Abstract

With high-quality community-based primary care, hospitalizations for ambulatory care sensitive conditions (ACSC) are considered avoidable. ACSC are promising healthcare quality indicators widely used internationally, potentially creating opportunity for health care system quality improvement. The overall aim of this thesis was to explore, assess and evaluate ACSC hospitalization as a healthcare quality indicator for one condition, uncomplicated hypertension.

We conducted three studies to achieve the aim. Our first study explored ACSC hospitalization rates for uncomplicated hypertension, taking into account important patient characteristics among hypertensive patients. Using population-based data in four provinces we found that the rate of hospitalizations for uncomplicated hypertension has decreased over time, potentially indicating improvement in community care. We found geographic variations in the rate of hospitalizations, potentially signifying disparity among the provinces and those residing in rural versus urban regions. Our second study examined the association between ACSC hospitalizations for uncomplicated hypertension and previous primary care physician (PCP) utilization. Among this population-based cohort of hypertensive patients we found as the frequency of hypertension-related PCP visits increased the adjusted rate of ACSC hospitalizations also increased, even when stratified by demographic and clinical variables. This suggests that hospitalization for uncomplicated hypertension is not reduced with increasing frequency of PCP visits and may not be an appropriate indicator to measure and evaluate patients’ access to primary care. Our final study tested inter-physician reliability of judgments of avoidable hospitalizations for uncomplicated hypertension derived from medical chart review. We found a low proportion of ACSC hospitalizations were rated as avoidable, with poor
agreement between physician raters. These findings point either to a need to abandon the use of the ACSC entirely; or alternatively a need to develop explicit criteria for judging avoidability.

This research has provided crucial information for the interpretation of ACSC findings for uncomplicated hypertension. The results indicate that the use of this health quality indicator is questionable and may not provide information that is applicable for interventions to improve quality of primary care. At present, ACSC are most appropriately used as a starting point for assessing potential issues in the community which would then require further, more in-depth analysis.
Preface

The following manuscripts, which have been authored based on work from this thesis, have been published or are under review. For all three papers, Robin Walker was involved in the conceptualization and design of the studies. She was also responsible for conducting the analysis, interpreting the data, and drafting the manuscripts, all with guidance from her thesis committee (Hude Quan, William Ghali, Nathalie Jette, Doreen Rabi, Elijah Dixon). All authors contributed important intellectual content and provided critical reviews of the papers.


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~ To Jake and Finlay – my two special boys – never stop learning and growing
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<td>Ambulatory Care Sensitive Conditions</td>
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<td>PCP</td>
<td>Primary care physician</td>
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<td>AMI</td>
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Chapter One: OVERVIEW OF THESIS
Internationally, there is widespread interest in the promise of ambulatory care sensitive conditions (ACSC). ACSC are chronic conditions that are ideally effectively managed in the community with appropriate medical screening, monitoring and follow-up. Initially, ACSC were developed using hospitalization data to identify hospitalizations in the United States (US) population that could potentially have been avoided with adequate access to appropriate ambulatory or primary care in the community. Since their inception in 1993, ACSC have provided the basis for measuring adequacy of ambulatory and primary health care performance in many regions and countries including Canada, the US, Australia and many European countries (1-5). Hospitalization for an ACSC is considered to be indicative of a sub-optimal health system (6;7), particularly sub-optimal primary health care services (4;6;8;9). In its national health indicators report, the Canadian Institute for Health Information (CIHI) reports hospitalization rates for seven ACSC: angina, asthma, chronic obstructive pulmonary disease, diabetes, epilepsy, heart failure, and hypertension.

As a health care quality indicator, ACSC hospitalization rates are used to drive system transformation and primary health care system management. To improve quality and provide patient-centered care, some provinces are reforming their primary care systems. For example, Alberta has developed Primary Care Networks, which are groups of family doctors who work with government and allied health professionals within a network of other clinics to coordinate the delivery of primary health services, promote preventive care, and enhance patient follow-up. While ACSC have been chosen as an indicator for the evaluation of Primary Care Network performance, the use of ACSC hospitalizations as a performance indicator for primary care has not been validated.
The overall purpose of this thesis is to explore, assess and evaluate ACSC hospitalization as a health care quality indicator for one condition, uncomplicated hypertension. To achieve this objective, three studies were conducted using health administrative data sources and patient medical charts (described below). The overall hypothesis of this research is that the validity of ACSC hospitalizations for uncomplicated hypertension as a health care quality indicator is questionable.

1. There is growing recognition that factors beyond the adequacy of primary care likely contribute to ACSC hospitalizations. For example, the role of patient characteristics has only been assessed using aggregate ACSC data and not stratified by individual conditions. Thus the purpose of this study was to determine risk adjusted rates and temporal trends of hospitalization and emergency department (ED) visits for one ACSC, uncomplicated hypertension. We also explored factors associated with ACSC hospitalizations for uncomplicated hypertension. This study provides information on the trends of ACSC hospitalization for uncomplicated hypertension over time and any geographic differences between provinces. It also identifies individuals who are at greatest risk for a hospitalization.

2. Hospitalization rates for ACSC have been suggested as a proxy for the presence or absence of appropriate primary and preventive care; more physician visits within a community should result in fewer hospitalizations for ACSC (9). A lower rate of ACSC is often interpreted as better access to or quality of primary health care services, resulting in prevention of hospitalizations. The purpose of this study was to examine primary care physician (PCP) utilization prior to hospitalization among patients hospitalized for uncomplicated hypertension.
This provides information on whether ACSC hospitalization for uncomplicated hypertension is associated with frequency of PCP visits.

3. Despite widespread use, it is unclear if ACSC is a reliable and valid indicator that accurately measures the performance of the primary health care system. ACSC hospitalization rates can potentially be used as a marker of access to and quality of primary care only if a significant proportion of hospitalizations are deemed avoidable and judgments of avoidability have high inter-rater reliability (i.e., judgments of avoidability are reproducible). The purpose of this study was to test inter-physician reliability of judgments of avoidable hospitalizations for uncomplicated hypertension derived from medical chart review. This provides important information as to whether ratings of avoidable hospitalizations can be reproduced. If the ratings of avoidable hospitalizations cannot be reproduced reliably between physicians, the validity and utility of this health indicator are questionable. If assessments of avoidable hospitalizations for ACSC derived from medical chart review are reproducible and therefore reliable between-physicians, it will provide a methodological foundation for determining the proportion of ACSC hospitalizations that are truly avoidable based on medical charts.

This thesis is divided into six chapters. Chapter 2 provides background information on quality of health care, health care quality indicators, ACSC, data sources to measure quality indicators, and hypertension. Chapters 3 to 5 report on the three studies described above, formatted for independent publication as part of a paper based thesis. Each of these three chapters represents an independent study distinguished by a specific research question, study cohort, and set of methods. Finally, Chapter 6 summarizes and synthesizes the findings of the thesis. This concluding chapter discusses whether: 1) ACSC can be used to measure quality of
primary health care; and 2) ACSC can be measured using administrative data, specifically the hospital discharge abstract database (DAD) in Canada. It also discusses directions for future research aimed at improving the use of ACSC and data quality.
Chapter Two: BACKGROUND
2.1 Quality in Health Care

2.1.1 What is it?

There are many different perspectives and definitions of quality in health care. In 1966, Avedis Donabedian, a leading figure in the theory and management of quality in health care, emphasized that defining quality of medical care is subjective and “may be almost anything anyone wished it to be”, “a reflection of values and goals current in the medical system and in larger society…” (10). In 1978, Donabedian suggested that “several formulations (of quality of health care) are both possible and legitimate, depending on where we are located in the system of care and on what the nature and extent of our responsibilities are” (11). Understanding different perspectives about quality does not prevent success in achieving quality of care as long as key principles and concepts of quality are identified, understood and used (12).

The most widely durable and accepted definition of health care quality was developed in 1990 by the Institute of Medicine (IOM). According to the IOM, quality consists of the “degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge” (13). Based on this definition, quality problems can be broadly categorized as problems of overuse, underuse, and misuse (14).

2.1.2 Accessing the health care system

With universal healthcare, accessing the health care system in Canada is commonly described as a component of quality in health care (15;16). In the US typically access and quality are measured separately given that there is no uniform health system and no universal healthcare coverage. Access to health services is defined by the IOM as the timely use of
personal health services to achieve the best health outcomes (14). The topic of access has been at
the forefront of health care policy and is an important political symbol. Authorities strive to
understand who has access to services, how access can be improved and how changes in health
policy or in the distribution of health services will affect access to health care. Despite its
importance, most experts agree that the concept of access is a poorly defined (17-19). This is
due to the multiple meanings given to the term and the fact that access is used synonymously
with other terms such as availability of health system resources.

There are several frameworks that have been used to study access to health care (17-22). Of these, the Aday and Andersen model of access to health care is a foundation from which other
frameworks have been built over the past 40 years (17). The framework they developed in 1974
includes five components that interact with each other to conceptualize access to health care
(Figure 2-1, page 40). These include health policy, characteristics of the health delivery system,
characteristics of the population at risk, utilization of health services, and consumer satisfaction.
The non-linear nature of access and the role of feedback loops in the system are emphasized in
this model. ACSC hospitalizations rates have been known to be a measure of access to primary
health care.

2.1.3 How do we measure quality in health care?

Over the last 10 to 15 years, the development of health and/or health care quality
indicators has gained momentum through the efforts of government, and public/private
organizations that are interested in measuring and improving quality of health care. By and
large, most agencies or groups have undertaken health care quality indicator initiatives with the
goal to provide information that will help to bring improvements to system performance and to quality of health care (23).

The terminology employed to describe health and/or health care quality indicators differs across the literature. While the terms are unclear much of the time, health indicators tend to denote a broader concept whereas health care quality indicators are narrower in scope. Health indicators are standardized measures that can be used to measure health status, health system performance, and characteristics across different populations and between jurisdictions, or over time (24). Primarily, health indicators are a tool to help jurisdictions track progress in the improvement and maintenance of a population’s health and health system. Health care quality indicators play a role similar to that of health indicators, but with a narrower focus to evaluate and monitor the status of organizations or system processes or performance (25).

2.2 Health Care Quality Indicators

2.2.1 Reasons for developing health care quality indicators

The unprecedented level of concern and action on improving the quality of health care was catalyzed by in part by two famed US IOM reports - *To Err Is Human: Building a Safer Health System* (26) and *Crossing the Quality Chasm: A New Health System for the 21st Century* (14). The first landmark report stated that as many as 98,000 people die annually in the US as the result of medical errors, and hundreds or thousands suffer or barely escape from nonfatal injuries that a truly high-quality health system would largely prevent. The latter report described broader quality issues and defined six aims of quality and rules for care delivery redesign.
Both reports highlighted two interrelated factors that justify the efforts of developing health care quality indicators: substantial variation in the quality of care and also in the cost of that care. Numerous studies have shown that unexplained variation in quality due to underutilization, overutilization, and inappropriate care leads to unnecessarily high morbidity and mortality rates (14;27-30). For example, a Swedish study showed that over 12% of hospitalized patients experience adverse events such as a hospital-incurred patient injury, 70% of which were preventable, over half of which lead to disability and increased length of stay (31). Comparative studies, such as the Organization for Economic Cooperation and Development (OECD) Health at a Glance, also showed variations in health care quality within and between countries (27), such as wide variability in mortality rates for stroke and acute myocardial infarction among the 32 OECD countries.

The second factor is the rising and unsustainable cost of health care. Overall, there are widespread perceptions of poor value for the money and effort spent on health care (32;33). While health spending across industrialized countries has almost doubled in the last thirty years, the countries with the highest health spending are not always the ones with the best results (34). In the US, health care costs exceeded $2.3 trillion in 2008, representing more than 16% of the gross domestic product (GDP) (35). Health care costs more than tripled from 1990 to 2008, and are projected to rise to 19.4 percent of GDP in 2019 (35). Canada spent $205.4 billion dollars on publicly funded health care in 2012, representing more than 11% of the GDP (36). There is little doubt that the aging population and increased demand for new services, technologies, diagnostics, and drugs are contributing to the steady increase in health care expenditures, but so,
too, is waste (14). As research has shown that high-quality care is often associated with lower or equal cost (37;38), one can surmise that a significant portion of these expenditures was misspent.

In addition to variation in quality of care and unsustainable health care costs, transparency and lack of accountability are further reasons for developing health care quality indicators. Early in the millennium, two landmark reports (Kirby; Romanow) on the status of health care in Canada were published, documenting the need for health care reform (39). These reports recognized the need for improved transparency and accountability in health care, and recommended regular reporting to the public on the state of the health care system, as well as health outcomes and the health status of Canadians. As a result, 2003 and 2004 saw the publication of two major health accords that contained a set of commitments that require each province, territory and the federal government to carry out reforms in certain areas of the health system and to report to the public on their progress.

As a result of the numerous compelling reasons for the development of health care quality indicators, there has been a proliferation of indicators internationally. A number of countries have sought to manage this proliferation through the creation and use of conceptual frameworks with which measures can be organized and prioritized.

### 2.2.2 Conceptual frameworks for health care quality indicator development

#### 2.2.2.1 Donabedian

The classic, widely accepted method for developing and categorizing health care quality indicators is the approach first conceptualized by Donabedian (11) which was based on earlier work by Sheps in the 1950s (40). Donabedian described three approaches for acquiring
information about health care quality, structure, process and outcome, depicted in Figure 2-2, page 41.

Structure refers to the characteristic of the health setting under which care is provided. These include the material (e.g. facilities, equipment) and human resources (e.g. staffing ratios, qualifications, experience) available to provide care, as well as the organizational context (e.g. size, volume, information technology systems) that facilitates or impedes the delivery of optimal care. An example of a structural indicator is whether physicians are suitably qualified and whether hospitals are properly equipped. Structural measures may represent necessary conditions for the delivery of a given quality of health care. However the major limitation is that the relationship between structure and process or between structure and outcomes is often not well established (10). Structural measures alone do not ensure that appropriate processes are carried out or that satisfactory outcomes are achieved by the health system.

Process refers to the methods of delivering care to patients. This includes actions that a health care provider takes to maintain or improve patients’ health, including appropriate and evidence-based screening, diagnosis, treatment, rehabilitation, education, prevention and providing follow-up care. An example of a process indicator is whether children receive the required immunizations according to guidelines, or whether patients’ blood pressure is monitored regularly by a physician. Process measures represent the closest approximation of actual health care offered and they may be easily acted upon to improve quality. Although process measures are the most clinically specific and can be defined precisely, the estimates of quality that one obtains are less stable and less final than those derived from measurements of outcomes (10).
An important concern is the degree to which process measures are related to clinically desirable outcomes (34).

“Outcome” refers to the changes in health status that are attributable to health care. They include measures such as morbidity (e.g. complications, unplanned readmissions to hospital), mortality, length of hospital stay, functional status, quality of life, and health related knowledge and behaviours. Outcomes may indicate good or poor quality of care in the aggregate, however alone they do not provide insight into the nature and location of the deficiencies or strengths to which the outcome may be attributed (10). Another substantial challenge is that outcome measures may be influenced by factors other than quality of care (10). For example, survival after stroke also depends on patient-level factors such as age, sex, severity of illness and socioeconomic status. There needs to be sufficient evidence that quality of care makes an independent contribution to the outcome of interest. As such, other factors that influence outcomes, such as age, sex, and case-mix, should be appropriately accounted for by risk adjustment (41). Regardless of their limitations, outcome measures, by and large, remain the ultimate validators and measures of the quality of health care (10).

While the dimensions of structure, process and outcomes are somewhat interdependent, it is important to stress that good quality in one area does not imply good quality in another (42).

2.2.2.2 Canadian Institute for Health Information framework

In 1999, CIHI and Statistics Canada launched a collaborative project on health indicators. The goal of the project was to identify indicators from existing data sources, and use the indicators to report publicly on the health of Canadians and the health system. As a first step the
Health Indicator Framework was developed and included the broad categories of health status, non-medical determinants of health, health system performance, and community and health system characteristics. The health system performance category included 8 dimensions of quality: acceptability, accessibility, appropriateness, competence, continuity, effectiveness, efficiency and safety. This framework was revised (Figure 2-3, page 42) to incorporate equity as a cross-cutting dimension. Equity underlies an ethical principle closely related to human rights and social justice in health (43). Measures of equity can identify disparities in health status, provision of health services, clinical outcomes, health behaviours and other non-medical determinants of health, across different groups of a population (43). In addition to CIHI’s framework, the provincial health councils in British Columbia, Alberta, Saskatchewan, Ontario and New Brunswick have also developed their own conceptual frameworks to guide indicator development and initiatives (39).

For over 15 years, CIHI has reported on over 80 health and/or health care quality indicators (44). To assess the adequacy, efficiency and quality of primary care within the broad Canadian health system, one indicator that has been reported by CIHI is hospitalizations for ACSC.

2.3 Ambulatory Care Sensitive Conditions (ACSC)

As provinces are struggling to control health care spending, especially after federal health care funding transfers were scaled back in 2014 (45-47), there is a need for a reliable measure of cost-effectiveness in the broader context of health system performance. The concept of ACSC was developed to evaluate health system performance, mainly in primary care. Hospitalization
for an ACSC is considered to be ‘avoidable’ and indicative of a suboptimal health system, particularly for primary health care services.

2.3.1 What are avoidable hospitalizations?

Health care leaders are driven to reduce waste and inefficiency through eliminating unnecessary hospital admissions. Reducing avoidable hospitalizations is a leading healthcare reform in many provinces across Canada and internationally (48;49). Avoidable hospitalizations are a common and costly occurrence and policymakers have identified reducing them as a quick and easy way to curb healthcare costs. In Canada, initiatives reducing ACSC hospitalizations are often referred to as "right care in the right place at the right time" (50;51). An avoidable hospitalization is defined as an admission or readmission that might ordinarily have been controlled or prevented (52). A disproportionate number of avoidable hospital admissions occur in people with chronic conditions, usually due to an acute exacerbation of one or more symptoms and often as a result of the absence of preventative measures or timely access to primary health care services (4;6;8;9). These hospitalizations are considered to be symptomatic of a sub-optimal health system (6;7). Clearly, these admissions cause additional burden on the health system and offer an opportunity for the government to intervene (53).

The underlying drivers to prevent hospitalizations are threefold. The first is cost-effectiveness: primary care and management of chronic conditions in the community may prevent use of more expensive hospital resources. At a health system level, acute hospitalizations comprise the highest proportion of healthcare spending. In 2011, acute hospitalizations in Canada accounted for 29.5% of total health expenditures, approximately $59.0 billion (36). The
second driver is risk to patients: hospitalizations have the potential to lead to poor health and functional outcomes that could have been avoided such as nosocomial infections, delirium, falls and in-hospital medication errors (54). Hospital transfers and treatments during hospital stays are thought to pose risks for functional decline independent of the disease that prompted the hospitalization (55;56). The third and final driver is process disruptions: avoidable hospitalizations cause disruption to elective healthcare (notably, surgical wait lists) (57).

2.3.2 What are ACSC?

Many chronic conditions can be effectively managed in the community with appropriate medical screening, monitoring, management and follow-up. These chronic conditions are referred to as ACSC, which were originally developed to identify hospitalizations in the US that could potentially be avoided with adequate access to ambulatory or primary care in the community (58;59). Since their inception in 1993, ACSC have provided the basis for measuring adequacy of ambulatory and primary health care performance in the US, Canada and internationally (1-5). A recent PubMed search revealed 363 published papers related to ACSC, indicating they are a “hot topic” with hundreds of publications on this health quality indicator. Currently ACSC hospitalization rates are reported in many countries including Canada, US, Spain, Germany, United Kingdom, Australia, etc. However, the list of conditions included and how they are measured and reported vary by country (described below in section 2.4.1).

In its national health indicators report, CIHI (60) focuses on seven ACSC: hypertension, diabetes, angina, asthma, chronic obstructive pulmonary disease (COPD), epilepsy, and heart failure/pulmonary edema (59). A recent Canadian study (61) reported that individuals who
experience an ACSC hospitalization represented 6.0% of all hospitalized Canadians, and used nearly 11.0% of all hospital days. Further, approximately 4.2 million persons between the ages of 12 and 74 have been diagnosed with one or more ACSC, with approximately 46% suffering from hypertension, 43% heart disease, 36% diabetes, 30% asthma, and 16% COPD. Among these, 3.8% (161,000) reported one or more ACSC hospitalizations over a four-year period (61).

As a health care quality indicator, ACSC hospitalization data are intended to be used to drive system transformation and primary health care system management. To improve quality and provide patient-centered care, some provinces are reforming their primary care system. The key feature of primary health care reform is a shift to teams of providers who are accountable for providing comprehensive services to their patients (62). There is a growing consensus that family physicians, nurses, and other professionals working as partners will result in better health, improved access to services, more efficient use of resources, and better satisfaction for both patients and providers. Such teams are well positioned to focus on health promotion and improving the management of chronic disease. This team approach, along with telephone advice lines, facilitates access to primary health care services after-hours, reducing the need for costly ED visits or hospitalizations. While ACSC have been chosen as an indicator to measure primary health care reform including in Alberta and British Columbia, the use of ACSC hospitalizations as a performance indicator for primary care has not been validated in Canada.

2.3.3 Primary care and ACSC

Although ACSC provide the basis for measuring adequacy of primary health care across many countries (63), it remains unclear whether this underlying assumption is correct. As it is
unethical to randomize patients with an ACSC to outpatient visits versus no outpatient visits, evidence to understand the role that outpatient visits play in subsequent hospitalization can only be assessed indirectly.

In the US, several studies have demonstrated an association between improved insurance and/or self-rated primary care access and lower hospitalization rates for ACSC (64-66). However, there is also evidence to show very small to no significant reductions in ACSC hospitalizations with an increase in the number of primary care providers (67-69). A recent study reported an association between limited primary care access and high ACSC hospitalization (70), but as with many other studies, all of the ACSCs were examined in aggregate form, and not stratified by individual conditions. Without individual stratification, the study is vulnerable to the ecological fallacy and it is difficult to determine whether an association exists between primary care access and reduced hospitalizations for specific conditions.

Without robust outpatient data, the independent association between access to primary care and subsequent hospitalization is less clear. There is a growing recognition that factors beyond the adequacy of primary care likely contribute to ACSC hospitalizations.

**2.3.4 Factors contributing to ACSC hospitalizations**

Given the multi-dimensional nature of factors that lead to ACSC hospitalizations, we developed and conceptualized a modified framework to describe factors relevant to ACSC hospitalizations in a Canadian context (Figure 2-4, page 43) (71;72). Research has focused on identifying various factors associated with ACSC hospitalizations including patient characteristics, processes of care, healthcare structures, access to primary care and self-care. As
indicated by the arrows, all components of this framework are interrelated and potentially contribute toward hospitalization. For example, processes of care vary given the structural support systems for care delivery (e.g. residing in an urban versus rural region). Patient characteristics can also impact primary care services accessed, treatment options, and influence the level of interpersonal intervention required for supporting self-care practices. For instance, frequent measurements of high blood pressure may alert PCP to pay greater attention to a patient’s medication adherence or sodium intake. The factors in the framework are explored in more detail below. It is important to note that the majority of literature assessing contributors to ACSC hospitalizations examines the conditions in aggregate form, rather than examining individual conditions separately.

2.3.4.1 Patient characteristics

There is recognition that factors beyond adequacy of primary care likely contribute to ACSC hospitalizations, including age, sex, burden of co-morbid conditions, socio-economic status (SES), family support, severity of disease, race and education (53;61;63). Some of these factors will be described in detail below.

There is growing evidence that the role of patient characteristics may place individuals at higher or lower risk for ACSC hospitalization. It has been found that males and people older than 65 years of age are more likely to experience an ACSC hospitalization than females or those under 65 years of age (73-75). Given that people with chronic conditions are higher users of healthcare services (76), it is not surprising that ACSC hospitalizations have been found to be more prevalent among people with poorer health and those with co-morbidities. There is limited
literature linking severity of disease to ACSC hospitalizations, likely due to lack of out-patient clinical data (e.g. blood pressure measurements). However, Muechberger and Kendall (53) and the Agency for Healthcare Research and Quality (AHRQ) (77) has identified disease severity (such as acuity of disease) as a significant predictor of avoidable hospitalization. The Charlson Comorbidity Index is often used as a proxy measure for severity of disease, but it has been shown to be inconsistently documented and not a good predictor of hospital readmission (78).

Patients residing in lower socioeconomic status regions are at increased risk of an ACSC hospitalization compared to those residing in higher socioeconomic status regions (6;53;61;70;75;79-82). Race is a predictor of ACSC hospital admissions (83;84), with non-Whites having more admissions than Whites. These studies are limited to African-American or Hispanic race, and few other racial groups have been studied (therefore not adequately addressing the racial mix in Canada).

*Even though patient characteristics play a role in ACSC hospitalizations, they have only been assessed using aggregate ACSC data and not stratified by individual conditions.*

2.3.4.2 Structural factors

**Geographic location**

The literature consistently shows that residing and receiving care in a rural location is associated with higher hospital admissions for ACSC than people residing in an urban location (6;53;61;70;75;81;85). CIHI has also reported sizable variations in ACSC hospitalization rates between rural and urban areas (81). Specifically in 2006-2007, the overall age-adjusted
hospitalization rate for all ACSC in rural areas was about 510 per 100,000, 60% higher than in urban areas, where the rate was 318 per 100,000 population.

**Primary health care supply**

Hospitalization rates for ACSC have been used in many jurisdictions as a proxy for the presence or absence of appropriate primary and preventive care; more physician visits within a community should result in fewer hospitalizations for ACSC (9). A lower rate of ACSC hospitalizations is often interpreted as being indicative of better access to primary care, or of better quality of primary care services, resulting in prevention of hospitalizations. While primary care chronic disease management and ACSC hospitalizations are theoretically linked, the evidence for this association is limited. Much of the research is based on ecological studies of the relationship between service capacity, such as the number of primary care practitioners, and ACSC hospitalizations. Additionally, in the literature the results are conflicting: some studies show no association (60;86), and others show the expected negative association, with lower admission rates in areas with more PCP (87;88). A 2013 systematic review (89) found inconclusive evidence that increased primary care resources are associated with reduced hospitalizations for ACSC.

2.3.4.3 Process factors

**Regular source of primary care**

In recent years health services researchers have become increasingly aware of the importance of a regular doctor whom the patient visits when sick or in need of advice about health, as a means of providing a point of entry to necessary health care. For example, people
who have a regular source of care are more likely to receive an annual physical examination, to experience continuity of care when needed, and to be satisfied with the care received (90). Additionally, having a regular source of care has been found to be associated with children receiving immunizations and adults receiving preventive services in the past year (91). Without access to a regular source of care, patients have fewer doctor visits, greater difficulty obtaining care, and more difficulty obtaining prescription drugs.

If ACSC hospitalizations indicate inadequate primary care, it would be expected that people who had such hospitalizations would report less access to primary care services. Contrary to what would be expected, a 2011 analysis from Statistics Canada (using linked survey and health administrative data) found that individuals who had an ACSC hospitalization were also more likely to be users of primary care and specialist services and more likely to have a regular medical doctor (61) compared to those without a ACSC hospitalization. Specifically, individuals with an ACSC hospitalization were more likely to self-report that they had access to a regular medical doctor compared to those with at least one non-avoidable hospitalization and those with no hospitalizations. Having a regular medical doctor was determined by the self-report question in the 2000/2001 Canadian Community Health Survey (CCHS), cycle 1.1, “Do you have a regular medical doctor?” (Y/N). Individuals with an ACSC hospitalization were also more likely to be frequent users of health care, with almost 70% reporting 4 or more occasions when they accessed PCP in the past 12 months; this compares to 50% of those who had no hospitalization. Similarly, they were more likely to have reported 4 or more specialist consultations in the past 12 months. Additionally they were more likely to have had an overnight hospital stay (for any reason) in the past year.
**Clinical care**

Clinical care is the application of knowledge, technology, and actions aimed at effectively addressing health issues. Sub-optimal monitoring and management by PCP is associated with ACSC hospitalizations (92). There is an assumption that when patients are treated based on consensus guidelines, a portion of hospital admissions should be avoidable. While there has been some improvement in uptake of consensus recommendations by PCP over time, it has been slow and patients with chronic conditions are not consistently receiving evidence-based treatment (93-96).

2.3.4.4 Access to primary care

Hospitalizations for ACSC have been used to measure the accessibility of health care, particularly in the US. As described above in section 2.1.2, accessing the health care system in Canada is commonly described as a component of quality in health care (15;16), whereas in the US access and quality are typically measured separately. This is because the two countries' health care systems are very different; Canada has a single-payer, mostly publicly-funded system, while the US has a multi-payer, heavily private system. Thus, in countries where access to primary care is universal and free at the point of delivery, interest in ACSC aims at measuring mainly the quality of care delivered (97).

In Canada, family physicians are the principal providers of primary healthcare and make up 52% of all physicians in Canada (98). Despite the principle of universal access to health care in Canada there are still concerns about problems with access, particularly in rural and remote areas, but also in urban centres where the lack of after-hours services often results in the use of
ED visits for non-urgent care (62). The 2014 Commonwealth Fund’s International Health Policy survey focused on those aged 55 years and older and found that 96% of Canadians had one or more physicians they usually went to for their medical care. However 53% of Canadians had to wait at least two days to see a physician when sick or needed medical attention and 51% felt it was difficult to get medical care in the evenings and weekends or holidays without going to the ED. Interestingly, the study reported that 1 in 5 ED visits in Canada was for a condition that could have been treated by primary care. Another recent survey (99) compared access to primary care in eleven developed countries, and found that Canada ranked lowest on the number of patients reporting that they were able to see a doctor on the “same or next day”, and highest on having to wait 6 days or more. Further, the National Physician Survey (98) has reported a decrease in accessibility to PCP in Canada from 2007 to 2010, despite the ratio of physicians increasing from 192 to 203 per 100,000 population over this time period. *In Canada, the association between access to primary care and subsequent ACSC hospitalization has not been studied for individual conditions.*

2.3.4.5 Self-care

Self-care is the work of living with a chronic illness and is thought to influence outcomes strongly, including hospital admissions and readmissions (100). While living with an ACSC, patient self-care involves self-maintenance behaviors (e.g. adhering to medications, diet, physical activity), monitoring for bodily changes (i.e., self-monitoring), and evaluating and acting on bodily changes (i.e., self-management). There is little to no research assessing the association between self-care and ACSC hospital admissions however there is a strong association between
inadequate self-care and hospital readmissions. Thus, we felt it was important to include self-care in our framework.

2.4 Potential limitations of ACSC for measuring quality of care

As illustrated in our conceptual framework (Figure 2-4, page 43), numerous factors contribute to an ACSC hospitalization, many of which are not “under primary care provider control” (57;92;101;102). Factors outside direct physician control include socioeconomic status, age, race and community (i.e., residing in urban versus rural location). Concerns have therefore been raised about the assumption that optimal primary care would prevent hospitalizations for ACSC (103;104). There is limited evidence about whether ACSC hospitalizations are ‘truly avoidable’, or whether, if ASCS are managed well by primary care, the number of ACSC hospitalizations could potentially be reduced.

Variations in ACSC rates across regions, provinces, and countries could be caused by true quality of care differences, along with differences in data quality or other factors such as patient characteristics, processes of care, healthcare structures, access to primary care and self-care. Another potential limitation of using ACSC to measure quality of primary care is that accurately identifying ACSC hospital admissions may be confounded by data quality. Below we describe how ACSC are measured and data that are used to measure health quality indicators.

2.4.1 How are ACSC measured?

Administrative data, specifically the hospital discharge abstract database (DAD), is the only data source for producing and reporting national and provincial rates of ACSC in Canada.
One key reason for the widespread use of ACSC is that the DAD a) is ready to be analyzed; b) has wide geographic coverage; c) is a relatively complete capture of episodes of patient contact with the health system; and d) is relatively low cost to use. Over 800 facilities in Canada routinely extract demographic and clinical information from medical charts to generate and submit the DAD to CIHI (105). Thus, the CIHI DAD allows for reporting of ACSC at a national level.

The DAD is generated by trained medical coders and includes information about all patients admitted to hospital. Each discharge record contains a unique identification number for each admission, a patient chart number, date of admission, date of discharge, location of residence, physician specialty, diagnoses (up to 25 coded diagnoses recorded using the International Classification of Disease (ICD) version 10 (ICD-10-CA) coding system), procedures (up to 20), and an indicator flagging the occurrence of death during a hospitalization. In Alberta, each hospital has a health records department where trained coders read through patients’ medical charts and assign appropriate ICD-10-CA diagnosis codes. The DAD also has a ‘diagnosis type’ indicator. The coders assign a one digit ‘diagnosis-type’ code to specify the timing of diagnosis. Type M is the most responsible diagnosis, which is defined in Canada as the condition responsible for the most resource use during the hospital stay (106).

To identify ACSC hospitalizations for each of the seven ACSC conditions, CIHI searches the most responsible diagnosis coding field in the DAD using specific ICD codes (e.g. ICD-10-CA codes I10.0, I10.1, I11 for uncomplicated hypertension) (44). Exclusion criteria include those who died before discharge, individuals aged 75 years and older and admissions recorded as newborn or stillbirth. CIHI reports aggregate age-standardized acute care hospitalization rates for
all seven ACSC conditions per 100,000 population younger than 75 years of age (44;107). The rates are not risk adjusted and ED visits for ACSC are not measured or reported.

In the US, the AHRQ Prevention Quality Indicators reports ACSC hospitalization rates for sixteen conditions: bacterial pneumonia, hypertension, dehydration, asthma, urinary tract infection, COPD, perforated appendix, diabetes short-term complication, low birth weight, diabetes long-term complication, angina without procedure, uncontrolled diabetes, congestive heart failure, lower-extremity amputation among patients with diabetes, and pediatric gastroenteritis and asthma. Similar to CIHI, the AHRQ identifies ACSC hospital admissions by searching the most responsible diagnosis coding field in the DAD using specific ICD-9-CM codes. However in the US, the most responsible diagnosis field is defined as the reason for hospital admission (106). In contrast to CIHI, the AHRQ reports individual hospitalization rates for each condition per 100,000 population over the age of 18 years (excluding pediatric conditions). Each condition has specific exclusion criteria (i.e., for hypertension exclusion criteria include kidney disease combined with dialysis access procedure admissions, cardiac procedure admissions, obstetric admissions, and transfers from other institutions).

2.5 Data used to measure health quality indicators

Commonly used data sources to measure health care quality indicators are survey, medical record, and health administrative data. In Canada, CIHI and Statistics Canada obtain their health quality indicators from readily available national data sets. Sources include national surveys (i.e., CCHS, National Population Health Survey, Canadian Health Measures Survey, etc.), registries (i.e., Canadian Cancer Registry), administrative health data (i.e., National
Ambulatory Care Reporting System, DAD, Vital Statistics). The most commonly used data source to report national health care quality indicators is the DAD.

2.5.1 Advantages of using the DAD for measuring quality indicators

The DAD provides a readily available, cost-effective source of information to measure health care quality indicators. Not only is the data relatively inexpensive to acquire in electronic format, and is population-based, it is representative of the population(s) of interest, and has the ability to span years and different health care settings (108). This is especially advantageous as it permits the measurement of health care quality indicators over time and allows comparisons of quality between health care settings. In contrast to data from randomized controlled trials, administrative data reflects “real-world” treatment settings in unselected populations, reducing selection bias (109). In addition, population loss to follow-up and recall bias is minimal in the DAD.

A main advantage of using the DAD to measure health care quality indicators is that the dataset is populated by professional coders using a common set of practices and guidelines. This brings some uniformity to the data that may be absent in clinical data abstracted from medical records or electronic medical records. ICD coding education is promoted and standardized at an international level through the World Health Organization (WHO), and at the national level through CIHI (102).

Using Donabedian’s typology of quality measures (11), the DAD is able to measure outcomes (including rare outcomes) and some structural measures such as volume. Common outcomes that have been measured include morbidity (e.g. complications, unplanned hospital
readmissions, ACSC), mortality (e.g. stroke in-hospital mortality rates), costs, specific procedures, adverse events and hospital length of stay.

Health care quality indicators in the DAD have the ability to be well-defined, with a clearly identified numerator and denominator. As an example, the AHRQ acute myocardial infarction (AMI) mortality rate indicator is defined as the number of deaths per 100 discharges with a principal diagnosis code of AMI (77). The numerator is the number of deaths with a principal diagnosis of AMI. The denominator is all discharges 18 years and older with a principal diagnosis code of AMI (excluding patients with a missing discharge disposition or a transfer to a short-term hospital).

A noteworthy advantage of the DAD is its potential to link to other administrative datasets to provide a more comprehensive assessment of health care quality measurement. For instance, the Manitoba Centre for Health Policy maintains a comprehensive data repository and links over 20 administrative datasets using unique personal identifiers (110). The unique identifier permits the user to build histories of individuals across administrative data files. For instance, patients who are discharged from hospital can be linked to physician claims data to determine if adverse events are being treated in physicians’ offices. Multiple databases can also be used to track utilization of health services accurately. Further, linking multiple administrative datasets that provide complementary information is advantageous as diagnoses that are typically under-coded in one dataset may be identified in another. For example, Abrams et al. (111) determined that using diagnosis from prior outpatient encounters increased the identification of psychiatric conditions compared to using diagnoses identified in hospital discharge data. Lastly, the overall match of record linkage between two or more separate administrative databases can
quantify the degree of agreement between items in the administrative datasets, providing a measure of reliability.

Given its numerous advantages, the DAD has been widely used to measure quality of health care for nearly three decades. Despite the advantages, however, there are many limitations of using this data that need to be taken into consideration to avoid erroneous measurement of health care quality indicators.

2.5.2 Disadvantages of using the DAD for measuring health care quality indicators

2.5.2.1 Conceptual disadvantages

Since the 1970s, the quality of administrative data, including the DAD, has come under scrutiny (112-115). Data quality has been defined as “the whole of planned and systematic procedures that take place before, during and after data collection to guarantee the quality of data in a database…for its intended use” (116). The role of administrative data in measuring health care quality indicators remains controversial primarily due to concerns over its quality (encompassing validity, reliability, comparability, completeness) and timeliness (117).

There are many steps in the generation of administrative data, and a number of points at which errors may occur. In the DAD, these errors are generally influenced by three major factors: data quality depends first on the accuracy of physicians’ diagnoses; second it depends on how clearly, precisely and completely physicians document diagnoses and treatments in a patient’s chart; and third, how accurately and consistently the charts are coded by professional coders (118). Errors of physician charting are difficult to assess, being highly variable and dependent on factors not explained in the DAD, including physician experience and expertise as well as the communication between physician and patient. Moreover, various factors can affect
the transfer of information into a medical chart, such as poor documentation, illegible charts, data loss and unavailability, and timeliness of chart completion (119). Despite coding standards, the steps in the process of coding a diagnosis or procedure introduce numerous opportunities for error (112;115). In fact, the process of assigning codes is complicated and has been referred to as “more of an art than a science” (108;112). Accordingly, health care quality measures derived from the DAD are highly dependent on the validity of the underlying data (41;120).

Sub-optimal data quality can affect the comparability of health care quality indicators across geographic areas, populations and time. One method to assess DAD quality is to use statistical estimates of sensitivity, specificity, positive predictive value, and negative predictive value to compare the data with a gold standard that is widely accepted (e.g. medical chart). A large amount of research, time and money have been invested into hospital discharge data quality measurement. Many investigators (121-131) have conducted validation studies focusing on comorbidities, clinical conditions, and complications of sub-standard care, and found that the DAD is accurately coded for many severe or life-threatening conditions such as myocardial infarction and cancer, but that some clinically nonspecific and symptomatic conditions such as rheumatologic disease are less accurately coded. Validation studies in Canada have shown that the Canadian Classification of Intervention (CCI) procedure codes perform reasonably well for coding major or invasive procedures, but are less valid for coding minor or less invasive procedures (132). Prior to using the DAD to assess health care quality indicators, it is imperative that the validity and accuracy of coding is deemed adequate for its intended use in terms of the conditions and procedures being measured. The validity of classifying an ACSC using the DAD has not been evaluated.
One major disadvantage to using the DAD for health care quality indicator measurement is the lack of clinical detail such as vital signs and laboratory test results. As a result, health care quality indicators that assess patient complexity are limited to demographics and comorbidity as measured by secondary ICD diagnosis codes (133). Further, due to limited clinical detail the data cannot generally provide information on errors of omission (failing to do necessary things) or commission (doing unnecessary things), appropriateness of care, patient centeredness (e.g. communication, caring and respect for patients preferences), and other important factors such as patients’ symptoms, functional status, and quality of life measures (41;108).

Unlike clinical registry data, the DAD is only able to provide limited information on processes of care. For example, whether or not a patient with diabetes has had a retinal exam (30), but not whether the patient had their glycosylated hemoglobin (A1C) or low-density lipoprotein cholesterol values taken. This is a substantial limitation for health care quality indicators, as the data are unable to specify what process needs to be targeted to improve quality. Resultantly, the DAD is unable to link process and outcome measures (concept that outcomes data, when viewed in isolation, are less “actionable” than process data).

Comparing outcome measures using the DAD requires risk adjustment, that is, employing statistical methods to “level the playing field” by adjusting for the effects of patient characteristics (41). It aims to account for differences in intrinsic health risks that the patient brings to a health care encounter (41). Patient outcomes are driven not just by quality of care, but also by other confounding factors such as age, sex, medical history, comorbidities, and social and physiologic factors. Without risk adjustment, patient outcome results can provide incorrect conclusions, because the hospitals or physician organizations that appear to have the worst
outcomes may simply treat the sickest patients. In the DAD, the main reason for hospitalization is recorded as well as secondary diagnoses (also called comorbid conditions or risk factors) using ICD codes. **The major limitation of risk adjustment using the DAD is that it can only account for the measurable and reported risk factors.** Important risk factors can be unavailable (e.g. pre-operative functional status) or inconsistently reported or coded (e.g. obesity).

Changes in coding practices are another potential disadvantage of using the DAD to measure health care quality indicators. Iezzoni explained that “to the extent that coding intensity has increased over time or differs across settings, comparisons (of quality) can be problematic”(41). For instance, more intensive coding of comorbidities can mislead risk adjusted outcomes (41), which was a concern in the New York coronary artery bypass surgery risk adjusted mortality report cards. Physicians were accused of intensively coding comorbidities making their patients “look sicker”, causing their risk adjusted outcomes to “look better” a phenomenon termed the death creep (41). Death creep occurs in part because publicly reported outcomes, particularly in the US, drive reimbursement, and overall hospital/physician reputation, which is a crucial element in the competition for patient care, clinical payment, and research funding (41).

The introduction of new coding systems also raises questions about coding accuracy and completeness of clinical information recorded in the DAD. This is especially important for health care quality indicators measured over time and across settings. For example, when the WHO introduced ICD-10, concerns were raised about the potential for coding errors in the data. This is largely because ICD-10 codes use a new alphanumeric system and each code in ICD-10 starts with a letter (e.g. A-Z), followed by two numeric digits, a decimal, and a digit (e.g. acute
bronchiolitis due to respiratory syncytial virus is J21.0). In contrast, codes in ICD-9 begin with three digit numbers (e.g. 001–999), that are followed by a decimal and up to two digits (e.g., acute bronchiolitis due to respiratory syncytial virus is 466.11). In addition, many ICD-10 codes are not directly convertible to corresponding ICD-9 codes.

A recent study (134) investigated whether the implementation of ICD-10 Canadian modification (ICD-10-CA) affected the DAD in Canada. It was found that implementation of ICD-10-CA did not substantially change coding practices, although the average number of diagnoses per hospital coding varied across the provinces. Quan et al. (135) also assessed the validity of the ICD-10 coding for 32 conditions with respect to the previous ICD-9-CM coding system and medical chart review. The study found that while the two coding systems had similar sensitivities for 24 of the conditions, there were some conditions where one coding system performed better than the other. Overall the authors concluded that there was no improvement in the validity of coding using ICD-10 version compared to ICD-9-CM for the 32 conditions studied. The validity of coding is also important for the process of risk adjustment. One Canadian study assessed the validity of ICD-10 coding algorithms developed for nine acute AMI-specific comorbidities and found that the newly developed coding algorithms performed as well as previous versions using ICD-9 coding algorithms. This illustrates the importance of validating new coding versions of ICD as they are developed to ensure that coding remains valid as revisions are made, especially for health care quality indicators measured over time.

The DAD typically has a time lag from when it is collected to when it is released. This is an important issue when it comes to measuring health care quality indicators. When reports are released using “old data” (e.g. 12 – 24 months behind), the results may not be current or
actionable; many times decision makers have moved on and changed priorities by the time the reports are released. It begs the question, if the DAD data are not timely; can the DAD be used effectively to have an impact on health care quality or health system performance? To overcome this barrier some organizations, such as Alberta Health Services (136), have implemented a dashboard of measurements where some quality indicators are reported on a quarterly or semi-annual basis using administrative data. Currently at Alberta Health Services the time lag for the DAD is 2 months. Since fiscal year 2013/14 Saskatchewan Health Quality Council has also developed an innovative tool entitled “Quality Insight” (137), allowing the public, care providers, managers and leaders to access information about health and health care quality indicators online in a timely fashion (generally a 3 month lag).

2.5.2.2 Specific disadvantages

A shortcoming of the DAD is the lack of international consistency for some coding rules, such as diagnosis-timing and main diagnosis definition. The DAD is unable to distinguish diagnoses present at admission or whether these occurred during the hospital stay. Diagnoses arising after hospital admission are of particular interest as they represent adverse events or complications of care that are important quality measures. To date, Canada, the US and Australia have addressed this limitation by implementing diagnosis-type indicators or ‘present-on-admission flags’ linked to each coded diagnosis in hospital discharge data (138). In the Canadian discharge abstract database (DAD), the use of a single-digit numeric code distinguishes diagnoses present at admission and those that occur after admission. The diagnosis-type indicators include: Type M (the most responsible or main diagnosis), Type 1
(primary comorbid conditions present at time of admission), Type 2 (diagnoses arising after admission), Type 3 (secondary comorbid conditions present at time of admission) (139;140). It should also be noted that the definition and coding rules for the main condition (otherwise called primary diagnosis) in hospital discharge data are also not consistent internationally, which raises an important issue when comparing coding across countries. For example, in Canada the coding of the main condition is based on the condition that takes up the majority of resource use during the hospital admission, whereas in the US it is based on the reason for admission (141). Further, in some countries such as France, the main condition coding definition has changed over time, which is not ideal for comparability (141).

The DAD is susceptible to the manipulation of information to enhance physicians’/hospitals’ own agendas, otherwise known as gaming. Health care quality indicators measured using the DAD that are linked to incentives, such as pay for performance, are susceptible to misuse of billing and/or coding to obtain more money, commonly termed “upcoding”. Concomitantly, conditions that are non-incentivized may either be neglected or not coded at all as there is no financial incentive to document them. For example, the Centers for Medicare and Medicaid Services in the US have deemed the occurrence of deep vein thrombosis (DVT) or pulmonary embolism after some orthopedic procedures a “never event” (142). As such, hospitals are not compensated for providing care necessary to treat these complications, a clear incentive to avoid diagnosing and coding these events, which are widely utilized as hospital health care quality indicators (143).

Prospective payment plans have a wide range of reimbursement scales for different ICD-driven diagnosis related groups (DRGs), providing opportunities for gaming. Specifically, the
structure of the reimbursement creates incentives to identify main diagnoses associated with higher reimbursing DRGs, known as the “DRG creep” phenomenon. For example, in the US, the use of sepsis as the main diagnosis among patients with pneumonia increased substantially from 2003 to 2009 (0.4 to 1.1/1000) (144). This in part can be explained by the 2009 DRG weights, which are proportional to reimbursement, for pneumonia which ranged from 0.73 to 1.43, while sepsis ranged from 1.15 to 5.83 (133). There is also evidence that after prospective payment was introduced in the US a significant amount of Medicare expenditure increase was due to case-mix upcoding (145).

Surveillance bias has been reported to be a source of error when using the DAD to measure health care quality indicators, particularly when reporting outcome measures (142). This non-random type of information bias refers to the concept that “the more you look, the more you find” (142). According to Haut et al., surveillance bias occurs “when some patients are followed up more closely or have more diagnostic tests performed than others, often leading to an outcome diagnosed more frequently in the more closely monitored group” (142). As a result, differences in outcomes may be related to surveillance bias rather than differences in quality. To illustrate, DVT, a common health care quality indicator, is a life-threatening complication among patients who have had trauma (146). As trauma patients are at increased risk for DVT, some physicians use an ultrasound to screen asymptomatic patients whereas other clinicians do not and argue it is not clinically necessary or cost-effective. This leads to variability in the use of ultrasound screening for DVT, and therefore variability in the rates of DVT identified and reported. Therefore, surveillance bias needs to be taken into consideration when measuring health care quality indicators.
As described, health care quality indicators based on the DAD have many limitations and nuances that need to be acknowledged and addressed. However there is opportunity for the data to be improved. There are many strategies underway to improve administrative data including the evolution of ICD-11, coding rules to standardize data internationally, physician documentation and linkages to other data sources. Not only should the aim be to improve the DAD, but importantly, to improve the knowledge of those who are using the data to measure quality.

2.6 Why hypertension was chosen for this study

This research focused on one ACSC, hypertension, as it is a cardiovascular risk factor of tremendous population health importance. Globally, it affects 40% of the global adult population or more than 1 billion individuals worldwide (147) and is the leading cause of death or disability in the world, accounting for 9.4 million deaths annually and 7% of disability-adjusted life years lost (147;148). It affects more than 20% of the Canadian adult population (149-152), and is the number one reason for primary care visits in Canada (153). Elevated blood pressure is a major etiological factor for stroke and coronary heart disease, despite the fact that it can be effectively controlled through pharmacotherapy or with lifestyle changes in physical activity, diet, sodium intake, alcohol use, weight management, and smoking status (154). Although treatment of hypertension reduces death, morbidity and health care costs, in 2009 about 34% of Canadians diagnosed with hypertension had not controlled their blood pressure below the clinical recommended value, and among people who were aware of having the disease, for 21% of them it remained uncontrolled (155).
Given that hypertension is readily detectable and treatable, such shortcomings in blood pressure control are difficult to justify, and can be very costly from both individual and population perspectives (156). Specifically in 2009, over 20 million visits (6.2% of all visits) to community physicians in Canada were for hypertension, and $7 billion was spent on antihypertensive medications (157). Hypertension leads to substantial health care costs, accounting for almost half of all direct cardiovascular healthcare spending (158). If indirect costs are added, cost estimates are nearly 20 times higher (159). In Canada, the costs of hypertension-related medical care were estimated in 2010 to be $13.1 billion (21% of the total direct adult health budget), rising to $20.5 billion by 2020 (160). To the best of our knowledge, this thesis is the first to explore and examine ACSC for one condition, uncomplicated hypertension.
Figure 2-1: Aday and Andersen Model of Access to Health Care (adapted from R.M. Andersen. "Revisiting the Behavioral Model and Access to Medical Care: Does it matter?" J Health Soc Behav 1995;36:1-10)
Figure 2-2: Depiction of the Donabedian Model (161)
Figure 2-3: Canadian Institute for Health Information health indicator framework (16)
Figure 2-4: Conceptual framework for factors contributing to ACSC hospitalization
Chapter Three: HOSPITALIZATION FOR UNCOMPLICATED HYPERTENSION: AN AMBULATORY CARE SENSITIVE CONDITION
3.1 Abstract

Background: Hospitalizations for ambulatory care sensitive conditions (ACSC) represent an indirect measure of access and quality of community care. This study explored hospitalization rates for one ACSC, uncomplicated hypertension, and the factors associated with hospitalization.

Methods: A cohort of patients with incident hypertension, and their covariates, was defined using validated case definitions applied to International Classification of Disease (ICD) administrative health data in 4 Canadian provinces between fiscal years 1997 and 2004. We applied the Canadian Institute for Health Information’s case definition to detect all patients who had an ACSC hospitalization for uncomplicated hypertension. We employed logistic regression to assess factors associated with an ACSC hospitalization for uncomplicated hypertension.

Results: The overall rate of hospitalizations for uncomplicated hypertension in the 4 provinces was 3.7 per 1000 hypertensive patients. The risk-adjusted rate was lowest among those in an urban setting (2.6 per 1000, 95% confidence interval (CI): 2.3-2.7), the highest income quintile (3.4 per 1000, 95%CI: 2.8-4.2), and those with no comorbidities (3.6 per 1000, 95%CI: 3.2-3.9). Overall, Newfoundland had the highest adjusted rate (5.7 per 1000, 95% CI: 4.9-6.7), while British Columbia had the lowest (3.7 per 1000, 95% CI: 3.4-4.2). The adjusted rate declined from 5.9 per 1000 in 1997 to 3.7 per 1000 in 2004.

Conclusion: We found that the rate of hospitalizations for uncomplicated hypertension has decreased over time, which may reflect improvements in community care. Geographic
variations in the rate of hospitalizations indicate disparity among the provinces and those residing in rural regions.
3.2 Introduction

Many chronic conditions, including hypertension, can be managed effectively in the community with appropriate medical screening, monitoring, management and follow-up. These conditions are referred to as ambulatory care sensitive conditions (ACSC). ACSC were initially developed to identify hospitalizations in the general United States population that could potentially be avoided with adequate access to ambulatory or primary care in the community (58;59). It is commonly thought that timely and effective primary care can prevent the onset of complications, reduce the risk of acute episodes, and prevent hospitalizations (162;163). Thus, ACSC hospitalizations are commonly referred to as admission or readmission that might ordinarily have been controlled or prevented, ‘avoidable hospitalizations’ (52). Avoidable hospital admissions are considered to be an indicator of a less than optimal health system (6;7) resulting in unnecessary costs and resource use (53). In Canada, individuals who experience an ACSC hospitalization represent 6.0% of all hospitalized Canadians, and nearly 11.0% of all hospital days (61).

Hospitalizations for ACSC are used internationally (including Canada) as an indicator for the adequacy of primary care in the community (2;6;59). In its national health indicators report, the Canadian Institute for Health Information (CIHI) (60) focuses on seven ACSC: angina, asthma, chronic obstructive pulmonary disease, diabetes, epilepsy, heart failure, and hypertension. Eliminating avoidable hospital admissions (and readmissions) for ACSC has been identified as a goal by both practitioners and policymakers in Canada (164;165). Patients and the general public also have a vested interest in avoiding hospitalizations and advocating for health interventions that will reduce preventable hospital admissions.
The purpose of this research is to explore the hospitalization rates and the factors associated with hospitalization for one ACSC, uncomplicated hypertension, using administrative health data. Further, we will explore temporal trends in hospitalization and emergency department (ED) visits for uncomplicated hypertension. We chose hypertension as it is a highly prevalent condition affecting more than 20% of the Canadian adult population (151), and is the number one reason for primary care visits in Canada (153). The health resource utilization associated with the management of hypertension is estimated to consume 10% of all health care spending. In fact, managing hypertension requires financial resources comparable to those used in diagnosis and management of stroke, myocardial infarction and all other ischemic heart diseases combined (166).

3.3 Methods

3.3.1 Data Sources

Administrative health databases from four Canadian provinces (Alberta, British Columbia, Manitoba and Newfoundland) were used. Databases used included provincial health insurance registries, hospital discharge abstracts (DAD), and physician billing claims between April 1, 1994 and March 31, 2006. Additionally in Alberta we used the Ambulatory Care Classification System (ACCS) data between April 1, 1997 and March 31, 2006. The databases were linked through a unique identifier, the Personal Health Number (PHN). Canadian universal health care insurance covers nearly all Canadian residents.

The insurance registry, which is updated regularly, contains registrants’ name, date of birth, sex, and postal code for all individuals eligible to receive health care services, and is
considered a proxy for census data. The DAD contains demographic and clinical information for all patients discharged from hospital, with each discharge record coded with up to 25 diagnosis codes using International Disease Classification (ICD) 9th Revision (ICD-9), ICD-9 Clinical Modification (ICD-9-CM), or ICD-10 Canadian Modification (ICD-10-CA). The physician billing claims database contains fee-for-service billing information that includes unique patient identifier, unique physician identifier, up to 3 ICD-9 diagnosis codes, 1 procedure code, provider specialty, and function centre type indicating where the service was provided. The physician claims database captures nearly all outpatient physician services and the majority of inpatient physician services because of our universal health insurance coverage. The ACCS database in Alberta includes facility-based ambulatory care information (same-day surgery, day procedures, emergency department (ED) visits, and community rehabilitation program services). Each record is coded with up to 10 diagnosis and 10 procedures.

3.3.2 Study Population

Newly diagnosed hypertension (denominator): The study population included all patients with an incident diagnosis of hypertension between April 1, 1997 and March 31, 2005 (fiscal years 1997 to 2004) in four Canadian provinces (Alberta, British Columbia, Manitoba and Newfoundland). Hypertension was defined using a validated ICD case definition for Canadian administrative databases (sensitivity 75%, specificity 94%, positive predictive value 81%, and negative predictive value 92%) (167): at least two physician claims for hypertension (ICD-9 codes 401.x, 402.x, 403.x, 404.x, or 405.x or ICD-10 codes I10.x, I11.x, I12.x, I13.x or I15.x) or one hospitalization with a primary or secondary diagnosis of hypertension within a two-year
period between April 1, 1994 and March 31, 2006. We excluded patients with any code for hypertension in either physician claims data or the hospital discharge abstracts in the first 3 years (April 1, 1994 to March 31, 1997) to eliminate prevalent cases of hypertension. To be consistent with CIHI case definition for ACSC (4) we also excluded those younger than age 20 or older than age 75 at the hypertension diagnosis index date. Further, as uncomplicated hypertension is defined as those with no vascular complications we excluded patients with cardiovascular disease (stroke, myocardial infarction, heart failure and peripheral vascular disease) at the time of their hypertension diagnosis (on the basis of outpatient and inpatient data 3 years prior to index diagnosis of hypertension). Thus, we identified individuals newly diagnosed with hypertension between April 1, 1997 and March, 31 2006. To ensure one-year of follow-up for all patients, incident hypertension cases without cardiovascular complications between April 1, 1997 to March 31, 2005 were analysed in this study.

Hospitalization for uncomplicated hypertension in the 4 provinces (primary outcome):

The primary outcome for this study was ACSC hospitalizations for uncomplicated hypertension. We identified hospitalizations for uncomplicated hypertension (i.e., hypertension without any vascular complications) - ICD-9 codes 401.0, 401.9, 402.0, 402.1, 402.9 or ICD-10 codes I10.0x, I10.1x, I11.x. Among those with incident hypertension, we applied ICD-9 and ICD-10 coding methodology that is used by CIHI (16) to the DAD for fiscal years 1997 to 2006 (inclusive) to detect patients with uncomplicated hypertension in the major diagnosis code up to 1 year after their index diagnosis of hypertension (Table 3-3S Supplementary Materials, page 63). The index diagnosis was defined as the earliest date for the diagnosis of hypertension in the study period. As per CIHI case definition we excluded patients who died in hospital.
ED visits for uncomplicated hypertension in Alberta (secondary outcome): To identify ED visits for uncomplicated hypertension we applied the same CIHI coding methodology (4) to the Alberta ambulatory care database. Between April 1, 1997 and March 31, 2005 we followed each patient for one year after their index diagnosis of hypertension to detect ED visits for uncomplicated hypertension in the first diagnosis code (same as the major diagnosis code in the DAD). To observe temporal trends in ED visits and hospitalizations for uncomplicated hypertension, we excluded patients who were hospitalized within 24 hours of ED visit (so that we were only assessing ED visits, and not those who came to the ED and then were subsequently hospitalized).

3.3.3 Study Variables

The age and sex at the date of hypertension diagnosis was generated using registry data. A measure of socioeconomic status and income quintile was assigned using 2001 Statistics Canada Census data. Specifically, median household income for each Census dissemination area, the smallest geographic unit for which Census data are released, was linked to each patient’s postal code assigned using the Statistics Canada Postal Code Conversion file (168). Rural and urban status was also defined using Census data. The Charlson comorbidities (except for stroke, myocardial infarction, heart failure and peripheral vascular disease) (169) were derived from the DAD and physician claims database in all 4 provinces using the three-year period up to and including the time of index diagnosis of hypertension.
3.3.4 Statistical Analysis

Baseline characteristics for those with and without a hospitalization for uncomplicated hypertension were calculated. Among those with incident hypertension, the rate of ACSC hospitalizations and ED visits for uncomplicated hypertension was estimated using standardization of rates using logistic regression (170). In a sensitivity analysis we found that the frequency of more than one hospitalization within a one year period was rare. Thus, if a patient experienced more than one hospitalization or ED visit in the year following their index diagnosis of hypertension only the first admission/ED visit was counted. Logistic regression was also used to assess factors associated with a hospitalization for uncomplicated hypertension (age group, sex, Charlson comorbidity (yes/no), region (urban vs. rural), income (subdivided into five income quintiles), fiscal year and province). Analyses were performed with SAS statistical software version 9.3 (SAS Institute Inc, Cary, North Carolina). The institutional review board for the University of Calgary approved the study.

3.4 Results

Of the 786,529 adults with newly diagnosed hypertension, 42.4% (n=333,665) were aged 50 to 64 years, 34.0% (n=267,380) were aged 20 to 49 years, 23.6% (n=185,484) were aged 65 to 74 years and 55.6% were female (n=437,327). The majority (75.6%) lived in an urban setting and had no Charlson comorbidities (72.5%).

There were 2,929 individuals who had an ACSC hospitalization for uncomplicated hypertension. These individuals were more likely to fall in the lowest household income quintile (28.6% versus 21.1%, p<0.0001), live in a rural setting (47.9% versus 19.5%, p<0.0001) and
have more comorbidities (39.5% versus 27.4%, p<0.0001) compared to those who did not have an ACSC hospitalization for uncomplicated hypertension (Table 3.1, page 59). When stratifying by type of Charlson Comorbidity, individuals with an ACSC hospitalization for uncomplicated hypertension were more likely to have diabetes without complication (6.1% versus 2.7%, p<0.0001) and renal disease (2.8% versus 0.9%, p<0.0001) compared to those who did not have a hospitalization (Table 3-4S in Supplementary Materials, page 64). The average length of stay for ACSC hospitalizations over the study period was 4.6 days.

The overall rate of ACSC hospitalizations for uncomplicated hypertension was 3.7 per 1000 hypertensive patients (Table 3.2, page 60). The ACSC hospitalization for uncomplicated hypertension was associated with age, sex, household income quintile, rural vs. urban residence, Charlson comorbidity status, year and province (all p<0.0001). The ACSC hospitalization rate for uncomplicated hypertension after adjustment for all of these variables remained significantly higher in patients younger than 50 years old, those with at least one Charlson comorbidity, and those from a rural region. The rate of ACSC hospitalizations for younger patients who had at least one comorbidity and lived in a rural area was 14.6 per 1000 hypertensive patients which is much higher than the 3.7 per 1000 hypertensive mean. The risk-adjusted rate was lowest among those in an urban setting (2.6 per 1000, 95%CI: 2.3-2.7), the highest income quintile (3.4 per 1000, 95%CI: 2.8-4.2), and those with no comorbidities (3.6 per 1000, 95%CI: 3.2-3.9). The risk adjusted rate declined from 5.9 per 1000 in 1997 to 3.7 per 1000 in 2004. Over the entire study period, Newfoundland had the highest risk adjusted rate (5.7 per 1000, 95%CI: 4.9-6.7), while British Columbia had the lowest (3.7 per 1000, 95%CI: 3.4-4.2). When stratifying by type of Charlson comorbidity, the risk-adjusted rate was highest among those with AIDS/HIV (16.5
per 1000, 95%CI: 6.8-39.3) and renal disease (15.2 per 1000, 95%CI: 12.0, 19.3) and lowest among those with moderate/severe liver disease (1.5 per 1000, 95%CI: 0.2, 10.9) (Table 3-4S in Supplementary Materials, page 64).

The decline in ACSC hospitalizations for uncomplicated hypertension between 1997 and 2004 were mirrored in the analysis of ED visits for uncomplicated hypertension (Figure 3-1, page 61). However, the decline in ACSC hospitalizations for uncomplicated hypertension was greater for those residing in a rural setting compared to those residing in an urban setting (Figure 3-2, 62). The risk adjusted rate for ED visits decreased slightly over the study period among those living in a rural setting, whereas the rate for ED visits was stable among urban residents.

### 3.5 Discussion

To the best of our knowledge, this study is the first to determine the rates of hospitalizations and ED visits for patients with uncomplicated hypertension (i.e., an ACSC) taking into account important patient characteristics among hypertensive patients. Importantly, we found that the rates of hospitalization for uncomplicated hypertension have been decreasing over time for both urban and rural patients and that the rate of ED visits decreased among rural patients, but not among urban patients. Individuals at greatest risk for a hospitalization for uncomplicated hypertension include those younger than age 50, those with lower household incomes, and those from rural areas. Our findings mirror Canadian data showing that these subgroups are more likely to be unaware that they have hypertension and are less likely to have regular primary care follow-up (171). CIHI has reported the aggregate rate of hospitalization for all 7 ACSC, which have decreased over the past several years (63). In fiscal year 2006, there
were 351 ACSC hospitalizations per 100,000 population, down from 447 per 100,000 population in fiscal year 1997.

In Canada, although estimates from the population-based physical measures surveys suggest that the prevalence of hypertension has been stable over the past decade (151), we have previously reported (as have others) that the age-standardized prevalence of physician recognized hypertension has increased from 12.5% in 1999 to 19.6% in 2007 (reflecting the decrease in the number of hypertensive individuals detected in cross-sectional surveys who were unaware they had hypertension and/or were not seeking medical attention) (172-175). Given this increase in the proportion of hypertensive patients who are receiving physician follow-up and treatment, it is not surprising that the rate of hospitalizations and ED visits for uncomplicated hypertension has decreased. Our finding that the presence of comorbid conditions increases the odds of an hospitalization for uncomplicated hypertension suggests that greater provision of primary care within integrated care models for those with comorbidities (176) may further improve preventive care and decrease hospitalizations (177).

The rate and temporal decline in ACSC hospitalization rates for uncomplicated hypertension varied by geographic location. After adjustment for risk factors, our study found that patients who resided in rural areas were more likely to be hospitalized and have an ED visit for uncomplicated hypertension compared to patients who resided in urban areas. This geographic variation may be related to disparate access to primary and ambulatory outpatient care. Previous studies have shown that individuals with chronic conditions living in rural areas are less likely to receive effective preventive services compared to those living in urban areas (178;179). Dansky et al. (179) found that patients with diabetes living in rural communities had
fewer physician office visits than their urban counterparts. In Canada rural area is large, and specialists are often only located in urban area and large medical centers. A Canadian study assessing chronic kidney disease found that individuals living in rural areas were less likely to receive specialist care, recommended laboratory testing, and appropriate medications and were more likely to be hospitalized compared to those living in the areas close to a specialist (180). Our finding of an increased rate of ACSC hospitalizations and ED visits for uncomplicated hypertension in rural residents compared to urban residents suggests an opportunity for targeted interventions to improve outcomes in this particular population.

The risk adjusted hospitalization rates for uncomplicated hypertension varied across the 4 provinces we studied. The reasons for the observed variation in ACSC rates across a country with a publicly funded universal access health care system are not well understood, but may be due to differences in access to primary care, quality of primary healthcare services and coverage of drugs among provinces (81). For example, the province of Alberta only covers drug costs for patients aged 65 years or older. Newfoundland, a province that is generally rural in nature (i.e., small population and large geographic area), had the highest risk adjusted rate of hospitalization for uncomplicated hypertension. The high rate may be related to limited number of family medicine or general practitioners and difficulties in access. Another possible explanation for the difference in rates seen across the provinces is the variation in primary care initiatives. Physicians in Alberta are primarily paid by fee-for-service, in which there are no added incentives for follow-up of these patients. British Columbia has established collaboratives to provide a range of services including disease management and preventive services to improve
quality of care for those with chronic conditions (181), however it is unknown if the collaboratives improve outcomes.

A number of studies, mainly ecological, have identified an inverse relationship between neighborhood income level and ACSC hospitalizations (58;61;81;82;182-184). Our study further supports this association for hypertension. Given Canada’s universal health care system that provides services based on need, rather than ability to pay, the fact that lower income individuals are more likely to have an ACSC hospitalization is related to patient's factors. One potential explanation is that income is a marker for differential access to and use of health care (61;183;185). It has been shown that individuals with lower income use community health services in Canada less compared to those with higher income (186). A second possible explanation may be related to barriers to hypertension management such as differential ability to pay for out-of-pocket expenses, such as pharmacotherapy (153;187) and a home blood pressure monitoring device (188). The third possible explanation is those with low income may not be compliant to physician recommendations and adhere to treatment.

Our study has limitations. First, results are based on data from four provinces, which may impact the generalizability of the findings at a national level; however, the results are consistent with other national studies assessing ACSC hospitalizations. Second, we utilized administrative data and thus were unable to assess detailed clinical information (i.e., severity of disease), and other patient factors such as education level, marital status and drug adherence. Third, misclassification of uncomplicated hypertension (i.e., non-coding of uncomplicated hypertension in the major diagnosis code) could have occurred, which would result in an underestimate in the ACSC hospitalization rates. Fourth, the case definition we used to identify patients with
hypertension has a low sensitivity (72%); thus, we did not capture all hypertensive Canadians. We may have under-sampled low-risk patients who are less likely to have received medical care and detect their elevated blood pressure. Lastly, health care utilization rates that vary by geography (i.e., urban/rural) may also interact with ethnicity and culture (189). However we did not assess the impact of ethnicity and culture in this study.

In conclusion, we found that the rate of ACSC hospitalizations for uncomplicated hypertension has decreased overtime (for both urban and rural patients), which may reflect improvements in community care. Geographic variations in the rate of hospitalizations were found, indicating disparity among the provinces and those residing rural regions.
Table 3-1: Characteristics of patients with and without an ACSC hospitalization for uncomplicated hypertension, among newly diagnosed hypertensive patients (aged 20 to 74, fiscal years 1997 to 2004)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Not hospitalized</th>
<th>Hospitalized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>% of 783,600</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-49</td>
<td>266,239</td>
<td>34.0</td>
</tr>
<tr>
<td>50-64</td>
<td>332,551</td>
<td>42.4</td>
</tr>
<tr>
<td>65-74</td>
<td>184,810</td>
<td>23.6</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>435,582</td>
<td>55.6</td>
</tr>
<tr>
<td>Male</td>
<td>348,018</td>
<td>44.4</td>
</tr>
<tr>
<td>Adjusted household income (quintiles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (lowest)</td>
<td>165,560</td>
<td>21.1</td>
</tr>
<tr>
<td>2</td>
<td>155,291</td>
<td>19.8</td>
</tr>
<tr>
<td>3</td>
<td>148,112</td>
<td>18.9</td>
</tr>
<tr>
<td>4</td>
<td>143,124</td>
<td>18.3</td>
</tr>
<tr>
<td>5 (highest)</td>
<td>129,865</td>
<td>16.6</td>
</tr>
<tr>
<td>Missing</td>
<td>41,648</td>
<td>5.3</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>152,616</td>
<td>19.5</td>
</tr>
<tr>
<td>Urban</td>
<td>593,152</td>
<td>75.7</td>
</tr>
<tr>
<td>Missing</td>
<td>37,832</td>
<td>4.8</td>
</tr>
<tr>
<td>Charlson Comorbidity*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>568,687</td>
<td>72.6</td>
</tr>
<tr>
<td>Yes</td>
<td>214,913</td>
<td>27.4</td>
</tr>
<tr>
<td>Province</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alberta</td>
<td>257,886</td>
<td>32.9</td>
</tr>
<tr>
<td>British Columbia</td>
<td>353,899</td>
<td>45.2</td>
</tr>
<tr>
<td>Manitoba</td>
<td>107,355</td>
<td>13.7</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>64,460</td>
<td>8.2</td>
</tr>
</tbody>
</table>

* Cardiovascular conditions (stroke, congestive heart failure, myocardial infarction, peripheral vascular disease) were excluded. Please see supplementary materials for distribution of Charlson comorbidity.

Note: ACSC=Ambulatory Care Sensitive Condition
Table 3-2: Crude and risk adjusted rate of ACSC hospitalizations for uncomplicated hypertension among newly diagnosed hypertensive patients (aged 20 to 74, fiscal years 1997 to 2004)

<table>
<thead>
<tr>
<th>Number of patients hospitalized</th>
<th>Hospitalization rate (per 1000 hypertensives)</th>
<th>p value</th>
<th>*Adjusted hospitalization rate (per 1000, 95% CI)</th>
<th>*Risk adjusted odds ratio 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>2,929</td>
<td>3.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Age (years)**

<table>
<thead>
<tr>
<th></th>
<th>Number of patients hospitalized</th>
<th>Hospitalization rate (per 1000 hypertensives)</th>
<th>p value</th>
<th>*Adjusted hospitalization rate (per 1000, 95% CI)</th>
<th>*Risk adjusted odds ratio 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-49</td>
<td>1141</td>
<td>4.3</td>
<td>&lt;0.0001</td>
<td>5.6 (5.0, 6.3)</td>
<td>reference</td>
</tr>
<tr>
<td>50-64</td>
<td>1114</td>
<td>3.3</td>
<td></td>
<td>4.3 (3.8, 4.7)</td>
<td>0.76 (0.70, 0.82)</td>
</tr>
<tr>
<td>65-74</td>
<td>674</td>
<td>3.6</td>
<td></td>
<td>4.3 (3.8, 4.9)</td>
<td>0.77 (0.69, 0.85)</td>
</tr>
</tbody>
</table>

**Sex**

<table>
<thead>
<tr>
<th></th>
<th>Number of patients hospitalized</th>
<th>Hospitalization rate (per 1000 hypertensives)</th>
<th>p value</th>
<th>*Adjusted hospitalization rate (per 1000, 95% CI)</th>
<th>*Risk adjusted odds ratio 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>1745</td>
<td>3.4</td>
<td>&lt;0.0001</td>
<td>4.5 (4.0, 5.1)</td>
<td>reference</td>
</tr>
<tr>
<td>Male</td>
<td>1184</td>
<td>4.0</td>
<td></td>
<td>4.8 (4.3, 5.3)</td>
<td>1.05 (0.97, 1.14)</td>
</tr>
</tbody>
</table>

**Adjusted household income ratio (quintiles)**

<table>
<thead>
<tr>
<th></th>
<th>Number of patients hospitalized</th>
<th>Hospitalization rate (per 1000 hypertensives)</th>
<th>p value</th>
<th>*Adjusted hospitalization rate (per 1000, 95% CI)</th>
<th>*Risk adjusted odds ratio 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (lowest)</td>
<td>838</td>
<td>5.0</td>
<td>&lt;0.0001</td>
<td>5.8 (5.0, 6.8)</td>
<td>reference</td>
</tr>
<tr>
<td>2</td>
<td>654</td>
<td>4.2</td>
<td></td>
<td>5.6 (4.8, 6.6)</td>
<td>0.97 (0.87, 1.07)</td>
</tr>
<tr>
<td>3</td>
<td>565</td>
<td>3.8</td>
<td></td>
<td>5.1 (4.3, 6.1)</td>
<td>0.88 (0.79, 0.98)</td>
</tr>
<tr>
<td>4</td>
<td>454</td>
<td>3.2</td>
<td></td>
<td>4.8 (4.0, 5.7)</td>
<td>0.82 (0.73, 0.92)</td>
</tr>
<tr>
<td>5 (highest)</td>
<td>277</td>
<td>2.1</td>
<td></td>
<td>3.4 (2.8, 4.2)</td>
<td>0.59 (0.51, 0.68)</td>
</tr>
<tr>
<td>Missing</td>
<td>141</td>
<td>3.4</td>
<td></td>
<td>3.7 (2.9, 4.8)</td>
<td>0.64 (0.44, 0.93)</td>
</tr>
</tbody>
</table>

**Region**

<table>
<thead>
<tr>
<th></th>
<th>Number of patients hospitalized</th>
<th>Hospitalization rate (per 1000 hypertensives)</th>
<th>p value</th>
<th>*Adjusted hospitalization rate (per 1000, 95% CI)</th>
<th>*Risk adjusted odds ratio 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>1402</td>
<td>9.1</td>
<td>&lt;0.0001</td>
<td>8.8 (8.1, 9.5)</td>
<td>reference</td>
</tr>
<tr>
<td>Urban</td>
<td>1417</td>
<td>2.4</td>
<td></td>
<td>2.5 (2.3, 2.7)</td>
<td>0.29 (0.26, 0.30)</td>
</tr>
<tr>
<td>Missing</td>
<td>110</td>
<td>2.9</td>
<td></td>
<td>4.6 (3.2, 6.6)</td>
<td>0.52 (0.34, 0.78)</td>
</tr>
</tbody>
</table>

**Charlson Comorbidity**

<table>
<thead>
<tr>
<th></th>
<th>Number of patients hospitalized</th>
<th>Hospitalization rate (per 1000 hypertensives)</th>
<th>p value</th>
<th>*Adjusted hospitalization rate (per 1000, 95% CI)</th>
<th>*Risk adjusted odds ratio 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1772</td>
<td>3.1</td>
<td>&lt;0.0001</td>
<td>3.6 (3.2, 3.9)</td>
<td>reference</td>
</tr>
<tr>
<td>Yes</td>
<td>1157</td>
<td>5.4</td>
<td></td>
<td>6.2 (5.5, 6.9)</td>
<td>1.74 (1.62, 1.88)</td>
</tr>
</tbody>
</table>

**Year**

<table>
<thead>
<tr>
<th></th>
<th>Number of patients hospitalized</th>
<th>Hospitalization rate (per 1000 hypertensives)</th>
<th>p value</th>
<th>*Adjusted hospitalization rate (per 1000, 95% CI)</th>
<th>*Risk adjusted odds ratio 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>475</td>
<td>4.9</td>
<td>&lt;0.0001</td>
<td>5.9 (5.2, 6.7)</td>
<td>reference</td>
</tr>
<tr>
<td>1998</td>
<td>409</td>
<td>4.6</td>
<td></td>
<td>5.6 (4.9, 6.5)</td>
<td>0.95 (0.83, 1.08)</td>
</tr>
<tr>
<td>1999</td>
<td>421</td>
<td>4.5</td>
<td></td>
<td>5.7 (5.0, 6.5)</td>
<td>0.97 (0.85, 1.10)</td>
</tr>
<tr>
<td>2000</td>
<td>362</td>
<td>3.7</td>
<td></td>
<td>4.7 (4.1, 5.4)</td>
<td>0.79 (0.69, 0.91)</td>
</tr>
<tr>
<td>2001</td>
<td>322</td>
<td>3.2</td>
<td></td>
<td>4.2 (3.6, 4.8)</td>
<td>0.71 (0.61, 0.81)</td>
</tr>
<tr>
<td>2002</td>
<td>313</td>
<td>3.1</td>
<td></td>
<td>4.0 (3.7, 4.9)</td>
<td>0.67 (0.58, 0.77)</td>
</tr>
<tr>
<td>2003</td>
<td>331</td>
<td>3.2</td>
<td></td>
<td>4.3 (3.7, 4.9)</td>
<td>0.72 (0.63, 0.83)</td>
</tr>
<tr>
<td>2004</td>
<td>296</td>
<td>2.8</td>
<td></td>
<td>3.7 (3.2, 4.3)</td>
<td>0.63 (0.54, 0.73)</td>
</tr>
</tbody>
</table>

**Province**

<table>
<thead>
<tr>
<th></th>
<th>Number of patients hospitalized</th>
<th>Hospitalization rate (per 1000 hypertensives)</th>
<th>p value</th>
<th>*Adjusted hospitalization rate (per 1000, 95% CI)</th>
<th>*Risk adjusted odds ratio 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>1083</td>
<td>4.2</td>
<td>&lt;0.0001</td>
<td>5.1 (4.6, 5.7)</td>
<td>reference</td>
</tr>
<tr>
<td>British Columbia</td>
<td>937</td>
<td>2.6</td>
<td></td>
<td>3.7 (3.4, 4.2)</td>
<td>0.74 (0.67, 0.80)</td>
</tr>
<tr>
<td>Manitoba</td>
<td>499</td>
<td>4.6</td>
<td></td>
<td>4.4 (3.9, 5.0)</td>
<td>0.87 (0.78, 0.97)</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>410</td>
<td>6.3</td>
<td></td>
<td>5.7 (4.9, 6.7)</td>
<td>1.18 (0.98, 1.27)</td>
</tr>
</tbody>
</table>

*Multivariate analysis adjusted by age, sex, adjusted household income ratio, region, Charlson Comorbidity, year and province.
* Cardiovascular conditions (stroke, congestive heart failure, myocardial infarction, peripheral vascular disease) were excluded. Please see supplementary materials for hospitalization rate stratified by type of Charlson comorbidity.
Note: CI=confidence interval, ACSC=Ambulatory Care Sensitive Condition

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Figure 3-1: Adjusted* rate and 95% confidence intervals of Albertan patients with newly diagnosed hypertension with an ACSC emergency department visit or hospitalization for uncomplicated hypertension, (aged 20 to 74 years, fiscal years 1997 to 2004)

* Multivariate analysis adjusted by age, sex, adjusted household income ratio, Charlson Comorbidity, and year
Note: CI=confidence interval, ACSC=Ambulatory Care Sensitive Condition
a) ACSC Hospitalizations in Alberta, British Columbia, Manitoba and Newfoundland

![Graph showing ACSC hospitalizations](image)

b) ACSC Emergency Department Visits in Alberta

![Graph showing ACSC emergency department visits](image)

Figure 3-2: Adjusted* rate and 95% confidence intervals of patients with newly diagnosed hypertension with an ACSC hospitalization (Alberta, British Columbia, Manitoba, and Newfoundland) or emergency department visit (Alberta) for uncomplicated hypertension (aged 20 to 74 years, fiscal years 1997 to 2004) * Multivariate analysis adjusted by age, sex, Charlson Comorbidity, and year

Note: CI=confidence interval, ACSC=Ambulatory Care Sensitive Condition
3.6 Supplementary Materials

Table 3-3S: Canadian Institute for Health Information Methodology to identify ACSC hospitalizations for uncomplicated hypertension in the discharge abstract database

<table>
<thead>
<tr>
<th>Ambulatory Care Sensitive Condition</th>
<th>ICD-9 and ICD-10-CA Codes in Major Diagnosis Field</th>
<th>Exclusion Criteria: Procedure Codes †</th>
<th>Other Exclusion Criteria</th>
</tr>
</thead>
</table>
| Uncomplicated Hypertension          | ICD-9: 1.0, 401.9, 402.0, 402.1, 402.9            | 1HA58, 1HA80, 1HA87, 1HB53, 1HB54, 1HB55, 1HB87, 1HD53, 1HD54, 1HD55, 1HH59, 1HH71, 1HJ76, 1HJ82, 1HM57, 1HM78, 1HM80, 1HN71, 1HN80, 1HN87, 1HP76, 1HP78, 1HP80, 1HP82, 1HP83, 1HP87, 1HR71, 1HR80, 1HR84, 1HR87, 1HS80, 1HS90, 1HT80, 1HT89, 1HT90, 1HU80, 1HU90, 1HV80, 1HV90, 1HW78, 1HW79, 1HX71, 1HX78, 1HX79, 1HX80, 1HX83, 1HX86, 1HX87, 1HY85, 1HZ53 rubric (except 1HZ53LAKP), 1HZ55 rubric (except 1HZ55LAKP), 1HZ56, 1HZ57, 1HZ59, 1HZ80, 1HZ85, 1HZ87, 1IF83, 1IJ50, 1IJ55, 1IJ57, 1IJ76, 1IJ86, 1IJ80, 1IK57, 1IK80, 1IK87, 1IN84, 1LA84, 1LC84, 1LD84, 1YY5 | • Death before discharge  
• Individuals age 75 years and older  
• Admission category recorded as newborn or stillbirth |

Note: ICD=International Classification of Disease, ACSC=Ambulatory Care Sensitive Condition *excluding cases with cardiac procedures, †cardiac procedure codes may be recorded in any position.
### Table 3-4S: Hospitalization rate of patients with an ACSC hospitalization for uncomplicated hypertension by Charlson Comorbidity*, among newly diagnosed hypertensive patients (aged 20 to 74, fiscal years 1997 to 2004)

<table>
<thead>
<tr>
<th>Charlson Comorbidity</th>
<th>Not hospitalized</th>
<th>Hospitalized</th>
<th>Crude Hospitalization rate (per 1000 hypertensives)</th>
<th>*Adjusted hospitalization rate (per 1000, 95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>% of 783,600</td>
<td>n</td>
<td>% of 2,929</td>
</tr>
<tr>
<td>TOTAL</td>
<td>568,687</td>
<td>72.6</td>
<td>1772</td>
<td>60.5</td>
</tr>
<tr>
<td>None</td>
<td>1,941</td>
<td>0.3</td>
<td>16</td>
<td>0.6</td>
</tr>
<tr>
<td>COPD</td>
<td>84,444</td>
<td>10.8</td>
<td>330</td>
<td>11.3</td>
</tr>
<tr>
<td>Connective Tissue Disease</td>
<td>5,794</td>
<td>0.7</td>
<td>40</td>
<td>1.4</td>
</tr>
<tr>
<td>Peptic Ulcer Disease</td>
<td>13,859</td>
<td>1.8</td>
<td>69</td>
<td>2.4</td>
</tr>
<tr>
<td>Mild Liver Disease</td>
<td>5,818</td>
<td>0.7</td>
<td>21</td>
<td>0.7</td>
</tr>
<tr>
<td>Diabetes without complication</td>
<td>20,938</td>
<td>2.7</td>
<td>178</td>
<td>6.1</td>
</tr>
<tr>
<td>Diabetes with complication</td>
<td>4,210</td>
<td>0.5</td>
<td>34</td>
<td>1.1</td>
</tr>
<tr>
<td>Paraplegia and Hemiplegia</td>
<td>1,221</td>
<td>0.2</td>
<td>12</td>
<td>0.4</td>
</tr>
<tr>
<td>Renal Disease</td>
<td>6,945</td>
<td>0.9</td>
<td>83</td>
<td>2.8</td>
</tr>
<tr>
<td>Cancer</td>
<td>30,350</td>
<td>3.9</td>
<td>95</td>
<td>3.2</td>
</tr>
<tr>
<td>Moderate/Severe Liver Disease</td>
<td>810</td>
<td>0.1</td>
<td>1</td>
<td>0.03</td>
</tr>
<tr>
<td>Metastatic Carcinoma</td>
<td>5,074</td>
<td>0.7</td>
<td>21</td>
<td>0.7</td>
</tr>
<tr>
<td>AIDS/HIV</td>
<td>459</td>
<td>0.06</td>
<td>5</td>
<td>0.1</td>
</tr>
</tbody>
</table>

*Multivariate analysis adjusted by age, sex, adjusted household income ratio, region, Charlson Comorbidity type, year and province.

*Cardiovascular conditions (stroke, congestive heart failure, myocardial infarction, peripheral vascular disease) were excluded.

Note: ACSC=Ambulatory Care Sensitive Condition
Chapter Four: THE RELATIONSHIP BETWEEN PRIMARY CARE PHYSICIAN UTILIZATION AND HOSPITALIZATIONS OR EMERGENCY DEPARTMENT VISITS FOR UNCOMPLICATED HYPERTENSION, AN AMBULATORY CARE SENSITIVE CONDITION
4.1 Abstract

Background: Hospitalizations for ambulatory care sensitive conditions (ACSC) represent an indirect measure of access and quality of community care. The purpose of this study was to examine the association between one ACSC, uncomplicated hypertension, and prior primary care physician (PCP) utilization.

Methods: A cohort of patients with hypertension was identified using administrative databases in Alberta between fiscal years 1994 and 2008. We applied the Canadian Institute for Health Information’s case definition to detect patients with uncomplicated hypertension as the most responsible reason for hospitalization and/or ED visit. We assessed hypertension-related and all-cause PCP visits.

Results: The overall adjusted rate of ACSC hospitalizations and ED visits for uncomplicated hypertension was 7.1 and 13.9 per 10,000 hypertensive patients, respectively. The likelihood of ACSC hospitalization for uncomplicated hypertension was associated with age, household income quintile, region of residence, and Charlson comorbidity status (all p<0.0001). The adjusted rate of ACSC hospitalizations for uncomplicated hypertension increased from 4.8 per 10,000 hypertensive patients for those without hypertension-related PCP visits prior to diagnosis to 10.5 per 10,000 hypertensive patients for those with 5 or more hypertension-related PCP visits. The rate of ACSC hospitalizations and/or ED visits for uncomplicated hypertension increased as the number of hypertension-related PCP visits increased even after stratifying by demographic and clinical characteristics.
Conclusion: As the frequency of hypertension-related PCP visits increased, the rate of ACSC hospitalizations and/or ED visits for uncomplicated hypertension increased. This suggests that ACSC hospitalization for uncomplicated hypertension may not be a particularly good indicator for access to primary care.
4.2 Introduction

An avoidable hospitalization is defined as an admission or readmission that might ordinarily have been controlled or prevented if patients are managed appropriately in the outpatient setting (52). There are many conditions for which a hospitalization can be considered avoidable, referred to as ambulatory care sensitive conditions (ACSC), including hypertension, diabetes, asthma, chronic obstructive pulmonary disease, epilepsy, heart failure, and angina. These conditions can generally be managed effectively in the community with appropriate medical screening, monitoring, management and follow-up. The concept of ACSC was developed to evaluate healthcare system performance, mainly primary care (58;59). Hospitalization for an ACSC is considered to be indicative of a sub-optimal health system (6;7), particularly sub-optimal primary health care services (4;6;8;9). Thus, a lower rate of hospitalization for an ACSC is often interpreted as being indicative of better access and/or quality of primary care services. In Canada, ACSC hospitalizations represent 6.0% of total hospitalizations, and nearly 11.0% of all hospital days (61).

The purpose of this study was to examine patients hospitalized for one ACSC, uncomplicated hypertension, and their primary care physician (PCP) utilization prior to that hospitalization. We chose hypertension as it is a highly prevalent condition worldwide affecting 40% of adults over age 25 (147), and the number one reason for PCP visits in Canada (153). Management of hypertension and related complications is estimated to consume 10% of all health care spending (190;191). In an earlier study we demonstrated that increased PCP utilization for patients with hypertension was associated with lower all-cause mortality but higher all-cause hospitalizations in Alberta, Canada (192). Some have argued that this finding
was merely an epiphenomenon and reflected the fact that sicker patients with severe acute illnesses and/or multiple comorbidities are more likely to need and/or seek out health care. Thus, high quality PCP care would not have been expected to positively impact that endpoint. In this study we delve deeper into this question to explore ACSC hospitalizations for uncomplicated hypertension, with the specific goal of determining whether this really is a reasonable indicator for access to PCP care.

4.3 Methods

4.3.1 Data Sources

We used administrative health databases from the province of Alberta, Canada, with a population of about 4 million including: the Alberta health insurance registry, hospital discharge abstracts (DAD), physician billing claims and Ambulatory Care Classification System (ACCS). The databases were linked through a scrambled unique identifier to maintain anonymity but permit longitudinal follow-up of patients. Canada provides universal medical health care services in which approximately 99% of the resident population are covered (First Nations, inmates of federal institutions, and members of the Armed Forces are not covered).

The Alberta health insurance registry, which is updated regularly, contains registrants’ name, date of birth, sex, and mailing address for all residents of the province eligible to receive health care services, and is considered a proxy for census data. The DAD contains demographic and clinical information for all patients discharged from hospital, with each discharge record coded with the Most Responsible Diagnosis and up to 25 diagnosis codes using International Disease Classification (ICD) 9th Revision (ICD-9), ICD-9 Clinical Modification (ICD-9-CM)
prior to April 1, 2002 or ICD-10 Canadian Modification (ICD-10-CA) after March 31, 2002. The physician billing claims database contains fee-for-service billing information that includes a unique personal and physician identifier, provider specialty, function centre type indicating where the service was provided, and at least one ICD-9 code, and up to three are recorded, corresponding to the primary reasons for each physician visit. Physicians submit claims for payment or reporting services to the provincial government insurance programs. The physician claims database captures nearly all outpatient physician services and the majority of inpatient physician services because of our universal health insurance coverage. The ACCS database in Alberta includes facility-based ambulatory care information (same-day surgery, day procedures, emergency department (ED) visits, and community rehabilitation program services). Each record is coded with up to 10 diagnosis and 10 procedures.

4.3.2 Study Population

We defined a cohort of patients with hypertension aged 20 to 74 years between April 1, 1994 and March 31, 2009 (fiscal years 1994 to 2008) in Alberta, Canada. Patients with hypertension were identified using a previously validated case definition for Canadian DAD and physician claims databases (sensitivity 75%, specificity 94%, positive predictive value 81%, and negative predictive value 92% when evaluated in the Alberta datasets in the same timeframe as this study) (167): at least two physician claims for hypertension within a two-year period (ICD-9 codes 401.x, 402.x, 403.x, 404.x, or 405.x or ICD-10 codes I10.x, I11.x, I12.x, I13.x or I15.x) or one hospitalization with a primary or secondary diagnosis of hypertension. The first date of hospital admission or physician service for hypertension in the study period was assigned to each patient as the diagnosis date. We excluded patients with a hypertension diagnosis date between
April 1, 1994 and March 31, 1995 to ensure all patients had at least one-year period for defining comorbidities prior to hypertension diagnosis. Pregnancy-related hypertension cases were excluded. To ensure two-year follow-up for all patients (up to March 31 2009), we analyzed the hypertension cases between April 1, 1995 and March 31, 2007.

4.3.3 Study Outcomes

The outcome for this study was ACSC hospitalizations for uncomplicated hypertension (i.e., hypertension without any vascular complications). We identified ACSC hospitalizations using ICD-9 codes 401.0, 401.9, 402.0, 402.1, 402.9 prior to 2002 or ICD-10 codes I10.0x, I10.1x, I11.x after 2002. Among those with hypertension, we applied the ICD-9 and ICD-10 coding methodology that is used by the Canadian Institute for Health Information (CIHI) to identify ACSC hospitalizations (16) to the DAD for fiscal years 1995 to 2006 (inclusive) to detect patients with uncomplicated hypertension as the most responsible reason for hospitalization in the second year after their diagnosis date of hypertension (Figure 4-1 page 83, Table 4-3 in Supplementary Materials page 86). As per CIHI methodology to identify ACSC (16) we excluded patients who died in hospital (n=3), and those younger than age 20 or older than age 75 at the time of hospitalization. If a patient experienced more than one ACSC hospitalization in the second year following their diagnosis date only the first admission was counted.

A secondary outcome for this study was emergency department (ED) visits for uncomplicated hypertension. To identify ED visits we applied the same CIHI coding methodology (16) to the ACSC between fiscal years 1995 to 2006 (inclusive). Among those with hypertension we detected ED visits for uncomplicated hypertension in the first diagnosis
code (same as the major diagnosis code in the DAD) in the second year after their diagnosis date of hypertension (Figure 4-1, page 83). We excluded patients who were hospitalized within 24 hours of ED visit so that we were only assessing ED visits, and not those associated with a hospitalization.

4.3.4 Exposure Variable

The main exposure variable was the number of PCP visits recording hypertension as the reason for the visit in the year following their index date of hypertension (i.e., the year prior to the study outcome being evaluated, Figure 4-1, page 83). As the majority of patients with hypertension are managed in the community by a PCP, only outpatient PCP services were analyzed in this study. We have previously shown (192) that less than 1% of patients with hypertension are seen solely by a specialist in the year after their hypertension diagnosis. Hypertension-related PCP visits were identified using ICD-9 codes 401.x, 402.x, 403.x, 404.x, or 405.x. PCP outpatient visits in the year following diagnosis were grouped as no visit, 1 to 4 visits per year and \( \geq 5 \) visits per year based on prior studies (193). If hypertension was defined using physician claims, the 2 visits required to meet the definition of hypertension were not included in the number of PCP visits. To ensure all patients PCP visits were measured for 1 year, those who died or moved out of the province in the year following their index date of hypertension were excluded from the analysis.

4.3.5 Potential Confounding Variables

We generated the age and sex at the date of hypertension diagnosis using the Alberta registry data. A measure of socioeconomic status and income quintile was assigned using 2001
Statistics Canada Census data. Specifically, median household income for each Census dissemination area, the smallest geographic unit for which Census data are released, was linked to each patient’s postal code assigned using the Statistics Canada Postal Code Conversion file (168). Rural and urban status was also defined using Census data. Charlson comorbidities (169) were derived from the DAD and physician claims database in the one year prior to hypertension diagnosis. Three categories of comorbidity were considered: 1) no comorbidity, 2) vascular risk-related comorbidity (myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, diabetes with and without complications and renal disease) and 3) unrelated comorbidity (i.e., unrelated to vascular risk including dementia, chronic pulmonary obstructive disease, connective tissue disease, rheumatic disease, peptic ulcer disease, paraplegia/hemiplegia, liver disease, cancer/metastatic carcinoma and AIDS/HIV). As a sensitivity analysis we assessed all PCP visits (not only hypertension-related) in the year following their diagnosis of hypertension. All-cause PCP outpatient visits in the year following diagnosis were grouped as 0 to 1, 2 to 4, 5 to 9 and $\geq 10$ visits per year.

4.3.6 Statistical Analysis

Baseline characteristics for those with and without an ACSC hospitalization for uncomplicated hypertension were described. Crude and adjusted rates of ACSC hospitalizations and ED visits for uncomplicated hypertension were reported. The adjusted rates were estimated in logistic regression (170) while adjusted for age group, sex, income quintile, region (urban/rural), specialist visits (yes/no), and Charlson comorbidity score. The crude rate was stratified by hypertension-related PCP visits and patient characteristics. Analyses were
performed with SAS statistical software version 9.3 (SAS Institute Inc, Cary, North Carolina). The institutional ethics review board for the University of Calgary approved the study.

4.4 Results

In total, 460,903 Albertan adults (mean age 54.2 years, range: 20-74, 50.7% male) with hypertension were identified in fiscal years 1995 to 2006. The majority of patients lived in an urban setting (75.1%) and had no Charlson comorbidities (66.2%) (Table 4-1, page 81).

There were 325 patients who had an ACSC hospitalization for uncomplicated hypertension in the second year following their hypertension index date. These patients were more likely to be in the lowest household income quintile (30.8% versus 19.7%, p<0.0001), live in a rural setting (48.0% versus 19.6%, p<0.0001), and have more comorbidities (41.2% versus 33.8%, p<0.05) compared to those who did not have an ACSC hospitalization for uncomplicated hypertension (Table 4-1, page 81). The average length of stay for an ACSC hospitalization for uncomplicated hypertension was 4.3 days.

The overall unadjusted rate of ACSC hospitalizations for uncomplicated hypertension was 7.1 per 10,000 hypertensive patients. The rate varied by age, household income quintile, region of residence, and Charlson comorbidity status (all p<0.0001). The mean number of hypertension-related PCP visits and all-cause PCP visits in the year following diagnosis was 2.6 and 8.1, respectively, for those with an ACSC hospitalization for uncomplicated hypertension compared to 1.8 and 6.7 for those without ACSC hospitalizations.

The rate of ACSC hospitalizations for uncomplicated hypertension increased as the number of hypertension-related PCP visits increased even after stratifying by demographic and
clinical characteristics (Table 4-2, page 82). The rate was 5.7 per 10,000 hypertensive patients for those without visits in the year following hypertension diagnosis, and increased to 6.8 and 11.7 per hypertensive patients for those with ‘1 to 4’ and ‘5 or more’ PCP visits, respectively. The unadjusted rate for those with vascular related comorbidities increased from 6.5 to 19.7 per 10,000 hypertensive patients for those without hypertension-related PCP visits and those with 5 or more hypertension-related PCP visits, respectively.

The unadjusted rate of ED visits for uncomplicated hypertension was 18.3 per 10,000 hypertensive patients. The rate for those living in a rural region increased from 3.6 to 42.3 per 10,000 hypertensive patients for those without hypertension-related PCP visits and those with 5 or more hypertension-related PCP visits, respectively. Further, the unadjusted rate of ED visits for uncomplicated of those living in the lowest income quintile increased from 20.1 per 10,000 hypertensive patients for those without hypertension-related PCP visits to 31.2 per 10,000 for those with 5 or more hypertension-related PCP visits.

The adjusted rate of ACSC hospitalizations for uncomplicated hypertension mirrors the crude rate (Figure 4-2 and Figure 4-3, pages 84 and 85). The adjusted rate for ACSC hospitalizations for uncomplicated hypertension was 6.4 and 9.5 per 10,000 hypertensive patients for those without all-cause PCP visits and those with 10 or more all-cause PCP visits, respectively.

4.5 Discussion

Among this population-based cohort of hypertensive patients we found that as the frequency of outpatient hypertension-related PCP visits increased the adjusted rate of ACSC
hospitalizations and/or ED visits for uncomplicated hypertension also increased, even when the rate was stratified by demographic and clinical variables. This suggests that hospitalization for uncomplicated hypertension is not reduced by increased frequency of PCP visits and that, indeed, hospitalization for uncomplicated hypertension in a universal healthcare system may not be an appropriate indicator to measure and evaluate the access to primary care. It should also be noted that the rates of hospitalization or ED visits for uncomplicated hypertension were extremely low, consistent with evidence that care for hypertension in Canada is among the best in the world (194;195).

While our findings indicate that hospitalizations for uncomplicated hypertension were not associated with lower PCP access, our data sources only permitted us to study quantity of PCP visits and not quality of care. Our finding that increased PCP use was associated with an increase in the risk of ACSC hospitalization is similar to findings from other studies (193;196;197), including a recent hypertension study conducted in Alberta (192). In contrast, there is also a body of literature showing that lower rates of ACSC hospitalizations are strongly associated with the receipt of primary care (198-202). Much of this literature examines the relationship between primary health care supply and ACSC hospitalizations in specific geographic locations. However, our study specifically looks at one ACSC, uncomplicated hypertension through population based follow-up (less likely to miss PCP visits and hospitalizations), as opposed to only examining admission to particular hospitals, thus filling a gap in the literature. A recent systematic review (203) reported that most ACSC studies found lower ACSC hospitalizations rates in areas with greater access to primary health care. However, it is important to note that making direct comparisons between countries may be misleading and
difficult due to differences in selected ACSC conditions, data quality, geographic and population coverage, health insurance and healthcare.

One potential reason why higher hypertension-related PCP visits was associated with higher numbers of ACSC hospitalizations may be caused by the time-dependent nature of the PCP user definition; patients have to survive long enough to have more PCP visits, thus having a greater chance to be hospitalized. Another reason is that there may be clinical and demographic differences between the different hypertension-related PCP groups. Patients who have additional health issues may have more PCP visits than those patients without underlying conditions. As seen in our study results, those who have more frequent hypertension-related and all-cause PCP visits are more likely to have comorbidities. Nevertheless, the optimal hypertension-related PCP use to achieve maximum clinical benefit remains unknown. Research focusing on the appropriate frequency of hypertension-related PCP visits required to maximize health benefits needs to be conducted.

Our findings indicate that ACSC hospitalization for uncomplicated hypertension is not associated with poor access to outpatient care, thereby suggesting that hypertension may not be sensitive to the quantity of ambulatory care. One reason for this may be that complicated hypertension cases are being coded incorrectly as uncomplicated hypertension. Another reason by be clinical inertia, which is a major factor that contributes to inadequate care for hypertensive patients (204). There appears to be a gap between blood pressure treatment guideline recommendations and their implementation in clinical practice. Many studies have shown that PCP are not aggressive enough with the management of hypertension (204-207), often hesitation to increase intensity or change antihypertensive medications even when a patient has
uncontrolled blood pressure. Another reason for this may be severity of hypertension. For example, “confounding by indication”(208) may occur; patients with very high blood pressure levels are more likely to have frequent hypertension-related PCP visits and also more likely to have an ACSC hospitalization for uncomplicated hypertension. There are also drug-resistant hypertension patients who have persistently high blood pressure levels despite being treated with 3 or more drugs at appropriate doses and combinations. Alternatively, patient non-adherence to therapy may be another reason for lack of blood pressure control (206). It is imperative for clinicians to recognize the importance of treating blood pressure to target, emphasize to patients the need to adhere to treatments, and provide persistent, goal-targeted therapy. With the increasing introduction of primary care electronic medical records, it may be possible in the near future to look at blood pressure readings and correlate these with ACSC hospitalizations for uncomplicated hypertension in patients with uncontrolled blood pressure.

The extent to which ACSC hospitalizations are actually avoidable through primary care alone has been questioned (103;104;209;210). As described in the Anderson Model of Health Care utilization (17), there are many factors (i.e., health care system, personal health choices, predisposing characteristics, needs, and enabling resources) affecting health care utilization. Variability in ACSC lists and in factors associated with hospitalizations rates raise questions as to the extent to which ACSC hospitalizations are actually preventable by PCP, especially when there is variation in the decision making among physicians who diagnose and admit patients to hospitals and variability in hospital admission criteria within and between hospitals. It is more likely that ED visits for uncomplicated hypertension could be avoided through primary care compared to hospitalizations. However in this study we found a similar gradient for ED visits
and ACSC hospitalizations for uncomplicated hypertension; as the frequency of hypertension-related PCP visits increased the adjusted rate of ED visits for uncomplicated hypertension also increased. These findings provide further evidence that hospitalizations and ED visits have multifactorial causes, not only determined by physicians but also by patient health status and social factors, such as family support. Blaming PCP for ACSC hospitalizations and ED visits for uncomplicated hypertension is unfair. Further, given that the rate of hospitalization and ED visits for uncomplicated hypertension was low in this study, it is unlikely that further improvements in primary care management of uncomplicated hypertension will significantly reduce hospitalizations in the future. Thus, strategies to improve access to PCP seem likely to be low-yield in terms of reducing potential hospital admissions.

Our study has limitations. First, we utilized administrative health data and thus were unable to assess detailed clinical information (i.e., blood pressure measurements, smoking status, severity of comorbidities), and other patient factors such as education level, marital status, family supports and drug adherence. Second, misclassification of uncomplicated hypertension (i.e., non-coding of uncomplicated hypertension in the major diagnosis code) could have occurred, particularly in patients with comorbid conditions. That could result in an underestimate in the ACSC hospitalization rates. However, in this study we observed the same pattern of ACSC rates when stratified by PCP use in those with none, vascular-related, and non-vascular comorbidities. Third, the case definition we used to identify patients with hypertension has a low sensitivity (72%); thus, we did not capture all hypertensive Albertans. However, the case definition has relatively high specificity (94%) and positive predictive value (81%)(167). Fourth, while we adjusted our statistical model with the administrative data variables available we were unable to
account for other variables that may play a part in avoidable hospitalizations (i.e., social support, availability of PCP, geographic distances, etc.). Fifth, as mentioned, we were only able to evaluate quantity of PCP visits and not quality of care.

In conclusion, we found that as the frequency of hypertension-related PCP visits increased, the rate of ACSC hospitalizations and/or ED visits for uncomplicated hypertension also increased. This suggests that ACSC hospitalization for uncomplicated hypertension may not be a particularly good indicator for access to primary care. Future studies should examine the relation between quality of primary care for patient with hypertension and rates of ACSC hospitalization for uncomplicated hypertension, ideally using datasets that include blood pressure measurements to allow adjustment for severity of hypertension at the clinic visits.
Table 4-1: Characteristics of hypertensive patients and those with and without an ACSC hospitalization for uncomplicated hypertension (aged 20 to 74, fiscal years 1995-2006)

<table>
<thead>
<tr>
<th>Overall Study Population</th>
<th>ACSC hospitalization for hypertension</th>
<th>Not hospitalized for hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>% of 460,930</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-49</td>
<td>164,389</td>
<td>35.7</td>
</tr>
<tr>
<td>50-64</td>
<td>197,666</td>
<td>42.9</td>
</tr>
<tr>
<td>65-74</td>
<td>98,875</td>
<td>21.4</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>227,321</td>
<td>49.3</td>
</tr>
<tr>
<td>Male</td>
<td>233,609</td>
<td>50.7</td>
</tr>
<tr>
<td>Adjusted household income (quintiles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (lowest)</td>
<td>90,802</td>
<td>19.7</td>
</tr>
<tr>
<td>2</td>
<td>89,428</td>
<td>19.4</td>
</tr>
<tr>
<td>3</td>
<td>88,458</td>
<td>19.2</td>
</tr>
<tr>
<td>4</td>
<td>85,710</td>
<td>18.6</td>
</tr>
<tr>
<td>5 (highest)</td>
<td>82,222</td>
<td>17.8</td>
</tr>
<tr>
<td>Missing</td>
<td>24,310</td>
<td>5.3</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>90,314</td>
<td>19.6</td>
</tr>
<tr>
<td>Urban</td>
<td>346,306</td>
<td>75.1</td>
</tr>
<tr>
<td>Missing</td>
<td>24,310</td>
<td>5.3</td>
</tr>
<tr>
<td>Charlson Comorbidity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>305,324</td>
<td>66.2</td>
</tr>
<tr>
<td>Vascular related</td>
<td>81,820</td>
<td>17.8</td>
</tr>
<tr>
<td>Not related</td>
<td>73,786</td>
<td>16.0</td>
</tr>
</tbody>
</table>

*ACSC = ambulatory care sensitive condition
Table 4-2: Stratified unadjusted rate of ACSC hospitalization and emergency department visit for uncomplicated hypertension by number of hypertension-related primary care practitioner visits, among hypertensive patients (aged 20 to 74, fiscal years 1995 to 2006, rate per 10,000 hypertensive patients)

<table>
<thead>
<tr>
<th>Hypertension-related PCP visits</th>
<th>Hospitalized for hypertension</th>
<th>Emergency Department Visit for hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (rate per 10,000)</td>
<td>n (rate per 10,000)</td>
</tr>
<tr>
<td>0 (n=100)</td>
<td>100</td>
<td>207 (15.9, 5.74, 95% CI: 4.72, 6.98)</td>
</tr>
<tr>
<td>1-4 (n=155)</td>
<td>155 (6.83, 95% CI: 5.83, 7.99)</td>
<td>138 (18.2, 95% CI: 18.5, 22.8)</td>
</tr>
<tr>
<td>5+ (n=70)</td>
<td>70 (11.73, 95% CI: 9.28, 14.82)</td>
<td>18.5 (22.8, 95% CI: 13.5, 21.1)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>307 (20.10, 95% CI: 19.5, 20.7)</td>
<td>76 (16.9, 95% CI: 16.2, 17.6)</td>
</tr>
</tbody>
</table>

Age (years)

<table>
<thead>
<tr>
<th>Age</th>
<th>Hospitalized for hypertension</th>
<th>Emergency Department Visit for hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (rate per 10,000)</td>
<td>n (rate per 10,000)</td>
</tr>
<tr>
<td>20-49</td>
<td>35 (5.6)</td>
<td>83 (16.9)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 5.1, 6.1)</td>
<td>(95% CI: 16.4, 17.4)</td>
</tr>
<tr>
<td>50-64</td>
<td>34 (4.7)</td>
<td>97 (17.6)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 4.2, 5.2)</td>
<td>(95% CI: 17.1, 18.1)</td>
</tr>
<tr>
<td>65-74</td>
<td>31 (7.9)</td>
<td>27 (10.1)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 7.4, 8.4)</td>
<td>(95% CI: 10.6, 11.6)</td>
</tr>
</tbody>
</table>

Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Hospitalized for hypertension</th>
<th>Emergency Department Visit for hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (rate per 10,000)</td>
<td>n (rate per 10,000)</td>
</tr>
<tr>
<td>Female</td>
<td>51 (6.3)</td>
<td>96 (16.2)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 5.8, 6.7)</td>
<td>(95% CI: 15.7, 17.7)</td>
</tr>
<tr>
<td>Male</td>
<td>49 (5.3)</td>
<td>111 (15.6)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 4.8, 5.8)</td>
<td>(95% CI: 15.1, 16.1)</td>
</tr>
</tbody>
</table>

Imputed household income (quintiles)

| Imputed household income quintiles | Hospitalized for hypertension | Emergency Department Visit for hypertension |
|                                  | n (rate per 10,000)           | n (rate per 10,000)                       |
| 1 (lowest)                      | 34 (9.4)                      | 53 (20.1)                                |
|                                  | (95% CI: 8.9, 9.8)            | (95% CI: 19.6, 20.6)                     |
| 2                                | 23 (6.8)                      | 50 (20.0)                                |
|                                  | (95% CI: 6.3, 7.3)            | (95% CI: 19.5, 20.5)                     |
| 3                                | 24 (7.2)                      | 40 (16.4)                                |
|                                  | (95% CI: 6.7, 7.7)            | (95% CI: 16.0, 17.0)                     |
| 4                                | 12 (3.8)                      | 34 (14.4)                                |
|                                  | (95% CI: 3.3, 4.3)            | (95% CI: 13.9, 15.0)                     |
| 5 (highest)                     | 4 (1.3)                       | 12 (5.2)                                 |
|                                  | (95% CI: 1.1, 1.5)            | (95% CI: 4.9, 6.5)                       |
| Missing                          | 3 (3.2)                       | 18 (21.9)                                |
|                                  | (95% CI: 2.8, 3.6)            | (95% CI: 17.7, 23.3)                     |

Region

<table>
<thead>
<tr>
<th>Region</th>
<th>Hospitalized for hypertension</th>
<th>Emergency Department Visit for hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (rate per 10,000)</td>
<td>n (rate per 10,000)</td>
</tr>
<tr>
<td>Rural</td>
<td>48 (13.7)</td>
<td>92 (3.6)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 13.2, 14.2)</td>
<td>(95% CI: 3.1, 4.1)</td>
</tr>
<tr>
<td>Urban</td>
<td>49 (3.8)</td>
<td>97 (10.0)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 3.3, 4.3)</td>
<td>(95% CI: 9.5, 10.5)</td>
</tr>
<tr>
<td>Missing</td>
<td>3 (3.2)</td>
<td>18 (21.9)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 2.8, 3.6)</td>
<td>(95% CI: 17.7, 23.3)</td>
</tr>
</tbody>
</table>

Charlson Comorbidity

<table>
<thead>
<tr>
<th>Charlson Comorbidity</th>
<th>Hospitalized for hypertension</th>
<th>Emergency Department Visit for hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>46 (4.5)</td>
<td>129 (16.9)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 4.0, 5.0)</td>
<td>(95% CI: 16.3, 17.5)</td>
</tr>
<tr>
<td>Vascular Related</td>
<td>28 (6.5)</td>
<td>52 (13.3)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 6.0, 7.1)</td>
<td>(95% CI: 12.8, 14.0)</td>
</tr>
<tr>
<td>Not Related</td>
<td>26 (8.9)</td>
<td>26 (17.3)</td>
</tr>
<tr>
<td></td>
<td>(95% CI: 8.3, 9.5)</td>
<td>(95% CI: 16.8, 18.0)</td>
</tr>
</tbody>
</table>

* ACSC = ambulatory care sensitive condition, PCP=primary care physician, CI=confidence interval

Note: Rate in this study is per 10,000 whereas in study #1 is was per 1,000
Figure 4-1: Flow chart for study population with study variable and outcome

*PCP=primary care physician, ACSC = ambulatory care sensitive condition
Figure 4-2: Unadjusted and *adjusted rate of hospitalization for uncomplicated hypertension, by a) hypertension-related primary care physician visits and b) all primary care physician visits among prevalent hypertensive patients (aged 20 to 74, fiscal years 1995 to 2006), rate per 10,000 hypertensive patients

* adjusted for age, sex, income quintile, region (urban/rural), specialist visits (yes/no), and Charlson comorbidity score. Note: Rate in this study is per 10,000 whereas in study #1 is was per 1,000
Figure 4-3: *Adjusted rate of hospitalization for uncomplicated hypertension by hypertension-related primary care physician visits and comorbidity status (no comorbidity, vascular-related comorbidity, non-vascular related comorbidity) among hypertensive patients (aged 20 to 74, fiscal years 1995 to 2006, rate per 10,000 hypertensive patients)

* adjusted for age, sex, income quintile, region (urban/rural), specialist visits (yes/no)

Note: Vascular related comorbidity includes myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, diabetes with and without complications and renal disease. Non-vascular related comorbidity are conditions unrelated to vascular risk including dementia, chronic pulmonary obstructive disease, connective tissue disease, rheumatic disease, peptic ulcer disease, paraplegia/hemiplegia, liver disease, cancer/metastatic carcinoma and AIDS/HIV.

Note: Rate in this study is per 10,000 whereas in study #1 is was per 1,000
4.6 Supplementary Materials

Table 4-3S: Canadian Institute for Health Information Methodology to identify ACSC hospitalizations for uncomplicated hypertension in the discharge abstract database

<table>
<thead>
<tr>
<th>Ambulatory Care Sensitive Condition</th>
<th>ICD-9 and ICD-10-CA Codes in Major Diagnosis Field</th>
<th>Exclusion Criteria: Procedure Codes †</th>
<th>Other Exclusion Criteria</th>
</tr>
</thead>
</table>
| Uncomplicated Hypertension          | ICD-9: 1.0, 401.9, 402.0, 402.1, 402.9            | 1HA58, 1HA80, 1HA87, 1HB53, 1HB54, 1HB55, 1HB87, 1HD53, 1HD54, 1HD55, 1HH59, 1HH71, 1HJ76, 1HJ82, 1HM57, 1HM78, 1HM80, 1HN71, 1HN80, 1HN87, 1HP76, 1HP78, 1HP80, 1HP82, 1HP83, 1HP87, 1HR71, 1HR80, 1HR84, 1HR87, 1HS80, 1HS90, 1HT80, 1HT89, 1HT90, 1HU80, 1HU90, 1HV80, 1HV90, 1HW78, 1HW79, 1HX71, 1HX78, 1HX79, 1HX80, 1HX83, 1HX86, 1HX87, 1HY85, 1HZ53 rubric (except 1HZ53LAKP), 1HZ55 rubric (except 1HZ55LAKP), 1HZ56, 1HZ57, 1HZ59, 1HZ80, 1HZ85, 1HZ87, 1IF83, 1IJ50, 1IJ55, 1IJ57, 1IJ76, 1I86, 1I80, 1IK57, 1IK80, 1IK87, 1IN84, 1LA84, 1LC84, 1LD84, 1YY5 | - Death before discharge  
- Individuals age 75 years and older  
- Admission category recorded as newborn or stillbirth |

Note: ICD=International Classification of Disease, *excluding cases with cardiac procedures, †cardiac procedure codes may be recorded in any position.
Chapter Five: **ACSC INDICATOR: TESTING RELIABILITY FOR HYPERTENSION**
5.1 Abstract

Purpose: With high-quality community-based primary care, hospitalizations for ambulatory care sensitive conditions (ACSC) are considered avoidable. The purpose of this study was to test the inter-physician reliability of judgments of avoidable hospitalizations for one ACSC, uncomplicated hypertension, derived from medical chart review.

Methods: We applied the Canadian Institute for Health Information’s case definition to obtain a random sample of patients who had an ACSC hospitalization for uncomplicated hypertension in Calgary, Alberta. Medical chart review was conducted by three experienced internal medicine specialists. Implicit methods were used to judge avoidability of hospitalization using a validated 5-point scale.

Results: There was poor agreement among three physicians raters when judging the avoidability of 82 ACSC hospitalizations for uncomplicated hypertension (κ=0.092). The κ also remained low when assessing agreement between raters 1 and 3 (κ=0.092), but the κ was lower (less than chance agreement) for raters 1 and 2 (κ=−0.119) and raters 2 and 3 (κ=−0.008). When the 5-point scale was dichotomized, there was fair agreement among three raters (κ=0.217). The proportion of ACSC hospitalizations for uncomplicated hypertension that were rated as avoidable was 32.9%, 6.1% and 26.8% for raters 1, 2, and 3, respectively.

Conclusion: This study found a low proportion of ACSC hospitalization were rated as avoidable, with poor to fair agreement of judgment between physician raters. This suggests that the validity and utility of this health indicator is questionable. It points to a need to abandon the
use of ACSC entirely; or alternatively to work on the development of explicit criteria for judging avoidability of hospitalization for ACSC such as hypertension.
5.2 Introduction

Internationally, there is widespread interest in the promise of ambulatory care sensitive conditions (ACSC). ACSC are chronic conditions that should be effectively managed in the community with appropriate medical screening, monitoring and follow-up. Initially ACSC were developed using hospitalization data to identify hospitalizations in the general United States population that could potentially have been avoided with adequate access to appropriate ambulatory or primary care in the community (58;59). Since their inception in 1993, hospitalization rates for ACSC have provided the basis for measuring adequacy of ambulatory and primary health care performance in many regions and countries (1-5). In its national health indicators report, the Canadian Institute for Health Information (CIHI) reports age-standardized hospitalization rates for seven ACSC: angina, asthma, chronic obstructive pulmonary disease, diabetes, epilepsy, heart failure, and hypertension. As a healthcare system performance indicator, ACSC have been used to inform health policy by assessing the primary health care system (including funding models), improving our understanding of the factors that influence health and by identifying gaps in health status and outcomes for specific populations (59). In Canada, individuals who experience an ACSC hospitalization represent 6.0% of all hospitalized Canadians, and account for nearly 11.0% of all hospital days (61).

Despite widespread use, it is unclear if ACSC is a reliable and valid indicator that accurately measures the performance of the primary health care system. ACSC hospitalization rates can potentially be used as a marker of access to and quality of primary care, however, only if a significant proportion of them are deemed avoidable and judgments of avoidability have high inter-rater reliability (i.e., judgments of avoidability are reproducible). Thus, the reliability of
physician judgment of avoidable hospitalizations for ACSC derived from medical chart review needs to be evaluated. If the ratings of avoidable hospitalizations cannot be reproduced reliably between physicians, the validity and utility of this health indicator are questionable. If assessments of avoidable hospitalizations for ACSC derived from medical chart review are (reproducible) reliable between-physician, it will provide a methodological foundation for determining the proportion of ACSC hospitalizations that are truly avoidable based on medical charts. Thus, the purpose of this research was to test the inter-physician reliability (reproducibility) of judgments of avoidable hospitalizations for one ACSC, uncomplicated hypertension, derived from medical chart review. We chose hypertension as it is a highly prevalent condition affecting more than 20% of Canadians (211), the number one reason for primary care physician visits in Canada (212), and the management of hypertension and related complications is estimated to consume 10% of all health care spending (190;191).

5.3 Methods

5.3.1 Data Sources

We used administrative health data, specifically the hospital discharge abstract database (DAD) from the province of Alberta, Canada from fiscal years 2012/13 to 2014/15. The DAD is generated by trained coders and includes information about all patients admitted to hospital. Each DAD record contains a unique identification number for each admission, a patient chart number, date of admission, date of discharge, location of residence, physician specialty, diagnoses (up to 25 coded diagnoses are recorded using the International Disease Classification 10thRevision Canadian Modification (ICD-10-CA) coding system), procedures (up to 20), and
an indicator flagging the occurrence of death during a hospitalization. The DAD also has a ‘diagnosis-type’ indicator. The coders assign a one digit ‘diagnosis-type’ code to specify the timing of diagnosis. Type M is the most responsible diagnosis, which is defined in Canada as the condition responsible for the greatest resource use during the hospital stay (106).

5.3.2 Identifying ACSC Hospitalization for Uncomplicated Hypertension in the Major Diagnosis Field

Following CIHI methods (16) (Table 5-5S in Supplementary Materials, page 108) we identified ACSC hospitalizations for uncomplicated hypertension (i.e., hypertension without any vascular complications) between April 1, 2012 and Aug 1, 2014 (fiscal years 2012 to 2014). Specifically, we identified ACSC hospitalizations by searching the most responsible diagnosis coding field using ICD-10 codes I10.0x, I10.1x, I11.x. As per CIHI methodology (16) we excluded patients who died in hospital, and those younger than age 20 or older than age 75 at the time of hospitalization. If a patient experienced more than one ACSC hospitalization in the study period only the first admission was selected.

5.3.3 Expert Medical Chart Review

A total of 238 patients with an ACSC hospitalization for uncomplicated hypertension were identified in the DAD at the Foothills Medical Centre in Calgary, Alberta. Assuming 80% power, the sample size was determined using prevalence of avoidable hospitalization and kappa, and was calculated to be 80 medical charts. Thus, we selected a random sample of 82 patient medical charts and chart review was conducted by three experienced physicians. We chose general internal medicine specialists as they typically have more experience with hypertension-
related hospital admissions compared to other specialties (i.e., surgeons). The three physicians underwent training, including a discussion of data extraction, the definition of avoidability (defined as a hospitalization that might ordinarily have been prevented (52)), the use of implicit methods for judging avoidability (213). As well the physician raters reviewed 10 charts together.

The physicians used a structured questionnaire for the medical chart review that included items to confirm the inclusion and exclusion criteria (see Figure 5-3S in Supplementary Materials, page 109). Once the physicians had gone over all aspects of the chart (including cover page, emergency department notes, narrative summaries, admission notes, consultation reports, surgery/operative reports, physician daily progress notes, physician orders and discharge summaries) they used their professional judgment to implicitly judge the avoidability of the hospitalization using a validated 5-point scale (214-216) (see Table 5-1, page 102). Experts commonly use implicit methods for clinical judgment, which rely on the subjective opinion of the individual judge; no predetermined criteria or factors are used (213). Implicit methods have traditionally been used to rate avoidability of hospital readmissions (217) and are also commonly used during medical panel ratings or Delphi processes (218-221).

5.3.4 ACSC Hospitalization for Uncomplicated Hypertension in Coding Fields 2 to 25

In addition to searching the major diagnosis field for complication hypertension as per CIHI’s methodology, we search the secondary diagnosis coding fields (2 to 25) in the DAD using ICD-10 codes I10.0x, I10.1x, I11.x between April 1, 2012 and Aug 1, 2014. We did this to assess coding misclassification of complication hypertension (i.e., non-coding of uncomplicated hypertension in the major diagnosis code). In Canada, the most responsible diagnosis coding
field is defined as the condition responsible for the greatest resource use during the hospital stay whereas in the United States it is defined as the reason for hospital admission (106). Thus, searching secondary diagnosis coding fields allows us to determine if patients were admitted to hospital for hypertension and had a subsequent complication such as stroke or congestive heart failure. For those patients the complication was likely to be coded as the most responsible condition.

A total of 12,917 patients with a secondary diagnosis of uncomplicated hypertension were identified in the DAD at the Foothills Medical Centre in Calgary, Alberta. A random sample of 320 medical charts were selected and reviewed by 2 trained nurses. The nurses reviewed the discharge summaries and if uncomplicated hypertension was mentioned or listed as a most responsible diagnosis then the chart was flagged. All of the flagged charts were then reviewed by the same three physicians as per the methodology described above.

### 5.3.5 Other Study Variables

The DAD was used to determine all other study variables: age, sex, income quintile, region, and Charlson Comorbidity. A measure of socioeconomic status and income quintile was assigned using the 2001 Statistics Canada Census data. Specifically, median household income for each Census dissemination area, the smallest geographic unit for which Census data are released, was linked to each patient’s postal code assigned using the Statistics Canada Postal Code Conversion file (168) Rural and urban status was also defined using postal code. Charlson comorbidities (169) were derived from the DAD and three categories of comorbidity were considered: (1) no comorbidity; (2) vascular risk-related comorbidity (myocardial infarction,
congestive heart failure, peripheral vascular disease, cerebrovascular disease, diabetes with and without complications and renal disease); and (3) unrelated comorbidity (ie, unrelated to vascular risk including dementia, chronic pulmonary obstructive disease, connective tissue disease, rheumatic disease, peptic ulcer disease, paraplegia/hemiplegia, liver disease, cancer/metastatic carcinoma, and AIDS/HIV).

### 5.3.6 Statistical Analysis

Cohen’s kappa statistic ($\kappa$) and its p-value were used to assess agreement among the three physician raters (222). The 5-point scale was dichotomized and assessed using the following cut point: not-avoidable points 1-3 and avoidable points 4-5. The $\kappa$ was interpreted as follows: a near perfect agreement ($0.81 \leq \kappa < 1.0$), substantial agreement ($0.61 \leq \kappa < 0.80$), moderate agreement ($0.41 \leq \kappa < 0.60$), fair agreement ($0.21 \leq \kappa < 0.40$), slight agreement ($0.01 \leq \kappa < 0.20$), and less than chance agreement ($\kappa < 0$) (223). In this study we are testing two components of validity: 1) face validity (does ACSC hospitalization rates capture an aspect of quality that it widely regarded as important to providers or the health care system (e.g. avoidable hospitalizations?)) and 2) construct validity (does ACSC hospitalization rates perform well in identifying true quality of care problems (e.g. avoidable hospitalizations)?). Analyses were performed with SAS statistical software version 9.3 (SAS Institute Inc, Cary, North Carolina). The institutional ethics review board for the University of Calgary approved the study.
5.4 Results

5.4.1 ACSC Hospitalization for Uncomplicated Hypertension in the Major Diagnosis Field

In total, 238 ACSC hospital admissions for uncomplicated hypertension were identified in the most responsible diagnosis coding field at the Foothills Medical Centre in fiscal years 2012 to 2014. Among the 82 patients whose medical charts were reviewed, 34.2% were younger than 50, 36.6% were aged 50 to 64 years, and 46.3% were male. Most patients resided in an urban setting (95.1%), and 45.1% had no Charlson comorbidities (Table 5-2, page 103). The average length of stay for an ACSC hospitalization for uncomplicated hypertension was 4.5 days.

Using the validated 5-point scale, there was poor agreement among the three physician raters when judging the avoidability of ACSC hospitalization (κ=0.092, Table 5-3, page 104). The κ remained low level when assessing agreement between raters 1 and 3 (κ=0.092), but the κ was lower (less than chance agreement) for raters 1 and 2 (κ=-0.119) and raters 2 and 3 (κ=-0.008). When the 5-point scale was dichotomized, there was fair agreement among three raters (κ=0.217) and among rater 1 and 3 (κ=0.388). The agreement was very low for raters 2 and 3 (κ=0.157), and raters 1 and 2 (κ=-0.009).

The proportion of ACSC hospitalizations for uncomplicated hypertension that were rated as avoidable was 32.9%, 6.1% and 26.8% for raters 1, 2, and 3, respectively (Table 5-4, page 105). The Venn diagrams (Figure 5-1 and Figure 5-2, pages 106 and 107) describe the agreement between raters, showing that 3 cases (3.7%) were rated as avoidable by all 3 raters, 12 cases (14.6%) by only 2 raters, and 21 cases (25.6%) by only 1 rater. The number of cases rated as not
avoidable by all 3 reviewers, by only 2 and by only 1 rater was 46 (56.1%), 21 (25.6%) and 12 (14.6%), respectively.

5.4.2 ACSC Hospitalization for Uncomplicated Hypertension in Coding Fields 2 to 25

There were 12,917 hospital admissions with uncomplicated hypertension listed as a secondary diagnosis (coding fields 2 to 25 in the DAD) at the Foothills Medical Centre and the Peter Lougheed Centre in Calgary, Alberta during the study period. Among the randomly chosen 320 medical charts reviewed by 2 nurses, 14 (4.4%) were flagged as admissions where uncomplicated hypertension was potentially the most responsible diagnosis. After reviewing the medical charts the three physicians agreed that 6 of the 14 (42.8%) admissions were actually ACSC hospital admissions for uncomplicated hypertension. When the 5-point scale was dichotomized, one physician rated one chart as an avoidable hospitalization. All other charts were rated as not avoidable by all three physician raters.

5.5 Discussion

Internationally, ACSC hospitalization rates are being used as a quality-of-care measure. Indeed ACSC admissions may indicate challenges with access to or signal sub-optimal primary care quality, but only if these ACSC admissions are truly avoidable. This study assessed the reliability of specialist ratings of avoidable ACSC hospitalizations for uncomplicated hypertension derived from medical chart review. Importantly, this study found a low proportion of hospitalizations rated as avoidable, and poor to fair agreement of judgment between physician raters. Given that the ratings of avoidability were low and were poorly reproduced, the study
findings suggest that the validity (both face and construct) and utility of this health indicator for uncomplicated hypertension is questionable. Therefore it may be unlikely that ACSC rates would significantly decrease with improved primary care management of uncomplicated hypertension as this health indicator may be too “soft” to measure performance of the primary healthcare system.

Although our study findings question the premise of the ACSC indicator, it may only be true at the level of implicit judgment of medical charts. In implicit review, sometimes termed peer review, the reviewer judges what is being studied (i.e., avoidability of hospitalization) against his/her own clinical knowledge, opinions and beliefs. Thus, implicit review may be biased by reviewers’ experience, consistency, attention to detail, and harshness of judgment (224). This begs the question: Can multiple physician reviewers judge avoidability of ACSC hospitalizations in the same way based on their own clinical experience? Our findings clearly demonstrate that this is difficult to do, which reflects findings from other studies assessing avoidability of hospital readmissions and quality of care (213;225-227).

One potential reason for the low ratings of avoidability and the poor to fair agreement of judgment between reviewers may be due to the definition of ACSC; the concept of ACSC is clear (i.e., no need to be hospitalized if the patient receives appropriate out-patient care), but it is hard to operationalize in practice. Another reason is that a medical chart may be insufficient to judge avoidability, which requires comprehensive information such as primary care visits, hypertension management, diagnoses/investigations, drug adherence and patient self-management. When this information is not documented in the medical chart, judging the avoidability of a hospital admission poses a great challenge. In the future, seamless health data
exchange between in-patient and out-patient providers will likely provide a more comprehensive resource to assess these important factors. Another potential reason is differing views of the definition of avoidability. For example, one rater could view lack of drug adherence as a patient issue and judge the hospital admission as unavoidable whereas another rater may believe it is amenable to intervention by the physician and hence judge the admission as avoidable. Lastly, there are no clear clinical guidelines for hospital admissions for patients with uncomplicated hypertension, making judgments of avoidability challenging.

One way to improve agreement of judgment of avoidability of ACSC hospitalizations for uncomplicated hypertension would be to develop explicit criteria. Explicit judgments rely on predetermined criteria set by group agreement (228). Explicit review has a certain “boilerplate” character because the same standards are applied to every case (227) and the burden of accuracy falls on the criteria, not on the reviewer. Unfortunately, such criteria for judging avoidable hospitalization due to ACSC are not available. To increase reproducibility of ratings explicit methods to guide judgment of avoidable hospitalizations based on medical charts (i.e., tools such as a checklist or decision tree) need to be developed.

Currently the DAD is the only data source for producing and reporting on ACSC statistics. In Canada, the most responsible diagnosis coding field is defined as the condition responsible for the greatest resource use during the hospital stay whereas in the United States it is defined as the reason for hospital admission (106). Thus, we completed a medical chart review where uncomplicated hypertension was listed in the secondary diagnosis field to determine if patients were admitted to hospital for hypertension and had a subsequent complication such as stroke or congestive heart failure. We did this because for those patients the complication was
likely to be coded as the most responsible condition. Our findings show that only a small proportion (1.6%) of charts were such cases. Further, it has been shown that coding hypertension in the DAD is done reasonably well. Quan et al. assessed hypertension coding accuracy using ICD-10 and reported sensitivity 68.3%, specificity 97.8%, positive predictive value 93.1%, and negative predictive value 87.7%. Overall it appears that coding misclassification does not significantly affect ACSC hospitalization rates.

Our study has limitations. First, medical chart review was conducted using only hospital medical records as linked hospital and outpatient medical records were not available. Second, we assessed only one of the seven ACSC reported by CIHI. However the ACSC that was chosen, hypertension, is a highly prevalent and high impact chronic condition commonly encountered within all clinical settings and is of major interest from a public health perspective. It is unclear if the results of this study are also applicable to the other ACSC conditions. Third, we reviewed medical charts in Calgary and did not assess for potential differences between tertiary care and community hospitals. Fourth, Canada has very high treatment and control rates for hypertension relative to other countries (211;229). Thus, these finding may only relate to Canada. In countries with low control rates of hypertension, the proportion of hospitalizations rated as avoidable may be higher.

In conclusion, this study found a low proportion of ACSC hospitalizations for uncomplicated hypertension were rated as avoidable. Assessments of avoidability were not reliably reproduced between physician raters, with only poor to fair agreement. These findings either points to a need to abandon the use of the ACSC entirely for uncomplicated hypertension (since the notion of avoidable hospital stays is so central to the concept of ACSC); or
alternatively a need to work on the development of more explicit criteria for judging avoidability of ACSC hospitalizations for uncomplicated hypertension (i.e., a Q&A checklist for physician reviewers, or a decision-tree logic model to aid decisions). As it stands currently, the validity and reliability of this health indicator for uncomplicated hypertension are questionable and it is potentially dangerous to link ACSC hospitalization rates to primary care funding models. As ACSC is a potential tool to trigger positive cases for further exploration, we recommend future research to develop explicit criteria for judging avoidability of ACSC hospitalizations.
Table 5-1: Instruction and validated 5-point scale given to physician raters to judge avoidability of ACSC hospital admission for uncomplicated hypertension, using implicit judgment

<table>
<thead>
<tr>
<th>Confidence Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Very low evidence of avoidability of hypertension admission</td>
<td>Very low evidence of avoidability of hypertension admission</td>
</tr>
<tr>
<td>2. Slight to modest evidence of avoidability of hypertension admission</td>
<td>Slight to modest evidence of avoidability of hypertension admission</td>
</tr>
<tr>
<td>3. Evidence of avoidability of hypertension admission is a “close call” (50/50)</td>
<td>Evidence of avoidability of hypertension admission is a “close call” (50/50)</td>
</tr>
<tr>
<td>4. Strong evidence of avoidability of hypertension admission</td>
<td>Strong evidence of avoidability of hypertension admission</td>
</tr>
<tr>
<td>5. Virtually certain evidence of avoidability of hypertension admission</td>
<td>Virtually certain evidence of avoidability of hypertension admission</td>
</tr>
</tbody>
</table>

*ACSC = ambulatory care sensitive condition
Table 5-2: Characteristics of patients with an ACSC hospitalization for uncomplicated hypertension (aged 20 to 74, fiscal years 2012 to 2014)

<table>
<thead>
<tr>
<th>Study Population</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-49</td>
<td>28</td>
<td>34.2</td>
</tr>
<tr>
<td>50-64</td>
<td>30</td>
<td>36.6</td>
</tr>
<tr>
<td>65-74</td>
<td>24</td>
<td>29.2</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>44</td>
<td>53.7</td>
</tr>
<tr>
<td>Male</td>
<td>38</td>
<td>46.3</td>
</tr>
<tr>
<td>Adjusted household income (quintiles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (lowest)</td>
<td>12</td>
<td>14.6</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>17.1</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>11.0</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>17.0</td>
</tr>
<tr>
<td>5 (highest)</td>
<td>15</td>
<td>18.3</td>
</tr>
<tr>
<td>Missing</td>
<td>18</td>
<td>22.0</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>4</td>
<td>4.9</td>
</tr>
<tr>
<td>Urban</td>
<td>78</td>
<td>95.1</td>
</tr>
<tr>
<td>Charlson Comorbidity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>37</td>
<td>45.1</td>
</tr>
<tr>
<td>Vascular related</td>
<td>43</td>
<td>52.4</td>
</tr>
<tr>
<td>Not related</td>
<td>2</td>
<td>2.4</td>
</tr>
</tbody>
</table>

*ACSC = ambulatory care sensitive condition
Table 5-3: Kappa agreement (and P-value) between the three raters by score 1 to 5 and score 1-3, 4-5

<table>
<thead>
<tr>
<th>Score</th>
<th>1, 2, 3, 4, 5</th>
<th>1-3, 4-5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>-0.119</td>
<td>0.093</td>
</tr>
<tr>
<td></td>
<td>(0.972)*</td>
<td>(0.057)</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>-0.008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.551)</td>
</tr>
<tr>
<td>All 3 raters</td>
<td>0.093</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.057)</td>
<td></td>
</tr>
</tbody>
</table>

*p-value
Table 5-4: Proportion of ACSC hospital admission for uncomplicated hypertension rated as *“avoidable”* by patient characteristics (aged 20 to 74, fiscal years 2012 to 2014) and by physician rater

<table>
<thead>
<tr>
<th></th>
<th>Rater 1 n (%)</th>
<th>Rater 2 n (%)</th>
<th>Rater 3 n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoidable Hospitalization</td>
<td>27 (32.9)</td>
<td>5 (6.1)</td>
<td>22 (26.8)</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-49</td>
<td>14 (51.9)</td>
<td>2 (40.0)</td>
<td>12 (54.5)</td>
</tr>
<tr>
<td>50-64</td>
<td>5 (18.5)</td>
<td>1 (20.0)</td>
<td>6 (27.3)</td>
</tr>
<tr>
<td>65-74</td>
<td>8 (29.6)</td>
<td>2 (40.0)</td>
<td>4 (18.2)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>13 (48.2)</td>
<td>1 (20.0)</td>
<td>9 (40.9)</td>
</tr>
<tr>
<td>Male</td>
<td>14 (51.8)</td>
<td>4 (80.0)</td>
<td>13 (59.1)</td>
</tr>
<tr>
<td>Adjusted household income (quintiles)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (lowest)</td>
<td>3 (11.1)</td>
<td>0 (0.0)</td>
<td>1 (4.5)</td>
</tr>
<tr>
<td>2</td>
<td>2 (7.4)</td>
<td>1 (20.0)</td>
<td>4 (18.2)</td>
</tr>
<tr>
<td>3</td>
<td>4 (14.8)</td>
<td>0 (0.0)</td>
<td>4 (18.2)</td>
</tr>
<tr>
<td>4</td>
<td>5 (18.5)</td>
<td>1 (20.0)</td>
<td>4 (18.2)</td>
</tr>
<tr>
<td>5 (highest)</td>
<td>8 (29.7)</td>
<td>1 (20.0)</td>
<td>5 (22.7)</td>
</tr>
<tr>
<td>Missing</td>
<td>5 (18.5)</td>
<td>2 (40.0)</td>
<td>4 (18.2)</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>1 (3.7)</td>
<td>1 (20.0)</td>
<td>1 (4.6)</td>
</tr>
<tr>
<td>Urban</td>
<td>26 (96.3)</td>
<td>4 (80.0)</td>
<td>21 (95.4)</td>
</tr>
<tr>
<td>Charlson Comorbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>14 (51.9)</td>
<td>2 (40.0)</td>
<td>9 (40.9)</td>
</tr>
<tr>
<td>Vascular related</td>
<td>12 (44.4)</td>
<td>2 (40.0)</td>
<td>12 (54.6)</td>
</tr>
<tr>
<td>Not related</td>
<td>1 (3.7)</td>
<td>1 (20.0)</td>
<td>1 (4.5)</td>
</tr>
</tbody>
</table>

* avoidable defined as points 4-5 on the 5-point validated scale, ACSC = ambulatory care sensitive condition
Figure 5-1: Proportion of ACSC hospital admission for uncomplicated hypertension rated as “avoidable” by only one rater, only two raters and all three raters (fiscal years 2012 to 2014)

Notes:

Only one rater: \[ \frac{a_1+a_2+a_3}{N} = \frac{13+1+7}{82} = 25.6\% \]

Only two raters: \[ \frac{b_1+b_2+b_3}{N} = \frac{0+11+1}{82} = 14.6\% \]

All three raters: \[ \frac{c}{N} = \frac{3}{82} = 3.7\% \]
Figure 5-2: Proportion of ACSC hospital admission for uncomplicated hypertension rated as “not avoidable” by only one rater, only two raters and all three raters (fiscal years 2012 to 2014)

Only one rater: \((a_1+a_2+a_3)/N = (1+11+0)/82 = 14.6\%\)

Only two rater: \((b_1+b_2+b_3)/N = (7+1+13)/82 = 25.6\%\)

All three raters: \(c/N = 46/82 = 56.1\%\)

*ACSC = ambulatory care sensitive condition
5.6 Supplementary Materials

Table 5-5S: Canadian Institute for Health Information methodology to identify ACSC hospitalizations for uncomplicated hypertension in the discharge abstract database.

<table>
<thead>
<tr>
<th>Ambulatory Care Sensitive Condition</th>
<th>ICD-10-CA Codes in Major Diagnosis Field</th>
<th>Exclusion Criteria: Procedure Codes †</th>
<th>Other Exclusion Criteria</th>
</tr>
</thead>
</table>
| Uncomplicated Hypertension          | ICD-10-CA: I10.0*, I10.1*, I11*          | 1HA58, 1HA80, 1HA87, 1HB53, 1HB54, 1HB55, 1HB87, 1HD53, 1HD54, 1HD55, 1HH59, 1HH71, 1HJ76, 1HJ82, 1HM57, 1HM78, 1HM80, 1HN71, 1HN80, 1HN87, 1HP76, 1HP78, 1HP80, 1HP82, 1HP83, 1HP87, 1HR71, 1HR80, 1HR84, 1HR87, 1HS80, 1HS90, 1HT80, 1HT89, 1HT90, 1HU80, 1HU90, 1HV80, 1HV90, 1HW78, 1HW79, 1HX71, 1HX78, 1HX79, 1HX80, 1HX83, 1HX86, 1HX87, 1HY85, 1HZ53 rubric (except 1HZ53LAKP), 1HZ55 rubric (except 1HZ55LAKP), 1HZ56, 1HZ57, 1HZ59, 1HZ80, 1HZ85, 1HZ87, 1IF83, 1IJ50, 1IJ55, 1IJ57, 1IJ76, 1IJ86, 1IJ80, 1IK57, 1IK80, 1IK87, 1IN84, 1LA84, 1LC84, 1LD84, 1YY5 | ▪ Death before discharge  
▪ Individuals age 75 years and older  
▪ Admission category recorded as newborn or stillbirth |

Note: ICD=International Classification of Disease, *excluding cases with cardiac procedures, †cardiac procedure codes may be recorded in any position.
*ACSC = ambulatory care sensitive condition

Figure 5-3S: Structured questionnaire used by physicians when reviewing medical charts.

---

Chart Number (HRN): ______________________
Admission Date: ______________________

**Hypertension**

1. Is hypertension the main reason for admission?
   - Yes
   - No
   - If No: Was hypertension listed as a secondary condition?
     - Yes
     - No
     - b. What was the main reason for admission? ______________________

2. Is this patient <75 years of age?
   - Yes
   - No

3. Did this patient die before discharge?
   - Yes
   - No

4. Did this patient have any complication(s) of hypertension?
   - Yes
   - No
   - If Yes: What type of complications did the patient have?
     - Vascular
     - Non-Vascular
     - Other

5. After due consideration of the clinical details of the patient’s medical chart, rate, on a 5-point scale, your confidence in the evidence for avoidability of the hospitalization:
   - Virtually no evidence of avoidability of hypertension admission
   - Slight to modest evidence of avoidability of hypertension admission
   - Evidence of avoidability of hypertension admission is a “close call” (50/50)
   - Strong evidence of avoidability of hypertension admission
   - Virtually certain evidence of avoidability of hypertension admission

6. Overall did you feel like there was enough information to make a judgment on hospital avoidability using the medical chart?
   - Yes
   - No
Chapter Six: SYNTHESIS AND OVERRIDING CONCLUSIONS
Primary care serves as the cornerstone for building a strong healthcare system that leads to positive health outcomes (230;231). With high-quality, community-based primary care, hospitalizations for ACSC are considered avoidable. As a health quality indicator, ACSC hospitalization rates are intended to evaluate quality of primary care, drive system transformation and primary health care system management. This was the first Canadian study to explore, assess and evaluate ACSC hospitalization as a health quality indicator for one condition, uncomplicated hypertension. To address this objective, we conducted three studies using Canadian provincial administrative data sources and patient medical charts.

Our first study explored ACSC hospitalization rates for uncomplicated hypertension, taking into account important patient characteristics among hypertensive patients. Using population-based data in 4 provinces we found that the rate of hospitalizations for uncomplicated hypertension decreased over time, potentially indicating improvement in community care. We found geographic variations in the rate of hospitalizations, potentially signifying disparity among the provinces and those residing in rural regions. Our second study examined the association between ACSC hospitalization for uncomplicated hypertension, and previous PCP utilization. Among this population-based cohort of hypertensive patients we found that as the frequency of hypertension-related PCP outpatient visits increased the adjusted rate of ACSC hospitalizations also increased, even when the rate was stratified by demographic and clinical variables. This suggests that hospitalization for uncomplicated hypertension is not reduced by increased frequency of PCP visits and may not be an appropriate indicator to measure and evaluate the access to primary care. Our final study tested inter-physician reliability of judgments of avoidable hospitalizations for uncomplicated hypertension derived from medical chart review.
We found a low proportion of ACSC hospitalizations were rated as avoidable, with poor to fair agreement between physician raters. These findings point either to a need to abandon the use of the ACSC entirely; or alternatively a need to develop more explicit criteria for judging avoidability.

6.1 Can we use ACSC to measure quality of primary care?

Theoretically the concept of ACSC is sound; it is a useful measure of the performance of primary health care at a population level, and of clear interest to policy makers. Practically, however, our research shows that using ACSC as an indicator of quality of primary care is questionable using administrative data. By definition, primary health care is the first point of care that is continuous, co-ordinated and comprehensive whilst being assessable, accessible, acceptable and affordable to the population it serves (232). The role of primary care is diverse and not simply about keeping people out of the hospital. Therefore, using ACSC to measure primary care performance can only ever be an incomplete and sometimes suboptimal measure. Further, hospitalizations for ACSC are complicated and dependent on many factors including data quality, factors related to physicians, patients, and the health care system (44). Consequently, it is debatable whether ACSC should be used to measure primary care performance. It is likely more appropriate to use ACSC as a screening tool rather than a definitive measure of quality issues as the indicator can provide initial information about potential problems in the community that may require further, more in-depth analysis.

It is widely-known that ACSC are influenced by factors other than quality of care, and that quality of primary care does not make an independent contribution to ACSC (233). Our
research findings align with our conceptual model (Figure 2-4, page 43), as many of the factors such as age, sex, socioeconomic status, co-morbid conditions, community and access to primary care contributed to ACSC hospitalizations for uncomplicated hypertension. Our findings also align with the Donebedian framework (71); ACSC (an outcome indicator) may indicate good or poor quality of care in the aggregate, however alone they do not provide insight into the nature and location of the deficiencies or strengths to which ACSC rates may be attributed (process measure). In other words, our research shows that using ACSC as an indicator of quality of primary care may not be applicable for interventions to improve quality of care. To date little evidence exists internationally on the impact of this quality improvement measure on the delivery of outpatient care for hypertension (233).

Although our research (projects 1 and 2) adjusted for the risk factors available in administrative data (e.g. age, sex, income, region, Charlson comorbidity, etc.), we were unable to adjust for detailed clinical information and other patient or provider factors. To improve the accuracy and interpretability of ACSC hospitalizations for uncomplicated hypertension we need additional measures that are not available using administrative health data. Examples of these measures include population characteristics (i.e., unhealthy lifestyle, poor environmental conditions), PCP characteristics, patient characteristics (i.e., severity of disease, blood pressure measurements, drug adherence, and family and social support), PCP practice behaviours (i.e., how often blood pressure measurements are taken, whether a physician follows clinical practice guidelines), PCP supply, etc. Gradual improvements in the scope and rigour of primary health data collection will allow for additional variables to be included in statistical models (e.g. blood pressure measurements) and should ultimately improve the applicability of ACSC hospitalization
rates as a measure of quality of care. Future linked electronic records (in-/outpatient) and primary data collection will likely provide more a comprehensive resource to assess these important factors. Hospital data linked to survey data could also be a source of some of the individual-level adjustment factors.

6.2 Can ACSC be measured using the DAD?

Currently the DAD is the only data source for producing and reporting national and provincial rates of ACSC. Despite the widespread recognition that the sensitivity of the DAD coding is not perfect, ACSC have been broadly implemented in analyses of the Canadian DAD under the assumption that the DAD is valid. This assumption has been made because there are no better measures or data currently available to conduct national surveillance and monitoring of avoidable hospitalizations at the population level.

Calculating ACSC hospitalization rates for uncomplicated hypertension using the DAD is questionable. First, the definition of uncomplicated hypertension is challenging for clinicians to diagnose and for health coders to code appropriately as the condition needs to exclude vascular related conditions (such as peripheral vascular disease). In many hospital admissions, the definition of uncomplicated hypertension is based on patients’ self-report of existing comorbidities and physical examination. The DAD itself cannot tell if hypertension is complicated by other vascular conditions. Health coders code co-existing conditions such as hypertension and myocardial infarction, but they do not code the relationship between the conditions. Thus, the data cannot delineate the sequence or clustering of diseases. Of note, in the US ACSC rates are based on 16 conditions (77); ACSC hospitalizations for hypertension include
all hospital admissions with hypertension in the principal diagnosis field (not just uncomplicated cases). Second, the DAD depends on the quality of medical charts in documenting patient medical conditions and other factors such as drug adherence. As previously discussed, one potential reason for the low reliability of avoidability judgements between physicians is that the information available in medical charts may be insufficient to judge avoidability of hospitalizations for uncomplicated hypertension. It is clear that ACSC hospitalization rates depend on the original data quality, so it is very important that the DAD is of the highest possible quality. Important data can be missing in the DAD; for example, if a patient has two conditions, only one might be coded. The data could also be incorrect; this could happen if the documentation was illegible and the diagnosis incorrectly coded. Further, the DAD may have information on a patient’s illness that is correct but not contain information on the severity of their disease.

One way to overcome data quality issues is to improve physician documentation of medical charts and coding of the DAD. Research has shown that the accuracy of chart documentation goes hand-in-hand with the quality of patient care, but physician documentation is often incomplete, inaccurate, and/or illegible (234-236). Physicians in Canada have no uniform standards and no set education requirements for the documentation of health information. In contrast, Canadian coders have standardized education programs and follow standardized coding protocols to ensure accuracy (237). To improve physician documentation and accuracy of data quality for ACSC hospitalizations, a potential intervention is to use a standardized template for clinicians to fill out for all ACSC hospital admissions. Educational interventions that train physicians on items on inpatient charts have been shown to improve
accuracy in charting significantly (238-246). Another potential avenue to improve coding of the DAD is to provide ACSC guidelines and train health coders how to appropriately identify and code ACSC hospital admissions. Coders could flag ACSC admissions to be re-checked later to ensure coding is correct and to determine the sequence and/or clustering of diseases.

As previously described, ACSC hospitalization rates are calculated using the most responsible diagnosis coding field in the DAD. Internationally the definition of the most responsible diagnosis is not consistent. Some countries employ a ‘reason for admission’ coding rule, while others, like Canada, employ a ‘resource use’ coding rule. Recently the Quality and Safety Topic Advisory Group for the WHO Family of International Classifications has recommended that all countries undertaking ICD coding of hospital episodes code both the ‘reason for admission’ and ‘resource use’ as key conditions in their ICD-coded health data (247). Thus, adding another coding field for ‘reason for admission’ in the DAD may be more appropriate for identifying ACSC hospitalizations than using the currently-used ‘resource use’ definition.

Reproducibility of judgment of avoidable hospitalization depends on the tools or guidelines used. In project 3 we highlighted the importance of developing explicit methods to guide judgment of avoidable hospitalizations based on medical charts. To our knowledge there is no research comparing the agreement of judgment of avoidable hospitalizations between implicit and explicit methods. If assessments of avoidable hospitalizations for ACSC derived from medical chart review were found to be reproducible using explicit methods (not yet developed), it would provide a methodological foundation to determine for determining the proportion of ACSC hospitalizations that are truly avoidable based on medical charts. It could
also provide an opportunity to conduct a validation study of the DAD using medical charts as a reference standard to test the premise of ACSC. Little evidence exists regarding the validity of ACSC hospitalizations rates for uncomplicated hypertension (233). Ideally, the gold standard for a validation study of ACSC would be interviews of patients, caregivers and health professionals. However, given the associated costs it is not feasible to interview such a large number of people. Thus, researchers often use medical chart review as the reference standard in validation studies as they are assessable and can be reviewed in large volumes with relatively low cost.

Despite its limitations, given that the DAD is currently the only data source to calculate ACSC rates and is objective, available and relatively inexpensive to gather, we recommend that the DAD still be used to measure ACSC rates for uncomplicated hypertension. Though it is not perfect, the DAD still permits quantification of this promising health care quality indicator.

6.3 Future Research

To evaluate the relationship between quality of care and ACSC, future studies should use datasets which include blood pressure measurements to adjust for severity of hypertension at PCP clinic visits. Further, given that there appears to be a gap between blood pressure treatment guideline recommendations and their implementation in clinical practice, it would be interesting to evaluate blood pressure readings with ACSC hospitalizations in patients with uncontrolled blood pressure. Further, outpatient data would enable analyses that examine the processes of care that can prevent hospitalizations due to uncomplicated hypertension. With the increasing introduction of primary care electronic medical records these analyses may be possible in the near future.
Our research in project 2 assessed quantity of PCP visits prior to hospitalization for uncomplicated hypertension. One of the hallmarks of primary care is continuity of care, which is defined as seeing the same health care provider over time. Systematic reviews have shown that patients with higher continuity of care have better patient outcomes, and fewer hospitalizations compared with their counterparts (248-254). It is thought that patients with higher provider continuity are more likely to: be satisfied with their care, adhere to medications, and have problems identified by their physician (255). As our research was unable to assess continuity of care, we recommend that future studies evaluate the association between continuity of PCP care prior to ACSC hospitalization for uncomplicated hypertension. This research could provide insight into whether continuity of care potentially reduces the need for hospitalization. In addition to continuity of care it would be interesting to study other important components of quality of care, such as timeliness and comprehensiveness of care. It is important to note that high continuity of care does not ensure adequate access to primary care and may in fact not always represent optimal care.

Emergency and ambulatory care is one of the largest-volume patient activities in the country, making it a key component of the continuum of health services in Canada. In addition to ACSC hospitalizations, avoidable encounters with the health care system also occur in ED settings however they are not being reported. Thus, we recommend future studies assess ED visits for all ACSC.

Briefly, other areas of future research that could provide insight into ACSC hospitalizations for uncomplicated hypertension that have been previously described include the effect ethnicity and culture may have on the varying rates of ACSC hospitalizations by
geography (i.e., urban or rural residence) (189), the development of explicit criteria for judgment of avoidable hospitalization for uncomplicated hypertension, and a validation study of the DAD using medical charts as a reference standard to test the premise of ACSC for uncomplicated hypertension.

6.4 Knowledge Translation

In addition to scientific presentations and publications, this research will be translated and disseminated provincially, nationally, and internationally. The key knowledge users of the study findings are researchers, government, decision-makers and health service providers. Thus, the knowledge translation strategy will involve dissemination of results to the following:

a) **CIHI Health Indicators Group and Coders:** Since the inception of this research, we have discussed and partnered with CIHI and they are very interested in our study and its results. We will be communicating our results to the lead of CIHI Health Indicators for broader dissemination and coders in provinces through a collaborator who is the Canadian leader of disease classification and coding guidelines.

b) **Canadian Hypertension Education Program Outcomes Research Task Force, Hypertension Canada:** We will disseminate results nationally to Hypertension Canada and the Canadian Hypertension Education Program who are well positioned to disseminate results to key researchers and clinicians nationally.

c) **Provincial Governments:** Study results will be disseminated to provincial governments who are interested in health care quality indicators such as Alberta Health Services (Applied Research and Evaluation Services, Primary Health Care Division).
d) **Public Health Agency of Canada, Statistics Canada:** Study results will be disseminated to 1) Public Health Agency of Canada Centre for Chronic Disease Prevention and Control for surveillance and outcomes of hypertension; and 2) Statistics Canada, Health Analysis Division. We will present and disseminate our results to the Public Health Agency of Canada through managers Drs. Sulan Dai and Oliver Baclic, and to Statistics Canada through Drs. Claudia Sanmartin and Deirdre Hennessy. Statistics Canada is particularly interested in our results given their recent report on hospitalizations for ACSC.

e) **Researchers focusing on ACSC:** Study results will be disseminated through email to researchers who are working in ACSC and who have published in Canadian journals.

f) **International Methodology Consortium for Coded Health Information (IMECCHI):** As ACSC hospitalization rates are a health care quality indicator reported internationally we will present our results at the annual IMECCHI meeting. IMECCHI is an international collaboration of health services researchers who aim to promote the methodological development and use of coded health information to promote quality of care and quality health policy decisions. The results of this study will also be applicable to other projects undertaken by IMECCHI such as patient safety indicators, hospital readmission research, etc. The research methodology will also be posted on the IMECCHI website ([www.imecchi.org/IMECCHI/](http://www.imecchi.org/IMECCHI/)) for people to use (free of cost). In the past, members of this research team have been successful in disseminating information using this method.

g) **WHO-Quality and Safety Topic Advisory Group (TAG):** There is tremendous opportunity for knowledge translation through the WHO. The TAG members include physicians, researchers, and decision makers from multiple countries and develop, disseminate,
implement and update the ICD to support national and international health information systems, statistics and evidence.

6.5 Conclusion

Health systems cannot improve what they do not measure. Use of ACSC hospitalization rates as health quality indicators are a reality in Canadian healthcare, and in health systems worldwide. They have been accepted by multiple agencies tasked with monitoring health system performance, and they are being implemented as part of ‘performance reports’ in many countries and jurisdictions. ACSC are promising quality of care indicators, potentially creating opportunity for health care system quality improvement, however as our research has shown that they require further evaluation. This research was the first study to explore, assess and evaluate ACSC hospitalization for uncomplicated hypertension as a health quality indicator and has provided important information into the interpretation of ACSC findings for uncomplicated hypertension. Specifically, we have shown that 1) ACSC hospitalization rates for uncomplicated hypertension have been declining over time; 2) the indicator might not be a good measure of access to primary care; and 3) the indicator may not be measuring what it’s supposed to be measuring (i.e., avoidable hospitalizations). Thus, the use of this specific health quality indicator for uncomplicated hypertension is questionable and may not provide information that is applicable for interventions to improve quality of primary care. It is best if ACSC for uncomplicated hypertension are used as a screening tool or as a starting point for assessing potential issues in the community which would then require further, more in-depth analysis. Further studies are needed to develop explicit criteria for judging avoidability of ACSC hospitalizations using medical charts.
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