from the

perspective of physicians and the health care system prior to change, otherwise, unintended consequences may lead to system inefficiencies.

Table 4.1 Weighted descriptive characteristics and outcomes for the national sample by survey cycle

CCHS Cycle	2010	2011	2012	2013	2014	2015	2016
Population Size, *N*	8,129	10,851	12,805	13,348	13,717	13,837	14,282
Province, *n* (%)							
Alberta	2,010 (24.7%)	2,389 (22.0%)	2,511 (19.6%)	2,510 (18.8%)	2,713 (19.8%)	2,672 (19.3%)	2,668 (18.7%)
British Columbia	0 (0.0%)	977 (9.0%)	2,200 (17.2%)	2,690 (20.1%)	2,680 (19.5%)	2,748 (19.9%)	2,803 (19.6%)
Nova Scotia	152 (1.9%)	355 (3.3%)	370 (2.9%)	377 (2.8%)	349 (2.6%)	370 (2.7%)	374 (2.6%)
Ontario	5,953 (73.2%)	7,116 (65.6%)	7,712 (60.2%)	7,753 (58.1%)	7,920 (57.7%)	7,994 (57.8%)	8,384 (58.7%)
Prince Edward Island	14 (0.2%)	14 (0.1%)	12 (0.1%)	19 (0.1%)	54 (0.3%)	53 (0.4%)	53 (0.4%)
Age, mean (SE)	43.16 (0.19)	42.98 (0.14)	43.52 (0.13)	43.40 (0.11)	44.10 (0.12)	44.23 (0.13)	44.21 (0.12)
Sex, *n* (%)							
Male	4,112 (50.6%)	5,295 (48.8%)	6,293 (49.1%)	6,483 (48.6%)	6,774 (49.4%)	6,772 (48.9%)	7,006 (49.1%)
Female	4,018 (49.4%)	5,556 (51.2%)	6,512 (50.9%)	6,865 (51.4%)	6,943 (50.6%)	7,066 (51.1%)	7,276 (50.9%)
Marital Status, *n* (%)							
Single	2,410 (29.6%)	3,495 (32.2%)	4,168 (32.5%)	4,353 (32.6)	4,407 (32.1%)	4,349 (31.4%)	4,651 (32.6%)
Married or Common-Law	4,675 (57.5%)	6,043 (55.7%)	7,070 (55.2%)	7,319 (54.8%)	7,640 (55.7%)	7,703 (55.7%)	7,957 (55.7%)
Separated, Divorced, or Widowed	1,044 (12.8%)	1,313 (12.1%)	1,567 (12.2%)	1,676 (12.6%)	1,669 (12.2%)	1,785 (12.9%)	1,675 (11.7%)
Household Size, mean (SE)	2.93 (0.03)	2.93 (0.02)	2.98 (0.02)	2.95 (0.02)	3.03 (0.02)	2.95 (0.02)	2.98 (0.02)
Minors in Household, *n* (%)	3,214 (39.5%)	3,942 (36.3%)	4,678 (36.5%)	4,929 (36.9%)	5,078 (37.0%)	4,981 (36.0%)	5,297 (37.1%)
Immigrant Status, *n* (%)							

Non-immigrant	5,766 (70.9%)	7,257 (66.9%)	8,420 (65.8%)	8,838 (66.2%)	8,910 (65.0%)	8,775 (63.4%)	8,904 (62.3%)
Short-term immigrant (< 5 years)	346 (4.3%)	545 (5.0%)	561 (4.4%)	620 (4.7%)	613 (4.5%)	494 (3.6%)	572 (4.0%)
Long-term immigrant (≥ 5 years)	2,017 (24.8%)	3,048 (28.1%)	3,824 (29.9%)	3,890 (29.1%)	4,193 (30.6%)	4,568 (33.0%)	4,806 (33.7%)
Education, *n* (%)							
Less than secondary school	1,409 (17.3%)	1,888 (17.4%)	2,241 (17.5%)	2,298 (17.2%)	2,215 (16.2%)	2,103 (15.2%)	2,218 (15.5%)
Secondary school graduation	1,297 (15.9%)	1,773 (16.3%)	2,257 (17.6%)	2,751 (20.6%)	2,745 (20.0%)	2,926 (21.1%)	3,381 (23.7%)
Post-secondary graduation	5,424 (66.7%)	7,190 (66.3%)	8,308 (64.9%)	8,298 (62.2%)	8,756 (63.8%)	8,808 (63.7%)	8,684 (60.8%)
Household Income Quintile, *n* (%)							
Q1	1,765 (21.7%)	2,200 (20.3%)	2,659 (20.8%)	2,732 (20.5%)	2,848 (20.8%)	2,917 (21.1%)	3,150 (22.1%)
Q2	1,541 (19.0%)	2,199 (20.3%)	2,605 (20.3%)	2,750 (20.6%)	2,705 (19.7%)	2,765 (20.0%)	2,955 (20.7%)
Q3	1,543 (19.0%)	2,158 (19.9%)	2,460 (19.2%)	2,658 (19.9%)	2,767 (20.2%)	2,802 (20.3%)	2,823 (19.8%)
Q4	1,557 (19.2%)	2,054 (18.9%)	2,550 (19.9%)	2,605 (19.5%)	2,716 (19.8%)	2,639 (19.1%)	2,723 (19.1%)
Q5	1,723 (21.2%)	2,240 (20.6%)	2,532 (19.8%)	2,604 (19.5%)	2,681 (19.5%)	2,713 (19.6%)	2,631 (18.4%)
Has Physician as Regular Source of Care, *n* (%)	7,079 (87.1%)	9,403 (86.7%)	11,255 (87.9%)	11,613 (87.0%)	12,070 (88.0%)	11,815 (85.4%)	12,276 (86.0%)
Chronic Conditions, *n* (%)							
Alzheimer's Disease and related dementias	32 (0.4%)	55 (0.5%)	74 (0.6%)	51 (0.4%)	53 (0.4%)	71 (0.5%)	95 (0.7%)
Arthritis	1,362 (16.8%)	1,702 (15.7%)	1,896 (14.8%)	2,118 (15.9%)	2,212 (16.1%)	2,646 (19.1%)	2,649 (18.5%)
Asthma	734	953	993	1,068	1,059	1,242	1,151

	(9.0%)	(8.8%)	(7.8%)	(8.0%)	(7.7%)	(9.0%)	(8.1%)
Cancer	138 (1.7%)	239 (2.2%)	275 (2.2%)	243 (1.8%)	248 (1.8%)	209 (1.5%)	203 (1.4%)
COPD	206 (2.5%)	243 (2.2%)	298 (2.3%)	353 (2.6%)	324 (2.4%)	380 (2.8%)	323 (2.3%)
Diabetes	529 (6.5%)	630 (5.8%)	819 (6.4%)	854 (6.4%)	937 (6.8%)	908 (6.6%)	982 (6.9%)
Heart Disease	381 (4.7%)	524 (4.8%)	521 (4.1%)	546 (4.1%)	587 (4.3%)	574 (4.2%)	575 (4.0%)
Mental Disorder	797 (9.78%)	1,260 (11.6%)	1,462 (11.4%)	1,659 (12.4%)	1,685 (12.3%)	1,793 (13.0%)	1,906 (13.3%)
Stroke	187 (2.3%)	260 (2.4%)	269 (2.1%)	280 (2.1%)	302 (2.2%)	291 (2.1%)	286 (2.0%)
Number of Chronic Conditions, *n* (%)							
0	5,235 (64.4%)	7,029 (64.8%)	8,409 (65.7%)	8,607 (64.5%)	8,734 (63.7%)	8,530 (61.6%)	8,846 (61.9%)
1	1,968 (24.2%)	2,565 (23.6%)	2,964 (23.1%)	3,210 (24.0%)	3,418 (24.9%)	3,562 (25.7%)	3,708 (26.0%)
2+	926 (11.5%)	1,257 (11.6%)	1,431 (11.2%)	1,532 (11.5%)	1,565 (11.4%)	1,746 (12.6%)	1,728 (12.1%)
ED visits per 1,000 patients per year, mean (SE)							
Total	362.7 (12.9)	383.7 (16.1)	359.6 (13.1)	369.7 (14.3)	376.7 (12.7)	379.0 (13.8)	364.1 (13.0)
Regular-Hours	136.0 (6.2)	151.8 (6.9)	130.4 (7.0)	142.1 (6.1)	144.0 (6.0)	143.3 (6.7)	131.5 (5.5)
After-Hours	226.6 (9.6)	231.9 (12.3)	229.2 (8.3)	227.7 (10.0)	232.8 (9.0)	235.7 (9.6)	232.5 (10.0)
Very-Urgent	55.4 (5.0)	49.6 (3.5)	60.3 (4.3)	67.0 (4.0)	68.5 (4.3)	72.4 (4.1)	71.1 (4.5)
Regular-Hours	19.7 (2.9)	19.4 (2.0)	20.0 (2.2)	22.4 (2.4)	21.8 (1.9)	25.8 (2.4)	25.7 (2.5)
After-Hours	35.7	30.2	40.2	44.7	46.7	46.5	45.4

	(3.3)	(2.6)	(3.1)	(3.0)	(3.4)	(2.8)	(3.4)
Urgent	154.9 (7.6)	152.8 (7.1)	156.2 (7.3)	154.0 (7.9)	169.9 (7.4)	172.8 (8.4)	168.8 (6.4)
Regular-Hours	58.5 (3.5)	60.5 (4.0)	55.5 (4.3)	55.4 (2.8)	65.8 (4.1)	63.8 (4.0)	58.9 (2.8)
After-Hours	96.4 (6.3)	92.2 (5.1)	100.7 (4.9)	98.7 (6.7)	104.0 (5.2)	109.0 (6.0)	109.9 (5.2)
Less-Urgent	152.4 (7.1)	181.4 (10.4)	143.1 (6.2)	148.7 (7.0)	138.4 (6.3)	133.9 (6.1)	124.1 (7.3)
Regular-Hours	57.8 (3.5)	71.9 (4.3)	54.9 (3.4)	64.3 (3.9)	56.3 (3.3)	53.7 (3.2)	46.9 (3.3)
After-Hours	94.6 (5.5)	109.5 (8.0)	88.2 (4.2)	84.3 (4.4)	82.1 (4.7)	80.2 (4.3)	77.2 (5.9)
Less-Urgent for FPSCs[a]	44.8 (3.9)	51.6 (5.0)	38.4 (2.9)	46.2 (4.5)	38.3 (3.4)	34.5 (2.9)	37.2 (5.7)
Regular-Hours	16.6 (1.7)	20.0 (2.1)	15.5 (1.8)	19.7 (2.2)	17.1 (1.7)	15.2 (1.9)	12.6 (1.7)
After-Hours	28.2 (3.2)	31.6 (3.7)	22.9 (1.9)	26.4 (3.1)	21.2 (2.9)	19.4 (2.0)	24.6 (5.0)

COPD: Chronic Obstructive Pulmonary Disease; ED: emergency department; FPSC: Family Practice-Sensitive Condition; SE: standard error
ED visits were measured over the fiscal year, from April of the survey year to March of the following year
Continuous variables reported as mean (standard error), counts reported as frequency (proportion); survey weights and clustered bootstrap standard errors were applied for all descriptive analyses and counts were rounded to the nearest 1,000 and all counts divided by 1,000 for readability
[a]Less-urgent ED visits for FPSCs are reported only for Alberta, Ontario, and Prince Edward Island, due to high levels of missingness in International Classification of Disease, 10th Revision codes for British Columbia and Nova Scotia

Table 4.2 Weighted descriptive characteristics and outcomes for the Ontario sample by survey cycle

CCHS Cycle	2010	2011	2012	2013	2014	2015	2016
Population Size, *n*	5,953	7,116	7,712	7,753	7,920	7,994	8,384
Age, mean (SE)	43.90 (0.33)	43.49 (0.36)	43.83 (0.34)	43.51 (0.30)	44.57 (0.35)	44.62 (0.37)	44.55 (0.34)
Sex, *n* (%)							
Male	2,995 (50.3%)	3,416 (48.0%)	3,833 (48.4%)	3,709 (47.8%)	3,859 (48.7%)	3,838 (48.0%)	4,054 (48.3%)
Female	2,958 (49.7%)	3,700 (52.0%)	3,978 (51.6%)	4,045 (52.2%)	4,061 (51.3%)	4,156 (52.0%)	4,331 (51.7%)
Marital Status, *n* (%)							
Single	1,720 (28.9%)	2,274 (32.0%)	2,504 (32.5%)	2,633 (34.0%)	2,595 (32.8%)	2,618 (32.8%)	2,822 (33.7%)
Married or Common-Law	3,483 (58.5%)	3,967 (55.7%)	4,259 (55.2%)	4,139 (53.4%)	4,337 (54.8%)	4,257 (53.3%)	4,601 (54.9%)
Separated, Divorced, or Widowed	750 (12.6%)	875 (12.3%)	949 (12.3%)	981 (12.6%)	988 (12.5%)	1,119 (14.0%)	961 (11.5%)
Household Size, mean (SE)	2.93 (0.03)	3.02 (0.03)	3.04 (0.03)	3.00 (0.03)	3.11 (0.04)	2.98 (0.03)	3.03 (0.04)
Presence of Minors in Household, *n* (%)	2,389 (40.1%)	2,691 (37.8%)	2,877 (37.3%)	2,888 (37.3%)	2,970 (37.5%)	2,857 (35.7%)	3,135 (37.4%)
Immigrant Status, *n* (%)							
Non-immigrant	4,069 (68.3%)	4,571 (64.2%)	4,970 (63.2%)	4,935 (63.7%)	4,935 (62.3%)	4,805 (60.1%)	4,955 (59.1%)
Short-term immigrant (< 5 years)	208 (3.5%)	353 (5.0%)	342 (4.4%)	351 (4.5%)	342 (4.3%)	268 (3.4%)	300 (3.6%)
Long-term immigrant (≥ 5 years)	1,676 (28.2%)	2,192 (30.8%)	2,500 (32.4%)	2,467 (31.8%)	2,643 (33.4%)	2,920 (36.5%)	3,129 (37.3%)
Education, *n* (%)							
Less than secondary school	1,023 (17.2%)	1,290 (18.1%)	1,430 (18.5%)	1,395 (18.0%)	1,315 (16.6%)	1,304 (16.3%)	1,344 (16.0%)
Secondary school graduation	945 (15.9%)	1,126 (15.8%)	1,351 (17.5%)	1,561 (20.1%)	1,527 (19.3%)	1,671 (20.9%)	1,962 (23.4%)

Post-secondary graduation	3,985 (66.9%)	4,700 (66.0%)	4,931 (63.9%)	4,798 (61.9%)	5,078 (64.1%)	5,020 (62.8%)	5,078 (60.6%)
Household Income Quintile, *n* (%)							
Q1	1,363 (22.9%)	1,492 (21.0%)	1,683 (21.8%)	1,665 (21.5%)	1,671 (21.1%)	1,750 (21.9%)	1,993 (23.8%)
Q2	1,176 (19.8%)	1,477 (20.8%)	1,606 (20.8%)	1,687 (21.8%)	1,623 (20.5%)	1,696 (21.2%)	1,742 (20.8%)
Q3	1,189 (20.0%)	1,487 (20.9%)	1,554 (20.2%)	1,512 (19.5%)	1,610 (20.3%)	1,533 (19.2%)	1,630 (19.4%)
Q4	1,127 (18.9%)	1,337 (18.8%)	1,535 (19.9%)	1,516 (19.5%)	1,526 (19.3%)	1,613 (20.2%)	1,584 (18.9%)
Q5	1,098 (18.4%)	1,322 (18.6%)	1,333 (17.3%)	1,374 (17.7%)	1,490 (18.8%)	1,402 (17.5%)	1,436 (17.1%)
Has Physician as Regular Source of Care, *n* (%)	5,358 (90.0%)	6,338 (89.1%)	7,011 (90.9%)	7,020 (90.5%)	7,300 (92.2%)	7,062 (88.4%)	7,418 (88.5%)
Chronic Conditions, *n* (%)							
Alzheimer's Disease and related dementias	27 (0.5%)	46 (0.6%)	54 (0.7%)	23 (0.3%)	28 (0.4%)	45 (0.6%)	63 (0.7%)
Arthritis	1,043 (17.5%)	1,194 (16.8%)	1,151 (14.9%)	1,282 (16.5%)	1,333 (16.8%)	1,638 (20.5%)	1,643 (19.6%)
Asthma	529 (8.9%)	627 (8.8%)	598 (7.8%)	597 (7.7%)	617 (7.8%)	712 (8.9%)	666 (7.9%)
Cancer	109 (1.8%)	166 (2.3%)	171 (2.2%)	166 (2.1%)	130 (1.7%)	118 (1.5%)	107 (1.3%)
COPD	165 (2.8%)	170 (2.4%)	189 (2.5%)	218 (2.8%)	182 (2.3%)	241 (3.0%)	207 (2.5%)
Diabetes	412 (6.9%)	436 (6.1%)	497 (6.4%)	535 (6.9%)	597 (7.5%)	567 (7.1%)	630 (7.5%)
Heart Disease	300 (5.0%)	380 (5.4%)	354 (4.6%)	323 (4.2%)	363 (4.6%)	370 (4.6%)	358 (4.3%)
Mental Disorder	578 (9.7%)	838 (11.8%)	866 (11.2%)	972 (12.5%)	957 (12.1%)	1,065 (13.3%)	1,062 (12.7%)

Stroke	143 (2.4%)	192 (2.7%)	177 (2.3%)	163 (2.1%)	182 (2.3%)	184 (2.3%)	184 (2.2%)
Number of Chronic Conditions, *n* (%)							
0	3,772 (63.4%)	4,544 (63.9%)	5,062 (65.6%)	4,939 (63.7%)	4,996 (63.1%)	4,844 (60.6%)	5,181 (61.8%)
1	1,479 (24.8%)	1,683 (23.7%)	1,751 (22.7%)	1,883 (24.3%)	1,973 (24.9%)	2,064 (25.8%)	2,138 (25.5%)
2+	702 (11.8%)	889 (12.5%)	899 (11.7%)	931 (12.0%)	950 (12.0%)	1,086 (13.6%)	1,065 (12.7%)
ED visits per 1,000 patients per year, mean (SE)							
Total	352.3 (15.5)	394.2 (23.4)	360.4 (15.1)	379.1 (16.5)	380.8 (17.8)	386.1 (18.3)	363.1 (17.0)
Regular-Hours	134.2 (7.2)	152.7 (8.9)	131.4 (8.3)	148.9 (7.8)	144.5 (8.3)	149.4 (10.3)	128.3 (7.0)
After-Hours	218.1 (11.7)	241.6 (17.9)	229.1 (10.2)	230.2 (11.2)	236.3 (12.9)	236.7 (11.2)	234.9 (13.0)
Very-Urgent	63.9 (6.3)	60.7 (5.1)	67.7 (6.1)	81.9 (6.1)	80.1 (6.4)	80.0 (6.4)	77.6 (6.9)
Regular-Hours	22.7 (3.8)	25.0 (2.9)	23.6 (3.2)	28.5 (3.7)	25.7 (2.7)	29.1 (3.8)	28.5 (3.7)
After-Hours	41.2 (4.2)	35.7 (3.7)	44.1 (4.3)	53.3 (4.3)	54.4 (5.3)	50.9 (3.9)	49.1 (5.3)
Urgent	163.2 (9.9)	169.8 (9.6)	163.6 (8.9)	167.1 (8.9)	181.4 (10.9)	184.4 (11.5)	176.5 (9.3)
Regular-Hours	63.4 (4.4)	65.3 (5.1)	55.7 (4.7)	61.9 (3.9)	72.2 (5.9)	70.8 (6.2)	61.0 (3.8)
After-Hours	99.8 (8.1)	104.5 (7.1)	107.9 (6.7)	105.2 (7.4)	109.3 (7.9)	113.8 (7.6)	115.4 (7.7)
Less-Urgent	125.2 (6.8)	163.7 (14.3)	129.2 (6.9)	130.1 (7.4)	119.3 (7.6)	121.7 (8.0)	109.1 (8.7)
Regular-Hours	48.1 (3.4)	62.4 (5.3)	52.1 (4.0)	58.5 (4.4)	46.7 (3.6)	49.5 (4.6)	38.7 (3.7)

After-Hours	77.1 (5.3)	101.3 (11.1)	77.1 (4.9)	71.7 (4.8)	72.6 (6.0)	72.1 (5.3)	70.4 (7.2)
Less-Urgent for FPSCs	32.1 (3.4)	40.3 (4.6)	30.5 (2.8)	32.2 (3.5)	32.0 (4.0)	27.8 (3.0)	31.0 (4.9)
Regular-Hours	11.4 (1.6)	15.5 (2.2)	12.5 (1.9)	13.9 (1.7)	11.6 (1.6)	12.9 (1.9)	10.6 (1.9)
After-Hours	20.7 (2.8)	24.8 (3.2)	18.0 (1.8)	18.3 (2.5)	20.4 (3.6)	14,9 (2.0)	20.4 (4.0)

COPD: Chronic Obstructive Pulmonary Disease; ED: emergency department; FPSC: Family Practice-Sensitive Condition; SE: standard error
Continuous variables reported as weighted mean (cluster bootstrap standard error), counts reported as weighted frequency (weighted proportion), with counts rounded to the nearest 1,000 and reported as per 1,000 population.

Table 4.3 Effect of the increase in the after-hours premium on ED visits in Ontario (*N* = 60,900)

	Total ED visits IRR (95% CI)	Very-Urgent ED visits IRR (95% CI)	Urgent ED visits IRR (95% CI)	Less-Urgent ED visits IRR (95% CI)
Premium	1.00 (0.93, 1.08)	1.24*** (1.07, 1.43)	1.05 (0.95, 1.15)	0.85*** (0.76, 0.94)
Age Spline				
12-18	1.14*** (1.09, 1.19)	1.10** (1.01, 1.21)	1.17*** (1.10, 1.24)	1.13*** (1.07, 1.19)
19-65	0.87*** (0.83, 0.91)	0.91* (0.83, 1.00)	0.84*** (0.80, 0.89)	0.87*** (0.83, 0.92)
66+	1.04*** (1.03, 1.05)	1.02*** (1.01, 1.04)	1.05*** (1.04, 1.06)	1.02*** (1.01, 1.04)
Female	1.05 (0.97, 1.13)	0.90 (0.78, 1.03)	1.10* (0.99, 1.20)	1.09* (0.99, 1.21)
Marital Status (reference: single)				
Married or Common-Law	1.03 (0.91, 1.17)	0.93 (0.74, 1.17)	1.08 (0.94, 1.25)	1.03 (0.88, 1.22)
Separated, Divorced, or Widowed	1.03 (0.89, 1.19)	0.93 (0.70, 1.23)	1.09 (0.92, 1.29)	1.00 (0.83, 1.20)
Living with Minors	1.03 (0.91, 1.16)	1.06 (0.83, 1.34)	1.07 (0.92, 1.24)	0.99 (0.85, 1.15)
Household Size	0.98 (0.94, 1.02)	1.01 (0.95, 1.08)	0.93*** (0.89, 0.98)	1.00 (0.94, 1.06)
Immigrant Status (reference: non-immigrant)				
Short-Term Immigrant	0.58*** (0.45, 0.75)	0.47*** (0.27, 0.82)	0.70** (0.51, 0.97)	0.45*** (0.30, 0.68)
Long-Term Immigrant	0.78*** (0.71, 0.85)	1.00 (0.86, 1.17)	0.83*** (0.75, 0.92)	0.58*** (0.51, 0.66)
Education (reference: less than secondary school graduation)				
Secondary school graduation	0.75*** (0.66, 0.85)	0.73*** (0.58, 0.91)	0.79*** (0.69, 0.91)	0.72*** (0.61, 0.85)
Post-secondary education	0.68*** (0.61, 0.77)	0.66*** (0.53, 0.82)	0.75*** (0.66, 0.85)	0.65*** (0.56, 0.76)
Household Income Quintile (reference: income quintile 1, lowest income quintile)				
2	0.81*** (0.74, 0.90)	0.73*** (0.58, 0.91)	0.79*** (0.71, 0.89)	0.83** (0.72, 0.96)
3	0.79*** (0.71, 0.88)	0.66** (0.53, 0.82)	0.69*** (0.60, 0.79)	0.93 (0.81, 1.08)
4	0.71*** (0.65, 0.79)	0.69*** (0.56, 0.84)	0.60*** (0.52, 0.68)	0.87 (0.75, 0.99)
5	0.64*** (0.56, 0.72)	0.73** (0.57, 0.95)	0.52*** (0.45, 0.60)	0.71*** (0.61, 0.84)
Regular Source of Care	1.15** (1.02, 1.30)	1.34** (1.06, 1.69)	1.25*** (1.07, 1.47)	0.99 (0.83, 1.18)
Number of Chronic Conditions (reference: no chronic conditions)				

1	1.61*** (1.47, 1.75)	1.92*** (1.63, 2.26)	1.64*** (1.48, 1.82)	1.43*** (1.28, 1.60)
2+	2.59*** (2.32, 2.89)	3.49*** (2.88, 4.21)	2.75*** (2.40, 3.15)	1.96*** (1.68, 2.29)
Distance to the nearest ED (km)	0.95*** (0.93, 0.96)	1.03*** (1.00, 1.05)	0.96*** (0.94, 0.98)	0.89*** (0.87, 0.91)

*P < 0.10, **P <0.05, *** P < 0.01
CI: Confidence Interval; ED: Emergency Department; IRR: Incidence Rate Ratio
Survey weights and clustered bootstrap standard errors were applied to all analyses.

Table 4.4 Effect of the increase in the after-hours premium on ED visits in Ontario by timing (*N* = 60,900)

	Total ED visits IRR (95% CI)	Very-Urgent ED visits IRR (95% CI)	Urgent ED visits IRR (95% CI)	Less-Urgent ED visits IRR (95% CI)
Regular-Hours	0.96 (0.88, 1.06)	1.11 (0.88, 1.39)	0.98 (0.86, 1.11)	0.89 (0.78, 1.02)
After-Hours	1.02 (0.93, 1.12)	1.31*** (1.12, 1.54)	1.09 (0.96, 1.22)	0.82*** (0.71, 0.93)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; ED: Emergency Department; IRR: Incidence Rate Ratio

Analyses conducted using survey weights and cluster bootstrap standard errors; analyses adjusted for respondent characteristics: age spline, sex, marital status, presence of minors living in household, household size, immigrant status, educational attainment, household income quintile, physician as a regular source of care, number of chronic conditions, and road distance to the nearest ED.

Regular-hours refers to 8:00 AM – 5:00 PM on weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any timing on weekends and Ontario statutory holidays.

Table 4.5 Sensitivity and subgroup analyses for the effect of the increase in the after-hours premium in Ontario

	Any Timing IRR (95% CI)	Regular-Hours IRR (95% CI)	After-Hours IRR (95% CI)
Sensitivity Analysis: Less-Urgent ED visits for FPSCs (*N* = 60,900)			
Less-Urgent for FPSCs	0.95 (0.82, 1.11)	1.01 (0.82, 1.24)	0.92 (0.76, 1.11)
Sensitivity Analysis: Respondents within 5 km of nearest ED (*N* = 39,705)			
ED	1.02 (0.93, 1.13)	0.97 (0.86, 1.09)	1.06 (0.94, 1.19)
Very-Urgent	1.21** (1.01, 1.45)	1.06 (0.79, 1.42)	1.30*** (1.07, 1.58)
Urgent	1.09 (0.97, 1.23)	0.97 (0.83, 1.14)	1.17** (1.01, 1.36)
Less-Urgent	0.88** (0.77, 1.00)	0.94 (0.79, 1.11)	0.84** (0.72, 0.99)
Sensitivity Analysis: Respondents within 20 km of nearest ED (*N* = 71,815)			
ED	1.02 (0.94, 1.10)	0.99 (0.90, 1.08)	1.04 (0.95, 1.13)
Very-Urgent	1.33*** (1.16, 1.52)	1.18 (0.95, 1.46)	1.42*** (1.23, 1.64)
Urgent	1.03 (0.94, 1.13)	0.99 (0.88, 1.12)	1.06 (0.95, 1.18)
Less-Urgent	0.87*** (0.78, 0.96)	0.91 (0.80, 1.04)	0.84*** (0.74, 0.95)
Subgroup Analysis: Has physician as a regular source of care (*N* = 55,825)			
ED	0.99 (0.91, 1.07)	0.95 (0.86, 1.06)	1.01 (0.91, 1.11)
Very-Urgent	1.26*** (1.09, 1.47)	1.09 (0.86, 1.39)	1.36*** (1.16, 1.60)
Urgent	1.02 (0.92, 1.13)	0.96 (0.84, 1.10)	1.05 (0.93, 1.20)
Less-Urgent	0.84*** (0.75, 0.93)	0.90 (0.78, 1.03)	0.79*** (0.69, 0.91)
Subgroup Analysis: Has full-time employment (*N* = 24,415)			
ED	0.98 (0.88, 1.10)	0.90 (0.77, 1.05)	1.03 (0.91, 1.18)
Very-Urgent	1.31** (1.01, 1.69)	1.33 (0.63, 2.81)	1.27 (0.97, 1.68)
Urgent	1.07 (0.92, 1.24)	0.87 (0.70, 1.07)	1.21** (1.01, 1.45)
Less-Urgent	0.80*** (0.68, 0.94)	0.83 (0.67, 1.03)	0.79*** (0.66, 0.95)
Subgroup Analysis: Has at least one chronic condition (*N* = 28,115)			
ED	0.96 (0.85, 1.09)	0.99 (0.87, 1.12)	0.95 (0.82, 1.11)
Very-Urgent	1.14 (0.96, 1.36)	0.95 (0.75, 1.21)	1.28** (1.05, 1.58)
Urgent	1.00	1.08	0.96

	(0.86, 1.15)	(0.92, 1.27)	(0.80, 1.14)
Less-Urgent	0.84** (0.71, 0.98)	0.93 (0.78, 1.11)	0.77** (0.63, 0.94)
Subgroup Analysis: Male respondent (*N* = 27,100)			
ED	1.04 (0.94, 1.16)	0.97 (0.85, 1.11)	1.08 (0.95, 1.22)
Very-Urgent	1.26** (1.03, 1.53)	1.14 (0.86, 1.53)	1.30** (1.04, 1.64)
Urgent	1.06 (0.93, 1.22)	0.90 (0.74, 1.08)	1.15* (0.98, 1.35)
Less-Urgent	0.91 (0.77, 1.07)	0.99 (0.81, 1.21)	0.85 (0.70, 1.02)
Subgroup Analysis: Female respondent (*N* = 33,800)			
ED	0.96 (0.87, 1.07)	0.95 (0.83, 1.08)	0.98 (0.86, 1.11)
Very-Urgent	1.20* (0.98, 1.49)	1.09 (0.79, 1.51)	1.30** (1.03, 1.64)
Urgent	1.03 (0.91, 1.17)	1.04 (0.88, 1.23)	1.03 (0.88, 1.21)
Less-Urgent	0.80*** (0.70, 0.91)	0.81** (0.69, 0.96)	0.79*** (0.67, 0.94)
Subgroup Analysis: Respondent in Lowest Income Quintile (*N* = 12,760)			
ED	1.03 (0.89, 1.18)	1.04 (0.87, 1.25)	1.00 (0.85, 1.17)
Very-Urgent	1.12 (0.85, 1.47)	1.04 (0.67, 1.62)	1.18 (0.90, 1.54)
Urgent	1.08 (0.90, 1.29)	1.07 (0.85, 1.33)	1.06 (0.85, 1.32)
Less-Urgent	0.84* (0.69, 1.02)	0.96 (0.76, 1.21)	0.77** (0.60, 0.98)
Subgroup Analysis: Respondent in Highest Income Quintile (*N* = 10,740)			
ED	1.01 (0.85, 1.20)	0.96 (0.75, 1.23)	1.03 (0.85, 1.26)
Very-Urgent	1.28 (0.87, 1.86)	1.37 (0.67, 2.78)	1.20 (0.77, 1.86)
Urgent	1.01 (0.79, 1.29)	0.83 (0.58, 1.18)	1.15 (0.87, 1.52)
Less-Urgent	0.90 (0.70, 1.15)	0.98 (0.74, 1.29)	0.86 (0.63, 1.18)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; ED: Emergency Department; FPSC: Family Practice-Sensitive Condition; IRR: Incidence Rate Ratio

Analyses conducted using survey weights and cluster bootstrap standard errors; analyses adjusted for respondent characteristics: age spline, sex, marital status, presence of minors living in household, household size, immigrant status, educational attainment, household income quintile, physician as a regular source of care, number of chronic conditions, and road distance to the nearest ED.

Regular-hours refers to 8:00 AM – 5:00 PM on weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any timing on weekends and Ontario statutory holidays.

Table 4.6 Weighted descriptive characteristics and outcomes for the control sample by survey cycle

CCHS Cycle	2010	2011	2012	2013	2014	2015	2016
Population Size, *n*	2,176	3,735	5,093	5,595	5,797	5,844	5,898
Province, *n* (%)							
Alberta	2,010 (92.4%)	2,389 (64.0%)	2,511 (49.3%)	2,510 (44.9%)	2,713 (46.8%)	2,672 (45.7%)	2,668 (45.2%)
British Columbia	0 (0.0%)	977 (26.2%)	2,200 (43.2%)	2,690 (48.1%)	2,680 (46.2%)	2,748 (47.0%)	2,803 (47.5%)
Nova Scotia	152 (7.0%)	355 (9.5%)	370 (7.3%)	377 (6.7%)	349 (6.0%)	370 (6.3%)	374 (6.3%)
Prince Edward Island	14 (0.6%)	14 (0.4%)	12 (0.2%)	19 (0.3%)	54 (1.1%)	53 (0.9%)	53 (0.9%)
Age, mean (SE)	41.12 (0.44)	42.02 (0.39)	43.04 (0.37)	43.26 (0.34)	43.47 (0.33)	43.68 (0.30)	43.71 (0.29)
Sex, *n* (%)							
Male	1,116 (51.3%)	1,879 (50.3%)	2,560 (50.3%)	2,774 (49.6%)	2,916 (50.3%)	2,934 (50.2%)	2,953 (50.1%)
Female	1,059 (48.7%)	1,856 (49.7%)	2,533 (49.7%)	2,820 (50.4%)	2,881 (49.7%)	2,910 (49.8%)	2,945 (49.9%)
Marital Status, *n* (%)							
Single	689 (31.7%)	1,221 (32.7%)	1,664 (32.7%)	1,720 (30.7%)	1,813 (31.3%)	1,731 (29.6%)	1,829 (31.0%)
Married or Common-Law	1,192 (54.8%)	2,076 (55.6%)	2,811 (55.2%)	3,180 (56.8%)	3,303 (57.0%)	3,447 (59.0%)	3,355 (56.9%)
Separated, Divorced, or Widowed	295 (13.5%)	438 (11.7%)	618 (12.1%)	695 (12.4%)	681 (11.8%)	666 (11.4%)	713 (12.1%)
Household Size, mean (SE)	2.93 (0.05)	2.78 (003)	2.90 (0.04)	2.89 (0.03)	2.90 (0.03)	2.90 (0.03)	.91 (0.03)
Presence of Minors in Household, *n* (%)	824 (37.9%)	1,250 (33.5%)	1,801 (35.4%)	2,040 (36.5%)	2,108 (36.4%)	2,124 (36.3%)	2,161 (36.6%)
Immigrant Status, *n* (%)							
Non-immigrant	1,697 (78.0%)	2,686 (71.9%)	3,549 (69.7%)	3,902 (69.7%)	3,975 (68.6%)	3,970 (67.9%)	3,950 (67.0%)

Short-term immigrant (< 5 years)	138 (6.4%)	192 (5.2%)	219 (4.3%)	269 (4.8%)	271 (4.7%)	226 (3.9%)	271 (4.6%)
Long-term immigrant (≥ 5 years)	340 (15.6%)	856 (22.9%)	1325 (26.0%)	1,423 (25.4%)	1,551 (26.7%)	1,648 (28.2%)	1,677 (28.4%)
Education, *n* (%)							
Less than secondary school graduation	385 (17.7%)	598 (16.0%)	811 (15.9%)	904 (16.2%)	901 (15.5%)	800 (13.7%)	874 (13.7%)
Secondary school graduation	351 (16.2%)	647 (17.3%)	905 (17.8%)	1,191 (21.3%)	1,219 (21.0%)	1,256 (21.5%)	1,419 (24.1%)
Post-secondary graduation	1,439 (66.1%)	2,490 (66.7%)	3,377 (66.3%)	3,501 (62.6%)	3,678 (63.4%)	3,789 (64.8%)	3,606 (61.1%)
Household Income Quintile, *n* (%)							
Q1	512 (23.5%)	828 (22.2%)	1,139 (22.4%)	1,168 (20.9%)	1,236 (21.3%)	1,253 (21.4%)	1,310 (22.2%)
Q2	460 (21.1%)	800 (21.4%)	1,005 (19.7%)	1,172 (21.0%)	1,267 (21.8%)	1,179 (20.2%)	1,262 (21.4%)
Q3	411 (18.9%)	740 (19.8%)	1,003 (19.7%)	1,124 (20.1%)	1,163 (20.1%)	1,238 (21.2%)	1,208 (20.5%)
Q4	408 (18.7%)	691 (18.5%)	1,057 (20.7%)	1,091 (19.5%)	1,130 (19.5%)	1,127 (19.3%)	1,138 (19.3%)
Q5	385 (17.7%)	675 (18.1%)	890 (17.5%)	1,039 (18.6%)	1,001 (17.3%)	1,046 (17.9%)	980 (16.6%)
Has Regular Source of Care, *n* (%)	1,721 (79.1%)	3,065 (82.1%)	4,244 (83.3%)	4,593 (82.1%)	4,769 (82.3%)	4,752 (81.3%)	4,858 (82.4%)
Chronic Conditions, *n* (%)							
Alzheimer's Disease and related dementias	4 (0.2%)	9 (0.2%)	20 (0.4%)	28 (0.5%)	25 (0.4%)	27 (0.5%)	33 (0.6%)
Arthritis	319 (14.7%)	508 (13.6%)	745 (14.6%)	836 (14.9%)	879 (15.2%)	1,009 (17.3%)	1,006 (17.0%)
Asthma	204 (9.4%)	326 (8.7%)	395 (7.8%)	470 (0.8%)	442 (7.6%)	530 (9.1%)	485 (8.2%)
Cancer	29	73	103	77	117	91	95

	(1.3%)	(2.0%)	(2.0%)	(1.4%)	(2.0%)	(1.6%)	(1.6%)
COPD	40 (1.9%)	73 (2.0%)	110 (2.2%)	134 (2.4%)	142 (2.5%)	140 (2.4%)	116 (2.0%)
Diabetes	117 (5.4%)	193 (5.2%)	322 (6.3%)	319 (5.7%)	340 (5.9%)	341 (5.8%)	352 (6.0%)
Heart Disease	81 (3.7%)	143 (3.8%)	167 (3.3%)	223 (4.0%)	224 (3.9%)	205 (3.5%)	217 (3.7%)
Mental Disorder	219 (10.0%)	422 (11.3%)	596 (11.7%)	687 (12.3%)	728 (12.6%)	728 (12.5%)	844 (14.3%)
Stroke	44 (2.0%)	68 (1.8%)	92 (1.8%)	117 (2.1%)	120 (2.1%)	107 (1.8%)	102 (1.7%)
Number of Chronic Conditions, *n* (%)							
0	1,463 (67.3%)	2,485 (66.5%)	3,347 (65.7%)	3,667 (65.5%)	3,738 (64.5%)	3,686 (63.1%)	3,665 (62.1%)
1	489 (22.5%)	882 (23.6%)	1,214 (23.8%)	1,327 (23.7%)	1,445 (24.9%)	1,498 (25.6%)	1,570 (26.6%)
2+	224 (10.3%)	369 (9.9%)	532 (10.5%)	601 (10.7%)	615 (10.6%)	660 (11.3%)	663 (11.2%)
ED visits per 1,000 patients per year, mean (SE)							
Total	391.0 (26.1)	363.6 (21.5)	358.3 (21.7)	356.8 (24.3)	371.2 (18.9)	369.4 (21.8)	365.4 (19.2)
Regular-Hours	140.4 (11.1)	149.6 (12.2)	129.0 (11.1)	132.2 (9.4)	143.2 (9.5)	135.2 (7.9)	136.2 (7.8)
After-Hours	250.6 (20.4)	214.0 (14.5)	229.3 (13.5)	224.6 (18.2)	228.0 (12.4)	234.2 (17.1)	229.2 (15.0)
Very-Urgent	31.9 (5.9)	28.4 (3.3)	49.1 (5.4)	46.5 (4.4)	52.7 (5.3)	62.0 (6.2)	62.0 (4.8)
Regular-Hours	11.5 (3.2)	8.7 (1.7)	14.7 (2.5)	13.8 (2.0)	16.5 (2.2)	21.5 (2.6)	21.8 (2.4)
After-Hours	20.5 (3.8)	19.7 (2.6)	34.5 (4.2)	32.6 (3.8)	36.2 (4.0)	40.5 (5.4)	40.1 (3.7)
Urgent	132.0	120.3	145.0	136.0	154.1	156.8	158.0

	(11.7)	(9.8)	(11.0)	(13.8)	(9.9)	(12.5)	(9.0)
Regular-Hours	45.0 (5.7)	51.5 (6.6)	55.1 (7.4)	45.9 (4.0)	57.2 (4.9)	54.1 (4.3)	55.8 (4.0)
After-Hours	87.0 (9.0)	68.8 (62.7)	89.8 (6.8)	90.1 (12.1)	102.7 (9.8)	102.2 (7.4)	102.2 (7.4)
Less-Urgent	227.0 (19.6)	214.9 (16.9)	164.2 (11.8)	174.3 (13.0)	164.5 (11.9)	150.7 (10.6)	145.4 (11.9)
Regular-Hours	84.0 (8.5)	89.4 (9.7)	59.1 (6.1)	72.5 (7.0)	69.5 (7.2)	59.6 (5.6)	58.6 (5.1)
After-Hours	143.0 (15.9)	125.5 (11.4)	105.0 (7.8)	101.9 (8.2)	95.0 (7.8)	91.1 (7.2)	86.9 (9.4)
Less-Urgent for FPSCs[a]	82.2 (11.8)	85.1 (14.6)	62.6 (8.3)	89.0 (14.7)	56.3 (6.5)	54.3 (7.2)	56.4 (17.8)
Regular-Hours	31.9 (4.8)	33.3 (5.6)	24.5 (4.6)	37.5 (7.3)	32.7 (4.7)	21.9 (4.7)	18.9 (4.1)
After-Hours	50.2 (9.4)	51.8 (11.0)	38.1 (5.5)	51.5 (9.8)	23.6 (4.0)	32.4 (5.2)	37.5 (1.6)

COPD: Chronic Obstructive Pulmonary Disease; ED: emergency department; FPSC: Family Practice-Sensitive Condition; SE: standard error
ED visits were measured over the fiscal year, from April of the survey year to March of the following year.
Continuous variables reported as mean (standard error), counts reported as frequency (proportion); survey weights and clustered bootstrap standard errors were applied for all descriptive analyses and counts were rounded to the nearest 1,000 and reported as 1,000.
[a]Less-urgent ED visits for FPSCs are reported only for Alberta and Prince Edward Island, due to high levels of missingness in International Classification of Disease, 10th Revision codes for British Columbia and Nova Scotia.

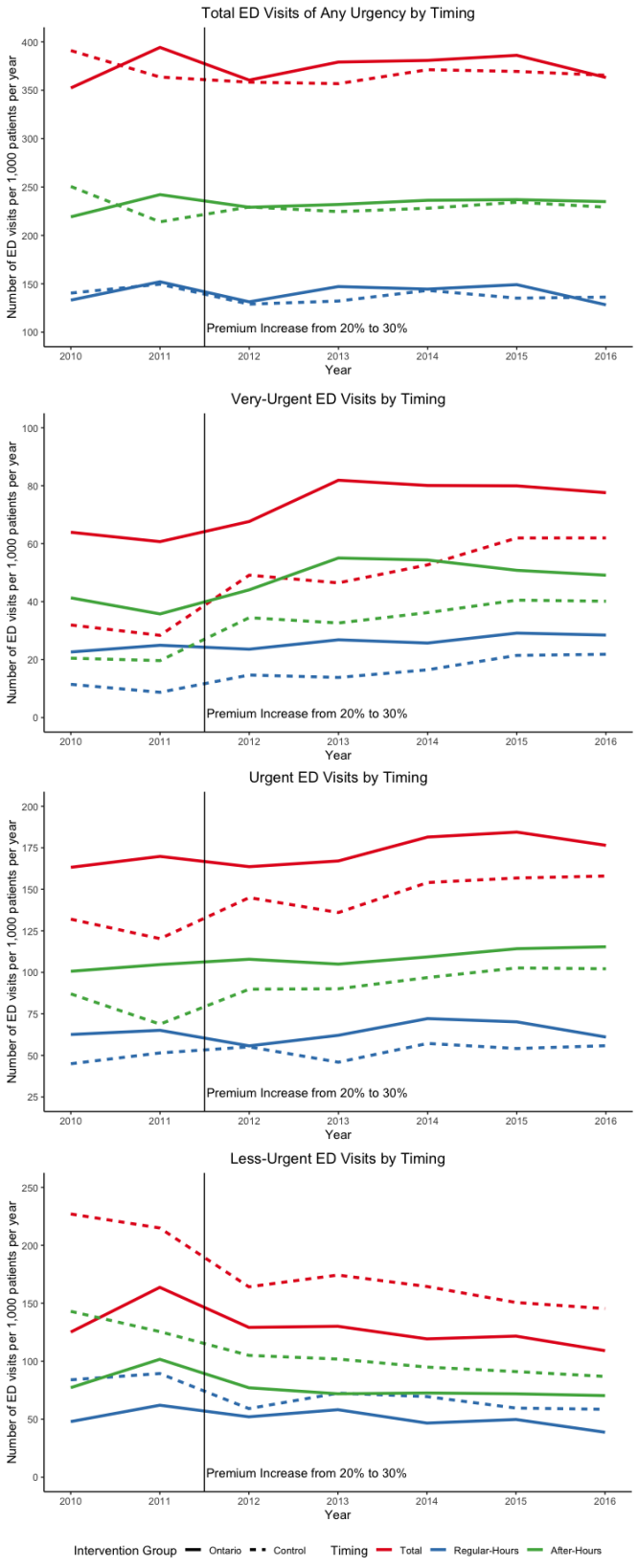

Figure 4.1 ED visit rates per 1,000 patients per year by intervention group, timing, and urgency

Table 4.7 Effect of the increase in Ontario's after-hours premium on ED visits relative to control province under difference-in-differences framework (*N* = 107,775)

	Total ED visits IRR (95% CI)	Very-Urgent ED visits IRR (95% CI)	Urgent ED visits IRR (95% CI)	Less-Urgent ED visits IRR (95% CI)
Premium	1.04 (0.94, 1.15)	1.93*** (1.52, 2.46)	1.26*** (1.10, 1.44)	0.64*** (0.55, 0.74)
Ontario	0.91* (0.82, 1.02)	1.75*** (1.36, 2.24)	1.28*** (1.12, 1.47)	0.64*** (0.55, 0.74)
Province (reference: Alberta)				
British Columbia	0.76*** (0.69, 0.84)	0.71*** (0.60, 0.85)	0.89* (0.80, 1.00)	0.70*** (0.62, 0.79)
Nova Scotia	0.63*** (0.55, 0.72)	0.73** (0.58, 0.93)	0.69*** (0.58, 0.81)	0.57*** (0.47, 0.70)
Prince Edward Island	0.66*** (0.54, 0.81)	0.64** (0.43, 0.94)	0.89 (0.68, 1.17)	0.49*** (0.39, 0.61)
DID effect	0.96 (0.85, 1.08)	0.64*** (0.49, 0.84)	0.83** (0.70, 0.98)	1.02 (0.87, 1.21)
Age Spline				
12-18	1.12*** (1.08, 1.15)	1.08** (1.01, 1.17)	1.14*** (1.09, 1.19)	1.12*** (1.08, 1.17)
19-65	0.89*** (0.96, 0.91)	0.93** (0.86, 0.99)	0.87*** (0.83, 0.91)	0.88*** (0.84, 0.91)
66+	1.04*** (1.03, 1.05)	1.02*** (1.01, 1.04)	1.05*** (1.04, 1.06)	1.02*** (1.02, 1.03)
Female	1.02 (0.96, 1.08)	0.88** (0.79, 0.98)	1.06 (0.98, 1.14)	1.05 (0.97, 1.13)
Marital Status (reference: Single)				
Married or Common-Law	1.05 (0.96, 1.15)	0.98 (0.81, 1.17)	1.08 (0.97, 1.20)	1.04 (0.93, 1.17)
Separated, Divorced, or Widowed	1.10 (0.98, 1.23)	1.05 (0.84, 1.30)	1.14* (0.99, 1.30)	1.04 (0.89, 1.22)
Living with Minors	1.03 (0.94, 1.13)	1.05 (0.87, 1.27)	1.01 (0.90, 1.14)	1.05 (0.94, 1.17)
Household Size	0.98 (0.95, 1.01)	1.01 (0.96, 1.06)	0.95*** (0.92, 0.99)	0.98 (0.94, 1.02)
Immigrant Status (reference: non-immigrant)				
Short-Term Immigrant	0.64*** (0.54, 0.77)	0.58*** (0.41, 0.83)	0.76** (0.60, 0.97)	0.54*** (0.41, 0.70)
Long-Term Immigrant	0.80*** (0.74, 0.85)	1.00 (0.96, 1.06)	0.84*** (0.78, 0.91)	0.64*** (0.58, 0.70)
Education (reference: less than secondary school education)				
Secondary school graduation	0.81*** (0.73, 0.89)	0.82** (0.68, 0.98)	0.86*** (0.77, 0.96)	0.75*** (0.66, 0.84)
Post-secondary education	0.72*** (0.66, 0.79)	0.73*** (0.62, 0.88)	0.78*** (0.71, 0.86)	0.68*** (0.61, 0.76)

Household Income Quintile (reference: income quintile 1, lowest income quintile)				
2	0.84*** (0.77, 0.90)	0.74*** (0.64, 0.85)	0.79*** (0.72, 0.87)	0.90* (0.81, 1.01)
3	0.81*** (0.74, 0.88)	0.73*** (0.63, 0.84)	0.68*** (0.62, 0.76)	0.99 (0.88, 1.11)
4	0.73*** (0.67, 0.79)	0.65*** (0.55, 0.76)	0.62*** (0.55, 0.69)	0.88** (0.78, 0.99)
5	0.67*** (0.61, 0.74)	0.65*** (0.53, 0.81)	0.54*** (0.48, 0.60)	0.81*** (0.72, 0.91)
Regular Source of Care	1.28*** (1.18, 1.39)	1.38*** (1.14, 1.66)	1.41*** (1.26, 1.57)	1.16** (1.04, 1.31)
Number of Chronic Conditions (reference: no chronic conditions)				
1	1.57*** (1.47, 1.69)	1.88*** (1.66, 2.14)	1.64*** (1.50, 1.78)	1.42*** (1.30, 1.55)
2+	2.64*** (2.43, 2.86)	3.42*** (2.94, 3.97)	2.84*** (2.58, 3.14)	2.10*** (1.88, 2.35)
Distance to the nearest ED (km)	0.95*** (0.94, 0.96)	1.02* (0.99, 1.04)	0.97*** (0.96, 0.98)	0.90*** (0.89, 0.92)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; DID: Difference-in-differences; ED: Emergency Department; IRR: Incidence Rate Ratio

Analyses conducted using survey weights and cluster bootstrap standard errors; analyses adjusted for respondent characteristics: age spline, sex, marital status, presence of minors living in household, household size, immigrant status, educational attainment, household income quintile, physician as a regular source of care, number of chronic conditions, and road distance to the nearest ED.

Table 4.8 Effect of the increase in Ontario's after-hours premium on ED visits relative to control province under the difference-in-differences framework by timing (*N* = 107,775)

	Total ED visits IRR (95% CI)	Very-Urgent ED visits IRR (95% CI)	Urgent ED visits IRR (95% CI)	Less-Urgent ED visits IRR (95% CI)
Regular-Hours				
Premium	0.99 (0.87, 1.13)	1.91*** (1.30, 2.81)	1.14 (0.95, 1.37)	0.83** (0.70, 0.99)
Ontario	0.91 (0.80, 1.04)	2.04*** (1.37, 3.06)	1.30*** (1.07, 1.58)	0.62*** (0.52, 0.75)
DID Effect	0.97 (0.83, 1.14)	0.58** (0.37, 0.92)	0.86 (0.69, 1.07)	1.07 (0.85, 1.34)
After-Hours				
Premium	1.08 (0.96, 1.21)	1.94*** (1.52, 2.47)	1.33*** (1.12, 1.57)	0.83** (0.71, 0.97)
Ontario	0.92 (0.81, 1.05)	1.63*** (1.26, 2.11)	1.28*** (1.08, 1.50)	0.65*** (0.55, 0.69)
DID Effect	0.94 (0.82, 1.09)	0.67*** (0.51, 0.89)	0.82* (0.66, 1.00)	0.98 (0.81, 1.20)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; DID: Difference-in-differences; ED: Emergency Department; IRR: Incidence Rate Ratio

Analyses conducted using survey weights and cluster bootstrap standard errors; analyses adjusted for respondent characteristics: age spline, sex, marital status, presence of minors living in household, household size, immigrant status, educational attainment, household income quintile, physician as a regular source of care, number of chronic conditions, and road distance to the nearest ED.

DID effect is the effect of the increase in the after-hours premium in Ontario relative to control provinces or the interaction between the Ontario and the premium variables.

Regular-hours refers to 8:00 AM – 5:00 PM on weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any timing on weekends and Ontario statutory holidays.

Table 4.9 Sensitivity and subgroup analyses for the effect of the increase in Ontario's after-hours premium on ED visits relative to control provinces under the difference-in-differences framework

	Any Timing IRR (95% CI)	Regular-Hours IRR (95% CI)	After-Hours IRR (95% CI)
Sensitivity Analysis: Less-Urgent ED Visits for FPSCs (*N* = 86,670)[a]			
Less-Urgent for FPSCs	1.16 (0.86, 1.56)	1.20 (0.85, 1.68)	1.14 (0.79, 1.65)
Sensitivity Analysis: respondents within 5 km of nearest ED (*N* = 71,660)			
ED	1.05 (0.90, 1.23)	1.06 (0.87, 1.29)	1.05 (0.87, 1.26)
Very-Urgent	0.63*** (0.45, 0.88)	0.53** (0.30, 0.95)	0.70** (0.49, 0.98)
Urgent	0.92 (0.75, 1.13)	0.89 (0.69, 1.15)	0.95 (0.74, 1.22)
Less-Urgent	1.14 (0.94, 1.40)	1.23 (0.94, 1.61)	1.08 (0.86, 1.36)
Sensitivity Analysis: respondents within 20 km of nearest ED (*N* = 123,260)			
ED	0.92 (0.81, 1.04)	0.95 (0.81, 1.11)	0.89 (0.77, 1.03)
Very-Urgent	0.64*** (0.49, 0.82)	0.57*** (0.37, 0.88)	0.68*** (0.52, 0.88)
Urgent	0.77*** (0.66, 0.91)	0.82* (0.67, 1.01)	0.76*** (0.62, 0.92)
Less-Urgent	0.99 (0.84, 1.16)	1.06 (0.86, 1.32)	0.93 (0.77, 1.13)
Sensitivity Analysis: Alberta control group (*N* = 85,280)			
ED	1.01 (0.88, 1.15)	0.97 (0.82, 1.14)	1.02 (0.87, 1.19)
Very-Urgent	0.68*** (0.50, 0.92)	0.59** (0.37, 0.95)	0.72** (0.52, 0.99)
Urgent	0.90 (0.75, 1.08)	0.90 (0.71, 1.15)	0.90 (0.72, 1.13)
Less-Urgent	1.02 (0.86, 1.22)	1.01 (0.82, 1.25)	1.02 (0.82, 1.26)
Sensitivity Analysis: British Columbia control group (*N* = 77,165)			
ED	0.83 (0.62, 1.12)	1.02 (0.65, 1.58)	0.74 (0.51, 1.07)
Very-Urgent	0.57 (0.25, 1.32)	0.66 (0.12, 3.78)	0.52 (0.24, 1.14)
Urgent	0.59** (0.36, 0.95)	0.70 (0.36, 1.36)	0.54 (0.28, 1.03)
Less-Urgent	1.07 (0.73, 1.57)	1.36 (0.68, 2.71)	0.94 (0.61, 1.44)
Sensitivity Analysis: Nova Scotia control group (*N* = 65,735)			
ED	0.72* (0.49, 1.04)	0.83 (0.54, 1.28)	0.62** (0.41, 0.95)
Very-Urgent	0.35*** (0.19, 0.64)	0.30** (0.10, 0.92)	0.39*** (0.19, 0.81)

Urgent	0.65* (0.42, 1.01)	0.78 (0.44, 1.37)	0.54*** (0.33, 0.88)
Less-Urgent	0.85 (0.48, 1.52)	1.08 (0.53, 2.21)	0.72 (0.38, 1.37)
Sensitivity Analysis: Prince Edward Island control group (N = 62,285)			
ED	2.02*** (1.45, 2.80)	2.33*** (1.43, 3.77)	1.85*** (1.14, 3.02)
Very-Urgent	2.90*** (1.29, 6.49)	3.16 (0.59, 16.93)	2.83** (1.03, 7.81)
Urgent	2.00*** (1.34, 2.98)	2.07* (0.99, 4.30)	1.92** (1.01, 3.63)
Less-Urgent	1.67** (1.01, 2.77)	2.27 (0.81, 6.37)	1.40 (0.66, 2.94)
Subgroup Analysis: Has a physician as a regular source of care (N = 96,000)			
ED	0.95 (0.82, 1.09)	0.98 (0.82, 1.17)	0.92 (0.78, 1.08)
Very-Urgent	0.62*** (0.48, 0.81)	0.50*** (0.32, 0.78)	0.69*** (0.52, 0.92)
Urgent	0.81** (0.68, 0.97)	0.89 (0.70, 1.12)	0.77** (0.61, 0.97)
Less-Urgent	1.02 (0.85, 1.22)	1.12 (0.87, 1.43)	0.96 (0.77, 1.19)
Subgroup Analysis: Has full-time employment (N = 47,475)			
ED	0.92 (0.78, 1.09)	0.87 (0.69, 1.10)	0.95 (0.78, 1.16)
Very-Urgent	0.63* (0.39, 1.01)	0.82 (0.37, 1.79)	0.56** (0.33, 0.93)
Urgent	0.77** (0.60, 0.98)	0.62*** (0.43, 0.88)	0.87 (0.64, 1.18)
Less-Urgent	0.98 (0.77, 1.24)	1.01 (0.75, 1.38)	0.95 (0.71, 1.26)
Subgroup Analysis: Has at least one chronic condition (N = 48,335)			
ED	0.84 (0.68, 1.04)	0.96 (0.76, 1.23)	0.77** (0.59, 0.99)
Very-Urgent	0.63*** (0.45, 0.88)	0.47*** (0.27, 0.83)	0.74 (0.52, 1.06)
Urgent	0.84 (0.65, 1.09)	1.14 (0.83, 1.55)	0.69** (0.50, 0.95)
Less-Urgent	0.85 (0.65, 1.12)	0.97 (0.69, 1.36)	0.77 (0.56, 1.07)
Subgroup Analysis: Male respondent (N = 48,415)			
ED	0.97 (0.81, 1.16)	0.94 (0.75, 1.17)	0.98 (0.80, 1.20)
Very-Urgent	0.55*** (0.38, 0.80)	0.40*** (0.23, 0.69)	0.63** (0.41, 0.96)
Urgent	0.82 (0.64, 1.05)	0.70** (0.51, 0.96)	0.89 (0.66, 1.20)
Less-Urgent	1.07 (0.85, 1.35)	1.21 (0.89, 1.63)	0.98 (0.75, 1.29)
Subgroup Analysis: Female respondent (N = 59,360)			

ED	0.94 (0.79, 1.12)	1.00 (0.79, 1.26)	0.91 (0.74, 1.12)
Very-Urgent	0.71* (0.48, 1.05)	0.75 (0.40, 1.41)	0.70* (0.47, 1.03)
Urgent	0.83 (0.67, 1.04)	1.00 (0.73, 1.35)	0.76** (0.57, 0.99)
Less-Urgent	0.98 (0.78, 1.24)	0.97 (0.70, 1.35)	0.99 (0.75, 1.31)
Subgroup Analysis: Respondent in Lowest Income Quintile (*N* = 23,375)			
ED	0.87 (0.68, 1.11)	0.85 (0.63, 1.15)	0.86 (0.63, 1.16)
Very-Urgent	0.50*** (0.32, 0.78)	0.63 (0.28, 1.38)	0.47*** (0.30, 0.75)
Urgent	0.84 (0.62, 1.13)	0.70* (0.48, 1.03)	0.90 (0.64, 1.28)
Less-Urgent	0.93 (0.66, 1.32)	1.01 (0.68, 1.51)	0.86 (0.54, 1.36)
Subgroup Analysis: Respondent in Highest Income Quintile (*N* = 18,930)			
ED	1.19 (0.89, 1.58)	1.15 (0.74, 1.80)	1.20 (0.87, 1.66)
Very-Urgent	0.58 (0.29, 1.20)	0.60 (0.19, 1.90)	0.56 (0.25, 1.29)
Urgent	0.88 (0.60, 1.29)	0.59* (0.35, 1.01)	1.11 (0.67, 1.81)
Less-Urgent	1.37 (0.95, 1.99)	1.56 (0.92, 2.65)	1.28 (0.81, 2.03)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; DID: Difference-in-differences; ED: Emergency Department; FPSC: Family Practice-Sensitive Condition; IRR: Incidence Rate Ratio

Analyses conducted using survey weights and cluster bootstrap standard errors; analyses adjusted for respondent characteristics: age spline, sex, marital status, presence of minors living in household, household size, immigrant status, educational attainment, household income quintile, physician as a regular source of care, number of chronic conditions, and road distance to the nearest ED.

DID effect is the effect of the increase in the after-hours premium in Ontario relative to control provinces or the interaction between the Ontario and the premium variables.

Regular-hours refers to 8:00 AM – 5:00 PM on weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any timing on weekends and Ontario statutory holidays.

[a]Analyses for less-urgent ED visits for FPSCs involves only Alberta, Ontario, and Prince Edward Island.

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5 Primary care payment model on provision of primary care services and emergency department visits in Ontario: a comparison of the Family Health Group and Family Health Organization models

5.1 Introduction

Models of remuneration can impact the way physicians deliver services to their patients.[1–3] Physicians are most commonly paid through fee-for-service (FFS), where a physician receives a fixed fee for each unit of health care service provided to their patients; however, two other methods are commonly available, capitation payment, where a physician receives a fixed fee for each patient on the roster, and salary, where a physician receives fixed salary on a regular basis, regardless of the number of services provided or patients seen.[4–7] Both in theory and in practice, these models have been found to impact the supply of health care services: FFS payment schemes promote an excess supply of services, with physicians encouraged to treat patients with greater need and provide more services to maximize income, while capitation and salary schemes promote the undersupply of services.[1,2] The empirical literature demonstrates that patients of physicians paid through FFS had higher levels of primary care and specialist visits compared to those paid by capitation, with no difference in emergency department (ED) utilization or hospitalizations.[1,3] Additionally, physicians who were paid by capitation may make more referrals to specialists for services that could have been provided by primary care physicians.[1,2,8,9] Canadian research also demonstrates similar findings, as FFS physicians provided more services compared to physicians remunerated through other models, with physicians in salary and capitation models dedicating less time to direct patient care and more to care outside the clinic, indirect care and the provision of preventive care services.[10–15]

One way to balance the issues of undersupply in capitation and oversupply in the FFS models is through blended payment schemes, where physicians receive remuneration through a combination of the pure payment schemes, with additional payments through pay-for-performance incentives for targeted care.[8] Ontario has experimented with these blended payment schemes with the introduction of patient enrolment models (PEMs),

introduced as part of their primary care reforms.[5] Two of these models, the Comprehensive Care Model (CCM) and the Family Health Group (FHG) are paid through enhanced or blended FFS, predominantly receiving FFS payments with additional pay-for-performance incentives for preventive care services and chronic disease management. The FHG requires at least three physicians working in a group, whereas the CCM is typically for solo physicians. The other two PEMs, the Family Health Network (FHN) and the Family Health Organization (FHO) are paid through blended capitation, predominantly paid age- and sex-adjusted capitation with FFS payments for services provided to non-enrolled patients and services outside the capitated basket of services, as well as similar pay-for-performance incentives as the enhanced FFS models. The core basket of services is larger in the FHO model compared to the FHN, and thus, physicians in the FHO model receive a higher base capitation rate. Uptake of these PEMs has been found to be quite strong and while 98% of family physicians were paid through FFS remuneration in 2000/01, by 2010/11, many had transitioned into PEMs, with 24% of physicians in each of the FHG and FHO models.[16] More recent estimates suggest the proportion of physicians in the traditional FFS model is continuing to decline as more physicians join the FHO model, increasing from 2,851 physicians in 2010/11 to 5,494 physicians in 2017/18.[17]

PEMs have been effective in changing the delivery of primary care – physicians in the FHG model delivered more services and had lower referral rates compared to traditional FFS physicians.[18] However, the delivery of care differs between the enhanced FFS and blended capitation models, as physicians who transitioned to an FHO model delivered 6-7% fewer services per year after switching.[19] Early evaluation of Ontario's FHG and FHN models in 2005/06 found FHN patients of physicians received fewer services during after-hours and made more emergency department (ED) visits.[20] Since then, Ontario's primary care landscape has changed greatly due to reforms, including the introduction of the FHO model in 2006, physician transitions between models, and the introduction of several pay-for-performance incentives that may affect health care utilization, including those targeting specific chronic conditions such as the congestive heart failure management incentive and the diabetes management incentive.[5,16,21] While physicians in the FHG model are known to provide better access to primary care than the FHN,

physicians in the FHO model may be incentivized to deliver more comprehensive care, as demonstrated with better rates of preventive care services, which may lead to reduction in emergency care utilization.[22,23] Therefore, this study seeks to investigate whether primary care services and ED visits differ between the FHO and the FHG models in the current practice setting. This study also evaluates whether this difference may be greater during after-hours compared to regular-hours, and whether the difference may be greater for those with chronic conditions.

5.2 Methods

5.2.1 Study Design

This study seeks to examine the difference in the rates of primary care services delivered and ED visits between patients of physicians practicing in the FHG model and those practicing in the FHO model. Analyses will be conducted separately by timing to evaluate whether there is a difference in primary care access between patients of the FHG and FHO models during after-hours. One incentive is the after-hours premium, an incentive on a specific set of services provided during after-hours.[24] While the value of the incentive itself is equivalent between groups, FHG physicians will receive the original FFS value of the service along with the after-hours premium for services provided during after-hours whereas FHO physicians only receive the after-hours premium. FHO physicians continue to receive the base capitation payment regardless of whether they provide any service. Therefore, FHG physicians may have a greater incentive to offer better care during after-hours. In addition to the after-hours premium, other incentives were introduced for disease prevention and chronic condition management, such as preventive cancer screening bonuses, the congestive heart failure management incentive, and the diabetes management incentive.[5] These incentives are available for rostered patients, and may incentivize the delivery of higher quality care to those with chronic conditions. Despite enhanced FFS models being demonstrated to offer better access to care, blended capitation models may offer care that is more comprehensive.[22,23] As a result, differences in primary and emergency care utilization

may differ based on patient morbidity status. As subgroup analyses, the difference in primary care and ED utilization between the FHG and FHO models will be compared separately based on the number of chronic conditions.

This retrospective cohort study compares the rate of primary care services provided and the rate of ED visits by adult patients of physicians who practiced in an FHG or FHO model between April 2012 to March 2017. The study period falls beyond the transitional phase of primary care reform period, capturing a period where Ontario primary care models have been more stable (i.e., physician transitions between FHG and FHO models have been minimal). All adult patients (18 years and older) rostered to FHG and FHO physicians were captured on an annual basis from April 1, 2012, to March 31, 2017. Physicians who switched between the FHG and FHO model during the study period were excluded from analysis, as well as those with roster sizes of less than 100 adult patients as they may only practice part-time. Despite rural-urban differences in health care utilization,[25] it is unclear whether physicians in the FHG and FHO models may differ in how they treat rural patients. Therefore, all patients were included, with a separate subgroup analysis conducted later for urban patients.

5.2.2 Study Data and Study Population

Seven health administrative databases were linked to capture information on patient and physician characteristics, primary care services and ED visits: 1) the Corporate Provider Database (CPDB) for physician practice characteristics and information on model type, 2) the ICES Physician Database (IPDB) for physician demographic characteristics; 3) the Client Agency Program Enrolment (CAPE) database used to link enrolled patients to their physicians in PEMs, 4) the Registered Persons Database (RPDB) for patient sociodemographic characteristics, 5) Census data for dissemination area-level income data, 6) the Ontario Health Insurance Plan Claims Database (OHIP) for primary care physician billing information, and 7) the National Ambulatory Care Reporting System (NACRS) database for information on ED visits. The CAPE database was used to capture the patient sample, as it captures all rostering and de-rostering requests by a physician,

allowing linkage of patients formally enrolled to a physician practicing in a PEM.[26] These datasets were linked using encoded identifiers and analyzed at ICES.

A set of 17 chronic conditions were used to capture morbidity, for which there were validated definitions at ICES (Appendix C). The set of chronic conditions was chosen based on a tool by the Canadian Institute of Health Research (CIHR) Community-Based Primary Health Care Signature Initiative and included: asthma, cancer, chronic kidney disease (CKD), chronic liver disease, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), dementia, diabetes, HIV, hypertension, inflammatory bowel disease (IBD), mental disorder or substance use, myocardial infarction, osteoporosis, rheumatoid arthritis, stroke/transient ischemic attack (TIA), and urinary incontinence.[27] This list of chronic conditions was based on a study by Ryan et al. (2018) and used similar methodology.[28,29] Information on chronic conditions was defined using existing disease cohorts in the ICES databases where available, otherwise, established algorithms using International Classification of Disease, 9th and 10th Revisions (ICD-9 and ICD-10) codes and OHIP billing codes were used. The presence of a chronic condition was defined based on whether an individual was included in a patient cohort at the beginning of each year in the study, or by looking back at their health care utilization over the previous 5-10 years depending on the chronic condition and applying the established algorithm. Ten chronic conditions were identified using ICES disease cohorts: 1) the Ontario Asthma Dataset (ASTHMA), 2) the CHF cohort, 3) the COPD cohort, 4) the Ontario HIV database, 5) the Ontario Hypertension dataset (HYPER), 6) the Ontario Crohn's and Colitis Cohort dataset (OCCC) for IBD, 7) the Ontario Cancer Registry (OCR), 8) the Ontario Diabetes Dataset (ODD), 9) the Ontario Myocardial Infarction Dataset (OMID), and 10) the Ontario Rheumatoid Arthritis Dataset (ORAD). Algorithms were applied to capture the remaining seven chronic conditions (CKD, chronic liver disease, dementia, mental disorder or substance use, stroke/TIA, and urinary incontinence) using four databases: 1) OHIP, 2) the Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD), 3) the Ontario Drug Benefit Claims (ODB) database, and 4) the Ontario Mental Health Reporting System (OMHRS) database.

5.2.3 Study Variables

All analyses were conducted at the physician-level. Outcomes of interest were the rate of primary care services delivered, the constant-dollar value of these primary care services using 2016 Canadian Dollars (2016 CAD), and the rate of ED visits made by any patient formally rostered to a physician per patient per year. Primary care services were stratified by timing; however, since OHIP does not record information on the time of visit, only date, services were defined as during after-hours if they were billed on weekends or statutory holidays or if they were billed with the after-hours premium. Although the after-hours premium may be billed 5:00 PM – 8:00 AM on weekdays and any time on weekends and statutory holidays, physicians may only bill the after-hours premium on a select set of fourteen services.[24] ED visits were stratified by timing and urgency. Timing was stratified into regular-hours (i.e., 8:00 AM – 5:00 PM on weekdays, excluding statutory holidays) and after-hours (i.e., visits 5:00 PM – 8:00 AM weekday and any time on weekends and statutory holidays), in line with the eligibility to bill the after-hours premium. Urgency was defined using the Canadian Triage and Acuity Scale (CTAS),[30] where visits with a CTAS score of 1 or 2 were defined as very-urgent, visits with a CTAS score of 3 were defined as urgent, and visits with a CTAS score of 4 or 5 were defined as less-urgent. Additionally, less-urgent ED visits for family practice-sensitive conditions (FPSCs), resulting in less than 1% probability of requiring hospitalization were captured.[31] Only less-urgent ED visits for FPSCs were considered, as these were most likely to be appropriately managed in the primary care setting.[32]

Physician characteristics include physician remuneration model, age, sex, and physician group size, the number of physicians working within a group based on information from the CPDB. International medical graduate (IMG) status, defined as graduation outside of Canada or the United States (US), was taken from the IPDB. All patient characteristics were aggregated to the physician-level, including: adult roster size, defined as the number of adult patients formally rostered to the physician; mean patient age; proportion of female patients; proportion of patients living in a rural area, defined as a Census subdivision with a population size less than 10,000;[33] proportion of patients living in a low-income area, defined as a the lowest two income quintiles based on Census

dissemination area income quintiles; proportion of patients with a single morbidity from the list of seventeen chronic conditions; and proportion of patients with multimorbidity, defined as two or more chronic conditions from the list of seventeen.

5.2.4 Statistical Analysis

All analyses were conducted at the physician-level. Physician characteristics are presented as mean (standard error [SE]) for continuous variables or frequency (proportion) for categorical variables while all patient characteristics and outcomes are presented as mean (SE).

Weighted multivariable negative-binomial regression models were estimated to compare the rate of primary care services and the rate of ED visits between patient rosters of physicians in the FHG and FHO models, controlling for the above physician and aggregate patient characteristics and year. Negative-binomial regression can be used to handle overdispersion (i.e., the case where the conditional variance of the outcome exceeds the conditional mean) by adding an overdispersion parameter to the standard Poisson regression model.[34] This overdispersion parameter corresponds to a value of zero in the Poisson model, zeroing out of the regression model in the case where the conditional mean and conditional variance are equal. The Poisson and negative-binomial regression models may be used to model the rate of an outcome as a dependent outcome rather than the count of the event by modelling an offset variable.[34] The offset term may be modelled by taking the log of the exposure or the denominator of the rate, and modelling with a coefficient constrained to one. The exposure was the number of patients rostered to the physician. This regression model is specified as:

$$\ln(Y_{it}) = \beta_0 + \beta_1 \cdot FHO + \beta_1 \cdot year + \boldsymbol{\beta X} + \ln(roster_{it}) + v_{it} + \epsilon_i \qquad (5.1)$$

where Y_i is the number of primary care services received or ED visits made by all patients under physician i's patient roster in year t, β_1 is the effect of being in an FHO on health care utilization, $\boldsymbol{X}$ is the set of control physician and aggregate patient characteristics, $\ln(roster_{it})$ is the offset parameter, or the log of the number of patients in physician i's

patient roster in year t, with a coefficient constrained to one, v_{it} allows for modelling of the overdispersion in the negative-binomial regression model, such that $e^{v_{it}}$ has a mean of 1 and the variance is the overdispersion parameter α, and ϵ_i is the standard error term.

Additionally, clustering of yearly observations was allowed for under physicians to ensure that the estimated standard errors are correct.[35]

For the value of primary care, weighted multivariable linear regression models were estimated where the outcome was the mean value of primary care services received by patients under the physician's roster and models controlled for an identical set of physician and aggregate patient characteristics.

As one purported mechanism by which physician remuneration model may influence ED visits involves access to primary care, models interacting physician remuneration model and the rate of primary care services will be estimated. For timing-specific models, the effect of the rate of services delivered during that timing was be used (i.e., the regular-hours specific model examined the effect of regular-hours primary care services on regular-hours ED visits, while the after-hours specific model examined the effect of after-hours primary care services on after-hours ED visits). Due to OHIP not recording timing of services, there were differences in the definitions of regular- and after-hours between the primary care and ED settings, and the rate of primary care services during after-hours is underestimated.

5.2.4.1 Propensity Score Weighting

Propensity score methods may reduce the confounding due to factors that differ between physicians in the FHO model and FHG models (see Section 3.2.4.1). Propensity score weighting methods control for the observable confounding that enters the model through these imbalances. While conventional propensity score methods are useful, they can be sensitive to misspecification of the model, and the covariate balancing propensity score (CBPS) may perform better.[36] The CBPS uses a set of moment conditions implied by the covariate balancing property while also incorporating the standard propensity score

estimation procedure. It dramatically improves the balance of covariates at the expense of likelihood. CBPS weighting is doubly robust, meaning that the estimated average treatment effect among the treated (ATT) will be consistent if either the propensity score model or the outcome model is correctly specified. Additionally, the ATT estimates will be efficient if both models are correctly specified. ATT effects were estimated using the CBPS weights, creating a pseudo-population of the control group, where FHG physicians are weighted, with weights defined using Equation 3.2.

The common support assumption is imposed to ensure that there is sufficient overlap in the FHG and FHO models, thus, physicians with a propensity score outside of the overlapping region between the FHG and FHO groups were be excluded from analysis. To test the balance of the sample after applying CBPS weights, the *t* test for equality of means, the standardized difference, and variance ratio were calculated for each covariate.[37–40]

5.2.4.2 Sensitivity Analyses

While blended capitation models may provide more comprehensive care compared to enhanced FFS models, interdisciplinary care models, with additional non-physician primary health care providers, may be even more advantageous in the management of chronically ill populations.[41] Previously, a systematic review found that the addition of interdisciplinary teams in primary care was associated with a reduction in ED visits.[42] Ontario has invested in one physician-led interdisciplinary model, the Family Health Team (FHT), which receives remuneration under either a salary or blended capitation model, such as the FHO, and additional funding to hire interdisciplinary health care providers, such as nurses dietitians, and physiotherapists.[5,43] Limited research has been conducted comparing the interdisciplinary team model with non-interdisciplinary team models in Ontario; however previous research found FHT physicians provided more services and were more likely to enroll patients compared to physicians practicing in the FHN model.[44] Separate pairwise comparisons between the FHG, non-FHT FHO, and FHT models were conducted to evaluate whether there were differential effects between

the FHT and FHO model. All FHT physicians in this sample are paid through the FHO remuneration scheme with additional funding support for interdisciplinary health care professionals and one-time funding for electronic medical records. The two-stage analysis procedure, including both the CBPS estimation and weighted multivariable negative-binomial or linear regression models, was conducted for each pairwise comparison.

5.2.4.3 Subgroup Analyses

An important objective of this study is to examine whether the difference in primary care services and ED visits between the FHG and FHO model changes by their patients' morbidity status as blended capitation models may offer more comprehensive care at the expense of poorer access. Subgroup analyses were conducted by the number of chronic conditions, for the non-morbid population, or those with none of the listed seventeen chronic conditions, the single-morbid population, or those with one of the chronic conditions, and the multimorbid population, or those with two or more of the chronic conditions. Additional subgroups analyses were conducted for chronic conditions with a prevalence of at least 5% in the study sample: asthma, cancer, COPD, diabetes, hypertension, and mental disorder or substance use. These chronic conditions may additionally be affected by some of the available pay-for-performance incentives including the diabetes management incentive and various cancer screening bonuses.[5] The two-stage analysis procedure was repeated for each subgroup from CBPS weighting to multivariable negative-binomial and linear regression analysis.

All patients under a physician roster were included; however, due to the urban-rural divide in how patients use primary care and emergency care services, a subgroup analysis focusing only on urban patients, excluding those living in rural region was conducted.[25] Additionally, previous research has found females use more health care services compared to males,[45] while socioeconomic status-related differences in health care utilization are apparent.[46] Therefore, patient subgroup analyses by sex and area-level income status were conducted to assess whether there were important inequalities

between the FHG and FHO models. Finally, subgroup analyses by physician sex will be conducted as physician sex has been found to be associated with performance and important differences may be found between model type by male and female physicians.[47]

5.2.4.4 Statistical Software

All analyses were conducted using Stata 15.1.[48] The user written Stata program psweight was used to estimate CBPS weights.[49]

5.2.5 Ethics Approval

The use of the data in this project is authorized under Section 45 of the Ontario Personal Health Information Protection Act and thus Research Ethics Board review was not required.

5.3 Results

Between 2012/13 and 2016/17, there were 7,155 physicians who practiced in an FHG or FHO model. After excluding 539 physicians who switched between models during the study period and 432 physicians who had fewer than 100 rostered patients during the study period, there were 6,184 physicians included in the analysis or 28,094 physician-year observations (Table 5.1). During the study period, 2,207 (36%) practiced in an FHG model and 3,977 (64%) practiced in an FHO model, of which 1,968 (49%) practiced in an FHT. Across the average physician practice, 55% of patients were females, 37% lived in a low-income area, and 7% lived in a rural area. In 2012/13, the average roster was comprised of 37% non-morbid patients, 30% with a single morbidity, and 33% with multimorbidity; however, the proportion of non-morbid patients increased over time while the proportion of multimorbid patients decreased.

Compared to physicians in the FHG model, physicians in the FHO model were younger, worked in smaller groups and had slightly smaller rosters. FHO physicians were more likely to be female and less likely to have international medical graduates. On average, FHO patients were older, and were less likely to live in a low-income area but more likely to live in a rural area. The average rate of primary care services provided by the physicians in the FHG practices was higher compared to the number provided by the FHO physicians, both during regular- and after-hours. Additionally, FHO physicians had patients who made 61 more ED visits per 1,000 patients per year compared to FHG physicians, comprised of 47 more less-urgent ED visits per 1,000 patients per year and 17 more urgent ED visits per 1,000 patients per year but 4 fewer very-urgent ED visits per 1,000 patients per year.

5.3.1 Propensity Score Weighting

After propensity score weighting, 367 physician-year observations were dropped from analysis as they were outside the common support region, leaving 27,727 physician-year observations for weighted analysis (Figure 5.1). Prior to weighting, large imbalances were found in IMG status and physician group size, as well as mean patient age and proportion of patients living in a rural area. CBPS weighting led to a reduction in imbalances across all variables, with an absolute reduction in bias that ranged from 99.0% to 100.0% for all physician and aggregate patient characteristics (Table 5.2). Standardized differences were reduced for all variables, and although the variance ratio increased after weighting for some aggregate patient characteristics, they remained within the acceptable limits (Figure 5.2).

5.3.2 Effect of Physician Remuneration on Primary Care Services and Emergency Department Visits

FHO physicians provided 14% fewer primary care services (95% Confidence Interval [CI]: 13%, 15%) per patient per year than their FHG counterparts, after controlling for

year, physician characteristics, and aggregate patient characteristics (Table 5.3). When stratified by timing, the relative difference in the average rate of services was larger during after-hours, and FHO physicians provided 13% fewer services per patient per year during regular-hours (95% CI: 12%, 14%) and 27% fewer services per patient per year during after-hours (95% CI: 25%, 29%). Similarly, analyses examining the effect of physician remuneration model on value of primary care services yielded similar results – FHO physicians provided an average value of care per year that was $67.55 CAD (95% CI: 59.62, 75.49) lower than the average value of care provided by FHG physicians.

While FHO physicians provided fewer services compared to FHG physicians, their patients made more ED visits – FHO patients made approximately 27% more less-urgent ED visits per patient per year (95% CI: 23%, 32%) compared to FHG patients. Similarly, total ED visits were also higher among FHO patients, with 12% more ED visits per patient per year (95% CI: 9%, 15%), as well as 10% more urgent ED visits per patient per year (95% CI: 7%, 13%); however, no difference was found in very-urgent ED visits between the FHG and FHO models. For less-urgent ED visits for FPSCs, FHO physicians' patients made 45% more visits per patient per year (95% CI: 38%, 53%). When stratified by timing, the relative difference in ED visits between the FHG and FHO models was found to be largely similar between regular- and after-hours ED visits, with only slightly larger increases in ED visits related to being in an FHO during regular-hours compared after-hours. These results translated to FHO patients making 32.92 more less-urgent ED visits per 1,000 patients per year (95% CI: 28.36, 37.48) compared to their FHG counterparts (Table 5.4). In total, FHO patients made 45.88 more ED visits per 1,000 patients per year (95% CI: 36.50, 55.27).

5.3.3 Association between Primary Care Services and Emergency Department Visits

The rate of primary care services delivered was associated with a reduction in less-urgent ED visits, with an increase of one primary care service per rostered patient associated with a 1% reduction in less-urgent ED visits per patient per year (95% CI: 1%, 2%) for

FHG patients and a slightly larger reduction of 3% (95% CI: 3%, 4%) for FHO patients (Table 5.5). The magnitude of these associations was larger during after-hours, and an increase of one primary care service provided during after-hours per rostered patient was associated with a 12% reduction in less-urgent ED visits during after-hours per patient per year (95% CI: 10%, 14%) for FHG patients and 16% (95% CI: 14%, 19%) for FHO physicians' patients. Conversely, increases in the rate of primary care services delivered were associated with increases in very-urgent and urgent ED visits, with a similar magnitude across the FHG and FHO models. When stratified by timing, the rate of services provided during regular-hours in the FHO was not associated with urgent ED visits; however, the rate of after-hours services was associated with larger increases in both very-urgent and urgent ED visits during after-hours in the FHO model compared to the FHG model.

5.3.4 Effects of Physician Remuneration on Primary Care Services and Emergency Department Visits by Morbidity

Subgroup analyses by the number of chronic conditions found that for patients of any morbidity group, being in an FHO was associated with the provision of fewer primary care services (Table 5.6). The association between physician model type and primary care services was greater for multimorbid patients, with FHO model being associated with 25% fewer primary care services per patient per year (95% CI: 23%, 26%). For non-morbid and single-morbid patients, FHO model was associated with 13% and 14% fewer primary care services, respectively. Across all three groups, the association between FHO and services provided during after-hours was similar. Although analyses demonstrated that all patient groups received fewer primary care services in the FHO model, the effects on ED visits were less consistent across chronic condition subgroups. FHO physicians had non-morbid and single-morbid patients who made more ED visits of urgent and less-urgent nature compared to FHG counterparts; however, for multimorbid patients, not only was there no difference in less-urgent ED visits between the FHG and FHO models, but multimorbid FHO patients made 7% fewer urgent ED visits per patient per year and 17% fewer very-urgent ED visits per patient per year than multimorbid FHG patients.

Total ED visits were higher among non-morbid and single-morbid FHO patients by 19% and 12% per patient per year, respectively, but FHO multimorbid patients made 8% fewer ED visits per patient per year.

Across subgroup analyses for the six common chronic conditions, the effect of FHO model on primary care services was smallest for patients with cancer (Incidence Rate Ratio [IRR]: 0.96; 95% CI: 0.94, 0.98) and largest for patients with asthma, diabetes, or a mental disorder or substance use, the reduction in services provided ranging from 22% to 27% (Table 5.7). The reduction in after-hours primary care services delivered by FHO physicians was as large as 37% per patient per year for patients with asthma. Increases in less-urgent ED visits were found for all groups, with the smallest difference in patients with a mental disorder or substance use (IRR: 1.05; 95% CI: 1.01, 1.09), and FHO patients with a mental disorder or substance use made fewer ED visits of very-urgent and urgent nature compared to their FHG counterparts. The largest differences in ED visits were found for cancer and COPD, as FHO cancer and COPD patients made 23% and 30% more less-urgent ED visits compared to FHG cancer and COPD patients, respectively, with higher rates of urgent ED visits also found.

5.3.5 Pairwise Comparisons between Family Health Group, Family Health Organization, and Family Health Team

Compared to the FHG model, both the non-FHT FHO and FHT physicians provided fewer primary care services (Table 5.8). The difference in primary care services between the non-FHT FHO and FHT models was small, and compared to the non-FHT FHO model, FHT physicians provided 3% fewer primary care services per patient per year (95% CI: 2%, 4%) during any timing, with 6% fewer primary care services provided during after-hours (95% CI: 4%, 8%). Pairwise comparisons demonstrated that much of the difference in ED visits between the FHG and FHO models was due to greater ED visits by FHT patients, with FHT patients making 38% more less-urgent ED visits per patient per year (95% CI: 32%, 44%) than FHG patients whereas non-FHT FHO patients made only 16% more less-urgent ED visits per patient per year (95% CI: 11%, 20%) than

FHG patients. Compared to non-FHT FHO physicians' patients, FHT patients made 26% more less-urgent ED visits per patient per year (95% CI: 21%, 30%). Additionally, the non-FHT FHO model was associated with a reduction in very-urgent ED visits, FHO patients making 6% fewer very-urgent ED visits per patient per year than their FHG counterparts.

5.3.6 Additional Subgroup Analyses

The subgroup analysis focusing only on urban patients demonstrated similar findings to the main analysis, with FHO patients receiving fewer primary care services compared to their FHG counterparts and making more less-urgent and urgent ED visits (Table 5.9). However, unlike the main analyses, urban FHO patients made 7% fewer very-urgent ED visits per patient per year compared to urban FHG patients. Subgroup analyses by patient sex found similar associations between FHO model and primary care services; however, for female patients, there was a larger effect of FHO model on the rate of less-urgent ED visits despite similar effects on the rate of urgent ED visits. Similarly, subgroup analyses by area income demonstrated similar associations between FHO model and primary care services, although only FHO patients living in a middle- or high-income area made fewer very-urgent ED visits in the FHO model compared to the FHG model.

For subgroup analyses by physician sex, male FHO physicians provided 15% fewer primary care services per patient per year than male FHG physicians while female FHO physicians provided 14% fewer services per patient per year than female FHG physicians. Despite the similar effect in primary care, there was a relatively smaller increase in ED visits between the FHO and FHG model for patients of female physicians compared to patients of male physicians. Female FHO physicians additionally had patients who made fewer very-urgent ED visits compared to patients of female FHG physicians, whereas no difference was found in very-urgent ED visits between the FHG and FHO models for male physicians.

5.4 Discussion

FHO physicians provided fewer primary care services but had patients who made more visits to the ED, especially for less-urgent visits. While the reduction in primary care services delivered by FHO physicians was greater during after-hours compared to regular-hours, the relative difference in ED visits between the FHG and FHO physicians' patients was similar between regular-hours and after-hours. Additionally, although the FHO model was consistently associated with fewer primary care services, very-urgent and urgent ED visits were lower in the FHO model for multimorbid patients, while less-urgent ED visits were similar between the two models for these patients.

Recent evidence suggests that physicians who switched from an FHG to an FHO model provided 5%-15% fewer primary care services after switching.[50,51] Similarly, these results suggest that FHO physicians provided 14% fewer primary care services even in the stable period after transitions between models had slowed. These results are additionally consistent with a previous study comparing the FHG model and the earlier FHN model, that found patients of enhanced FFS physicians received more primary care services compared to patients of capitation physicians.[20] However, while one study suggested that FHO physicians offer better access to care during after-hours after switching from an FHG model, an even greater reduction in services provided during after-hours was found, closer to results of earlier comparisons between the FHN and FHG, which found physicians paid by blended capitation provided less access to care during after-hours.[20]

In turn, FHO patients made more ED visits, especially for those of less-urgent nature. Previous studies also found that the blended capitation models were associated with an increase in ED visits relative to both the traditional FFS and enhanced FFS models.[3,20,52] Perhaps, one incentive that may be responsible for the higher rate of less-urgent ED visits in the FHO group, and especially the visits for FPSCs that are more likely to be treatable in the primary care setting, is the access bonus, which is clawed back as patients use primary care services outside their physician group.[5] However, the access bonus is not clawed back because of ED visits. Previously, a study noted that the access bonus was rewarding physicians whose patients used fewer services rather than being used to reward physicians who provided better access.[53] Due to the incentive structure, FHO physicians

may be redirecting their patients away from primary care setting towards the ED when they are not available. In contrast, FHG physicians may be indifferent to the type of care their patient uses outside of their services. Therefore, the access bonus may be driving an increase in the rate of less-urgent ED visits for FHO patients. Large differences for less-urgent ED visits for FPSCs were found between the FHO and FHG models, possibly indicating that FHO patients may lack suitable care from their own primary care provider, instead visiting the ED for conditions potentially treatable in the primary care setting.

For multimorbid patients, despite FHO physicians providing fewer services to this group, these patients made fewer very-urgent and urgent ED visits in the FHO model compared to the FHG model. Although studies found that the blended capitation models delivered fewer primary care services, they found they were more likely to reach preventive targets and provide more comprehensive and continuous care than physicians in the enhanced FFS models.[19,20] More preventative care delivered by FHO physicians may contribute to the reduction in very-urgent and urgent ED visits related to the FHO model for the multimorbid subgroup. Another explanation for the reduction in both primary care services and ED visits may be better management of chronic conditions through greater specialist visits, as some studies have found evidence that blended capitation models provide more specialist referrals.[2,8,9]

Sensitivity analyses demonstrated that much of the difference in primary care services and ED visits between the FHG and FHO models was driven by FHO-FHT patients. FHT physicians provided fewer primary care services and had patients who made more ED visits than both the FHG and non-team FHO physicians. This conflicts with previous evidence, including a review of teams which found that interdisciplinary teams were associated with a reduction in ED visits, as well as an Ontario-based study, which found a slower increase in ED visits among patients enrolled in the team-based model.[42,54]

Finally, several additional subgroup analyses by patient and physician demographic factors found that FHO physicians consistently provided fewer primary care services and made more less-urgent ED visits compared to their FHG counterparts; however, for

patients living in an urban area or a middle- or high-income area as well as patients with a female physician, the FHO model was associated with fewer very-urgent ED visits.

5.4.1 Limitations

Although this study uses rich retrospective data, it comes with several limitations. First, there may be minor differences in the total proportion of all services billed between the FHG and FHO models, as while FHG physicians receive the complete value of all services billed, FHO physicians receive only a 15% shadow-billing premium on in-basket services. Ensuring all records are complete is thus of greater interest to FHG physicians compared to FHO physicians, who would receive capitation payment regardless of whether they provide services to rostered patients and submit shadow-billing. Secondly, for both groups, OHIP does not record timing of primary care services, and thus weekday out-of-hour services are based on the after-hours premium, which is only available on a select set of services. The actual number of after-hours services provided are underestimated by this analysis. Additionally, for the analysis examining the association between the rate of primary care services and ED visits, caution is warranted on the timing-specific models as the definitions of after-hours are slightly different between the primary care and ED settings.

Thirdly, multimorbidity is constructed from a set of seventeen chronic conditions, which may differ in severity both across and within conditions, neither of which were accounted for in the analyses. For example, patients with CHF or cardiovascular disease may require greater attention from a primary care provider than patients with hypertension. The definition of multimorbidity does not account for disease severity, such as complications that may arise from a condition, which may be subject to physician selection between models. Fourth, all analyses were conducted at the physician-level, and while results demonstrate that physician remuneration is associated with their patients' healthcare utilization, the same magnitude and direction of effect may not hold at the individual patient-level. Therefore, caution is warranted when attempting to interpret how these results may apply to patients. Additionally, because analyses were conducted at the

physician-level, only aggregated patient characteristics were controlled in the analysis. Finally, while these analyses capture the impact of physician remuneration on primary care and ED visits, it does not capture other health care utilization such as specialist visits and walk-in clinics. Specialist services may contribute to more comprehensive care avoiding very-urgent and urgent ED visits, while one reason for patients to visit the ED in favour of a walk-in clinic in the FHO model is advice from physicians, who are penalized by the access bonus as their patients use primary care services outside of their group.[53]

5.4.2 Future Directions

Further research is required to investigate access and quality of care in the FHG and FHO models. Surveys of physicians and patients are required to capture whether access to primary care services differs between the models, and whether there may be differences in the way access is promoted between these two models, especially during after-hours. Additionally, while multimorbid patients in the FHO make fewer very-urgent and urgent ED visits, further investigation on the mechanisms by which these visits are minimized is required. While it is possible that FHO physicians are offering care that is more comprehensive, it is also possible that FHO physicians are simply selecting patients with lower severity of disease, leaving sicker patients who require more health care services to FHG physicians. Future research should investigate what drives these differences in ED visit rates for multimorbid patients. Research exploring the differential impact of incentives for comprehensive care management and preventive care bonuses between the FHG and FHO models along with different processes of care should be investigated in future studies. Future work may also be used to explore what common combinations of chronic conditions may be better managed by primary care physicians, not only focusing on the effects of the payment model but also how team-based primary care could potentially affect health care utilization of patients with different levels of morbidity.

5.5 Conclusion

As primary care models have stabilized in Ontario, physicians in the FHO model offer fewer primary care services compared to physicians in the FHG model, with their patients making more less-urgent ED visits, especially those that may be potentially treatable in the primary care setting. Although FHO primary care physicians provide far fewer services during after-hours, the difference in ED visits between the FHG and FHO models does not appear to differ by timing. Despite this, multimorbid patients make fewer very-urgent and urgent ED visits in the FHO model compared to the FHG model. Policymakers should consider the potential trade-offs in access to and quality of care when considering the implementation of these different remuneration models.

Table 5.1 Physician and aggregate physician-level patient descriptive characteristics and outcomes by fiscal year

	2012/13	2013/14	2014/15	2015/16	2016/17
Physician Characteristics					
Number of Physicians	5,466	5,648	5,716	5,697	5,567
FHG, *n* (%)	1,953 (35.73%)	2,033 (36.00%)	2,031 (35.53%)	2,016 (35.39%)	1,962 (35.24%)
FHO, *n* (%)	3,513 (64.27%)	3,615 (64.00%)	3,685 (64.47%)	3,681 (64.61%)	3,605 (64.76%)
non-FHT FHO	1,862 (53.00%)	1,874 (51.84%)	1,901 (51.59%)	1,908 (51.83%)	1,854 (51.43%)
FHT	1,651 (47.00%)	1,741 (48.16%)	1,784 (48.41%)	1,773 (48.17%)	1,751 (48.57%)
Physician Age, mean (SE)	51.77 (0.15)	52.09 (0.15)	52.49 (0.15)	52.96 (0.15)	53.51 (0.15)
Female Physician, *n* (%)	2,317 (42.39%)	2,4431 (43.04%)	2,496 (43.67%)	2,527 (44.36%)	2,503 (44.96%)
International Medical Graduate, *n* (%)	1,171 (21.42%)	1,278 (22.63%)	1,332 (23.30%)	1,346 (23.63%)	1,330 (23.89%)
Group Size, mean (SE)	28.3 (0.6)	28.0 (0.5)	27.2 (0.5)	26.0 (0.5)	25.1 (0.5)
Roster Size, mean (SE)	1,178 (8)	1,163 (8)	1,152 (8)	1,140 (7)	1,136 (7)
Aggregate Patient Characteristics					
Mean Age, mean (SE)	48.50 (0.06)	48.76 (0.06)	49.07 (0.06)	49.39 (0.06)	49.63 (0.07)
Proportion Female (%), mean (SE)	55.10 (0.18)	54.98 (0.17)	54.84 (0.17)	54.68 (0.17)	54.63 (0.17)
Proportion Low-Income Rrea (%), mean (SE)	35.49 (0.20)	37.80 (0.20)	37.49 (0.20)	37.22 (0.20)	36.98 (0.19)
Proportion Rural (%), mean (SE)	6.49 (0.25)	6.60 (0.25)	6.60 (0.25)	6.62 (0.25)	6.53 (0.25)
Proportion Non-Morbid (%), mean (SE)	37.44 (0.11)	38.09 (0.11)	38.74 (0.11)	39.46 (0.11)	40.13 (0.12)
Proportion Single-Morbid (%), mean (SE)	29.78 (0.04)	30.02 (0.04)	30.25 (0.04)	30.44 (0.04)	30.64 (0.04)
Proportion Multimorbid (%), mean (SE)	32.78 (0.12)	31.89 (0.12)	31.01 (0.12)	30.11 (0.12)	29.23 (0.12)
Proportion with a Chronic Condition (%), mean (SE)					
Arthritis	1.45 (0.01)	1.42 (0.01)	1.37 (0.01)	1.33 (0.01)	1.29 (0.01)
Asthma	7.63 (0.04)	8.07 (0.04)	8.48 (0.04)	8.87 (0.04)	9.26 (0.04)
Cancer	8.28 (0.04)	7.81 (0.04)	7.38 (0.04)	6.96 (0.03)	6.56 (0.03)
CHF	4.24 (0.04)	3.92 (0.03)	3.58 (0.03)	3.26 (0.03)	2.92 (0.03)

CVD	2.27 (0.02)	2.15 (0.02)	2.03 (0.02)	1.91 (0.02)	1.80 (0.010
CKD	2.17 (0.02)	2.03 (0.02)	1.88 (0.02)	1.72 (0.01)	1.58 (0.01)
COPD	10.77 (0.08)	10.33 (0.08)	9.89 (0.08)	9.45 (0.07)	9.02 (0.07)
Dementia	2.86 (0.04)	2.59 (0.04)	2.31 (0.04)	2.06 (0.05)	1.76 (0.05)
Diabetes	15.07 (0.07)	14.72 (0.07)	14.36 (0.07)	13.97 (0.07)	13.59 (0.07)
HIV	0.14 (0.01)	0.14 (0.01)	0.14 (0.01)	0.15 (0.01)	0.14 (0.02)
Hypertension	33.75 (0.13)	32.86 (0.13)	32.02 (0.12)	31.15 (0.12)	30.33 (0.12)
IBD	0.96 (0.01)	0.95 (0.01)	0.94 (0.01)	0.93 (0.01)	0.92 (0.01)
Liver Disease	1.60 (0.01)	1.52 (0.01)	1.45 (0.01)	1.37 (0.01)	1.28 (0.01)
Mental Disorder or Substance Use	25.85 (0.12)	25.53 (0.11)	25.15 (0.11)	24.72 (0.11)	24.24 (0.11)
Osteoporosis	2.45 (0.03)	2.37 (0.02)	2.30 (0.02)	2.23 (0.02)	2.16 (0.02)
Stroke	2.55 (0.02)	2.37 (0.02)	2.19 (0.02)	2.01 (0.02)	1.82 (0.02)
Urinary Incontinence	3.99 (0.03)	3.89 (0.03)	3.78 (0.03)	3.67 (0.03)	3.57 (0.03)
Outcomes					
Primary Care, mean (SE)					
Services per 1,000	15,081 (50)	15,214 (52)	15,372 (52)	15,398 (53)	15,393 (53)
Regular-Hours	13,660 (45)	13,750 (46)	13,849 (46)	13,832 (46)	13,878 (46)
After-Hours	1,421 (12)	1,464 (12)	1,523 (13)	1,565 (13)	1,515 (13)
Value (2016 CAD)	577.27 (1.93)	592.42 (2.01)	606.24 (2.00)	621.44 (2.08)	636.39 (2.14)
Regular-Hours	526.27 (1.76)	539.39 (1.83)	550.63 (1.81)	562.03 (1.87)	577.48 (1.92)
After-Hours	51.00 (0.32)	53.04 (0.34)	55.60 (0.35)	59.40 (0.37)	58.91 (0.38)
ED Visits per 1,000 patients, mean (SE)					
Total	396.30 (2.56)	396.07 (2.43)	399.79 (2.41)	403.13 (2.37)	402.30 (2.31)
Regular-Hours	163.84 (1.30)	165.19 (1.26)	165.80 (1.23)	167.15 (1.19)	167.17 (1.16)
After-Hours	232.46 (1.33)	230.88 (1.24)	233.98 (1.24)	235.98 91.24)	235.13 (1.22)
Very-Urgent	72.93	79.85	83.60	86.20	88.11

	(0.42)	(0.43)	(0.43)	(0.44)	(0.44)
Regular-Hours	27.53 (0.18)	30.41 (0.18)	31.68 (0.18)	32.64 (0.18)	33.46 (0.18)
After-Hours	45.39 (0.27)	49.44 (0.27)	51.92 (0.27)	53.56 (0.28)	54.66 (0.28)
Urgent	176.71 (0.94)	180.61 (0.92)	185.99 (0.94)	187.94 (0.95)	189.06 (0.96)
Regular-Hours	70.52 (0.44)	73.46 (0.44)	75.67 (0.44)	76.50 (0.45)	77.39 (0.45)
After-Hours	106.19 (0.54)	107.15 (0.52)	110.32 (0.53)	111.44 (0.54)	111.67 (0.55)
Less-Urgent	146.66 (1.79)	135.62 (1.67)	130.20 (1.59)	128.99 (1.50)	125.12 (1.40)
Regular-Hours	65.78 (0.97)	61.33 (0.92)	58.45 (0.87)	58.01 (0.80)	56.32 (0.75)
After-Hours	80.88 (0.87)	74.29 (0.79)	71.74 (0.76)	70.97 (0.73)	68.79 (0.69)
Less-Urgent for FPSCs	26.07 (0.44)	23.67 (0.40)	24.10 (0.40)	23.36 (0.38)	22.31 (0.36)
Regular-Hours	10.87 (0.22)	9.95 (0.21)	10.11 (0.21)	9.80 (0.19)	9.34 (0.18)
After-Hours	15.20 (0.23)	13.72 (0.21)	13.99 (0.21)	13.56 (0.20)	12.97 (0.19)

CAD: Canadian Dollars; CHF: Coronary Heart Failure; CKD: Chronic Kidney Disease; CVD: Cardiovascular Disease; COPD: Chronic Obstructive Pulmonary Disease; FHG: Family Health Group; FHO: Family Health Organization; FHT: Family Health Team; FPSC: Family Practice-Sensitive Condition; HIV: Human Immunodeficiency Virus; IBD: Inflammatory Bowel Disease

Frequencies presented as n (%), while means presented as mean (SE).

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays for ED visits; regular-hours refers to weekdays, while after-hours refers to weekends, statutory holidays, and services billed with the after-hours premium for primary care services.

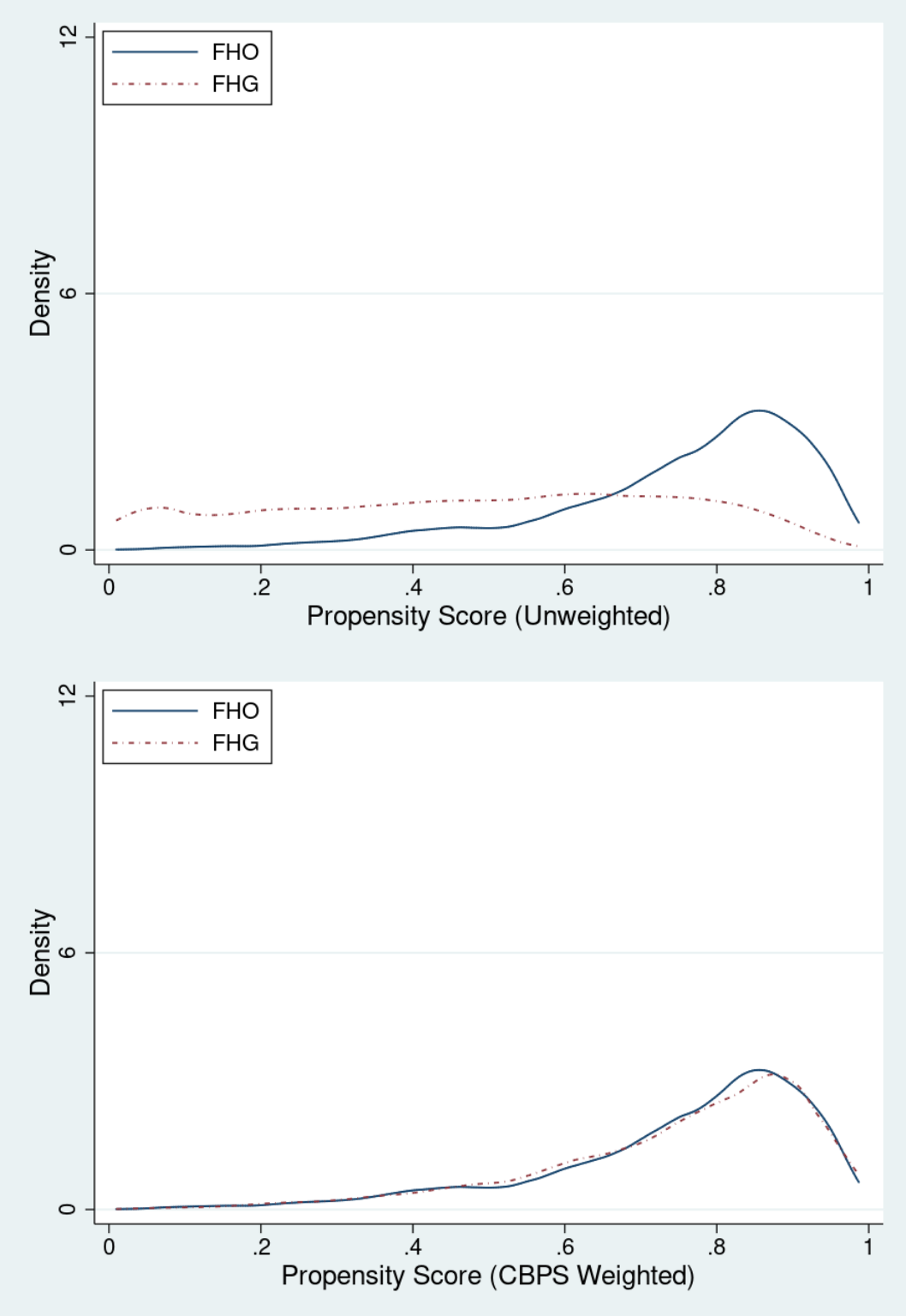

Figure 5.1 Propensity score distribution before and after CBPS weighting

Table 5.2 Propensity score model diagnostics, before and after CBPS weighting

Variable	Unweighted				CBPS Weighted				
	FHG	FHO	P-value	% Bias	FHG	FHO	P-value	% Bias	Reduction in |Bias|
Sample Size	9,668	18,059			9,668	18,059			
Year	2015	2015	0.78	0.4	2015	2015	0.92	0.1	65.6
Physician Characteristics									
Physician Age	54.00	51.66	0.000	-21.2	51.63	51.66	0.83	0.2	98.9
Physician Age-Squared	3,039	2,790	0.000	-21.2	2,787	2,790	0.85	0.2	98.9
Physician Female	0.42	0.45	0.000	5.7	0.45	0.45	0.93	0.1	98.1
IMG	0.36	0.15	0.000	-49.6	0.15	0.15	0.98	0.0	100.0
Group Size	38.88	17.40	0.000	-57.2	17.36	17.40	0.84	0.1	99.8
Roster Size	1,208	1,124	0.000	-14.2	1,123	1,124	0.91	0.1	99.1
Aggregate Patient Characteristics									
Patient Age	47.75	49.84	0.000	43.7	49.86	49.84	0.82	-0.3	99.3
Patient Female	54.35	55.16	0.000	6.1	55.15	55.16	0.95	0.1	98.7
Low-Income Area	38.40	35.95	0.000	-16.2	35.98	35.95	0.86	-0.2	98.7
Rural	2.77	8.55	0.000	33.9	8.71	8.55	0.58	-0.9	97.4
Single-Morbid	29.91	30.43	0.000	16.4	30.44	30.43	0.90	-0.2	99.0
Multimorbidity	31.05	30.85	0.08	-2.1	30.85	30.85	0.99	0.0	99.2

CBPS: Covariate-Balancing Propensity Score; IMG: International Medical Graduate

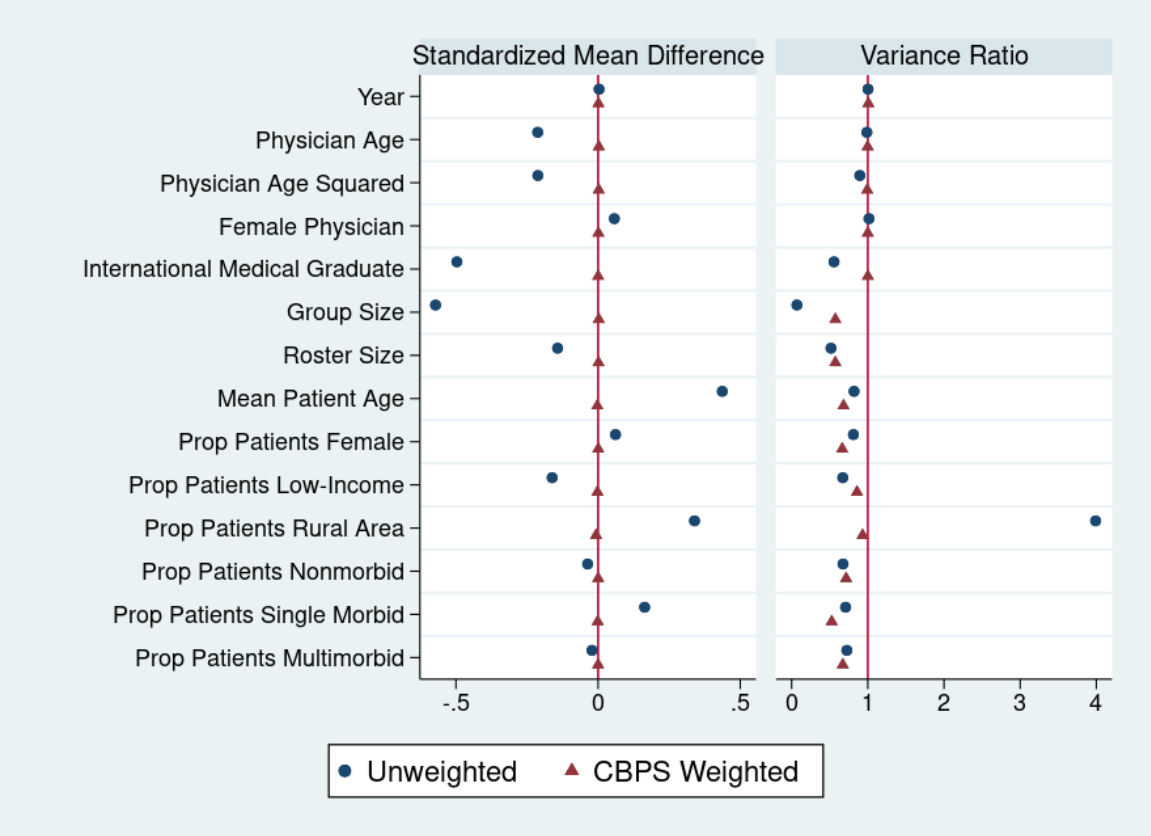

Figure 5.2 Standardized mean difference and variance ratio before and after weighting using propensity score weighting and entropy balancing

Table 5.3 Effect of being in an FHO model compared to FHG model on primary care services and ED visits (*N* = 27,727)

	Any Timing	Regular Hours	After-Hours
Primary Care			
Services per 1,000 patients IRR (95% CI)	0.86*** (0.85, 0.87)	0.87*** (0.86, 0.88)	0.73*** (0.71, 0.75)
Value (2016 CAD per year) Difference (95% CI)	-67.55*** (-75.49, -59.62)	-56.84*** (-63.71, -49.97)	-10.71*** (-12.92, -8.51)
ED visits per 1,000 patients IRR (95% CI)			
Total	1.12*** (1.09, 1.15)	1.14*** (1.11, 1.17)	1.11*** (1.08, 1.13)
Very-Urgent	0.98 (0.96, 1.01)	0.99 (0.96, 1.02)	0.98* (0.95, 1.00)
Urgent	1.10*** (1.07, 1.13)	1.11*** (1.08, 1.14)	1.09*** (1.06, 1.11)
Less-Urgent	1.27*** (1.23, 1.32)	1.29*** (1.24, 1.34)	1.26*** (1.21, 1.30)
Less-Urgent for FPSCs	1.45*** (1.38, 1.53)	1.47*** (1.39, 1.55)	1.44*** (1.37, 1.52)

*P < 0.10, **P <0.05, *** P < 0.01

CAD: Canadian Dollars; CI: Confidence Interval; ED: Emergency Department; FHG: Family Health Group; FHO: Family Health Organization; FPSC: Family Practice-Sensitive Condition; IRR: Incidence Rate Ratio

Controlled for year, physician (physician age, physician sex, international medical graduate status, and group size) and aggregate patient characteristics (roster size, mean patient age, proportion of female patients, proportion of patients living in low-income area, proportion of patients living in rural area, proportion of patients with a single-morbidity, and proportion of patients with multimorbidity) in CBPS weighted multivariable negative-binomial (and linear for primary care value) regression models. Confidence intervals are based on standard errors clustered at the physician-level.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays for ED visits; regular-hours refers to weekdays, while after-hours refers to weekends, statutory holidays, and services billed with the after-hours premium for primary care services.

Table 5.4 Absolute difference using marginal effects of being in an FHO model compared to FHG model on primary care services and ED visits (*N* = 27,727)

	Any Timing	Regular Hours	After-Hours
Primary Care Services per 1,000 patients per year Difference (95% CI)			
Services	-2,387*** (-2,565, -2,210)	-1,905*** (-2,067, -1,743)	-449*** (-496, -401)
ED visits per 1,000 patients per year Difference (95% CI)			
Total	45.88*** (36.50, 55.27)	22.41*** (18.12, 26.71)	23.81*** (18,56, 29.06)
Very-Urgent	-1.58 (-3.72, 0.56)	-0.29 (-1.28, 0.70)	-1.17* (-2.39, 0.04)
Urgent	16.85*** (12.22, 21.48)	8.02*** (5.98, 10.06)	8.94*** (6.30, 11.58)
Less-Urgent	32.92*** (28.36, 37.48)	15.86*** (13.69, 18.03)	17.19*** (14.70, 19.67)
Less-Urgent for FPSCs	9.50*** (8.31, 10.70)	4.19*** (3.65, 4.73)	5.31*** (4.62, 6.00)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; ED: Emergency Department; FHG: Family Health Group; FHO: Family Health Organization; FPSC: Family Practice-Sensitive Condition

Marginal effects from CBPS weighted multivariable negative-binomial regression models, controlling for year, physician (physician age, physician sex, international medical graduate status, and group size) and aggregate patient characteristics (roster size, mean patient age, proportion of female patients, proportion of patients living in low-income area, proportion of patients living in rural area, proportion of patients with a single-morbidity, and proportion of patients with multimorbidity). Confidence intervals are based on standard errors clustered at the physician-level.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays for ED visits; regular-hours refers to weekdays, while after-hours refers to weekends, statutory holidays, and services billed with the after-hours premium for primary care services.

Table 5.5 Physician remuneration model and the association between the rate of primary care services on ED visits (*N* = 27,727)

		ED visits IRR (95% CI)		
		Any Timing	Regular-Hours	After-Hours
Total	Services	1.01*** (1.01, 1.02)	1.02*** (1.01, 1.03)	0.96*** (0.94, 0.98)
	FHO	1.38*** (1.24, 1.54)	1.52*** (1.34, 1.73)	1.07*** (1.03, 1.12)
	Interaction of Services and FHO	0.99*** (0.98, 0.99)	0.98*** (0.97, 0.99)	1.01 (0.99, 1.04)
Very-Urgent	Services	1.03*** (1.02, 1.04)	1.04*** (1.03, 1.04)	1.02 (0.99, 1.04)
	FHO	1.02 (0.90, 1.16)	1.09 (0.95, 1.24)	0.88*** (0.84, 0.92)
	Interaction of Services and FHO	1.00 (0.99, 1.01)	0.99 (0.99, 1.01)	1.10*** (1.06, 1.13)
Urgent	Services	1.02*** (1.01, 1.02)	1.03*** (1.02, 1.03)	0.97*** (0.95, 0.98)
	FHO	1.33*** (1.19, 1.48)	1.48*** (1.30, 1.68)	1.03 (0.99, 1.08)
	Interaction of Services and FHO	0.99*** (0.98, 0.99)	0.98*** (0.97, 0.99)	1.03** (1.01, 1.06)
Less-Urgent	Services	0.99*** (0.98, 0.99)	1.00 (0.99, 1.01)	0.88*** (0.86, 0.90)
	FHO	1.74*** (1.49, 2.02)	1.93*** (1.63, 2.30)	1.26*** (1.18, 1.35)
	Interaction of Services and FHO	0.98*** (0.87, 0.98)	0.97*** (0.96, 0.98)	0.95*** (0.91, 0.99)
Less-Urgent for FPSCs	Services	0.96*** (0.95, 0.97)	0.97*** (0.95, 0.98)	0.79*** (0.76, 0.82)
	FHO	2.05*** (1.64, 2.57)	2.19*** (1.68, 2.84)	1.48*** (1.34, 1.63)
	Interaction of Services and FHO	0.97*** (0.95, 0.98)	0.96*** (0.95, 0.98)	0.90*** (0.85, 0.95)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; ED: Emergency Department; FHG: Family Health Group; FHO: Family Health Organization; FPSC: Family Practice-Sensitive Condition; IRR: Incidence Rate Ratio

Controlled for year, physician (physician age, physician sex, international medical graduate status, and group size) and aggregate patient characteristics (roster size, mean patient age, proportion of female patients, proportion of patients living in low-income area, proportion of patients living in rural area, proportion of patients with a single-morbidity, and proportion of patients with multimorbidity) in CBPS weighted multivariable negative-binomial (and linear for primary care value) regression models.

Confidence intervals are based on standard errors clustered at the physician-level.

Services refers to the effect of an increase in the rate of services by one primary care service received per patient per year. IRR is for the ratio of ED visits per patient per year.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays for ED visits; regular-hours refers to weekdays, while after-hours refers to weekends, statutory holidays, and services billed with the after-hours premium for primary care services.

Table 5.6 Effect of being in an FHO model compared to FHG model on primary care services and ED visits by number of chronic conditions

	Any Timing	Regular Hours	After-Hours
Non-Morbid Patients (*N* = 27,620)			
Primary Care Services IRR (95% CI)	0.87*** (0.85, 0.90)	0.89*** (0.87, 0.92)	0.72*** (0.69, 0.76)
Primary Care Value Difference (95% CI)	-38.23*** (41.73, -34.73)	-32.47*** (-35.67, -29.27)	-5.76*** (-6.46, -5.05)
Total ED Visits IRR (95% CI)	1.19*** (1.16, 1.22)	1.21*** (1.18, 1.25)	1.18*** (1.15, 1.21)
Very-Urgent	1.03** (1.00, 1.06)	1.04** (1.01, 1.07)	1.03* (0.99, 1.05)
Urgent	1.14*** (1.11, 1.17)	1.16*** (1.12, 1.19)	1.13*** (1.10, 1.17)
Less-Urgent	1.31*** (1.26, 1.35)	1.33*** (1.28, 1.38)	1.30*** (1.26, 1.34)
Less-Urgent for FPSCs	1.51*** (1.43, 1.59)	1.53*** (1.44, 1.62)	1.49*** (1.42, 1.58)
Single-Morbid Patients (*N* = 27,737)			
Primary Care Services IRR (95% CI)	0.86*** (0.83, 0.89)	0.88*** (0.85, 0.91)	0.68*** (0.65, 0.71)
Primary Care Value Difference (95% CI)	-89.50 (-113.36, -65.65)	-73.38 (-91.21, -55.55)	-16.12 (-25.62, -6.63)
Total ED Visits IRR (95% CI)	1.12*** (1.08, 1.16)	1.13*** (1.10, 1.17)	1.11*** (1.07, 1.14)
Very-Urgent	0.99 (0.96, 1.02)	1.00 (0.96, 1.03)	0.98 (0.95, 1.01)
Urgent	1.08*** (1.05, 1.12)	1.09*** (1.06, 1.13)	1.07*** (1.04, 1.10)
Less-Urgent	1.25*** (1.19, 1.31)	1.25*** (1.20, 1.31)	1.23*** (1.18, 1.28)
Less-Urgent for FPSCs	1.41*** (1.33, 1.49)	1.42*** (1.34, 1.52)	1.38 (1.31, 1.47)
Multimorbid Patients (*N* = 27,894)			
Primary Care Services IRR (95% CI)	0.75*** (0.74, 0.77)	0.77*** (0.75, 0.78)	0.66*** (0.63, 0.69)
Primary Care Value Difference (95% CI)	-137.57*** (-156.22, -118.93)	-112.55 (-127.12, -97.98)	-25.02*** (-31.43, -18.61)
Total ED Visits IRR (95% CI)	0.92*** (0.90, 0.95)	0.94*** (0.91, 0.97)	0.91*** (0.89, 0.94)
Very-Urgent	0.83*** (0.81, 0.86)	0.84*** (0.82, 0.87)	0.83*** (0.80, 0.85)
Urgent	0.93*** (0.90, 0.96)	0.94*** (0.91, 0.97)	0.92*** (0.90, 0.95)
Less-Urgent	1.03 (0.98, 1.08)	1.04* (0.99, 1.09)	1.02 (0.98, 1.07)
Less-Urgent for FPSCs	1.17 (1.10, 1.24)	1.17*** (1.09, 1.25)	1.16*** (1.09, 1.24)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; ED: Emergency Department; FHG: Family Health Group; FHO: Family Health Organization; FPSC: Family Practice-Sensitive Condition; IRR: Incidence Rate Ratio
Controlled for year, physician (physician age, physician sex, international medical graduate status, and group size) and aggregate patient characteristics (roster size, mean patient age, proportion of female patients, proportion of patients living in low-income area, and proportion of patients living in rural area) in CBPS weighted multivariable negative-binomial (and linear for primary care value) regression models. Confidence intervals are based on standard errors clustered at the physician-level.
Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays for ED visits; regular-hours refers to weekdays, while after-hours refers to weekends, statutory holidays, and services billed with the after-hours premium for primary care services.
Primary care services and ED visits are per patient per year; primary care value is average value per patient per year in 2016 CAD (Canadian Dollars).

Table 5.7 Effect of being in an FHO model compared to FHG model on primary care services and ED visits by chronic condition

	Any Timing	Regular Hours	After-Hours
Asthma (*N* = 27,124)			
Primary Care Services IRR (95% CI)	0.75*** (0.3, 0.77)	0.77*** (0.75, 078)	0.63*** (0.60, 0.65)
Primary Care Value Difference (95% CI)	-100.01*** (-112.19, -87.83)	-81.74*** (-91.97, -71.51)	-18.27*** (-21.53, -15.02)
Total ED Visits IRR (95% CI)	0.99 (0.96, 1.02)	1.02 (0.99, 1.06)	0.97* (0.94, 1.00)
Very-Urgent	0.87*** (0.84, 0.90)	0.89*** (0.86, 0.92)	0.86*** (0.83, 0.89)
Urgent	0.97* (0.94, 1.00)	1.00 (0.97, 1.04)	0.96*** (0.93, 0.99)
Less-Urgent	1.13*** (1.08, 1.18)	1.17*** (1.12, 1.22)	1.11*** (1.06, 1.16)
Less-Urgent for FPSCs	1.30*** (1.22, 1.38)	1.31*** (1.22, 1.40)	1.30*** (1.22, 1.38)
Cancer (*N* = 28,052)			
Primary Care Services IRR (95% CI)	0.96*** (0.94, 0.98)	0.97*** (0.95, 0.99)	0.87*** (0.85, 0.90)
Primary Care Value Difference (95% CI)	-161.56 (-18.5,81, -137.31)	-137.23*** (-157.49, -116.98)	-24.32*** (-30.51, -18.13)
Total ED Visits IRR (95% CI)	1.10*** (1.07, 1.13)	1.11*** (1.07, 1.14)	1.08*** (1.05, 1.11)
Very-Urgent	0.98 (0.95, 1.02)	0.98 (0.95, 1.02)	0.98 (0.95, 1.01)
Urgent	1.09*** (1.06, 1.12)	1.10*** (1.06, 1.13)	1.08*** (1.05, 1.11)
Less-Urgent	1.23*** (1.18, 1.29)	1.24*** (1.18, 1.30)	1.22*** (1.16, 1.28)
Less-Urgent for FPSCs	1.38*** (1.28, 1.48)	1.37*** (1.26, 1.49)	1.37*** (1.27, 1.47)
COPD (*N* =27,0247)			
Primary Care Services IRR (95% CI)	0.90*** (0.87, 0.93)	0.91*** (0.88, 0.94)	0.81*** (0.77, 0.85)
Primary Care Value Difference (95% CI)	-152.87*** (-175.83, -129.91)	-125.20*** (-143.61, -106.80)	-27.67*** (-34.44, -20.90)
Total ED Visits IRR (95% CI)	1.12*** (1.07, 1.17)	1.14*** (1.09, 1.19)	1.10*** (1.05, 1.15)
Very-Urgent	0.98 (0.93, 1.03)	0.99 (0.94, 1.04)	0.97 (0.93, 1.02)
Urgent	1.13*** (1.08, 1.18)	1.14*** (1.09, 1.19)	1.12*** (1.07, 1.17)
Less-Urgent	1.30*** (1.23, 1.37)	1.32*** (1.25, 1.40)	1.28*** (1.20, 1.35)
Less-Urgent for FPSCs	1.46*** (1.36, 1.57)	1.46*** (1.34, 1.58)	1.44*** (1.34, 1.56)
Diabetes (*N* =27,356)			

Primary Care Services IRR (95% CI)	0.78*** (0.76, 0.89)	0.79*** (0.77, 0.81)	0.65*** (0.62, 0.69)
Primary Care Value Difference (95% CI)	-115.89*** (-136.82, -94.96)	-82.37*** (-108.24, -76.49)	-23.52*** (-30.96, -16.08)
Total ED Visits IRR (95% CI)	0.99 (0.95, 1.02)	1.01 (0.97, 1.04)	0.97* (0.94, 1.01)
Very-Urgent	0.87*** (0.84, 0.90)	0.89*** (0.85, 0.92)	0.87*** (0.83, 0.90)
Urgent	1.00 (0.96, 1.03)	1.01 (0.98, 1.05)	0.99 (0.96, 1.02)
Less-Urgent	1.13*** (1.08, 1.19)	1.16*** (1.10, 1.22)	1.12*** (1.07, 1.17)
Less-Urgent for FPSCs	1.31*** (1.23, 1.40)	1.34*** (1.25, 1.44)	1.30*** (1.22, 1.38)
Hypertension (N = 27,915)			
Primary Care Services IRR (95% CI)	0.82*** (0.80, 0.84)	0.83*** (0.81, 0.85)	0.70*** (0.67, 0.72)
Primary Care Value Difference (95% CI)	-108.88 (-124.71)	-88.28*** (-100.89, -75.67)	-20.61*** (-26.09, -15.12)
Total ED Visits IRR (95% CI)	1.02 (0.99, 1.05)	1.04** (1.01, 1.08)	1.00 (0.98, 1.03)
Very-Urgent	0.90*** (0.87, 0.93)	0.92*** (0.88, 0.95)	0.90*** (0.87, 0.93)
Urgent	1.03* (0.99, 1.06)	1.05*** (1.01, 1.08)	1.02 (0.99, 1.05)
Less-Urgent	1.16*** (1.11, 1.21)	1.18*** (1.12, 1.24)	1.15*** (1.09, 1.20)
Less-Urgent for FPSCs	1.33*** (1.24, 1.42)	1.36*** (1.27, 1.46)	1.30*** (1.21, 1.39)
Mental Disorder or Substance Use (N = 27,127)			
Primary Care Services IRR (95% CI)	0.73*** (0.71, 0.76)	0.74*** (0.72, 0.77)	0.66*** (0.63, 0.68)
Primary Care Value Difference (95% CI)	-126.54*** (141.10, -111.98)	-107.51*** (-120.18, -94.84)	-19.03*** (-22.60, -15.47)
Total ED Visits IRR (95% CI)	0.95*** (0.92, 0.97)	0.96** (0.94, 0.99)	0.94*** (0.91, 0.96)
Very-Urgent	0.86*** (0.84, 0.89)	0.87*** (0.85, 0.90)	0.85*** (0.83, 0.88)
Urgent	0.93*** (0.91, 0.96)	0.95*** (0.92, 0.98)	0.92888 (0.90, 0.95)
Less-Urgent	1.05*** (1.01, 1.09)	1.07*** (1.02, 1.11)	1.04** (1.00, 1.09)
Less-Urgent for FPSCs	1.21*** (1.15, 1.28)	1.22*** (1.15, 1.29)	1.21*** (1.15, 1.28)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; COPD: Chronic Obstructive Pulmonary Disorder; ED: Emergency Department; FHG: Family Health Group; FHO: Family Health Organization; FPSC: Family Practice-Sensitive Condition; IRR: Incidence Rate Ratio

Controlled for year, physician (physician age, physician sex, international medical graduate status, and group size) and aggregate patient characteristics (roster size, mean patient age, proportion of female

patients, proportion of patients living in low-income area, proportion of patients living in rural area, and proportion of patients with multimorbidity) in CBPS weighted multivariable negative-binomial (and linear for primary care value) regression models. Confidence intervals are based on standard errors clustered at the physician-level.
Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays for ED visits; regular-hours refers to weekdays, while after-hours refers to weekends, statutory holidays, and services billed with the after-hours premium for primary care services.
Primary care services and ED visits are per patient per year; primary care value is average value per patient per year in 2016 CAD (Canadian Dollars).

Table 5.8 Effect of physician model on primary care services and ED visits, comparing between FHG, FHO, and FHT

	Any Timing	Regular Hours	After-Hours
non-FHT FHO vs. FHG (reference: FHG) (*N* = 18,195)			
Primary Care Services IRR (95% CI)	0.86*** (0.5, 0.87)	0.88*** (0.87, 0.89)	0.75*** (0.73, 0.78)
Primary Care Value Difference (95% CI)	-67.85*** (-76.51, -59.19)	-57.17*** (-64.71, -49.63)	-10.68*** (-13.19, -8.18)
Total ED Visits IRR (95% CI)	1.05*** (1.03, 1.08)	1.08*** (1.05, 1.10)	1.04*** (1.02, .106)
Very-Urgent	0.94*** (0.92, 0.97)	0.95*** (0.93, 0.98)	0.94*** (0.92, 0.96)
Urgent	1.05*** (1.02, 1.07)	1.07*** (1.04, 1.10)	1.04*** (1.01, 1.06)
Less-Urgent	1.16*** (1.11, 1.20)	1.18*** (1.13, 1.23)	1.14*** (1.10, 1.18)
Less-Urgent for FPSCs	1.29*** (1.21, 1.36)	1.32*** (1.24, 1.40)	1.26*** (1.19, 1.34)
FHT vs. FHG (reference: FHG) (*N* = 18,253)			
Primary Care Services IRR (95% CI)	0.85*** (0.84, 0.86)	0.87*** (0.86, 0.88)	0.70*** (0.68, 0.73)
Primary Care Value Difference (95% CI)	-66.01*** (-74.60, -57.41)	-55.15 (-62.68, -47.61)	-10.86*** (-12.89, -8.83)
Total ED Visits IRR (95% CI)	1.19*** (1.16, 1.23)	1.21*** (1.17, 1.25)	1.18*** (1.15, 1.21)
Very-Urgent	1.03* (0.99, 1.06)	1.04** (1.00, 1.09)	1.03* (0.99, 1.05)
Urgent	1.15*** (1.12, 1.19)	1.17*** (1.13, 1.21)	1.14*** (1.11, 1.18)
Less-Urgent	1.38*** (1.32, 1.44)	1.39*** (1.33, 1.45)	1.37*** (1.31, 1.43)
Less-Urgent for FPSCs	1.60*** (1.50, 1.69)	1.60*** (1.50, 1.70)	1.60*** (1.50, 1.70)
FHT vs. non-FHT FHO (reference: non-FHT FHO) (*N* = 17,272)			
Primary Care Services IRR (95% CI)	0.97*** (0.96, 0.98)	0.97*** (0.96, 0.98)	0.94*** (0.92, 0.96)
Primary Care Value Difference (95% CI)	-10.99 (-17.82, -4.17)	-10.10 (-16.50, -3.70)	-0.89* (-1.82, -0.37)
Total ED Visits IRR (95% CI)	1.15*** (1.13, 1.18)	1.15*** (1.12, 1.18)	1.16*** (1.13, 1.18)
Very-Urgent	1.07*** (1.05, 1.10)	1.09*** (1.06, 1.11)	1.07*** (1.05, 1.09)
Urgent	1.11*** (1.08, 1.13)	1.09*** (1.06, 1.13)	1.12*** (1.10, 1.14)
Less-Urgent	1.26*** (1.21, 1.30)	1.25*** (1.20, 1.29)	1.27*** (1.23, 1.31)
Less-Urgent for FPSCs	1.36*** (1.29, 1.43)	1.34*** (1.27, 1.42)	1.37*** (1.31, 1.44)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; ED: Emergency Department; FHG: Family Health Group; FHO: Family Health Organization; FHT: Family Health Team; FPSC: Family Practice-Sensitive Condition; IRR: Incidence Rate Ratio

Controlled for year, physician (physician age, physician sex, international medical graduate status, and group size) and aggregate patient characteristics (roster size, mean patient age, proportion of female patients, proportion of patients living in low-income area, proportion of patients living in rural area, proportion of patients with a single-morbidity, and proportion of patients with multimorbidity) in CBPS weighted multivariable negative-binomial (and linear for primary care value) regression models. Confidence intervals are based on standard errors clustered at the physician-level.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays for ED visits; regular-hours refers to weekdays, while after-hours refers to weekends, statutory holidays, and services billed with the after-hours premium for primary care services.

Primary care services and ED visits are per patient per year; primary care value is average value per patient per year in 2016 CAD (Canadian Dollars).

Table 5.9 Subgroup analyses for urban patients and by patient sex and area-level income, and physician sex

FHO	Any Timing	Regular Hours	After-Hours
Patients in Urban Area (*N* = 28,067)			
Primary Care Services IRR (95% CI)	0.80*** (0.78, 0.81)	0.81*** (0.80, 0.83)	0.68*** (0.66, 0.70)
Primary Care Value Difference (95% CI)	-75.05*** (-83.05, -67.05)	-63.45*** (-70.55, -56.36)	--1.60*** (-13.65, -9.54)
Total ED Visits IRR (95% CI)	1.07*** (1.04, 1.10)	1.09*** (1.06, 1.12)	1.05*** (1.03, 1.08)
Very-Urgent	0.93*** (0.91, 0.95)	0.95*** (0.92, 0.98)	0.92*** (0.90, 0.94)
Urgent	1.05*** (1.02, 1.08)	1.07*** (1.04, 1.10)	1.04*** (1.02, 1.07)
Less-Urgent	1.22*** (1.18, 1.27)	1.25*** (1.20, 1.30)	1.21*** (1.17, 1.25)
Less-Urgent for FPSCs	1.43*** (1.36, 1.51)	1.47*** (1.39, 1.55)	1.42*** (1.35, 1.50)
Male Patients (*N* =27,586)			
Primary Care Services IRR (95% CI)	0.84*** (0.82, 0.86)	0.86*** (0.84, 0.87)	0.70*** (0.68, 0.73)
Primary Care Value Difference (95% CI)	-61.69*** (-70.81, -52.56)	-51.08*** (-59.01, -43.14)	-10.61*** (12.72, -8.50)
Total ED Visits IRR (95% CI)	1.10*** (1.06, 1.13)	1.12*** (1.09, 1.16)	1.08*** (1.05, 1.11)
Very-Urgent	0.97* (0.94, 1.00)	0.98 (0.95, 1.01)	096** (0.93, 0.99)
Urgent	1.09*** (1.06, 1.12)	1.11*** (1.07, 1.14)	1.08*** (1.05, 1.11)
Less-Urgent	1.21*** (1.17, 1.26)	1.24*** (1.19, 1.29)	1.20*** (1.15, 1.24)
Less-Urgent for FPSCs	1.39*** (1.32, 1.47)	1.41*** (1.33, 1.49)	1.38*** (1.31, 1.46)
Female Patients (*N* = 27,731)			
Primary Care Services IRR (95% CI)	0.86*** (0.84 0.88)	0.88*** (0.86, 0.89)	0.73*** (0.71, 0.76)
Primary Care Value Difference (95% CI)	-76.35*** (-86.1, -66.51)	-64.93*** (-73.65, -56.20)	-11.42*** (-13.64, -9.20)
Total ED Visits IRR (95% CI)	1.13*** (1.09, 1.16)	1.14*** (1.11, 1.18)	1.11*** (1.08, 1.15)
Very-Urgent	0.98 (0.94, 1.01)	0.99 (0.95, 1.03)	0.97* (0.94, 1.00)
Urgent	1.09*** (1.06, 1.13)	1.10*** (1.07, 1.14)	1.08*** (1.05, 1.12)
Less-Urgent	1.30*** (1.25, 1.35)	1.31*** (1.25, 1.36)	1.29*** (1.24, 1.34)
Less-Urgent for FPSCs	1.48 (1.40, 1.56)	1.49*** (1.40, 1.58)	1.46*** (1.38, 1.54)
Patients in Low-Income Area (N = 27,370)			

Primary Care Services IRR (95% CI)	0.84*** (0.82, 0.86)	0.86*** (0.84, 0.88)	0.71*** (0.68, 0.74)
Primary Care Value Difference (95% CI)	-84.63 (-94.34, -74.92)	-71.53 (-79.81, -63.26)	-13.10*** (15.69, -10.50)
Total ED Visits IRR (95% CI)	1.13*** (1.09, 1.17)	1.15*** (1.11, 1.20)	1.12*** (1.08, 1.16)
Very-Urgent	1.00 (0.97, 1.03)	1.01 (0.97, 1.05)	1.00 (0.96, 1.03)
Urgent	1.12*** (1.08, 1.16)	1.14*** (1.10, 1.18)	1.11*** (1.07, 1.15)
Less-Urgent	1.27*** (1.20, 1.33)	1.28*** (1.22, 1.35)	1.26*** (1.19, 1.32)
Less-Urgent for FPSCs	1.43*** (1.33, 1.53)	1.43*** (1.33, 1.54)	1.41*** (1.31, 1.52)
Patients in Middle- or High-Income Area (*N* = 27,700)			
Primary Care Services IRR (95% CI)	0.85*** (0.83, 0.86)	0.86*** (0.84, 0.88)	0.72*** (0.70, 0.75)
Primary Care Value Difference (95% CI)	-64.96*** (-73.80, -56.13)	-53.95*** (-61.17, -46.74)	-11.01*** (-13.96, -8.06)
Total ED Visits IRR (95% CI)	1.10*** (1.07, 1.12)	1.12*** (1.09, 1.15)	1.08*** (1.06, 1.11)
Very-Urgent	0.95*** (0.93, 0.98)	0.96*** (0.93, 0.99)	0.95*** (0.92, 0.97)
Urgent	1.07*** (1.04, 1.09)	1.08*** (1.05, 1.11)	1.06*** (1.03, 1.08)
Less-Urgent	1.25*** (1.21, 1.29)	1.27*** (1.23, 1.32)	1.23*** (1.91, 1.28)
Less-Urgent for FPSCs	1.46*** (1.39, 1.53)	1.48*** (1.40, 1.56)	1.44*** (1.37, 1.52)
Male Physicians (*N* = 15,713)			
Primary Care Services IRR (95% CI)	0.85*** (0.84, 0.86)	0.86*** (0.85, 0.88)	0.71*** (0.68, 0.74)
Primary Care Value Difference (95% CI)	-74.83*** (-87.01, -62.65)	-60.67*** (-70.41, -50.94)	-14.15*** (-18.57, -9.73)
Total ED Visits IRR (95% CI)	1.12*** (1.09, 1.16)	1.15*** (1.11, 1.20)	1.10*** (1.07, 1.14)
Very-Urgent	0.99 (0.95, 1.02)	1.00 (0.97, 1.04)	0.98 (0.94, 1.01)
Urgent	1.10*** (1.06, 1.13)	1.12*** (1.08, 1.16)	1.08*** (1.05, 1.11)
Less-Urgent	1.28*** (1.22, 1.34)	1.30*** (1.23, 1.37)	1.26*** (1.20, 1.33)
Less-Urgent for FPSCs	1.44*** (1.34, 1.55)	1.46*** (1.35, 1.57)	1.42*** (1.32, 1.53)
Female Physicians (*N* = 11,584)			
Primary Care Services IRR (95% CI)	0.86*** (0.85, 0.88)	0.88*** (0.86, 0.89)	0.74*** (0.71, 0.78)
Primary Care Value Difference (95% CI)	-58.07*** (-69.35, -46.79)	-50.07*** (60.50, -39.64)	-8.00 (-9.81, -6.20)
Total ED Visits	1.07***	1.09	1.07***

IRR (95% CI)	(1.04, 1.11)	(1.05, 1.13)	(1.03, 1.10)
Very-Urgent	0.94*** (0.90, 0.98)	0.94** (0.90, 0.99)	0.94*** (0.91, 0.98)
Urgent	1.06*** (1.02, 1.10)	1.06*** (1.02, 1.11)	1.06*** (102, 1.09)
Less-Urgent	1.20*** (1.15, 1.26)	1.21*** (1.15, 1.28)	1.19*** (1.14, 1.25)
Less-Urgent for FPSCs	1.35*** (1.26, 1.45)	1.37*** (1.27, 1.47)	1.34*** (1.25, 1.44)

*P < 0.10, **P <0.05, *** P < 0.01

CI: Confidence Interval; ED: Emergency Department; FHG: Family Health Group; FHO: Family Health Organization; FPSC: Family Practice-Sensitive Condition; IRR: Incidence Rate Ratio

Controlled for year, physician (physician age, physician sex, international medical graduate status, and group size) and aggregate patient characteristics (roster size, mean patient age, proportion of female patients, proportion patients living in low-income area, proportion of patients living in rural area, proportion of patients with a single-morbidity, and proportion of patients with multimorbidity) in CBPS weighted multivariable negative-binomial (and linear for primary care value) regression models. Confidence intervals are based on standard errors clustered at the physician-level.

Regular-hours refers to 8:00 AM – 5:00 PM weekdays, while after-hours refers to 5:00 PM – 8:00 AM weekdays and any time weekends and statutory holidays for ED visits; regular-hours refers to weekdays, while after-hours refers to weekends, statutory holidays, and services billed with the after-hours premium for primary care services.

Primary care services and ED visits are per patient per year; primary care value is average value per patient per year in 2016 CAD (Canadian Dollars).

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6 Conclusion

This thesis aimed to evaluate whether Ontario's primary care reforms reduced potentially avoidable emergency department (ED) visits. Specifically, it focused on two elements of primary care reform in Ontario, the after-hours premium and physician remuneration models, and their impact on less-urgent ED visits during after-hours. While these less-urgent ED visits may lead to increased healthcare spending, unnecessary testing and treatment, and poorer continuity with a primary care provider,[1–5] they may also act as a proxy measure for access to primary care.[6–8] To improve access to primary care, it is imperative that health care policymakers look to the success and failure of other health care systems as examples of what policies can efficiently benefit the health care system. In this thesis, a review of the literature was taken examining the effects of access to primary care during after-hours on primary care and ED visits. Additionally, ED visits were compared over time to evaluate the impact of the introduction of the after-hours premium and the subsequent increases in its value on less-urgent ED visits, while the rates of primary care services and ED visits were compared between the enhanced fee-for-service (FFS) and blended capitation models to investigate the effects of physician remuneration.

6.1 Summary of Findings

6.1.1 Evidence in the Literature on Access to After-Hours Primary Care and Primary Care and Emergency Department Utilization

Findings from the review examining the relationship between after-hours primary care and both primary care and ED visits demonstrated that while measures to improve access outside of the regular working-hours led to an increase in primary care utilization, the effects on ED visits were less conclusive. While some studies did find that better access to primary care during after-hours was related to a reduction in ED visits, among the studies that found a reduction in ED visits, the range in the reduction was very wide, from 2% to 50%. Despite this, several studies found an increase in primary care utilization and

a reduction in ED visits, suggesting that improving access to primary care could potentially divert some patients from the emergency setting and towards the primary care setting. Several interventions, including financial incentives and extension of existing clinic hours, were more consistent in demonstrating a reduction in ED visits. When considering the impact of improving access to after-hours primary care, it is important to consider both the context of the health care system and the intervention used to improve access should be considered.

While the review found issues in the generalizability of the relationship between access to after-hours and ED visits, it also points to the need for more high-quality evidence. Much of the evidence was either cross-sectional in nature or used a pre-post design and lacked a concurrent comparator group that would have helped to limit the influence of bias. The review demonstrated the need for stronger future research, research using controlled pre-post design studies or quasi-experimental studies. Additionally, it demonstrated the need for research to place greater focus on separating ED visits by timing and severity, focusing on visits that could potentially be treatable in primary care settings.

6.1.2 Ontario's After-Hours Premium on Emergency Department Utilization

Results from the two studies evaluating the impact of Ontario's after-hours premium on ED visits produced new evidence on the impact of the introduction of after-hours primary care and its subsequent increases in value on ED visits. The introduction of the after-hours premium was associated with a reduction of 1.26 less-urgent ED visits per 1,000 patients per month (95% Confidence Interval [CI]: -1.48, -1.04), mainly driven by the reduction in visits during after-hours of 0.87 ED visits per 1,000 patients per month (95% CI: -1.03, -0.72). Subsequent increases in the value of the premium were found to be associated with much smaller reductions in less-urgent ED visits made during after-hours, with increases in the premium associated with reductions ranging from 0.13 to 0.17 fewer ED visits per 1,000 patients per month. Despite this, reductions in total less-urgent ED

visits were not apparent, and instead, increases in very-urgent and urgent ED visits were found during both regular- and after-hours over the study period.

Using a sample of respondents from the Canadian Community Health Survey (CCHS) linked with the National Ambulatory Care Reporting System (NACRS) data yielded similar results – the increase in Ontario's after-hours premium from 20% to 30% was associated with a 15% reduction in less-urgent ED visits (95% CI: 6%, 24%). There was a significant reduction in less-urgent ED visits during after-hours by 18% (95% CI: 7%, 29%) but no significant association with less-urgent ED visits during regular-hours. Additionally, there was no association with urgent ED visits and an increase in very-urgent ED visits. However, when compared to four control provinces, the increase in the after-hours premium was not associated with a reduction in less-urgent ED visits in Ontario, but instead, associated with a reduction in very-urgent (Incidence Rate Ratio [IRR]: 0.64; 95% CI:0.49, 0.84) and urgent (IRR: 0.83; 95% CI: 0.70, 0.98) ED visits compared to the control provinces. Although the introduction of Ontario's after-hours premium was clearly associated with a reduction in less-urgent ED visits, the subsequent increases in the value of the premium are unlikely to be causally associated with a reduction in less-urgent ED visits. Compared to the review examining the effect of improving access to after-hours primary care on ED visits in the literature, Ontario's after-hours premium appears to fall on the lower end of effectiveness, with only a small reduction in less-urgent ED visits related to its introduction.

6.1.3 Remuneration Models and Primary Care and Emergency Department Use

Physician remuneration models were found to play a role in primary care use and its link to ED visits. Patients in the Family Health Group (FHG) model, where physicians receive payments predominantly through FFS, were found to receive more primary care services than patients in the Family Health Organization (FHO) model, where physicians receive payment predominantly through capitation. FHO physicians provided 14% fewer primary care services per patient per year (95% CI: 14%, 16%) compared to FHG physicians;

however, when stratified by timing, the difference was much larger during after-hours as FHO physicians provided 27% fewer primary care services per patient per year than FHG physicians compared to 13% fewer primary care services per patient per year during regular-hours.

FHO physicians' patients made 27% more less-urgent ED visits and 10% more urgent ED visits per patient per year compared to patients rostered to FHGs. The largest difference was found in less-urgent ED visits for family practice-sensitive conditions (FPSCs), which are most likely to be treatable in the primary care setting. However, FHO physicians' patients were found to make similar rates of very-urgent ED visits to FHG physicians' patients. Despite much fewer primary care services received during after-hours, the ratio of ED visits between the FHG and FHO models were similar by timing.

When stratified by the number of chronic conditions, the results demonstrate that different physician remuneration models may be better equipped to handle various patient populations differently. While FHO physicians provided fewer primary care services for all patients, regardless of morbidity, there were differences in patterns of ED visits between the FHG and FHO models. FHO physicians' non-morbid and single-morbid patients made more less-urgent and urgent ED visits; however, FHO physicians' multimorbid patients made 17% fewer very-urgent and 7% fewer urgent ED visits per patient per year compared to FHG physicians' multimorbid patients, with no difference in the rates of less-urgent ED visits. These results provide supporting evidence that FHO physicians may offer more preventative care These results suggest there may be trade-offs in access to and quality of care that should be considered between the two remuneration models.

6.2 Strengths and Limitations

The main strengths of this thesis are the use of large health administrative datasets and rigorous statistical methods to investigate two important elements of Ontario's primary care reforms. These studies make use of large samples of data, the first of which takes a

10% random sample of Ontario residents and uses monthly health care utilization over 14 years. The third study contains all data on adult patients of FHG and FHO physicians over five years, while the second study makes use of seven cycles of data representative survey data linked with NACRS data. The use of datasets through ICES allows for access to complete data, patient demographic and area-level socioeconomic characteristics, patient chronic condition information, physician characteristics, primary care utilization, and ED visits. Finally, these analyses are rigorously conducted to reduce the influence of bias using statistical methods such as fixed-effects regression models, which can control for time-invariant confounding factors, difference-in-differences methods, which may mitigate the effect of extraneous factors, and propensity score weighting, which can reduce confounding by factors that cause groups to differ.

However, these studies are not without their limitations. Firstly, data linked between the CCHS and NACRS has incomplete coverage that may bias results. Additionally, this study makes use of repeated cross-sections of data, and thus important, time-varying confounders are not controlled for in the analysis. The CCHS also does not record information on physician characteristics and so using this dataset, it was not possible to determine which respondents were impacted by the policy change. Secondly, for both studies evaluating the impact of the after-hours premium, especially the first study that evaluated the impact of the premium over the entire reform period, other reforms were implemented and may have impacted ED. In the late 2000s, it was impossible to completely disentangle the effects of multiple policy changes, and thus, the effects of the increases in the premium are unlikely to be the pure effects of the after-hours incentives, but combined with those of other incentives, such as the screening bonuses and chronic condition management incentives. Thirdly, for the final study comparing health care utilization between the FHG and FHO models, measurement of primary care services may be affected by differences in timing recorded by OHIP. Finally, all studies focus on ED visits and only the third study examines primary care utilization as an outcome, and as such, a complete picture of health care utilization cannot be established. Based on the data used, it is unclear for all studies what services patients use between settings, whether patients attempt to use primary care during after-hours but are unable to access it,

whether patients are referred to the ED or instructed by telephone helpline directives, and whether patients use walk-in clinics.

6.3 Future Directions

As data quality improves across the province and the country, future analyses should make use of these evolving databases. First, more complete pictures of the health care system should be examined when looking at how after-hours primary care can affect the system, including walk-in clinic use, non-physician-led service use, and how telephone referrals may impact ED use. It is also worth investigating whether the increase in access to primary care during after-hours leads to a reduction in unmet health care needs. Secondly, the impact of the after-hours premium on primary care utilization requires further investigation, whether the after-hours premium increases total primary care services or merely diverts daytime visits. Research should also look at the cost-effectiveness of the after-hours premium, and whether there is an optimal value of the after-hours premium to reducing health care expenses could be of great use to policymakers. Thirdly, Ontario's after-hours premium is the only after-hours incentive in Canada to be evaluated through these studies. Additional analyses should examine the effectiveness of after-hours incentives introduced in other provinces. Comparisons of effects on the health care system as well as cost-effectiveness comparisons should be conducted to evaluate which policies are worth adopting and which policies should be reconsidered. Lastly, when comparing differences in health care utilization by remuneration model, differences arise between non-morbid and single-morbid versus multimorbid patients. Drivers of these differences require further investigation, which may include evaluation of the difference in process of care-related chronic disease management and preventive care between models, as well as evaluation of differences in health status of patients.

6.4 Conclusion

Improving access to primary care could potentially divert patients away from the emergency setting towards the primary care setting. The evidence in the literature suggests that this is often context-dependent and requires information about the intervention used to improve access to care as well as the health care system characteristics. Evaluation of the after-hours premium suggests that while the introduction was likely associated with a reduction in less-urgent ED visits, further reductions in less-urgent ED visits related to increases in the value of the premium were less likely to occur. Blended capitation models were found to offer fewer primary care services and have patients who made more less-urgent ED visits. For multimorbid patients, blended capitation was associated with a reduction in primary care services and in very-urgent and urgent ED visits.

As pressures on the health care system continues to rise, policymakers need to look to more effective policies to reduce rising health care costs. While the introduction of a small after-hours incentive may represent a possible effective strategy in diverting patients away from the ED and back towards primary care, higher values of the premium could potentially represent inefficiencies due to higher costs with diminishing returns to incentives. Remuneration models could also represent inefficiencies, as physicians of different models may be better suited to treat specific patients based on their health status. This thesis has identified that some policies and advancements may not have been as efficient as believed and builds foundation for future research and policy evaluation on the impact of primary care reforms on patient outcomes.

Table 6.1 Summary of key findings

Chapter	Key Findings
2	Better access to primary care during after-hours was associated with an increase in primary care utilization The effect of better access to primary care during after-hours on ED visits was mixed and findings varied by intervention and context of the health care system
3	The introduction of Ontario's after-hours premium was associated with a reduction in less-urgent ED visits, mainly through a reduction in visits during after-hours Subsequent increases in the value of Ontario's after-hours premium were associated with much smaller reductions in less-urgent ED visits made during after-hours Over the study period, there were increases in very-urgent and urgent ED visits
4	In Ontario, the increase in Ontario's after-hours premium from 20% to 30% was associated with a reduction in less-urgent ED visits, of similar relative values during regular- and after-hours Compared to control provinces, the increase was not significant, increases in the value of Ontario's after-hours premium were unlikely to be causally associated with a reduction in less-urgent ED visits
5	FHO physicians provided fewer primary care services than FHG physicians, but their patients made more urgent and less-urgent ED visits Despite providing fewer primary care services during after-hours relative to during regular-hours, the difference in ED visits between FHG and FHO patients was relatively similar during regular- and after-hours In addition to receiving fewer primary care services, multimorbid patients in an FHO made fewer very-urgent and urgent ED visits

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Appendix

Appendix A Search strategy

Search Term	Medline	EMBASE	CINAHL	Scopus
After-Hours				
exp After-Hours Care/	1,851			
after-hour*	2,942	2,133	850	3,348
out of hour*	2,088	3,952	1,251	2,674
Total	4,431	5,900	2,087	4,991
Primary Care				
exp Primary Health Care/	157,010			
exp General Practitioners/	7,743			
exp Physicians, Family/	16,322			
exp primary medical care/		103,703		
exp primary health care/		167,825		
exp general practitioner/		102,161		
(MH “Primary Health Care”)			66,329	
(MH “Physicians, Family”)			20,410	
primary care	115,507	156,430	89,581	135,091
primary health care	90,703	77,597	71,415	106,988
family doctor*	4,621	7,143	12,639	6,813
family physician*	14,574	19,002	15,905	19,038
general practitioner*	52,028	131,014	20,006	116,376
Total	294,213	333,563	137,087	292,503
Total	**1,416**	**1,491**	**777**	**1,436**
Limited to English Language, Full-Text	**1,348**	**1,415**	**229**	**1,087**

Final search conducted May 8, 2020.

Appendix B Family practice-sensitive conditions along with ICD-10 codes

Condition	ICD-10 Code
Other protozoal intestinal diseases	A07
Other sexually transmitted chlamydial diseases	A56
Trichomoniasis	A59
Other predominantly sexually transmitted diseases, not elsewhere classified	A63
Unspecified sexually transmitted disease	A64
Other diseases caused by chlamydiae	A74
Rubella (German measles)	B06
Viral warts	B07
Other viral infections characterized by skin and mucous membrane lesions, not elsewhere classified	B08
Unspecified viral infection characterized by skin and mucous membrane lesions	B09
Viral conjunctivitis	B30
Dermatophytosis	B35
Other superficial mycoses	B37
Candidiasis	B37
Schistosomiasis (bilharziasis)	B65
Enterobiasis	B80
Unspecified intestinal parasitism	B82
Other helminthiases	B83
Pediculosis and phthiriasis	B85
Scabies	B86
Other malignant neoplasms of skin	C44
Carcinoma in situ of skin	D04
Benign neoplasm of bone and articular cartilage	D16
Benign lipomatous neoplasm	D17
Melanocytic naevi	D22
Other benign neoplasms of skin	D23
Benign neoplasm of breast	D24
Benign neoplasm of male genital organs	D29
Benign neoplasm of other and unspecified sites	D36
Other disorders of thyroid	E07
Testicular dysfunction	E29
Deficiency of other B group vitamins	E53
Deficiency of other nutrient elements	E61
Disorders of lipoprotein metabolism and other lipidaemias	E78
Phobic anxiety disorders	F40
Migraine	G43
Mononeuropathies of upper limb	G56
Hordeolum and chalazion	H00

Other inflammation of eyelid	H01
Disorders of lacrimal system	H04
Conjunctivitis	H10
Other disorders of conjunctiva	H11
Disorders of sclera	H15
Other disorders of cornea	H18
Disorders of vitreous body	H43
Other disorders of eye and adnexa	H57
Otitis externa	H60
Other disorders of external ear	H61
Nonsuppurative otitis media	H65
Suppurative and unspecified otitis media	H66
Eustachian salpingitis and obstruction	H68
Other disorders of Eustachian tube	H69
Perforation of tympanic membrane	H72
Other disorders of tympanic membrane	H63
Other disorders of middle ear and mastoid	H74
Other hearing loss	H91
Otalgia and effusion of ear	H92
Other disorders of ear, not elsewhere classified	H93
Diseases of capillaries	I78
Acute nasopharyngitis (common cold)	J00
Acute sinusitis	J01
Acute pharyngitis	J02
Acute upper respiratory infections of multiple and unspecified sites	J06
Vasomotor and allergic rhinitis	J30
Chronic rhinitis and nasopharyngitis and pharyngitis	J31
Chronic sinusitis	J32
Other disorders of nose and nasal sinuses	J34
Disorders of tooth development and eruption	K00
Embedded and impacted teeth	K01
Dental caries	K02
Diseases of pulp and periapical tissues	K04
Gingivitis and periodontal diseases	K05
Dentofacial anomalies (malocclusion)	K07
Other disorders of teeth and support structures	K08
Other diseases of lip and oral mucosa	K13
Impetigo	L01
Atopic dermatitis	L20
Seborrhoeic dermatitis	L21
Diaper (napkin) dermatitis	L22

Allergic contact dermatitis	L23
Irritant contact dermatitis	L24
Unspecified contact dermatitis	L25
Lichen simplex chronicus and prurigo	L28
Pruritus	L29
Other dermatitis	L30
Pityriasis rosea	L42
Lichen planus	L43
Urticaria	L50
Sunburn	L55
Skin changes due to chronic exposure to nonionizing radiation	L57
Nail disorders	L60
Alopecia areata	L63
Other nonscarring hair loss	L65
Acne	L70
Rosacea	L71
Follicular cysts of skin and subcutaneous tissue	L72
Other follicular disorders	L73
Eccrine sweat disorders	L74
Other disorders of pigmentation	L81
Seborrhoeic keratosis	L82
Corns and callosities	L84
Other epidermal thickening	L85
Atrophic disorders of skin	L91
Granulomatous disorders of skin and subcutaneous tissue	L92
Arthrosis of first carpometacarpal joint	M18
Acquired deformities of fingers and toes	M20
Disorders of patella	M22
Other dorsopathies NEC	M53
Other disorders of synovium and tendon	M67
Soft tissue disorders related to use, overuse, and pressure	M70
Shoulder lesions	M75
Enthesopathies low limb excluding foot	M76
Other enthesopathies	M77
Other disorders of bone density and structure	M85
Other juvenile osteochondrosis	M92
Other disorders of cartilage	M94
Urethritis and urethral syndrome	N34
Benign mammary dysplasia	N60
Hypertrophy of breast	N62
Unspecified lump in breast	N63

Other disorders of breast	N64
Inflammatory disease of cervix uteri	N72
Other noninflammatory disorders of vagina	N89
Absent, scanty, and rare menstruation	N91
Pain and other conditions associated with female genital organs and menstruation	N94
Female infertility	N97
Other disorders of breast and disorders of lactation associated with pregnancy and the puerperium	O92
Other congenital infections and parasitic diseases	P37
Other perinatal digestive system disorders	P78
Congenital malformations of eyelid, lacrima apparatus and orbit	Q10
Congenital deformities of feet	Q66
Cough	R05
Rash and other nonspecific skin eruption	R21
Pain associated with micturition	R30
Urethral discharge	R36
Abnormality of red blood cells	R71
General examination and investigation of persons without complain and reported diagnosis	Z00
Examination and encounter for administrative purposes	Z02
Follow-up examination after treatment for conditions other than malignant neoplasms	Z09
Special screening examination for infectious and parasitic diseases	Z11
Special screening examination for neoplasms	Z12
Special screening examination for other diseases and disorders	Z13
Contact with and exposure to communicable diseases	Z20
Need for immunization against single bacterial diseases	Z23
Need for immunization against certain viral diseases	Z24
Need for immunization against other viral diseases	Z25
Need for immunization against other infectious diseases	Z26
Need for immunization against combinations of infectious diseases	Z27
Need for other prophylactic measures	Z29
Contraceptive management	Z30
Procreative management	Z31
Pregnancy examination and test	Z32
Procedures for purposes other than remedying health state	Z41
Adjustment and management of implanted device	Z45
Fitting and adjustment of other devices	Z46
Other orthopaedic follow-up care	Z47
Other surgical follow-up care	Z48
Other medical care	Z51
Persons encounter health services for specific procedures, not carried out	Z53

Problems related to employment and unemployment	Z56
Problems related to certain psychosocial circumstances	Z64
Counseling related to sexual attitude, behaviour, and orientation	Z70
Persons encountering health services in other circumstances	Z76
Personal history of medical treatment	Z92

ICD-10: International Classification of Disease, 10th Revision

Appendix C Data Sources for Chronic Conditions

Condition	Existing Cohort or Algorithm (Look-back Window)	Source
Asthma	Existing cohort	ASTHMA
Cancer	Existing cohort	OCR
Congestive Heart Failure	Existing cohort	CHF cohort
CKD	Algorithm (10 years)	DAD, OHIP
Chronic Liver Disease	Algorithm (10 years)	DAD, OHIP
COPD	Existing cohort	COPD cohort
Dementia	Algorithm (10 years)	DAD, OHIP, ODB
Diabetes	Existing cohort	ODD
HIV	Existing cohort	HIV
Hypertension	Existing cohort	HYPER
IBD	Existing cohort	OCCC
Mental Disorder or Substance Use	Algorithm (5 years)	DAD, OHIP, OMHRS
Myocardial Infarction	Existing Cohort	OMID
Osteoporosis	Algorithm (10 years)	DAD, OHIP
Rheumatoid Arthritis	Existing cohort	ORAD
Stoke / TIA	Algorithm (10 years)	DAD, OHIP
Urinary incontinence	Algorithm (5 years)	DAD, OHIP

ASTHMA: Ontario Asthma dataset; CHF: Congestive Heart Failure; Chronic Kidney Disease; COPD: Chronic Obstructive Pulmonary Disease; DAD: Discharge Abstract Database; HIV: Ontario HIV Database; HYPER: Ontario Hypertension Dataset; IBD: Inflammatory Bowel Disease; OCCC: Ontario Crohn's and Colitis Cohort dataset; OCR: Ontario Cancer Registry ODB: Ontario Drug Benefits Database; ODD: Ontario Diabetes Dataset; OHIP: Ontario Health Insurance Plan Database; OMHRS: Ontario Mental Health Reporting System; OMID: Ontario Myocardial Infarction Dataset; ORAD: Ontario Rheumatoid Arthritis Database; TIA: Transient Ischaemic Attack

Curriculum Vitae

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2. Formation of Ontario health teams and quadruple-aim outcomes: Quasi-experimental evaluation. PI: Sarma S, Hayes A. Co-Applicants: Ali S, Anderson KK, Belhadji B, Devlin RA, Hong M, Meyer M, Stranges S, Thind A, Wodchis W, Zaric G, Zou G. Canadian Institutes of Health Research Catalyst Grant: Quadruple Aim and Equity.

Publications:

1. Hong M, Jones PM, Martin J, Kiaii B, Arellano R, Cheng D, John-Baptiste AA. Clinical impact of disinvestment in hydroxyethyl starch for patients undergoing coronary artery bypass surgery: A retrospective observational study. *Canadian Journal of Anesthesia*. 2019;66(1):25-35.
2. Hong M, Sarma S (2019) Medicaid. In: Gu D, Dupree M. (eds) Encyclopedia of Gerontology and Population Aging. Springer, Cham.
3. Hong M**,** Thind A, Zaric G, Sarma S. The impact of improved access to after-hours primary care on emergency department and primary care utilization: A systematic review. *Health Policy*. 2020;124(8):812-818.
4. Hong M, Thind A, Zaric G, Sarma S. Link between incentives to provide after-hours primary care and emergency department utilization: Results of a retrospective cohort analysis from Ontario, Canada. *CMAJ*. 2021;193(3):E85-E93.
5. Rondina R, Hong M, Sarma S, Mitchell M. Is it worth it? Cost-effectiveness analysis of a commercial physical activity app. *BMC Public Health*. 2021;21:1950.

Presentations

1. **Hong M**, Thind A, Zaric G, Sarma S. The impact of Ontario's after-hours premium on emergency department utilization. Presented at the 2019 Canadian Association of Health Services and Policy Research Scientific Conference, Halifax Convention Centre, Halifax, Nova Scotia. May 29-31, 2019.

2. **Hong M**, Thind A, Zaric G, Sarma S. The impact of Ontario's after-hours premium on emergency department utilization. Presented at the Canadian Society of Epidemiology and Biostatistics 2019 Biennial National Conference, Carleton University, Ottawa, Ontario. May 13-15, 2019.
3. **Hong M**, Thind A, Zaric G, Sarma S. The impact of Ontario's after-hours premium on emergency department utilization. Presented at London Health Research Day, London Convention Centre, London, Ontario. April 30, 2019.
4. **Hong M**, Thind A, Zaric G, Sarma S. After-hours access to primary care and emergency department utilization: A systematic review. Presented at the Canadian Society for Epidemiology and Biostatistics 2018 National Student Conference, Lakehead University, Thunder Bay, Ontario. June 15-17, 2018.
5. **Hong M**, Thind A, Zaric G, Sarma S. After-hours access to primary care and emergency department utilization: A systematic review. Presented at London Health Research Day, London Convention Centre, London, Ontario. May 10, 2018.
6. **Hong M**, Jones PM, Martin J, Kiaii B, Arellano R, Cheng D, John-Baptiste AA. Clinical impact of disinvestment in hydroxyethyl starch for patients undergoing coronary artery bypass surgery. Presented at Student Rounds, University of Western Ontario, London, Ontario. January 18, 2018.