The association between physician competence at licensure and the quality of asthma management and patient morbidity

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Abstract

Asthma imposes a substantial burden on patient health and health care expenditures. Persistent trends of sub-optimal asthma management and significant morbidity indicate the need to search for other key barriers and facilitators of quality of care. Through the use of administrative databases, this project first addressed the methodological challenge of identifying asthma patients, and then investigated the role of physicians and determinants of their approach to effective asthma management. Our objectives were 1) to develop an algorithm to identify patients with asthma, based on potential asthma-specific markers, from medical service and prescription claims databases, 2) to estimate the extent to which physician characteristics, specifically clinical competence, influenced the quality of asthma medication utilization and asthma morbidity.

In the first study, 1,434 patients with confirmed asthma were identified from clinic medical records available through an existing electronic medical record project. Therapeutic indication for electronic prescriptions and the confirmed asthma from an inter-institutional automated problem list were used as the gold standard for physician-confirmed asthma. Using multiple logistic regression, we estimated the probability of the presence of asthma, using a combination of five groups of asthma-specific markers from administrative databases. Receiver Operating Characteristic (ROC) curves was used to assess the optimal cut-off probability of algorithms. The algorithm that showed the best performance in discriminating between the patients with asthma and those without it included indicators from medical services, pharmacy, and the demographic databases. The best fitting algorithm used a cut-off probability of 0.128 for asthma with sensitivity of 71%, specificity of 93%, and positive predictive value of 62%.

In the second study, a prospective cohort of 609 physicians, who took the Medical Council of Canada (MCC) Part 2 examination between 1993 and1996 and provided a care for asthma patients in Quebec between 1993 and 2003 was assembled. Patients whose asthma was out-of-control at the index visit were followed for 6 months after the first visit with a study physician (index visit). Patients of physicians who achieved higher scores in communication (per 1 Standard Deviation (SD) increase in score) had a lower risk of persistent Fast-Acting Beta Agonist (FABA) overuse (OR=0.97; 95%CI: 0.94-1.0) and multiple ER visits for respiratory problems (OR=0.90; 95%CI:0.82-1.00). Higher MCCQE1, MCCQE2 and MCCQE2 communication scores were associated with a 4 to7% greater likelihood of inhaled corticosteroid (ICS) use (per 1SD increase). Similarly, higher scores achieved on the MCCQE1 as well as the MCCQE2 exams were associated with a 4 to 9% higher likelihood of the ICS/Total asthma medication (ICS plus FABA) ratio being >0.5 (per 1 SD increase).

This project presents two major contributions. First, we demonstrated a unique and practical methodological approach to identify patients with asthma from administrative claims databases for the future assessment of asthma management. Second, we identified important physician abilities for effective management of patients with out-of-control asthma.

Résumé

L'asthme impose un fardeau important sur les individus et sur les dépenses du système de santé. La gestion de l'asthme demeure sous optimale et la persistance de conditions associées mettent en lumière la nécessité de poursuivre la recherche sur les facteurs facilitants et les barrières à la qualité des soins et services. À travers l'utilisation des banques de données administratives, ce projet a tout d'abord cherché à résoudre le défi méthodologique lié à l'identification des patients asthmatiques et a ensuite cherché à investiguer le rôle des médecins et les déterminants de leur approche pour gérer efficacement l'asthme. Nos objectifs étaient; 1) développer un algorithme pour identifier, à partir des banques de données sur les services pharmaceutiques et les services médicaux, les patients asthmatiques à l'aide de marqueurs spécifiques à l'asthme , 2) estimer le degré d'influence des caractéristiques des médecins, plus particulièrement, la compétence Clinique sur l'utilisation des médicaments contre l'asthme et sur les conditions associées.

Dans la première étude, 1 434 patients avec un diagnostic confirmé d'asthme, ont été identifiés à partir de dossiers médicaux disponibles par le biais d'un projet de dossier médical informatisé. L'intention thérapeutique liée à une prescription électronique et la confirmation par le médecin du problème d'asthme sur une liste de problèmes de santé inter établissements ont été utilisés comme mesure-étalon pour la confirmation de l'asthme par le médecin. À l'aide de régression multiple logistique, nous avons estimé la probabilité de la présence d'un problème d'asthme en combinant cinq groupes de marqueurs spécifiques à l'asthme à partir des banques de données administratives. Les courbes ROC (Receiver Operating Characteristic) ont été utilisées pour évaluer le seuil de probabilité optimale pour les algorithmes. L'algorithme démontrant la meilleure performance pour discriminer les patients avec asthme des patients sans asthme intégrait des indicateurs des services médicaux, des services pharmaceutiques et des données démographiques. L'algorithme le plus performant avait une probabilité «seuil» de 0.128 pour l'asthme, une sensitivité de 71%, une spécificité de 93% et une valeur prédictive positive de 62%.

Dans la deuxième étude, nous avons créé une cohorte prospective regroupant 609 médecins ayant pris part à la seconde partie de l'examen du Conseil médical du Canada entre 1993 et 1996 et ayant dispensé des soins aux personnes asthmatiques entre 1993 et 2003 dans la province de Québec. Les patients présentant un asthme hors de contrôle à la visite-index ont été suivis pendant 6 mois à partir de la date de la première visite auprès d'un médecin de l'étude (visite-index). Les patients des médecins avec un score élevé au niveau de leur communication (pour un écart-type d'augmentation du score) avaient un risqué moins élevé de surutilisation persistante de FABA (OR=0.97; 95%CI: 0.94-1.0) et de visites multiples au département d'urgence pour raisons de problèmes respiratoires (OR=0.90; 95%CI:0.82-1.00). Les scores élevés aux examens

MCCQE1, MCCQE2 et au MCCQE2 communication étaient associés à 4% à 7% plus de chance d'utiliser les cortico-stéroïdes en inhalation (CSI) (pour un écart-type d'augmentation). De la même façon, des scores plus élevés sur les examens MCCQE1 et le MCCQE2 étaient associés à 4% à 9% plus de chance d'avoir un ratio CSI/asthme total supérieur à 0.5 (pour un écart-type d'augmentation).

Ce projet présente deux contributions majeures. Premièrement, nous avons établi une approche méthodologique unique et pratique permettant d'identifier les patients asthmatiques à partir des banques de données administratives. Cette approche sera utile dans le futur pour évaluer la gestion de l'asthme. Deuxièmement, nous avons identifié les aptitudes importantes qu'un médecin devrait avoir pour gérer efficacement les patients dont l'asthme n'est pas contrôlé.

Authorship

For the first manuscript, the project was carried out as a part of the Medical Office of the 21st Century Part-III (MOXXI-III) Project. The questions and methods were defined entirely by the candidate. The data extraction and reduction was performed entirely by the candidate. The candidate was responsible for drafting and revising the manuscript. Dr. Michal Abrahamowicz contributed to the original concept and design/data analysis of the study and provided a critical review of the manuscript. Dr. Pierre Ernst contributed to the design and analysis of the study and provided critical comments on the manuscript. Dr. Robyn Tamblyn contributed to the design and the analysis/ interpretation of the data and writing the manuscript.

For the second manuscript, the project was carried out as a part of the larger research program to investigate an association between scores achieved on the MCCQE Part II examination and performance in clinical practice. The variables specific to this research project were defined entirely by the candidate. The initial data reduction was carried out by a research associate, Mr. Rene Fouodjio, according to the instruction provided by the candidate. Variables used in this project were jointly created by Mr Fouodjio and the candidate. When Mr. Fouodjio performed the particular task, the specific and detailed instructions were provided by the candidate. The candidate was responsible for conceptualization, data analysis and interpretation, and drafting and revising the manuscript. Dr. Robyn Tamblyn contributed to the original concept and design of the study, data analysis and interpretation, and writing the manuscript. Dr. Pierre Ernst contributed to the design of the study and provided critical review of the manuscript. Dr. Michal Abrahamowicz contributed to the design and data analysis/interpretation and provided critical comments on the manuscript.

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Statement of Originality

The projects presented in this thesis are original research. First, the project has made an original contribution to research on the methodological challenges in identifying asthma patients using an administrative health care database. The development of a predictive algorithm that used a broad spectrum of indicators from administrative health care databases improved the ability to correctly discriminate between patients with and without asthma, compared to a gold standard of confirmed asthma by the patients' physician. This particular methodology has the potential for wider use and applicability to identify patients with other types of chronic disease.

To the candidate's knowledge, this is the first article to investigate an association between the Canadian national licensing examination and the quality of asthma care and patient morbidity. Our research findings presented additional and original evidence to support the validity of the Canadian national licensing exam. In particular, the current findings highlight the importance of the critical components of clinical competence assessed by the Canadian national licensing examination: knowledge, clinical skills, and effective communication, for optimal asthma management.

An additional contribution of the project was the multi-level assessment of determinants of effective asthma management including characteristics of the physician, patient, and practice environment. The second study showed the effect of physician management decisions at the index visit. To the candidate's knowledge, current findings regarding physician gender on optimal asthma management is original and have not been empirically established previously. Our evidence is valuable in establishing and implementing an intervention to facilitate optimal asthma management in a cost-effective manner.

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Chapter 1. Literature Review

1.1 Overview of Asthma

Asthma is a serious public health problem worldwide and imposes a substantial burden on patients' health as well as on health care expenditures. In Canada, asthma is a major cause of morbidity for two million Canadians, and the prevalence of asthma has been rising steadily over the last twenty years. [1-3] Asthma represents a substantial burden on health care resources. The direct health care costs for asthma care in Canada are conservatively estimated at $600 million per year, and the cost of hospitalization alone was $135 million in 1994.[4;5]

1.2 Epidemiology of Asthma

1. Definition of Asthma

Asthma is a chronic inflammatory disease of the airways, associated with paroxysmal or persistent symptoms (including dyspnea, chest tightness, wheezing, sputum production and cough) and a variable degree of hyperresponsiveness of airways to endogenous or exogenous stimuli.[6]

2. Prevalence, Morbidity, and Mortality

a. Prevalence

Results of studies of the prevalence of asthma in the general population are highly variable. This may be the result of actual differences at different times and in different locales or could be the result of variation in the definition of asthma and its measurement. [7]

Cross-sectional studies have found a continuous increase in asthma prevalence since the 1980s. From 1980 to mid 1990's several Canadian studies utilized physician claims information from health administrative databases to assess prevalence of physician diagnosed-asthma. These studies did demonstrate a rapid increase in asthma prevalence from 1980's to early 1990's for both genders across

all age groups.[8-11] The prevalence among children was higher among males; however, the gender difference was reversed for those over 12 years old.[8].

The substantial increase in asthma prevalence between 1980 and 1990 appeared to plateau by the mid-1990s. From 1994 to 2000, the Statistics Canada National Population Health Surveys show only a slight increase in prevalence for both genders and all age groups[12]. For instance, in 1994, asthma prevalence was estimated to be 13.3% among children less than 12 years old of age and 6.2% for subjects 12 years old and over; whereas, in 2000, the prevalence was estimated to be 15.2% and 8.9%, respectively. In 2000, the study also demonstrated differences in asthma prevalence by gender. For children less than 11 years of age, 12.7% of girls and 17.6% of boys have self-reported asthma. The prevalence over 65 year of age was 8.9% for women and 6.8% for men. Similarly, a study from Saskatchewan also reported that the stabilization or a slight decline in the prevalence of physician-diagnosed asthma after 1996.[8;13] The reason for the plateau has not been clearly identified; however, potential explanations include the availability of new asthma medication and improved self-management or parental management of asthma.

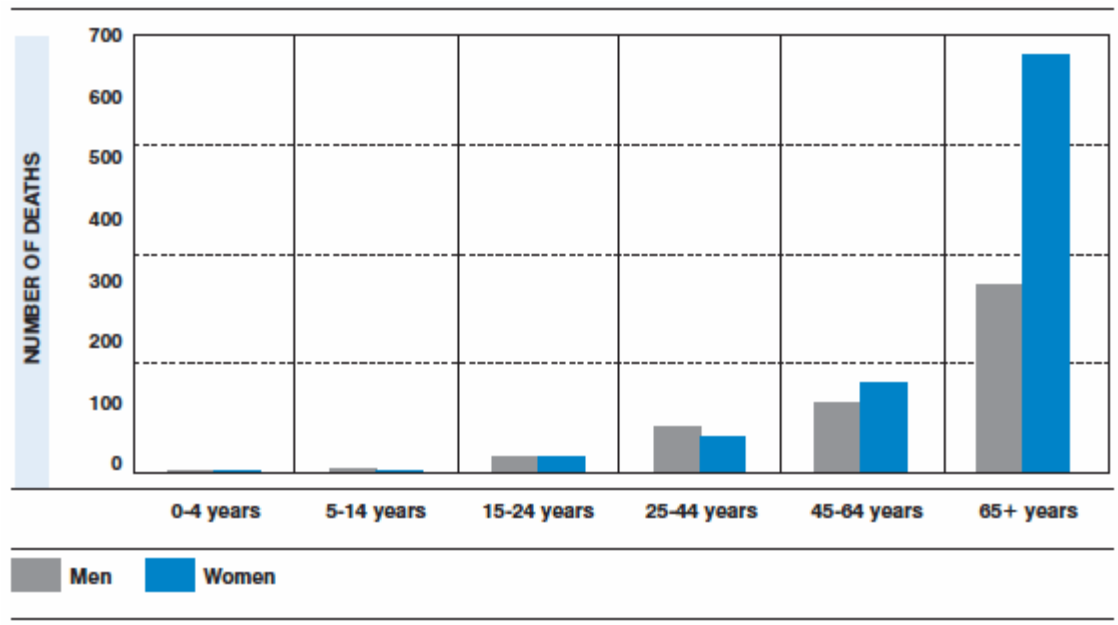
b. Mortality

Asthma can result in serious adverse events including death. Asthma mortality has slowly decreased since 1990; however, it is estimated that approximately 20 children and 500 adults in Canada die each year from asthma.[1-3;8]. Moreover, it is estimated that more than 80 percent of these asthma deaths are highly preventable if optimal treatment including proper asthma education is provided.[14]

The rate of death from asthma varies by age. For instance, according to Statistics Canada annual mortality data, the majority of asthma deaths between 2000 and 2004 occurred among patients over 65 years old.(Figure 1.1.2.1)[12] In this age group, women are approximately twice as likely to die from asthma, compared to

men over 65 years old. On the other hand, there is no apparent difference in asthma mortality between men and women who are younger than 65 years old. As women live longer than men, the apparent difference in asthma mortality in elderly women may represent residual confounding by age. [12]

Figure 1.1.2.1 Asthma Death by Age Group and Sex, Canada 2000-2004



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Statistics Canada annual mortality data.

c. Hospitalization

Asthma-related hospitalization reflects the presence of severe, uncontrolled, or progressive disease and is one of the important predictors of asthma-related death.[15] The asthma hospitalization rate decreased across all age groups since the 1990s. Especially, among young children, the rate has decreased dramatically since 1992. In 1992, the rate among boys 0-4 years old was as high as 1,500 per 100,000. However, by 2004, the rate declined to approximately 600 per 100,000. A similar trend was observed among seniors. The rate among over 65 years old in late 1980's was the highest; approximately 300 per 100.000 for both males and females. The rate in this age group has decreased over the years to 50 per 100,000 for females and 80 per 100.000 for males in 2004. [12]

According to public health agency of Canada, the majority of asthma-related hospitalizations in 2004/2005 occur among young children, and the rate for children between 0-4 years old was 1,000 per 100,000, and the rate for children between 5-14 years old was 216 per 100,000.[16] In childhood, boys are at greater risk of being hospitalized for asthma, while in adults, women have a slightly higher rate of asthma-related hospitalization. [16]

d. Asthma exacerbation

According to a Canadian Community Survey in 2003, approximately 50% of people who reported having asthma, had asthma symptoms or asthma attacks (exacerbation) in the past 12monts. Females had a 10 % higher risk of having asthma attacks compared to male (59.8% vs. 48.2%). Especially, females aged 20 to 64, who had the highest prevalence of self-reported asthma attacks (64%), and males, aged 12 to 19 years had the lowest prevalence of asthma attacks (37.1%) [16]

e. Cost

The high prevalence of asthma-related morbidity and mortality has a substantial impact on the cost of health care services. In Canada, the direct health care costs of asthma care are conservatively estimated to be $600 million per year, with hospitalizations accounting for $135 million in 1994.[4;5] In 2004, the annual cost in Canada due to uncontrolled asthma is estimated at $162 million per year, with the cost of hospitalization being due to uncontrolled asthma alone was the largest contributor at $102 millions, followed by unscheduled family physician visits ($33 million), and emergency room visits ($19 million).[17] Sub-optimal management of asthma is believed to be responsible for a substantial proportion of health care resource utilization.[17]

1.3 Asthma Management: The Evidence Base

1. Evidence Guidelines for Asthma Management

a. Overview

While the cause of asthma is not yet known and there is no known cure, the condition can be successfully managed with available evidence-based treatment.[18] Consensus-based asthma clinical guidelines, developed by a panel of experts and based upon the integration of scientific evidence, have been widely distributed in various countries to provide physicians with recommendations for optimal management for asthma.[19]

In Canada, evidence-based asthma clinical guidelines were introduced in 1996, [20] and the latest guidelines were developed in 2003 and published in 2005.[21] While specific aspects of the guidelines are periodically updated, the overall principles for the best management of asthma have been maintained.[19] The main goal of optimal asthma management is the control of asthma, which is defined by the absences of respiratory symptoms and normal pulmonary function. All evidence-based asthma clinical guidelines emphasize that the inflammatory process needs to be controlled by limiting exposure to triggering factors and using anti-inflammatory medications for effective asthma treatment.[20;21] Therapy is based on individual assessment of the severity of the underlying illness and degree of control achieved. Regular assessment of symptoms and lung function should be performed and the treatment adjusted according to this assessment. [19;22]

Clinical guidelines identify several critical factors to achieve optimal control.[19] First, effective disease management depends on the integration of new knowledge of asthma drug therapy into clinical practice.[23] A second component in effective asthma care is the education of patients in disease self-management[24] and regular monitoring of asthma control between visits in partnership with their physicians.[25;26]

b. Diagnosis

Establishment of the diagnosis of asthma is one of the fundamental requirements for optimal treatment. In the case of asthma, the pathologic hallmark is airway inflammation. Diagnosis of airway inflammation is difficult, and there is no single diagnostic marker currently available for asthma.[27] Instead, expert consensus is used to identify clinical and pathologic signs where asthma is more likely to be the diagnosis. The international consensus report summarized the following major components of asthma diagnosis: susceptibility (atopy); airway inflammation; variable airflow obstructions; symptoms; responses to treatment; and responsiveness to variety of stimuli. [27]

Spirometry is widely used as a gold standard to assess airflow obstruction. Asthma is considered to be present when FEV1 (Forced Expiratory Volume in one second) improves by 12 % or more (minimum 180 ml) or when the FEV1 drops significantly with various bronchoconstricting stimuli such as methacholine, exercise or hyperventilation.[27;28] Once the diagnosis of the airway obstruction is established, the severity of the airway obstruction is assessed. The post-bronchodilator FEV1 measures the best lung function that can be achieved by bronchodilator therapy on the day of the visit.[28]

Another diagnostic test of airflow obstruction is peak expiratory flow, is referred to as the forced expiratory flow maximum and measure the highest expiratory flow achieved with a maximally forced effort from a position of maximum inspiration or total lung capacity. PEF meters provide a less expensive and easy to use method of monitor changes in the degree of obstruction by permitting multiple measurements of airflow obstruction for days to weeks in the patient's natural setting. [29]

c. Drug Management

Canadian asthma guidelines summarize general principal for appropriate drug therapy [19] with respect to the two main categories of medications for asthma treatment: controllers and relievers. Short-acting beta-agonists are relievers which should only be used as needed for relief of symptoms and at the minimum dose and frequency required.[21] Controllers, generally taken regularly to control symptoms, include anti-inflammatory medication, including inhaled and oral glucocorticosteroids, leukotriene-receptor antagonists and long acting bronchodilators. Anti-allergic or nonsteroidal inhaled agents (cromoglycate and nedocromil) were also used as controllers in the past.

Current Canadian asthma guidelines recommend the use of inhaled corticosteroids(ICSs) as a first line anti-inflammatory maintenance therapy for controlling the symptoms of asthma and reducing airway inflammation and hyper-responsiveness. [15;19] There are several inhaled corticosteroids available for asthma treatment, these are becomethasone dipropinate(BDP), triamcinolone, flunisolide, budesonide, and fluticasone propionate (FP).[30] A variety of device systems are available to deliver the inhaled medications. [31] The pressurized metered dose inhalers (pMDIs) and dry powder inhalers (DPIs) are most frequently used. Various combinations of inhaled corticosteroids are now commonly used in combination with long-acting beta-agonist in a single inhaler.[32]

c.1. Benefits of Proper Use of Inhaled Corticosteroids (ICS)

i. Symptoms and Lung Functions

There is well documented evidence of the beneficial effect of ICS in controlling asthma symptoms. A Cochrane systematic review of 60 randomized clinical trials showed the effect of ICS use compared to placebo.[33] In patients with mild to moderate asthma, the use of Fluticasone showed improvements in indicators of asthma control from baseline compared with placebo: forced expiratory volume in one second (FEV1) (between 0.13 to 0.45 litres); morning peak expiratory flow (between 27 and 47 L/min); symptom scores (based on a standardized scale,

between 0.5 and 0.85); and reduction in rescue beta-2 agonist use (between 1.2 and 2.2 puffs/d). The outcomes related to ICS use were consistent across all dose ranges (100 to 1000 mcg/d) and all ages. [33]

There is also evidence of the effectiveness of ICS as first-line treatment with mild asthma. A randomized controlled trial of 103 patients with newly diagnosed mild asthma, showed that patients who received the ICS (budsonide 600µg twice daily) had a statistically significant reduction in self-reported symptoms and improved peak expiratory flows after six weeks of treatment, compared to patients treated with inhaled beta-agonists alone.[34] The difference was sustained over the two year study period. A subsequent study also showed a continued effect of using ICS as first line treatment in preventing deterioration in lung function by the third year of treatment. [30]

However, a dose-response relationship for the clinical efficacy of ICS have not always been demonstrated. A randomized controlled trial was conducted to compare three parallel treatment groups receiving 400µg, 800µg, or placebo among patients with mild asthma.[35] The study found that most of a clinical benefit of ICS is at the lowest dosage for patient with mild asthma. Patients receiving inhaled budesonide 400µg/d had better asthma control when compared to bronchodilators alone; however, no difference was demonstrated between the use of 400µg/d and 800µg/d. A similar finding was reported in another study investigating the dose-response effect of two doses of inhaled budesonide; 200µg and 1600µg.[36] Significant improvement in the morning peak expiratory flow and FEV1 was found as dose was increased from 200µg to 400µg; however, there was very small non-significant improvement in the outcome by doubling the dose from 400µg to 800µg.

The lack of evidence of the dose-response relationship could be explained by several factors. A critical review by O'Byrne et al.[37] indicated that the measured response to the treatment is highly dependent on the duration treatment

and monitoring. O'Byrne argued that most of studies investigating the dose-response effect were of short duration (2 weeks to 16 weeks)[35;36;38;39]; therefore, the effect may not have been apparent for some outcomes.[37] For instance, symptoms of asthma may show a clear improvement within days, a maximal improvement in a lung function for several weeks and in airway hyper-responsiveness for months to years.[40]

ii. Hospitalization

Evidence from epidemiological studies supports an association between ICS use and a reduction in the risk of hospitalization.[15] A retrospective cohort study conducted between 1991 and 1994 with 16,941 asthmatics in a Health Maintenance Organization (HMO) reported that the relative risk of hospitalization among those who used ICS, relative to no ICS users, was 0.5 (95% confidence interval (CI): 0.4-0.6) after adjusting for beta-agonist dispensing, age, race, other asthma medication, and amount and type of ambulatory care for asthma.[41]

The effectiveness of regular ICS use in reducing hospitalization is likely to be evident anytime during the course of the disease. In Canada, a nested case-control study was conducted using Saskatchewan health care databases (1977-1993) to investigate first treatment with ICS and the likelihood of hospitalization during the first year with 13,563 asthma patients. The study reported that the likelihood of hospitalization during the first year of treatment among patients who use ICSs regularly is between 40% less for initial therapy (RR=0.6; 95% CI: 0.4-1.0) and 80% less (RR=0.2; 95%CI: 0.1-0.5) for subsequent therapy than those who are treated with theophylline, after adjusting for age and sex, and disease severity.[42]

In investigating the likelihood of asthma-related hospital readmission, a cohort study among Medicaid recipients in Texas reported that initiation of ICS within 100 days following hospitalization reduced subsequent hospitalization by 61% (RR=0.39; 95%CI: 0.28-0.55) in one year follow-up, compared to no ICS users, after adjusting for demographics and previous ER visits.[43] Finally, a nested

case-control study of a long-term effect of hospital admission and readmission using Saskatchewan health database demonstrated a significant reduction of 30% of hospitalization rate for asthma and 42% of hospital readmission rate during the first four years of follow up, compared to irregular or no users of ICS. This reduction was sustained over time for more than four years of follow up, demonstrating the overall reduction of 35%. [44]

iii.Mortality

The relationship between regular use of ICS and a decrease in mortality was initially supported by ecological studies. [15] The subsequent critical review identified several studies with a secular trend indicating a decrease of asthma mortality in industrialized countries between 1980s and 1990s with increasing sales of inhaled corticosteroids. [45-47] The level of evidence using these types of aggregated measures is generally weak due to ecological fallacy, a bias associated with an association observed between variables on an aggregate level does not represent the association that exist at an individual level.

Several observational studies were subsequently conducted to investigate the association between ICS use and mortality. The findings have been contradictory; [15;48] however, the protective effect of ICS use on mortality appears to be limited to those who regularly use ICS.[49;50] A nested case-control study using Saskatchewan Health Databases with 12,301 patients with asthma from 1980 to 1987 indicated that the likelihood of experiencing death or near death among patients who received 12 or more inhalers of ICS in the previous 12 months was only one-tenth, compared to nonusers (RR=0.1; 95%CI: 0.02-0.6). However, the protective effect of ICS among patients receiving less than 12 ICS inhalers was not found in the same study (RR=1.6; 95%CI: 0.9-2.7).[50]

A subsequent study conducted using data from 1975-1991 also showed an association between reduced risk of death with higher cumulative use of ICS. The average reduction in mortality for each additional ICS inhaler filled in the

previous 6 months was 54% (95%CI: 0.26-0.79), while the ICS use in the previous 12 month reduced the mortality by 21% (95%CI: 0.65-0.97). The same study showed an increased risk of mortality with the discontinuation of ICS use. The rate of death among patients within the first three months after the discontinuation of ICS was 4.6 times higher (95%CI: 1.1-19.1) than the patients who continued using ICS. This appears due to discontinuation of necessary therapy among patients with severe disease. [49]

d. Patient Education and Self-Management

Asthma clinical guidelines emphasize limiting exposure to triggering factors and the use of anti-inflammatory agents to reduce the inflammatory process as the major interventions for effective asthma treatment.[6] This requires individual assessment of the need for therapeutic interventions according to the severity of the underlying illness and degree of control achieved. Regular assessment of the symptoms and lung function is required so that treatment can be adjusted as necessary to maintain or to achieve asthma control. Patient education is considered to be necessary to teach patients these essential skills in self-monitoring and treatment adjustment. Therefore, effective asthma education is crucial to achieve many of the recommended components of optimal asthma care.

Current asthma clinical guidelines recommend that patients receive a written action plan that includes overall goals, doses and frequencies of medications, and actions to take in the event of an asthma exacerbation.[6] However, the provision of these written asthma action plans without self-management education and reinforcement is unlikely to be successful in improving patient outcomes. A Cochrane review evaluated whether the provision of a written asthma self-management plan increases adherence and improves outcome.[51] Six trials were included in the analysis. Written management plans to adjust asthma treatment in relationship to changes in either peak flow or symptoms were compared with each other or compared to no written management plan. Reported outcomes included: hospitalization, emergency department visits, oral corticosteroid use, lung

function, days lost from school/work, unscheduled doctor visits and respiratory tract infections. The systematic review concluded that there was no consistent evidence that written plans produced better patient outcomes than no written plan. [51]

Another Cochrane review assessed the effectiveness of asthma education programmes that included self-monitoring by either peak expiratory flow or symptoms, coupled with regular medical review and a written action plan. In the target population of adults over 16 years of age, 36 studies were included in the systematic review and self-management education was compared with usual care. The results reported that self-management education reduced hospitalisations by 36% (Relative Risk (RR) 0.64, 95% CI: 0.50 to 0.82); emergency room visits (RR 0.82, 95% CI: 0.73 to 0.94); unscheduled visits to the doctor (RR 0.68, 95% CI: 0.56 to 0.81); days off work or school (RR 0.79, 95% CI: 0.67 to 0.93); nocturnal asthma (RR 0.67, 95% CI: 0.56 to 0.79); and improved quality of life (standard mean difference 0.29, confidence interval: 0.11 to 0.47). Measures of lung function were not changed.[52]

1.4 Asthma Management in Practice

1. Drug Management

Despite evidence supporting the effectiveness of regular use of inhaled corticosteroids (ICS), sub-optimal use of ICS appears to be substantial. Overall, the average rate of adherence to ICS is approximately 50% across all age groups.[53;54] However, several systematic reviews report considerable variation in adherence rates with asthma medication, ranging from 2% to 100%. [55;56]

The reported variation in adherence rates partially reflects differences in evaluation methodologies, including differences in clinical judgment, biological measurement, observations of metered dose inhaler, self-report/family interview, electronic measurement, and administrative pharmacy records [57;58] In addition, there is a major methodological challenge in establishing evidence of sub-optimal use of ICS relating to a lack of conceptual distinctions of the terms among 'use', 'dispensation', 'prescription', and 'compliance'. The failure to make a clear distinction among these terms creates a problem in determining root causes of the problem. For example, a failure to receive a prescription for ICS implies that the physician has not initiated evidence-based treatment; whereas a failure to have an ICS dispensed, when it was prescribed, implies that patient barriers are important determinants of sub-optimal ICS use.

Despite the lack of conceptual clarity in assessing ICS use, there is evidence that sub-optimal ICS use is especially common among patients, who were either hospitalized or who visited emergency room.[59-61] For instance, a study by Hartert et al. (1996) reported that, among 101 asthma patients admitted with an asthma exacerbation, less than a half of those had been prescribed ICS.[62] Apter et al. (2001) in the Managed Care setting also reported that, among patients with at least one hospitalization or ER visit during one year study period, only 46% patients were prescribed ICS. [63]

Moreover, the sub-optimal level of ICS use is likely to be associated with the level of asthma control. According to a study by Milgrom et al., children who experienced acute severe exacerbation failed to take any of their prescribed ICS on a median of 76% of days over 13-week follow-up period; whereas those who remained well controlled missed only 5.8% of days.[64] Similarly, among patients with moderate to severe asthma and who experienced multiple hospitalization in the previous year, the National Health and Nutrition Examination survey reported that only 26% had taken a asthma controller medication during the previous month.[65]

a. Multiple Determinants of Sub-optimal Use of ICS

The reported sub-optimal use of ICS is influenced by a number of modifiable factors, and several systematic reviews identified the following barriers that are related to patients. Suboptimal ICS use is more common in patients with: mild or severe asthma, poor understanding of the need for treatment, insufficient confidence in the clinician or medication, cost, the presence of psychological problems, low motivation to change behaviour, and negative health beliefs and attitude toward asthma treatment. [55;66] In addition, several health care system barriers have been identified for the sub-optimal use of ICS, and they are: difficulty in scheduling and time constraints, treatment by multiple care providers, and perceived clinician disinterest. [55;55]

It is not well understood; however, whether these modifiable barriers regarding the sub-optimal use of ICS are potentially inter-related with each other across different levels of care; patient, provider, practice context, and health care system. In turn, these concerns among patients may become barriers among physicians for prescribing ICS. [67;68]. For instance, patients' concerns of adverse effects and cost regarding ICS are also acknowledged by physicians. According to Cabana et al (2007), 60% of primary care physicians reported that the most common barrier to prescribe ICS is a perceived cost of the asthma medications for families.[69] Similarly, Finkelstein et al (2000) reported that approximately 50% of

pediatricians expressed concern regarding adverse effects, especially growth retardation, with ICS therapy.[70] In addition, a lack of motivation to change behaviour and health beliefs/attitude toward asthma treatment among patients may influence the level of outcome expectancy as well as self-efficacy among physicians[71], which in turn creates barriers for physicians to prescribe ICS. [72]

The communication ability between physicians and patients to exchange information about asthma management is critical to assess asthma status accurately and, in turn, make optimal treatment decisions.[73] Especially, a recent study has demonstrated that practicing physicians frequently do not utilize objective measures of lung function to assess asthma status or control, but rather base treatment decisions on patient symptoms alone,[74] and the quality of such assessment is often inappropriate. [75] According to Shim et al (1980), when physicians from a pulmonary division of hospital in the Bronx estimated peak expiratory flow rate, only 44% of the their estimates were within 20% of the actual value. [76] Moreover, Wolfenden et al. reported that, among 4,005 asthma patients in a managed care setting with a medical encounter of asthma, most patients had moderate (39.4%) or severe asthma (50.1%), based on self-reported symptoms. However, most of the physicians rated these same patients as mild (44.6%) and moderate (44.5%), respectively. The lower estimates of underlying severity by physicians are more likely to be associated with care that is less consistent with the guidelines. For instance, among those patients reporting moderate symptoms, daily inhaled corticosteroid use was reported in 35.2% when physician estimates were mild, 53.0% when moderate, and 68.1% when severe (P =.001). [77]

Insufficient confidence in clinicians, and involvement of multiple care providers across health care system will exacerbate barriers to effective communication, and influence the quality of clinical information available for physicians to assess asthma control and ICS use. [78] For instance, insufficient confidence in clinicians may undermine the quality of information exchange between physicians

and patients. [79] On the other hand, care provided by multiple care providers may limit physician's ability to assess patient disease status simply due to a lack of vital information. [80-82]

Patients' beliefs regarding the processes underlying asthma and the role of ICS may also result from a lack of explanation by physicians.[83] For instance, Boulet et al (1998) conducted a telephone survey for over 600 asthmatic adults regarding their perception of the role of ICS and the potential side- effects of this therapy. The results showed that, among the 46% of patients indicating that they were reluctant to take ICS regularly, only 25% of patients reported that they had discussed their fears and concerns with their primary care provider. [84]

Finally, inadequate physician knowledge may also contribute to sub-optimal quality of prescribing. For instance, a systematic review by Harrold et al (1999) reported that a greater possession of knowledge related to selected medical conditions was associated with higher rates of use of medications that improved patients' survival.[85] Moreover, a previous study has shown that a lower level of medical knowledge among physicians has been associated with sub-optimal level of ICS use. [86;87]

2. Education and Self-Management

Appropriate and accurate assessment of the severity of bronchoconstriction is vital to effective asthma management. A patient's failure to recognize changes in the severity of their asthma-related airway obstruction may result in inappropriate utilization of anti-inflammatory medication, delay in seeking appropriate medical care, and avoidable deaths. [88;89] Although the benefit and importance of asthma education and self-management is well documented, there are a number of outstanding challenges to implement the essential components of asthma education and self-management in practice.

a. Self-Monitoring

It has been reported that general knowledge regarding content of asthma management seems to be high among patients. Among 197 asthmatic children, who attend ER for their acute asthma exacerbations, 71% reported that they have received some types of asthma education. Moreover, almost all those patients received education about asthma medication and treatment (95%), asthma triggers (89%), and asthma attack strategies (83%)[81]

However, the education for asthma self-monitoring skills seems to be inadequate. For instance, the ability to perceive changes in respiratory symptoms and asthma control is critical but highly variable across patients. Among 1,048 asthma patients recruited from 348 pharmacies, 68.5% (n=718) patients with inadequate asthma control indicated that their asthma was "completely" or "well" controlled.[90]

b Action Plan

Current asthma clinical guidelines recommend that patients receive a written action plan that includes overall treatment goals, doses and frequencies of medications, and actions to take in the event of an asthma exacerbation. [6] The particular component of self-management has been reported as sub-optimal. For instance, in a cross-sectional study using questionnaire and pharmacy data over the 12-month period from asthmatic children (2-9 years of age), less than a half of patient (41%) reported having a written asthma action plan.[59] In addition, in a cross-sectional telephone survey of 1,648 parents of asthmatic children (age 2-16), only 28% reported having received a written action plan even though it was insured through Medicaid. [61]. A cross-sectional survey of 393 adults (over 15 years old) in Australia with physician-diagnosed asthma, reported that the prevalence of possession of written action was as low as 18.5%. [91]

Such treatment plans offer the opportunity to include objective measures of lung function using the Peak Flow Meters (PFM). However, most of the patients would

not utilize PFM even during asthma exacerbation.[92] For instance, in the multi-national working class neighbourhood, 16% of patients, who possessed the PFM, reported using PFM to monitor their condition. Only 8% of the patient utilized PFM in their early stage of worsening asthma, and 26% of the patients rarely or never used PFM. [93]

c. Regular Medical Review

Regular review of patients' asthma control by health care professionals is an essential component of optimal asthma management. The regular medical review has a greater impact when patients are regularly followed by the same physician.[94] However, according to Reeves et al (2006), less than half of children aged 2 - 17 years, who presented to ER for acute asthma exacerbations in Michigan, had attended at least two scheduled appointments for asthma with a regular asthma provider in the previous year.[81] Moreover, only 20% of those patients visited their regular asthma provider within a week of ER visits[81].

d. Multiple Determinants of Sub-Optimal Education and Monitoring

Several modifiable barriers are likely to contribute to this phenomenon. First, low prevalence of possession of an action plan among patients may be due to non-adherence to asthma practice guidelines by physicians. For instance, Wisnivesky et al. (2008) surveyed 202 inner-city primary care providers regarding self-reported adherence to five components of the National Heart, Lung, and Blood Institute (NHLBI) guidelines. Self-reported adherence of action plan use was only 9%. Wisnivesky et al. further reported that the presence of self-efficacy to use action plan among the primary care physicians was associated with a nearly five times greater likelihood of adherence to action plan use, compared to physicians without self-efficacy (Odds Ratio (OR)=4.9;p=0.03)[95].

In addition, a distinctive pattern of health care system utilization among sub-group patients lowers the opportunity to receive a regular medical review and written action plan. Several studies have reported that the lack of an action plan is

especially common among patients who visit the emergency room repeatedly (71-87%), [96-99] and who are admitted to hospital (57-72%)[62;96]. Moreover, according to Fernandes et al (2003), the lack of a written asthma action plan (OR=3.3, P =0.03) were independently associated with frequent visits to the ED. [100]

Even when an action plan is provided, several factors potentially delay initiating appropriate action in the case of worsening asthma among some patients. There is a considerable variability among patients in detecting airway obstruction. [74] Some patients also have distinctive health beliefs, including denial of and downplaying the importance or severity of attacks.[101] Furthermore, the written asthma management plan may not have been appropriately explained by the health care provider. Using a standardized self-administered questionnaire, 32% of 111 consecutive patients presenting to the emergency room for asthma with a written treatment plan stated that the plans were never discussed with a physician.[102] In addition, a little over half (53.6%) of patients, who presented to one of three ERs in Michigan, reported ever receiving education about how to use the written asthma action plan, although 95% of those patients reported having a primary care provider.[81]

1.5 Predictors of sub-optimal Asthma Management

1. Physician Characteristics

a. Physician Gender

Physician gender is associated with the nature and quality of clinical practice in many domains.[103-110] In terms of preventive care, both male and female physicians are more likely to perform gender-specific examination on patients of the same gender.[107;111] For instance, the rate of pap smear and mammography performed by female physicians is higher than the rate of male physicians.[107;108] Male physicians are more likely to prescribe newly released medications.[109] Moreover, male obstetricians are more likely to perform caesarean sections, and patients of male physicians are more likely to undergo cardiac catheterization.[110]

To date, no studies explicitly have examined whether there are any difference in quality of asthma care and patient outcome according to physician gender. In other area of chronic disease management, two studies has reported that female physicians provided better care for type 2 diabetes.[105;112] For instance, Kim et al (2005) examined a North American population with diabetes (n = 6,368), treated by 1213 male and 473 female physicians. The study found that patients of female doctors were more likely to receive lipid, HbA1c and urine protein measurements, and to have an LDL cholesterol <130 mg dL−1. The second study from Germany reported similar findings [105]

There are several mechanisms to explain the reported gender-difference in the delivery of health care. First, physician's practice pattern tends to be influenced by and may influence types of patients as well as the medical conditions. For instance, female patients prefer to see female physicians[113-115]; but evidence is scarce on whether there is similar gender concordance among male patients.[116] Physician gender is also associated with the types of medical conditions managed. Female physicians are more likely to manage female-specific,[116]

psychosocial,[116;117] endocrine problem[116;118] and preventive care[119]; but less likely to manage musculoskeletal and respiratory problems.[116;118]

In addition, prior research has supported the contention that there are gender-specific differences in physician-patient communication styles during patient encounters. Female physicians are more likely to engage in patient-centered communication, have longer consultations, and to arrange follow-up visit and referrals, compared to male physicians.[113;120]. Female physicians are more likely to spend a greater proportion of a visit providing preventive service, counselling and information, and ordering laboratory testing; whereas male physicians are more likely to spend more time in history taking, physical examination, and discussing treatment.[106]

In summary, even though female physicians are less likely to see respiratory problems in their practice, the distinctive communication and prevention-oriented practice style of female physicians may provide advantages in managing asthma. For instance, physicians with a participatory communication style and those who arrange regular follow-up are more likely to have asthma patients who make regular use of controller medication.[91;106] Therefore, we hypothesize that patients of female physicians will be more likely to make regular use of controller medication, and less likely to experience asthma morbidity.

b. Physician Specialty

Abundant evidence exists to show that there is a marked difference between general practitioner and specialists regarding the adherence to national asthma practice guidelines. Several studies have demonstrated that asthma specialists are more likely to provide care that is more consistent with evidence-based practice guidelines.[23;121;122] For instance, Diette et al. [86] conducted a cross-sectional survey of parents of 260 children with asthma in the national managed care organization to investigate specialty differences in adherence to national practice guidelines four domains: patient education, control of triggers, lung

function monitoring, and medication use. The results indicated that the likelihood of guideline adherence in each of the domains was greater when asthma patients were managed primarily by specialists, compared to GP managed patients. The greatest difference for the physician specialty was found in the use of controller medication (OR=6.7; 95%CI:1.5-30.4).

A similar cross-sectional survey was conducted in 6,612 health plan enrolees, who had at least 2 visits with a diagnostic code of asthma, and were at least 18 years of age. The results indicated that underuse of inhaled corticosteroids was significantly less common in patients who were managed by allergists (OR=0.53; 95%CI:0.43-0.66) and pulmonologists (OR=0.61; 95%CI: 0.51-0.73) compared with generalists.[123] Similar results were found in a large HMO study in Portland.[121]

Patients managed by specialists also appear to experience better outcomes, compared to those managed by general practitioners. A cross-sectional survey of 1,954 enrolees with asthma in a national managed care organization and their 1,078 treating physicians reported that, allergist-managed patients were approximately 50% less likely to experience hospitalization and emergency-room visits (OR=0.55; 95%CI: 0.33-0.87) and to cancel activities in previous month due to asthma (OR=0.51; 95%CI:0.34-0.77), compared to patients who were managed by GPs. Moreover, patients of allergists also had a great improvement in asthma symptom scores (p=.007) and rated overall quality of care higher (OR=1.75; 95%CI:1.14-2.78)[124]. Similar findings were reported in the HMO study as well.[121]

When patients are referred to asthma specialists after an ER visit for an asthma exacerbation, these patients are more likely to have an improved asthma outcome. For instance, in the HMO setting, patients with asthma between the ages of 6 and 59 years presenting for ER visit for asthma were systematically assigned to receive either (1) facilitated referral to an asthma specialist within the allergy

department and concomitant comprehensive ongoing asthma care (intervention group, n = 149) or (2) continued outpatient management from generalist physicians (control group, n = 160). The course of their asthma was evaluated blindly during the subsequent 6 months by review of medical records, initial and follow-up questionnaires, and spirometry. The intervention group had an almost 50% reduction in asthma ER relapses compared to the control group (22.1% vs. 33.1%; $p = 0.017$) and in the frequency of multiple relapses (5.4% vs. 13.1%; $p = 0.005$), and a greater likelihood of receiving inhaled corticosteroids (36.5% vs. 13.9%; $p < 0.00001$). [125]

One mechanism that could explain the marked differences in guideline adherence and patient outcomes between GP and respiratory-related specialists is based on a model proposed by Cabana et al. (1999).[126] The model proposed a general mechanism for evidence-based guideline adoption; the knowledge, attitude, and behavior framework. The framework proposes that, before practice guidelines can affect patient outcomes, changes need to take place in physician knowledge, then attitude, and finally behavior.

First, knowledge of evidence-based practice guidelines differs by physician specialty. Doerscug et al (1999) developed 31 questions, multiple-choice tests of asthma knowledge based upon the NHLBI recommendation in the Expert Panel Report2: Guidelines for the Diagnosis and Management of Asthma. The test was distributed to a total of 191 physicians, including faculty members in family medicine (n=16), general internal medicine (n=12), asthma specialists (n=23), internal medicine residents (n=102), family medicine residents (n=26), and asthma subspecialty fellows (n=12). The results indicated that asthma specialists scored significantly higher overall than primary care faculty (mean+ SEM: 78 + 3 vs. 65 + 3). Asthma specialists also scored significantly higher in the knowledge of guidelines related to pharmacology, prevention, and diagnosis of asthma compared to family practitioners.[87]

Second, there may be a difference in physicians' attitudes towards guidelines by physician specialty. For instance, a cross-sectional survey of a national random sample of 829 pediatricians investigated self-reported adherence to four major components of the NHLBI guideline and possible barriers to adherence.[71] The study found that non-adherence was associated with specific barriers for each guideline component. Specifically, lack of adherence to the use of inhaled corticosteroids in asthma management was associated with a lack of agreement (OR=6.8; 95%CI: 3.2-14.4). On the other hand, a cross-sectional survey among 202 primary care physicians who provided care for inner-city, minority patients with asthma, indicated that lack of adherence to the use of inhaled corticosteroids was due to a lack of self-efficacy (OR=2.8; $p<.03$).[95] Self-efficacy, refers to the providers' beliefs about their capability to organize and execute specific guideline recommendation. Self-efficacy is positively associated with the provision of preventive care across adult and pediatric primary care setting. [95]

Respiratory specialists and family physicians cite different barriers to prescribing ICS, in accordance to guidelines. For family physicians, the most common barrier that prevents them from prescribing corticosteroids is a perceived cost of the asthma medications for families (60% vs 20%; $p<.05$); whereas a lack of time was more likely to be the barrier cited by pediatricians (21% vs 10%; $p<.05$).[69]. This particular specialty difference could be related to a difference in patient characteristics and practice style. For instance, patients who are managed by general practitioners tends to be younger [121], male [127], having lower educational status[127;128] and lower income[127] than those managed by pediatricians.

On the other hand, respiratory specialists are more likely to treat patients with severe asthma than patients who are managed by GPs.[121;127;128] However, patients managed by respiratory specialists are more likely to have asthma exacerbations treated in a clinic setting rather than an emergency department.[121] In addition, patients treated by respiratory specialists are more likely to possess

greater knowledge of asthma management and engage in the self-management behavior, compared to patients cared by GPs .[127] Thus, respiratory specialists appear to more likely to engage in prevention-related behavior and provide effective patient self-management education. In a national survey of 512 physicians who treat asthma patients with asthma at outpatient setting (n=512) in U.S., respiratory specialists are more likely to emphasis on the topic of controlling asthma at the first visit; whereas primary care physicians tend to focus specifically on the topic of trigger. [129;130]

In summary, respiratory specialists possess greater asthma knowledge and have more confidence in providing education and counselling for asthma-self management. Therefore, respiratory specialists, even though they have a tendency to see patients with severe asthma, are expected to show a superior performance in the management of asthma patients in comparison to GPs, family physicians, or other specialists.

2. Patients Characteristics

a. Patient Age and Gender

It is not clear whether the likelihood of experiencing an asthma exacerbation is related to patient age. A baseline survey of a prospective cohort study of 6,590 adults with asthma in 15 managed care organization, reported that elderly patients were more likely to experience daily asthma symptoms in the past four weeks compared with younger patients [131]. The study found that the mean asthma symptom index score, based on the presence of seven symptoms (chest tightness, wheezing, shortness of breath, cough sputum production, nocuturnal symptoms, and persistence of symptoms between attacks), was positively associated with patients' age. However, older patients were less likely to report having asthma attacks, compared to younger patients.[131] A similar result was reported in a Canadian community health survey, where the likelihood of having asthma

attacks was elevated among patients between the ages of 20-44 years (61.1%) and 45-64 years (57.9%) compared to younger and older patients [16]

On the other hand, when asthma control status of 10,428 asthmatic patients was assessed by their primary care physicians, age and the likelihood of asthma being out-of-control were negatively associated[132]. Compared to patients over 65 years old, middle-aged patients (36-50 years) and young adults (12-35 years) had a 14% (OR=1.14; 95%CI: 0.99-1.30) and 40% (OR=1.41; 95%CI: 1.20-1.66) higher likelihood of poor asthma control. [132]

According to the Public Health Agency of Canada, the majority of asthma-related hospitalization occurs among young children. [16]. The rate of asthma-related hospitalization between 0-4 years old in 2004-2005 was the highest at 1,000 per 100,000, followed by the rate for children between 5-14 years (216 per 100,000). The rate of asthma-related hospitalization stabilizes until 64 years of age, and then increases slightly thereafter to 80 per 100,000 .[16]

Taking patients' gender into consideration may provide more insight into the relationship between age and asthma morbidity. According to the Statistics Canada National Population Health Survey, there is a gender difference in asthma prevalence, which varies by age.[12]. In 1994, the prevalence of physician-diagnosed asthma was estimated to be 13.3% among patients less than 12 years old of age and 6.2% for patients of 12 years old and over; whereas, in 2000, the prevalence was estimated to be 15.2% and 8.9%, respectively for these two age groups.[13] In 2000, among children less than 11 years of age, the prevalence was 12.7% for girls and 17.6% for boys. This female-male trend is reversed for patients with 20-34 years of age, where the prevalence was 13.5 % for female patients; and 7.5% for male patients. The prevalence of asthma among female patients over 35 years of age ranged from 8.9% and 10.1% in 2000; whereas the range for males were from 4.8% and 6.8% in 2000. [13] A similar trend was observed in the US. [133] Potential mechanisms have been identified to explain

the gender shift in asthma prevalence around puberty, including the effect of sex hormones, changes in airway size, anxiety-depression, and obesity. [134]

Even after taking the higher asthma prevalence among women into account, asthmatic women are more likely to experience morbidity than men. In Canada, according to the Canadian Community Survey, approximately 50% of people who reported having asthma in 2003 experienced asthma symptoms or asthma attacks in the past 12 months. Females had a 10 % higher risk of having asthma attacks compared to males (59.8% vs. 48.2%). Females aged 20 to 64 has the highest likelihood of experiencing asthma attacks (64%), while males aged 12 to 19 had the lowest risk of asthma attacks (37.1%) [16]

Several studies reported that asthma-related hospital admissions are approximately twice as likely among boys than girls up to 15 years of age, yet, in adult populations, females have three times the rate of asthma-related hospital admissions compared to males.[133;135] A similar finding was reported in a Canadian study.[136] According to Baibergenova et al., even though female patients presented at ER with less severe asthma than male patients, female patients were approximately 60% more likely to be admitted to hospital compared to male patients (OR=1.64; 95%CI: 1.41-1.90).[136]

There are several potential mechanisms to explain the observed excess morbidity among asthmatic women. Although there is a potential physiological explanation that non-specific bronchial hyper-responsiveness is more commonly found among female patients, [137] female patients are potentially more sensitive to perception of or reactivity to the asthma physiologic change. A cross-sectional study of 914 individuals aged 3-55 years of age with physicians diagnosed asthma found that, even with the same lung function test results, female patients reported more daytime and nocturnal symptoms, compared to male patients. In addition, female patients, aged 33-55 years reported significantly lower levels of quality of life related to physical functioning, social functioning, and bodily pain [138]

Moreover, according to a study by Cydulk RK et al (2001), among 1,291 patients presenting to the emergency department in the US and Canada with moderate to severe exacerbation, 62.2% were female patients.[139] Even though female patients were less likely to have severe exacerbation, female patients were more likely to report symptoms, both in terms of frequency and intensity compared to male patients, with equivalent lung function.[139] At a 2-week follow-up assessment, female patients were 50% more likely to experience on-going exacerbation.(OR=1.5; 95%CI: 1.0-2.4).[135]

Gender may also influence the general approach to the treatment of asthma. For instance, a large HMO study by Schatz et al [133] demonstrated that mean number of short-acting beta agonists dispensation is significantly higher among male patients than female patients across the following three age categories: 2-13 years old, 14-22 years old, and 23-64 years old. On the other hand, female patients showed significantly higher number of outpatient visits and emergency room visits ($p<.01$) except in the 2-13 years old age category. Even among patients, aged 18-54 years, presenting at ER for acute exacerbation, female patients were more likely to have primary care physician (74% vs 48%; $p<.01$). [135]

Finally, female patients may have a tendency to have their asthma treated less aggressively with inhaled corticosteroid than males, due to either provider or patient behavior.[140] First, according to Williams et al (2007), female patients are 90% less likely to fill inhaled corticosteroid prescriptions than male patients (OR=1.90; 95%CI: 1.01-3.66)[141]. Moreover, female patients also have lower levels of adherence to inhaled corticosteroids. For instance, Schatz et al.[133] reported that the percentage of patients who filled any inhaled corticosteroid prescription during the 2-year study period was significantly higher among female patients who were 14 years of age or older than male patients in the same age category. However, across all age categories, the mean number of actual

prescriptions dispensed was significantly higher among male patients than female patients. A similar finding was reported in asthmatic children [142].

In summary, there is strong evidence of a higher prevalence of asthma morbidity among adult females than males. There are multiple factors that potentially contribute to this phenomenon. Female patients have been reported to be more sensitive to physiologic changes and to report symptoms, to seek medical care, and to be less likely to utilize inhaled corticosteroid.

b. Socioeconomic Status

Socioeconomic Status (SES) has been reported as a major determinant of sub-optimal use of ICS [57;65;143] and higher morbidity. Although the rate of inhaled corticosteroids use is substantially lower than guideline recommendations, [62;144;145] this disparity seems to vary according to patients' SES. [57;63;144-146] Among asthma patients of lower SES, the proportion of patients who received anti-inflammatory maintenance medication ranged from 5.3% to 46%. [62;63;146] For instance, the use of inhaled corticosteroids was the lowest in patients with lowest family income quartile (6%), compared to 28% in the highest family income quartile.[145] In addition, in east Harlem, with the highest hospitalization and mortality rate in the United States, only 22% reported the use of anti-inflammatory maintenance medication on a daily basis during the previous 12 month. [147]

The sub-optimal use of inhaled corticosteroids in lower SES groups appears to be largely independent of drug costs. [148;149] A study from Manitoba, Canada, found that, in comparison to children who insured through a provincial cost-sharing drug plan, those of lower socioeconomic status who had complete coverage were less likely to be dispensed new inhaled corticosteroid prescription. Furthermore, the rate of dispensed prescriptions was 12% lower for lower income patients with a cost-sharing drug plan compared to high income children with the same cost-sharing drug plan. However, the rate was 18% lower for the lowest income children, who receive medication at no charge. [148]

In addition, patients of lower SES tend to have fragmented health care. Patients with lower SES are more likely to use the ER when they have exacerbations of their asthma.[99;149-151] Hanainia et al [99] compared patients who depend on ER for their asthma exacerbations with the patients who were seen in an ambulatory asthma care facility and showed that patients seen at the ER were more likely to have a below average gross annual income (55% vs. 3% for patients seen in an ambulatory asthma care facility). Moreover, care patterns after discharge from a hospital showed that patients with lower SES were less likely to receive follow-up treatment, including visits with an asthma specialist, therapy with anti-inflammatory medication, and pulmonary function test. [152]

The distinctive pattern of using the emergency room for asthma management among patients with lower SES could be due to issues related to difference in the accessibility to outpatient care even in a universal health care system. Socio-cultural circumstances, such as difficulty getting time off work without loss of pay, as well as travel costs[153;154] may create a situation where the ER is the only source of care for patients who cannot attend day-time clinics. In a cross-sectional study of 138 patients aged 15-50 years admitted to hospital with acute severe asthma, Kolbe et al. reported that concerns about taking time off work was one of the independent predictors of delay in the use of ambulatory services.[155] Similar findings are reported in other asthma studies.[156;157]

c. Number of Visits

Having a regular contact with physicians is a key factor in optimal management of asthma.[6] Patients' motivation for optimal management of asthma is substantially reinforced by a partnership with their physicians as it allows regular monitoring of asthma control[78;143] and treatment[78;143;146;158] between medical visits.[24;146;159] Previous studies have demonstrated that regular monitoring of asthma control in conjunction with a written action plan results in

less hospitalization,[24] increased likelihood of receiving anti-inflammatory maintenance therapy [160] and better asthma control.[93]
Increasing number of contacts with physicians has been shown to reduce the number of asthma-related ER visits in several studies. Among 411 children with asthma aged 5-14 years enrolled in an HMO between 1992 and 1996, asthma-related ED use was less among children with increasing number of visits to a primary care physician for asthma (OR = 0.82; 95% Cl: 0.70-0.96). [161]. Similarly, among Medicaid children (age 2-17) in the U.S, the likelihood that children with 3 or more asthma-related primary care visits and a filled inhaled corticosteroid (ICS) had an asthma ER visit was 1/5 those of children with fewer asthma-related visits or filled ICS (OR = 0.20; 95% CI: 0.06-0.65) [162] In addition, children with asthma who have close contact with an asthma primary care provider report their disease severity more accurately [78] and have a greater likelihood of receiving prophylactic therapy for asthma [143].

Thus, we expect that increasing number of contacts with study physicians would be associated with a better quality of asthma care and lower morbidity among patients.

d. Previous Emergency Room (ER) visits

Several studies have reported that previous ER visits is a major predictor of the future multiple ER visits [163-166] and urgent or unscheduled visits.[166] For instance, a Canadian study by Rowe et al. (2008) reported that patients with ER visits in the past 2 years had an approximately 50% higher likelihood of multiple future ER visits for acute asthma (RR=1.47; 95%CI: 1.18-1.80). Several studies have reported that, among sub-population of patients, there is a tendency to use ER as one of their regular source of care. A substantial portion of patients who visit the ER for asthma are frequent visitors, [100] and they visit within a short period of time.[100] Approximately 80-90% of patients who presented to the ER for acute asthma are discharged. Among those discharged, 5-25 % of patients return to the ER for asthma treatment within the first week, and a further 21-35%

within the three weeks after discharge.[163;165] Most patients (91%) will return ER before they see their primary care physician. [165] The previous study by Ford et al (2001) reported that, even though patients with more severe asthma were more likely to have a primary asthma care provider, 69% of those patients identified the ER as their preferred source of care. [167].

3. Physician Practice characteristics

Unexplained variation in the quality of asthma care and asthma morbidity could be explained by differences in physician practice. [168]

a. Practice Workload

A number of studies have shown that practice workload has been associated with a provision of a wide range of medical procedures and clinical outcomes.[169] The so-called 'volume-outcome relationship' has been studied based upon two principal hypotheses: 1) physicians who treat a larger number of patients with a given condition will develop more effective skills in clinical management and/or 2) physicians who have more effective skills in clinical management will deliver better quality of care, receive more referrals, and thus accrue larger volumes. According to a systematic review of 135 articles, approximately 70% of studies have shown support for the hypothesis that higher volume is associated with better quality of care across a wide range of procedures and medical conditions, whether assessed by hospital or by physicians.[169]

In a chronic disease management in ambulatory care, this hypothesis has been supported in diabetes care. For instance, primary care physicians with greater numbers of diabetic patients in their practice are more likely to receive essential aspects of diabetes care including hemoglobin A1c measurements, lipid profiles, and retinal eye examinations. [170] Even after adjustment for multiple factors, for each quintile increase in the number of diabetics treated in a primary care practice, the odds of receiving a hemoglobin A1c measurement increased by 16% (OR: 1.16; 95% CI:1.10-1.23), by 12% for a lipid profile (OR: 1.12; 95% CI: 1.07-

1.18), by 6% for a retinal eye examination , (OR: 1.06; 95% CI: 1.02-1.09), and by 48% for receiving all 3 measures (OR: 1.48; 95% CI:1.22-1.81). Similar findings were reported in a study in England as well.[171] Moreover, the quality of care provided in cardiovascular disease management has also been shown to be volume sensitive [172]. For instance, a practice with higher caseload of patients of cardiovascular disease was more likely to conduct early diagnostic investigation, including referral for exercise testing and/or specialist assessment.[172]

A practice which treats a high volume of patients with a particular condition is not the same as a practice which sees a high total number of patients per day. High daily visit volumes tend to be negatively associated with quality of care. For instance, in Quebec, inappropriate antibiotic prescribing was investigated in relationship to practice volume.[173]. Physicians with a higher daily practice volume were more likely than those with low practice volume to prescribe antibiotics for viral respiratory infections (Risk Ratio (RR)=1.27; 95% CI:1.09-1.48) and to prescribe second-and third-line antibiotics as first-line treatment (RR=1.20; 95% CI:1.06-1.37). [173] Several other Canadian studies had a similar results.[109;174]

Insufficient time during patient visits has been reported as barrier to adhering to asthma practice guidelines. For instance, a study from Scotland reported that time was a major barrier to providing self-management education and making an objective diagnosis.[175] A national cross-sectional survey was conducted to identify factors associated with physician nonadherence to National Heart, Lung, and Blood Institute guidelines for prescribing inhaled corticosteroids. The study reported that 40% of paediatricians indicated insufficient time was one of barriers to prescribe inhaled corticosteroids to asthmatic children.[69] Therefore, we expect that a higher practice volume would negatively impact a quality of asthma management and asthma morbidity.

b. Practice Population Profile

As graduates enter practice, they establish their practice population in the community they serve, and characteristics of each practice population will vary across physicians. [168] If there is a higher proportion of asthmatics, women, elderly, or children in his/her practice population, it may influence the way a physician manages patient care in his/her practice. The influence of the demographic composition of the practice population has not been extensively investigated.

According to the previously described 'practice-volume relationship', physician may develop more effective skills for a particular medical condition as a consequence of treating a large number of patients. For instance, by treating a large number of elderly patients, physicians may develop skills in dealing with the distinctive needs of the elderly population such as adverse drug reactions and polypharmacy due to high prevalence of co-existing illness.[176] Previous studies have demonstrated that proportion of elderly population was associated with physicians' prescribing approaches for the elderly [176] and mammography referral rate for women aged 50-69 years old.[177]. In the case of asthma, disease prevalence and its morbidity predominantly occur among younger populations. [16] Therefore, a higher proportion of elderly in the practice population is expected to negatively influence quality of asthma care. Similarly, females patients are more likely to experience asthma-related morbidity [13] but have a greater tendency to receive preventive service during their medical visits. [178] Therefore, it was tentatively hypothesized that a higher proportion of female patients would be associated with higher quality of asthma management and greater asthma morbidity.

4. Health Care System Policy Characteristics

a. Overview

Physician payment is a major component of health care costs, consisting of 13.3% of total Canadian health expenditure.[179] In Canada, health care is managed by the provinces, with subsidization by annual funding from the federal government In each provincial health care system, policy makers need to negotiate a physicians reimbursement plan that optimizes quality, accessibility, and efficiency of health care. [180]

Overall, there are two major remuneration methods: fee-for-service and alternative payment. Fee-for-service reimburses physicians for each unit of service or procedure according to a negotiated fee schedule.[181] Alternative payment system includes salary, capitation, and a blended system. Salaried physicians are paid for a specified number of hours of work per week regardless of services provided or the number of patients enrolled in their practice. In a capitation system, the physician receives a set amount of money for each patient registered and is then obliged to provide specific services to these patients. Finally, blended payment scheme consists of a fixed payment (salary, capitation or lump sum) and variable payment incentives. [182] Each remuneration method is assumed to provide a unique incentive to physicians. The College of Family Physician of Canada summarizes advantages and disadvantages of each remuneration method.[183] Determining the impact of each of these remuneration methods in achieving policy objectives is a major and an essential challenge. In Canadian health care system, fee-for-service has been the dominant remuneration method for primary care physicians for years, accounting for over 90% of physician earning in 1990. [184]

The advent of Canadian health care system reforms in the last 2 decades has led to a gradual restructuring of the physician remuneration system, with a commensurate increase in the number of primary care physicians whose remuneration methods is alternative payments. According to the 2007 National

Physician Survey, nearly a half of family physicians were paid through fee-for-service (48.3%), followed by blended payment(31.2%) and salary (7.7%) [185]

b. Fee-for-service Reimbursement System and Quality of Care

A Cochrane review by Gosden et al. (2000) evaluated the effects of different types of physician payment system on health service utilization, health care cost, and patient outcome in primary care. Compared with capitation, fee-for-service resulted in more primary care visits/contacts, visits to specialists and diagnostic and curative services, but fewer hospital referrals and repeat prescriptions. Compliance with the recommended number of visits was higher under fee-for-service compared with capitation payment. In addition, compared with salaried payment, fee-for-service resulted in more patient visits, greater continuity of care, higher compliance with a recommended number of visits, but patients were less satisfied with access to their physician. [186]

Overall, physicians paid through fee-for-service mode have an incentive to see a large number of patients or to provide more procedures. As accessibility to primary care physicians/medical service is particularly essential in optimal asthma care. [187], the important consideration is whether provision of care by physicians paid through fee-for-service would be advantageous in ongoing monitoring for asthma control, compared to other modes of remuneration. [188]

Unfortunately, there is no direct evidence available on the effect of physician remuneration on the quality and outcomes of asthma care. Indirectly, in a controlled trial of the effects of medical insurance on spending and health status, the additional contact with physicians under free care led to better detection and treatment of hypertensives patients not under care at the start of the study. [189]. This suggests that more frequent visits, propagated by a fee-for-service system may result in more frequent monitoring and better outcomes for fee-for-service physicians.

Nevertheless, under some circumstances, physicians paid through fee-for-service may provide care that is either unnecessary or sub-optimal. A Canadian study examined an association between antibiotic prescribing and physician characteristics, in particular remuneration method and patient volume. The result reported that physicians who are paid through fee-for-service payment have a higher rate of antibiotic prescribing, compared to the rate of salaried physicians. Furthermore, increasing patient volume was also associated with higher prescription rates in both payment systems, but the association was much stronger among fee-for-service physicians [190] Similar results were also reported for a study in the US. [191] Thus, while fee-for-service remuneration systems provide incentives for physicians to see a large number of patients, and provide more procedures, patients have relatively short physician encounters. Specifically, insufficient time during patient visits has been reported as one of barriers in adhering asthma practice guideline.[192]

1.6 Clinical Competence and Assessment

1. Overview

The ultimate aim of a physician credentialing process is to assess clinical competence and to select and retain qualified clinicians who will provide safe and high quality of care to patients. In general, medical school focuses on the acquisition of relevant basic science and disease-specific knowledge and clinical judgment; whereas postgraduate education has been provided as a form of service-oriented apprenticeship [193]

2. Assessment of Clinical Competence: Credentialing Examinations

Credentialing examinations are one of several methods employed by medical regulatory authorities to assure the public that physicians are safe and effective practitioners at the time of licensure.[194] There are two types of examinations: licensing examinations that must be passed in order to receive a license to practice, and certification examinations that are taken after specialty training to assess

specific advanced areas of clinical competence (e.g. neurosurgery). Traditionally, credentialing examinations use paper and pencil tests to assess medical knowledge, and clinical decision-making [195]. More recently, standardized clinical performance examinations have been added to licensing examination requirements[196]. These examinations, introduced in Canada as a requirement for licensure in 1992, and in the United States in 2005 assess proficiency in communication, history-taking, and physical examination—additional skills that are essential for safe and effective practice [197].

There are many unanswered questions about the predictive validity of credentialing examinations as there is little research on whether these examinations predict quality of care in future practice. In the US certification literature, a systematic review by Sharp et al (2002) reported that over the half of studies (16 out of 29) showed a positive association between specialty certification (i.e. physicians who applied for and passed a specialty certification examination) and quality of care in practice. [198] Studies after 1999 reported a consistent association between certification status in various specialties and several outcomes, including mortality[199] and quality of care [200] in acute myocardial infarction, mortality in surgery, [201] mortality in anesthesiology,[202], and disciplinary action [203-205]. However, these findings may not reflect the validity of credentialing examinations per se, as specialty certification is optional in most jurisdictions, and more qualified physicians are more likely to take the examination.

In theory, higher scores on credentialing examinations should be associated with better quality of care in practice, as the examination is intended to assess the extent of a physician's knowledge and the appropriateness of medical decision-making for common and important medical problems. While little is known about whether the score achieved on a credentialing exam is associated with quality of future performance, there is some support for this supposition. For instance, higher board certification scores are more likely to lead to higher recertification

score. [206] Within the limited empirical evidence in Canada, higher total scores obtained on the licensing exam at the end of medical school were associated with several future indicators of the quality of practice in primary care, including preventive care, consultation, appropriate prescribing .[207] In addition, physicians who obtained higher scores on both the written and clinical skills components of the licensing examination had up to 50 % lower likelihood of being the subject of complaints in future medical practice.[197]

There is evidence that standardized clinical skills examinations (OSCE: objective structured clinical examination) measure a separate domain of clinical competence that is not assessed by traditional written examinations [208]. The results were reported in several areas of training programms including internal medicine[209], general surgery[210], and pediatrics.[211] A study by Gilson et al (1998) reported that the correlation between traditional written tests and faculty clinical evaluation in third year medical students was as low as 0.10 and 0.32, respectively.[210] Gilson et al (1998) further reported that, among 5 subjects who failed the OSCE exam, only 2 performed very poorly on the written examination (i.e. scored below the 10^{th} percentile nationally). On the other hand, among 13 students who received outstanding scores on the OSCE, only 5 achieved 95^{th} percentile on written examination scores.[210] This observation reinforces the notion that standardized clinical skills examinations provide complimentary information about physicians' clinical competence.

3. Context of Asthma

a. Knowledge and clinical judgment

In general, medical knowledge and clinical judgment skills are the fundamental and critical components of clinical competence [212] They also play two major roles during the patient encounter: 1) correctly evaluating the state of patients' medical condition and 2) determining the quality of medical decision making. [213;214]

There is limited direct evidence about the contribution of medical knowledge and clinical judgment to optimal management of asthma. Previous studies have shown that physicians with specialty training in pulmonary medicine have higher levels of factual knowledge about asthma management. [87] As outlined previously, Doerscug et al (1999) showed that asthma specialists had better knowledge of the NHLBI: Guidelines for the Diagnosis and Management of Asthma [87] Specialty trained physicians are also more likely to provide care that is more consistent with evidence-based asthma practice guidelines,[23;77;121;122] particularly for the use of controller medication. [86;123] Although patients managed by physicians with more training are more likely to have severe asthma, they appear to experience better outcomes, including a reduction in asthma-related hospitalization and emergency room visits and asthma exacerbation[121;124]

b. Communication Skills

Patient-physician communication is an essential component of optimal asthma management. For instance, it is essential to establish ongoing partnerships between physicians and patients to monitor patients' disease status regularly. Follow-up visits for asthma monitoring requires several essential elements of communication, including assessment of symptoms and medication use, discussion of treatment decisions, and provision of education regarding asthma management. Effective communication between patients and physicians likely plays a key role in helping to build patients' confidence and ability to engage in asthma self-management. [215;216] According to Ong et al (1995), effective medical communication between physicians and patients includes the following three main components: inter-personal relationship, information exchange, and making treatment decisions. [73]

Interpersonal relationship

Previous studies have shown that excellent interpersonal skills are associated with optimal asthma management.[73] In one study, careful listening, nonverbal attention, and interactive conversation were associated with positive perception of physician's performance. [217] Specifically, patients who rated their doctors as having more interactive conversation were significantly less likely to experience unscheduled office visits.[217] In addition, patients' ratings of physicians' ease of communication was independently associated with adherence to twice-daily dosing of ICS. [57]

Information exchange

Quality of the information exchange by alternating information-giving and information-seeking between patients and physicians assists in the accurate assessment of asthma status, and, in turn, making optimal treatment decisions.[73] Previous studies reported that the quality of information-giving behavior by physicians has a beneficial impact on asthma management. For instance, patients who report that their physicians were excellent at explaining asthma management were significantly more likely to engage in a regular use of controller medication. [218] In addition, the provision of long-term and short-tem self-management goals by physicians was associated with a reduction of unscheduled office visits and emergency room visit. [217]

However, several studies have shown that the information exchange between patients and physicians is often ineffective. For instance, in order to prescribe ICS, the expertise of physicians plays a critical role in assessing disease severity and prescribing the medication according to the severity assessment. [78] However, the level of agreement between patients' and physicians' perception of asthma control is extremely low. Prieto et al (2007) conducted 4-week follow-up study using 777 asthmatic patients. A low degree of concordance of asthma control was found between physicians and their patients based upon a diary by patients who recorded Peak Expiratory Flow (PEF), symptoms and use of rescue

medication. (Kappa score=0.02; 95% CI:0.01-0.05).[219] There is a tendency for patients to consider their asthma to be in better control than their physicians[220].

Physicians may not be provided with accurate information to assess asthma status. For instance, among 315 caregivers of asthmatic children, approximately 40% of the caregivers denied using controller therapy although their physicians reported prescribing controller therapy.[79] Among 96 asthmatic children with parent-defined mild to severe persistent asthma, only 40% of children was described as their symptom severity accurately, and only 50% of the children were prescribed controller therapy. [78]

There seem to be several factors contributing to ineffective information exchange between physicians and patients. For instance, patient-related factors that negatively affect information exchange include a sub-optimal level of health literacy and health beliefs related to medical treatment,[221] fragmented care delivery involving frequent emergency room visits and no continuous primary care provider.[81] On other hand, physician-related factors, such as a lack of time during office visits, may limit the physician's ability to retrieve essential from their patients. [82]

Some patterns of health care utilization could also inhibit effective communication between patients and physicians. For instance, among 197 asthmatic children aged 2 to 17 years who presented at emergency room for an acute asthma exacerbation in western Michigan, 95% of the patients with multiple visits to emergency room reported having primary care physicians but less than half of the children had attended at least 2 scheduled asthma appointments with their regular asthma care provider in the previous year.[81] Furthermore, even though notification of the family physicians or specialist of an asthma attack is one of the critical components of asthma management, only 4% of patients responded that they would contact their physicians, among inner-city children with asthma with high morbidity and frequent visitors to ER and hospital due to

asthma in the previous years. [82] This pattern of health care utilization may lead to communication barriers due to a lack of vital information of asthma control status, and limit the ability of physicians to accurately assess the effectiveness of treatment.[78]

Treatment decisions

The last essential component of medical communication is to enable physicians and patients to make decisions about treatment through acknowledgment of the complementary expertise and knowledge that patients and physicians bring to the consultation. [215;216] Evidence from studies of a number of chronic illness have shown that patients who rated their physicians as more participatory during treatment decision making are more satisfied with care and are more likely to experience better health outcomes. [106;222] In asthma, previous studies reported that patients who rated their physicians as more participatory during treatment decision were significantly more likely to report a higher quality of life [223] and a higher level of satisfaction with the medical consultation.[224] In addition, a greater propensity to involve patients in treatment decisions was associated with regular use of controller medication, independent of symptom severity, [91] and a reduction of unscheduled office visits. [217]

Chapter 2. Methodological Review for Studying Quality of Care Research

The following chapter provides an overview of the potential bias that could threaten the internal validity of this research project. It also outlines the advantages and challenges of using the administrative databases as well as the overview in the context asthma.

2.1 Challenges in Studying Quality of Care

1. Source of Potential Selection/Participation Bias

a. Overview

The participation rate in epidemiologic studies has declined over the last 30 years. [225] The level of participation in epidemiologic observational studies is highly variable, and is influenced by several characteristics. In general, participation in health research studies may be a surrogate measure of the level of consciousness toward health and the health status of the respondent [226] According to the systematic review by Galea et al (2007), there are the two major predictors: demographics and type and objective of studies. [225]

b. Characteristics of Non-Participation

Regardless of the type of study or mode of data collection, research participants are more likely to have higher educational achievement, be employed, and married. [226;227] In addition, women have a higher likelihood of participating in studies than men.[227;228] On the other hand, age and race/ethnicity have not been systematically shown to influence participation in research studies. [225]

In contrast, lower participation rates are systematically reported for subpopulations with a higher prevalence of risk behaviour, in particular, smoking. [225] For instance, Stang et al (2005) conducted a population-based prospective cardiovascular cohort study based upon a random samples of men and women aged 45-74 years. The comparison of participants of the baseline examination

with non-participants among 4,487 eligible subjects demonstrated that the proportion of current smokers was up to 50% higher in non-participants compared to participants.[229] In addition, Cunradi et al (2005) conducted a longitudinal follow-up study on substance use and socio-demographic factors using self-administered questionnaire among 2838 men and women. The results indicated that baseline tobacco use was significant predictor of attrition from the study (OR=1.63; 95%Cl: 1.37-1.95]. [227] The effect of higher risk behaviour on participation status is highly heterogeneous across previously described demographic characteristics. For instance, Cunradi et al (2005) showed a significant interaction between level of education and drug use. Participants with less than a college education who were also drug users were at over 200% elevated risk for attrition, compared to highly educated without drug use. (OR = 2.39; 95% CI: 1.09-5.28).

Finally, according to Galea et al (2007), particular study characteristics are closely related to participation status. For instance, persons with socially undesirable/stigmatized conditions, such as eating disorder and sexual transmitted disease are less likely to participate in studies. [225;230] On the other hand, a study with a hypothesized exposure that is exogenous in nature, including environmental or occupational exposure is more likely to have higher rates of participation.

2. Source of Potential Information Bias

a. Overview

Self-report has been the most practical and cost-effective method of measurement in epidemiological observational studies to assess a wide range of factors, including demographics, disease status, treatment adherence, beliefs and knowledge. In general, the accuracy of self-report may be either overestimated or underestimated depending upon the extent of social desirability, misunderstanding and/or inability to accurately recall among patients.[231] In addition, the degree of information accuracy involves several other factors, including characteristics of

respondents, type of illness and nature of questions [232], and method of obtaining the responses. [233]

b. Presence of Medical Condition(s)

Variability in the accuracy of self-report has shown to be associated with patient demographics. In general, previous studies have shown that the accuracy of self-report improves with higher levels of education.[233;234] In addition, increased age has shown to be associated with greater accuracy of self-report in relationship with several chronic diseases, including a level of cholesterol,[235] stroke,[236] cardiovascular disease, and blood pressure.[237] There is no consistent effect of gender on self-report accuracy. While several studies reported that there is no gender difference in the accuracy of self-report,[234;238] several other studies reported that female have tendency to report less accurately, compared to males. For instance, Johansson et al (1999) reported that the sensitivity of self-reported hypertension among female is only 29%; whereas it was 69% for males.[239] For stroke, the positive predictive value of self-report for males was 0.88; whereas for females it was 0.73.[236] On the other hand, being female is independently associated with a greater agreement between self-report health problems and medical record documentation of the following chronic disease conditions: heart failure, diabetes, and MI.[240]

Nature and/or severity of the disease are also related with the accuracy of self-report. [237] For instance, Okura et al (2004) demonstrated that chronic disease that requires on-going management, such as hypertension and diabetes, was associated with higher agreement between self-report and medical record documentation of these health problems (Kappa:0.75 and 0.76, respectively). Moreover, a disease involving acute onset of disease associated with recurrent and severe symptoms, such as stroke and myocardial infarction, has also been shown to have the higher agreement between the medical record and self-report(Kappa=0.71 and 0.80, respectively). [240]

Finally, the method and timing of self-report assessment are factors associated with self-report accuracy. In general, in-person interview is more accurate than self-administered questionnaire.[241] In addition, self-report questionnaires administered by postal survey have a higher likelihood of underreporting of medical conditions, compared to telephone interview or home interview. [242] The time period since the occurrence of a particular medical event also impacts on the accuracy of self-report. For instance, Colditz et al (1987) reported on the reproducibility of self-reported age at menopause. Among 31,405 women who were menopausal in 1976, reported age at menopause on consecutive questionnaires showed increasing within-person variance with increasing duration since menopause.[243]

c. Assessment of Medication Utilization/Adherence

Assessment of medication utilization is another important element of quality of care assessment. This assessment requires a valid methodology for identifying the type and extent of medication utilization. As there is no gold standard in measuring medication utilization or medication adherence, there has been a wide range of methods. Some of the most commonly used measurements include: judgement based upon health care professionals opinions or medical record documentation, prescription filling, pill count, electronic measurement devices, canister weights, clinical outcome measures, a measurement based upon blood or urinary samples.[244]

Available measurements can be classified into the two major categories: direct and indirect. Direct measures, including direct observed therapy and measurement of blood or biological marker, are objective and accurate. But, they are not feasible in many situations, are not cost-effective for population studies, and require extensive involvement of health care professionals. Indirect measures include prescription filling, pill count, electronic measurement devices, and canister weights. Similar to other indirect measures, self-report also serves as relatively feasible, and frequently used method in medication utilization

assessment in a large group of patients. However, self-report has a tendency to overestimate actual medication utilization. For instance, Bender et al (2000) conducted a study to compare the four measures of adherence assessment methods: child report, mother report, canister weight, and electronic measurement of metered dose inhaler (MDI) actuation, among 27 children with mild-to-moderate asthma. They concluded that electronic measurement showed the most accurate method of adherence assessment (50% of adherence), followed by canister weight and self-report (69% and 80% of adherence, respectively). [245] In this way, the electronic measurement device, especially in the case of asthma, has been widely used and can provide precise and detailed measurement of medication taking behaviour in clinical situations and several research settings. However, there are other indirect methods of measuring medication adherence that do not document actual ingestion of the correct drug or correct dose. These alternate methods require purchase of a measurement device or extensive patient cooperation which has impeded routine use. [246]

The quality of self-reported drug utilization also varies by several factors, including type of drug, patient demographics, recall interval, duration, and repetitiveness of use. [247] Duration and repetitiveness of use is a distinctive factor that is specific to medication utilization assessment. West et al. (1997) conducted a study to assess recall accuracy for a target drug among a randomly selected sample of men and women aged 50-80 years of age. The study found that recall and the repetitiveness of medication use differed by type of drug. For instance, while only 30% of patients who ever used non-steroidal anti-inflammatory drugs (NSAIDs) recalled the generic or brand name of the target NSAID, 75% of women were able to recall the name of the target estrogen medication, regardless of the generic or the brand name. However, the number of filled prescriptions was positively associated with the recall accuracy; while the number of prescriptions filled was not predictive of recall for estrogens.[247]

2.2 Advantage and Challenge Using Administrative Database

1. Overview

Large population-based administrative database studies can provide effective and efficient opportunities to conduct an investigation, with limited selection and information bias, and without constraints of disease prevalence and of time period. [248] In addition, information on prescription filling provides an accurate measure of overall adherence with some medications as well as medication-specific adherence at multiple points in time.[249]

However, administrative databases have several limitations. First, the prescription database provides information on drugs that were dispensed but this does not necessarily reflect actual usage of the medication. Another limitation of the prescription database involves an inability to determine if a prescription was written but never filled (primary non-adherence). In general, the rate of primary non-adherence varies by several characteristics, including patient age and gender, physician specialty, prescription insurance status, and the day of week when the prescription was written.[250] For asthma, Williams et al (2007) reported the rate of primary non-adherence using electronic prescription information and pharmacy claims data of 1,064 patients. Of these patients, 82 (8%) never filled their ICS prescription, at least within the 3-months after the prescription was written. Factors associated with an increased likelihood of primary nonadherence were: younger age, female sex, African American race-ethnicity, and lower rescue medication use. [141] Information on the prescriptions written as well as those filled would help to determine whether not filling their prescription was due to physicians' non-adherence to asthma clinical guidelines or a failure of patients' in appropriate self-management.

Similarly, administrative databases do not include information on some important potential confounders for asthma morbidity and asthma management, including smoking, lung function, and exposure to triggering factors.[6;19] This may have

an affect on the current study results; however, the degree and its consequence are difficult for us to estimate.

2 .Context of Asthma in Administrative Database

a .Identification of Patients with Asthma

One of the challenges in using administrative databases is the difficulty in identifying patients with asthma. There is no single symptom, physical characteristics, or laboratory test that definitively characterizes a patient as having asthma.[7] Several epidemiological studies have used the reason for the medical visit, coded using the International Classification of Diseases 9th version (ICD-9) diagnostic codes in the medical service claims database, as a marker of physician-diagnosed asthma.[43] However, the validity of the ICD-9 asthma diagnosis code in the Canadian medical services claims data has been shown to have poor to moderate sensitivity but good specificity.[251;252] In contrast, when the utilization of asthma medication from the prescription claims database is used as a marker of asthma, sensitivity is dramatically improved at a cost of lower specificity.[253;254]

b. *Asthma Practice/Prescribing Indicators*

Several practice performance indicators have been identified as markers to assess the quality of asthma drug prescribing using information from administrative databases. First, use of inhaled corticosteroids (ICS) is a critical aspect of optimal asthma management, but ICS use in current asthma management is sub-optimal. As described previously, several studies reported that a lack of the ICS is extremely common among patients, particularly those who were either hospitalized or visited the emergency room. [59-63] Several empirical studies showed that the simple institution of the ICS reduces a likelihood of hospitalization [41;60;255] or ER visits by approximately 50%. [255]

The Health Employer Data and Information Set (HEDIS) is a widely use measure for assessing appropriate prescribing of daily controller medication for patients

with persistent asthma. The measures, developed in 2000, are meant to be consistent with the National Heart, Lung, and Blood Institute (NHLBI) guideline in the United States.[256] The HEDIS criteria identify patients with 'persistent asthma' if there was 1 emergency-department (ED) visit or inpatient discharge listing asthma as the primary diagnosis, ≥4 outpatient asthma visits with 2 medication-dispensing events, or 4 medication-dispensing events in the year prior to the measurement year. To achieve acceptable performance on this measure, members with the "persistent" asthma must fill a prescription for the daily controller medication, including inhaled steroid in the year of evaluation. [256] The ability of HEDIS criteria to predict asthma-related quality of care among patients with persistent asthma has been demonstrated in several studies. For instance, a cross-sectional study conducted in children aged 3-15 years with persistent asthma reported that one of the HEDIS measures, dispensing ICS lowered the risk of subsequent ER visit by 70% (OR=0.3; 95%CI: 0.2-0.4). [255]

Nevertheless, there is evidence to suggest that the HEDIS criteria for classifying persistent asthma may result in high levels of misclassification. According to Berger et al (2004), among 49,637 patients identified as having persistent asthma based upon the HEDIS criteria, 45.9% (n=22,796) did not take any long-term controller medication and 25.5% (n=12,679) did not take any asthma medication. Moreover, the same study reported that a person identified as having persistent asthma using the HEDIS criteria who received at least 1 type of long-term controller medication had a significantly higher asthma-related ER visit/ hospitalization compared to those without any long-term-controller medication (2.5% vs. 1.1%; $p<.001$). [257]

To explore this matter further, Cabana et al (2004) conducted a cross-sectional study to examine an accuracy of HEDIS criteria for measuring persistent asthma using a nation-wide sample of pediatric patients having asthma.[256] Using a interview with their parents, a child, who was classified if he/she has a persistent asthma according to the HEDIS criteria, were also classified as having persistent

asthma based upon National Heart, Lung, and Blood Institute (NHLBI) criteria (having experienced night time asthma symptoms more than 2 nights per month or daytime symptoms more than 2 days per week). As NHLBI criteria was used as a gold standard, the results indicated the combined HEDIS criteria to be fairly sensitive (0.89) but were not very specific (0.70). . This finding may indicate that the HEDIS criteria are overly broad and may result in identifying a large number of patients with mild persistent asthma and those with intermittent disease, who may not require asthma medication or patients adhering and doing well with care. [256]

The third major marker of persistent asthma that has been evaluated is the ratio of controller to reliever asthma medication. However, the accuracy of this approach for measuring asthma persistence has shown conflicting results. Averyard et al.[258], Gottlieb et al.[144] , and Griffiths et al.[259] reported that a lower value of the ratio of controller medication to reliever medication is associated with asthma-related emergency room visits and hospitalization. However, Griffiths et al.[260] and Shelley et al.[261] reported that there was no association between the ratio and hospitalization for asthma, and Fuhlbrigge et al. [262] reported an inverse association between the controller medication to reliever medication ratio and asthma-related emergency room visits.

Finally, the last performance measure is the inhaled corticosteroid (ICS) to total asthma medication (ICS plus fast-acting beta-agonists (FABA) ratio. According to Schatz M et al, who conducted a number of studies to assess the validity of the particular measure, a higher value of this particular ratio has been associated with lower likelihood of asthma-related ER visits/hospitalization and better asthma-related quality of life, and better asthma control, compared to the lower value of the ratio [263;264].

Chapter 3. Summary of Study Rationale and Overall Study Objective

In spite of the development and implementation of evidence-based asthma practice guidelines, sub-optimal asthma management and substantial asthma morbidity impose a significant burden on health care expenditure. Extensive investigation into patient-related barriers has not led to substantial improvements in preventable morbidity. This suggests the necessity for widening the investigation to other key barriers and facilitators of optimal asthma management.

The contribution of physicians to effective management, particularly for out-of-control patients, has not been well understood. Specifically, physician knowledge and clinical skills are the fundamental components of clinical competence and appear to influence the quality of care. However, there has been no robust assessment of this relationship in asthma management as a systematic and objective measurement of clinical competence, including communication ability, has not been available.

A population-wide administrative healthcare database provides an effective and unique opportunity for conducting such an investigation. The availability of information on healthcare services throughout the Canadian health care system would elucidate the contribution of clinical competence as well as other hypothesized key determinants of effective asthma management: physicians, their practice environments, and patients with asthma.

However, identification of patients with asthma imposes a challenge with the use of administrative health care databases due to an absence of single symptoms, physical characteristics, or laboratory tests to characterize a patient as having asthma. Neither information from medical services nor information from prescription claims databases have demonstrated their validity as markers of asthma. A combination of various markers from both databases potentially provides a practical and effective approach to identifying patients with asthma.

This dissertation will address methodological challenges in identifying patients with asthma and advance knowledge on the physician's role in facilitating effective asthma management.

The overall study objectives are:

- To develop an algorithm to identify patients with asthma, based on potential asthma-specific markers, from medical services and prescription claims databases.
- To estimate the extent to which physician characteristics, specifically clinical competence, influenced the quality of asthma management.

Chapter 4. Data Sources

Several data Sources were used in our current assessment and details of each data source are summarized in Table 4.1.

4.1 The Medical Council of Canada (MCC) Qualifying Exam

The Medical Council of Canada (MCC) qualifying exam Part I (QE1) and Part II (QE2) database provides information on overall scores and subscores of each examination component and the number of examination attempts.

a. Medical Council of Canada Qualifying Exam Part I (MCCQE Part I):
MCCQE Part I is a computer-based test that assesses the competence of candidates who have obtained the medical degree for entry into supervised clinical practice in postgraduate training programs with respect to their knowledge, clinical skills and attitudes.

b. Medical Council of Canada Qualifying Exam Part II (MCCQE Part II):
MCCQE Part II is an Objective-Structured Clinical Examination (OSCE) to assess the clinical skills of candidates, specifically communication, data collection (history and physical examination) and clinical management decision-making skills. The exam is taken after a minimum of 12 months' supervised postgraduate training. Both Part I and Part II exam scores have been standardized between administrations to adjust for variation in examination difficulty.

4.2 Canadian Post-graduate Educational Registry (CAPER)

The Canadian Post-graduate Educational Registry (CAPER) provides information on an undergraduate location of medical school training, postgraduate training (type of specialty/training program, location, training completion date) and initial practice location. When these data are not available because of a failure to link files, it will be provided by the respective College of Physicians for candidates whose files are successfully linked by the respective College.

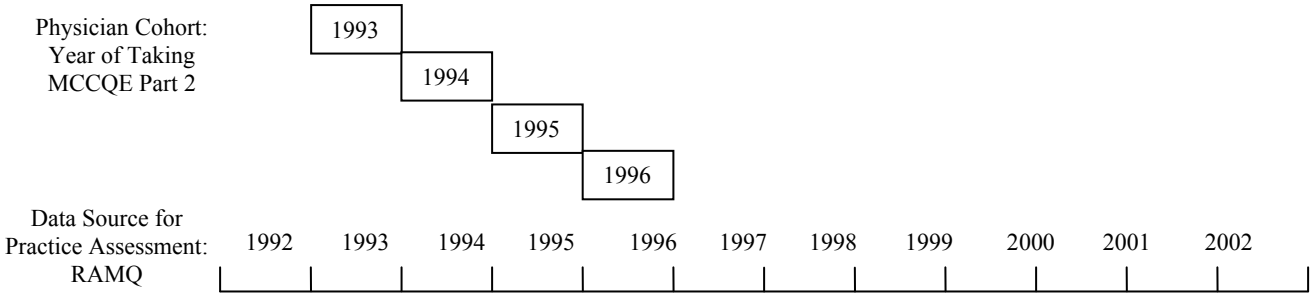
4.3 RAMQ

The provincial health insurance agency (RAMQ) provides first dollar coverage for all medical and hospital care for all Quebec residents. The RAMQ beneficiary demographic database provides data on age, sex, postal code-linked data on income and education based on the 2001 Statistics Canada census. The medical services claims database provides information on the beneficiary, date, type, provider, and location of service delivery (e.g. inpatient, emergency, clinic) for all medical services remunerated on a fee-for-service basis (approximately 86% of all services).[265]

The prescription claims database provides information on each drug dispensed including the drug name, quantity, date and duration for each prescription, the prescribing physician, and the dispensing pharmacy. The provincial drug insurance agency (RAMQ), covers approximately half of the population, including the elderly, welfare recipients, and persons without employer-provided drug insurance.[266] The drug insurance plan database provides name of patients, start and end dates of insurance coverage, and type of insurance plan.

Data retrieved from the RAMQ were used to follow clinical activities of each study physician from the date of entry to practice (earliest date: 1993) to 2003, providing a maximum of 10 years of follow-up for physicians who completed their postgraduate training in 1993 and 1.0 year for graduates who completed 6 years of postgraduate specialty training after taking the Part 2 examination in 1996. (Figure 4.1)

Figure 4.1.



4.4 Database Linkage Process

To protect confidentiality, the respective provincial College of Physician staff used nominal information in the MCC file (age, sex, name, date of birth, medical school) to assign the physician's provincial license number, and then replace the license number with a study identification number that was available to the scientific team. To ensure the confidentiality of individual physicians, the MCC encrypted the examination score files so that College of Physician staff does not have access to information about individual candidates' examination scores without their permission.

Nominal information used for linkage was replaced by an encrypted study number so that the research team did not have confidential information on individual physicians. To assess the association between examination scores and asthma practice outcomes, the research team was provided with files that had encrypted identifiers for study physicians, and the score file de-encryption key. This enabled them to retrieve information on examination scores, linked to individual physicians and practice outcomes, by a unique encrypted physician identifier.

Table 4. 1. Data Source and Years of Date Availability

	Database	Contents	Year
Exam Score	1) MCC QE Part1	1. Overall scores 2. Subscores - Key features - Discipline-specific content areas 3. Number of examination attempts	
	2) MCC QE Part2	1. Overall scores 2. Subscores - communication - data collection - diagnosis - management 3. Case-specific subscores 4. Number of examination attempts	1993-1996
	3) Canadian Post-graduate Educational Registry (CAPER)	1. Undergraduate training location of medical school 2. Postgraduate program 3. Years of postgraduate training 4. Post graduate completion date 5. Practice Location * Information is missing for international graduates?	
RAMQ		1. Beneficiary (patient/ Professional) 2. Medical Service 3. Pharmacy Data 4. Drug Insurance Plan	1993-2003

Chapter 5. Manuscript 1

5.1 Study Rationale

The first article addresses a methodological challenge in identifying asthma patients using administrative health care database. The identification of patients with asthma is one of the challenges in using administrative databases as there is no single symptom, physical characteristic, or laboratory test that definitively characterizes a patient as having asthma.[7] Several epidemiological studies have used the reason for the medical visit, coded using the International Classification of Diseases 9th version (ICD-9) diagnostic codes in the medical service claims database as a marker of physician-diagnosed asthma.[43] However, the validity of the ICD-9 asthma diagnosis codes in the Canadian medical services claims data has been shown to have poor to moderate sensitivity but good specificity.[251;252] In contrast, when the utilization of asthma medication from the prescription claims database is used as a marker of asthma, sensitivity is dramatically improved at a cost of lower specificity.[253;254] Therefore, the combined use of information from the medical service and prescription claims databases is a potential solution to improve sensitivity and specificity of algorithms used to identify patients with asthma.[267]

Our study objective is to develop a viable algorithm to identify patients with asthma, based on potential asthma-specific markers, from medical service and prescription claims databases. Specifically, the study examined the ability of individual and combined asthma-specific markers to identify patients with physician confirmed asthma.

This manuscript is based on the initial exploratory study to verify the visit and diagnosis grouping data. Please see appendix I for the details.

Manuscript 1: Development of an Algorithm to Identify Patients with Asthma in Health Administrative Claims Databases

Y Kawasumi, M Abrahamowicz, P Ernst, R Tamblyn

Abstract

Background
Asthma is a serious public health problem. The predictors of suboptimal asthma management need to be identified to improve patients' control status across the continuum of care. Administrative healthcare databases provide a unique opportunity for such assessment, as they are typically based on the health care activity of a complete census of the population in health care systems such as Canada. However, one of the challenges in using such administrative databases is to accurately identify patients with asthma. A combined use of medical service and prescription claims databases may potentially improve ability in identifying patients with asthma.

Objectives
The study objective is to develop an accurate algorithm to identify patients with asthma, based on potential asthma-specific markers from medical service and prescription claims databases and to evaluate its diagnostic performance.

Methods
1,434 patients with confirmed asthma status were identified from physician's records available through an existing electronic medical record project. Therapeutic indication for electronic prescriptions and the confirmed asthma from an inter-institutional automated problem list were used as the gold standard for physician-confirmed asthma. Multiple logistic regression was employed to estimate the probability of the presence of asthma, using a combination of five groups of asthma-specific markers from administrative databases. A Receiver Operating Characteristic (ROC) curves plotted the range of the cut-off probability of algorithms. C-statistics, sensitivity, specificity, and positive predictive value were used to evaluate algorithm performances.

Results
The algorithm that showed the best performance in discriminating between the patients with asthma and those without it, included indicators from medical service, pharmacy, demographic, and comorbidity markers, The best fitting algorithm had a sensitivity of 71% and a specificity of 93%, and positive predictive value of 62% .

Conclusions
An algorithm using asthma-specific markers from administrative claims databases provided moderate sensitivity and high specificity. Our finding can be used to identify patients with asthma from administrative claims databases for the future assessment of asthma management and its predictors.

Background

Asthma is a chronic health condition which results in avoidable exacerbations of disease and unnecessary health care expenditures.[17] Despite the development and dissemination of asthma clinical guidelines for over a decade, optimal care has not been achieved.[6] While hospital discharge databases have been frequently used for epidemiological research on asthma, this necessarily only provides information on the more severe and most poorly controlled patients.[268] On the other hand, population-based administrative health databases provide the opportunity to identify factors associated with sub-optimal care of asthma in ambulatory care.

In Canada, ambulatory data are routinely collected and available through population based insurance and reimbursement databases. Each province administers an universal health plan for all eligible residents. Payment of physicians on a fee-for service basis provides a record of each service delivered to a beneficiary. In addition, provincial-specific drug insurance programs provide information on drugs dispensed from community pharmacists for each beneficiary. These data can be used to create a longitudinal record of medical services and prescription drug use by linking information for an individual using an encrypted health care number.

One of the challenges in using such administrative databases to identify predictors of poor health outcomes is the difficulty in accurately identifying patients with asthma. Several epidemiological studies have used the reason for the medical visit, coded using the International Classification of Diseases 9th version (ICD-9) diagnostic codes in the medical service claims database, as a marker of physician-diagnosed asthma.[43] However, the validity of the ICD-9 asthma diagnosis codes in the Canadian medical services claims data have been shown to have poor to moderate sensitivity in spite of good specificity.[251;252] In contrast, when the utilization of asthma medication from the prescription claims database is used

as a marker of asthma, sensitivity is dramatically improved at a cost of a substantial decrease in specificity.[253;254;269]

The combined use of information from the medical service and prescription claims databases provides a potential way to simultaneously improve sensitivity and specificity in identifying patients with asthma. This particular approach has been used in identifying patients in another medical condition but not for asthma. [267]

Study Objective

Our study objective is to develop an accurate algorithm to identify patients with asthma based on potential asthma-specific markers available in medical service and prescription claims databases. Specifically, we will assess and compare the performance of individual and combined asthma-specific markers in identifying patients with physician-confirmed asthma.

3. Methodology

Study Design and Population

From January 2003 to October 2005 we identified a fixed cohort of patients, 5 to 65 years old, for whom the diagnosis of asthma was confirmed by their primary care physicians. Physicians and patients were recruited from an existing electronic health record and prescription project.[270] Administrative database indicators for the study patients were created using data from the Quebec provincial health insurance agency (RAMQ) for the 12 month period from November 2004 to October 2005. We restricted the patient population to those continuously covered by the RAMQ drug plan during the study period in order to have complete information on prescribed medication. To avoid misclassifying patients, we excluded patients with chronic obstructive pulmonary disease (COPD) using information in the electronic health record problem list as well as the following ICD9 diagnostic codes in the RAMQ medical service file: 490.x, 491.x, 492.x 494.x, 495.x, 496.x, 500.x, 501.x, 503.x, 504.x, 505.x, and 506.4.

Physician Confirmed Asthma Status

The Medical Office of the Twenty First Century (MOXXI) system is an electronic prescription and drug management system for primary care physicians, community-based pharmacists and their 15,398 consenting patients in Montreal, Quebec. The MOXXI system allows physicians to write prescriptions electronically and retrieve information on dispensed prescriptions, diagnostic codes and dates of all medical visits recorded for a patient from the health insurance program and community pharmacy network.

Two sources of information from the MOXXI system were used to confirm patients' asthma status. The first is the automated problem list. The problem list generates potential patient-specific medical conditions based upon two sources of information. Daily downloads of all newly reported ICD-9 diagnosis codes are retrieved from the medical service database and transformed into text-based health problems. The provincial drug and health insurance database was used to identify health problems associated with single-indication drugs that are dispensed to the patient.

For each patient, the generated potential list of patient-specific medical conditions is presented to the study physicians at the time they open the patient file in the MOXXI system. Study physicians are prompted to verify the status of the generated potential medical conditions as "confirmed", "rejected", or have it remained as a potential problem.

The second source of information was the electronic prescription. To complete each electronic prescription, the physician must select a therapeutic indication. The therapeutic indication of asthma is included in drug-specific drop down menus for all inhaled corticosteroids, fast acting beta-agonists, long-acting beta-agonists, leukotrienes, and oral corticosteroids.

Using these two sources of information, patients were considered to have asthma on the basis of the following criteria. First, asthma was generated as one of the

medical conditions in the problem list and the status was either confirmed or yet to be confirmed by a study physician from January 2003 to October 2005. When the status of asthma in the problem list is "yet to be confirmed", we searched at least one written electronic prescription from January 2003 to October 2005. The second criterion was established to ensure that study physicians had had an opportunity to acknowledge the condition: 'asthma' in the generated medical condition(s) of a given patient, and we assumed that the study physician chose not respond to the status.

Patients were considered 'not having asthma' according to the following two criteria during the same time period. First, asthma was generated as one of the medical conditions in the problem list but the status was rejected by a study physician. Among patients' asthma status were rejected, we excluded patients who also received an electronic prescription with therapeutic indication of asthma. Second, there were no records of asthma as a generated medication condition in the problem list AND physicians had at least one opportunity to write electronic prescription without a therapeutic indication of asthma.

4. Administrative Database Indicators

Data Sources

The provincial health insurance agency (RAMQ) provides first dollar coverage for all medical and hospital care for all Quebec residents. The medical services claims database provides information on the beneficiary, date, type, provider, diagnosis (ICD9 classification) and location of service delivery (e.g. inpatient, emergency, clinic) for all medical services remunerated on a fee-for-service basis (approximately 86% of all services).[265] The health beneficiary demographic database provides information on age, sex, and postal code for each patient. The prescription claims database provides information on each drug dispensed including the drug name, quantity, date and duration for each prescription, the prescribing physician, and the dispensing pharmacy. Beneficiary and physicians identification were encrypted.

Identification of Patients with Asthma

We assessed five groups of asthma indicators from the RAMQ database based on the data from November 2004 to October 2005.

(1) Medical Service Database Indicators

We examined three measures from the medical services claims file indicating respiratory care: number of asthma-related visits to primary care physicians (see table 5.2.1 for ICD-9 diagnostic codes from medical services file); number of asthma-related visits (see table 5.2.1) to respiratory-related specialists (respirologists, allergists, medical internists, or pediatricians, and pulmonary function testing from the appropriate procedure codes in the medical services file. An assessment of asthma-related visits was measured by physician specialty as there is a difference in the process and outcome of care for asthma between primary care physicians and respiratory-related specialists is widely recognized.[70;86;121;271]

(2) Asthma Prescription Indicators

Number of controller medications used was defined as the number of the prescriptions dispensed for: inhaled corticosteroids, long-acting beta-agonists, and leukotriene receptor antagonists from November 2004 to October 2005 (Table 5.2.1) *Number of rescue medications use* was defined as the number of prescriptions of short-acting beta-agonists from November 2004 to October 2005. (Table 5.2.1) The information of dispensation date and supply days in the prescription claims file was used to determine the start date and the expected end date of each prescription. Prescriptions were considered 'active' if the time period between the starting date and the expected end date of a given prescription overlapped with the time period between November 1st, 2004 and October 31st, 2005. The identified prescriptions of the two types of asthma medications was counted for each patient.

(3) Asthma-related Covariate Indicators

a. Demographics

A number of studies reported that asthma prevalence and severity, as well as asthma disease management varies by age and gender.[272-274] The information on patient's age and gender were identified from the health beneficiary demographic database in the RAMQ for each patient.

b. Co-morbidity conditions

Three categories of medical condition: 'upper airways conditions', 'somatic complaints/neurotic disorder', and 'cardiac-related conditions' were created to investigate *whether inclusion or exclusion of these condition would* increase the likelihood of identifying the presence of asthma based upon the following three underlying mechanisms: pathophysiological model [275], maladaptive illness behaviour model[276], and confusing origins of chest pain [277], respectively.

The pathophysiological model attempts to explain a direct or indirect biologic relationship between asthma and upper airways conditions.[275] Thus, we hypothesized that the presence of upper airway conditions would increase the likelihood of having asthma. In addition, the maladaptive illness behavior model hypothesizes that there may be a greater likelihood of having physician-confirmed asthma if there was a greater tendency to exhibit maladaptive and suboptimal patterns of illness coping behaviors.[276]

Finally, a presence of cardiac conditions in a patient often creates an extra challenge for health care professionals to confirm asthma status because the 'cardiac conditions' can be often confused in differentiating the chest pain caused by cardiac from pulmonary problems.[278] Thus, we hypothesized that an absence of cardiac condition would increase the likelihood of having a confirmed asthma diagnosis. ICD-9 diagnosis codes in the medical services file for each patient were used to identify the presence of each of the three co-morbidities categories from November 2004 to October 2005. (Table 5.2.1)

c. Health Care System Utilization Indicators

Two measures: 1) total number of health care visits and 2) number of physicians seen, were used to explore if the likelihood of identifying patients with asthma would increase as the number of encounters with health care professionals increased.[279] *Total Number of Health Care Visits* was defined as the number of days on which a patient received medical service in any health care setting. The dates of each visit or procedure in the medical services claim file, from November 2004 to October2005, was used to produce a count for each patient. *Number of physicians seen* was defined as the number of different physicians who provided medical services for a given patient during the same time period. The provider's identification number in the medical services claims database was used to produce a count for each patient.

5. Identification of Patients with Severe Asthma

Asthma-related hospitalization and emergency room visits reflect the presence of severe, uncontrolled, or progressive disease.[100;280;281] For the assessment of asthma quality of care, it is essential to evaluate the predictive ability of an algorithm to identify patients who experience serious adverse asthma outcomes. *Patients with severe asthma* were defined as those who received medical services in an emergency room or were hospitalized for an asthma-related condition for at least one day during the follow-up period. The service location code and date in the RAMQ medical service claims database were used to identify these events. A dichotomous variable (yes/no) was created for each patient who experienced at least one asthma-related hospitalization and/or emergency room visit during the study period.

5. Statistical Analysis

Descriptive statistics were used to characterize the study population and to evaluate differences in the distribution of each asthma-specific marker between asthma patients and patients without asthma. Multi-variable logistic regression was used to estimate the probability of the presence of asthma as a function of relevant indicators developed from administrative databases. The hypothesized indicators were grouped into five categories: asthma-specific health service use, asthma-specific medication utilization, comorbidity, demographics, and overall health services utilization.

Several criteria were used to assess the optimal combination of indicators and the incremental value of each regression model. The C-statistic, representing the area under the receiver operating characteristic curve, was used to evaluate the ability of the identified algorithm to correctly classify subjects according to asthma status. [282] An area of 1 represents an algorithm with perfect sensitivity and specificity, while an area of 0.5 represents a 'random' classification without any explanatory capacities. The C-statistics from different models were compared using a nonparametric test for pair-wise comparisons, proposed by DeLong et al., which

accounts for correlation between the curves.[283] Akaike Information Criteria (AIC) were used to assess the goodness-of-fit to the data while taking into account the number of independent variables in the models to avoid potential overfitting.[284]

In addition, based on the results of each regression model, we constructed a receiver operating characteristic (ROC) curve by plotting sensitivity against the false-positive rate (1-specificity) over the range of cut-off values for the estimated probability of the presence of asthma. The optimal cut-off point for the probability was selected by evaluating the upper left hand corner of the graph, to correspond to a combination of maximum gain of sensitivity with a minimum reduction in specificity. Sensitivity, specificity, and positive predictive values were evaluated on the basis of the identified optimal cut-off for the probability of "having asthma".

The probability of the presence of asthma was calculated based on the estimated multiple logistic regression models. The optimal cut-off point for the probability of the presence of asthma was used to evaluate the number of patients with severe asthma, who would have been identified using a given algorithm. Based on this number, we evaluated the performance of diagnostic algorithm in identifying patients with severe asthma.

6. Results

6.1 Study Population

In total, 1,434 patients were included in our study. Table 5.2.2 shows asthma classification status according to the two gold standards: automated problem list and electronic prescription. 202 patients (14.1 %) were identified as 'having asthma', and 1,232 patients (85.9%) as 'not having asthma'. Patient characteristics by asthma status are shown in Table 5.2.3. Patients with asthma were more likely to be younger and female. As expected, patients with asthma showed a greater tendency of having asthma-related medical visits and asthma

drug use during the study follow-up period. Among the three groups of comorbidity conditions considered, the prevalence of neurotic disorder/somatic complaints and upper airway conditions were slightly higher in patients with asthma. On the other hand, patients with asthma showed a slightly increased tendency of having fragmented care as they were more likely to see a greater number of unique physicians and had more health care visits during the follow-up period. (Table 5.2.3)

6.2 Multivariable Logistic Regression Analysis

Table 5.2.4 presents the incremental value of each of the five indicators in the logistic models in relationship with the presence of asthma. The use of controller medication was the strongest predictor of identifying patients with asthma (OR=49.0 for 1 dispensed controller medication and OR=50.0 for $\geq$2 dispensed controller medication), followed by the use of rescue medication (OR=9.29 for 1 dispensed rescue medication and OR= 40.7 for $\geq$2 dispensed rescued medication). Overall, there was little change in odds ratios for medication use even after adjusting for other groups of indicators.

Among indicators of asthma-related health service use, visits to general practitioners was predictive. Specifically, patients who had more than three visits to general practitioners for asthma related conditions during the follow-up visits were 7.9 times more likely to have asthma, compared to patients without any visits to general practitioners for asthma related conditions (95%CI: 1.62-38.6). Furthermore, patients without cardiac-related conditions were nearly 5 times more likely to have asthma (OR=4.88; 95%CI: 1.72-13.8). In addition, increasing number of unique physician (per 1 MD) was associated with approximately 10% increased likelihood of having asthma (OR=1.09; 95%: 1.01-1.18). None of the other potential predictors had statistically significant associations with the presence of asthma. Finally, AIC values of the four logistic models were compared, and the results indicated that Model 3 (AIC=697) and Model 4 (AIC=696.2) had the best fit to data. (Table 5.2.4)

6.3 Diagnostic Performance

Table 5.2.5 presents the diagnostic performance of each of the four logistic models shown in Table 5.2.4. The addition of prescription claims-based indicators to medical services indicators resulted in a significant increase in the c statistics (0.658 to 0.822; $p<0.01$). Inclusion of other indicators to the model yielded very small improvements in the values of c-statistics. The incremental value of adding comorbidity indicators to model 1 was statistically significant ($p<0.05$); however, inclusion of either the demographic or health service utilization indicators to model 2 did not produce statistically significant increases in c-statistics.

The ROC curves obtained from each logistic model are compared in Figure 5.2.1. Based upon the ROC curves, the optimal probability cut-offs were identified, and the resulting sensitivity, specificity, and positive predictive values were estimated.(Table 5.2.5) As presented in Table 5.2.5, inclusion of additional indicators gradually increased the levels of sensitivity, specificity, and positive predictive value. Comparing the diagnostic performance of all the models, the logistic Model 3 indicated the best performance in discriminating between the patients with asthma and patients without asthma. The corresponding 'optimal' cut-off was estimated at 0.128 (Table 5.2.5), suggesting that any patients with probability of asthma estimated from model 3 above 0.128 should be considered as 'having asthma'. In spite of the low cut-off, the sensitivity of the resulting diagnosis criteria (0.708) is considerably lower than that specificity (0.929) and the PPV is only moderate (0.622).

Model 3 also showed the best performance in correctly identifying patients with severe asthma. Using the probability cut-off of 0.128 estimated based on Model 3, 17 out of 18 patients with severe asthma were correctly identified (sensitivity=0.94); whereas a number of falsely identified patients with severe asthma were reduced to 6 out of 47 patients.(Specificity=87.2), resulting in PPV=0.739. (Table 5.2.5)

7. Discussion

The availability of administrative health care databases creates an extremely valuable opportunity for researchers to capture and assess a wide range of clinical information at the population level in a cost-effective manner. As asthma continues to be a serious public health problem, administrative health care databases have a great advantage, as they provide a method to monitor quality of care and monitor asthma patients' control status throughout the health care continuum. In achieving this objective, this study identified an algorithm to accurately identify patients' asthma status to enable optimal use of administrative databases for this purpose.

The present study illustrated that use of a broad spectrum of indicators from administrative health care database helps to correctly discriminate between patients with and without asthma. The combined use of asthma-specific indicators from medical services claims and asthma-related medication use showed a sensitivity of 69.3% and specificity of 90.7%. In addition, ROC curves indicated that the combination of asthma-specific indicators from medical services claims and asthma-related medication utilization from prescription claims showed a better classification of asthma status, compared to the model with either prescription claims or medical service claims alone.

Previous studies reported that there is a difference between patients with an asthma diagnosis alone and patients who receive prescription medication for asthma. For instance, one of the major barriers in achieving optimal asthma management is sub-optimal use of asthma medication among patients with a diagnosis of asthma or asthma-related conditions. It is likely that both physician and patients may contribute to under use of control medication. [78] Riekert et al reported that, even among children experiencing persistent symptoms of asthma, only 42% of their primary asthma care physicians prescribe controller medication for asthma. [79] Moreover, even when asthma medication is prescribed by physicians, nearly one third of the prescriptions are not filled by patients within 1-

year period.[285]

On the other hand, 20-40% of patients who receive a prescription for asthma medications do not have a record of either asthma or asthma-like diagnosis. [286-289] This particular mismatch is complex; however, it could be related to a distinctive pattern of health service use by patients. For instance, Yeatter et al reported that 7% of children with current asthma-related medications but no diagnosis of asthma are likely to visit the emergency room for asthma-related conditions. [290] The combined use of medical and pharmacy claims file have a particular advantage in identifying a wide range of patients with asthma who represent very different aspects of the spectrum of asthma management.

Another major and unique finding of the current study is that other patient characteristics, including comorbidity, demographic characteristics, and health service utilization patterns, improved the ability to discriminate patients with asthma and those without. Specifically, inclusion of the covariate indicators contributed to further improve specificity only. The same finding was also observed in identification of patients with severe asthma.

The inclusion of comorbidity indicators in the algorithm showed a slight improvement in predicting the presence of asthma. The number of patients who were falsely identified as asthmatics in an algorithm using asthma-specific indicators from medical services and pharmacy claims file were reduced from 115 to 99 (specificity: 90.7% and 91.7%, respectively). The performance in identifying patients with severe asthma also showed similar results. (Table 5.2.5)

Over 50% of patients with asthma suffer from one or more disease conditions, in addition to asthma.[291;292] Three mechanisms were hypothesized that might explain an association between the presence of asthma and three categories of medical conditions: ‘upper airways conditions’, ‘somatic complaints/neurotic disorder’, and ‘cardiac conditions’.

First, pathophysiological mechanisms may explain the relationship between the presence of asthma and upper airway conditions based upon a direct or indirect biologic relationship.[275] For example, an association between the presence of asthma and "upper airway conditions", such as sinusitis has been widely recognized.[293] Although an establishment of underlying biological mechanism of the relationship between asthma and upper airway conditions is still part of ongoing investigation, the mechanism is likely to be associated with the inflammatory process of the airways as several studies have shown an improvement of asthma control with treatment with anti-inflammatory medication for conditions, including otitis media, sinusitis, and allergic rhinitis.[275] The likelihood of having an asthma diagnosis also increases approximately 2-12 times when the concomitant conditions of sinusitis, rhinitis, or otitis media are present.[275]

Second, we hypothesized that the presence of 'neurotic disorder/somatic complaint' may be associated with the presence of asthma.[276] A number of studies demonstrated an association between asthma and somatic complaints, including headache/migraine[294], low- back pain,[294] fatigue and dizziness,[277] and neurotic disorder.[295] There are several potential pathways to explain this relationship. For instance, asthma patients may be more likely to experience the physical symptoms or distress from physiological change due to airway inflammation and symptoms.[296] Alternatively, some patients may experience physical symptoms or distress as a result of the difficulties in achieving optimal asthma control. Either way, those who experience these somatic symptoms or distress may have a tendency to exhibit a variety of maladaptive illness coping behavior, including excessive level of symptom reporting, request for medical test/investigation, and excessive outpatients visits, which may create additional opportunities to identify whether the patient has asthma or not [297] However, our study showed that strength of association between the presence of asthma and the presence of these comorbidity conditions was relatively small.

On the other hand, the absence of cardiac-related conditions was one of the major discriminating predictors of patients with asthma from those without it. The clinical features of chest tightness or chest pain is a common clinical complaint in a primary care setting,[298] It is widely recognized that physicians have difficulty in differentiating chest pain caused by cardiac from pulmonary problems.[277;278] Therefore, our finding may suggest that an absence of the cardiac related symptoms may have facilitated a confirmation of patients as having asthma.

Demographic characteristics, patient age and gender, are likely to be associated with asthma prevalence and severity and various components of asthma disease management.[272-274] Further improvement in the specificity of the algorithm to identify the presence of asthma was observed with the inclusion of demographic characteristics in the algorithm, but addition of these variables failed to reach statistical significance.

There are several limitations that need to be recognized in interpreting our results. Although we evaluated algorithm performances in identifying patients with severe asthma, patients with an optimal cut-off probability as low as 0.128, may represent various types of patients with asthma. For instance, it is possible that patients whose asthma is well controlled may have higher probability than those who have a difficulty in achieving optimal level of asthma control.

In addition, the optimal cut-off point for the best-fitting algorithm provides a sensitivity of 70.8% and specificity level of 92.9%. Therefore, our algorithm fails to identify approximately 30% of patients who were identified as “having asthma” using our gold standard. One of the potential explanations for this particular finding is the absence of any major asthma-specific indicators in the algorithms for those patients. We defined “having asthma’ for the gold standard based upon an approximately 3 years’ worth of information from January 2003 to October 2005. On the other hand, algorithm indicators were developed from administrative database based on the 12-month period from November 2004 to

October 2005. According to Ernst et al, [299] 23% of patients with asthma who are initially treated with therapy appropriate for mild asthma are rarely treated with therapy when followed up to 5 years. Therefore, asthma severity as well as an intensity of treatment may have changed over time among patients whose asthma was confirmed earlier in the study period.

Medical care for asthma is delivered by both general practitioners and specialists, but only a small proportion of patients with asthma receive care from both. [86] Patients who are seen by specialists are more likely to have severe asthma, be older, be a regular user of anti-asthma medication, be less likely to visit the emergency room for their asthma exacerbations, compared to patients who are cared by general practitioners. [121] In the present study, a gold standard was established based on the confirmation of asthma status by physicians in the Quebec primary care network. Thus, our finding may not be generalizable to patients whose asthma is cared solely by respiratory-related specialists.

According to current evidence, asthma varies by patient age. The distinctive difference between children and adult asthmatics has been especially demonstrated for hospital admissions[13], and inhaled corticosteroid use [138]. Such differences may reflect the differences in several relevant factors in achieving optimal control, including underlying biology[20], health care service utilization patterns [138], barriers in engaging in optimal self-management[300;301], or the quality of communication between physician and patients/caregivers [302]. The distinctive clinical profile that is specific to each age group in various aspects of asthma management may contribute differently to the age-specific level of sensitivity and sensitivity in the identification of patients with asthma. Future research should take into account age differences as this may improve the diagnostic performance of the algorithm in identifying patients with asthma.

Finally, the predictive ability of our algorithm may be overestimated as it was developed and tested in the same population of patients. Future research should

test the performance of this asthma case identification algorithm in different datasets, and with populations of patients seen by both generalists and specialists. In conclusion, the current study demonstrated an extremely useful and practical approach of using administrative claims databases to identify patients with asthma.[269;303] Using ROC curves, we identified the optimal cut-off of discriminating patients with asthma and those without. Our findings can be used to identify patients with asthma from administrative claims databases for the future assessment of asthma management and its predictors.

Table 5.2.1. A List of ICD9 Diagnostic Codes and Asthma Medication

1. ICD9 Diagnosis Codes of Asthma-related Conditions:

493.0-9:	Asthma
465.9:	Acute Upper Respiratory Infection
466.0-9:	Acute Bronchitis
786.0:	Dyspnea & Respiratory Abnormalities
786.1:	Stridor
786.4:	Abnormal Sputum
786.5:	Chest Pain
786.7:	Abnormal Chest Sounds
786.9:	Other Symptoms involving Respiratory System and Chest

2. ICD9 Diagnosis Code of Comorbidity Indicators

(1) Cardiac related Conditions:

413.9:	Other and Unspecified Angina Pectoris
427.9:	Cardiac Dysrhythmia, Unspecified
786.5:	Chest Pain
785.1:	Palpitations

(2) Neurotic Disorder/ Somatic Complaints:

724.2	Lumbago
784.0	Headache
780.7	Malaise and Fatigue
780.4	Dizziness and Giddiness
300.9	Unspecified Neurotic Disorder

(3) Upper Airway Conditions:

786.2	Cough
461.9	Acute Sinusitis, Unspecified
477.9	Allergic Rhinitis, Cause Unspecified
382.9	Unspecified Otitis Media
372.3	Other and Unspecified Conjunctivitis

3. List of Asthma Medication

(1) Controller Medication

a. Inhaled Corticosteroid: Beclomethasone, Budesonide, Fluticasone, Belcomethasone
b. Long-acting beta-agonist: Salmeterol, Formoterol
c. Leukotriene: Zafirlukast, Montelukast
d. Combination Medication: Salmeterol+Fluticasone, Formterol+Budesonide

(2) Rescue Medication: Fenoterol, Terbutaline, Salbutamol

Table.5.2.2 Asthma Classification Status based upon the Two Gold Standards

			b) Electronic Prescription (Erx) with Asthma Indication		
				No	
			Yes (n=202)	>1 Erx without Asthma Indication (n=1,369)	No Records for Electronic Prescriptions (n-939)
a) Problem List	Confirmation Status	Confirmed as Yes (n=144)	48	81	15
		Confirmed as No (n=24)	1	22	1
		Not Yet Confirmed (n=175)	1	57	117
		No Record (n=2,015)	0	1209	806

: Asthma Present (n=202)

: Asthma Absent (n=1,232)

Table 5.2.3 Characteristics of Study Patients by Confirmed Asthma Status (n=1,434)

	Patients with Asthma (n=202) n (%)	Patients without Asthma (n=1,232) n (%)	p-value[4]
Patient Demographics			
Age; mean [SD; Range]	47.7 [14.2;6-65]	50.2 (13.0; 5-65)	0.012
Gender, Female	143 (70.8)	785 (63.7)	0.051
Medical Service File Indicators			
# of Visit to General Practitioners, mean [SD; Range]	0.70 [1.28;0-7]	0.16 [0.90;0-27]	0.017
0	126 (62.4%)	1109 (89.8%)	<0.001
1	47 (23.3%)	92 (7.5%)	
2	13 (6.4%)	23 (1.9%)	
>3	16 (7.9%)	8 (0.7%)	
# of Visit to Respiratory-related Specialists[1], mean [SD; Range]	0.11 [0.56;0-5]	0.04 [0.38;0-8]	0.050
0	190 (94.1%)	1212 (98.4%)	0.043
≥1	12 (5.9%)	20 (1.6%)	
Pulmonary Function Test			
Yes	2 (1.0%)	9 (0.7%)	0.797
Prescription Claims File Indicators			
# of Controller Medication[2] Dispensed, mean [SD; Range]	2.45 [4.8;0-27]	0.04 [0.65;0-20]	<0.001
0	96 (47.5%)	1220 (99.0%)	<0.001
1	47 (23.3%)	7 (0.6%)	
≥2	59 (29.2%)	5 (0.4%)	
# of Rescue Medication[3] Dispensed, mean [SD; Range]	1.56 [3.05;0-15]	0.02 [0.17;0-3]	<0.001
0	117 (57.9%)	1213 (98.5%)	<0.001
1	32 (15.8%)	16 (1.3%)	
≥2	53 (26.2%)	3 (0.2%)	
Co-morbidity Indicators			
Cardiac related Conditions	15 (7.4%)	96 (7.8%)	0.857
Neurotic Disorder/Somatic Complaints	27 (13.4%)	122 (9.9%)	0.135
Upper Airway Conditions	31 (15.4%)	82 (6.7%)	<0.001
Health Service Utilization Indicators			
# of Unique MD Seen, mean [SD; Range]	6.26 [5.30;1-37]	4.60 [4.85; 1-69]	<0.001
# of Health Care Visits, mean [SD; Range]	11.3 [10.7;1-81]	8.50 [10.2;1-155]	<0.001
Number of Patients with Severe Asthma	18 (0.09)	49 (0.04)	

1. Respiratory-related specialists includes respirologist, allergist, medical internist, and pediatricians
2. Control medical includes Inhaled Corticosteroid (Beclomethasone, Budesonide, Fluticasone, Belcomethasone), Long-acting beta-agonist (Salmeterol, Formoterol), Leukotriene (Zafirlukast, Montelukast), and combination medication (Salmeterol+Fluticasone), (Formterol+Budesonide).
3. Rescue medication includes Fenoterol, Terbutaline, and Salbutamol
4. p-value indicated the result of chi-square test for categorical variable and student t-test for continuous variable

Table 5.2.4. Results of Multivariable Logistic Regression Models in Identifying Patients with Asthma Using Indicators from Health Care Administrative Database and their Independent Contribution of Each Indicator

Type of Indicators	Variables	Logistic Regression Grouped by Type of Indicators		Multivariable Logistic Regression							
				Model 1		Model 2		Model 3		Model 4	
		OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95%CI)	OR	(95% CI)
Medical Services	**Number of GP Visits:**										
	No Visits (Reference)	--	--	--	--	--	--	--	--	--	--
	1 Visits	4.40	(2.95-6.57)	2.67	(1.53-4.66)	3.57	(1.99-4.22)	3.53	(1.95-6.38)	3.48	(1.92-6.30)
	2 Visits	4.94	(2.43-10.0)	0.91	(0.26-3.15)	1.95	(0.46-8.20)	1.83	(0.43-7.83)	1.86	(0.42-8.20)
	≥3 Visits	16.7	(6.96-40.1)	5.22	(1.42-19.2)	11.8	(2.61-53.4)	11.1	(2.43-50.6)	7.90	(1.62-38.6)
	Number of Specialists Visits:										
	No Visits (Reference)	--	--	--	--	--	--	--	--	--	--
	≥1 Visits	3.74	(1.55-9.02)	0.91	(0.26-3.15)	0.91	(0.21-3.87)	0.92	(0.21-4.10)	0.85	(0.19-3.78)
	Pulmonary Function Test:										
	No Tests (Reference)	--	--	--	--	--	--	--	--	--	--
	≥1 Tests	0.51	(0.09-2.93)	0.36	(0.03-4.53)	0.33	(0.03-4.19)	0.30	(0.03-3.68)	0.32	(0.03-3.63)
Prescription Claims	**# of Controller Medication Dispensed:**										
	Never (Reference)	--	--	--	--	--	--	--	--	--	--
	1	50.2	(21.2-119)	46.1	(19.2-110)	43.7	(17.7-107)	51.4	(20.4-129)	49.0	(19.5-123)
	≥2	52.1	(19.0-142)	41.4	(14.3-119)	37.6	(12.8-110)	46.9	(15.6-141)	50.0	(16.3-153)
	# of Rescue Medication Dispensed:										
	Never (Reference)	--	--	--	--	--	--	--	--	--	--
	1	9.52	(4.31-21.0)	7.71	(3.35-17.8)	8.91	(3.79-20.9)	8.91	(3.76-21.1)	9.29	(3.90-22.1)
	≥2	36.5	(9.62-138)	39.6	(9.53-164)	41.7	(9.43-184)	39.5	(8.78-177)	40.7	(9.00-184)
Co-morbidities	**Absence of Cardiac related Conditions**	1.10	(0.62-1.94)			4.34	(1.62-11.7)	3.93	(1.44-10.7)	4.88	(1.72-13.8)
	Presence of Neurotic Disorder/ Somatic Complaints:	2.51	(1.61-3.92)			1.20	(0.63-2.31)	1.24	(0.64-2.39)	1.21	(0.62-2.38)
	Presence of Upper Airway Conditions	1.10	(1.61-3.92)			1.88	(0.96-3.68)	1.66	(0.84-3.30)	1.61	(0.81-3.21)
Age Gender	**Age: in years**	0.99	(0.98-0.99)					0.98	(0.96-0.99)	0.98	(0.96-0.99)
	Gender: Female	1.36	(0.98-1.88)					0.83	(0.53-1.29)	0.79	(0.51-1.23)
Health Service Usage	**Total Number of Health Care Visits**	0.99	(0.96-1.02)							0.97	(0.93-1.01)
	Number of Unique Physicians Seen	1.07	(1.01-1.13)							1.09	(1.01-1.18)
		AIC[1]		708.6		700.8		697.0		696.2	

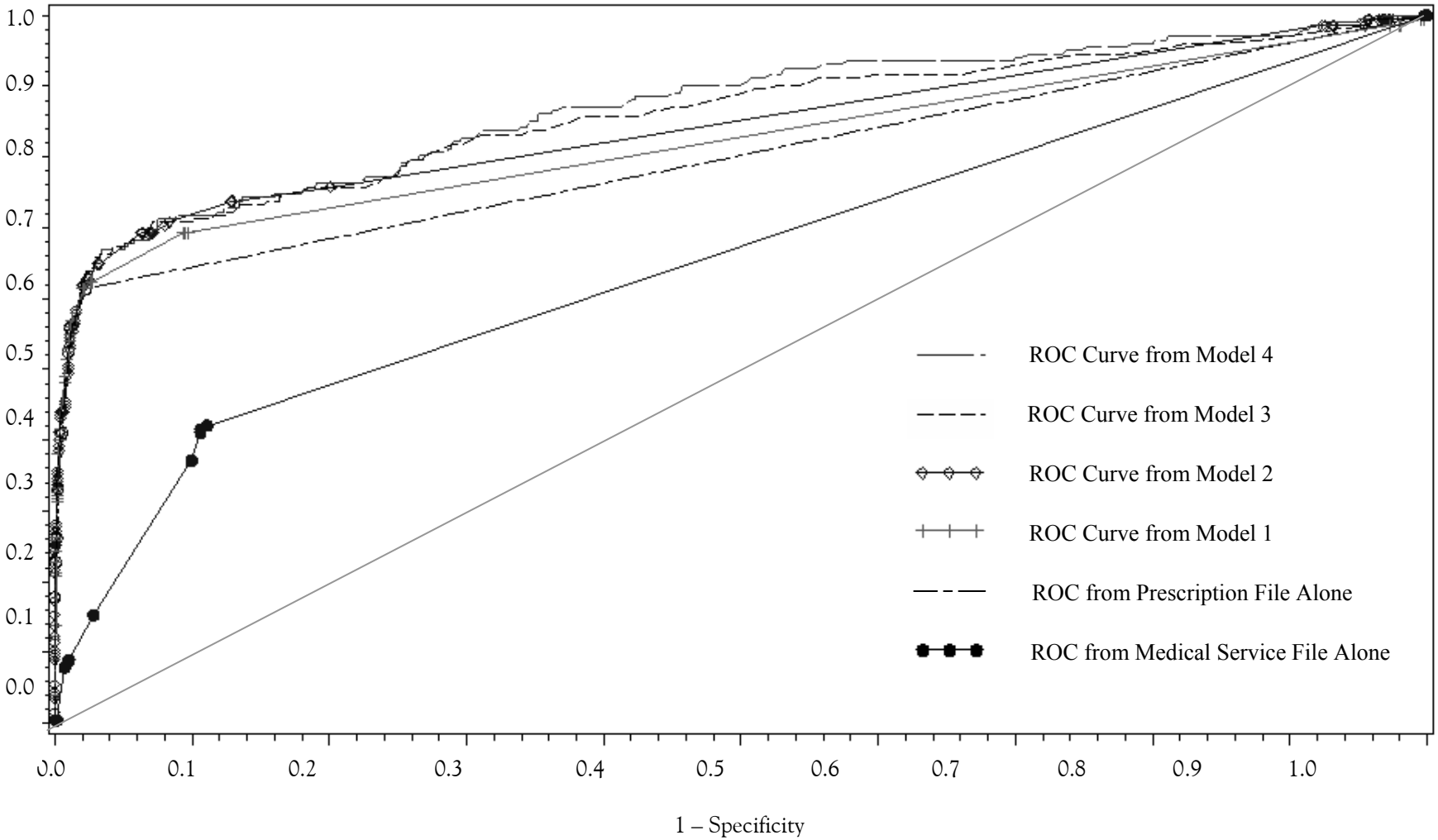
[1] AIC value of logistic regression results based on medical service claims indicators was 1073.4

Table 5.2.5. Diagnostic Performance of Five Predictive Models in Identifying Patients with Asthma

Model	Indicators included in the model	Diagnostic Performance for All Patients							Identification of Patients with indication of Severe Asthma		
		C Statistics	P-value[1]	Optimal Probability Cut-Off	Sensitivity	Specificity	Positive Predictive Value	# of Correctly Identified Patients as having Asthma (n=202)	# of identified Patients as False Positive (n=1232)	Gold Standard		Positive Predictive Value
										Patients with Asthma (n=18)	Patients without Asthma (n=47)	
--	Medical Service Claims Alone	0.658	--	0.174	0.421	0.889	0.383	85	137	16	39	0.290
1	Medical Service & Rx Claims	0.822	<0.01	0.134	0.693	0.907	0.557	140	115	17	27	0.386
2	Medical Service, Rx Claims, & Commorbidity	0.837	<0.05	0.111	0.703	0.917	0.589	142	99	17	10	0.630
3	Medical Service, Rx Claims, Commorbidity, & Demographics	0.859	0.11	0.128	0.708	0.929	0.622	143	87	17	6	0.739
4	Medical Service, Rx Claims, Commorbidity, Demographics, Health Service Usage	0.869	0.07	0.125	0.713	0.925	0.608	144	93	17	10	0.630

1. Each P-value, based upon a statistical approach by Delong et al (1998)[283], indicates whether there is a significant incremental value of introducing additional indicators

Figure 5.2.1. ROC Curves for Various Combinations of Indicators from Fitting a Logistic Regression Model for Identification of Patients with Asthma



Chapter 6. Manuscript 2

6.1 Study Objective and Rationale

The second manuscript investigates the association between scores achieved on the National Licensing Examination and the quality of asthma management and morbidity. In this manuscript, we address the role of physicians and their practice approaches to asthma management, specifically, in relationship to knowledge, clinical decision-making, and clinical skills as they are the fundamental and critical components of clinical competence [212] and clinical practice guideline adherence.[72] In particular, we elucidate the independent contribution of physician clinical competence to effective asthma management, specifically in realationship with the prophylactic medication use and asthma morbidity, through simultaneous assessment of the three key components: physicians, their practice environment, and patients.

The detailed examination of the overall population of possible asthmatics (n=90,078) provided us a comprehensive understanding of the target population, and identified a sub-group of patients who may be at a particularly high risk of experiencing adverse outcomes of asthma. (Appendix II) Manuscript 2 focused on the patients who were out-of-control at the time of the index visit to the study physician. A 6-month follow-up period was used to assess the effects of physician management to minimize confounding by co-intervention of other health professionals that would dilute the effect of the physician management decisions at the index visit.

6.2. Manuscript 2: The Association between Physician Competence at Licensure and the Quality of Asthma Management and Patient Morbidity

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Abstract

Background Asthma imposes a substantial burden on health care expenditures and compromises patients' health. Persistent trends of sub-optimal asthma management and significant morbidity indicate the need to search for other key barriers and facilitators. In particular, the role of physicians and determinants of their approach to asthma management is not well understood. Specifically, knowledge, clinical skills, and effective communication skills are the fundamental and critical components of clinical competence. However, there is no direct evidence on the extent to which a physicians' clinical competence has an influence on the quality of asthma medication use and morbidity. The study objective is to estimate the extent to which physician characteristics, specifically clinical competence, influence the quality of asthma medication utilization and asthma morbidity.

Methods A prospective cohort of 609 physicians, who took the Medical Council of Canada (MCC) Part 2 examination between 1993 and1996 and provided a care for asthma patients in Quebec between 1993 and 2003 was assembled. Patients whose asthma was out-of-control at the index visit were followed up for 6 month period after the first visit with a study physician (index visit). Linked databases were used to assess the quality of asthma management (use of inhaled corticosteroid (ICS) and ICS/Total asthma medication ratio) and outcomes (multiple respiratory-related emergency room (ER) visits, persistent fast-acting beta agonists (FABA) overuse).

Results In total, 3,981 asthma patients were identified as having out-of-control asthma at the index visit with the study physician. Among those, 1,960 patients received at least 1 asthma prescription from the study physicians during the follow-up period. Patients of physicians who achieved higher scores in communication (per 1 Standard Deviation (SD) increase in score) had a lower risk of persistent FABA overuse (Odds Ratio (OR)=0.97; 95%CI:0.94-1.0) and multiple ER visits for respiratory problems (OR=0.90; 95%CI:0.82-1.00). Higher QE1, QE2 and QE2 communication scores were associated with a 4-7% greater likelihood of ICS use (per 1SD increase). Similarly, higher scores achieved on QE1 as well as QE2 exams were also associated with a 4-9% higher likelihood of ICS/Total asthma medication ratio >0.5 (per 1 SD increase).

Conclusions Clinical competence, as assessed by the Canadian national licensing exam, was associated with the quality and outcome of management for patients with out-of-control asthma.

Background

Asthma is a serious public health problem that imposes a substantial burden on health care expenditures and compromises patients' health.[17] In Canada, asthma is a major cause of morbidity for two million Canadians, and the prevalence of asthma has been rising steadily over the last twenty years.[1;2] While the cause of asthma is not yet known and there is no known cure, the condition can be successfully managed with available evidence-based treatment.[18] To foster effective asthma management, consensus-based asthma clinical guidelines have been developed by a panel of experts based upon the continuously updated scientific evidence, to provide physicians with recommendations for optimal asthma management.[19]

Even after the institution of interventions for various patient-related barriers, including demographics, attitude, disease/treatment knowledge, and patterns of health care utilization, [54;304] sub-optimal use of asthma medication persists. The persistence of sub-optimal management and significant morbidity from asthma may indicate the existence of other key barriers to effective management.

In particular, the role of physicians and their approach to asthma management is not well understood. A conceptual model by Cabana et al. (1999)[126] proposes a general mechanism of evidence-based guideline adoption; the knowledge, attitude, and behavior framework. The framework proposes that, before practice guidelines can affect patient outcomes, changes need to take place in physician knowledge, then attitude, and finally behavior. (Figure 6.1)

According to the model [126], physician knowledge and clinical skills are the fundamental components of clinical competence [212] and appear to influence adherence to clinical practice guidelines.[72] Knowledge and clinical skills play a major role in the evaluation of a patients' medical condition and the quality of medical decision making.[213;214] A limited empirical body of literature has provided indirect evidence of the effect of physician competence on quality of

practice and patient outcomes. Physicians with specialty training, particularly in respiratory medicine, possess a higher level of knowledge about asthma.[87] Physicians with more extensive specialty training are also more likely to provide care that is consistent with national asthma practice guidelines,[23;121;122] and their patients are more likely to experience better outcomes. [121] However, there is no direct evidence that physicians' clinical competence influences the quality of asthma management and asthma morbidity, as distinct from their specialty and practice environment.[214]

Practice conditions are known to influence the quality of care delivered.[169] Practice conditions are highly variable across settings, especially within the fee-for-service reimbursement system.[121;127;128] According to the model by Cabana et al. (1999), in addition to physicians' knowledge and skills to effectively manage asthma, the practice environment influences their ability to provide quality care.[72] Physicians' practice environment has been associated with prescribing [109;173;174;305] and asthma practice guideline adherence.[69;175] Thus, it is important to distinguish positive effects on asthma management that are attributable to clinical competence from those due to differences in practice environment in order to design effective interventions.

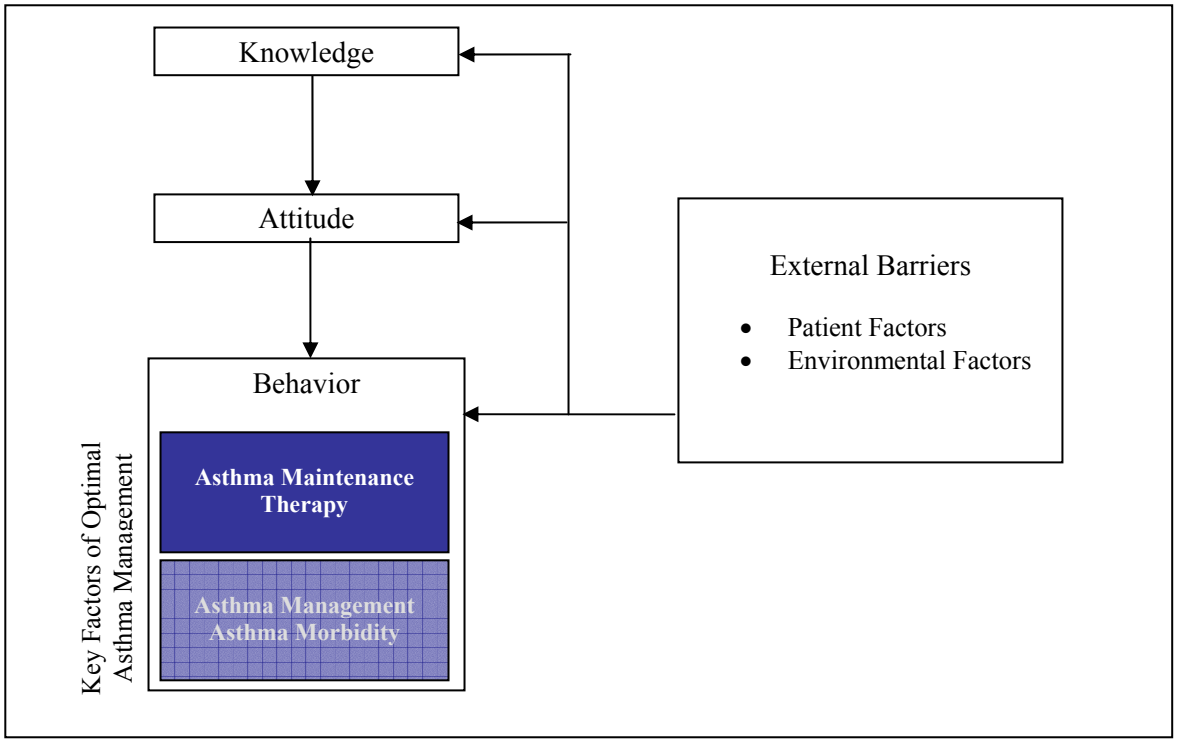
Further, it has been postulated that effective doctor-patient communication is essential to optimal disease management, particularly in relationship to asthma management.[306] Yet, there has been no robust assessment of this relationship, as systematic objective measurements of physician communication ability have not been available. The recent requirement that all Canadian physicians pass an examination that tests their ability to communicate with patients to be eligible for a license to practice medicine has provided the first opportunity to directly test the influence of physician communication skills on the quality of asthma management, particularly as it relates to the underuse of preventive medication (i.e. inhaled steroids).

We had the opportunity to follow a cohort of physicians from the point of the national licensure examination into practice in Quebec, enabling us to investigate the relationship between medical knowledge, clinical decision-making, and doctor-patient communication and the quality of asthma management.

Objective

Our objective is to estimate the extent to which physician clinical competence, training, and demographics, influence the quality of asthma medication management and asthma morbidity

Figure 6.1 Conceptual Model of Physician Behaviour Change in Achieving Key Factors of Optimal Asthma Management



Method

Data Sources

Practice Assessment

Quality of care, patient, and practice population characteristics were assessed using the provincial health insurance agency (RAMQ) that provides first dollar coverage for all medical and hospital care for all Quebec residents. Four linkable databases administered by RAMQ were used. The health beneficiary demographic database provided data on age, sex, drug insurance status, and postal code. The medical services claims database provided information on the beneficiary, date, type, provider, and location of service delivery (e.g. inpatient, emergency, clinic) for all medical services remunerated on a fee-for-service basis (approximately 86% of all services).[307;308] The prescription claims database provided information on each drug dispensed including the drug name, quantity, date and duration for each prescription, the prescribing physician, and the dispensing pharmacy.[309] Finally, the drug insurance coverage database was used to identify patients who were insured through RAMQ drug insurance plan.

Design and Study Population

A prospective cohort was assembled and comprised all physicians who took the national licensing examination (MCC QE2) between 1993 and1996 and entered practice in Quebec between 1993 and 2003. All asthma patients who received care in an out-patient setting for respiratory-related conditions from a study physician for the first time between 1993 and 2003 were identified, and those whose asthma was out-of-control at the first visit with the study physician were followed up for a 6 month period after the index visit. Out-of-control patients were used to assess the quality of asthma care because of the expectation that the physician must intervene to ameliorate the situation, even if it is a first visit with the patient, because of the increased risk of adverse outcomes (death and near death from asthma) without treatment intervention [310].

To be included in the study, asthma patients met the following six eligibility criteria: (1) made a visit to a study physician for respiratory-related conditions between 1993-2003 in an outpatient setting; (2) 5-60 years of age; (3) insured through RAMQ drug insurance plan in the one year prior to the index visit and in the six-months follow-up period; (4) had a diagnosis of asthma in the 12 months before or at the study physician visit, 5) did not have a diagnosis of COPD in the 12 months before or at the study physician visit, and 6) asthma was out-of-control during 3-month period prior to the index visit.

An index visit was defined as the first encounter between an eligible patient and a study physician, where the visit was made for a respiratory-related condition and was made in an outpatient clinic or community setting. Respiratory-related visits were defined as a visit where any of the following ICD9 codes were recoded as the reason for the visit (490.x (bronchitis), 493.x (asthma), 465.9 (upper respiratory infection), 466.x (acute bronchitis), and 786.x (symptoms involving the respiratory system (e.g. dyspnea)). Outpatient settings were defined using the following service location codes on the billing claim: hospital outpatient clinic, public residential home, private clinic, and community clinic.

The RAMQ beneficiary file was used to identify a patient's age at the time of the index visit, and diagnosis codes in the medical service file were used to identify patients with a COPD diagnosis (ICD-9 code: 491.x , 492.x, and 496.x). In order to identify patients who were insured through RAMQ drug insurance plan during the year prior to and 6 months after the index visit, two variables, start and end dates of insurance coverage, in the RAMQ drug insurance coverage database were used. To confirm the diagnosis of asthma, we used the algorithm developed by Kawasumi et al. (2006) based on the information specific to asthma, including asthma medication utilization, asthma-related medical service visits, comorbidity, and demographics during 1 year prior to the date of the index visit. The optimal cut-off of the probability of asthma, 0.128, was used to identify patients with asthma. [311]

A patient's asthma was defined as being out-of-control at the visit if the cumulative dispensed dosage of fast-acting beta agonists (FABA) exceeded 250 inhalations over the 3-month period prior to the index date. Fenoterol, terbutaline, and salbutamol were the drugs included in the calculation of FABA overuse. Information from the prescription claims database on the drug, quantity, and dates of dispensing was used to determine the presence of FABA over-use. In order to determine the number of doses dispensed, the quantity dispensed field from the record was multiplied by the conversion factor for each drug for each 3-months period in order to convert the quantity supplied from the RAMQ to a number of doses supplied for each drug. The time interval between two consecutive dispensing dates was used as duration of each prescription. In the case of a prescription, which extended outside of the time window of the study, the duration of each prescription was corrected by taking the duration of prescription within the study time window only.

In order to identify a unique combination of study physician and patients, only the first visit made by an eligible patient to a study physician was included in the analysis, as the outcome of the first visit may be related to the likelihood of subsequent visits.

Quality of Asthma Care

The quality and outcome of asthma management was assessed for each patient using the following four indicators: 1) multiple respiratory-related emergency room visits, 2) fast-acting beta agonists (FABA) overuse, 3) use of inhaled corticosteroid (ICS) and 4) ICS/Total asthma medication ratio. These quality indicators were assessed in the 6-month follow-up period after the index visit.

(1) Multiple Respiratory-related Emergency Room Visits

Emergency room visits for asthma have been associated with markers of asthma exacerbation, including FABA overuse and sub-optimal use of controller therapy. [280] Patients who require frequent visits to emergency room for asthma are more

likely to have very poorly controlled asthma as well as an increased risk of death.[100;281] Multiple respiratory-related emergency room visits was defined as having received medical services in the ER more than 1 time during the 6-month follow-up period. ICD-9 diagnostic codes in the RAMQ medical service file were used to identify visits for respiratory-related conditions (490.x, 493.x, 465.9, 466.x, and 786.x). The service location code and date in the RAMQ medical service claims was used to determine the number of ER visits for respiratory-related conditions for each patient during the follow-up period.

(2) Continuous Fast-Acting Beta Agonists (FABA) Overuse

Overuse of FABA is associated with near-fatal and fatal asthma [48;312] and has been used a marker of poor control in all clinical practice guidelines for asthma.[313] Based upon the Canadian asthma practice guidelines,[21] overuse of fast-acting beta agonists (FABA) was defined as a cumulative dispensed dosage of 250 inhalations of FABA or more during a 3-month period. Continuous FABA overuse was defined as FABA overuse in the two consecutive three-month periods during the 6-month follow-up period.

(3) Quality of Asthma Prescribing

In order to assess quality of asthma prescribing, each prescription of inhaled corticosteroids (ICS) and FABA, written by study physicians, was identified for each study patient during the 6-month follow-up period. Only prescriptions from the study physician were included for assessment of prescribing quality during the follow-up period.

i. Use of Inhaled Corticosteroids

Use of inhaled corticosteroid (ICS) is a critical aspect of optimal asthma management. Several empirical studies have shown that use of ICS reduces the likelihood of hospitalization[41;60;255] or ER visits [255] by approximately 50%. Each prescription of ICS from the study physician seen at the index visit was retrieved. ICS drugs included fluticasone, budesonide, flunisolide, belcometasone,

and triamcinolone. Patients were classified as having an ICS if they were dispensed at least one ICS dispensed in the 6 months after the index visit, where the prescribing physician was the study physician.

ii. Inhaled Corticosteroid (ICS)/ Total Asthma medication Ratio

The inhaled corticosteroid (ICS) to total asthma medication (ICS plus FABA) ratio proposed by Schatz M et al. was used.[264] A value of greater than 0.5 for this particular ratio has been associated with lower likelihood of asthma-related ER visits/hospitalization, better asthma-related quality of life, and better asthma control.[263;264]. In our current study, the controller/total medication ratio was calculated using defined daily dose (DDDs) for each drug that are published by the World Health Organization (WHO) Collaborating Centre for Drug Statistic Methodology.[314] The WHO has standardized DDD units corresponding to the assumed average daily dose of the drug used in adults. Each prescription was converted into the number of defined daily doses using the following formula: (formulation strength in mg x quantity dispensed)/ defined daily dose.

Clinical Competence (Medical Knowledge and Clinical Skills)

Previous studies indicate that physicians with a greater number of years of postgraduate specialty training possess a higher level of asthma knowledge.[87] Specialty trained physicians are also more likely to provide care that is consistent with asthma practice guidelines,[23;121;122] and their patients are more likely to experience better outcomes. [121] Therefore, we hypothesized that higher scores on the national licensing examination of clinical competence would be associated with better asthma medication management, and lower asthma morbidity, even after adjustment for specialty training.

The Medical Council of Canada (MCC) qualifying examination Part 1 (QE1) and Part 2 (QE2) were used to assess a physician's clinical competence.[315-317] Scores on these examinations are strongly correlated with academic achievement and ratings of clinical competence on clinical rotations in medical school and

subsequently in postgraduate training.[318;319] The QE1 tests an individual's clinical competence to enter postgraduate training. It is generally taken at the end of medical school and must be passed to be eligible for licensure. The first component of the QE1 exam is medical knowledge using approximately 450 multiple-choice questions to assess knowledge in medicine, surgery, obstetrics-gynecology, psychiatry, pediatrics, and preventive medicine.[315] The second component of the QE1 exam assesses clinical decision-making, using key feature problems.[316] Examinees are asked to respond to critical aspects of diagnosis or management in 36-40 clinical problems using write-in or menu-selection response formats.[316] Unlike multiple choice questions, key feature questions focus exclusively on the components of a case where physicians are required to make critical decisions that errors could have an effect on patient outcome.

Grading is based on the relative quality of the response, rather than a single correct answer, and errors of both omission and commission are considered in scoring. The score is calculated as the weighted sum of the multiple choice (weight=0.75) and clinical decision-making components (weight=0.25), where the weights reflect the amount of testing time devoted to each component. A criterion-based passing score is established by a modified Nedelsky method, [315;316] and scores for first-time takers are standardized to a mean (SD) of 500 (100). For the study population, the Cronbach alpha estimate of the reliability of the written examination varied from 0.90 to 0.92 for the multiple-choice component, and from 0.60 to 0.69 for the clinical decision-making component in different administrations.

The MCC clinical skill exam Part 2 (QE2) assesses competence in data collection (history, physical examination), patient communication, and medical management decision-making through a 20-case objective structured clinical examination. The exam is generally taken after one year of postgraduate training.[317] Most physicians take the examination in the second postgraduate year or the first half of the third postgraduate year. Data collection is assessed in a 5 or 10 minute

interaction with a standardized patient, by trained physician observers using case-specific checklists. [317] Patient-centered communication is assessed in 3-4 cases, selected to represent situations where communication is required for effective management (e.g. discuss refusal of treatment for a terminal illness, counsel an adolescent about birth control). Condescending, offensive, and/or judgmental behavior or ignoring patient responses during the encounter are examples of physician-patient communication that would receive a low score Problem-solving is assessed by post-encounter written responses to short-answer questions on diagnosis, investigation, interpretation of test results, and management. Responses are scored by physician examiners using an answer key. The passing score for the overall examination is established using criterion-referenced methods,[315-317;320] and scores for first-time takers are standardized to a mean (SD) of 500 (100). For the study population, the Cronbach alpha estimate of the reliability of the QE2 scores ranged from 0.25 to 0.50 for communication, 0.59 to 0.75 for data acquisition, 0.41 to 0.67 for problem-solving in different administrations.

Potential Physician and Patient-Related Factors

Several physician and patient-related characteristics that may be associated with the quality of asthma care were measured as potential confounders. Physician gender and specialty were measured using data retrieved from the RAMQ and the College of Physicians. The information for each patient was retrieved from the RAMQ beneficiary and medical service files.

Physician Characteristics

Physician Gender

To date, no studies explicitly have examined whether there are any difference in quality of care and patient outcome according to physician gender. However, physician gender influences quality of clinical practice.[104] Female physicians are more likely to engage in patient-centered communication, have longer consultations , and arrange follow-up visit and referrals compared to male physicians.[113;120] A participatory communication style and regular follow-up visits have been associated with a greater likelihood of optimal use of controller medication.[91;106] Therefore, we hypothesized that female physicians may be more likely to achieve better asthma controller medication use in their practice.

Physician Specialty

Abundant evidence exists to show marked difference between general practitioner and specialists in their adherence to practice guidelines. [271;321;322] Asthma specialists are more likely to provide care that is consistent with evidence-based practice guidelines, even though they have a tendency to see patients with severe asthma. [23;121;122] Therefore, we hypothesized that respiratory specialists would achieve better use of asthma controller medication use in their practice, fewer ER visits for respiratory conditions, and less overuse of FABA. Physician specialty was categorized into the following: general practitioner/family physician, respiratory specialists, cardiologists, and others. Respiratory specialists refer to any health care provider who received specialty–level training in adult or pediatric asthma[323], defined as respirologists, allergists, medical internists, and paediatricians.

Patient Characteristics

Patient Age and Gender

Higher asthma prevalence is observed among women. In addition, asthmatic women are also more likely to experience exacerbations[324] and asthma-related hospital admission.[133;135] There are multiple inter-related factors that are

potentially contributing to this phenomenon. Female patients have been reported to have higher occurrence of non-specific bronchial hyperresponsiveness [132] and higher sensitivity to this physiologic change. Female patients have a greater tendency to seek medical care for managing bronchial hyperresponsiveness [135] and to volunteer symptoms to physicians. [139] Female patients are also less likely to utilize inhaled corticosteroids, compared to male patients.[133;140;142] Thus, we hypothesized that female patients would be more likely to have asthma exacerbations and would be less likely to use inhaled corticosteroids.

Number of Visits

Asthma practice guidelines recommend having a regular contact with physicians as one of key factors in optimal asthma management.[6] Increasing number of contacts with physicians has shown to have a beneficial impact on reducing number of asthma-related ER visits[161;162] and use of anti-inflammatory asthma medication [143] Thus, it was hypothesized that increasing number of contacts with study physicians would be associated with better use of inhaled corticosteroids, and lower morbidity. The number of visits was measured by counting visits to the study physicians for respiratory conditions in outpatient settings during the 6-month follow-up period.

Patient Socioeconomic Status

Lower socioeconomic status has been reported as one of major determinants of sub-optimal use of ICS [57;65;143] and higher asthma-related morbidity [99;150;151;325] Socioeconomic status was measured using area-based mean household income from the 1991, 1996, and 2000 Statistic Canada Census. Low income cut-offs (LICOs) were used to categorize the value of area-base mean household income into either above or below the LICOs.[326]

Previous Emergency Room (ER) visits

A history of ER visits for respiratory problems is one of the makers of poorly controlled asthma. Several studies have reported that previous ER visits is a significant predictor of the multiple future ER visits[163-166] and urgent or unscheduled Visits.[166] Previous ER visit was defined as having received medical services in the ER for respiratory-related conditions during the 6-month baseline period. ICD-9 diagnosis codes in the RAMQ medical service file was used to identify for respiratory-related conditions. The service location code and date in the RAMQ medical service claims was used to determine the number of ER visits for each patient for baseline period.

Practice Characteristics

Unexplained variation in the quality of asthma care and morbidity could be explained by physicians' practice characteristics.[168] In the current study, practice characteristics of each study physician were assessed to measure two main attributes: 1) practice workload and 2) practice population profile. Practice workload and practice population profile were assessed using information for only the ambulatory care components of the physician's practice. Relevant information was retrieved from the RAMQ beneficiary and medical service file for all the patients seen by the study physicians and aggregated into as a summary measure for each study physician during the year prior to the index visit.

1) Practice Workload

Practice workload has been associated with a provision of a wide range of medical procedures and clinical outcomes.[169;305] Specifically, a high volume practice environment has shown to be associated with suboptimal prescribing [173] and patient morbidity.[109;174;305] Insufficient time associated with a busy practice environment was reported as one of barriers to prescribing inhaled corticosteroids to asthmatic children.[69] Therefore, it was hypothesized that a higher practice volume and higher number of working days would be negatively associated with the quality of asthma prescribing and morbidity. Annual practice volume was

defined as number of patients seen in an outpatient setting in the year prior to the index visit. Number of working days was defined as number of unique days billed in the year prior to the index visit.

2) Practice Population Profile

Disease prevalence and the demographic characteristics of the practice population vary across physicians,[168] and these differences may influence management decision-making and approaches to care delivery. In the case of asthma, disease prevalence and its morbidity predominantly occur among younger population.[327] Therefore, it was hypothesized that a higher proportion of elderly population is expected to have a negative influence on the quality of asthma management and asthma morbidity. Similarly, there is a higher asthma prevalence in females with a greater likelihood of experiencing asthma-related morbidity.[13] Therefore, it was hypothesized that a higher proportion of female patients would be associated with lower quality of asthma management and greater asthma morbidity. The proportion of elderly patients was defined as number of patients 65 years of age or older who were seen by study physicians, divided by total number of patients seen by study physician during the year prior to the index visit. The proportion of female patients was defined as number of female patients who were seen by study physicians, divided by total number of patients seen by study physicians during the year prior to the index visit.

Statistical Analysis

We estimated separate models for the following four outcomes: 1) multiple respiratory-related emergency room visits, 2) fast-acting beta agonists (FABA) overuse, 3) use of inhaled corticosteroid (ICS) and 4) ICS/Total asthma medication ratio. We used the Generalized Estimation Equation (GEE) extension of multiple logistic regression for correlated data with an auto-regressive first-order AR(1) correlation structure.[328] The AR(1) structure implies that the correlation between outcomes of different patients of the same physician decreases as the difference in time between their respective visits increases and,

thus, will account for possible secular trends in the quality of asthma care. Patients were units of analysis, and were clustered within study physicians' practices. All potential confounders, and the hypothesized physician, patients, and practice-level characteristics were included as independent variables, regardless of their statistical significance, in each regression model. To avoid multi-collinearity problems, each of the examination scores was modeled separately. The estimated ORs for the examination scores, which were standardized to have SD=100, represent the adjusted change in odds of a given outcome per 1SD increase in the respective score.

The extent of contribution of physician, patients, and practice characteristics in relationship with asthma prescribing pattern and morbidity was assessed. All variables representing (a) physician, (b) patient, or (c) practice characteristics were simultaneously entered into the model and retained regardless of their statistical significance in the multivariable GEE models. As each group of variables was entered in the model, Pseudo-R^2 was used to assess the additional amount of variance explained by this set of variable, while taking sample size and number of covariates into account.[329]

Finally, the population impact of low levels of clinical competence was assessed using the population attributable fraction.[330] We estimated an excess number of each of the following adverse outcomes: not being prescribed ICS, ICS/total medication ratio <0.5, multiple respiratory-related ER visits, which were due to being seen by physicians with the examination scores in the lowest quartile, relative to the number expected if all these physicians with the clinical competence ability above the bottom quartile.

Results

Study Population

From 1993 to 2003, a total of 90,078 asthma patients received care from 609 study physician in an out-patient setting for respiratory-related conditions. Among those, 3,981 asthma patients (4.4%) were out-of-control during the 3-month period before the index visit. Study physicians who provided care for patients whose asthma was out-of-control at the index visit, were more likely to be respiratory specialists. Study physicians who saw out-of-control patients had a slightly lower volume of practice and fewer workdays in the year prior to index visit. Patients, whose asthma was out-of-control at the visit were more likely to be older than 45 years of age, to be referred by another physician, and to re-visit the study physician after the index visit. Study physicians who prescribed asthma prescription during the follow-up period were more likely to be male and GPs. Patients who received asthma medication from a study physician were more likely to be older than 45 years of age and to re-visit the study physician after the index visit (Table 6.2.1).

Quality of Asthma Prescribing

i. Provision of ICS

Of 1,960 out-of-control patients who were prescribed any asthma medication by the study physician, 1028 patients (52.5%) were prescribed ICS during 6-month follow-up period (Table 6.2.2). Medical knowledge, clinical decision-making, and communication examination scores were all significantly associated with the likelihood of providing ICS. The likelihood of receiving ICS increased approximately 4-7% per 1 SD increase in each score. Female patients and patients who made more visits to the study MD during follow-up period were more likely to receive ICS. (Table 6.2.2)

ii. ICS/ Total Medication Ratio >0.5

Of 1,960 out-of-control patients who were prescribed any asthma medication by the study physician, 1028 patients (52.5%) had ICS/total asthma medication

ratio>0.5 (Table 6.2.3). The likelihood of having an ICS/total asthma medication ratio >0.5 increased by 6-9% per 1 SD increase with QE1 total score and QE2 total score. The likelihood of the ratio>0.5 was approximately 20% higher among female patients. In contrast, every 10% increase of proportion of elderly patient their practice was associated with 6-7% reduction of the likelihood of having a ratio>0.5. (Table 6.2.3)

Asthma Morbidity

Among 3,981 out-of-control patients, 1,837 patients (46.1%) continuously experienced poor asthma control during the 6-month follow-up period. Only the communication score had a protective effect against persistent out-of-control status as the likelihood was reduced by 3% for every 1 SD increase in communication score. (OR=0.97; 95%CI:0.94-0.99). Patients who were provided care by respiratory specialists were approximately 30% less likely to experience continuous out of control status, compared to general practitioners. Similarly, patients seen by female physicians, and by physicians with a higher number of workdays per year, were less likely to be continuously out-of-control. (Table 6.2.4)

Among the 3,981 out-of-control patients, 380 patients (9.6%) visited the emergency room (ER) for respiratory-related conditions multiple times during 6-month follow-up period. The communication score showed a significant protective effect against multiple ER visits; a reduction in risk of 10% for every 1 SD increase in communication score. (OR=0.90; 95%CI=0.81-0.99) Previous respiratory-related ER visits was the strongest predictor of the multiple respiratory-related ER visits during the follow-up period. (OR=5.87; 95% CI=4.81-7.19). (Table 6.2.5)

Contribution of Patient, Physician, and Practice Environment to the Quality of Asthma Management

The extent of the contribution of physician, patient, and practice characteristics to variance in asthma quality of care was assessed. (Table 6.2.6) The prescription of an ICS, was influenced by both physician and patient characteristics (35.4% and 32.3 % of the total explained variance was explained, respectively). With respect to the ICS/total asthma medication ratio being >0.5, patients characteristics alone explained almost half of the total explained variance.

Patient characteristics alone explained 45.5% of the total explained variance in persistent out-of-control, and physicians and patients characteristics explained the most (77.2% of variance explained). Patient characteristics explained approximately 90% of total explained variance of multiple ER visits, which corresponded to 13.9% of the total residual variance from the model without any covariates. In contrast, physician characteristics alone explained only an extremely small amount of total residual variance (0.03%). (Table 6.2.6)

Population Impact

Among patients who were seen by physicians in the bottom QE1 score quartile, 6.1% of patients with lower than 0.5 of the ICS/total medication ratio could be avoided if those patients were seen by physicians with the clinical competence ability above the bottom quartile. Similarly, among patients who were seen by physicians in the bottom communication score quartile, 7.1 % of patients experiencing multiple ER visits could be avoided if those patients were seen by physicians with clinical competence ability above the bottom quartile.

Discussion

Clinical Competence

Our study found that physicians with greater proficiency in medical knowledge, decision-making and clinical skills provided better asthma care and had fewer adverse outcomes. Higher scores on the QE1 and QE2 components of the national licensing examination and higher communication scores were associated with an increased likelihood of providing ICS during the 6 months follow-up period for patients with out-of-control asthma. Similarly, QE1 and QE2 total scores predicted higher use of preventative medications (ICS/Total asthma medication Ratio >0.5). On the other hand, only communication score was associated with asthma morbidity. There was a 3% reduction in persistent out of control (OR=0.97; 0.94-0.99) and 10% reduction for multiple ER visits for respiratory-related conditions for every 1 SD increase in communication score (OR=0.90; 95%CI=0.81-0.99)

Knowledge, clinical judgment, and communication are fundamental components of clinical competence, [316;317] and they are abilities required in two major aspects of care delivery: (1) the evaluation of a patient's medical condition based on the medical history and physical examination and 2) the quality of diagnostic and management decisions made on the basis of this evaluation.[213;214] Effective clinical assessment and medical management will be influenced by the quality of patient-physician communication. In particular, the quality of the information-giving and information-seeking exchange between patients and physicians will influence accuracy of asthma status assessment and the appropriateness and acceptability of subsequent treatment decisions.[73;78]

The ability of physicians and patients to make shared decisions acknowledges the complementary expertise and knowledge that patient and physicians bring during the consultation.[215;216] Prior studies supported that patients who rated their physicians as being more participatory during treatment decisions were significantly more likely to report: higher quality of life,[223] a higher level of

satisfaction with the medical consultation,[224] regular use of controller medication,[91] and a reduction in unscheduled office visits.[217] Moreover, a physician's communication skill plays a key role in maintaining an ongoing partnership with his/her patients to monitor asthma status regularly and build a patient's confidence and ability to engage in self-management. [73;215;216] Patients who rated their doctors as having interactive conversational style were significantly less likely to make unscheduled office visits, [217] and were more likely to adhere to twice-daily dosing of ICS.[57] The quality of information-giving behavior by physicians is also associated with the regular use of controller medication [218] and a reduction of unscheduled office and emergency room visits by their patients. [217]

Prior research in Canada has shown similar findings. Higher scores on the QE1 exam were associated with the quality of future practice in primary care, including better preventive care, higher rates of referral, and more disease prescribing rather than symptom relief prescribing.[207] In addition, national licensing examination scores are predictors of the future complaints. Physicians with higher QE1 score receive up to 50 % fewer complaints about the quality of their practice compared to physicians with lower scores. (ß=1.54; 95%CI=1.06-2.22) Similarly, higher QE2 scores also showed a similar significant association with respect to overall complaints(ß=1.19; 95%CI=1.0-1.42) as well as communication complaints (ß=1.28; 95%CI=1.0-1.64) Finally, physicians with higher QE2 communication examination subscores received up to 43% fewer complaints, compared to those with lower communication scores.[197]

The predictive ability of licensing exam scores for the quality of future practice, including asthma care, has several significant implications for medical school educators. For instance, it is possible to use these types of evaluation methods to provide earlier detection and remediation of trainees who would be likely to provide sub-optimal care in future practice. Yedidia et al (2003) has demonstrated that implementation of a dedicated communication training program has produced

a significant improvement in communication skills and relationship building among third-year medical students. [331]

Moreover, it is possible to screen some abilities such as communication at admission to medical school.[332] Veloski et al (1987) reported that Grade Point Average (GPAs) in the first two years of medical school are highly correlated with the subsequent scores achieved on certifying test of the national board of medical examination (NBME). The correlation between the NBME and freshman GPA, and between the NBME and sophomore GPA ranged from 0.48-0.74 and 0.56-0.76 respectively.[318] Moreover, according to Papadakis et al (2005), poorer academic performance in the Medical College Performance Test (MCAT) has also been predictive of unprofessional behavior later in their practice.[333]. Future research should assist medical educators in establishing benchmarks for required levels of performance during medical school to be future effective physicians.

Physician Determinants

Physician Gender

This study found that, compared to male physicians, patients of female physicians are approximately 10% less likely to be persistently out-of-control in the 6-months after their visit to the study physician. This is one of the first studies to report that physician gender is a predictor of asthma morbidity. Our finding could be indirectly explained by a distinctive practice style of female physicians. Female physicians are more likely to engage in patient-centered communication and to arrange follow-up visit and referrals, compared to male physicians.[113;120] Similarly, female physicians tend to have preventive practice style; spending more time in a visit providing preventive service, counselling, and information-giving.[106] Female physicians are also more likely to order laboratory testing; whereas male physicians are more likely to spend time in history taking, physical examination and discussing treatment. [106] Thus, it is possible that the distinctive practice style of female physicians could have positively influenced asthma control.

Physician Specialty

Our study found that patients who were provided care by respiratory specialists were also approximately 20% less likely to experience continuous out-of-control status in the 6 months after the index visit, compared to general practitioners. Previous evidence supports this finding. Patients managed by specialists are approximately 50% less likely to cancel activities because of their asthma compared to patients who were managed by GPs. Moreover, patients of allergists also show greater improvement in asthma symptom control than patients of GPs. [124]

Respiratory-specialists are more likely to treat patients with severe asthma than patients managed by GPs.[121;127;128] However, patients managed by respiratory specialists are more likely to have asthma exacerbations treated in a clinic setting rather than an emergency department,[121], to possess greater knowledge of asthma management, and to engage in the self-management behaviour, compared to patients cared by GPs .[127] Respiratory specialists may be more likely to provide comprehensive patient education. According to a U.S national survey of physicians who treat patients with asthma (n=512) , pulmonologists are more likely to place emphasis on the topic of controlling asthma at the first visit with an asthma patient; whereas primary care physicians tend to focus specifically on the topic of triggers. [129;130]

In our study, use of inhaled steroids was not associated with the speciality of the treating physician. This particular finding could be explained by the reasons for referral and the relationship between primary care and specialty practice. In the US, the two major reasons for referral from family physicians are to receive advice on treatment (48%), followed by an advice on diagnosis (44%).[334] A shared responsibility is anticipated for 30% of referrals, and complete transfer of management is for 15% of referrals only. [334] Even though we could not examine the specific reasons for the referral, respiratory specialists were less likely to prescribe asthma medication in our study, which may be explained by the

expected role of respiratory-related specialists in relationship to the referring physician in Quebec.

Practice Environment Determinants
Practice Workload

Previous studies documented that the higher workload in the practice environment has a negative impact on the quality of physician prescribing [173] and patient morbidity. [109;174;305] Even when physicians are aware of appropriateness, safety, and cost of prescribing, these considerations may be outweighed by a lack of sufficient time to negotiate different care management strategies. [335] Specifically, insufficient time during patient visits has been reported as one of barriers in adhering to asthma practice guideline.[69;175] Therefore, we hypothesized that a higher intensity of activity in the practice environment, measured by higher practice volume and greater number of workdays, would be negatively associated with a quality of asthma prescribing and positively associated with greater morbidity among patients.

However, our results failed to support the hypothesis. Overall practice volume did not show any significant association with quality of asthma prescribing or patient morbidity. In contrast, patients of physicians with higher number of workdays were approximately 15% less likely to experience persistent out-of-control. Our study finding could be explained by another attribute of workload: "volume of experience". A number of studies examined the association between patient outcomes and the volume of health services provided by hospitals and physicians. In systematic reviews, approximately 70% of studies support the association between higher volume and better quality of care across a wide range of procedures and medical conditions, although the magnitude of the volume-outcome relationship varies greatly.[169] The so-called 'volume-outcome relationship' has been studied based upon two principal hypotheses: 1) greater development of effective physician's skills as a consequence of treating a large number of patients or 2) more effective physician's skills lead to better quality of

care and outcomes, more referrals in recognition of expertise, and thus the accrual of higher volumes of patients.

Practice Population Profile

Our findings showed that the practice population profile were associated with the quality of asthma prescribing and asthma morbidity. First, an increase every 10% increase in the proportion of elderly in the physician's practice was associated with a 5-7% reduction in the likelihood of an asthma patient having an ICS/total asthma medication Ratio >0.5. In addition, an increase of 10% in the proportion of female patients in the practice population was associated with a 6% and 16% increase in the likelihood of being persistently out-of-control and having multiple ER visits in the 6-month follow-up period.

According to the previously described 'volume-outcome relationship', physicians may develop more effective skills for a particular medical condition as a consequence of treating a large number of patients. For instance, by treating a large number of elderly patients, physicians may develop skills in dealing with the distinctive needs of a seniors population such as a higher likelihood of adverse drug reaction and polypharmacy due to high prevalence of co-existing illness.[176] Previous studies demonstrated that a proportion of elderly population was associated with more conservative prescribing practices for the elderly[176] and lower rates of mammography screening for women aged 50-69 years old.[177]. Treating a large number of elderly patients may increase sensitivity and knowledge in providing care for elderly, potentially generating practice policies that may be sub-optimal for younger patients. In the case of asthma, disease prevalence and its morbidity predominantly occur among younger populations.[336] It is possible that a higher proportion of elderly in the practice population generate more conservative prescribing policies, particularly as it relates to adverse effects from inhaled corticosteroid use leading to an underutilization of preventive therapies and poorer quality of asthma management.[337;338]

Prior research suggests that females have a higher prevalence of asthma and a greater likelihood of experiencing asthma exacerbation[13] and asthma-related hospital admission. [133;135] Female patients also tend to have longer consultations during physician visits, compared to male patients.[339] During an encounter with physicians, female patients are more talkative and more likely to discuss psychosocial problems.[340] Hence, physicians treating a large number of female patients with this particular communication style may face time constraints either in providing comprehensive patient education for optimal asthma management[69;175] or in creating a barriers to timely access to physicians during office hours. [341] In this way, a higher proportion of female patients could have negatively influenced on achieving optimal level of asthma control and use of ER for multiple times.

Patient Characteristics

Age and Patient Gender

Our study found that patients 45 years of age and older were approximately 20% more likely to experience persistent out-of-control asthma and 50% more likely to have multiple ER visits. Previous studies also showed that asthma morbidity increases with age. For instance, a Canadian cross-sectional study by Chapman et al (2008) reported that a likelihood of achieving asthma control is negatively associated with age. Compared to patients 65 years of age and older, the likelihood of asthma control was approximately 15% and 40% higher among patients 36 to 50 years of age (OR=1.14; 95%CI=0.99-1.3) and patients 12 to 35 years old (OR=1.41; 95%CI=1.20-1.66), respectively. [137]

This finding may be related to a high prevalence of severe asthma among older asthmatics, or misclassification of asthma with chronic obstructive pulmonary disease (COPD). According to a review by Quadrelli et al (2001), the frequency of symptom free periods and number of patients showing mild symptoms is less prevalent among older asthmatics.[338] The aging process may play a key role; however, another review by Braman et al (2007) reported that onset and duration of having asthma are also an important factor determining disease severity among

this particular population. Specifically, patients, who started having asthma symptoms in early life are more likely to have disease with severe and irreversible airway obstruction.[342]

The likelihood of having several co-morbid conditions is also greater among older asthmatics, and they may face several challenges in managing their health care needs. For instance, the side effect of taking prophylactic medication is particularly troublesome for patients with several comorbid conditions, including hypertension and diabetes. [337;338;342] Similarly, the presence of co-morbid conditions may exacerbate the perception of bronchoconstriction and delay appropriate and timely medical intervention. [342] Alternately the effectiveness of ICS may less pronounced in this population as older asthmatics were more likely to use ICS and have a higher ICS/ total asthma medication ratio.

We found that female patients had 6% higher likelihood of receiving ICS and approximately 15% higher likelihood of having an ICS/total medication ratio>0.5. Female patients have shown lower levels of adherence to inhaled corticosteroids in some studies, however they appear to be more likely to be started on ICS.[133;142] For example, Schatz et al. [133] reported that the percentage of patients who dispensed any inhaled corticosteroid during the 2-year study period was significantly higher among female patients over 14 years of age compared to male patients in the same age group. However, across all age groups, the mean number of actual ICS dispensing was significantly higher among male patients than female patients. A similar finding was reported in asthmatic children.[142]. Thus, our study findings with respect to female patients of ICS use is particularly surprising. One of several potential mechanisms to explain this particular finding could be related to a reported tendency of beta-agonist underuse among female patients.[133;343] For instance, a large HMO study by Schatz et al.[133] demonstrated that mean number of short-acting beta agonists dispensed is significantly higher among male patients than female patients. In our current study, the denominator of the ICS to total asthma medication ratio was calculated

using ICS and fast-acting beta-agonists (FABA). It is possible that underuse of short-acting beta-agonist among female patients may have increased the magnitude of the ICS/total asthma medication ratio, even if the same or fewer number of ICS prescriptions were dispensed to female patients.

Number of Visits

Asthma practice guidelines recommend having a regular contact with physicians as one of the key factors in optimal management of asthma[6]. Increasing number of contacts with physicians has shown to have a beneficial impact on use of anti-inflammatory asthma medication.[143] In our study, more frequent visits to the study physician who was seen at the index visit was associated with higher likelihood of ICS use. However, our study findings also found that having multiple visits to the index visit study physician during the 6-month follow-up period increased the likelihood of multiple ER visits for respiratory conditions, and persistent out of control.

Similar results were reported in a Canadian Study [344]; patients who made frequent visits to their regular physician were approximately 4 times more likely to make multiple ER visits (OR=3.7; 95%CI=1.9-7.0). Greater health care resource use may be a marker of asthma severity.[167] According to a cross-sectional survey in Harlem, NY, Ford et al (2001) found that patients with more severe asthma were more likely to have had more scheduled office visits for asthma in the year prior to the interview (mean number of visits for patients with severe asthma, 3.6 visits; moderate asthma, 2.4 visits; and mild asthma, 1.7 visits).Those patients with moderate or severe asthma were 3.8 times more likely to be frequent ED users compared to those with mild asthma (OR=3.8; 95% CI: 2.2 - 6.6).[167]

Poor general health with a higher number of co-morbid conditions may increase the extent of health care needs.[111] Ford et al. (2001) also reported that a number of co-morbid conditions are an independent predictor of the multiple visits to ER (OR=1.5; 95% CI: 1.1-2.1).[167] Similarly, compared to patients

without frequent ER visits, asthma patients with frequent ER visits are more likely to have other medical conditions, including mental illness (32% vs. 10%; $p<0.05$) as well as diabetes (18% vs. 10%; $p<0.05$).

Nevertheless, several studies have reported that in certain sub-populations of patients, there is a tendency to use ER as a regular source of care. Our current study found that previous ER visits was the strongest predictor of multiple ER visits during the follow-up period—approximately 6 times higher likelihood of multiple ER visits was found among patient with previous ER visits. A substantial portion of patients who make ER visits for asthma are frequent visitors,[100] and they visit within a short period of time.[100] Approximately 80-90% of patients who present to the ER for acute asthma are discharged. Among those who are discharged, 5-25 % will return to the ER for asthma-related problems within the first week and 21-35% within the three weeks after the discharge.[163;165] Most of those patients (91%) will return to the ER before they see their primary care physician.[165] The study by Ford et al (2001) reported that, even though patients with more severe asthma were more likely to have a primary asthma care provider, 69% of those patients identified the ER as their preferred source of care.[167]

Contribution of Patient, Physician and Practice Environment to the Quality of Asthma Management

Our study assessed the extent to which physician, patient, and practice characteristics contributed to variance in the quality of asthma care. In relationship to the use of asthma controller medication, we found that almost half of the variance in the ICS/total asthma medication ratio was explained by patient characteristics alone, but both factors combined explained 75% of the variance. In relationship to the use of ICS, both physician and patient characteristics explained roughly 80% of the variance. The use of any ICS is a simple measure of the quality of asthma management. In order to prescribe maintenance medication, accurate assessment of symptoms and severity plays a critical role. When such

assessment was accurately performed by physicians in one study, 83% of children received maintenance medication.[78] However, the quality of the information providing by patients is often sub-optimal due to several factors, including their level of health literacy, health beliefs about treatment,[221] and patterns of health care utilization.[81] . Ineffective provision of information may negatively impact a physician's ability to provide appropriate treatment. [78;79] Under such circumstances, lack of time during office visits may also penalize a physician's ability to obtain vital information from patients.[82] In this way, the patient-physician relationship may have played a major role in determining both the prescription and use of ICS.

Limitations

This study has several limitations. There is consistent evidence in the literature that patients of lower socioeconomic status are more likely to have sub-optimal use of asthma controller medication (ICS) and higher likelihood of experiencing asthma morbidity. Our current study failed to provide results that were consistent with prior research. Socioeconomic status did not show any association with the quality of asthma care or asthma morbidity. This unexpected finding may be because measurement of socio-economic status was based on ecological neighbourhood measures.

In addition, the level of a patient's socioeconomic status was assigned using area-based mean household income using the following three Statistics Canada census: 1991, 1996, and 2000. In order to deal with increase of average income over the 10 years of study period and to determine whether patients with the lowest income status were adversely affected, we used low income cut-offs (LICOs). LICOs are intended to convey the income level at which a family may be in strained circumstances as result of the necessity to spend a greater portion of its income on the basics (food, clothing and shelter) than an average family of similar size. [326] Therefore, we suspect that random misclassification due to measurement error could have occurred and may have attenuated the potentially existing association.

Alternately, it is possible that the comparatively generous drug insurance program offered in Quebec may have offset trends for underuse by the poor and females who are over-represented in the economically disadvantaged population.

Our current study did not measure asthma specific caseload as one of the practice predictors.[169] In order to calculate the 'asthma-specific caseload' for each study physician, a probability of having asthma needs to be estimated using asthma algorithm by Kawasumi et al. (2006) for each patient seen by the study physician in the previous year of the index visit.[311] However, this calculation requires pharmacy data, which is available for approximately half of population. Therefore, it was not possible to calculate the asthma probability for all the patients seen by the study physicians.

There is evidence that a higher caseload of patients with a specific medical condition is associated with a better quality of care. For instance, primary care physicians with a greater numbers of diabetic patients in their practice are more likely to provide recommended disease-related monitoring, including hemoglobin A1c measurements, lipid profiles, and retinal eye examinations for patients with diabetes. [170] Even after adjustment for multiple factors, for each one quintile increase in the number of diabetics in the practice among primary care physicians, the odds of receiving a hemoglobin A1c measurement increased by 1.16 (95% CI:1.10-1.23), 1.12 (95% CI: 1.07-1.18) for a lipid profile, 1.06 (95% CI: 1.02-1.09) for a retinal eye examination, and 1.48 (95% CI:1.22-1.81) for receiving all 3 measures. A similar finding was reported in practices in England as well.[171] Moreover, similar results have been shown for quality of cardiovascular disease management in primary care practices in England. For instance, a practice with higher caseload of patients of cardiovascular disease had a higher level of achievement in indicators of early diagnostic investigation, including referral for exercise testing and/or specialist assessment.[172]

The degree of underlying asthma severity and level of asthma control are related but are distinctive concepts.[345] Underlying asthma severity represents a relatively stable individual characteristics that reflects the underlying pathophysiology of the disease; whereas level of asthma control refers to current asthma status, which could vary over very short time frames.[345]

There is no gold standard for measuring the degree of asthma severity. The Canadian Asthma consensus guidelines[19] recommends that, prior to the treatment, the severity of asthma is determined by the frequency and duration of respiratory symptoms, the presence of persistent airflow limitation and the intensity of therapy required to achieve optimal level of asthma control. [299] Following treatment, asthma severity is best assessed by the minimum amount of therapy required to achieve and maintain ideal level of asthma control.

In this research project, the association between the degree of underlying asthma severity and asthma-related morbidity was not addressed. Instead, the role of physician competence was examined in relationship with the management of patients with out-of-control asthma because the level of asthma control is an essential barometer of the quality of health care being provided as well as an indicator of patients who may benefit from optimal management,[345;346]

Use of administrative databases provides several advantages for researchers. With limited information bias, a large population-based database provides effective and efficient opportunities to conduct an investigation without any constraints of disease prevalence and of time period.[248] However, the database has several limitations. For instance, we used the prescription database to measure quality of asthma prescribing such as the ICS/total asthma medication ratio. The prescription database provides information on drugs that were dispensed and does not reflect actual usage of the medication. Nevertheless, the ICS/total asthma medication has some evidence to support validity as higher values of this particular ratio have been associated with lower likelihood of asthma-related ER visits/hospitalization,

better asthma-related quality of life, and better asthma control, compared to the lower values of the ratio.[263;264]

Another limitation that may have impacted on our results is that prescription databases can only be used to measure drugs that are dispensed. Therefore, we were not able to determine prescriptions that were prescribed by physicians but were never filled. In turn, we were not able to determine whether not filling their prescription was due to physicians' non-adherence to asthma practice guidelines or a failure in patient self-management.

Similarly, administrative databases does not include information on all potential confounders for asthma morbidity and asthma drug management , including smoking, lung function, and exposure to triggering factors.[6;19] The inability to measure these confounders may have an affect on our results; however, the degree and its consequence are difficult for us to estimate.

In summary, our study found that clinical competence, as assessed by licensing examination scores predict the quality of asthma care and morbidity, explaining additional variation in management to that explained by other patient, physician and practice characteristics.

Table 6.2.1. Characteristics of Study Physicians, Practice, and Patients

MD Characteristics	*Number of patients with Index Visits (n=90,078)*	*Number of patients, whose asthma was out of control in 3 month prior to the Index Visits (n=3,981; 4.4%)*	Number of Patients being prescribing Any Asthma Medications by the Study MDs (n=1960;2.2%)
Gender			
Female	46,192 (51.3%)	2099 (52.7%)	911 (46.5%)
Male	43,886 (49.7%)	1,882 (47.3%)	1,049 (53.5%)
Undergraduate			
McGill	7,195 (8.0%)	285 (7.2%)	132 (6.7%)
Montreal	29,443 (32.6%)	1,368 (34.3%)	664 (33.9%)
Laval	17,120 (19.0%)	838 (21.1%)	369 (18.8%)
Sherbrooke	20,939 (23.3%)	909 (22.8%)	486 (24.8%)
Outside Quebec	4,547 (5.1%)	167 (4.2%)	75 (3.8%)
Outside Canada	10,834 (12.0%)	414 (10.4%)	234 (11.9%)
Post-Graduate Training Program	17,939 (19.9%)		329 (16.8%)
McGill	36,862 (40.9%)	672 (16.9%)	855 (43.6%)
Montreal	16,132 (17.9%)	1,698 (42.7%)	336 (17.1%)
Laval	17,330 (19.2%)	743 (18.7%)	401 (20.5%)
Sherbrooke	1,794 (2.0%)	758 (19.0%)	39 (2.0%)
Outside Quebec	21 (0.02%)	110 (2.8%)	0 (--)
Outside Canada		0 (--)	
Practice Specialty			
GPs	77,338 (85.9%)	3,319 (83.4%)	1,783 (91.0%)
Respiratory Specialists	7,468 (8.3%)	516 (13.0%)	169 (8.6%)
Other Specialists	1862 (2.1%)	49 (1.2%)	5 (0.3%)
Cardiologists	3,410 (3.8%)	97 (2.4%)	3 (0.2%)
Exam Scores Mean (SD; range)			
QE1 Total Score	519.0 (79.3; 344-732)	523.8 (77.7; 344-728)	516.0 (75.9; 344-728)
QE2 Total Score	526.9 (79.5; 158-749)	528.6 (78.4; 158-749)	528.2 (79.2;270-749)
QE2 Communication Score;	503.2 (97.0; 167-705)	505.1 (96.7; 178.0-699)	504.9 (100.4; 192-698)
Practice Characteristics			
Average Practice Volume / Year Mean (SD; range)	3122.7 [1,749.5; 5-9,075]	2,897.8 [1690.7; 55-9,075]	3,032.0 [1,658.9;110-8,110]
Number of Days Billed / Year Mean (SD; rannge)	122.4 [52.9; 1-270]	118.6 [52.3; 2-270]	\ 120.8 [51.5; 2-270]
Average % of Patients >65 Mean (SD; rannge)	0.14 [0.11; 0-0.97]	0.14 [0.11; 0-0.97]	0.12 [0.09; 0-0.97]
Average % of Female Patients Mean (SD; rannge)	0.57 [0.08; 0.12-1.00]	0.57 [0.08; 0.24-1.00]	0.59 [0.08; 0.38-0.79]
Patient Characteristics			
Gender			
Female	54,840 (60.9%)	2,366 (59.4%)	1,129 (57.6%)
Male	35,238 (39.1%)	1,615 (40.6%)	831 (42.4%)
Age			
Age>45	21,328 (23.7%)	1,257 (31.6%)	446 (22.8%)
Age≤45	68,750 (76.3%)	2,724 (68.4%)	1,514 (77.2%)
Referral			
Yes	5,980 (6.6%)	338 (5.5%)	92 (4.7%)
No	84,098 (93.4%)	3,643 (91.5%)	1868 (95.3%)
Patient Socioeconomic Status			
Below Poverty Line	29,632 (32.9%)	1,478 (37.1%)	703 (35.9%)
Above Poverty Line	60,446 (67.1%)	2,503 (62.9%)	1,257 (64.1%)
Number of Visits to Study MD			
Never Visit	81,584 (90.6%)	3,292 (82.7%)	1,549 (79.0%)
1	6,800 (7.6%)	512 (12.9%)	288 (14.7%)
>1	1,694 (1.8%)	177 (4.5%)	123 (6.3%)

Table 6.2.2 The Likelihood of Study Physicians Prescribing Inhaled Corticosteroid during 6-month after Index Visit for Patients whose asthma was out-of-control at the index visit (n=1,960)

Predictors	Category	Univariate Analysis Mean [SD; Range] No (%)			Multivariate Analysis		
		Prescribing ICS		Crude OR (95% CI)	QE1 Total Score Adjusted OR (95%CI)	QE2 Total Score Adjusted OR (95%CI)	Communication Adjusted Score OR (95%CI)
		No (n=599; 30.6%)	Yes (n=1361; 69.4%)				
Physician Characteristics							
Exam Scores	QE1 Total QE2 Total QE2 Communication	507.0 [77.5; 344-720] 518.8 [79.0; 270-749] 493.9 [104; 222-698]	520.0 [74.8; 344-728] 532.3 [78.9; 270-749] 509.7 [98.7; 192-698]	1.05 (1.00-1.10) 1.05 (1.01-1.10) 1.05 (1.00-1.10)	1.06 (1.02-1.11)	1.07 (1.02-1.11)	1.04 (1.00-1.09)
MD Gender	Female Male	297 (49.6%) 302 (50.4%)	752 (55.3%) 609 (44.8%)	1.07 (0.99-1.16) Ref	1.06 (0.98-1.14)	1.07 (0.99-1.15)	1.05 (0.97-1.13)
Practice Specialty	Respiratory Specialist GP	39 (6.5%) 560 (93.5%)	130 (9.6%) 1231 (90.5%)	1.12 (1.00-1.25) Ref	1.09 (0.98-1.21)	1.09 (0.98-1.21)	1.11 (0.99-1.24)
Patient Characteristics							
Patient Gender	Female Male	322 (53.8%) 277 (46.2%)	807 (59.3%) 554 (40.7%)	1.07 (1.00-1.14) Ref	1.06 (0.99-1.12)	1.05 (0.99-1.11)	1.06 (1.00-1.12)
Age	> 45 ≤45	134 (22.4%) 465 (77.6%)	312 (22.9%) 1049 (77.1%)	1.01 (0.94-1.09) Ref	1.00 (0.93-1.09)	1.00 (0.93-1.08)	0.99 (0.92-1.08)
Socioeconomic Status	Above Below Poverty Line	199 (33.2%) 400 (66.8%)	504 (37.0%) 857 (63.0%)	1.05 (0.99-1.12) Ref	1.05 (0.99-1.12)	1.04 (0.99-1.10)	1.05 (0.99-1.10)
Number of Visit to Study MD	Multiple Single Never (ref)	24 (4.0%) 82 (13.7%) 493 (82.3%)	99 (7.3%) 206 (15.1%) 1056 (77.6%)	1.08 (1.03-1.13)	1.07 (1.02-1.11)	1.07 (1.03-1.11)	1.07 (1.02-1.11)
Practice Characteristics							
Practice Volume	Per 100 Visits increase	3100 [1643; 62-8110]	3003 [1666; 85-8110]	0.99 (0.97-1.01)	0.98 (0.95-1.01)	0.98 (0.95-1.01)	0.98 (0.96-1.01)
Number of Practice Days	Per 100 Days increase	119 [52.1; 5-270]	122 [51.2; 2-264]	1.03 (0.97-1.10)	1.07 (0.97-1.18)	1.10 (0.99-1.21)	1.08 (0.99-1.17)
% of Patients >65	Per 10% increase	12.4 [9.2; 0-96.7]	11.8 [8.7; 0-84.9]	0.98 (0.94-1.02)	0.95 (0.91-0.99)	0.96 (0.92-1.00)	0.96 (0.93-1.01)
% of Female Patients	Per 10% increase	58.4 [7.9; 38.1-84.1]	58.7% [8.3; 37.9-92.2]	1.01 (0.97-1.05)	1.01 (0.96-1.05)	0.99 (0.95-1.05)	0.99 (0.95-1.03)

‡ Odds Ratio was estimated based upon Logistic regression within Generalized Equation Framework using auto-regressive correlation structure.

+ Odds Ratio was adjusted simultaneously for Physician (gender, physicians specialty) patient (gender, age, referral, respiratory condition-specific number of visit to study MDs at outpatient setting)and practice characteristics (out-patient specific practice volume, number of days billed at out-patient setting, proportion of elderly patients and of female patients)

$ Each of examination scores was included in the model separately

Table 6.2.3. The likelihood of ICS/Total Asthma Medication Ratio >0.5 in the 6-months after the Index Visit for Patients whose asthma was out-of-control at the index visit (n=1,960)

Predictors	Category	Univariate Analysis Mean [SD; Range] No (%)			Multivariate Analysis		
		ICS/Total Asthma Medication Ratio >0.5		Crude OR (95% CI)	QE1 Total Score Adjusted OR (95%CI)	QE2 Total Score Adjusted OR (95%CI)	Communication Adjusted Score OR (95%CI)
		No (n=932; 47.6%)	Yes (n=1028; 52.5%)				
Physician Characteristics							
Exam Scores	QE1 Total QE2 Total QE2 Communication	509.6 [77.0; 344-720] 523.8 [80.0; 270-749] 500.8 [106; 192-698]	521.9 [74.4; 353-728] 532.1 [78.2; 270-749] 508.5 [95.5; 247-698]	1.10 (1.04-1.17) 1.03 (0.98-1.09) 1.04 (0.98-1.10)	1.09 (1.02-1.16)	1.06 (1.00-1.13)	1.04 (0.99-1.11)
MD Gender	Female Male	492 (52.8%) 440 (47.2%)	557 (54.2%) 471 (45.9%)	1.03 (0.93-1.14) Ref	1.04 (0.92-1.16)	1.05 (0.94-1.18)	1.03 (0.92-1.17)
Practice Specialty	Respiratory Specialist GP	61 (6.6%) 871 (93.5%)	108 (10.5%) 920 (89.5%)	1.25 (1.07-1.45) Ref	1.17 (0.99-1.39)	1.20 (1.01-1.42)	1.21 (1.02-1.44)
Patient Characteristics							
Patient Gender	Female Male	498 (53.4%) 434 (46.6%)	631 (61.4%) 397 (38.6%)	1.17 (1.07-1.28) Ref	1.16 (1.06-1.26)	1.16 (1.07-1.26)	1.17 (1.07-1.28)
Age	> 45 ≤45	193 (20.7%) 739 (79.3%)	253 (24.6%) 775 (75.4%)	1.11 (0.99-1.23) Ref	1.12 (1.01-1.24)	1.11 (0.99-1.24)	1.11 (0.99-1.24)
Socioeconomic Status	Above Below Poverty Line	312 (33.5%) 620 (66.5%)	391 (38.0%) 637 (62.0%)	1.09 (1.00-1.19) Ref	1.09 (1.00-1.19)	1.08 (0.99-1.18)	1.09 (0.99-1.18)
Number of Visit to Study MD	Multiple Single Never (ref)	57 (6.1%) 139 (14.9%) 736 (79.0%)	66 (6.4%) 149 (14.5%) 813 (79.1%)	1.00 (0.93-1.08)	0.95 (0.88-1.04)	0.96 (0.88-1.04)	0.96 (0.89-1.04)
Practice Characteristics							
Practice Volume	Per 100 Visits increase	3036 [1609;62-8110]	3030 [1703; 85-8110]	1.00 (0.97-1.03)	1.00 (0.95-1.05)	0.99 (0.94-1.05)	1.00 (0.95-1.06)
Number of Practice Days	Per 100 Days increase	120 [51.7; 5-270]	122 [51.3; 2-264]	1.03 (0.95-1.13)	1.04 (0.88-1.22)	1.06 (0.89-1.25)	1.04 (0.88-1.23)
% of Patients >65	Per 10% increase	12.2 [9.1; 0-96.8]	11.7 [8.7; 0-52.7]	0.97 (0.91-1.03)	0.93 (0.88-0.99)	0.94 (0.89-0.99)	0.95 (0.90-1.01)
% of Female Patients	Per 10% increase	58.9 [8.1; 38.1-89.3]	58.3 [8.2; 37.9-92.2]	0.95 (0.90-1.01)	0.96 (0.89-1.03)	0.94 (0.88-1.02)	0.95 (0.88-1.01)

‡ Odds Ratio was estimated based upon Logistic regression within Generalized Equation Framework using auto-regressive correlation structure.
+ Odds Ratio was adjusted simultaneously for Physician (gender, physicians specialty) patient (gender, age, referral, respiratory condition-specific number of visit to study MDs at outpatient setting)and practice characteristics (out-patient specific practice volume, number of days billed at out-patient setting, proportion of elderly patients and of female patients). $ Each of examination scores was included in the model separately

Table 6.2.4. The likelihood of Persistent Out-of Control in the 6-months after the Index Visit for Patients whose asthma was out-of-control at the index visit (n=3,981)

Predictors	Category	Univariate Analysis Mean [SD; Range] No (%); Mean [SD; Range]			Multivariate Analysis		
		Persistent Out-of-Control*		Crude OR (95% CI)	QE1 Total Score Adjusted OR (95%CI)	QE2 Total Score Adjusted OR (95%CI)	Communication Adjusted Score OR (95%CI)
		No n=2,144; 53.9%	Yes n=1837; 46.1%				
Physician Characteristics							
Exam Scores	QE1 Total QE2 Total QE2 Communication	524.3 [77.3; 344-728] 529.4 [78.2; 158-749] 506.4 [95.1; 178-698]	523.1 [78.1; 344-728] 527.7 [78.6; 270-749] 503.5 [98.5; 178-699]	0.99 (0.9501.04) 1.03 (0.98-1.07) 0.99 (0.96-1.03)	0.99 (0.96-1.04)	0.99 (0.95-1.03)	0.97 (0.94-1.00)
MD Gender	Female Male	1167 (54.4%) 977 (45.6%)	932 (50.7%) 905 (49.3%)	0.92 (0.86-0.99) Ref	0.90 (0.83-0.98)	0.90 (0.84-0.98)	0.91 (0.84-0.99)
Practice Specialty	Respiratory Specialist GP	321 (15.0%) 1823 (85.0%)	195 (10.6%) 1642 (89.4%)	0.80 (0.68-0.94) Ref	0.80 (0.68-0.94)	0.80 (0.68-0.94)	0.80 (0.67-0.94)
Patient Characteristics							
Patient Gender	Female Male	1300 (60.6%) 844 (39.4%)	1066 (58.0%) 771 (42.0%)	0.94 (0.88-1.01) Ref	0.93 (0.87-0.99)	0.93 (0.87-0.99)	0.93 (0.87-0.99)
Age	> 45 ≤45	594 (27.7%) 1550 (72.3%)	663 (36.1%) 1174 (63.9%)	1.22 (1.15-1.31) Ref	1.23 (1.15-1.31)	1.23 (1.15-1.31)	1.23 (1.16-1.31)
Socioeconomic Status	Above Below Poverty Line	808 (37.7%) 1336 (62.3%)	670 (36.5%) 1167 (63.5%)	0.97 (0.91-1.04) Ref	0.96 (0.90-1.03)	0.96 (0.90-1.03)	0.96 (0.90-1.03)
Number of Visit to Study MD	Multiple Single Never (ref)	83 (3.9%) 265 (12.4%) 1796 (83.8%)	94 (5.1%) 247 (13.5%) 1496 (81.4%)	1.08 (1.01-1.14)	1.09 (1.03-1.16)	1.09(1.03-1.16)	1.09 (1.03-1.16)
Practice Characteristics							
Practice Volume	Per 100 Visits increase	2937.6 [1689; 55-9075]	2851 [1692; 56-8110]	0.98 (0.96-1.0)	1.01 (0.97-1.05)	1.01 (0.97-1.05)	1.00 (0.96-1.04)
Number of Practice Days	Per 100 Days increase	121.4 [52.3; 2-264]	115 [52.1; 2-270]	0.88 (0.83-0.94)	0.85 (0.76-0.96)	0.86 (0.76-0.96)	0.86 (0.77-0.97)
% of Patients >65	Per 10% increase	13.6 [10.8; 0-66.4]	13.9 [10.8; 0-96.8]	1.01 (0.98-1.05)	1.01 (0.98-1.05)	1.01 (0.98-1.05)	1.01 (0.98-1.05)
% of Female Patients	Per 10% increase	57.3 [8.5; 29.1-92.2]	57.7 [8.2; 24.2-100]	1.03 (0.99-1.07)	1.06 (1.01-1.11)	1.06 (1.01-1.11)	1.06 (1.01-1.11)

*Persistent out-of-control is defined as overuse of FABA for two consecutive 3-month periods

‡ Odds Ratio was estimated based upon Logistic regression within Generalized Equation Framework using auto-regressive correlation structure.

+ Odds Ratio was adjusted simultaneously for Physician (gender, physicians specialty) patient (gender, age, referral, respiratory condition-specific number of visit to study MDs at outpatient setting)and practice characteristics (out-patient specific practice volume, number of days billed at out-patient setting, proportion of elderly patients and of female patients)

$ Each of examination scores was included in the model separately

Table 6.2.5. The likelihood of Multiple Respiratory-related Emergency Room Visits in the 6-months after the Index Visit for Patients whose asthma was out-of-control at the index visit (n=3,981)

Predictors	Category	Univariate Analysis Mean [SD; Range] No (%)			Multivariate Analysis		
		Multiple Respiratory-related ER visits*		Crude OR (95% CI)	QE1 Total Score Adjusted OR (95%CI)	QE2 Total Score Adjusted OR (95%CI)	Communication Adjusted Score OR (95%CI)
		No (n=3601; 90.4%)	Yes (n=380; 9.6%)				
Physician Characteristics							
Exam Scores	QE1 Total QE2 Total QE2 Communication	523.8 [77.7; 344-728] 528.6 [78.6; 158-749] 505.2 [96.3; 178-699]	523.7 [77.0; 347-728] 528.9 [76.6; 341-749] 503.8 [100; 192-698]	0.99 (0.88-1.13) 1.00 (0.90-1.13) 0.99 (0..88-1.10)	0.99 (0.87-1.12)	0.97 (0.86-1.09)	0.90 (0.82-1.00)
MD Gender	Female Male	1883 (52.3%) 1718 (47.7%)	216 (56.8%) 164 (43.2%)	1.18 (0.95-1.46) Ref	1.07 (0.86-1.32)	1.07 (0.86-1.32)	1.10 (0.89-1.36)
Practice Specialty	Respiratory Specialist GP	473 (13.1%) 3128 (86.9%)	43 (11.3%) 337 (88.7%)	0.86 (0.63-1.16) Ref	0.78 (0.54-1.11)	0.77 (0.54-1.10)	0.76 (0.54-1.07)
Patient Characteristics							
Patient Gender	Female Male	2,133 (59.2%) 1,468 (40.8%)	233 (61.3%) 147 (38.7%)	1.09 (0.92-1.28) Ref	1.01 (0.86-1.18)	1.01 (0.86-1.18)	1.01 (0.86-1.18)
Age	> 45 ≤45	1098 (30.5%) 2503 (69.5%)	159 (41.8%) 221 (58.2%)	1.56 (1.28-1.90) Ref	1.56 (1.30-1.87)	1.56 (1.39-1.86)	1.57 (1.31-1.88)
Socioeconomic Status	Above Below Poverty Line	1338 (37.2%) 2263 (62.8%)	140 (36.8%) 240 (63.2%)	0.99 (0.82-1.19) Ref	0.93(0.55-1.12)	0.93 (0.78-1.12)	0.94 (0.78-1.13)
Number of Visit to Study MD	Multiple Single Never	150 (4.2%) 457 (12.7%) 2994 (83.1%)	27 (7.1%) 55 (14.5%) 298 (78.4%)	1.26 (1.06-1.51)	1.20 (1.03-1.40)	1.20(1.03-1.40)	1.22 (1.05-1.42)
Previous ER Visit	Yes No	770 (21.4%) 2,831 (78.6%)	254 (66.8%) 126 (33.2%)	4.42 (3.67-5.32) Ref	5.88 (4.89-7.08)	5.89 (4.89-7.06)	5.91 (4.91-7.11)
Practice Characteristics							
Practice Volume	Per 1000 Visits	2910 [1690; 55-9080]	2764 [1662; 107-7885]	0.95 (0.89-1.02)	1.03 (0.92-1.14)	1.03 (0.92-1.14)	1.01 (0.91-1.12)
Number of Practice Days	Per 100 Days	119 [52; 2-270]	115 [53,6; 3.0-261]	0.89 (0.74-1.07)	0.88 (0.66-1.19)	0.89 (0.66-1.19)	0.89 (0.67-1.19)
% of Patients >65	Per 10%	13.7 [10.8; 0-96.8]	14.1 [10.8; 0-56.7]	1.03 (0.94-1.13)	0.97 (0.88-1.06)	0.96 (0.88-1.06)	0.96 (0.88-1.05)
% of Female Patients	Per 10%	57.4 [8.3; 24.2-100]	58.6 [8.8; 32.6-85.2]	1.16 (1.03-1.31)	1.14 (1.00-1.32)	1.15 (1.00-1.32)	1.16 (1.01-1.32)

*Multiple respiratory-related ER visits was defined as having received medical services in the ER more than 1 time during the 6-month follow-up period
‡ Odds Ratio was estimated based upon Logistic regression within Generalized Equation Framework using auto-regressive correlation structure.
+ Odds Ratio was adjusted simultaneously for Physician (gender, physicians specialty) patient (gender, age, referral, respiratory condition-specific number of visit to study MDs at outpatient setting)and practice characteristics (out-patient specific practice volume, number of days billed at out-patient setting, proportion of elderly patients and of female patients). $ Each of examination scores was included in the model separately

Table 6.2.6. The Amount of Variance Explained by Hypothesized Patient, Physician and Practice Characteristics

Outcomes	Various Combination of Predictors						
	Null Model	MD Characteristics[1] Alone	Practice Characteristics[2] Alone	Patient Characteristics[3] Alone	MD [1] Plus Practice Characteristics[2]	MD [1] Plus Patient Characteristics[3]	Full Model[4]
	-log likelihood (% of Total Residual Variance Explained£; % Explained within Total Residual Variance) [Number of Covariates]						
Prescribing Any ICS (n=1,960)	-1206.47 (--; 0%) [0]	-1191.82 (1.1%; 35.4%) [5]	-1199.85 (0.7%; 22.6%) [4]	-1197.02 (1.0%; 32.3%) [5]	-1188.08 (2.1%; 67.7%) [9]	-1184.94 (2.5%; 80.6%) [10]	-1180.51 (3.1%; 100%) [14]
ICS/Total Asthma RX Ratio (n=1,960)	-1356.22 (--; 0%) [0]	-1345.56 (0.7%; 25.0%) [5]	-1351.60 (0.6%; 21.4%) [4]	-1342.03 (1.3%; 46.4%) [5]	-1342.22 (1.6%; 57.1%) [9]	-1335.93 (2.1%; 75.0%) [10]	-1330.51 (2.8%; 100%) [14]
Persistent Out-of Control (n=3,981)	-2747.57 (--; 0%) [0]	-2735.77 (0.5%; 22.7%) [5]	-2735.66 (0.5%; 22.7%) [4]	-2727.33 (1.0%; 45.5%) [5]	-2725.60 (1.1%; 50.0%) [9]	-2712.94 (1.7%; 77.2%) [10]	-2701.90 (2.2%; 100%) [14]
Multiple Respiratory-related Emergency Room Visits (n=3,981)	-1253.92 (--; 0%) [0]	-1251.81 (0.04%; 0.03%) [5]	-1248.5 (0.06%; 0.03%) [4]	-1083.85 (13.9%; 88.5%) [6]	-1247.46 (1.1%; 7.0%) [9]	-1075.24 (15.2%; 96.8%) [11]	-1071.86 (15.7%; 100%) [15]

£ Percentage of total residual variance explained was calculated based upon Pseudo R-square using the following formula by Shtatland et al (1998): 1- ((log-liklihood for the fitted model-(number of covariates +1)(samplesize-1)/(sample size-number of covariates-1))/(log-likelihood for a null model-1) [1] MD Characteristics includes gender, specialty, QE1 and QE2 total score and Communication Scores
[2] Practice Characteristics includes out-patient specific practice volume, number of days billed at out-patient setting, proportion of elderly patients and of female patients. [3] Patient Characteristics includes gender, age, referral, respiratory condition-specific number of visit to study MDs at outpatient setting, and socioeconomic status. Previous ER visit was included as patient characteristic in the multiple respiratory-related ER visit only . [4] Full model includes MD, Practice, and Patient characteristics

Chapter 7. Conclusion

This chapter summarizes the key findings of this thesis and presents the implications for practice, and recommendations for future research.

7.1 Overview

In Canada, asthma is a major cause of morbidity for two million Canadians and imposes a substantial burden on health care expenditures. Even after an extensive effort to foster effective asthma management through consensus-based asthma clinical guidelines, sub-optimal levels of effective asthma management persist. Despite evidence supporting the effectiveness of regular use of inhaled corticosteroids (ICS), sub-optimal use of ICS appears to be substantial. Moreover, there are a number of outstanding challenges to implement the essential components of asthma education and self-management in practice.

This thesis investigated the role of physicians in optimal asthma management, particularly in relationship to their knowledge and clinical judgement, and their approach to asthma management. Knowledge, clinical judgment, and communication ability are fundamental components of clinical competence and play a major role in the quality of clinical practice and medical decision making. In the context of asthma, our literature review showed that there is a limited amount of evidence to support that medical knowledge and communication skills contributes to optimal asthma management.

The literature review also indicated that several modifiable factors are potentially inter-related with each other across different levels of care; patient, provider, practice context, and health care system, and they contributed to this phenomenon. Thus, we elucidated the independent contribution of physician clinical competence by simultaneous assessment of the three key components: physicians, their practice environment, and patients.

The investigation was performed with a prospective cohort of 609 physicians who took the Medical Council of Canada (MCC) Part 2 examination between 1993 and1996 and provided care for asthma patients in Quebec between 1993 and 2003. We identified 3,981 patients whose asthma was out-of-control at the index visit and who were then followed up for a 6 month period after the first visit with a study physician. We assessed the following four outcomes: 1) multiple respiratory-related emergency room visits, 2) fast-acting beta agonists (FABA) overuse, 3) use of inhaled corticosteroids (ICS) and 4) ICS/total asthma medication ratio.

7.2 Summary of Key Findings

As prior research has shown, our current study also found an independent association between better medical knowledge and clinical skills and a greater likelihood of better asthma management. Higher scores on the QE1 and QE2 components of the national licensing examination and higher communication scores were associated with an increased likelihood of providing inhaled corticosteroids. Similarly, higher QE1 and QE2 scores predicted greater use of preventative medications (ICS/total asthma medication Ratio >0.5). In contrast, the communication score was only the predictor of asthma morbidity. For every 1 standard deviation increase in communication score, the likelihood of a patient experiencing persistent out-of-control asthma was reduced by 3% (OR=0.97; 0.94-0.99). In addition, we found a 10% reduction in multiple ER visits for respiratory-related conditions for every standard deviation increase in communication score (OR=0.90; 95%CI=0.81-0.99).

This thesis also pointed out multiple determinants of sub-optimal inhaled corticosteroid use and asthma morbidity across different levels of health care. This is one of the first studies to show an association between physician gender and the quality of asthma management. Gender-based distinctive practice style exists, and several essential components of these styles may have positively contributed to effective asthma management, including patient-centered

communication,[113;120] making arrangements for follow-up visits and referrals,[113;120] preventive services,[119] counselling, and providing information.[106]

Another novel finding of this thesis is the elucidation of practice environment determinants of optimal asthma management. Previous studies documented a negative impact of the higher workload in the practice environment on the quality of physician prescribing.[109;173;174] In contrast, our results indicated that patients of physicians with a higher number of work days were less likely to experience persistent out-of-control asthma, which may reflect greater opportunities to access physicians to manage poorly controlled chronic problems. Characterization of the physician's practice population profile provided new insights about conditions for effective asthma management. Our findings indicate that a higher proportion of female patients and elderly patients in the practice have a negative impact on effective asthma management.

7.3 Recommendations for Future Research

The first recommendation concerns the validity of the Canadian national licensing exam. Our study demonstrated that medical knowledge and communication scores in the national licensing scores are important predictors of effective asthma management. Future research should be conducted with a wide range of indicators of the clinical care in the various practice settings. For instance, an investigation of evidence-based disease management of other ambulatory care sensitive conditions, such as diabetes, will establish the evidence of the predictive validity of the licensing examinations in determining future performance.

Second, we addressed a methodological challenge in identifying asthma patients using administrative health care databases. In the first manuscript, we showed how the development of the algorithm using a broad spectrum of indicators from an administrative health care database could improve the identification of patients with asthma and those without. The combined use of asthma-specific indicators

from medical services claims and asthma-related medication use demonstrated a sensitivity of 70.8% and specificity of 92.9%. The predicted probability of asthma based on a combination of database algorithms has the potential for wider use and applicability to identify patients with other types of chronic disease. However, in the present study, a gold standard was established based on the confirmation of asthma status by the patient's primary care physician. Thus, our findings may not be generalizable to patients whose asthma is cared for solely by asthma specialists. In order to enhance the validity, future research should be conducted to examine the performance of this algorithm for asthma case identification in different datasets, and with populations of patients seen by both generalists and specialists.

Moreoever, this research project was conducted using the information from the provincial administrative healthcare databases (RAMQ). While RAMQ covers the cost of medical services, including physicians visits, hospitalization, and medical procedures, provided to all the residents in Quebec, it only covers prescription costs of individuals 65 years and older, welfare recipients, and workers and their families who do not have access to private drug insurance program, accounting for approximately less than half of the entire Quebec population.[347]

Due to the nature of the RAMQ drug insurance coverage in Quebec, the generalizability of our current findings to other Canadian provinces or other jurisdictions should be carefully examined. Patients who are covered by the RAMQ drug plan are more likely have characteristics that are associated with lower socioeconomic status (SES), including unemployment, lower educational attainments, and a household income below poverty level.[348] The previous literature showed consistent evidence regarding the association between lower SES and a sub-optimal level of asthma management; therefore, our current finding may not be generalizable to administrative databases in other provinces with a various level of prescription coverage as well as availability of pharmacy data.

Although there is variation in the completeness of data available across provinces and other jurisdictions, the development of algorithm to identify patients with asthma in the first paper was performed using indicators that are generally available in other administrative databases. Use of these generic indicators will be advantageous in applying the current methodology to conduct a similar study using administrated health care database in other provinces and jurisdictions.

This project demonstrated an association between practice environment and optimal asthma management. The so-called 'volume-outcome relationship' noted in other domains of quality assessment could explain this phenomenon,[169] and further research should be directed toward disentangling the two principal hypotheses: 1) greater development of effective physician skills is a consequence of treating a large number of patients or 2) more effective physicians lead to , more referrals in recognition of expertise, and thus the accrual of higher volumes of patients. In turn, we are able to identify the key players in the health care system for potentially effective chronic disease management. Our study found that different population profiles were associated with different components of asthma management. For instance, a higher proportion of elderly patients in the practice was associated with a sub-optimal level of asthma prescribin; whereas a higher proportion of female patients in the practice was associated with sub-optimal level of asthma management. Future research is needed to profile practice population characteristics that predict the likelihood of optimal chronic disease management.

To assess the volume-outcome relationship, one of the first approaches would be to examine asthma specific caseloads as one of the practice predictors for optimal asthma management. Our current study did not measure this particular aspect of the practice environment.. Previous studies showed better quality of care is associated with a higher caseload of patients with a specific medical condition, such as diabetes and cardiovascular disease.[170;171] Thus, future research should examine the impact of the asthma specific caseload that influences the

quality of asthma management. These aspects may include the relative volume of asthma patients, the proportion of severe asthmatics, and the extent of control.

7.4 Recommendations for Future Practice and Policy

Our findings regarding the predictive ability of licensing exam scores have significant implications for medical school educators in two ways. First, performance on licensing exam scores could be utilized for early detection of trainees who would likely provide sub-optimal care and identify areas of remedial training. Our study indicated that each domain of asthma management seems to be related to a different component of clinical competence. For instance, knowledge may play a critical role in determining the quality of prescribing; whereas communication skills is the key factor in establishing on-going relationships with patients and their quality of self-management. This suggests that post graduate training programs need to target relevant skill sets in their practice domains.

Performance on licensing examinations potentially also offers a critical opportunity to screen key abilities such as communication. As several studies have reported, early years of academic performance have been associated with the subsequent scores achieved on certifying tests of the National Board of Medical Examiners(NBME)[318] as well as unprofessional behaviour later in their practice.[333] Thus, future study should be directed toward establishing benchmarks for required levels of performance during medical school training to advance into further training and to residency programs.

Finally, the findings of this thesis offer significant implications for policy-makers. Our study demonstrated the joint contribution of determinants of the quality of asthma management and the effect of the physician management decisions at the index visit. Our findings offer new insights for identification of patterns that facilitate optimal care or that predict substandard quality of care.

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Appendix I

Manuscript 1: Study Population and Methodological Development

1. Study Objective

The study objective is to develop and validate an algorithm for identifying patients with asthma based upon relevant markers in administrative databases, including patterns of health services utilization and prescription dispensation. We will use the algorithm to estimate probabilities for a given patient to have asthma in the analysis of determinants of the quality of asthma management in the second manuscript

2. Identification of Study Population

Patients were included in the study population according to the following eligible criteria:

- Patients who consented to the Medical Office of the Twenty First Century (MOXXI) project in Montreal so that physician-confirmed asthma could be retrieved from electronic medical record information

- Covered by RAMQ drug insurance plan as information about dispensed prescriptions is only available for patients with government drug insurance

- Age 5-65 without COPD diagnosis in MOXXI problem list and in medical service file based upon the following ICD-9 Codes: "490.x","490.x""492.x","494.x","495.x","496.x","500.x","501.x""502.x", "503.x","504.9","505.x",and "506.4"

- Whose RAMQ data was available from January 2003 to December 2005

2. Data Source

i. Medical Service and prescription Claims Database

The provincial health insurance agency (RAMQ) provides first dollar coverage for all medical and hospital care for all Quebec residents. The medical services claims database provided information on the beneficiary, date, type, provider, and location of service delivery (e.g. inpatient, emergency, clinic) for all medical services remunerated on a fee-for-service basis (approximately 86% of all services).[265] The health beneficiary demographic database provided data on age, sex, and postal code for each patient. The prescription claims database provided information on each drug dispensed including the drug name, quantity, date and duration for each prescription, the prescribing physician, and the dispensing pharmacy.

ii. Novel Information of Prescribing Indication as a Gold Standard

The MOXXI system is an electronic prescription and drug management system for primary care physicians, community-based pharmacists and their 15,398 consenting patients. The MOXXI system allows physicians to write prescriptions electronically and retrieve information on dispensed prescriptions , diagnostic codes and dates of all medical visits recorded for a patient from the health insurance program and community pharmacy network.

3. Gold Standard: Physician Diagnosis of Asthma

A combination of the two sources of information from the Medical Office of 21st Century (MOXXI) system were used as the gold standard: a) the therapeutic indication of asthma in the electronic prescription field and b) the automated problem list

a) Therapeutic Indication of Asthma

When the drug name is entered in the electronic prescription field in the MOXXI system, a list of potential therapeutic indications for the specific prescriptions appears in the MOXXI system. The physician must select at least one treatment indication for the prescribed medication to complete the electronic prescription. The mandatory requirement to complete a treatment indication field with each prescription served to identify all patients with asthma who were prescribed medication for their problem by primary care physicians.

b) Automated Problem List

The automated problem list in the MOXXI system generates potential patient-specific medical conditions based upon three sources of information: 1) therapeutic indication in the electronic prescription field, 2) ICD-9 diagnosis code in the RAMQ medical service database, and 3)single indication drugs in the the RAMQ prescription database. The daily updated list of patient-specific medical conditions is shown each time the study physician opens a patient file in the MOXXI system. Physicians verify the status of each medical conditions as "verified", "rejected", or "yet to be confirmed". This source was used to identify patients who had asthma but were not treated with medication or who were treated (i.e. prescribed drugs) by another physicians.

Patients were considered to have asthma on the basis of the following criteria: (1) at least one written electronic prescription with a treatment indication of asthma and 2) having asthma as a generated medical condition in the problem list and the status having been verified or yet to be confirmed by study physicians. Patients were considered <u>not</u> to have asthma based upon the following criteria: (1) having asthma as a generated medical condition in the problem list and the status that was rejected by the study physician and (2) no records of asthma as a generated medication condition in the problem list with at least one electronic prescription for any medical conditions except asthma. The second criterion was established to ensure that study physicians had opportunities to assess if a given patient had 'asthma'.

Table i.1.1 describes 2, 438 study patients that were initially identified from January 2003 to Febrary 2006 based upon the preliminary eligibility criteria. Among those, 284 patients were considered having “asthma present’; whereas 1,232 patients were considered having “asthma absent”.

Table i.1.1 Asthma Classification Status by Two Gold Standards

n=2,438			a) Electronic Prescription (Erx) with Asthma Indication		
			Yes (n=132)	No	
				>1 Erx without Asthma Indication (n=1369)	No Records of any Electronic Prescriptions (n-939)
b) Problem List	Status	Yes	130	81	15
		No	1	22	1
		Not Yet	1	57	117
		No Record	0	1209	806

: Asthma Present (n=284)

: Asthma Absent (n=1,232)

4. Identifying the Indicators of Asthma in the RAMQ Medical Service Claims File

(1) Asthma-Specific Indicators

Asthma-specific visits were identified in the ICD-9 diagnosis codes (493.x) of the RAMQ medical service claims. Each record of a medical service in the RAMQ administrative database provides a ICS-9 diagnostic code indicating the reason for the visit. Number of asthma-specific visits were identified as one indicator of asthma contingent on them being delivered by the following types of health care providers : general practitioners and specialists that could be involved in asthma management: respirologists, allergists, and medical internists, and pediatricians. An examination of asthma-specific visits by gold standard assessment of physician-confirmed asthma revealed a low level of sensitivity. (Table i.1.2-i.1.5) The maximum sensitivity was 43.6% using, with an indicator: number of asthma-specific visits regardless of provider type (Table i.1.2).

a) Inclusion only Asthma Specific Visits

Table i.1.2 The Likelihood Ratio of Asthma-Specific Visits to Any Providers by Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Specific Visits to Any Provider	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	160 (56.3)	1202 (97.6)	0.58
1	48 (16.9)	22 (1.8)	9.39
2-5	58 (20.4)	7 (0.6)	34.0
>5	18 (6.3)	1 (0.1)	63.0
Mean (Range)	[]	[]	

Table i.1.3 The Likelihood Ratio of Asthma-Specific Visits to General Practitioners by Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Specific Visits to General Practitioners	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	166 (58.4)	1208 (98.1)	0.88
≥1	118 (41.6)	24 (1.9)	21.9
Range	0-13	0-3	

Table i.1.4 The Likelihood Ratio of Asthma-Specific Visits to Specialists by Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Specific Visits to Specialists	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	263 (92.6)	1226 (99.5)	0.93
≥1	21 (7.4)	6 (0.24)	30.8
Range	1-12	1-5	

Table i.1.5 The Likelihood Ratio of Asthma-Specific Visits to Other Type of Health Care Professionals by Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Specific Visits to Other Health Care Professionals	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	283 (99.6)	1232 (99.5)	1.00
≥1	1 (0.4)	0 (--)	--
Range	0-1	0	

(2) Efforts to Improve Sensitivity of Indicators Identified from Medical Claims File

Our initial results indicated that an inclusion of indicators that are specific to asthma-related specialist management did not improve sensitivity. Thus, several additional source of the information in the medical service claims database in the RAMQ were explored to improve the level of sensitivity while not penalizing specificity.

i.. Broadening Diagnosis to Respiratory Related Visits

First, examination of asthma-specific visits was extended to the following respiratory-related conditions:

460: ACUTE BRONCHITIS
4659: ACUTE UPPER RESPIRATORY INFECTION
7860: DYSPNEA&RESPIRATORY ABNORMALITIES
7861: STRIDOR
7864: ABNORMAL SPUTUM
7865: CHEST PAIN
7867: ABNORMAL CHEST SOUNDS
7869: OTHER SYMPTOMS INVOLVING RESPIRATORY SYSTEM & CHEST

The number of respiratory-related visits was examined according to the type of health care provider. (Table i.1.6-16) The addition of those respiratory-related visits improved the level of sensitivity up to 72.2% but slightly lowered the level of specificity, as low as 72.1%, from the specificity of asthma-specific visits. (Table i.1.7)

b) Addition of Respiratory Related Visits by Type of Provider

1) Any Provider

Table i.1.6 The Likelihood Ratio of Asthma-related Visits in relationship to Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to Any Providers	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	109 (38.4)	963 (78.2)	0.49
1	58 (20.4)	153 (12.4)	1.65
2-5	80 (28.2)	98 (8.0)	3.53
>5	37 (13.0)	18 (1.5)	8.67
Mean (Range)	0-17	0-101	

Table i.1.7 Asthma-related Visits in relationship to Asthma Diagnosis (after including Acute bronchitis and acute upper respiratory infection)

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to Any Providers	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	79 (27.8)	888 (72.1)	38.6
1	65 (22.9)	208 (16.9)	1.36
2-5	96 (33.8)	117 (9.5)	3.56
>5	44 (15.5)	19 (1.5)	10.3
Mean (Range)	0-17	0-101	

2) General Practitioners

Table i.1.8 The likelihood ratio of Asthma-related Visits to General Practitioners in relationship to Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to General Practitioners	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	127 (44.7)	1042 (84.6)	0.53
1	55 (19.4)	122 (9.9)	1.96
2-5	74 (26.0)	56 (4.5)	5.78
>5	28 (9.9)	12 (0.9)	11.0
Range	0-17	0-101	

Table i.1.9 The likelihood ratio of Asthma-related Visits to General Practitioners in relationship to Asthma Diagnosis (after adding acute bronchitis ICD9:460.0)

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to GPs	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	93 (32.7)	963 (78.2)	0.42
1	65 (22.9)	180 (14.6)	1.57
2-5	89 (31.3)	76 (6.2)	5.05
>5	37 (13.0)	13 (1.1)	11.8
Range	0-17	0-101	

Table i.1.10 The likelihood ratio of Asthma-related Visits to General Practitioners in relationship to Asthma Diagnosis (after adding acute upper respiratory infection ICD9:465.9)

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to GPs	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	94 (33.1)	963 (78.2)	0.39
1	64 (22.5)	180 (14.6)	1.24
2-5	98 (34.5)	81 (6.6)	3.38
>5	28 (9.9)	8 (0.6)	9.0
Range	0-18	0-101	

3) Specialists

Table i.1.11 The likelihood ratio of Asthma-related Visits to Specialists in relationship to Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to Specialists	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	240 (84.5)	1187 (96.3)	0.88
1	17 (6.0)	22 (1.8)	3.33
2-5	15 (5.3)	18 (1.5)	3.53
>5	8 (2.8)	5 (0.4)	7.00
Mean (Range)	0-8	0-12	

Table i.1.12 The likelihood ratio of Asthma-related Visits to Specialists in relationship to Asthma Diagnosis (after including acute bronchitis ICD9:460.0)

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to Specialists	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	246 (86.6)	1186 (96.3)	0.90
1	16 (5.6)	23 (1.9)	2.94
2-5	16 (5.6)	18 (1.5)	3.73
>5	6 (2.1)	5 (0.4)	5.25
Mean (Range)	0-8	0-12	

Table i.1.13 The likelihood ratio of Asthma-related Visits to Specialists in relationship to Asthma Diagnosis (after including acute upper respiratory infection ICD9:465.9)

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to Specialists	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	245 (86.3)	1187 (96.3)	0.90
1	17 (6.0)	23 (1.9)	3.16
2-5	16 (5.6)	17 (1.5)	3.73
>5	6 (2.1)	5 (0.4)	5.25
Mean (Range)	0-8	0-12	

4) Other Health Care Professionals

Table i.1.14 The likelihood ratio of Asthma-related Visits to Other health care professionals in relationship to Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to Other Health Care Professionals	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	254(89.4)	1139 (92.5)	96.7
$\geq$ 1	30 (10.6)	93(7.5)	1.41

Table i.1.15 The likelihood ratio of Asthma-related Visits to Other health care professionals in relationship to Asthma Diagnosis (after adding acute bronchitis ICD9:460.0)

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to Other Health Care Professionals	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	254(89.4)	1139 (92.5)	96.7
$\geq$ 1	30 (10.6)	93(7.5)	1.41

Table i.1.16. The likelihood ratio of Asthma-related Visits to Other health care professionals in relationship to Asthma Diagnosis (after adding acute upper respiratory infection ICD9:465.9)

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Asthma Related Visits to Other Health Professionals	Asthma Present n=284 (%)	Asthma Absent n=1232 (%)	Likelihood Ratio
0	254(89.4)	1136 (92.2)	97.0
$\geq$ 1	30 (10.6)	97(7.8)	1.36

ii. Co-morbidity

The next methodological improvement was emphasized in improving the sensitivity while not penalizing the specificity. We compared all diagnosis codes in the medical service file between patients with asthma and those without asthma. The frequency distribution of diagnosis codes according to asthma status, shown in Table i.1.17, identified several diagnosis codes that were distinctive to patients with asthma. The two diagnosis codes: cough and acute sinusitis, unspecified were identified only in the group of patients with asthma.

Among patients who were confirmed as asthma present, there were several patients who did not have any visits for any respiratory-related conditions. Thus, the distribution was further stratified according to the presence of any respiratory-related visits. The results were shown in Table i.1.18. Among patients with any respirator-related visits, the frequency distribution identified several diagnosis codes that were uniquely prevalent in patients with confirmed asthma. For instance, in addition to asthma, unspecified, cough was more prevalent among patients with asthma (20%), compared to patients without asthma (7.6%). On the other hand, cardiac-related conditions were more likely to be absent among patients with asthma. For instance, an approximately a half of patients without asthma had visits for chest pain (46.8%); whereas 26.3% of patients with asthma had visits for chest pain.

Similarly, among patients with any respiratory-related visit condition, patients with asthma showed a uniquely high prevalence of conditions that are closely related to somatic complaints, including headache, fatigue, dizziness and giddiness. In addition, patients with asthma had a higher prevalence of conditions that are closely related to upper airway, ear, nose and throat disease, including allergic rhinitis and otitis media. As a result, those distinctive conditions were categorized into the three groups: upper airway conditions, cardiac conditions, and neurotic disorder/somatic complaints. The frequency distributions according to the new grouping of medical conditions are shown in Table i.1.19.

Finally, several visits in the medical service claims file provided unknown diagnosis codes: ‘999’ or missing. We explored this matter further and looked up the procedure codes associated with the unknown diagnosis codes. However, we didn’t find any systematic patterns with the procedure codes across the four groups (Table i.1.20)

Table i.1.17 Top Frequency Distribution of Diagnosis codes (respiratory related conditions were excluded)

	Asthma Present (n=284)		Asthma Absent (n=1,232)	
Rank	Diagnosis (Code)	Frequency (%)	Diagnosis (Code)	Frequency (%)
1.	No Record	218	No Record	809
2.	V999	182	V999	658
3.	V70.0 General medical examination	136	V70.0 General medical examination	556
4.	300.0 Neurotic disorders Anxiety states	77	401.9 Essential hypertension, Unspecified	348
5.	401.9 Essential hypertension, Unspecified	68	300.0 Neurotic disorders Anxiety states	277
6.	789.0 Abdominal pain	66	789.0 Abdominal pain	208
7.	250.0 Diabetes mellitus without mention of complication	47	*311 Depressive disorder, not elsewhere classified*	179
8.	786.2 Cough	45	250.0 Diabetes mellitus without mention of complication	176
9.	311 Depressive disorder, not elsewhere classified	45	272.9 Unspecified disorder of lipoid metabolism	134
10.	729.5 Pain in limb	42	726.9 Unspecified enthesopathy	131
11.	726.9 Unspecified enthesopathy	42	729.5 Pain in limb	130
12.	461.9 Acute sinusitis, unspecified	38	627.2 Symptomatic menopausal or female climacteric states	125
13.	724.5 Backache, unspecified	37	V04.8 Influenza	123
14.	627.2 Symptomatic menopausal or female climacteric states	34	V72.3 Gynecological examination	118
15.	715.9 Osteoarthrosis, unspecified whether generalized or localized	33	715.9 Osteoarthrosis, unspecified whether generalized or localized	114
16.	V04.8 Influenza	32	724.5 Backache, unspecified	110
17.	784.0 Headache	32	V70.9 Unspecified general medical examination	109
18.	692.9 Contact dermatitis and other eczema, unspecified sites	31	692.9 Contact dermatitis and other eczema, unspecified sites	106
19.	272.9 Unspecified disorder of lipoid metabolism	31	*216.9 Benign neoplasm of skin, Site Unspecified*	106
20.	216.9 Benign neoplasm of skin, Site Unspecified	30	733.0 Osteoporosis	100
	724.2 Lumbago	29	V72.9 Unspecified examination	81
	558.9 Other and unspecified noninfectious gastroenteritis and colitis	28	401.1 Essential hypertension. Benign	81

Note: Chest pain(n=161)/upper respiratory (n=162) were higher rank in the group of asthma absent
Note: Asthma, unspecified (n=124) acute bronchitis (n=74) upper respiratory (n=64) chest pain (n=54) dysnea(n=32) were at the higher rank in the group of asthma present

Table i.1.18. Frequency Distribution of ICD9 Diagnosis according to Asthma Status and the Presence of Respiratory-related Conditions.

	Asthma Present n=284	Asthma Absent n=1,232
Patients with Respiratory related Visits Present: Other Conditions that are distinctive enough to be able to use potential indicators for asthma Present	Group A: (n=205)	Group B: (n=344)
1. Conditions that are more prevalent in Group A, compared to Group B:		
493.9 Asthma, unspecified	n=124 (60.5%)	n=29 (14.1%)
786.2 Cough	n=41 (20%)	n=26 (7.6%)
2. Conditions that are more prevalent in Group B, Compared to Group A:		
786.5 Chest pain	n=54 (26.3%)	n=161 (46.8%)
413.9 Other and unspecified angina pectoris	n=8 (3.9%)	n=38 (11.0%)
427.9 Cardiac dysrhythmia, unspecified	n=4 (2.0%)	n=18 (5.2%)
785.1 Palpitations	n=4 (2.0%)	n=17 (4.9%)
Patients with Respiratory related Visits Absent: Other Conditions that are distinctive enough to be able to use potential indicators for asthma Present	Group C: (n=79)	Group D: (n=888)
3. Conditions that are more prevalent in Group C, compared to Group D:		
461.9 Acute sinusitis, unspecified	n=10 (12.7%)	n=47 (5.3%)
724.2 Lumbago	n=9 (11.4%)	n=48 (5.4%)
599.0 Urinary tract infection, site not specified	n=8 (10.1%)	n=46 (5.2%)
V72.5 Radiological examination, not elsewhere classified	n=7 (8.9%)	n=37 (4.2%)
784.0 Headache	n=7 (8.9%)	n=42 (4.7%)
682.9 Other cellulitis and abscess	n=7 (8.9%)	n=18 (2.0%)
780.7 Malaise and fatigue	n=7 (8.9%)	n=40 (4.5%)
780.4 Dizziness and giddiness	n=6 (7.6%)	n=34 (3.8%)
995.3 Allergy, unspecified	n=5 (6.3%)	n=22 (2.5%)
477.9 Allergic rhinitis, Cause unspecified	n=5 (6.3%)	n=27 (3.0%)
382.9 Unspecified otitis media	n=5 (6.3%)	n=31 (3.5%)
372.3 Other and unspecified conjunctivitis	n=5 (6.3%)	n=21 (2.4%)
300.9 Unspecified neurotic disorder	n=5 (6.3%)	n=22 (2.5%)
229.9 Benign neoplasm of other and unspecified sites, Site unspecified	n=5 (6.3%)	n=30 (3.4%)
4. Conditions that are more prevalent in Group D, compared to Group C:		
None		

Table i.1.19 Frequency Distribution of ICD9 Diagnosis with a new grouping according to Asthma Status and the Presence of Respiratory-related Conditions

	Asthma Present n=284	Asthma Absent n=1,232
Patients with Respiratory related Visits Present: Other Conditions that are distinctive enough to be able to use potential indicators for asthma Present	Group A: (n=205)	Group B: (n=344)
1. Conditions that are more prevalent in Group A, compared to Group B: 493.9 Asthma, unspecified Upper Airway Condition	n=124 (60.5%) n=96 (46.8%)	n=29 (14.1%) n=101 (29.4%)
2. Conditions that are more prevalent in Group B, Compared to Group A: Cardiac Conditions	n=70 (34.1%)	n=234 (68.1%)
3. Conditions that are approximately equally prevalent in both groups: Neurotic Disorder/Somatic Complaints	n=78 (38.0%)	n=105 (30.5%)
Patients with Respiratory related Visits Absent: Other Conditions that are distinctive enough to be able to use potential indicators for asthma Present	Group C: (n=79)	Group D: (n=888)
4. Conditions that are more prevalent in Group C, compared to Group D: Cardiac Conditions Neurotic Disorder/Somatic Complaints Upper Airway Condition	n=7 (8.9%) n=33 (41.8%) n=29 (36.7%)	n=42 (4.7%) n=189 (21.3%) n=161 (18.1%)
5. Conditions that are more prevalent in Group D, compared to Group C: None		

Table. i.1.20 Frequency Distribution of Procedure codes for diagnosis code v999 or missing

	Asthma Present n=284	Asthma Absent n=1,232
Patients with Respiratory related Visits Present	**Group A: (n=205)** **'Missing'** **8100**: Thorax poumons (n=22) **8871**: Examen (patients de moins de 70 ans) en cabinet (patients de moins de 60 ans) complet (n=13) **8079** : Mammographie dans une région où le programme québécois de dépistage du cancer du sein est mis en place de dépistage systématique (pour les femmes âgées de 50 à 69 ans) comprend une incidence craniocaudale et une incidence oblique médiolatérale bilatérale (n=10) **56** : Examen dans un centre hospitalier de soins de courte durée et dans un C.L.S.C. (patients de moins de 70 ans) complet patient inscrit sans déplacement (n=10) **8246 :** Divers mesure de la densité osseuse: ostéodensitométrie radiologique (dxa) suivi (" follow-up "): deux sites ou plus (n=5) **8135 :** Mammographie dans une région où le programme québécois de dépistage du cancer du sein est mis en place de dépistage sélectif pour les femmes de 40 à 49 ans présentant un facteur de risque important associé au cancer du sein ou pour les femmes de 70 ans ou (n=5) **8062** : Membres supérieurs épaule (n=5) **'V999'** **8100**: Thorax poumons (n=21) **8049**: Mammographie dans une région où le programme québécois de dépistage du cancer du sein est mis en place diagnostique sans examen clinique bilatérale (n=8)_ **8259**: Tomographie par ordinateur tête sans injection de substance de contraste (n=7) **8326 :** Échographie abdominale complète (trois organes et plus) (n=4) **8086 :** Membres inférieurs cheville (n=4) **8059 :** Colonne et bassin colonne lombaire ou lombo-sacrée (n=4)	**Group B: (n=344)** **'Missing'** **8100**: Thorax poumons (n=27) **8079** : Mammographie dans une région où le programme québécois de dépistage du cancer du sein est mis en place de dépistage systématique (pour les femmes âgées de 50 à 69 ans) comprend une incidence craniocaudale et une incidence oblique médiolatérale bilatérale (n=24) **8049** : Mammographie dans une région où le programme québécois de dépistage du cancer du sein est mis en place diagnostique sans examen clinique bilatérale (n=15) **8871** : Examen (patients de moins de 70 ans) en cabinet (patients de moins de 60 ans) complet (n=11) **8158** : Voies gastro-intestinales et biliaires (incluant fluoroscopie) tube digestif supérieur en double contraste, incluant l'oesophage, l'estomac et le duodénum OU Voies gastro-intestinales et biliaires tube digestif supérieur (comprend au moins 5 films ou 10 e (n=9) **56** : Examen dans un centre hospitalier de soins de courte durée et dans un C.L.S.C. (patients de moins de 70 ans) complet patient inscrit sans déplacement (n=9) **9170** : ' ' (n=8) **'V999'** **8100**: Thorax poumons (n=32) **8326 :** Échographie abdominale complète (trois organes et plus) (n=19) **8321 :** Échographie pelvienne ou obstétricale échographie pelvienne complète par voie transvésicale ou endovaginale (n=8) **8268** : Tomographie par ordinateur abdomen et pelvis (ne peut être facturé en sus des codes d'acte pour "abdomen" ou pour " pelvis ") avec injection de substance de contraste ou avec et sans injection de substance de contraste OU Tomographie par ordinateur abdome (n=8) **8259** : Tomographie par ordinateur tête sans injection de substance de contraste (n=8)

Table. i.1.20 Frequency Distribution of Procedure codes for diagnosis code v999 or missing (Cont'd)

	Asthma Present n=284	Asthma Absent n=1,232
Patients with Respiratory related Visits Absent	**Group C: (n=79)** **'Missing'**: **8079**: Mammographie dans une région où le programme québécois de dépistage du cancer du sein est mis en place de dépistage systématique (pour les femmes âgées de 50 à 69 ans) comprend une incidence craniocaudale et une incidence oblique médiolatérale bilatérale (n=6) **8049** : Mammographie dans une région où le programme québécois de dépistage du cancer du sein est mis en place diagnostique sans examen clinique bilatérale (n=4) **8243** : Divers mesure de la densité osseuse: ostéodensitométrie radiologique (dxa) examen initial de base (n=4) **'V999':** **8100**: Thorax poumons (n=9) **8259** : Tomographie par ordinateur tête sans injection de substance de contraste (n=3) **8326 :** Échographie abdominale complète (trois organes et plus) (n=3)	**Group D: (n=888)** **'Missing'** **8079**: Mammographie dans une région où le programme québécois de dépistage du cancer du sein est mis en place de dépistage systématique (pour les femmes âgées de 50 à 69 ans) comprend une incidence craniocaudale et une incidence oblique médiolatérale bilatérale (n=101) **8100**: Thorax poumons (n=28) **8049**: Mammographie dans une région où le programme québécois de dépistage du cancer du sein est mis en place diagnostique sans examen clinique bilatérale (n=25) **56** : Examen dans un centre hospitalier de soins de courte durée et dans un C.L.S.C. (patients de moins de 70 ans) complet patient inscrit sans déplacement (n=25) **8871** : Examen (patients de moins de 70 ans) en cabinet (patients de moins de 60 ans) complet (n=23) **'V999'** **8100**: Thorax poumons (n=25) **8326 :** Échographie abdominale complète (trois organes et plus) (n=24) **8321** : Échographie pelvienne ou obstétricale échographie pelvienne complète par voie transvésicale ou endovaginale (n=22)

5. Identifying Indicators of Asthma in the Prescription Claims File

We examined dispensing of prescriptions for asthma medication according to asthma status. In order to identify a maximum number of prescriptions, we included prescriptions with the dispensation date within 30 days from the beginning of the study period. The examination was performed by type of prescriber and of asthma medication (controller vs. rescue medication (FABA)). The diagnostic performance of the specific indicator from prescriptions claims file showed higher levels of both sensitivity (81.7%) and specificity (91.1%) for physician-confirmed asthma. (Table i.1.21)

In addition, we compared and contrasted prescription claim indicators with medical services indicators of any respiratory-related visit. We found some discrepancies between indicators that were critical to potential diagnostic performance. For instance, among asthmatic patients who didn't have any asthma medications dispensed (n=52), 48.1% had visits for respiratory-related conditions. This particular discrepancy between the two claims files would potentially be critical in improving the level of sensitivity, if we would examine the diagnostic performance of the combined use of the two claims files. On the other hand, among 1,122 patients without asthma who didn't have any asthma medication dispensed, we identified 25.8% of the patients (n=289), who had visits for respiratory-related conditions. Thus, the combined use of the two claims file may potentially penalize the specificity.

Table i.1.21. The likelihood ratio of Asthma Drug Use in relationship to Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Having Asthma Prescription Dispensed	Asthma Present (n=284)	Asthma Absent (n=1232)	Likelihood Ratio
No	52 (18.3%)*	1122 (91.1%)#	0.20
Yes	232 (81.7%)+	110 (8.9%)&	9.16

*27 out 52 patients didn't have any respiratory conditions associated visits (51.9%)
+ 52 out of 232 patients didn't have any visits (22.4%)
# 833 out 1122 patients didn't have any respiratory conditions associated visits (74.2%)
& 55 out of 110 patients didn't have any respiratory conditions associated visits (50.0%))

3.1 By Prescriber

Table i.1.22 The likelihood ratio of General Practitioners as a prescriber in relationship to Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Prescriptions that were prescribed by GPs	Asthma Present (n=284)	Asthma Absent (n=1232)	Likelihood Ratio
0	55 (19.4%)	1139 (92.5%)	0.21
1	58 (20.4%)	59 (4.8%)	4.25
2-5	84 (29.6%)	27 (2.2%)	13.5
5-10	48 (16.9%)	3 (0.2%)	84.5
≥10	39 (13.7%)	4 (0.3%)	45.7
Mean (Range)	0-84	0-29	

Table i.1.23 The likelihood ratio of Specialists as a prescriber in relationship to Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Number of Prescriptions that were prescribed by Specialists	Asthma Present (n=284)	Asthma Absent (n=1232)	Likelihood Ratio
0	259 (91.2%)	1225 (99.4%)	0.92
≥1	25 (8.8%)	7 (0.6%)	14.7
Mean (Range)	0-20	0-59	

3.2 By Type of Asthma Prescription

Table i.1.24. The likelihood ratio for Use of FABA in relationship to Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Fast Acting Bata-Agonists	Asthma Present (n=284)	Asthma Absent (n=1232)	Likelihood Ratio
0	144 (50.7%)	1205 (97.8%)	0.52
1-5	44 (15.5%)	24 (1.9%)	8.16
≥5	96 (33.8%)	3 (0.2%)	169
Range	0-36	0-15	

Table i.1.25 The likelihood ratio for Use of Controller Medication in relationship to Asthma Diagnosis

	Asthma Diagnosis Identified based upon information from MOXXI system(n=1,516)		
Inhaled Corticosteroids	Asthma Present (n=284)	Asthma Absent (n=1232)	Likelihood Ratio
0	73 (25.7%)	1142 (92.7%)	0.28
1	74 (26.1%)	50 (4.1%)	6.37
2-5	71 (25.0%)	27 (2.2%)	11.4
6-10	22 (7.7%)	4 (0.3%)	25.7
≥10	44 (15.5%)	9 (0.7%)	22.1
Range	0-58	0-59	

Appendix II

Manuscript 2: Methodological Development and Overview of Study Population

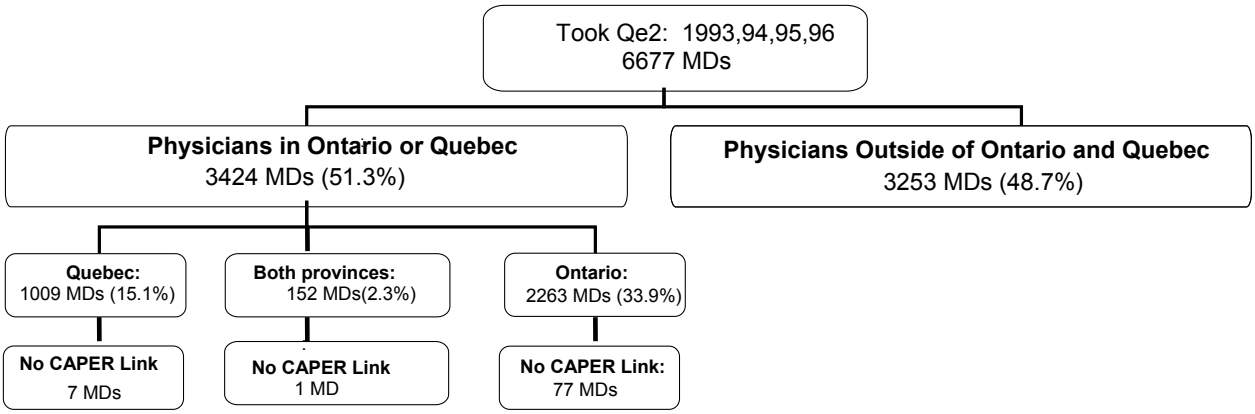
1. Background and Methodological Development

1.1 Sample Selection Procedure and Study Population Description

(1) Physician Eligibility

In total, 6,677 study physicians who took the Medical Council of Canada (MCC) QE Part 2 examination between 1993 and 1996 in Canada. Among those, 1,161 completed post graduate training in Canada by 2003 and entered practice in Quebec between 1993 and 2003. (Figure ii.1.1) Among those, 1052 physicians (90.6%), who provided care at least one patient during a follow-up period between 1993-2003 were the study population of the current project.

Figure ii.1.1 Study Physician Eligibility



(2) Patients Eligibility

a. Identification of Index Physician-Patients Encounter for Respiratory-related Visits

An index visit for respiratory-related conditions was defined as the first encounter for a asthma -related condition between a patient and a study physician in an outpatient setting. The index date for each patient was defined by the unique combination of physician identification, visit diagnosis and visit date. Figure ii.1.2 describes how index physician-patient encounter dates for outpatient respiratory-related visits were identified.

For each study physician, eligible patients were dynamically identified for the practice assessment according to the six eligibility criteria:

1) Having made an index visit to a study physician for respiratory-related conditions from 1993-2003 at outpatient setting
2) 5-60 years of age
3) without COPD diagnosis (ICD-9 codes: 491.x, 492.x, 496.x)
4) Insured through RAMQ Drug insurance plan during baseline period and outcome assessment period
5) Having a diagnosis of asthma; and
6) Having inadequate level of asthma control in the last 6 month prior to the original visit date to study physicians.

Asthma status assessment was conducted to determine a likelihood of having asthma for each patient, and the asthma control status for the patients who made the index visit for respiratory-related conditions. A status of having asthma was assessed based upon the algorithms by Kawasumi et al. (2006) using the information specific to asthma, including asthma medication, asthma-related medical service visits, comorbidity, demographics, during 1 year prior to the date of the index visit.[311] Optimal cut-off of the probability of asthma ($p<0.128$) is used to determine if the patients have asthma or not.

Figure ii.1.2. Patient Identification and Outcome Assessment Plan

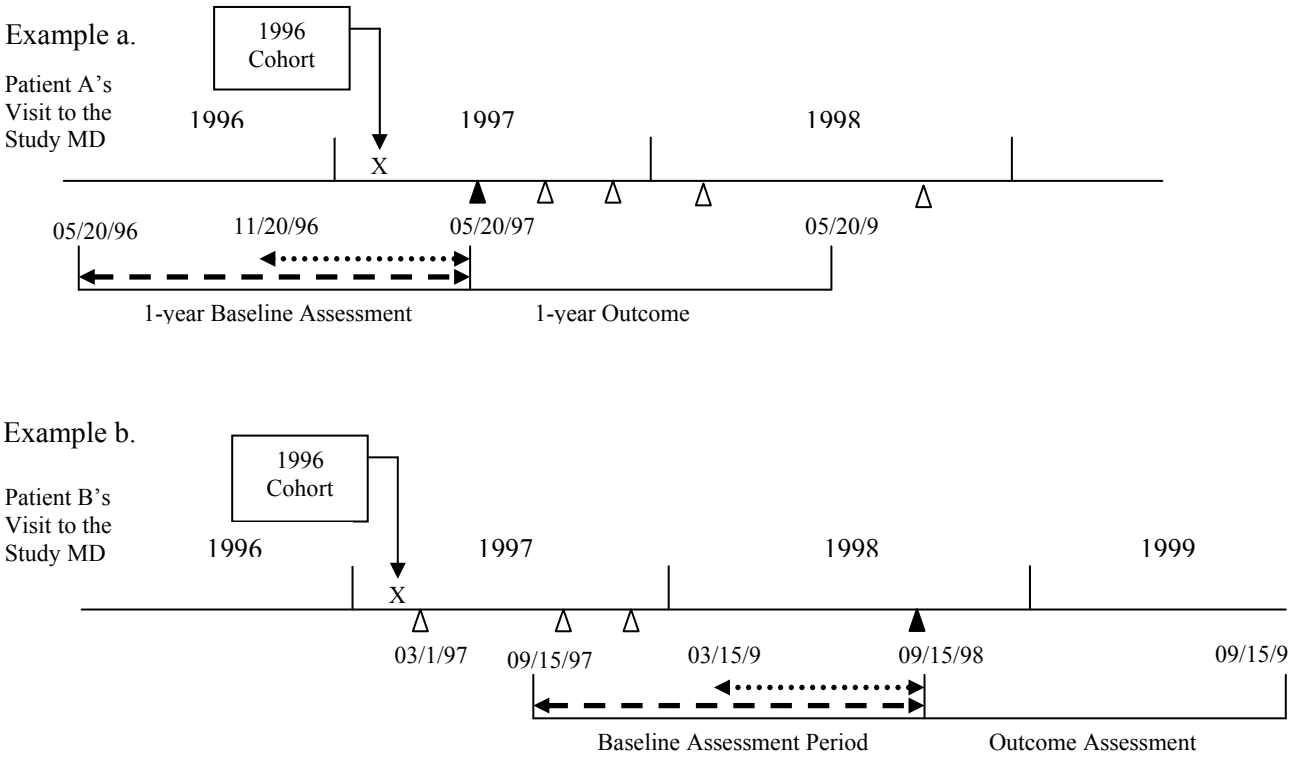


Table ii.1.1 ICD9 Diagnosis Codes of Respiratory-related Conditions

ICD9 Code:	
490.1-9:	Bronchitis Not Specific as Acute/Chronic
493.0-9:	Asthma
465.9:	Acute Upper Respiratory Infection
466.0-9:	Acute Bronchitis
518	Diseases of lung
519	Diseases of respiratory system
786.0:	Dyspnea & Respiratory Abnormalities
786.1:	Stridor
786.4:	Abnormal Sputum
786.5:	Chest Pain
786.7:	Abnormal Chest Sounds
786.9:	Other Symptoms involving Respiratory System and Chest
786.2:	Cough

Table ii.1.2 List of Asthma Medication

(1) Rescue Medication(CDNOM): Fenoterol, Terbutaline, Salbutamol

(2) Inhaled Corticosteroids Fluticasone, Budesonide, Flunisolide, Belcometasone, Triamcinolone

(3) Overview Description of 2Ps Database and Study Population Selection

Figure ii.1.3.a describes the selection of the study population based upon eligibility criteria. In total, there were 332,492,650 visits in the 2PS database from 1993 to 2003. Among those visits, 14,643,573 visits (4.4%) were made to 1,052 unique study physicians at some point during the follow-up period. Of these visits, 1,178,746 visits (8.1%) were related to respiratory-related conditions in any health care setting, involving 819 unique study physicians. Respiratory-related visits were further stratified by type of health care settings (outpatients or non-outpatient settings), 644,068 visits (40.0%) were made at outpatient settings. Among those 644,068 visits, the first encounter between each study physician and patient comprised 377,238 (58.6%) visits. With the age-restriction of the study population to those between 5-60 years old, the number of visits was 251,850 for 671 study physicians. The study population was further restricted to the patients who were covered by the RAMQ drug insurance plan (n=90,078) for 609 study physicians.

In order to assess potential selection bias, characteristics of the 109 physicians without any visits from 1993 to 2003 were compared with 1,052 physicians who received at least one visit from 1993-2003. (Table ii.1.3) Overall, physicians who didn't have any patient visits from 1993 to 2003 were more likely to go to either an undergraduate medical school or postgraduate training program outside Quebec, (18.2% and 31.2%, respectively), compared to the physicians who received at least one visit from 1993 to 2003 (13.4% and 8.8% respectively).

Figure ii.1.3.b describes several potential reasons why 109 physicians didn't receive any visits from 1993 to 2003. Among 24 physicians who practiced in Quebec 2 years after their post-graduate training (n=24), 2 physicians had salary-based practice. Similarly, another 2 physicians took QE2 exam in 1997. One physician only exited post graduate training in 2003. The above factors are some of the legitimate reasons why records of those physicians did not appear in our database. The reasons of the rest of 19 physicians were not identified; however, they potentially didn't start practice after completing their post-graduate training.

Figure ii.1.3.a Information of 2PS Database and of Eligibility of Study Physicians and Patients

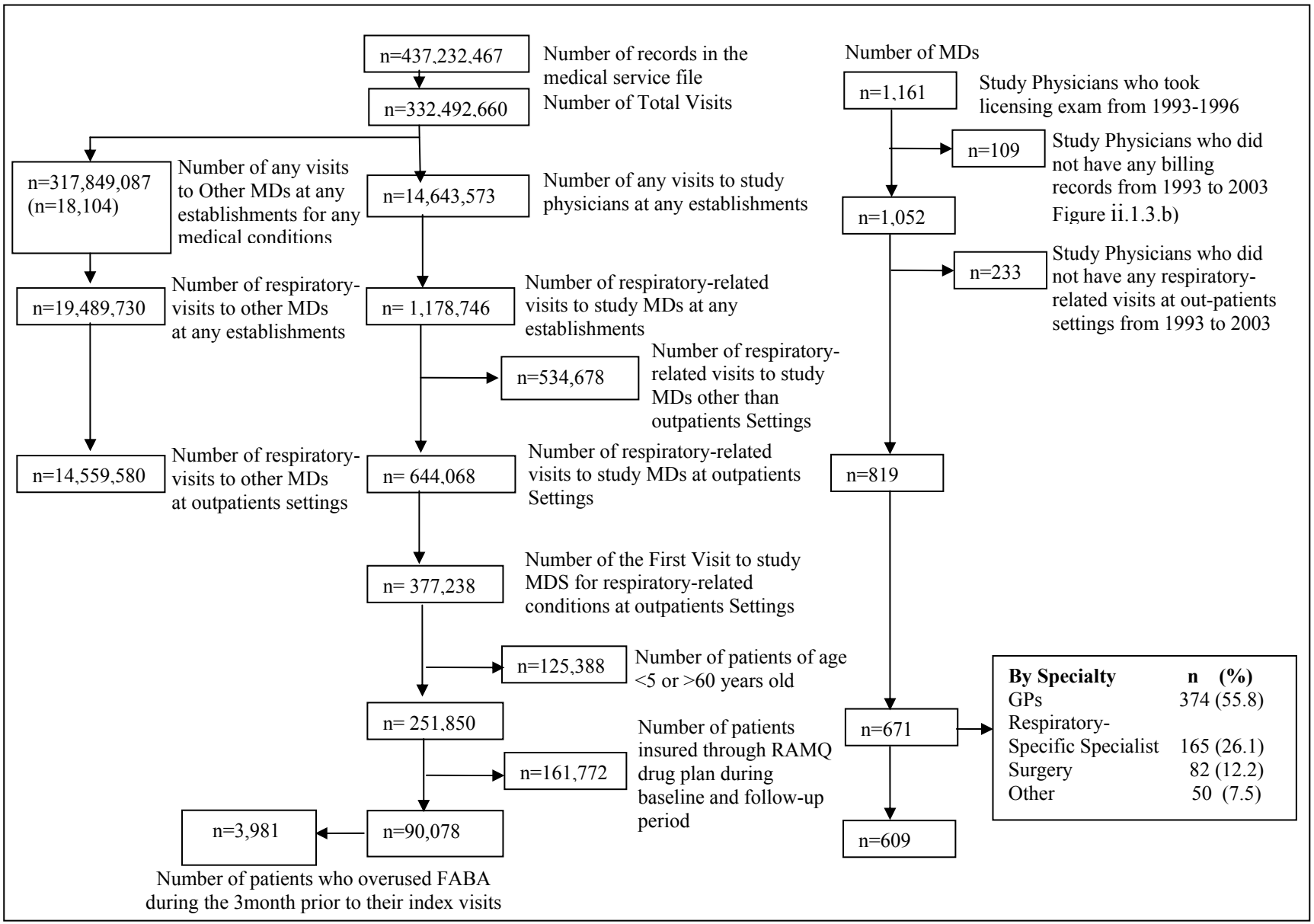


Figure ii.1.3.b Potential Reasons Why 109 MDs Didn't Receive Any Visits

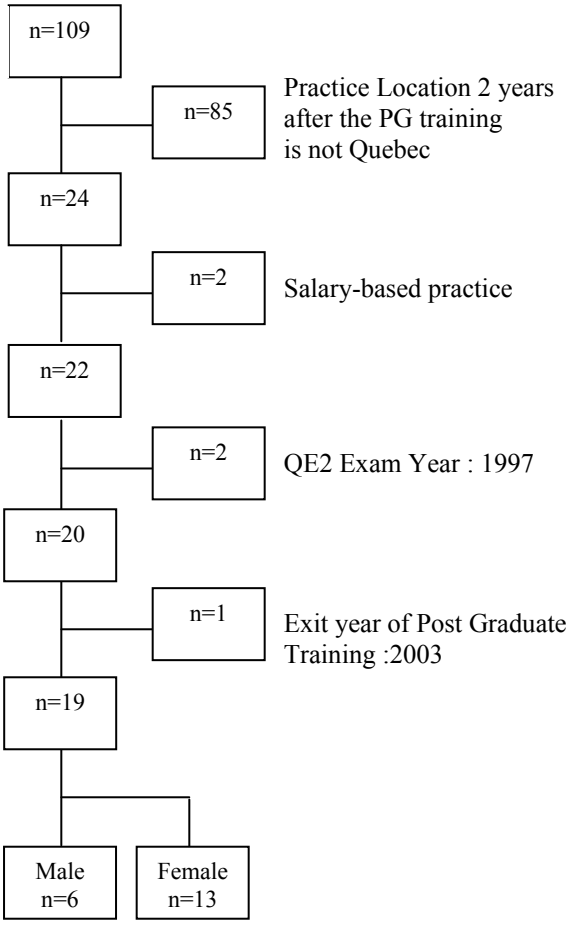


Table ii.1.3. Physician Characteristics by a status whether there were any visits from 1993-2003

Physician Characteristics (Data Source)	Total Physician (n=1,161) n (%)	Study Physicians with Any Visits from 1993-2003 (n=1,052) n (%)	Study Physicians without Any Visits from 1993-2003 (n=109) n (%)
Undergrad(RAMQ):			
Non disponible	55 (4.7%)	53 (5.0%)	2 (0.9%)
Laval	242 (20.8%)	223 (21.2%)	19 (17.4%)
Montréal	363 (31.3%)	340 (32.3%)	23 (21.1%)
McGill	204 (17.6%)	178 (16.9%)	26 (23.9%)
Sherbrooke	191 (16.5%)	169 (16.1%)	22 (20.2%)
Canadiennes	99 (8.5%)	82 (7.8%)	17 (15.6%)
Américaines	7 (0.6%)	7 (0.7%)	0 (--)
Undergrad (LMCC);			
Laval	238 (20.5%)	219 (20.8%)	19 (17.4%)
Montreal	363 (31.3%)	340 (32.3%)	23 (21.1%)
McGill	210 (18.1%)	184 (17.5%)	26 (23.9%)
Sherbrooke	190 (16.4%)	169 (16.0%)	21 (19.3%)
Alberta	8 (0.7%)	7 (0.7%)	1 (0.9%)
Dalhousie	5 (0.4%)	3 (0.3%)	2 (1.8%)
Manitoba	4 (0.3%)	2 (0.2%)	2 (1.8%)
Memorial	6 (0.5%)	4 (0.4%)	2 (1.8%)
Ottawa	36 (3.1%)	28 (2.7%)	8 (7.3%)
Queen's	8 (0.7%)	7 (0.7%)	1 (0.9%)
Toronto	18 (1.6%)	15 (1.4%)	3 (2.8%)
McMaster	10 (0.9%)	10 (1.0%)	0 (--)
British Columbia	3 (0.3%)	3 (0.3%)	0 (--)
Calgary	3 (0.3%)	3 (0.3%)	0 (--)
Saskatchewan	4 (0.3%)	4 (0.4%)	0 (--)
Western Ontario	5 (0.4%)	5 (0.4%)	0 (--)
Other	50 (4.3%)	49 (4.7%)	1 (0.9%)
Postgraduate: (CAPER)			
Laval	174 (15.0%)	163 (15.5%)	3 (2.8%)
McGill	301 (25.9%)	265 (25.2%)	36 (33.0%)
Montreal	444 (38.2%)	420 (39.9%)	24 (22.0%)
Sherbrooke	122 (10.5%)	110 (10.5%)	12 (11.1%)
British Columbia	15 (1.3%)	11 (21.2%)	4 (3.7%)
Calgary	2 (0.2%)	2 (0.2%)	0 (--)
Dalhousie	4 (0.3%)	2 (0.2%)	2 (1.8%)
Manitoba	4 (0.3%)	1 (0.1%)	11 (10.1%)
McMaser	6 (0.5%)	4 (0.4%)	2 (1.8%)
Ottawa	25 (2.2%)	21 (2.0%)	4 (3.7%)
Queen's	2 (0.2%)	1 (0.1%)	1 (0.9%)
Toronto	51 (4.4%)	42 (4.0%)	9 (8.3%)
Western Ontario	3 (0.3%)	3 (0.3%)	0 (--)
No Information	8 (0.7%)	7 (0.7%)	1 (0.9%)

Table ii.1.3. Physician Characteristics by a status whether there were any visits from 1993-2003 (cont'd)

Physician Characteristics (Data Source)	Total Physician (n=1,161) n (%)	Study Physicians with Any Visits from 1993-2003 (n=1,052) n (%)	Study Physicians without Any Visits from 1993-2003 (n=109) n (%)
Sex:			
Female	526 (46.3%)	580 (55.1%)	55 (50.5%)
Male	635 (54.7%)	472 (44.9%)	54 (49.5%)
Specialty: - need to fix			
GPs	468 (40.3%)	428 (40.3%)	40 (36.7%)
Respiratory- related Specialists	116 (10.0%)	104 (9.8%)	12 (11.0%)
Other	577 (49.7%)	520 (49.0%)	57 (52.3%)
Numeration:			
Salary anytime during follow-up	71 (6.1%)	68 (6.4%)	3 (2.8%)
QE2 Exam Year:			
1993	156 (13.4%)	147 (13.8%)	9 (8.3%)
1994	260 (22.4%)	234 (22.0%)	26 (23.9%)
1995	311 (26.8%)	286 (26.9%)	25 (22.9%)
1996	396 (34.1%)	352 (33.1%)	44 (40.4%)
1997	28 (2.4%)	23 (2.2%)	5 (4.6%)
1998	5 (0.4%)	5 (0.5%)	--
1999	4 (0.3%)	4 (0.4%)	--
2000	1 (0.1%)	1 (0.1%)	--
2001	9 (0.8%)	9 (0.9%)	--
2002	--	--	--
2003	--	--	--
Practice Location after 2 years			
Quebec	919 (79.1%)	895 (85.1%)	24 (22.0%)
Ontario	78 (6.7%)	47 (4.5%)	31 (28.4%)
Other Canada	45 (3.9%)	22 (2.1%)	23 (21.1%)
Outside Canada	81 (7.0%)	60 (5.7%)	21 (19.3%)
Missing	30 (2.6%)	21 (2.0%)	9 (8.3%)
None	8 (0.7%)	7 (0.7%)	1 (9.2%)
Practice Location after 5 years			
Quebec	663 (57.1%)	649 (61.7%)	14 (12.8%)
Ontario	67 (5.8%)	42 (4.0%)	25 (22.9%)
Other Canada	36 (3.1%)	18 (1.7%)	18 (16.5%)
Outside Canada	39 (3.4%)	26 (2.5%)	13 (11.9%)
Missing	348 (30.0%)	310 (29.5%)	38 (34.9%)
None	8 (6.9%)	7 (6.6%)	1 (0.9%)
QE2 Exam Score:	Mean[SD; Range]	Mean[SD; Range]	Mean[SD; Range]
Total Score	527.3 [79.6;158-749]	528.9 [79.4; 158-749]	512.8 [80.7;351-744]
Communication	510.2 [89.7;167-705]	509.9 [90.5;167-705]	513.6 [82.5;280-690]
Problem-Solving Score	536.6 [105;195-850]	537.8 [103.8;195-842]	525.3 [111.3;270-850]

1.2 Methodological Developments

There were several methodological refinements to be addressed during the selection of the study population.

(1) Inclusion of Respiratory-Related Conditions

It has been reported that medical service claim ICD-9 codes have an extremely low sensitivity to correctly identify patients with asthma. Therefore, we identified multiple ICD-9 diagnosis codes for asthma-related respiratory-related conditions that are clinically important for identifying patients with asthma. (Table ii.1.1)

(2) Eligible medical care setting for quality care assessment for asthma

Among 1,052 study physicians who started their practices in Quebec between 1993 and 2003, 233 study physicians (22.1%) provided their care in 534,678 visits for asthma-related respiratory related conditions only at inpatient and long term care settings. The occurrence of the particular type of visits turned out to be as high as 51.7% of all the respiratory-related visits to study physicians between 1993 and 2003 (Figure ii.1.3.a). However, asthma is the ambulatory care sensitive conditions and asthma morbidity is highly preventable when asthma is effectively managed in outpatient settings. Therefore, it was decided to focus our assessment of quality of asthma care in outpatient settings.

(3)Consults/ Physician Specialty/Referral

Among 251,850 patients with an index visit to study physicians for respiratory-related conditions, 15,728 visits (6.2%) were made based upon the referral by other physicians. (Table ii.1.4). 57.9% of the referred visits were made specifically to respiratory-related specialists, including respirologists, allergists, medical internists, and paediatricians. In total, various types of other specialists received 6,205 (38%) referred visits for the respiratory-related conditions. Among those specialists, the majority of visits (72.6%) were to cardiologists. The frequency of the index visits due to referral from other physicians was approximately 3 times higher among patients who visited emergency room in the

6-month prior to the index visits for respiratory conditions than those who did not (17.9% vs. 5.3%). However, we did not observe any major difference by specialty of physicians (Table ii.1.4).

Table ii.1.4. Number of Patients who first visit study MD for Respiratory-related conditions was due to referral, Stratified by Baseline ER Status

Total n=251,850	Patient Who Visited ER in the 6 months prior to the First Visits to Study MDs (n=18,102)	Patient without ER visits in the 6 months prior to the First Visits to Study MDs (n=233,748)
Number of Patients whose First Visits to Study MDs for Respiratory-related Conditions was based upon Referral (n=15,728; 6.2%)	3,248 (17.9%)	12,480 (5.3%)
Type of Specialty of the First Visits		
GPs	**99 (3.0%)**	**353 (2.8%)**
Respiratory-related Specialists[1]	**2,006 (61.8%)**	**7,075 (56.7%)**
Surgery	**26 (0.8%)**	**144 (1.2%)**
Others	**1,117 (34.4%)**	**4,908 (15.2%)**
anesthésie-réanimation	*16 (1.4%)*	*140 (2.9%)*
microbiologie médicale et infectiologie	*3 (0.3%)*	*72 (1.5%)*
cardiologie	*945(84.7%)*	*3561 (72.6%)*
dermatologie	*--*	*2 (0.4%)*
gastro-entérologie	*43 (3.8%)*	*90 (1.8%)*
obstétrique-gynécologie	*1 (0.8%)*	*5 (0.1%)*
physiatrie	*11 (0.9%)*	*29 (0.6%)*
neurology	*5 (0.5%)*	*46 (1.0%)*
ophtalmologie	*5 (0.5%)*	*65 (1.3%)*
oto-rhino-laryngologie	*68 (6.1%)*	*635 (13.0%)*
psychiatrie	*--*	*1 (0.02%)*
radiologie diagnostique	*8 (0.7%)*	*28 (0.6%)*
urologie	*6 (0.5%)*	*193 (3.9%)*
médecine nucléaire	*--*	*1 (0.02%)*
néphrologie	*--*	*1 (0.02%)*
endocrinologie	*4 (0.4%)*	*34 (0.7%)*
rhumatologie	*2 (0.2%)*	*5 (0.1%)*

[1.] Respiratory-related Specialists includes respirologist, allergist, medical internist, and paediatricians

(4) Study Population Restriction to Patients with Drug Insurance Plan

In total, 251,850 patients were identified as having first visits to 671 study physicians at outpatient settings for asthma-related respiratory conditions. As previously noted, the RAMQ medical services claims database provides information on the beneficiary, date, type, provider, and location of service delivery (e.g. inpatient, emergency, clinic) for all medical services remunerated on a fee-for-service basis (approximately 86% of all services). Thus, the medical service claims database allows us to investigate one of the outcomes, respiratory-related emergency room visits, for the entire initial cohort of 251,850 patients.

However, in order to assess the overuse of fast-acting beta-agonist and other prescribing performance indicators, the study population had to be restricted to those continuously covered during the study period by the provincial drug insurance agency. The RAMQ drug insurance program covers approximately one-half of the population, including the elderly, welfare recipients, and persons without employer-provided drug insurance.[266] Therefore, our study population was restricted to those who were covered by the RAMQ drug insurance plan during the entire study period.

To determine who was covered by the RAMQ drug plan for the entire study period, the drug plan coverage status of each patient was assessed during 2-year baseline and follow-up period. Two variables: dtdebut and dtfin, in the drug insurance coverage database from the RAMQ were used to calculate two types of information: number of gaps, the extent of the period of time when patients were off of the RAMQ drug insurance plan, and the number of the days of each of the gaps.

Figure ii.1.4 presents the results of the assessment of continuous drug coverage during the 2-year study period. We identified 90,078 patients (35.8%) whose drug insurance coverage overlaps with the 2-year study period in some manner. In order to include a maximum number of patients with continuous drug insurance coverage, we examined the impact of tolerating various number of days for each

gap for an eligible patient. For instance, if we allowed any gap to be a maximum of 45 days, 87,859 patients were to be included in our study (34.9%). On the other hand, if we allowed any gap to be a maximum of 14 days, 87, 247 patients were to be included in our study (34.6%). Overall, the number of unique physicians remained same as 606 in all scenarios. (Figure ii.1.5)

We assessed several critical characteristics of both physicians and patients to assess if restricting study population to those who are continuously covered by provincial drug plan would potentially threaten the validity of our results. (Figure ii.1.6) A distinctive difference between the entire study population and the restricted population with drug plan was observed specifically in patient characteristics. For instance, the number of patients who visited the emergency room for respiratory related conditions during 1-year baseline period was 7,916 (43.7%) if study population were restricted to those with continuous provincial drug plan. The same procedure also limited the number of patients whose first visit to study physicians for respiratory-conditions at an outpatient setting based upon referral from 15,728 to 5,980 (38.0%). Therefore, the restriction of the study population to patients with a RAMQ drug plan may potentially influence external validity; however, this particular restriction allows us to ensure the internal validity of the study results.

(6) Training Completion Date by Type of Training and Major Events related to Asthma Practice

Figure ii.1.7 describes major events associated with asthma practice change from 1988 and 2003 and potential earliest completion date of post-graduation training program by type of specialty during the same time period. [349] In the meantime, this particular figure describes several major events that are potentially associated with changes in asthma practice.

The use of inhaled corticosteroid as a prophylactic medication for asthma started around the early 1990's. Other types of prophylactic medication, including long-

acting beta-agonists, leukotrienes, and combination drugs, were either introduced around year 2000 or were not covered by the RAMQ during the study period.

Figure ii.1.7 shows that there is a specialty-specific variation in post-graduate training program completion year. For instance, the 1993 cohort completed their post-graduate program as early as in 1993 if family medicine was chosen for their specialty; whereas year 2001 is the earliest completion year if cardiac surgery was chosen for their specialty. This variation may have a particular relevancy in considering years of practice. For instance, in the 1993 cohort, there is up to 10 year of practice information available for our assessment for family medicine physicians, in comparison to 3 years of practice information for physicians choosing cardiac surgery as their specialty. This particular variation may impact on the validity of hypothesized associations; therefore, it needs to be taken into account.

One of the approaches to account for practice experience is to create a time-dependent covariate for practice years. In calculating practice years, we initially used two different calculations: number of years since taking the QE2 exam and number of years since completion of post-graduate training program. Our analysis indicated that physicians start billing before completion of post-graduate training program. Among 609 physicians who were included in our analysis, in total, 95 physicians (15.6%) started billing before their completion of post-graduate training program. Especially, physicians, who were under specialty training, including respiratory specialists and other specialists, where a higher percentage of physicians (24.5% and 37.9%, respectively) started billing before their completion of the post-graduate training program; whereas 6.3% and 9.5% of GPs and surgeons, respectively, did so. On the other hand, a relatively small number of physicians also started billing before taking QE2 exam. For instance, in total, 27 physicians (4.4%) started billing before the exam. Among these physicians, 13 were GPs and 12 were other specialists. These results suggest that the proposed methods for calculating practice years would be problematic.

Therefore, the first billing date was used as the start date of practice so that no physician had a practice experience calculation of less than 0 year.

Figure ii.1.4. RAMQ Drug Insurance Coverage Decision Tree

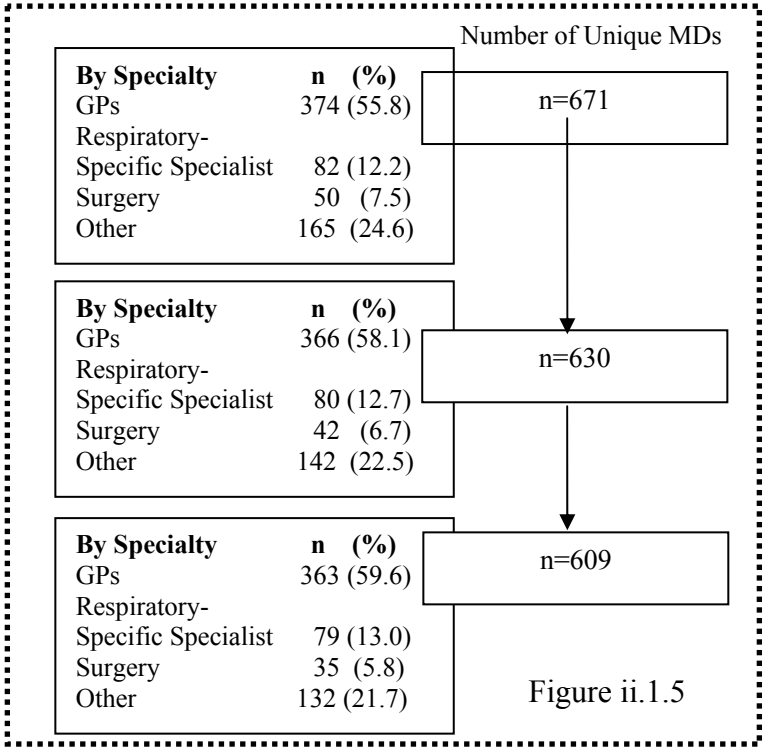
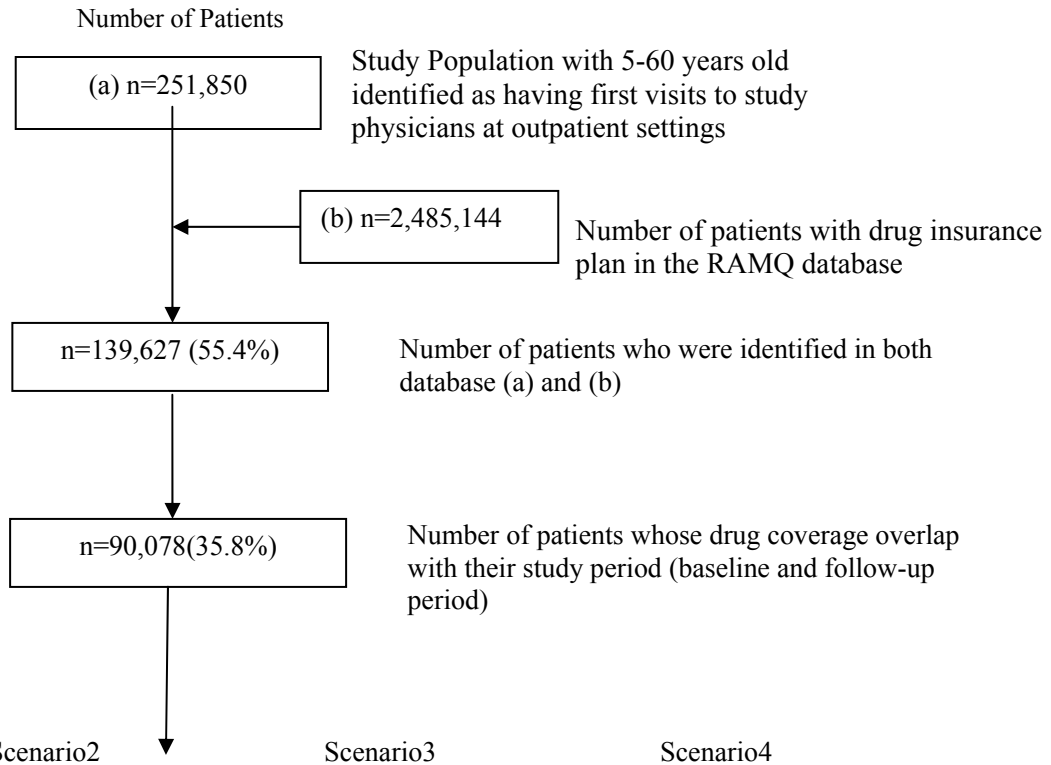


Figure ii.1.5



	Scenario1 if each gap≤14 days	Scenario2 if each gap≤21 days	Scenario3 if each gap≤30 days	Scenario4 if each gap≤45 days
# of Patients	n=87,247 (34.6%)	n=87,330(34.7%)	n=87,447(34.7%)	n=87,859(34.9%)
# of Unique MDs	n=606	n=606	n=606	n=606
By Specialty				
GPs	n=363	n=363	n=363	n=363
Respiratory-Specific Specialists	n=79	n=79	n=79	n=79
Surgery	n=34	n=34	n=34	n=34
Other	n=130	n=130	n=130	n=130

	num_gap	Frequency Count	Percent of Total Frequency
1	0	25165	27.936899132
2	1	63056	70.001554209
3	2	1390	1.543107085
4	3	370	0.4107551233
5	4	76	0.0843713226
6	5	19	0.0210928307
7	6	2	0.002220298

Quantile	Estimate
100% Max	654
99%	154
95%	1
90%	1
75% Q3	0

Figure ii.1.6. RAMQ Drug Insurance Coverage Decision Tree (2): Physician and Patient Characteristics

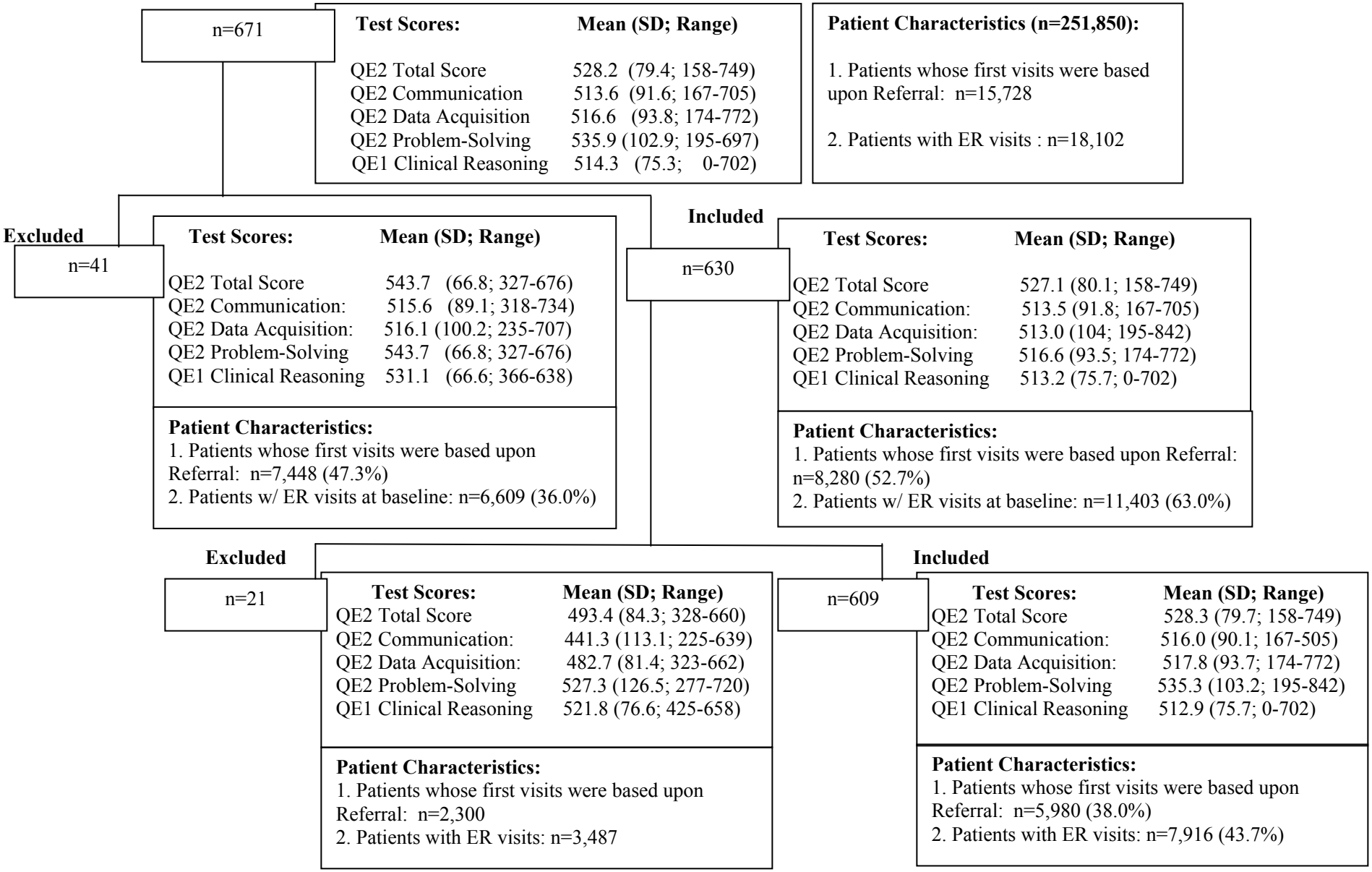
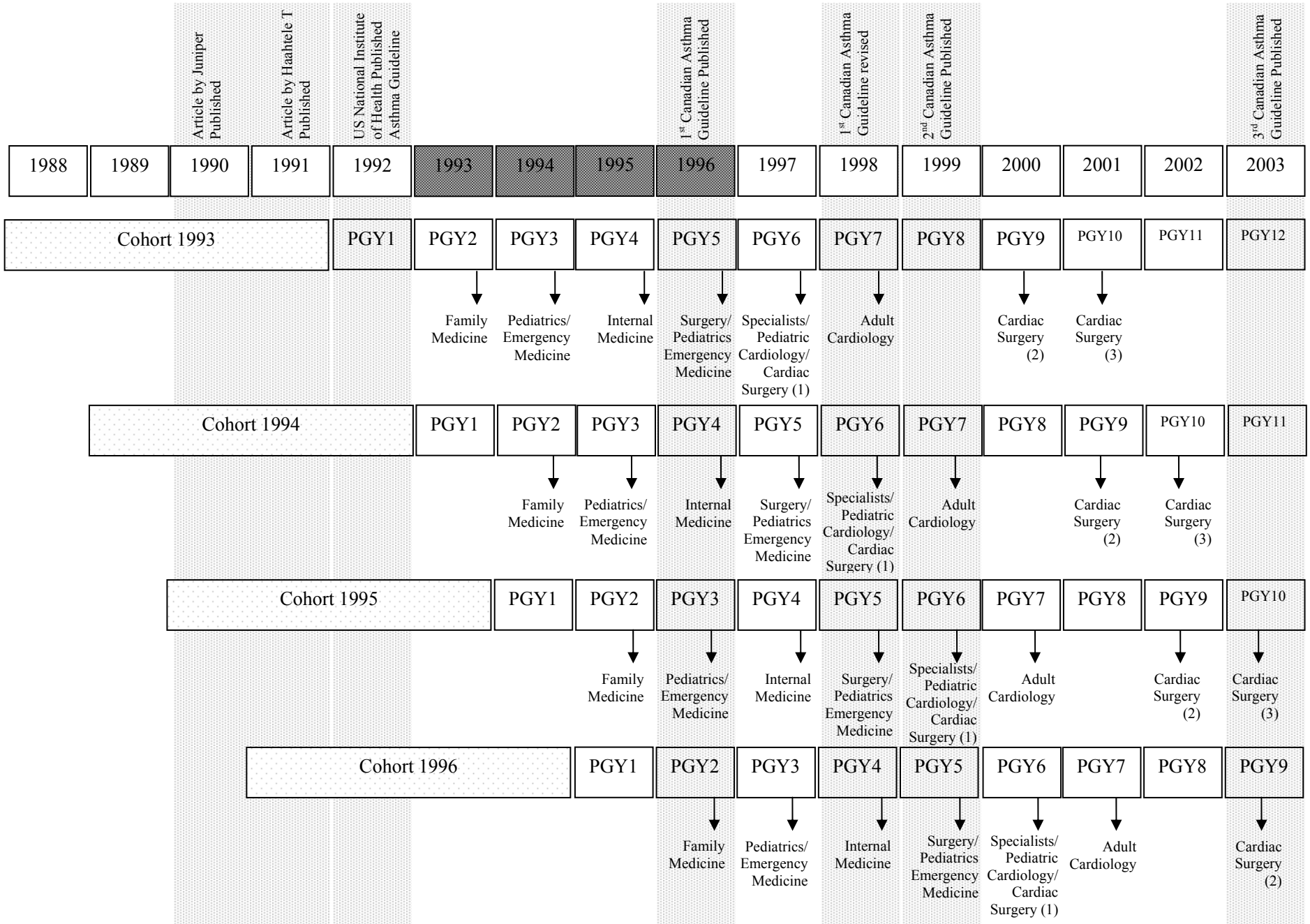


Figure ii.1.7. Study Cohort Year in relationship with Potential Earliest Post-Graduate Training Completion Year by Type of Specialty and with Implementation of Asthma Practice Guideline



Baseline and Outcome Assessment: Asthma Practice Performance indicators

Asthma outcome and control status assessment for each patient was performed based upon three indicators: respiratory-related emergency room visits, overuse of fast-acting beta agonists, inhaled corticosteroid: total asthma medication ratio.

Baseline Assessment

Asthma Control Status Assessment: Fast-Acting Beta Agonists Overuse

Asthma control status for each patient was determined based upon overuse of fast-acting beta agonists. A baseline assessment of asthma control status for each patient was performed within the 3 months prior to the index visit as baseline measurement. Based upon a recommendation by Canadian asthma practice guideline, fast-acting beta agonists (FABA) is determined as overused if the cumulative dispensed dosage of fast-acting beta agonists exceeds 250 inhalations over a 3-month period. Fenoterol, Terbutaline, Salbutamol were included in the fast-acting beta agonists overuse calculation. Information on quantity, drug identification numbers, date of dispensation in the prescription claims database was used to determine each patient's over-use status. In order to determine the number of doses dispensed, the quantity dispensed field from the record was multiplied by the conversion factor for each drug for each 3-months period in order to convert the quantity supplied from the RAMQ to a number of doses supplied for each inhaler. The time interval between two consecutive dispensing dates was used as the duration of each prescription. In the case of a prescription, which extended outside of the time window of the study, the duration of each prescription was corrected by taking the duration of prescription within the study time window only. (Figure ii.1.8)

Outcome Assessment

Outcome assessment of emergency room visits and Inhaled Corticosteroid (ICS): ICS Plus Fast-Acting Beta Agonists (FABA) Ratio was initially performed in a 12-month follow-up period after the index visits to the study physician for respiratory-related conditions in an outpatient setting. On the other hand, Fast-Acting Beta Agonists (FABA) Overuse was assessed during 6 months after the index visit and 3 months before the index visit in the initial assessment.

(1) Emergency Room Visits

a. Respiratory-Related Emergency Room Visits

Respiratory-related emergency room visits were defined as the number of distinct days that a asthma patient received medical services in the ER during the follow-up period. A list of ICD 9 diagnosis code in Table ii.1.1 was used to define whether emergency room visits were for respiratory-related conditions. The service location code and date in the RAMQ medical service claims was used to produce a count for each patient for the follow-up period.

b. Asthma-Specific Emergency Room Visits

Similarly, asthma-specific emergency room visits was defined as the number of distinct days that a patient received medical services in the ER during the follow-up period specifically for asthma. ICD 9 diagnosis code (493.x) was used to define whether emergency room visits were for asthma. The service location code and date in the RAMQ medical service claims was used to produce a count for each patient for the follow-up period.

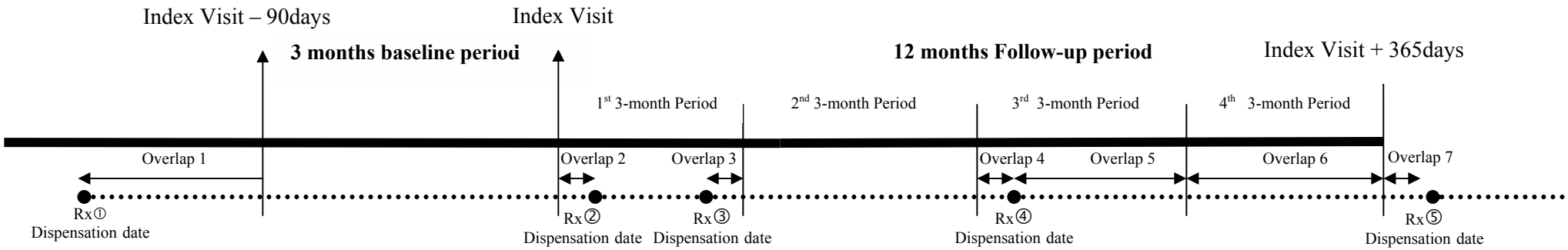
(2) Fast-Acting Beta Agonists (FABA) Overuse

Based upon the Canadian asthma practice guidelines[6], fast-acting beta agonists (FABA) was defined as overused if cumulative dispensed dosage of FABA exceeded 250 inhalations over any consecutive two 3-month periods during the 6-months follow-period. Table ii.1.2 lists names of drugs included in fast-acting beta agonists overuse calculation.

(3) Inhaled Corticosteroid (ICS): ICS Plus Fast-Acting Beta Agonists (FABA) Ratio

The inhaled corticosteroid/ fast-acting beta agonist ratio was calculated using defined daily dose (DDDs) according to the World Health Organization Collaborating Centre for Drug Statistic Methodology. Table ii.1.2 lists the asthma medications included in the ratio calculation. Each prescription of ICS and FABA that were dispensed to study patients were identified and converted into the number of daily defined dose using the following formula: (formulation strength in mg x quantity dispensed)/ defined daily dose. This calculation was performed per prescription, and the ICS: ICS + FABA ratio was calculated for each patient. The ratio ranged from 0 (FABA only) to 1 (ICS only). The value of 0.5 indicates 1:1 Ratio for ICS: FABA. Patients were classified into one of the following categories: No asthma medication use (Ratio=missing), FABA only user (Ratio=0), FABA main user (0<Ratio<0.5), 1:1 user (Ratio=0.5), ICS main user (0.5<Ratio).

Figure ii.1.8: Fast-Acting Beta Agonist Overuse Calculation Algorithm



Study Period-Specific FABA Duration Calculations Examples

For 3-month Baseline Period:
Duration=Rx② dispensation date
– Rx1dispensation date-(overlap1+Overlap2)

For 1st 3-month Follow-up Period:
Duration=Rx3 dispensation date
– Rx2 dispensation date + (overlap2+ overlap3)

For 2nd 3-month Follow-up Period
Duration= Rx4dispensation date
– Rx3 dispensation date – (overlap3+overal4)

For 3rd 3-month Follow-up Period:
Duration= Rx5 dispensation date
– Rx4 dispensation date – (overlap5+6+7)+overlap4

For 4th 3-month Follow-up Period:
Duration= Rx5 dispensation date
– Rx4 dispensation date – (overlap5+7)

2. Descriptive Statistics

Study Physician Characteristics: Demographics

Table ii.2.1 describes demographic characteristics of study physician who were included in the analysis (n=609). Their demographic characteristics were compared with the characteristics of 1,161 physicians who took the QE2 examination between 1993 and 1996 and were licensed to practice in Ontario or Quebec. Study physicians who were included in our study are more likely to be female, to go through the same post-graduate training program as undergraduate medical school and are less likely to be medical specialists other than respiratory-related specialists and cardiologists. There was not distinctive difference in exam scores and training programs (both undergraduate and postgraduate program) between the two groups.

Figure ii.2.1 shows a number of study physicians by gender and medical specialty. Nearly 60% of the study physicians (n=363) were general practitioners (GPs), followed by other specialists (21.8%), respirologists (n=13.0%), and cardiologists (5.6%). Cardiologists had the smallest proportion of females (29.4%) among the four specialty groups; whereas nearly 50% or more were female in three other groups of study physicians. Number of study physicians was further stratified by post-graduate training program (Table ii.2.2). Overall, across gender-medical specialty sub-groups, the majority of study physicians went to the University of Montreal for their post-graduate training. There was several distinctive medical specialty differences in post-graduate training distribution. For instance, regardless of their gender, GPs were less likely to do post-graduate training outside Quebec (3.2% for female and 4.9% for male). Similarly, the proportion of respiratory specialists, who did post-graduate training at Laval University was extremely small (5.8% for female and 3.9% for male).

Study Physician Characteristics: Exam Scores

Distribution of QE1 and QE2 examination scores and sub-scores by physician demographic characteristics are shown in Table ii.2.3. The QE2 communication score showed statistically significant differences across all of the physician demographic characteristics. There were several specific physician characteristics that were associated with a difference in each exam score. For instance, female physicians had a significantly higher QE2 Communication mean score than male physicians. In addition, cardiologists had the highest mean scores for all the exam scores except QE2 communication score (the lowest score among the four specialty groups). For undergraduate medical school, international graduates had the lowest scores across all the exam scores. Physicians who went to the University of Montréal or Sherbrooke University had considerably higher scores for all the QE2 exam scores. Similarly, physicians, who went through the same post-graduate training program as their undergraduate medical school, had higher QE2 exam scores than those who went to a different university for post-graduate training than their undergraduate training.

Table ii.2.4 shows the correlation between QE1 and QE2 total score and each sub-score. Overall, the QE2 total score is highly correlated with the QE1 clinical reasoning score (r=0.60). Similarly, the QE1 total score was highly correlated with the QE2 problem solving score (r=0.69).

Number of Index Visits: Physician Demographics

In total, 609 study physicians received 90,078 index visits by asthma patients from 1993 to 2003. (Figure ii.2.2) The highest number of the index visits was made to GPs (n=77,338; 85.9%), followed by respiratory related specialists (n=7,468; 8.3%). When we examined the status as to whether the index visit was due to referral by another physicians, the particular index visits to GPs had the lowest percentage (0.2%). On the contrary, almost half of the index visits, which were made to either respiratory specialists or cardiologists, were due to referral by other physicians (Figure ii.2.2).

The specialty difference with respect to the number of index visits and as to whether the visits were due to referrals by other physicians were further examined by stratifying by physician-specific practice year, defined as number of calendar years since first date of billing. Time trends in the number of the index visits were slightly different by physician specialty (Table ii.2.5). For instance, GPs experience a relatively slow increase in the number of visits up to their 4th year of practice. Similarly, the number of the index visits was slowly decreased over the latter five years of practice. On the other hand, both respiratory specialists and other specialists had a similar but distinctive trend from the one of GPs. These two particular specialty groups received a relatively a higher proportion of their visits in early year of their practice. For instance, nearly half of the index visits were received within the third year of their practice (46.7% for respiratory specialists and 53.5% for other specialists). After the third year, the number of the index visits in both specialty groups decreased gradually and there were a very small number of visits after the 7th year of their practice. Finally, cardiologists also showed a similar trend as the trend of GPs up to the third year of their practice. The highest proportion of the visits in the 4th and 5th year of their practice, the number of index visits gradually decreased up to 8th year of the practice and became zero after the year there were no cardiologists with more than 8 years of practice follow-up.

In addition, there was a specialty-specific time trend with respect to frequency of the index visits that were due to referral. For instance, GPs received very small number of index visits that were referred by other physicians throughout study period. Although respiratory specialists and cardiologists had similar overall percentage of the number of index visits that were due to referral (48.4% for respiratory-related specialists and 46.9% for cardiologists; Figure ii.2.2), each of the two specialties showed distinctive time trends. For instance, cardiologists had a highest percentage of the number of index visits due to referral in the first year of their practice (63.1%) and steadily decreased the percentage until the 8th year of their practice (40.4%). On the other hand, respiratory-related specialists started

their practice around 40% of the number index visits that were referred by other doctors, and its percentage gradually increased over their practice years, up to 68.8% in the 8th year of their practice.

Patient Characteristics

Demographics

A total of 90,078 index visits in our study were made by 90,078 distinctive patients. Of these visits, 60.9% (n=54,840) were made by females. Overall, 76.3% of patients were younger than 45 years old, and the age distributions were similar between male patients and female patients. (Table ii.2.6).

Continuity of Care (COC)

(1) Respiratory-related Continuity of Care

Respiratory-related continuity of care was measured for each patient who made a visit to a study physician for a respiratory problem for two time-periods after the index visit: 6 months and 1 year (Table ii.2.7.a). Overall, as expected, the longer follow-up period was associated with an increase in the number of patients who made at least one visit to the same study physician. Levels of continuity of care were commonly lower than 50%, but there was no distinctive pattern by physician specialty or practice year.

(2) Respiratory-related Outpatient Continuity of Care

A similar assessment was conducted for respiratory-related continuity of ambulatory care by limiting assessment to visits in out-patient settings. (Table ii.2.7.b) Overall, the similar pattern was observed across physician specialty and practice year.

Asthma Status

An assessment of asthma status of 90,078 patients who made index visits from 1993 to 2003 was performed. The characteristics of patients that were used to establish asthma status based on information retrieved for each patient in the year prior to the index visit are listed in Table ii.2.8. A cut-off probability of 0.128 was used to classify a patient as having asthma based upon the model developed by Kawasumi et al. (2006).[311]

Based upon the Kawasumi cut-off,[311] 79,781 patients (88.6%) were identified as having asthma. Mean probabilities of patients with asthma was 0.6; whereas 0.05 for patients without asthma. Compared to patients without asthma, patients with asthma were more likely to have following characteristics: younger, made at least one visit to GPs for respiratory-related conditions, no visits to respiratory-related specialists, dispensed at least one controller medication and rescue medication, absence of cardiac-related conditions, and presence of upper airway conditions.

Patient Socioeconomic Status (SES)

Socioeconomic status of the 90, 078 patients who made an index visits was examined and stratified by the practice year. (Table ii.2.9) Patients' socioeconomic status changed over the practice years of study physicians. Specifically, in early years of practice, patients who made an index visit had lower SES than those who visited study physicians after they had been in practice a number of years.

Physician Practice and Workload Characteristics

Number of Unique Practice Settings per Year

(1)Overall (Table ii.2.10)

The number of unique practice settings was measured for each physician in each practice year. The number of practice settings for cardiologists gradually increased with more years in practice; whereas other physician specialities had a relatively stable number of practice settings.

(2)Outpatient Settings Only (Table ii.2.11)

The number of unique practice setting specific in outpatient settings showed a similar pattern as for all service locations but to a smaller degree.

Number of Patients Seen per Year

(1) Overall (Table ii.2.10)

The number of patients seen by GPs in all service locations showed a gradual increase with increasing years in practice. On the other hand, the pattern among cardiologists showed rather a sharp increase in the number of patients seen per year. The pattern among respiratory specialists and other specialists showed a slight increase in the early years of practice experience but decreased after the 5th practice year.

(2) Outpatient Settings Only (Table ii.2.11)

Overall, the number of patients seen in outpatients setting showed a similar pattern but to a smaller degree. Among GPs, there was a sharp increase in the number of patients seen in the early practice years which became stable by the 7th year of practice.

Number of Work Days per Year

(1) Overall (Table ii.2.10)

Across physician specialties, there was roughly a two-fold increase in the number of days worked in the second year of practice compared to the first year. While the number of days worked among GPs and respiratory specialists stabilized after the first year, cardiologists showed a gradual and steady increase of work days.

(2) Outpatient Settings Only (Table ii.2.11)

As expected, the mean numbers of days worked in outpatient settings was smaller than the numbers of days worked in any service location; however, the patterns were similar among physician specialties and by practice year.

Proportion of Female Seen Per year

(1) Overall (Table ii.2.10)

The proportion of female patients seen per year was examined by physician specialty and practice year. In all service locations, cardiologists saw the lowest proportion of female patients of the four physician specialties examined, comprising less than 50% of their practice. Moreover, the proportion of females seen by cardiologists gradually decreased with increasing years in practice (to 42% by their 8^{th} year)

(2) Outpatient Settings Only (Table ii.2.11)

In outpatient settings, the proportion of female patients seen by GPs was the highest of the four physician specialties, approximately 60%. On the other hand, cardiologists showed the same pattern of having the lowest proportion of female patients.

Proportion of Elderly Seen Per year

(1) Overall (Table ii.2.10)

The proportion of elderly patients (>65 years old) seen per year was examined by physician specialty and practice year. The proportion of elderly patients seen by cardiologists was the highest, with elderly comprising more than 50% of their practice population throughout the practice years; whereas the mean proportion for the three other specialties ranged from approximately 20-30%.

(2) Outpatient Settings Only (Table ii.2.11)

In the outpatient setting, a similar pattern was observed. Cardiologists had the highest proportion of elderly patients in their practice. The proportion increased with increasing years in practice from 30% in their first year to 46% in their 8th year of practice. The rest of the specialty groups saw approximately 10-20% of elderly patients each practice year.

Outcome Evaluation (1): Respiratory-related/ Asthma-specific Emergency Room (ER) Visits (Figure ii.2.3 and Table ii.2.12)

In total, 30, 371 patients (33.7%) had at least 1 visit to emergency room for respiratory-related conditions during the follow-up period. Overall, the ER rate for respiratory-related conditions was 2.8 per 1,000 person-days. On the other hand, 2,534 patients (2.8%) had at least 1 visit to ER specifically for asthma, and the ER rate for asthma was 0.13 per 1,000 person-days.

The association between ER visit and patient and physician characteristics was examined using Poisson regression within a generalized estimating equation framework. Patient was the unit of analysis and physician was the clustering variable. An autoregressive correlation structure was used take into account clustering nature of the observations over time.

ER Visits by Physician Demographics (Table ii.2.13)

In relationship to respiratory-related ER visits, patients who saw physicians who completed post-graduate training at Laval University had a 23% higher risk of respiratory-related ER visits than patients of physicians with post-graduate training from the University of Montreal (RR=1.23; 95%CI=1.07-1.44). However, when the comparison was confined to asthma-specific ER visits, there was a 16% lower risk of an ER visit among patients seen by physicians who went Laval University for their post-graduate training, compared to those who went to the University of Montreal. (RR=0.84; 95%CI=0.71-0.98).

In addition, compared to GPs, patients who saw either respiratory-related specialists or cardiologists had a 30% to 70% significantly higher risk of respiratory-related ER visits, compared to patients who saw GPs at the index visit (RR=1.29, 1.42, 1.8, respectively). Other type of specialists had a 24% lower risk of asthma-specific ER visits, compared to GPs (RR=0.76; 95%CI=0.59-0.97).

ER Visits by Licensing Examination Score (Table ii.2.14)

Overall, there were no significant associations between scores achieved on the licensing examination and the risk of ER visits, except QE1 clinical reasoning score and asthma-specific ER visits. Patients, who saw physicians with QE1 clinical reasoning score in the top quartile, were 35% more likely to have asthma-specific ER visits, compared with physicians with QE1 clinical reasoning score in the bottom quartile (RR=1.35; 95%CI=1.00-1.82).

ER Visits by Visit/Patients Characteristics (Table ii.2.15)

Patients who were at a higher risk of having respiratory-related ER visits were: older than 45 years of age (RR=1.34; 95%CI=1.29-1.44); seen on the basis of referral on their index visit (RR=1.4; 95%CI: 1.21-1.68); had a probability of asthma $\geq$0.6 (RR=2.16; 95%CI:2.05-2.27); lived in an area where mean household incomes were below the poverty line (RR=1.22; 95%CI:1.16-1.29); and had lower continuity of care for respiratory problems (RR=2.88; 95%CI:2.75-3.02).

The characteristics of patients with a higher risk of asthma-specific ER visits were: having a probability of asthma $\geq$0.6 (RR=1.40; 95%CI:1.21-1.62), and having poor continuity of care for asthma-specific conditions (RR=1.35; 95%CI:1.23-1.49.

Finally, both respiratory-related and asthma-specific ER visit rates showed a gradual decrease over practice years. For example, the risk of respiratory-related ER visits diminished by 13% in the 1st year of practice (RR=0.87) and by 37% by the 5th year of practice (RR=0.63), compared to the baseline year. Asthma-specific ER visit rate ratios showed a similar pattern of decrease as the respiratory-related ER rates but more steadily.

Outcome Evaluation (2): Fast-Acting Beta-Agonist (FABA) Overuse

Among 90,078 patients in our study, 35,709 patients (40%) were identified as using FABA during the study period. Each patient's FABA overuse status was defined as more than 250 doses of FABA during a three months period. Patient FABA use was assessed in the consecutive three 3-month periods following the index visit, as well as in the 3 months before the index visit. During each of the three periods, 3,981 (4.4%), 4,141 (4.6%), and 3,322 (3.7%) were identified as over-users of FABA, respectively. (Figure ii.2.4)

The association between FABA overuse in each of the three periods and patient and physician-related characteristics was examined using logistic regression within a generalized estimating equation framework. Patient was the unit of analysis and physician was the clustering variable. An autoregressive correlation structure was used take into account clustering of patients within physician over time.

FABA Overuse status by Physician Characteristics (Table ii.2.16)

Baseline Period:

In the three months before the index visit, patients who saw respiratory-specialists had a 61% higher risk of being over-users of FABA, compared to patients who saw GPs (RR=1.61; 95% CI:1.32-1.96). Patients, who saw either cardiologists or other types of specialists at their index visits, were 35-40% less likely to over-use FABA in the same time period, compared to patients who were cared for by GPs (RR=0.66; 95%CI: 0.53-0.84, RR=0,61; 95%CI: 0.43-0.87, respectively).

Follow-up Period 1 and 2:

During the first three-month period and the second three-month period after index visits, similar associations were observed as in the baseline period. Patients who saw respiratory-specialists at their index visits are approximately 40% more likely to be over-users of FABA compared to patients who saw GPs (RR=1.44; 95%CI:1.22-1.7 for follow-up months 1-3, RR=1.41; 95% CI: 1.19-1.67 for

follow-up months 4-6). Patients who were cared by either a cardiologist or other type of specialist had an approximately 30-40% lower risk of being over-users of FABA.

FABA Overuse status by Licensing Examination Scores (Table ii.2.17)
There was no significant association between licensing examination scores and the risk of overusing FABA in the baseline or follow-up period.

FABA Overuse Status by Visit/Patient Characteristics (Table ii.2.18)
Several visit/patient characteristics were consistently associated with the overuse of FABA. For example, patient over 46 years of age had a 50-60% higher likelihood of FABA overuse, compared to patients who were younger. Patients who were living in areas where the mean household income was below poverty line had 20% higher likelihood of FABA overuse in all the three time period compared to those above the poverty line. Having at least one visit for a respiratory-related condition during follow-up period was associated with a higher risk of FABA overuse; a 250-450% higher likelihood of being over-users of FABA, compared to patients with no visits for respiratory-related problems. Patients, whose index visits were due to referral from other physicians, had 30% higher likelihood of FABA overuse during the baseline period, compared to the rest of study patients. However, these patients were not more likely than other study patients to over-use FABA after the index visit.

Outcome Evaluation (3): Inhaled Corticosteroid (ICS): ICS plus Fast-acting Beta-agonists (FABA) Ratio

The ICS to ICS+FABA ratio was assessed for each patient for the following three periods: 6 months before the index visit, 6 months after the index visits and 6-12 month after the index visit. Initially, two types of ratio were calculated for each patient: medication that was prescribed by the study physician only and medication that were prescribed by all physicians.

Overall, more than 80% of 90,078 patients were not taking any asthma medication. Among patients with at least one asthma medication, and by definition, most of the medications were prescribed by other physicians during baseline period, before the first contact for a respiratory problem with the study physician. During the 6 months after the index visit, the number of patients who received at least 1 asthma medication from a study physician increased by more than 10%. During 6-month period from 6-12 month after the index visits, the number of patients who were prescribed by an asthma medication by the study physician was approximately the same as the baseline period (Table ii.2.19).

Inhaled Corticosteroid (ICS): ICS plus Fast-acting Beta-agonists (FABA) Ratio, based upon the prescription by Study MDs: Physician Characteristics (Table ii.2.20)

During the first 6-month follow-up period after the index visit, several physician characteristics were associated with the ICS: total medication ratio. Patients of physicians who graduated for Sherbrook University medical school, and those completing postgraduate training at Sherbrooke or Laval University were more likely to have a higher ratio value. A similar trend was found in the second 6-month follow-up period.

Inhaled Corticosteroid (ICS): ICS plus Fast-acting Beta-agonists (FABA) Ratio, based upon the prescription by Study MDs: Exam Scores (Table ii.2.21)

During the first 6-month follow-up period, patients were more likely to have a low ratio value if they were seen by physicians in the bottom quartile of the QE1 total score, QE1 clinical reasoning score, and QE2 communication score. During the second 6-month follow-up period, the same associations were found for the QE1 clinical reasoning score and QE2 communication score.

Inhaled Corticosteroid (ICS): ICS plus Fast-acting Beta-agonists (FABA) Ratio, based upon the prescription by Study MDs: Patient Characteristics (Table ii.2.21)

During the first 6-month period, higher ratio values were found for patients with a probability of having asthma>0.6, and having a follow-up visit to the study physician for respiratory-related conditions (either overall or at outpatient setting). The same trend was found during the second 6-month period.

Table ii.2.1. Study Physicians Characteristics: Demographics

Study Physician Characteristics	Study Physician (n=609) n (%)	Physician Population (n=1,161) n (%)
Sex		
Female	342 (56.2%)	526 (46.3%)
Undergraduate Medical School		
McGill	94 (15.4%)	210 (18.1%)
Montreal	209 (34.3%)	363 (31.3%)
Laval	128 (21.0%)	238 (20.5%)
Sherbrooke	99 (16.3%)	190 (16.4%)
School Outside Quebec	44 (7.2%)	110 (9.5%)
School Outside Canada	35 (5.8%)	50 (4.3%)
Post-Graduate Training Faculty		
McGill	143 (23.5%)	301 (25.9%)
Montreal	250 (41.1%)	444 (38.2%)
Laval	100 (16.4%)	174 (15.0%)
Sherbrooke	73 (12.0%)	122 (10.5%)
Faculty Outside Quebec	41 (6.7%)	112 (9.6%)
Missing	2 (0.33%)	8 (0.7%)
Post-Graduate Training Program Exit Year		
1993	7 (1.2%)	8 (0.7%)
1994	42 (6.9%)	47 (4.1%)
1995	74 (12.2%)	92 (7.9%)
1996	101 (16.6%)	129 (11.1%)
1997	142 (23.3%)	222 (19.1%)
1998	81 (13.3%)	167 (14.3%)
1999	57 (9.4%)	155 (13.4%)
2000	55 (9.0%)	174 (15.0%)
2001	34 (5.6%)	103 (8.9%)
2002	7 (1.2%)	26 (2.2%)
2003	5 (0.8%)	16 (1.4%)
2004	2 (0.33%)	12 (1.0%)
Missing	2 (0.33%)	10 (0.8%)
Specialty		
General Practice	363 (59.6%)	468 (40.3%)
Respiratory-related Specialist	132 (21.7%)	116 (10.0%)
Cardiologists	79 (13.0%)	44 (3.8%)
Other Medical Specialists	35 (5.8%)	533 (45.9%)
Same Post-Graduate Training as Undergraduate Medical School		
Same	388 (63.8%)	680 (58.6%)
Different	219 (36.0%)	473 (40.7%)
Missing	2 (0.33%)	8 (0.7%)
Exam Scores:		
QE1 Total Score	531.6 [78.9; 344-657]	537.0 [79.6; 158-746]
Clinical Reasoning	512.9 [75.2; 0-702]	517.0 [75.7; 0-702]
QE2 Total Score	528.3 [79.7; 158-749]	527.3 [79.6; 158-749]
Communication	516.0 [90.1;167-705]	510.2[89.7; 167-705]
Data Acquisition	517.8 [93.7; 174-772]	514.4 [92.3; 174-772]
Problem-Solving	535.3 [103.2; 195-842]	536.6 [104.5; 195-850]

Figure ii.2.1. Number of MDs by Gender and Specialty (n=609)

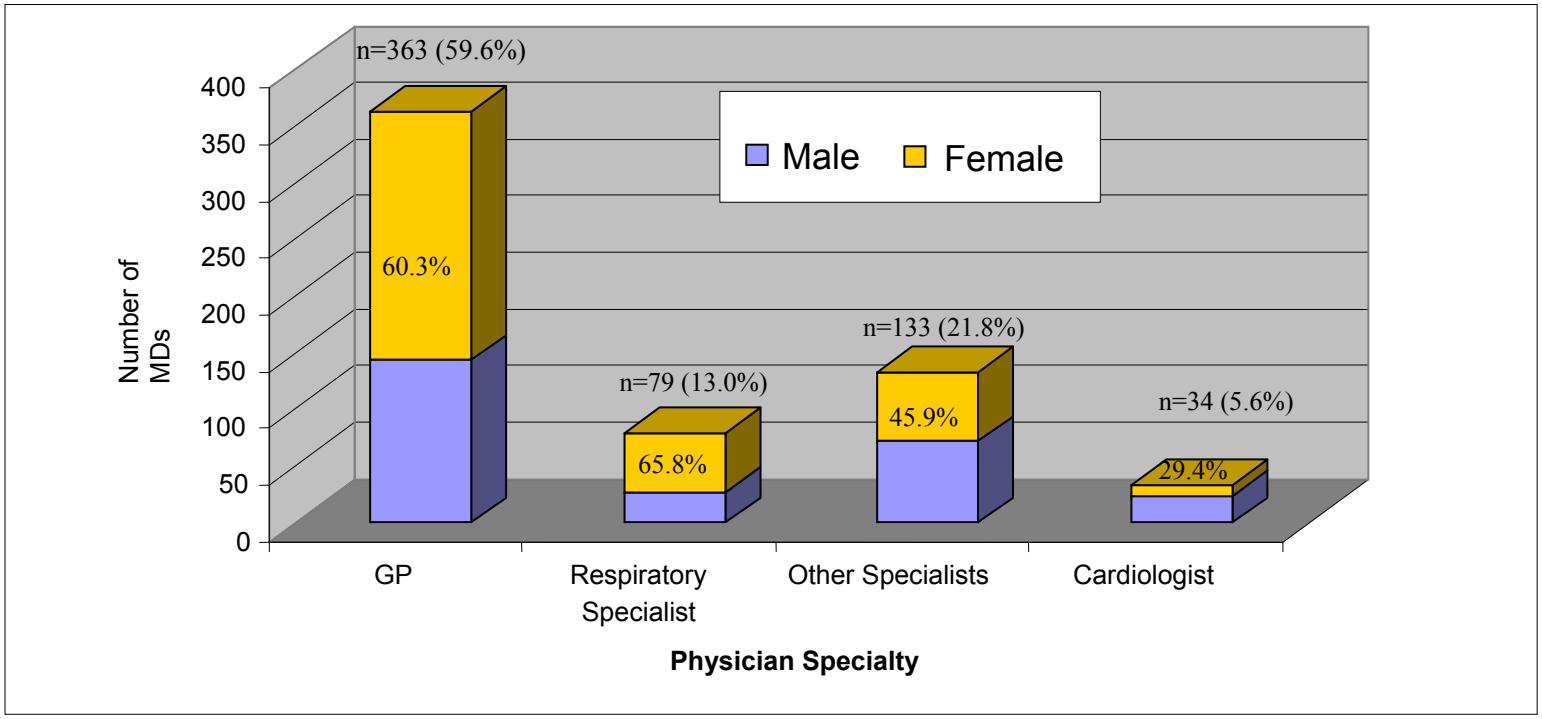


Table ii.2.2 Number of Study MDs by Gender, Specialty, and Post-Graduate Training Program (n=609)

	Female (n=342; 56.2%)				Male (n=267; 43.8%)			
	GP n(%)	Respiratory Specialists n(%)	Other Specialists n(%)	Cardiologists n(%)	GP n(%)	Respiratory Specialists n(%)	Other Specialists n(%)	Cardiologists n(%)
Total	219 [60.3%]	52 [65.8%]	61 [45.9%]	10 [29.4%]	144 [39.7%]	26 [34.2%]	72 [54.2%]	24 [70.5%]
Laval	39 (17.8%)	3 (5.8%)	12 (19.7%)	1 (10.0%)	20 (14.0%)	1 (3.9%)	19 (19.7%)	5 (20.8%)
McGill	41 (18.7%)	15 (28.9%)	15 (24.6%)	2 (20.0%)	42 (29.4%)	9 (34.6%)	14 (22.5%)	5 (20.8%)
Montreal	106 (48.4%)	22 (42.3%)	21 (34.4%)	4 (40.0%)	56 (39.2%)	9 (34.6%)	18 (38.0%)	14 (58.3%)
Sherbrooke	26 (11.9%)	7 (13.5%)	7(11.5%)	2 (20.0%)	18 (12.6%)	4 (15.4%)	12 (8.5%)	0 (12.0%)
Outside Quebec	7 (3.2%)	5 (9.6%)	6 (9.8%)	1 (10.0%)	7 (4.9%)	3 (11.5%)	9 (11.3%)	0 (16.0%)

Table ii.2.3. Study Physician Characteristics: National Licensing Examination Scores (n=609)

	QE1 Total Score Mean [SD; Range]		QE1 Clinical Reasoning Mean [SD; Range]		QE2 Total Score Mean [SD; Range]		QE2 Communication Mean [SD; Range]		QE2 Data Acquisition Mean [SD; Range]		QE2 Problem-Solving Mean [SD; Range]	
Overall	531.6 [78.9; 344-732]		512.9 [75.2; 0-702]		528.3 [79.7; 158-749]		516.0 [90.1;167-705]		517.8 [93.7; 174-772]		535.3 [103.2; 195-842]	
	Score	**n(%)**	**Score**	**n(%)**	**Score**	**n(%)**	**Score**	**n(%)**	**Score**	**n(%)**	**Score**	**n(%)**
Top Quartile	≥588	n=154(25.3%)	≥566	n=154 (25.2%)	≥ 585	n=154 (25.3%)	≥575	n=154(25.3%)	≥586	n=153 (25.1%)	≥605	n=153 (25.1%)
Third Quartile	531-587	n=152(25.0%)	518-565	n=152 (25.0%)	533-584	n=152 (25.0%)	527-575	n=157(25.8%)	518-585	n=153 (25.1%)	538-605	n=154 (25.3%)
Second Quartile	478-530	n=151(24.8%)	467-517	n=152 (25.0%)	476-532	n=151 (24.8%)	463-526	n=152 (5.0%)	453-517	n=151 (24.8%)	472-538	n=151 (24.8%)
Bottom Quartile	<478	n=152(25.0%)	<467	n=151 (24.8%)	<476	n=152 (25.0%)	<463	n=154 (25.3%)	<453	n=152 (25.0%)	<472	n=151 (24.8%)
By Gender (Number of Physicians)												
Female (n=342)	526.5 [77.8; 347-732]		510.9 [78.2; 0-702]		532.7[76.2; 211-749]		**531.5 [86.7; 178-705]**		523.3 [90.2; 273-742]		533.7 [99.8; 235-842]	
Male (n=267)	538.0 [80.0; 344-709]		515.4 [72.1; 285-688]		522.6 [83.9; 158-739]		**496.1 [90.6; 167-675]**		510.8 [97.7; 174-772]		537.3 [107.6; 195-835]	
By Practice Specialty (Number of Physicians)												
GP (n=363)	**518.8 [75.3; 344-720]**		**505.7 [78.6; 0-702]**		532.4 [80.5; 158-749]		**525.8 [88.2; 192-705]**		521.8 [90.5; 174-772]		539.3 [102.0; 195-842]	
Respiratory Specialist(n=79)	**552.0 [80.8; 353-728]**		**528.1 [64.9; 358-684]**		525.9 [66.2; 360.3-663]		**524.6 [80.1; 222-675]**		506.2 [91.2; 323-684]		536.7 [105.9; 235-754]	
Cardiologists (n=34)	**578.6 [66.8; 449-696]**		**542.8 [53.1; 448-680]**		533.3 [80.4; 315-644]		**481.9 [103.9; 178-675]**		537.7 [112.5; 234-702]		552.9 [83.5; 400-738]	
Other Specialist (n=133)	**542.4 [82.3; 345-732]**		**515.7 [76.0; 285-688]**		517.2 [79.2; 323-648]		**492.6 [91.8; 167-658]**		508.6 [97.1;229-725]		519.1 [108.5;240-799]	
By Undergraduate Medical School (Number of Physicians)												
McGill (n=94)	**511.9 [81.9; 347-696.8]**		**525.9 [70.9; 320-682]**		**522.9 [68.1; 328-652]**		**513.8 [91.8; 167-675]**		**495.5 [83.6; 305-684]**		**551.0 [93.1; 277-754]**	
Montreal (n=209)	**558.7 [73.4; 360.4-728]**		**524.0 [68.2; 324-702]**		**539.6 [79.8; 252-698]**		**530.5 [83.7; 178-742]**		**524.1 [100.7; 234742]**		**544.1 [94.3; 294-842]**	
Laval (n=128)	**534.1 [77.6; 344-732]**		**503.6 [71.5; 285-636]**		**533.0 [69.6; 341-739]**		**503.2 [89.8; 192-699]**		**520.8 [82.5; 310-705]**		**539.9 [104.7; 240-835]**	
Sherbrooke (n=99)	**521.0 [70.3; 353-695]**		**517.2 [66.4; 367-688]**		**538.2 [77.2; 343-749]**		**529.2 [90.7; 178-705]**		**545.3 [86.4; 323-772]**		**521.9 [119.7; 235-828]**	
Outside Quebec (n=44)	**514.8 [68.0; 377-661]**		**520.4 [72.2; 395-656]**		**536.7 [74.8; 384-663]**		**519.5 [72.6; 351-679]**		**516.0 [81.5; 301-703]**		**538.1 [92.4; 356-707]**	
Outside Canada (n=35)	**463.7 [80.2; 345-619]**		**424.1 [110.3; 0-627]**		**432.4 [94.7; 158-557]**		**439.6 [101.4; 228-634]**		**453.4 [111.2; 174-608]**		**458.0 [107.3; 195-645]**	

*One-way ANOVA was tested an equality of the mean score of each exam sub-score across the sub-groups of physician characteristics. Numbers in bold indicates that means scores are significantly different among sub-group of a physician characteristics at level of $p<.05$

Table ii.2.3. Study Physician Characteristics: National Licensing Examination Scores (n=609) (cont'd)

	QE1 Total Score Mean [SD; Range]	**QE1 Clinical Reasoning Mean [SD; Range]**	**QE2 Total Score Mean [SD; Range]**	**QE2 Communication Mean [SD; Range]**	**QE2 Data Acquisition Mean [SD; Range]**	**QE2 Problem-Solving Mean [SD; Range]**
By Post-Graduate Training Program (Number of Physicians)						
McGill (n=143)	**513.9 [79.9; 347-696.8]**	**515.3 [72.8; 330-682]**	**513.3 [78.0; 211-633]**	**494.4 [96.1;178-679]**	**504.1 [91.1; 229-705]**	532.1 [95.1;195-740]
Montreal (n=250)	**548.2 [73.7; 360.4-728]**	**519.8 [70.1;285-702]**	**535.3 [79.0; 270-710]**	**525.9 [88.6;167-699]**	**523.7 [97.9; 293-742]**	539.0 [102.5; 235-842]
Laval (n=100)	**521.4 [81.5; 344-732]**	**493.6 [78.9; 285-680]**	**516.5 [86.4;158-739]**	**506.9 [84.4;247-665]**	**501.8 [86.8;174-693]**	527.6 [118.7; 211-835]
Sherbrooke (n=73)	**520.5 [74.2; 348-698]**	**505.6 [90.1;0-642]**	**549.5 [71.5;387-749]**	**533.2 [89.3;248-676]**	**557.1 [84.7; 395-772]**	533.1 [105.4; 324-828]
Outside Quebec (n=41)	**541.2 [88.5; 345-709]**	**526.2 [75.4;313-688]**	**532.9 [74.4; 391-652]**	**504.4 [81.6;351-705]**	**504.4 [86.0; 301-703]**	543.7 [94.5; 382-772]
Missing (n=2)	**430.3 [59.8; 388-472.5]**	**436.0 [110.3; 358-514]**	**452.6 [130.6; 360-545]**	**503.0 [21.2;488-518]**	**401.5 [64.4;356-447**	593.5 [88.4;531-656]
Same Post-Graduate Training as Undergraduate Medical School						
Same (n=388)	532.6 [80.0; 344-732]	514.9 [71.4; 285-702]	**537.8 [73.9; 270-749]**	**525.0 [82.8; 200-698]**	523.0 [91.1; 293-772]	**544.7 [99.7; 240-842]**
Different (n=219)	530.6 [76.6; 345-709]	510.1 [82.6; 0-688]	**512.2 [86.5; 158-695]**	**500.1 [100.3; 167-705]**	509.6 [97.4; 174-705]	**518.1 [107.4; 195-772]**
Missing (n=2)	430.3 [59.8; 388-472.5]	436[110.3; 358-514]	**452.6 [130.6; 360-545]**	**503.0 [21.2;488-518]**	401.5 [64.4;356-447]	**593.5 [88.4;531-656]**

*One-way ANOVA was tested an equality of the mean score of each exam sub-score across the sub-groups of physician characteristics.
Numbers in bold indicates that means scores are significantly different among sub-group of a physician characteristics at level at p<.05

Table ii.2.4. Pearson Correlation Coefficient among National Licensing Examination Scores

	QE1Total Score	QE1 Clinical Reasoning	QE2 Total Score	QE2 Communication	QE2 Data Acquisition	QE2 Problem Solving
QE1 Total Score	--	--	--	--	--	--
QE1 Clinical Reasoning Score	0.41 (p<.001)	--	--	--	--	--
QE2 Total Score	0.19 (p<.001)	0.60 (p<.001)	--	--	--	--
QE2 Communication Score	0.22 (p<.001)	0.14 (p<.001)	0.52 (p<.001)	--	--	--
QE2 Data Acquisition Score	0.38 (p<.001)	0.15 (p<.001)	0.67 (p<.001)	0.31 (p<.001)	--	--
QE2 Problem Solving Score	0.69 (p<.001)	0.26 (p<.001)	0.61 (p<.001)	0.16 (p<.001)	0.22 (p<.001)	--

Figure ii.2.2 Number of Index Visits and Percentage of the Index Visits Due to Referral by Physician Specialty (n=90,078)

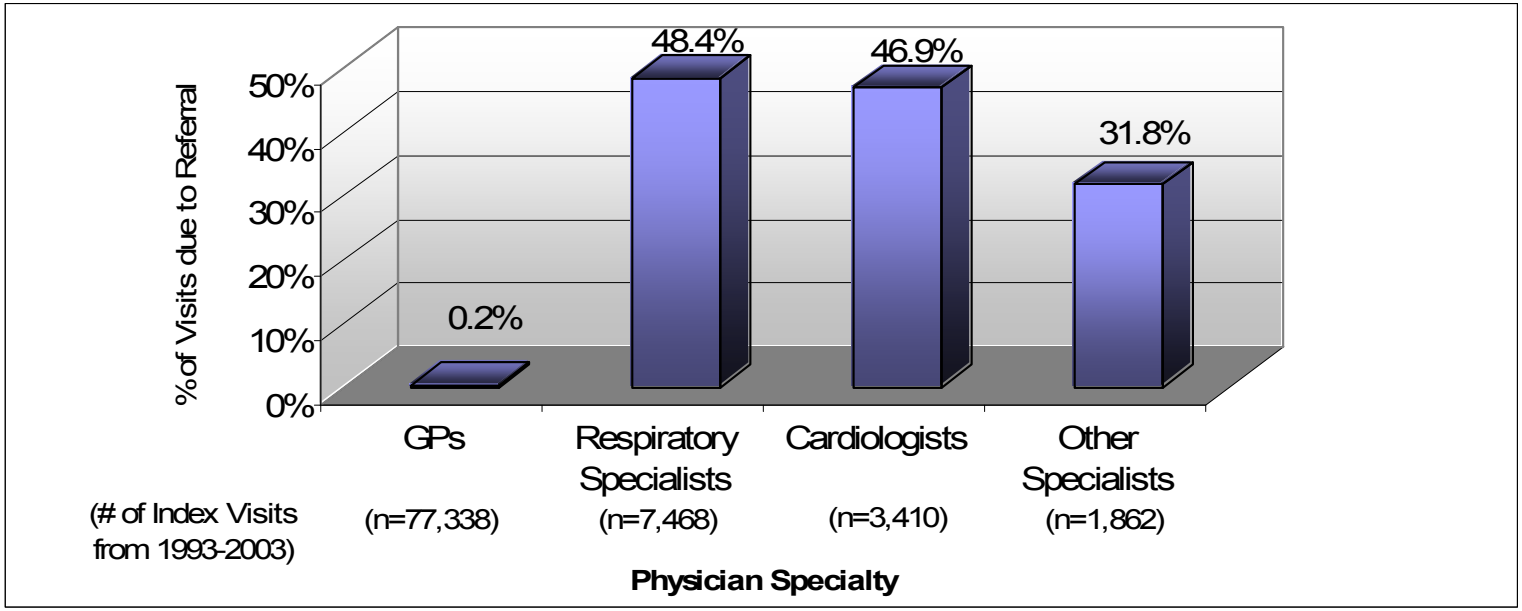


Table ii.2.5. Number of Index Visits and Proportion of the Visits due to Referral by Physician Specialty and Practice Year (n=90,078)

		Physician Specialty							
		GPs		Respiratory Specialist		Other Specialists		Cardiologists	
		Number of Index Visits n(%)	Number of Index Visits due to Referral n[%]	Number of Index Visits n(%)	Number of Index Visits due to Referral n[%]	Number of Index Visits n(%)	Number of Index Visits due to Referral n[%]	Number of Index Visits n(%)	Number of Index Visits due to Referral n[%]
Practice Year+	0	4,056 (5.2%)	3 (0.0%)	615 (8.2%)	224 (39.7%)	210 (11.3%)	57 (27.1%)	111 (3.3%)	70 (63.1%)
	1	9,782 (12.7%)	21 (0.02%)	1,338 (17.9%)	666 (49.8%)	390 (21.0%)	131 (33.6%)	374 (11.0%)	215 (57.5%)
	2	10,428 (13.5%)	23 (0.02%)	1539 (20.6%)	761 (49.4%)	394 (21.2%)	108 (27.4%)	395 (11.6%)	247 (62.5%)
	3	11,312 (14.6%)	22 (0.02%)	1406 (18.8%)	703 (50.0%)	217 (11.7%)	73 (33.6%)	769 (22.6%)	336 (43.7%)
	4	11,926 (15.4%)	23 (0.02%)	1306 (17.5%)	611 (46.8%)	224 (12.0%)	105 (46.9%)	647 (19.0%)	266 (41.1%)
	5	10,764 (13.9%)	13 (0.01%)	776 (10.4%)	389 (50.1%)	176 (9.5%)	75 (42.6%)	473 (13.9%)	204 (43.1%)
	6	8711 (11.3%)	25 (0.03%)	332 (4.5%)	174 (52.4%)	58 (3.1%)	27 (46.6%)	339 (9.9%)	138 (40.7%)
	7	5619 (7.3%)	33 (0.06%)	141 (1.9%)	97 (68.8%)	34 (1.8%)	4 (11.8%)	302 (8.9%)	122 (40.4%)
	8	3252 (8.7%)	12 (0.04%)	0 (--)	0 (--)	48 (2.6%)	3 (6.3%)	0 (--)	0 (--)
	9	1314 (3.5%)	0 (--)	2 (0.03%)	0 (--)	48 (2.6%)	5 (10.4%)	0 (--)	0 (--)
	10	174 (0.2%)	0 (--)	13 (0.17%)	0 (--)	63 (3.4%)	4 (6.3%)	0 (--)	0 (--)

+ Practice year was defined as years since first date of billing.

1. Patient Demographics: Age and Gender

Table ii.2.6 Patient Characteristics: Demographics (n=90,078)

Age	**Male (n=35,238; 39.1%)** Mean [SD; Range] n(%)	**Female (n=54,840; 60.9%)** Mean [SD; Range] n(%)
	30.1 [17.0; 5-60]	32.1 [15.9 5-60]
5-45	27,247 (77.3%)	41,503 (75.7%)
46-60	7,991 (22.7%)	13,337 (24.3%)

(2) Continuity of Care

Table ii.2.7.a. Respiratory-related Continuity of Care (COC) during Follow-Up Period by Physician Specialty and Practice Years (n=90,078)

Practice Year+	GPs n(%)				Respiratory Specialist n(%)				Other Specialists n(%)				Cardiologists n(%)			
	6month		1-year		6month		1-year		6month		1-year		6month		1-year	
	Having at least 1 Visit related to Respiratory –related Conditions				Having at least 1 Visits related to Respiratory –related Conditions				Having at least 1 Visits related to Respiratory –related Conditions				Having at least 1 Visits related to Respiratory –related Conditions			
	Number of Patients (%)	Respiratory-related COC mean [SD; Range]	Number of Patients (%)	Respiratory-related COC mean [SD; Range]	Number of Patients (%)	Respiratory-related COC mean [SD; Range]	Number of Patients (%)	Respiratory-related COC mean [SD; Range]	Number of Patients (%)	Respiratory-related COC mean [SD; Range]	Number of Patients (%)	Respiratory-related COC mean [SD; Range]	Number of Patients (%)	Respiratory-related COC mean [SD; Range]	Number of Patients (%)	Respiratory-related COC mean [SD; Range]
0	n=1,588 (39.2%)	0.21 [0.37;0-1]	n=2,061 (50.8%)	0.20 [0.35;0-1]	n=352 (57.2%)	0.29 [0.40;0-1]	n=409 (66.5%)	0.25 [0.37;0-1]	n=70 (33.3%)	0.27 [0.41;0-1]	n=98 (46.7%)	0.20 [0.35;0-1]	n=41 (36.9%)	0.25 [0.40;0-1]	n=52 (46.8%)	0.20 [0.37;0-1]
1	n=3,602 (36.8%)	0.21 [0.37;0-1]	n=4,956 (50..7%)	0.19 [0.35;0-1]	n=693 (51.8%)	0.36 [0.42;0-1]	n=834 (62.3%)	0.31 [0.40;0-1]	n=153 (39.2%)	0.28 [0.41;0-1]	n=200 (51.3%)	0.24 [0.39;0-1]	n=147 (39.3%)	0.36 [0.45;0-1]	n=197 (52.7%)	0.30 [0.42;0-1]
2	n=3,618 (34.7%)	0.21 [0.37;0-1]	n=5,012 (48.1%)	0.19 [0.35;0-1]	n=757 (49.2%)	0.34 [0.42;0-1]	n=922 (59.9%)	0.29 [0.39;0-1]	n=118 (29.9%)	0.19 [0.35;0-1]	n=167 (42.4%)	0.15 [0.32;0-1]	n=166 (42.0%)	0.26 [0.38;0-1]	n=203 (51.4%)	0.26 [0.38;0-1]
3	n=3,977 (35.2%)	0.21 [0.37;0-1]	n=5,501 (48.6%)	0.19 [0.35;0-1]	n=679 (48.3%)	0.31 [0.41;0-1]	n=832 (59.2%)	0.28 [0.38; 0-1]	n=76 (35.0%)	0.34 [0.45;0-1]	n=98 (45.2%)	0.29 [0.42;0-1]	n=299 (38.9%)	0.24 [0.39;0-1]	n=362 (36.9%)	0.22 [0.37;0-1]
4	n=4,051 (34.0%)	0.21 [0.37;0-1]	n=5,592 (46.9%)	0.19 [0.34;0-1]	n=587 (44.9%)	0.27 [0.39;0-1]	n=696 (53.3%)	0.24 [0.36;0-1]	n=71 (31.7%)	0.16 [0.32;0-1]	n=92 (41.1%)	0.19 [0.35;0-1]	n=259 (40.0%)	0.25 [0.39;0-1]	n=317 (36.9%)	0.21 [0.35;0-1]
5	n=3,431 (31.9%)	0.21 [0.38;0-1]	n=4,675 (43.4%)	0.19 [0.35;0-1]	n=324 (41.8%)	0.28 [0.40;0-1]	n=372 (47.9%)	0.27 [0.39;0-1]	n=54 (30.7%)	0.26 [0.42;0-1]	n=65 (30.9%)	0.23 [0.40;0-1]	n=176 (37.2%)	0.19 [0.35;0-1]	n=226 (36.9%)	0.17 [0.33;0-1]
6	n=2,644 (30.4%)	0.21 [0.37;0-1]	n=3,573 (41.0%)	0.19 [0.35;0-1]	n=150 (45.2%)	0.35 [0.43;0-1]	n=173 (52.1%)	0.32 [0.41;0-1]	n=24 (41.4%)	0.35 [0.46;0-1]	n=28 (48.3%)	0.35 [0.46;0-1]	n=160 (47.2%)	0.17 [0.33;0-1]	n=191 (36.9%)	0.17 [0.33;0-1]
7	n=1,605 (28.6%)	0.21 [0.38;0-1]	n=2,090 (37.2%)	0.20 [0.36;0-1]	n=47 (33.3%)	0.38 [0.44;0-1]	n=77 (54.6%)	0.32 [0.42;0-1]	n=13 (38.2%)	0.15 [0.32;0-1]	n=13 (38.2%)	0.15 [0.31;0-1]	n=118 (39.1%)	0.17 [0.32;0-1]	n=118 (43.0%)	0.17 [0.32;0-1]
8	n=914 (28.1%)	0.22 [0.38;0-1]	n=1,186 (36.5%)	0.21 [0.36;0-1]	-- (--)	-- (--)	-- [--]	-- [--]	n=14 (29.2%)	0.07 [0.27;0-1]	n=17 (35.4%)	0.06 [0.24;0-1]	-- [--]	-- [--]	-- [--]	-- [--]
9	n=314 (23.9%)	0.26 [0.41;0-1]	n=393 (29.9%)	0.25 [0.39;0-1]	n=2 (100%)	0 [--]	n=2 (100%)	0 [--]	n=17 (35.4%)	0.14 [0.27;0-1]	n=20 (41.7%)	0.12 [0.26;0-1]	-- [--]	-- [--]	-- [--]	-- [--]
10	n=33 (19.0%)	0.51 [0.45;0-1]	n=42 (24.1%)	0.45 [0.46;0-1]	n=6 (46.2%)	0.17 [0.41;0-1]	n=11 (84.6%)	0.05 [0.15;0-5]	n=14 (22.2%)	0.37 [0.45;0-1]	n=17 (27.0%)	0.36 [0.46;0-1]	-- [--]	-- [--]	-- [--]	-- [--]

Table ii.2.7.b Respiratory Outpatient Specific Continuity of Care (COC) at Outpatient Settings during Follow-Up Period by Physician Specialty and Practice Years (n=90,078)

Practice Year+	GPs n(%)				Respiratory Specialist n(%)				Other Specialists n(%)				Cardiologists n(%)			
	6month		1-year		6month		1-year		6month		1-year		6month		1-year	
	Having at least 1 Visits related to Respiratory –related Conditions at Outpatient Settings				Having at least 1 Visits related to Respiratory –related Conditions at Outpatient Settings				Having at least 1 Visits related to Respiratory –related Conditions at Outpatient Settings				Having at least 1 Visits related to Respiratory –related Conditions at Outpatient Settings			
	Number of Patients (%)	Respiratory Outpatient Specific COC mean [SD; Range]	Number of Patients (%)	Respiratory Outpatient Specific COC mean [SD; Range]	Number of Patients (%)	Respiratory Outpatient Specific COC mean [SD; Range]	Number of Patients (%)	Respiratory Outpatient Specific COC mean [SD; Range]	Number of Patients (%)	Respiratory Outpatient Specific COC mean [SD; Range]	Number of Patients (%)	Respiratory Outpatient Specific COC mean [SD; Range]	Number of Patients (%)	Respiratory Outpatient Specific COC mean [SD; Range]	Number of Patients (%)	Respiratory Outpatient Specific COC mean [SD; Range]
0	n=1,429 (35.2%)	0.23 [0.39;0-1]	n=1,884 (46.4%)	0.21 [0.37;0-1]	n=322 (52.4%)	0.32 [0.42;0-1]	n=385 (62.6%)	0.28 [0.39;0-1]	n=62 (29.5%)	0.29 [0.43;0-1]	n=89 (42.4%)	0.22 [0.37;0-1]	n=30 (27.0%)	0.32 [0.46;0-1]	n=40 (36.0%)	0.24 [0.42;0-1]
1	n=3,277 (33.5%)	0.22 [0.38;0-1]	n=4,533 (46.3%)	0.20 [0.36;0-1]	n=636 (47.5%)	0.39 [0.44;0-1]	n=771 (57.6%)	0.34 [0.41;0-1]	n=137 (35.1%)	0.32 [0.44;0-1]	n=184 (47.2%)	0.27 [0.41;0-1]	n=130 (34.8%)	0.39 [0.47;0-1]	n=174 (46.5%)	0.32 [0.44;0-1]
2	n=3,293 (31.6%)	0.22 [0.39;0-1]	n=4,646 (44.6%)	0.20 [0.36;0-1]	n=705 (52.7%)	0.36 [0.44;0-1]	n=846 (55.0%)	0.32 [0.42;0-1]	n=102 (25.9%)	0.18 [0.35;0-1]	n=144 (36.5%)	0.15 [0.33;0-1]	n=145 (36.7%)	0.28 [0.41;0-1]	n=176 (44.6%)	0.28 [0.39;0-1]
3	n=3,588 (31.7%)	0.22 [0.39;0-1]	n=5,058 (44.7%)	0.19 [0.36;0-1]	n=635 (45.2%)	0.34 [0.42;0-1]	n=767 (54.6%)	0.31 [0.40; 0-1]	n=67 (30.9%)	0.34 [0.45;0-1]	n=85 (39.2%)	0.29 [0.42;0-1]	n=254 (33.0%)	0.28 [0.42;0-1]	n=303 (39.4%)	0.26 [0.41;0-1]
4	n=3,707 (31.1%)	0.22 [0.38;0-1]	n=5,168 (43.3%)	0.19 [0.36;0-1]	n=529 (40.5%)	0.29 [0.40;0-1]	n=624 (47.8%)	0.26 [0.38;0-1]	n=59 (26.3%)	0.16 [0.35;0-1]	n=79 (35.3%)	0.18 [0.36;0-1]	n=220 (34.0%)	0.25 [0.40;0-1]	n=275 (42.5%)	0.22 [0.37;0-1]
5	n=3,160 (29.4%)	0.22 [0.39;0-1]	n=4,349 (40.4%)	0.19 [0.36;0-1]	n=295 (38.0%)	0.31 [0.42;0-1]	n=339 (43.7%)	0.30 [0.41;0-1]	n=45 (25.6%)	0.29 [0.43;0-1]	n=55 (31.3%)	0.24 [0.40;0-1]	n=150 (31.7%)	0.23 [0.39;0-1]	n=202 (42.7%)	0.20 [0.36;0-1]
6	n=2,421 (27.8%)	0.21 [0.38;0-1]	n=3,307 (38.0%)	0.20 [0.37;0-1]	n=136 (41.0%)	0.38 [0.44;0-1]	n=154 (46.4%)	0.35 [0.42;0-1]	n=21 (36.2%)	0.37 [0.47;0-1]	n=24 (41.4%)	0.34 [0.45;0-1]	n=139 (41.0%)	0.20 [0.35;0-1]	n=170 (50.1%)	0.18 [0.34;0-1]
7	n=1,468 (26.1%)	0.21 [0.39;0-1]	n=1,919 (37.2%)	0.21 [0.38;0-1]	n=35 (24.8%)	0.44 [0.46;0-1]	n=41 (29.1%)	0.36 [0.44;0-1]	n=10 (29.4%)	0.30 [0.48;0-1]	n=10 (29.4%)	0.30 [0.48;0-1]	n=99 (32.8%)	0.22 [0.38;0-1]	n=113 (37.4%)	0.22 [0.37;0-1]
8	n=844 (26.0%)	0.23 [0.40;0-1]	n=1,107 (34.0%)	0.22 [0.38;0-1]	-- (--)	-- (--)	-- [--]	-- [--]	n=10 (20.8%)	0 [--]	n=13 (27.1%)	0 [--]	-- [--]	-- [--]	-- [--]	-- [--]
9	n=291 (22.1%)	0.26 [0.41;0-1]	n=366 (27.9%)	0.26 [0.41;0-1]	n=2 (100%)	0 [--]	n=2 (100%)	0 [--]	n=13 (27.1%)	0.13 [0.30;0-1]	n=15 (31.3%)	0.12 [0.28;0-1]	-- [--]	-- [--]	-- [--]	-- [--]
10	n=29 (16.7%)	0.49 [0.47;0-1]	n=38 (21.8%)	0.44 [0.47;0-1]	n=6 (46.2%)	0.17 [0.41;0-1]	n=11 (84.6%)	0.09 [0.30;0-5]	n=11 (17.5%)	0.44 [0.50;0-1]	n=13 (20.6%)	0.37 [0.47;0-1]	-- [--]	-- [--]	-- [--]	-- [--]

(4) Asthma Status

Table ii.2.8. Asthma Status by Patient Demographics and Asthma-related Characteristics During 1-Year Prior to the Index Visits (n=90,078)

	Asthma Status* n(%) Mean [SD; Range]	
	Yes 79,781 (88.6%)	No 10.297 (11.4%)
Probability of Having Asthma	0.60 [0.35; 0.128-0.99]	0.05 [0.03; 0.01-0.12]
1. Patient Demographics:		
(1) Age	29.8 (16.1; 5-60)	43.2 (13.3; 5-60)
(2) Gender: Female	49,010 (60.9%)	5,830 (56.6%)
2. Asthma-related Characteristics		
(1)Number of Visits to GP**:**		
No Visits	5,998 (7.5%)	6,776 (65.8%)
1 Visits	45,049 (56.5%)	350 (3.4%)
2 Visits	14,071 (17.6%)	3,116 (30.3%)
≥3 Visits	14,673 (18.4%)	55 (0.5%)
(2)Number of Visits to Respiratory- related Specialists		
No Visits	73,840 (92.6%)	3,644 (35.4%)
≥1 Visits	5,941 (7.5%)	6,653 (64.6%)
(3) Number of Controller Medication Dispensed:		
Never	46,721 (58.6%)	10,297 (100%)
1	9,163 (11.5%)	0 (--)
≥2	23,897 (30.0%)	0 (--)
(4) Number of Rescue Medication Dispensed:		
Never	37,006 (51.0%)	10,153 (98.6%)
1	10,523 (14.5%)	144 (1.4%)
≥2	25,026 (34.5%)	0 (--)
(5) Comorbidity		
Absence of Cardiac related Conditions	74,660 (93.6%)	6,359 (61.8%)
Presence of Neurotic Disorder/Somatic Complaints	10,133 (12.7%)	2,136 (12.2%)
Presence of Upper Airway Conditions	30,771 (38.6%)	898 (8.7%)

*A cut-off probability of asthma status, 0.128, was calculated based upon a logistic regression model including the following covariates: number of visits to GPs, number of visits to respiratory-related specialists, number of controller medication dispensed, number of rescue medication dispensed, co-morbidity, age, and gender.

(5) Socioeconomic Status

Table ii.2.9. Level of Patients' Socioeconomic Status by Practice Experience (n=90,078)

Practice Year+	n(%)	Income		Education		
		Number of Patients under Poverty Line* n (%)	Area-Based Household Income Mean[SD; Range]	% of Patients with University Degree Mean[SD; Range]	% of Patients with High School Degree Mean[SD; Range]	% of Patients without Secondary Degree Mean[SD; Range]
0	4992 (5.54%)	2,192 (43.9%)	33,301.7 [24,032.8; 0-192,127]	16.8 [19.6; 0-132]	29.0 [26.0; 0-151]	27.0 [19.1;0-92]
1	11,884 (13.19%)	4,427 (37.3%)	38,141.3 [23,861.3; 0-397,972]	19.4 [20.1; 0-153]	33.1 [25.5; 0-162]	30.0 [17.4; 0-87]
2	12,756 (14.16%)	3,968 (31.1%)	41756.6 [21,865.4; 0-21,865.4]	21.0 [20.5; 0-143]	35.8 [24.9; 0-162]	32.9 [15.4; 0-87]
3	13,704 (15.21%)	4,173 (30.5%)	43,997.0 [21,400.6; 0-392,032]	22.6 [21.0; 0-160]	38.2 [24.8; 0-170]	33.8 [14.3; 0-92]
4	14,103 (15.66%)	4,151 (29.4%)	44943.7 [21376.7; 0-382,508]	23.7 [21.0; 0-150]	39.9 [24.6; 0-164]	33.5 [13.9; 0-87]
5	12,189 (13.53%)	3,917 (32.1%)	45848.4 [22271.0; 0-397,972]	26.2 [22.6; 0-153]	42.8 [26.0; 0-162]	32.2 [13.8; 0-87]
6	9,440 (10.48%)	3,090 (32.7%)	45719.8 [20,892.5; 0-349,609]	25.2 [21.1; 0-160]	41.8 [24.6; 0-170]	32.4 [13.5; 0-87]
7	6,096 (6.77%)	1,941 (31.8%)	45953.2 [20,379.8; 0-349,609]	24.8 [20.3; 0-135]	41.4 [23.9; 0-148]	32.7 [13.6; 0-87]
8	3,300 (3.66%)	1,230 (37.3%)	43918.0 [19,126.3; 0-349,609]	24.4 [20.0; 0-144]	40.6 [23.6; 0-155]	33.7 [13.8; 0-87]
9	1,364 (1.51%)	442 (32.4%)	46512.9 [21667.2; 0-372,057]	29.8 [22.4; 0-153]	47.0 [25.1; 0-159]	31.0 [12.2;0-87]
10	250 (0.28%)	101 (40.4%)	42920.5 [18203.8; 0-172,899]	26.4 [19.7; 0-97]	42.0 [23.2; 0-118]	34.9 [12.7; 0-64]

*Poverty line is based on family size of 4 in the community of Residence with the population of more than 500,000. Information of poverty line was used from Statistics Canada Low-Income Cut-Off

+ Practice year was defined as years since first date of billing.

3. Physician Practice and Workload Characteristics

Table ii.2.10. Physician Practice Pattern and Workload Characteristics by Practice Year

(1) Overall		**Practice Year+** (n); Mean[SD; Range]										
Number of Unique Practice Settings Per Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Physician Specialty	GPs	(n=363) 2.90 [1.49;1-8]	(n=354) 3.34 [1.51;1-7]	(n=339) 3.20 [1.53; 1-8]	(n=322) 3.23 [1.52; 1-8]	(n=311) 3.10 [1.4; 1-7]	(n=301) 3.00 [1.39; 1-7]	(n=253) 2.98 [1.39; 1-7]	(n=164) 2.88 [1.45; 1-7]	(n=88) 3.04 [1.42; 1-7]	(n=29) 2.69 [1.44; 1-7]	(n=3) 3.67 [2.31; 1-5]
	Respiratory Specialist	(n=78) 3.53 [0.98;1-6]	(n=78) 3.77 [1.10; 1-6]	(n=73) 3.81 [1.10; 1-6]	(n=69) 4.03 [0.94;.1-6]	(n=61) 3.70 [1.04; 1-6]	(n=38) 4.0 [1.12;.1-6]	(n=19) 3.37 [1.01;.1-5]	(n=7) 2.86 [1.07;1-4]	(n=1) 1 [--; --]	(n=1) 2 [--; --]	(n=1) 2 [--; --]
	Other Specialists	(n=133) 3.18 [1.38; 1-6]	(n=127) 3.45 [2.34; 1-6]	(n=123) 3.49 [1.24; 1-6]	(n=104) 3.34 [1.28; 1-6]	(n=80) 3.33 [1.33; 1-7]	(n=56) 3.23 [1.39; 1-6]	(n=32) 2.90 [1.38; 1-5]	(n=13) 2.85 [1.95; 1-6]	(n=12) 3.08 [1.78;.1-6]	(n=11) 4.09 [1.30; 2-6]	(n=12) 4.41 [1.16;3-6]
	Cardiologists	(n=34) 3.65 [0.98; 2-6]	(n=34) 3.71 [0.97; 1-5]	(n=28) 4.0 [0.72; 3-5]	(n=32) 4.44 [0.67; 3-6]	(n=28) 4.54 [0.64; 4-6]	(n=19) 4.37 [0.60; 4-6]	(n=13) 4.31 [0.48; .4-5]	(n=7) 4.86 [0.69; .4-6]	(n=0) -- [--; --]	(n=0) -- [--; --]	(n=0) -- [--; --]
Mean Number of Patients Seen/ Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Physician Specialty	GPs	(n=363) 1539.4 [1394; 1-7640]	(n=354) 3221.8 [1877; 2-9658]	(n=339) 3331.2 [1962; 1-11917]	(n=322) 3492.0 [1892;17-12643]	(n=311) 3466.9 [1970.2; 11-11831]	(n=301) 3284.3 [2069; 1-12616]	(n=253) 3471.0 [1878; 26-9090]	(n=164) 3467.7 [1998; 1-9506]	(n=88) 3779.0 [2015; 127-11512]	(n=29) 4030.1 [1934; 396-9690]	(n=3) 6686.0 [2125; 4854-9015]
	Respiratory Specialist	(n=78) 1153.9 [1168.0; 18-7793]	(n=78) 2408.0 [1417.5; 1-5669]	(n=73) 2581.0 [1590.5; 2-8140]	(n=69) 2556.5 [1491.3; 99-8819]	(n=61) 2556.1 [145.7; 53-5835]	(n=38) 2634.9 [1594.8; 143-6255]	(n=19) 2166.2 [1228.7; 137-4260]	(n=7) 1763.3 [1171; 103-3097]	(n=1) 138 [--; --]	(n=1) 159 [--; --]	(n=1) 269 [--; --]
	Other Specialists	(n=133) 1094.4 [1053.4; 5-6113]	(n=127) 2590.8 [1977; 1-7756]	(n=123) 2799.0 [2110; 3-8770]	(n=104) 2858.2 [2348.3; 1-9326]	(n=80) 3011.3 [2336; 5-9507]	(n=56) 3435.6 [2688; 4-9691]	(n=32) 2583.3 [2235; 1-6867]	(n=13) 1606.3 [2438; 2-6936]	(n=12) 1666.1 [2264.1; 37-7358]	(n=11) 1785.9 [1243.2; 674-4976]	(n=12) 3012.1 [1426; 812-5031]
	Cardiologists	(n=34) 516.0 [620.1; 34-2164]	(n=34) 1319.0 [1778; 80-5561]	(n=28) 1909.5 [1802; 97-5714]	(n=32) 2895 [2011; 221-7235]	(n=28) 3294.1 [1846; 396-6845]	(n=19) 3770.8 [1886; 1179-7515]	(n=13) 4048.7 [1508;1764-6150]	(n=7) 4935.1 [1535; 2516-6997]	(n=0) -- [--; --]	(n=0) -- [--; --]	(n=0) -- [--; --]

+ Practice year was defined as years since first date of billing.

Table ii.2.10. Physician Practice Pattern and Workload Characteristics by Practice Year (Cont'd)

		Practice Year (n); Mean[SD; Range]										
Mean Number of Work Days/Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Physician Specialty	GPs	(n=363) 94.6 [73;1-384]	(n=354) 191.1 [100;1-476]	(n=339) 187.8 [96; 1-453]	(n=322) 193.9 [92; 5-485]	(n=311) 186.9 [92; 4-492]	(n=301) 177.7 [94; 1-490]	(n=253) 187.4 [84; 8-479]	(n=164) 182.5 [89; 1-473]	(n=88) 197.9 [82; 24-465]	(n=29) 216.2 [95.9; 62-462]	(n=3) 281.3 [19; 270-303]
	Respiratory Specialist	(n=78) 118.5 [86.7;4-400]	(n=78) 239.9 [123; 1-486]	(n=73) 245.9 [122; 2-538]	(n=69) 240.1 [100; 22-534]	(n=61) 240.4 [103; 7-510]	(n=38) 254.7 [101;52-511]	(n=19) 231.0 [109;49-540]	(n=7) 241.7 [149;78-546]	(n=1) 106 [--; --]	(n=1) 97 [--; --]	(n=1) 119 [--; --]
	Other Specialists	(n=133) 133.7 [91.4; 1-497]	(n=127) 274.6 [131; 1-487]	(n=123) 280.5 [124; 2-533]	(n=104) 275.8 [131; 1-524]	(n=80) 281.9 [134; 4-510]	(n=56) 283.9 [130; 3-491]	(n=32) 258.8 [155; 1-522]	(n=13) 173 [193; 2-656]	(n=12) 197.3 [175;.4-647]	(n=11) 226.2 [74; 105-327]	(n=12) 316.7 [53;216-390]
	Cardiologists	(n=34) 43.0 [62.8; 2-209]	(n=34) 103.8 [150; 2-453]	(n=28) 162.4 [150; 4-447]	(n=32) 247.5 [135.2; 7-451]	(n=28) 292.3 [109.4;44-468]	(n=19) 332.4 [93; 110-461]	(n=13) 350.0 [73; 201-445]	(n=7) 338.7 [74; 197-406]	(n=0) -- [--; --]	(n=0) -- [--; --]	(n=0) -- [--; --]
% of Female Seen Per Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Physician Specialty	GPs	(n=363) 0.55 [0.1;.0-.99]	(n=354) 0.56 [0.09;.0-.99]	(n=339) 0.57 [0.1; 0.24-1]	(n=322) 0.58 [0.09; .34-.98]	(n=311) 0.59 [0.1; .34-.98]	(n=301) 0.59 [0.11; 0-.98]	(n=253) 0.59 [0.10; .23-.91]	(n=164) 0.60 [0.11; .3-1]	(n=88) 0.59 [0.10; .29-.91]	(n=29) 0.60 [0.10; .47-.89]	(n=3) 0.59 [0.10; .53-.71]
	Respiratory Specialist	(n=78) 0.47 [0.11;.17-.94]	(n=78) 0.48 [0.11; 0.11-1]	(n=73) 0.46 [0.12; 0-.71]	(n=69) 0.48 [0.09;.15-.70]	(n=61) 0.47 [0.1; .11-.67]	(n=38) 0.48 [0.07;.35-.64]	(n=19) 0.48 [0.08;.37-.69]	(n=7) 0.51 [0.12;.38-.74]	(n=1) 0.70 [--; --]	(n=1) 0.62 [--; --]	(n=1) 0.59 [--; --]
	Other Specialists	(n=133) 0.54 [0.15; 0-.99]	(n=127) 0.54 [0.15; 0-1]	(n=123) 0.56 [0.16; .26-1]	(n=104) 0.54 [0.17; 0-1]	(n=80) 0.56 [0.14; 0.2-1]	(n=56) 0.55 [0.16; 0-.99]	(n=32) 0.54 [0.17; 0-.99]	(n=13) 0.58 [0.17; 0.4-1]	(n=12) 0.53 [0.15;.27-.82]	(n=11) 0.49 [0.05; .43-59]	(n=12) 0.49 [0.05;.42-.58]
	Cardiologists	(n=34) 0.46 [0.08;.28-.68]	(n=34) 0.46 [0.08;.28-.68]	(n=28) 0.46 [0.04; .40-.53]	(n=32) 0.44 [0.06; .29-.54]	(n=28) 0.43 [0.06; .32-.53]	(n=19) 0.44 [0.05; .33-.52]	(n=13) 0.43 [0.06; .3-.51]	(n=7) 0.42 [0.06; .34-.51]	(n=0) -- [--; --]	(n=0) -- [--; --]	(n=0) -- [--; --]
% of Elderly Seen Per Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Physician Specialty	GPs	(n=363) 0.20 [0.16;0-1]	(n=354) 0.20 [0.15 0-1]	(n=339) 0.21 [0.15 0-1]	(n=322) 0.22 [0.15; 0-1]	(n=311) 0.22 [0.15; 0-0.97]	(n=301) 0.22 [0.16; 0-0.91]	(n=253) 0.21 [0.15; 0-0.82]	(n=164) 0.21 [0.15; 0-0.96]	(n=88) 0.23 [0.15;0-0.97]	(n=29) 0.21 [0.13;0-0.52]	(n=3) 0.19 [0.17; 0.02-0.4]
	Respiratory Specialist	(n=78) 0.30 [0.29; 0-0.85]	(n=78) 0.29 [0.29; 0-0.85]	(n=73) 0.27 [0.28; 0-0.77]	(n=69) 0.29 [0.28;0-0.77]	(n=61) 0.28 [0.29; 0-0.8]	(n=38) 0.31 [0.28;0-0.78]	(n=19) 0.20 [0.24; 0-0.62]	(n=7) 0.23 [0.24;0-0.54]	(n=1) 0.18 [--; --]	(n=1) 0.17 [--; --]	(n=1) 0.15 [--; --]
	Other Specialists	(n=133) 0.25 [0.16; 0-0.66]	(n=127) 0.25 [0.17; 0-0.62]	(n=123) 0.25 [0.16;0-0.57]	(n=104) 0.25 [0.17;0-0.69]	(n=80) 0.26 [0.17;0-0.69]	(n=56) 0.25 [0.15;0-0.62]	(n=32) 0.20 [0.15;0-0.49]	(n=13) 0.21 [0.25;0-0.72]	(n=12) 0.23 [0.21; 0-0.59]	(n=11) 0.30 [0.2; 0-0.53]	(n=12) 0.32 [0.2; 0-0.56]
	Cardiologists	(n=34) 0.55 [0.18; 0-.85]	(n=34) 0.56 [0.17; 0-0.78]	(n=28) 0.53 [0.16;0-0.70]	(n=32) 0.52 [0.15; 0-0.68]	(n=28) 0.50 [0.15; 0-0.66]	(n=19) 0.54 [0.06; 0.4-0.6]	(n=13) 0.55 [0.06; 0.4-0.6]	(n=7) 0.54 [0.06; 0.5-0.6]	(n=0) -- [--; --]	(n=0) -- [--; --]	(n=0) -- [--; --]

+ Practice year was defined as years since first date of billing.

Table ii.2.11. Physician Practice Pattern and Workload Characteristics by Year of Practice: Outpatient-Specific

(2) Outpatient		**Practice Year+** (n); Mean[SD; Range]										
Number of Unique Practice Settings Per Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Physician Specialty	GPs	(n=314) 1.38 [0.55; 1-3]	(n=331) 1.51 [0.56; 1-3]	(n=305) 1.54 [0.57; 1-3]	(n=297) 1.56 [0.59; 1-3]	(n=287) 1.49 [0.58;1-3]	(n=279) 1.47 [0.55; 1-3]	(n=234) 1.50 [0.59; 1-3]	(n=153) 1.50 [0.62; 1-3]	(n=84) 1.56 [0.65;1-4]	(n=27) 1.48 [0.75;1-4]	(n=3) 2.0 [1;1-3]
	Respiratory Specialist	(n=69) 1.35 [0.48;1-2]	(n=70) 1.41 [0.50;1-2]	(n=68) 1.46 [0.50; 1-2]	(n=67) 1.51 [0.50;1-2]	(n=58) 1.36 [0.48;1-2]	(n=37) 1.46 [050; 1-2]	(n=17) 1.29 [0.47;1-2]	(n=7) 1.14 [0.38;1-2]	(n=1) 1.0 [--; --]	(n=1) 2.0 [--; --]	(n=1) 1.0 [--; --]
	Other Specialists	(n=127) 1.35 [0.49; 1-3]	(n=122) 1.49 [0.52; 1-3]	(n=118) 1.47 [0.51;.1-2]	(n=100) 1.43 [0.50;.1-2]	(n=76) 1.46 [0.50;1-2]	(n=53) 1.47 [0.50;1-2]	(n=32) 1.34 [0.48;1-2]	(n=12) 1.42 [0.67;.1-3]	(n=11) 1.54 [0.69;1-3]	(n=11) 1.82 [0.75;1-3]	(n=12) 1.92 [0.67;1-3]
	Cardiologists	(n=17) 1.12 [0.33; .1-2]	(n=20) 1.0 [0; .1-1]	(n=22) 1.1 [0.29; 1-2]	(n=31) 1.26 [0.49;.1-2]	(n=28) 1.36 [0.49;1-2]	(n=19) 1.26 [0.45;1-2]	(n=13) 1.23 [0.44;1-2]	(n=7) 1.71 [0.49;1-2]	(n=0) -- [--; --]	(n=0) -- [--; --]	(n=0) -- [--; --]
Average Number of Patients Seen Per Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Physician Specialty	GPs	(n=314) 744.9 [817; 1-5385]	(n=331) 1573.2 [1426; 1-7320]	(n=305) 1719.4 [1460; 1-6528]	(n=297) 1879.0 [1462; 1-6521]	(n=287) 2052.7 [1618; 1-7885]	(n=279) 1969.7 [1061; 1-7439]	(n=234) 2130.2 [1572; 1-8110]	(n=153) 2199.0 [1621; 1-7197]	(n=84) 2327.5 [1717; 26-7559]	(n=27) 2872.2 [1518; 1-6198]	(n=3) 4547.0 [1462; 3388-6189]
	Respiratory Specialist	(n=69) 583.4 [824; 1-5627]	(n=70) 1239.8 [984; 6-4088]	(n=68) 1347.9 [1159; 1-6833]	(n=67) 1282.0 [1176; 13-7547]	(n=58) 1289.0 [1193;6-5106]	(n=37) 1240.2 [1025; 13-4249]	(n=17) 1225.9 [829; 84-2955]	(n=7) 892.1 [901; 103-2454]	(n=1) 138 [--; --]	(n=1) 159 [--; --]	(n=1) 269 [--; --]
	Other Specialists	(n=127) 789.6 [0914; 2-5727]	(n=122) 1989.0 [1870; 4-6855]	(n=118) 2173.1 [2014; 1-8325]	(n=100) 2212.1 [2189; 5-8580]	(n=76) 2456.2 [2201; 1-8933]	(n=53) 2847.0 [2441;.15-9075]	(n=32) 1997.2 [1988;1-6177]	(n=12) 1332.5 [1932;.2-6111]	(n=11) 1126.4 [1601; 103-4285]	(n=11) 1038.6 [1190.5;. 101-4414]	(n=12) 1846.5 [1517.7; 64-4540]
	Cardiologists	(n=17) 308.8 [384; 1-1354]	(n=20) 819.0 [1019; 3-3176]	(n=22) 999.1 [958.0; 8-3423]	(n=31) 1331.9 [1155;. 16-4551]	(n=28) 1486.2 [1136;.61-4047]	(n=19) 1759.2 [1178;271-4355]	(n=13) 2004.5 [1050; 543-3755]	(n=7) 2679.4 [924.9; 1281-4015]	(n=0) -- [--; --]	(n=0) -- [--; --]	(n=0) -- [--; --]

+ Practice year was defined as years since first date of billing.

Table ii.2.11. Physician Practice Pattern and Workload Characteristics by Year of Practice: Outpatient-Specific (Cont'd)

(2) Outpatient		**Practice Year** (n); Mean[SD; Range]										
Mean Number of Working Days/Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Physician Specialty	GPs	(n=314) 44.9 [41; 1-187]	(n=331) 89.9 [67; 1-244]	(n=305) 93.5 [64.0; 1-250]	(n=297) 98.4 [64.7; 1-250]	(n=287) 102.3 [65.0;1-261]	(n=279) 98.9 [64; 1-255]	(n=234) 105.4 [61.1; 1-261]	(n=153) 108.4 [64.0; 1-264]	(n=84) 113.7 [64.5;2-255]	(n=27) 140.5 [60.1;1-242]	(n=3) 192.3 [87;98-270]
	Respiratory Specialist	(n=69) 61.6 [45;1-204]	(n=70) 123.1 [62;3-237]	(n=68) 125.6 [67; 3-237]	(n=67) 119.8 [59.1;2-288]	(n=58) 123.4 [63;1-273]	(n=37) 124.1 [63.1;8-265]	(n=17) 135.5 [57;11-287]	(n=7) 131.3 [75.7;26-252]	(n=1) 106 [--; --]	(n=1) 97 [--; --]	(n=1) 119 [--; --]
	Other Specialists	(n=127) 70.9 [50; 1-233]	(n=122) 147.9 [67; 4-260]	(n=118) 152.6 [68.3;.1-287]	(n=100) 151.7 [71.2;.4-288]	(n=76) 159.5 [68.9;1-295]	(n=53) 166.6 [62.0;11-261]	(n=32) 142.4 [79.1;1-264]	(n=12) 112.9 [86.8;.2-309]	(n=11) 115.4 [76;.53-301]	(n=11) 115.8 [50;51-187]	(n=12) 157.8 [61.1;52-259]
	Cardiologists	(n=17) 36.3 [39; .1-100]	(n=20) 79.1 [87; .1-217]	(n=22) 97.5 [73.5; 1-221]	(n=31) 120.3 [68.0;.7-220]	(n=28) 134.8 [59;11-234]	(n=19) 157.4 [47;.47-.231]	(n=13) 168.0 [33;112-203]	(n=7) 167.9 [34;95-200]	(n=0) -- [--; --]	(n=0) -- [--; --]	(n=0) -- [--; --]
% of Female Seen Per Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Physician Specialty	GPs	(n=314) 0.59 [0.15; 0-1]	(n=331) 0.58 [0.14; 0-1]	(n=305) 0.60 [0.13; 0-1]	(n=297) 0.60 [0.13; 0-1]	(n=287) 0.61 [0.14;0-1]	(n=279) 0.61 [0.15; 0-1]	(n=234) 0.62 [0.14; 0-1]	(n=153) 0.61 [0.14; 0-1]	(n=84) 0.61 [0.13;.29-.91]	(n=27) 0.61 [0.18;0-.99]	(n=3) 0.60 [0.1;.53-.71]
	Respiratory Specialist	(n=69) 0.53 [0.15;0-1]	(n=70) 0.53 [0.11;.38-.95]	(n=68) 0.50 [0.12; 0-.95]	(n=67) 0.52 [0.10;.39-.94]	(n=58) 0.51 [0.08;.36-.79]	(n=37) 0.51 [0.09;.38-.84]	(n=17) 0.51 [0.08;.40-.69]	(n=7) 0.52 [0.13;.33-.74]	(n=1) 0.70 [--; --]	(n=1) 0.62 [--; --]	(n=1) 0.58 [--; --]
	Other Specialists	(n=127) 0.55 [0.17; 0-1]	(n=122) 0.54 [0.14;.19-1]	(n=118) 0.55 [0.15;.21-1]	(n=100) 0.57 [0.16;.24-1]	(n=76) 0.56 [0.15;.16-1]	(n=53) 0.55 [0.15;.26-.99]	(n=32) 0.54 [0.18;0-.99]	(n=12) 0.58 [0.19;.4-1]	(n=11) 0.57 [0.17;.27-.82]	(n=11) 0.51 [0.07;.34-.64]	(n=12) 0.49 [0.08;.34-.64]
	Cardiologists	(n=17) 0.43 [0.22; .0-1]	(n=20) 0.47 [0.08;.29-.51]	(n=22) 0.49 [0.12; 0-.65]	(n=31) 0.45 [0.09;.1-.58]	(n=28) 0.44 [0.06;.30-.57]	(n=19) 0.44 [0.05;.31-.53]	(n=13) 0.42 [0.05;.34-.51]	(n=7) 0.43 [0.97;.33-.52]	(n=0) -- [--; --]	(n=0) -- [--; --]	(n=0) -- [--; --]
% of Elderly Seen Per Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Physician Specialty	GPs	(n=314) 0.10 [0.11; 0-1]	(n=331) 0.12 [0.14; 0-1]	(n=305) 0.12 [0.12; 0-1]	(n=297) 0.12 [0.13; 0-1]	(n=287) 0.12 [0.13;0-1]	(n=279) 0.12 [0.11;.0-0.98]	(n=234) 0.12 [0.12; 0-0.90]	(n=153) 0.12 [0.12;0-0.96]	(n=84) 0.15 [0.14;0-0.97]	(n=27) 0.15 [0.04;0-0.2]	(n=3) 0.11 [0.1; .8-0.97]
	Respiratory Specialist	(n=69) 0.16 [0.18;.0-0.59]	(n=70) 0.18 [0.18;0-0.67]	(n=68) 0.18 [0.18;0-0.54]	(n=67) 0.20 [0.20; 0-0.54]	(n=58) 0.20 [0.20; 0-0.64]	(n=37) 0.22 [0.18;0-0.54]	(n=17) 0.15 [0.17; 0-0.42]	(n=7) 0.14 [0.15; 0-0.30]	(n=1) 0.18 [--; --]	(n=1) 0.17 [--; --]	(n=1) 0.15 [--; --]
	Other Specialists	(n=127) 0.20 [0.14; 0-0.65]	(n=122) 0.20 [0.14;0-0.58]	(n=118) 0.21 [0.15;.42-1]	(n=100) 0.20 [0.15;.39-1]	(n=76) 0.21 [0.13;0-0.58]	(n=53) 0.21 [0.14;0-0.59]	(n=32) 0.17 [0.14;0-0.5]	(n=12) 0.12 [0.13;0-0.4]	(n=11) 0.13 [0.13;0-0.36]	(n=11) 0.22 [0.19;0-0.52]	(n=12) 0.26 [0.21;.003-.57]
	Cardiologists	(n=17) 0.30 [0.22; 0-0.67]	(n=20) 0.37 [0.18; 0-0.67]	(n=22) 0.35 [0.14; 0-0.51]	(n=31) 0.40 [0.14;0-0.61]	(n=28) 0.40 [0.13; 0-0.58]	(n=19) 0.44 [0.06;0.3-0.6]	(n=13) 0.48 [0.07;.34-.57]	(n=7) 0.46 [0.08;.34-.56]	(n=0) -- [--; --]	(n=0) -- [--; --]	(n=0) -- [--; --]

+ Practice year was defined as years since first date of billing.

Outcome Evaluation(1): Respiratory Condition-related Emergency Room Visit Rate

Figure ii.2.3. Outcome (1) : Respiratory-related Emergency Room Visit Rate and Follow-up Period

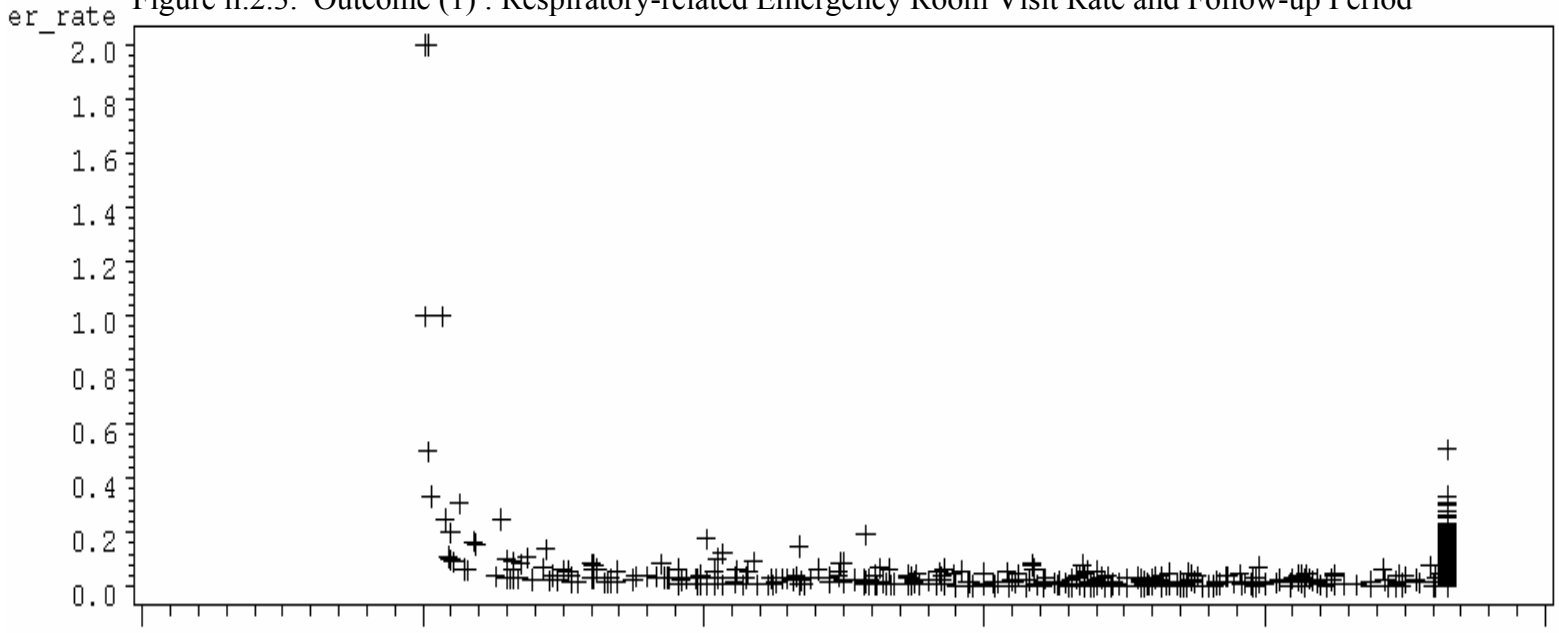


Table ii.2.12. Outcome (1): Respiratory-related Emergency Room Visits during 1-year Follow-Up (n=90,078)

Overall; Mean [SD; Range]; n (%)						
Overall	Yes ; n=30,371 (33.7%)			No; n=59,347(66.3%)		
ER Rate/1000 person-days	Mean ER Rate/1000 person-days	Mean Number of Respiratory ERVisits	Mean Number of Days for Follow-up	Mean Rate	Mean Number of Respiratory ERVisits	Mean Number of Days for Follow-up
2.8	0.09 [0.02; 0.002-2.0]	296 [4.43; 1-185]	363.2 [20.1; 1-365]	--	--	364.8 [8.0;0-365]

Table ii.2.13. Outcome (1): Respiratory-related Emergency Room Visit Rate by MD Characteristics (n=90,078)

	(Number of Patients; %) [Number of MDs; %]	Respiratory-related Emergency Room Visits Rate		Asthma-specific Emergency Room Visits Rate	
		Rate/1,000 person-days	**Rate Ratio+ [95%CI*]**	**Rate/1,000 person-days**	**Rate Ratio+ [95%CI*]**
(1) By MD Gender:					
Female	(n=46,192;51.3%) [n=342;56.2%]	2.7	0.97 [0.86-1.09]	0.15	1.01 [0.86-1.18]
Male	(n=43,886;48.7%) [n=267;43.8%]	2.8	Reference†	0.12	Reference†
(2) By Undergraduate Medical School					
McGill	(n=7,195; 8.0%) [n=94;15.4%]	3.5	0.95 [0.76-1.18]	0.14	1.04 [0.78-1.39]
Montreal	(n=29443;32.6%) [n=209;34.3%]	2.6	Reference†	0.15	Reference†
Laval	(n=17120;19.0%) [n=128;21.0%]	3.1	1.06 [0.90-1.26]	0.13	0.85 [0.71-1.01]
Sherbrooke	(n=20939;23.3%) [n=99;16.3%]	2.6	0.97 [0.81-1.16]	0.12	0.95 [0.79-1.11]
Outside Quebec	(n=4,547; 5.1%) [n=44;7.2%]	2.9	0.93 [0.71-1.21]	0.23	1.50 [0.89-2.52]
Outside Canada	(n=10834;12.0%) [n=35; 5.7%]	2.7	0.93 [0.70-1.16]	0.12	1.05 [0.87-1.26]
(3) By Post-Graduate Training Program					
McGill	(n=17,939; 19.9%) [n=143; 23.5%]	2.9	1.10 [0.93-1.30]	0.16	1.13 [0.88-1.48]
Montreal	(n=36,862;40.9%) [n=250; 41.4%]	2.6	Reference†	0.14	Reference†
Laval	(n=16,132;17.9%) [n=100; 16.4%]	3.2	1.23 [1.07-1.44]	0.13	0.84 [0.71-0.98]
Sherbrooke	(n=17,330; 19.2%) [n=73; 12.0%]	2.6	1.02 [0.87-1.20]	0.15	0.93 [0.79-1.10]
Outside Quebec	(n=1,794; 2.0%) [n=41; 6.7%]	3.0	1.16 [0.90-1.49]	0.15	1.25 [0.66-2.35]
Missing	(n=21; 0.02%) [n=2; 0.03%]	2.6	0.90 [0.17-4.68]	0.12	--
(4) Same Post-Graduate Training Program as Undergraduate Medical School					
Same	(n=60,651;67.3%) [n=388; 63.7%]	2.8	Reference†	0.13	Reference†
Different	(n=29,406; 32.7%) [n=219; 36.0%]	2.8	0.99 [0.87-1.13]	0.15	1.22 [1.02-1.44]
Missing	(n=21; 0.02%) [n=2; 0.03%]	2.3	0.84 [0.16-4.35]	0.26	1.14 [1.05-1.25]
(5) By Practice Specialty: Mean [SD; Range]; n (%)					
GPs	(n=77,338; 85.9%) [n=363; 59.6%]	2.6	Reference†	0.14	Reference†
Respiratory Specialists	(n=7,468;8.3%) [n=79; 13.0%]	3.4	1.29 [1.09-1.53]	0.16	0.95 [0.82-1.12]
Other Specialists	(n=1862; 2.1%) [n=132; 21.7%]	3.7	1.42 [1.16-1.73]	0.06	0.76 [0.59-0.97]
Cardiologists	(n=3,410; 3.8%) [n=35;5.7%]	4.4	1.68 [1.42-1.97]	0.02	1.06 [0.74-1.51]

† Reference indicates reference group; * 95% Confidence Interval; + Bivariate analysis was performed using GEE model as physician as a clustering variable with autoregressive correlation structure ; -- indicates that model didn't converge

Table ii.2.14. Outcome (1): Mean Respiratory-related Emergency Room Visit Rate by Licensing Scores (n=90,078)

	(Number of Patients; %) [Number of MDs.%]	Respiratory-related Emergency Room Visits		Asthma-specific Emergency Room Visits	
		Rate/1,000 person-days	**Rate Ratio+ [95%CI*]**	**Rate/1,000 person-days**	**Rate Ratio [95% CI]**
By QE1 Total Score of the Physicians Who Provided Care on the Index Visits					
Top Quartile	(n=22,872;25.4%) [n=154; 25.3%]	2.7	1.09 [0.85-1.18]	0.14	1.10 [0.89-1.36]
Thrid Quartile	(n=2,864;25.4%) [n=152; 25.0%]	2.9	1.09 [0.92-1.30]	0.13	1.12 [0.90-1.38]
Second Quartile	(n=22,023; 24.5%) [n=151; 24.8%]	2.8	1.07 [0.88-1.28]	0.15	1.08 [0.97-1.20]
Bottom Quartile	(n=22,319; 24.8%) [n=152;25.0%]	2.7	Reference†	0.13	Reference†
By QE1 Clinical Reasoning Scores of the Physicians Who Provided Care on the Index Visits					
Top Quartile	(n=18,254; 20.3%) [n=154; 25.3%]	2.9	1.02 [0.87-1.20]	0.12	1.35 [1.00-1.82]
Thrid Quartile	(n=21,885; 24.3%) [n=152; 25.0%]	2.7	0.97 [0.82-1.15]	0.15	1.02 [0.91-1.14]
Second Quartile	(n=20,054; 22.3%) [n=152; 25.0%]	2.8	0.99 [0.84-1.16]	0.15	1.10 [0.98-1.25]
Bottom Quartile	(n=29,885; 33.2%) [n=151; 25.0%]	2.8	Reference†	0.14	Reference†
By QE2 Total Scores of the Physicians Who Provided Care on the Index Visits					
Top Quartile	(n=21,414;23.8%) [n=154; 25.3%]	2.7	1.01 [0.87-1.16]	0.13	1.11 [0.89-1.40]
Thrid Quartile	(n=22,967;25.5%) [n=152; 25.0%]	2.6	0.97 [0.83-1.13]	0.13	0.90 [0.81-1.01]
Second Quartile	(n=22,844;25.4%) [n=151; 24.8%]	3.1	1.09 [0.98-1.37]	0.16	1.08 [0.89-1.31]
Bottom Quartile	(n=22,853;25.4%) [n=152; 25.0%]	2.7	Reference†	0.13	Reference†
By QE2 Communication Score of the Physicians Who Provided Care on the Index Visits					
Top Quartile	(n=21,414;23.8%) [n=154; 25.3%]	2.7	1.04 [0.88-1.23]	0.14	1.13 [0.93-1.43]
Thrid Quartile	(n=22,967;25.5%) [n=152; 25.0%]	2.7	1.11 [0.94-1.31]	0.17	1.07 [0.86-1.34]
Second Quartile	(n=22,844;25.4%) [n=151; 24.8%]	2.9	1.01 [0.87-1.19]	0.13	1.09 [0.97-1.22]
Bottom Quartile	(n=22,853;25.4%) [n=152; 25.0%]	2.8	Reference†	0.12	Reference†
By QE2 Data Acquisition Score of the Physicians Who Provided Care on the Index Visits					
Top Quartile	(n=24,258; 26.9%) [n=153; 25.1%]	2.8	1.00 [0.86-1.16]	0.14	1.12 [0.91-1.38]
Thrid Quartile	(n=27,115; 30.1%) [n=153; 25.1%]	3.1	0.91 [0.79-1.06]	0.14	1.07 [0.88-1.30]
Second Quartile	(n=21,621; 24.0%) [n=151; 24.8%]	2.5	1.14 [0.96-1.37]	0.14	0.98 [0.86-1.12]
Bottom Quartile	(n=17,084; 19.0%) [n=152; 25.0%]	2.8	Reference†	0.13	Reference†
By QE2 Problem Solving Score of the Physicians Who Provided Care on the Index Visits					
Top Quartile	(n=20,937;23.2%) [n=153; 25.1%]	0.0027	1.03 [0.88-1.22]	0.14	0.99 [0.86-1.13]
Thrid Quartile	(n=23,537; 26.1%) [n=154; 25.3%]	0.0030	1.01[0.86-1.19]	0.17	0.89 [0.80-1.00]
Second Quartile	(n=21,042; 23.4%) [n=151; 24.8%]	0.0027	1.13 [0.96-1.34]	0.12	1.11 [0.88-1.42]
Bottom Quartile	(n=24,562; 27.3%) [n=151; 24.8%]	0.0028	Reference†	0.13	Reference†

† Reference indicates reference group; * 95% Confidence Interval; + Bivariate analysis was performed using GEE model as physician as a clustering variable with autoregressive correlation structure ; -- indicates that model didn't converge

Table ii.2.15 Outcome (1): Respiratory-related &Asthma-Specific Emergency Room Visit Rate by Visit & Patient Characteristics (n=90,078)

			Respiratory-related Emergency Room Visits Rate		Asthma-specific Emergency Room Visits Rate	
		(Number of Patients; %)	Rate/1,000 person-days	Rate Ratio+ [95%CI*]	Rate/1,000 person-days	Rate Ratio[95% CI]
(1) By Patient Gender						
Female		(n=54,840; 60.9%)	2.8	1.03 [0.99-1.08]	0.14	1.04 [0.93-1.17]
Male		(n=35,238; 39.1%)	2.7	Reference†	0.13	Reference†
(2) By Patient Age						
Age>45		(n=21,328; 23.7%)	3.1	1.36 [1.29-1.44]	0.11	1.02 [0.87-1.19]
Age≤45		(n=68,750; 76.3%)	2.6	Reference†	0.15	Reference†
(3) By Index Visits were due to Referral						
Yes		(n=5,980; 6.6%)	3.8	1.40 [1.21-1.68]	0.11	1.49 [0.74-3.01]
No		(n=84,098; 93.4%)	2.7	Reference†	0.14	Reference†
(4) By Probability of Having Asthma*						
Yes		(n=79,781; 88.6%)				
Asthma Probability≥0.6		(n=39,947; 44.4%)	3.8	2.16 [2.05-2.27]	0.30	1.40 [1.21-1.62]
Asthma Probability<0.6		(n=39,834; 44.2%)	1.8	Reference†	0.01	Reference†
No		(n=10,297; 11.4%)	2.7	1.53 [1.40-1.68]	0.008	0.97 [0.79-1.20]
(5) By Patient Socioeconomic Status						
Below Poverty Line		(n=29,632; 32.9%)	3.2	1.22 [1.16-1.29]	0.16	1.06 [0.91-1.24]
Above Poverty Line		(n=60,446; 67.1%)	2.6	Reference†	0.13	Reference†
(6)Continuity of Care: Follow-Up Period By Continuity of Care During 1-year after the Index Visits: Asthma-Specific						
Number of Respiratory related Visits	0	--; (n=48,200; 53.5%)	1.5	Reference†	0.00	Reference†
	>0	COC≤0.5 (n=35,256; 39.1%)	4.5	2.88 [2.75-3.02]	0.34	1.35 [1.23-1.49]
		COC>0.5 (n=6,622; 7.4%)	2.8	1.81 [1.68-1.96]	0.09	--
By Continuity of Care During 1-year after the Index Visits: Asthma Outpatient-Specific						
# of Respi-ratory related Visits at outpatient	0	--; (n=51,599; 57.3%)	2.1	Reference†	0.05	Reference†
	>0	COC≤0.5; (n=31,759; 35.3%)	3.8	1.79 [1.71-1.88]	0.29	1.32 [1.21-1.45]
		COC>0.5; (n=6,720; 7.5%)	3.2	1.24 [1.39-1.63]	0.14	1.11 [0.97-1.26]
(7) By Practice Year						
0		(n=4,992;5.5%)	3.7	Reference†	0.27	Reference†
1		(n=11,884;13.2%)	3.2	0.87 [0.78-0.97]	0.19	0.92 [0.62-1.35]
2		(n=12,756; 14.2%)	3.0	0.81 [0.72-0.92]	0.16	0.81 [0.58-1.14]
3		(n=13,704;15.2%)	3.1	0.82 [0.72-0.93]	0.13	0.74 [0.53-1.05]
4		(n=14,103; 15.7%)	2.9	0.77 [0.68-0.88]	0.14	0.76 [0.54-1.08]
5		(n=12,189;13.5%)	2.3	0.63 [0.54-0.73]	0.09	0.70 [0.49-0.99]
6		(n=9,440;10.5%)	2.4	0.63 [0.54-0.74]	0.10	0.74 [0.52-1.05]
7		(n=6,096;6.8%)	2.0	0.54 [0.46-0.64]	0.09	0.71 [0.49-1.01]
8		(n=3,300;3.7%)	1.7	0.46 [0.37-0.56]	0.07	0.82 [0.50-1.33]
9		(n=1,364;1.5%)	1.5	0.40 [0.74-0.58]	0.04	0.59 [0.40-0.87]
10		(n=250;0.3%)	2.2	0.56 [0.32-0.98]	0.09	0.63 [0.39-1.02]

† Reference indicates reference group; * 95% Confidence Interval; + Bivariate analysis was performed using GEE model as physician as a clustering variable with autoregressive correlation structure ; -- indicates that model didn't converge

Outcome Evaluation(2): Fast-acting Beta-Agonist Overuse
Figure ii.2.4. Flow Chart for FABA Overuse Assessment

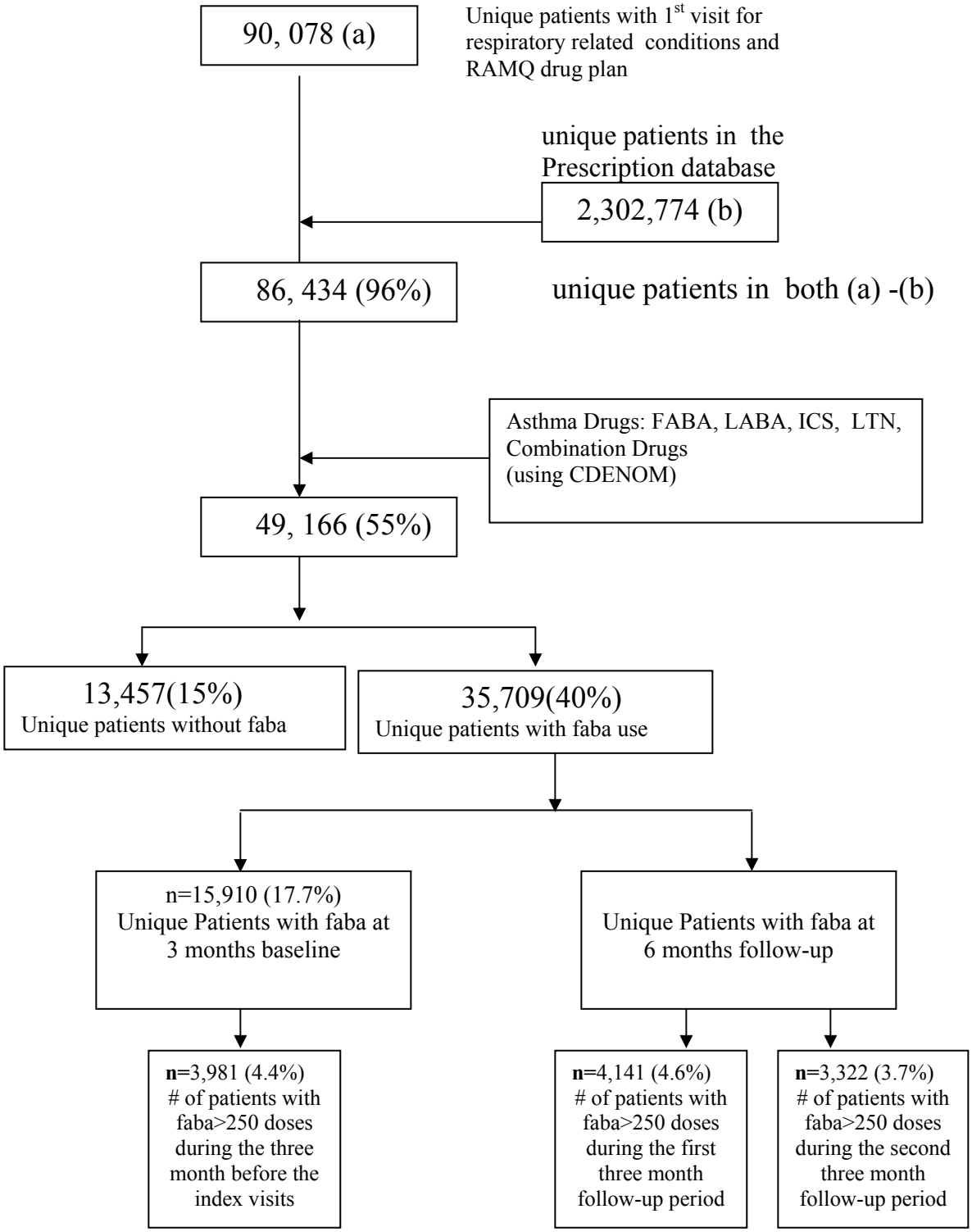


Table ii.2.16. Outcome (2): Fast-Acting Beta Agonists (FABA) Overuse by Physician Characteristics (n=90,078)

(Number of Patients; %) [Number of MDs.%]		Baseline Period		Follow-up Period			
		FABA Overuse[1] Three months before the Index Visits		FABA Overuse[1] 1st three months after the Index Visits		FABA Overuse[1] 2nd three months after the Index Visits	
		n (%)	Odds Ratio+ [95% CI*]	n (%)	Odds Ratio+ [95% CI*]	n (%)	Odds Ratio+ [95% CI*]
(1) By MD Gender							
Female	(n=46,192;51.3%) [n=342;56.2%]	2,099 (4.5%)	1.06 [0.93-1.21]	2,193 (4.7%)	1.07 [0.95-1.20]	1,709 (3.7%)	1.01 [0.89-1.14]
Male	(n=43,886;49.7%) [n=267;43.8%]	1,882 (4.3%)	Reference†	2,948 (6.7%)	Reference†	1,613 (3.7%)	Reference†
(2) By Undergraduate Medical School							
McGill	(n=7,195; 8.0%) [n=94;15.4%]	285 (3.9%)	0.85 [0.69-1.03]	315 (4.4%)	0.91 [0.75-1.11]	255 (3.5%)	0.94 [0.76-1.15]
Montreal	(n=29,443;32.6%) [n=209;34.3%]	1,368 (4.6%)	Reference†	1,411 (4.8%)	Reference†	1,114 (3.8%)	Reference†
Laval	(n=17,120;19.0%) [n=128;21.0%]	838 (4.9%)	1.06 [0.90-1.24]	824 (4.8%)	1.00 [0.86-1.17]	702 (4.1%)	1.08 [0.93-1.26]
Sherbrooke	(n=20,939;23.3%) [n=99;16.3%]	909 (4.3%)	0.93 [0.78-1.12]	935 (4.5%)	0.93 [0.80-1.08]	731 (3.5%)	0.92 [0.78-1.09]
Outside Quebec	(n=4,547; 5.1%) [n=44;7.2%]	167 (3.7%)	0.78 [0.60-1.01]	197 (4.3%)	0.90 [0.72-1.13]	146 (3.2%)	0.85 [0.67-1.08]
Outside Canada	(n=10,834;12.0%) [n=35; 5.7%]	414 (3.8%)	0.82 [0.62-1.07]	459 (4.2%)	0.88 [0.68-1.14]	374 (3.5%)	0.91 [0.70-1.19]
3) By Post-Graduate Training Program							
McGill	(n=17,939; 19.9%) [n=143; 23.5%]	672 (3.7%)	0.84 [0.70-1.01]	720 (4.0%)	0.87 [0.74-1.03]	584 (3.3%)	0.90 [0.76-1.07]
Montreal	(n=36,862;40.9%) [n=250; 41.4%]	1,698 (4.6%)	Reference†	1,784 (4.8%)	Reference†	1,396 (3.8%)	Reference†
Laval	(n=16,132;17.9%) [n=100; 16.4%]	743 (4.6%)	1.00 [0.87-1.16]	739 (4.6%)	0.92 [0.79-1.08]	643 (4.0%)	1.02 [0.87-1.19]
Sherbrooke	(n=17,330; 19.2%) [n=73; 12.0%]	758 (4.4%)	1.05 [0.87-1.25]	781 (4.5%)	1.00 [0.86-1.16]	617 (3.6%)	0.98 [0.82-1.18]
Outside Quebec	(n=1,794; 2.0%) [n=41; 6.7%]	110 (6.1%)	1.16 [0.83-1.61]	117 (6.5%)	1.24 [0.94-1.62]	82 (4.6%)	1.05 [0.78-1.42]
Missing	(n=21; 0.02%) [n=2; 0.03%]	0 (--)	--	0 (--)	--	0 (--)	--
(4) Same Post-Graduate Training Program as Undergraduate Medical School: n (%)							
Same	(n=60,651;67.3%) [n=388; 63.7%]	2,710 (4.5%)	Reference†	2,796 (4.6%)	Reference†	2,253 (3.7%)	Reference†
Different	(n=29,406; 32.7%) [n=219; 36.0%]	1,271 (4.3%)	--	1,345 (4.6%)	--	1,069 (3.6%)	--
Missing	(n=21; 0.02%) [n=2; 0.03%]	0 (--)	--	0 (--)	--	0 (--)	--
(5) By Practice Specialty							
GPs	(n=77,338; 85.9%) [n=363; 59.6%]	3,319 (4.3%)	Reference†	3,512 (4.5%)	Reference†	2,810 (3.6%)	Reference†
Respiratory Specialists	(n=7,468;8.3%) [n=79; 13.0%]	516 (6.9%)	1.61 [1.32-1.96]	488 (6.5%)	1.44 [1.22-1.70]	383 (5.1%)	1.41 [1.19-1.67]
Other Specialists	(n=1862; 2.1%) [n=132; 21.7%]	49 (2.6%)	0.61 [0.43-0.87]	51 (2.7%)	0.60 [0.44-0.82]	43 (2.3%)	0.64 [0.46-0.87]
Cardiologists	(n=3,410; 3.8%) [n=35;5.7%]	97 (2.8%)	0.66 [0.53-0.84]	90 (2.6%)	0.58 [0.46-0.73]	86 (2.5%)	0.69 [0.52-0.92]

1. 3 month FABA overuse was defined as >250 dose; † Reference indicates reference group; * 95% Confidence Interval; + Bivariate analysis was performed using GEE model as physician as a clustering variable with autoregressive correlation structure ; -- indicates that model didn't converge

Table ii.2.17. Outcome (2): Fast-Acting Beta Agonists (FABA) Overuse by Licensing Scores (n=90,078)

(Number of Patients; %) [Number of MDs.%]		Baseline Period		Follow-up Period			
		FABA Overuse[1] Three months before the Index Visits		FABA Overuse [1] 1st three months after the Index Visits		FABA Overuse[1] 2nd three months after the Index Visits	
		n (%)	Odds Ratio+ [95% CI*]	n (%)	Odds Ratio+ [95% CI*]	n (%)	Odds Ratio+ [95% CI*]
(1) By QE1 Total Scores of the Physicians Who Provided Care on the Index Visits							
Top Quartile	(n=22,872;25.4%) [n=154; 25.3%]	1,177 (5.1%)	1.11 [0.92-1.32]	1,203 (5.3%)	1.06 [0.90-1.25]	978 (4.3%)	1.08 [0.91-1.29]
Thrid Quartile	(n=22,864;25.4%) [n=152; 25.0%]	960 (4.2%)	1.08 [0.90-1.30]	1,012 (4.4%)	1.07 [0.90-1.27]	804 (3.5%)	1.07 [0.90-1.27]
Second Quartile	(n=22,023; 24.5%) [n=151; 24.8%]	802 (3.6%)	1.08 [0.89-1.32]	819 (3.7%)	1.04 [0.88-1.23]	657 (3.0%)	1.05 [0.95-1.15]
Bottom Quartile	(n=22,319; 24.8%) [n=152;25.0%]	1,042 (4.7%)	Reference†	1,107 (5.0%)	Reference†	883 (4.0%)	Reference†
(2) By QE1 Clinical Reasoning Scores of the Physicians Who Provided Care on the Index Visits							
Top Quartile	(n=18,254; 20.3%) [n=154; 25.2%]	834 (4.6%)	1.04 [0.87-1.26]	856 (4.7%)	1.05 [0.88-1.25]	688 (3.8%)	1.08 [0.89-1.30]
Thrid Quartile	(n=21,885; 24.3%) [n=152; 25.0%]	970 (4.4%)	1.01 [0.85-1.21]	1,025 (4.7%)	1.05 [0.89-1.22]	806 (3.7%)	1.05 [0.89-1.25]
Second Quartile	(n=20,054; 22.3%) [n=152; 25.0%]	869 (4.3%)	1.01 [0.84-1.17]	921 (4.6%)	1.03 [0.88-1.20]	782 (3.9%)	1.11 [0.95-1.31]
Bottom Quartile	(n=29,885; 33.2%) [n=151; 24.8%]	1,308 (4.4%)	Reference†	1,339 (4.5%)	Reference†	1,046 (3.5%)	Reference†
(3) By QE2 Total Scores of the Physicians Who Provided Care on the Index Visits							
Top Quartile	(n=21,414;23.8%) [n=154; 25.3%]	986 (4.6%)	1.07 [0.90-1.28]	972 (4.5%)	0.97 [0.82-1.14]	813 (3.8%)	1.05 [0.84-1.20]
2nd Quartile	(n=22,967;25.5%) [n=152; 25.0%]	978 (4.3%)	0.99 [0.82-1.20]	1,059 (4.6%)	0.99 [0.83-1.17]	821 (3.6%)	0.95 [0.79-1.14]
3rd Quartile	(n=22,844;25.4%) [n=151; 24.8%]	1,037 (4.5%)	1.06 [0.88-1.27]	1,041 (4.6%)	0.97 [0.82-1.16]	825 (3.6%)	0.96 [0.80-1.15]
Bottom Quartile	(n=22,853;25.4%) [n=152; 25.0%]	980 (4.3%)	Reference†	1,069 (4.7%)	Reference†	863 (3.8%)	Reference†
(4) By QE2 Communication Score of the Physicians Who Provided Care on the Index Visits							
Top Quartile	(n=21,753; 24.1%) [n=154; 25.3%]	950 (4.4%)	1.01 [0.85-1.19]	986 (4.5%)	1.02 [0.87-1.18]	752 (3.5%)	0.93 [0.78-1.10]
Thrid Quartile	(n=17,997; 20.0%) [n=157; 25.8%]	858 (4.8%)	1.10 [0.89-1.35]	921 (5.1%)	1.15 [0.95-1.38]	729 (4.1%)	1.09 [0.90-1.32]
Second Quartile	(n=23,852; 26.5%) [n=152; 15.0%]	1,025 (4.3%)	0.99 [0.83-1.19]	1,052 (4.4%)	0.99 [0.84-1.67]	856 (3.6%)	0.96 [0.81-1.15]
Bottom Quartile	(n=26,476; 29.4%) [n=154; 25.3%]	1,148 (4.3%)	Reference†	1,182 (4.5%)	Reference†	985 (3.7%)	Reference†
(5) By QE2 Data Acquisition Score the Physicians Who Provided Care on the Index Visits							
Top Quartile	(n=24,258; 26.9%) [n=153; 25.1%]	1,044 (4.3%)	0.94 [0.80-1.11]	1,055 (4.3%)	0.93 [0.79-0.92]	885 (3.6%)	0.95 [0.81-1.12]
Thrid Quartile	(n=27,115; 30.1%) [n=153; 25.1%]	1,230 (4.5%)	0.99 [0.85-1.17]	1,272 (4.7%)	1.00 [0.85-1.17]	982 (3.6%)	0.95 [0.80-1.12]
Second Quartile	(n=21,621; 24.0%) [n=151; 24.8%]	927 (4.3%)	0.94 [0.77-1.14]	1,012 (4.7%)	1.00 [0.83-1.19]	801 (3.7%)	0.97 [0.80-1.17]
Bottom Quartile	(n=17,084; 19.0%) [n=152; 25.0%]	780 (4.6%)	Reference†	802 (4.7%)	Reference†	654 (3.8%)	Reference†
(6) By QE2 Problem Solving Score of the Physicians Who Provided Care on the Index Visits							
Top Quartile	(n=20,937;23.2%) [n=153; 25.1%]	985 (4.7%)	1.11 [0.93-1.34]	1,010 (4.8%)	1.04 [0.88-1.23]	823 (3.9%)	1.10 [0.91-1.32]
Thrid Quartile	(n=23,537; 26.1%) [n=154; 25.3%]	965 (4.1%)	0.97 [0.81-1.16]	973 (4.1%)	0.89 [0.76-1.04]	797 (3.4%)	0.95 [0.79-1.13]
Second Quartile	(n=21,042; 23.4%) [n=151; 24.8%]	994 (4.7%)	1.12 [0.94-1.33]	1,016 (4.8%)	1.04 [0.88-1.22]	825 (3.9%)	1.10 [0.92-1.30]
Bottom Quartile	(n=24,562; 27.3%) [n=151; 24.8%]	1,037 (4.2%)	Reference†	1,142 (4.6%)	Reference†	878 (3.6%)	Reference†

1. 3 month FABA overuse was defined as >250 dose; † Reference indicates reference group; * 95% Confidence Interval; + Bivariate analysis was performed using GEE model as physician as a clustering variable with autoregressive correlation structure ; -- indicates that model didn't converge

Table ii.2.18. Outcome (2): Fast-Acting Beta Agonists (FABA) Overuse by Visit/Patient Characteristics (n=90,978)

			Baseline Period		Follow-up Period			
			FABA Overuse[1] Three months before the Index Visits		FABA Overuse 1st three months after the Index Visits		FABA Overuse 2nd three months after the Index Visits	
			n (%)	Odds Ratio+ [95% CI*]	n (%)	Odds Ratio+ [95% CI*]	n (%)	Odds Ratio+ [95% CI*]
(1) By Patient Gender								
Female		(n=54,840; 60.9%)	2,366 (4.3%)	0.94 [0.88-1.01]	2,410 (4.4%)	0.89 [0.84-0.95]	1,922 (3.5%)	0.88 [0.82-0.94]
Male		(n=35,238; 39.1%)	1,615 (4.6%)	Reference†	1,731 (4.9%)	Reference	1,400 (4.0%)	Reference†
(2) By Patient Age								
Age>45		(n=21,328; 23.7%)	1,257 (5.9%)	1.49 [1.37-1.62]	1,313 (6.2%)	1.50 [1.38-1.62]	1,117 (5.2%)	1.63 [1.51-1.77]
Age≤45		(n=68,750; 76.3%)	2,724 (4.0%)	Reference†	2,828 (4.1%)	Reference	2,205 (3.2%)	Reference[3]
(3) By Index Visits were due to Referral								
Yes		(n=5,980; 6.6%)	338 (5.7%)	1.30 [1.02-1.66]	295 (4.9%)	1.07 [0.88-1.31]	260 (4.3%)	1.19 [0.98-1.43]
No		(n=84,098; 93.4%)	3,643 (4.3%)	Reference†	3,846 (4.6%)	Reference†	3,062 (3.6%)	Reference†
(4) By Probability of Having Asthma*								
Probability≥0.6		(n=39,947;44.4%)	3,974 (9.9%)	Reference†	4,129 (10.3%)	Reference†	3,316 (8.3%)	Reference†
Probability<0.6		(n=39,834; 44.2%)	7 (0.01 %)	--	12 (0.03%)	--	6 (0.02 %)	--
No		(n=10,297; 11.4%)	0 (--)	--	0 (--)	--	0 (--)	--
(5) By Patient Socioeconomic Status								
Below Poverty Line		(n=29,632; 32.9%)	1,478 (5.0%)	1.21 [1.11-1.30]	1,529 (5.2%)	1.19 [1.11-1.29]	1,241 (4.2%)	1.22 [1.12-1.32]
Above Poverty Line		(n=60,446; 67.1%)	2,503 (4.1%)	Reference†	2,612 (4.3%)	Reference†	2,081 (3.4%)	Reference†
(6)Continuity of Care (COC): Follow-Up Period By Continuity of Care During 6-month after the Index Visits: Asthma-Specific								
Number of Respiratory related Visits	0	--; (n=48,200; 53.5%)	1,432 (2.4%)	Reference†	1,257 (2.1%)	Reference†	957 (1.6%)	Reference†
	>0	COC≤0.5 (n=35,256; 39.1%)	2,183 (8.6%)	3.49 [3.24-3.75]	2,450 (9.6%)	4.47 [4.16-4.80]	2,061 (8.1%)	4.94 [4.54-5.37]
		COC>0.5 (n=6,622; 7.4%)	366 (6.3%)	2.57 [2.26-2.92]	434 (7.5%)	3.48 [3.10-3.90]	304 (5.2%)	3.20 [2.76-3.70]
By Continuity of Care During 6-month after the Index Visits: Asthma Outpatient-Specific								
# of Respi-ratory related Visits at outpatient	0	--; (n=51,599; 57.3%)	1,685 (2.7%)	Reference†	1,503 (2.4%)	Reference†	1,164 (1.9%)	Reference†
	>0	COC≤0.5; (n=31,759; 35.3%)	1,907 (8.4%)	3.07 [2.86-3.27]	2,181 (9.6%)	3.93 [3.66-4.22]	1,827 (8.1%)	4.25 [3.91-4.62]
		COC>0.5; (n=6,720; 7.5%)	389 (6.7%)	2.44 [2.17-2.74]	457 (7.9%)	3.22 [2.90-3.57]	331 (5.7%)	3.00 [2.64-3.42]

1. 3 month FABA overuse was defined as >250 dose; † Reference indicates reference group; * 95% Confidence Interval; + Bivariate analysis was performed using GEE model as physician as a clustering variable with autoregressive correlation structure ; -- indicates that model didn't converge

Table ii.2.18. Outcome (2): Fast-Acting Beta Agonists (FABA) Overuse by Visit/Patient Characteristics (n=90,078) (cont'd)

		Baseline Period		Follow-up Period			
		FABA Overuse[1] Three months before the Index Visits		FABA Overuse 1st three months after the Index Visits		FABA Overuse 2nd three months after the Index Visits	
		n (%)	Odds Ratio+ [95% CI*]	n (%)	Odds Ratio+ [95% CI*]	n (%)	Odds Ratio+ [95% CI*]
(7) By Practice Year							
0	(n=4,992;5.5%)	277 (5.5%)	Reference†	290 (5.8%)	Reference†	268 (5.4%)	Reference†
1	(n=11,884;13.2%)	577 (4.9%)	0.88 [0.74-1.04]	628 (5.3%)	0.91[0.79-1.05]	552 (4.6%)	0.87[0.73-1.02]
2	(n=12,756; 14.2%)	596 (4.7%)	0.84 [0.72-0.98]	627 (4.9%)	0.85[0.73-0.98]	515 (4.0%)	0.75[0.64-0.89]
3	(n=13,704;15.2%)	638 (4.7%)	0.84 [0.72-0.98]	661 (4.8%)	0.83[0.71-0.96]	535 (3.9%)	0.73[0.62-0.86]
4	(n=14,103; 15.7%)	641 (4.5%)	0.82 [0.69-0.98]	659 (4.7%)	0.80[0.68-0.95]	523 (3.7%)	0.69[0.58-0.82]
5	(n=12,189;13.5%)	507 (4.2%)	0.75 [0.62-0.90]	482 (4.0%)	0.68[0.56-083]	391 (3.2%)	0.60[0.49-0.74]
6	(n=9,440;10.5%)	385 (4.1%)	0.74 [0.61-0.88]	374 (4.0%)	0.68[0.57-0.82]	281 (3.0%)	0.55[0.45-0.68]
7	(n=6,096;6.8%)	214 (3.5%)	0.63 [0.51-0.78]	226 (3.7%)	0.64[0.52-0.78]	142 (2.3%)	0.43[0.34-0.55]
8	(n=3,300;3.7%)	119 (3.6%)	0.65 [0.49-0.86]	140 (4.2%)	0.73[0.57-0.93]	91 (2.8%)	0.51[0.38-0.70]
9	(n=1,364;1.5%)	22 (1.6%)	0.29 [0.15-0.57]	46 (3.4%)	0.58[0.37-0.92]	18 (1.3%)	0.25[0.15-0.40]
10	(n=250;0.3%)	5 (0.2%)	0.36 [0.25-0.52]	8 (0.3%)	0.55[0.15-1.97]	6 (0.2%)	0.45[0.22-0.89]

1. 3 month FABA overuse was defined as >250 dose; † Reference indicates reference group; * 95% Confidence Interval; + Bivariate analysis was performed using GEE model as physician as a clustering variable with autoregressive correlation structure ; -- indicates that model didn't converge

Table ii.2.19. Outcome (3): ICS/ICS Plus FABA Ratio (n=90,078)

	Baseline Period				**Follow-up Period**							
	ICS/ICS Plus FABA Ratio Six months before the Index Visits				**ICS/ICS Plus FABA Ratio 1st 6 months after the Index Visits**				**ICS/FABA Ratio 2nd 6 months after the Index Visits**			
	Prescribed by Study MDs Only		Prescribed by All MDs		Prescribed by Study MDs Only		Prescribed by All MDs		Prescribed by Study MDs Only		Prescribed by All MDs	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
No Asthma Meds User	89,562	99.4%	77,126	85.6%	78,652	87.32%	69,814	77.5%	87,657	97.3%	78,465	87.1
FABA Only User (Ratio=0)	0	--	4,206	4.67%	3,682	4.09%	5,544	6.15%	1,015	1.13%	3,550	3.94%
FABA Main User (0<Ratio<0.5)	73	0.08%	2,150	2.39%	981	1.09%	2.868	3.18%	236	0.26%	1,844	2.05%
ICS: FABA=1:1 User (Ratio=0.5)	157	0.17%	2,182	2.42%	2,457	2.73%	4,062	4.51%	360	0.40%	2,032	2.26%
ICS Dominant User (0.5<Ratio≤1)	286	0.31%	4,415	4.90%	4,306	4,78%	7,790	8.65%	810	0.90%	4,187	4.65%

Table ii.2.20. Outcome (3): ICS/ICS Plus FABA Ratio by Physician Characteristics: *Medications Prescribed by Study MDs Only* (n=90,078)

		Baseline Period					**Follow-up Period**									
		Six months before the Index Visits					**1st 6 months after the Index Visits**					**2nd 6 months after the Index Visits**				
		Non-Users	FABA only	FABA Main	1:1 User	ICS Main	Non-Users	FABA only	FABA Main	1:1 User	ICS Main	Non-Users	FABA only	FABA Main	1:1 User	ICS Main
(1) By MD Gender																
Female	(n=46,192;51.3%) [n=342;56.2%]	45,864 (51.2%)	0 (--)	51 (69.9%)	112 (71.3%)	165 (58.3%)	39,760 (50.6%)	1,930 (52.4%)	583 (59.4%)	1,432 (58.3%)	2,487 (57.8%)	44,807 (51.1%)	557 (54.9%)	139 (58.9%)	221 (61.4%)	468 (57.8%)
Male	(n=43,886;49.7%) [n=267;43.8%]	43698 (48.8%)	0 (--)	22 (30.1%)	45 (28.7%)	121 (41.7%)	38,892 (49.5%)	1,752 (47.6%)	398 (40.6%)	1,025 (41.7%)	1,819 (42.2%)	42,850 (48.9%	458 (45.1%)	97 (41.1%)	139 (38.6%)	342 (42.2%)
(2) By Undergraduate Medical School																
McGill	(n=7,195; 8.0%) [n=94;15.4%]	7,161 (8.0%)	0 (--%)	5 (6.9%)	7 (4.5%)	22 (7.7%)	6,457 (8.2%)	301 (8.2%)	88 (9.0%)	108 (4.4%)	241 (5.6%)	7,028 (8.0%)	69 (6.8%)	24 (10.2%)	23 (6.4%)	51 (6.3%)
Montreal	(n=29,443;32.6%) [n=209;34.3%]	29,223 (32.6%)	0 (--%)	32 (43.8%)	67 (42.7%)	111 (38.8%)	25,559 (32.5%)	1,210 (32.9%)	347 (35.4%)	866 (35.3%)	1,461 (33.9%)	28,583 (32.6%)	348 (34.3%)	77 (32.6%)	121 (33.6%)	314 (38.8%)
Laval	(n=17,120;19.0%) [n=128;21.0%]	17,014 (19.0%)	0 (--%)	13 (17.8%)	29 (18.5%)	64 (22.4%)	14,733 (18.7%)	629 (17.1%)	193 (19.7%)	584 (23.8%)	981 (22.8%)	16,595 (18.9%)	196 (19.3%)	50 (21.2%)	92 (25.6%)	187 (23.1%)
Sherbrooke	(n=20,939;23.3%) [n=99;16.3%]	20,827 (23.3%)	0 (--%)	10 (13.7%)	36 (22.9%)	66 (23.1%)	18,279 (23.2%)	810 (22.0%)	206 (21.0%)	589 (24.0%)	1,055 (24.5%)	20,388 (23.3%)	239 (23.6%)	51 (21.6%)	94 (26.1%)	167 (20.6%)
Outside Quebec	(n=4,547; 5.1%) [n=44;7.2%]	4,535 (5.1%)	0 (--%)	2 (2.7%)	4 (2.6%)	6 (2.1%)	4,057 (5.2%)	240 (6.5%)	54 (5.5%)	56 (2.3%)	140 (3.1%)	4,458 (5.1%)	54 (5.3%)	8 (3.4%)	10 (2.8%)	17 (2.1%)
Outside Canada	(n=10,834;12.0%) [n=35; 5.7%]	10,792 (12.1%)	0 (--%)	11 (15.1%)	14 (8.9%)	17 (5.9%)	9,567 (12.2%)	492 (13.4%)	93 (9.5%)	254 (10.3%)	428 (9.9%)	10,605 (12.1%)	109 (10.7%)	26 (11.0%)	20 (5.6%)	74 (9.1%)
3) By Post-Graduate Training Program																
McGill	(n=17,939;19.9%) [n=143; 23.5%]	17,870 (20.0%)	0 (--%)	12 (16.4%)	18 (11.5%)	39 (13.6%)	16,123 (20.5%)	741 (20.1%)	172 (17.5%)	283 (11.5%)	620 (14.4%)	17,541 (20.0%)	177 (17.4%)	40 (17.0%)	52 (14.4%)	129 (15.9%)
Montreal	(n=36,862;40.9%) [n=250; 41.4%]	36,639 (40.9%)	0 (--%)	36 (49.3%)	75 (47.8%)	112 (39.2%)	32036 (40.7%)	1,610 (43.7%)	408 (41.6%)	1,057 (43.0%)	1,751 (40.7%)	35,855 (40.9%)	414 (40.8%)	97 (41.1%)	147 (40.8%)	349 (43.1%)
Laval	(n=16,132;17.9%) [n=100; 16.4%]	16.024 (17.9%)	0 (--%)	13 (17.8%)	31 (19.8%)	64 (22.4%)	13794 (17.5%)	569 (15.5%)	193 (19.7%)	603 (24.5%)	973 (22.6%)	15,672 (17.9%)	181 (17.8%)	39 (16.5%)	79 (21.9%)	161 (19.9%)
Sherbrooke	(n=17,330;19.2%) [n=73; 12.0%]	17,225 (19.2%)	0 (--%)	11 (15.1%)	29 (18.5%)	65 (22.7%)	15081 (19.2%)	665 (18.1%)	179 (18.3%)	478 (19.5%)	927 (21.5%)	16,828 (19.2%)	213 (21.0%)	53 (22.5%)	77 (21.4%)	159 (19.6%)
Outside Quebec	(n=1,794; 2.0%) [n=41; 6.7%]	1,783 (2.0%)	0 (--%)	1 (1.4%)	4 (2.6%)	6 (2.1%)	1597 (2.0%)	97 (2.6%)	29 (3.0%)	36 (1.5%)	35 (0.81%)	1,740 (2.0%)	30 (3.0%)	7 (3.0%)	5 (1.4%)	12 (1.5%)
Missing	(n=21; 0.02%) [n=2; 0.03%]	21 (0.02%)	0 (--%)	0 (--%)	0 (--%)	0 (--%)	21 (0.03%)	0 (--%)	0 (--%)	0 (--%)	0 (--%)	21 (0.02%)	0 (--%)	0 (--%)	0 (--%)	0 (--%)

Table ii.2.20. Outcome (3): ICS/ICS Plus FABA Ratio by Physician Characteristics: *Medications Prescribed by Study MDs Only* (n=90,078) *(cont'd)*

		Baseline Period					Follow-up Period									
		Six months before the Index Visits					1st 6 months after the Index Visits					2nd 6 months after the Index Visits				
		Non-Users	FABA only	FABA Main	1:1 User	ICS Main	Non-Users	FABA only	FABA Main	1:1 User	ICS Main	Non-Users	FABA only	FABA Main	1:1 User	ICS Main
(4) Same Post-Graduate Training Program as Undergraduate Medical School: n (%)																
Same	(n=60,651;67.3%) [n=388; 63.7%]	60.277 (67.3%)	0 (--%)	53 (72.6%)	113 (72.9%)	208 (72.7%)	52,716 (67.0%)	2,429 (66.0%)	705 (71.9%)	1,746 (71.1%)	3,055 (71.0%)	58,980 (%)	693 (68.3%)	159 (67.4%)	254 (70.6%)	565 (70.0%)
Different	(n=29,406;32.7%) [n=219; 36.0%]	29,264 (32.7%)	0 (--%)	20 (27.4%)	44 (28.0%)	78 (27.3%)	25,915 (33.0%)	1,253 (34.0%)	276 (28.1%)	711 (28.9%)	1,250 (29.1%)	28,556 (%)	322 (31.7%)	77 (32.6%)	106 (29.4%)	245 (30.3%)
Missing	(n=21; 0.02%) [n=2; 0.03%]	21 (0.02%)	0 (--%)	0 (--%)	0 (--%)	0 (--%)	21 (0.02%)	0 (--%)	0 (--%)	0 (--%)	0 (--%)	21 (0.02%)	0 (--%)	0 (--%)	0 (--%)	0 (--%)
(5) By Practice Specialty																
GPs	(n=77,338;85.9%) [n=363; 59.6%]	76,925 (85.9%)	0 (--%)	67 (91.8%)	112 (71.3%)	234 (81.8%)	66,756 (84.9%)	3,501 (95.1%)	907 (92.5%)	2,234 (90.9%)	3,940 (91.5%)	75,267 (85.9%)	919 (90.5%)	211 (89.4%)	292 (81.1%)	649 (80.1%)
Respiratory Specialists	(n=7,468;8.3%) [n=79; 13.0%]	7,367 (8.2%)	0 (--%)	6 (8.2%)	45 (28.7%)	50 (17.5%)	6,647 (8.5%)	173 (4.7%)	72 (7.3%)	220 (9.0%)	356 (8.3%)	7.126 (8.1%)	94 (9.3%)	23 (9.8%)	67 (18.6%)	158 (19.5%)
Other Specialists	(n=1862; 2.1%) [n=132; 21.7%]	1,861 (2.1%)	0 (--%)	0 (--%)	0 (--%)	1 (0.4%)	1,851 (2.4%)	4 (0.11%)	0 (--%)	2 (0.1%)	5 (0.1%)	1,860 (2.1%)	0 (--%)	1 (0.4%)	0 (--%)	1 (0.1%)
Cardiologists	(n=3,410; 3.8%) [n=35;5.7%]	3,409 (3.8%)	0 (--%)	0 (--%)	0 (--%)	1 (0.4%)	3,398 (4.3%)	4 (0.11%)	2 (0.2%)	1 (0.04%)	5 (0.1%)	3,404 (3.9%)	2 (0.2%)	1 (0.4%)	1 (0.3%)	2 (0.3%)

Table ii.2.21. Outcome (3): ICS/ICS Plus FABA Ratio by National Licensing Examination Scores: *Medications Prescribed by Study MDs* (n=90,078)

		Baseline Period					**Follow-up Period**									
		Six months before the Index Visits					**1st 6 months after the Index Visits**					**2nd 6 months after the Index Visits**				
		Non-Users	FABA Only	FABA Main	1:1 User	ICS Main User	Non-Users	FABA only	FABA Main	1:1 User	ICS Main User	Non-Users	FABA only	FABA Main	1:1 User	ICS Main User
(1) By QE1 Total Scores of the Physicians Who Provided Care on the Index Visits																
Top Quartile	(22,872;25.4%) [154; 25.3%]	25,495 (28.5%)	0 (--%)	26 (35.6%)	55 (35.0%)	92 (32.2%)	22,635 (28.8%)	940 (25.5%)	242 (24.7%)	670 (27.3%)	1,181 (27.4%)	24,963 (28.5%)	271 (26.7%)	53 (22.5%)	105 (29.2%)	276 (34.1%)
2nd Quartile	(n=22,864;25.4%) [n=152; 25.0%]	21,292 (23.8%)	0 (--%)	11 (15.1%)	34 (21.7%)	66 (23.1%)	18,820 (23.9%)	888 (24.1%)	209 (21.3%)	494 (20.1%)	992 (23.0%)	20,810 (23.7%)	248 (24.4%)	57 (24.2%)	98 (27.2%)	190 (23.5%)
3rd Quartile	(n=22,023; 24.5%) [n=151; 24.8%]	17,781 (19.9%)	0 (--%)	14 (19.2%)	27 (17.2%)	59 (20.6%)	15,247 (19.6%)	766 (20.8%)	227 (23.1%)	544 (22.1%)	917 (21.3%)	17,376 (19.8%)	217 (21.4%)	62 (26.3%)	71 (19.7%)	155 (19.1%)
Bottom Quartile	(n=22,319; 24.8%) [n=152;25.0%]	24,994 (27.9%)	0 (--%)	22 (30.1%)	41 (26.1%)	70 (24.1%)	21,770 (27.7%)	1,088 (29.6%)	303 (30.9%)	749 (30.5%)	1,216 (28.2%)	24,508 (28.0%)	279 (27.5%)	64 (27.1%)	86 (23.9%)	189 (23.3%)
(2) By QE1 Clinical Reasoning Scores of the Physicians Who Provided Care on the Index Visits																
Top Quartile	(n=18,254; 20.3%) [n=154; 25.2%]	18,124 (20.2%)	0 (--%)	20 (27.4%)	46 (29.3%)	64 (22.4%)	16,217 (20.6%)	619 (16.8%)	164 (16.7%)	460 (18.7%)	794 (18.4%)	17,732 (%)	199 (19.6%)	42 (17.8%)	85 (23.6%)	196 (24.2%)
2nd Quartile	(n=21,885; 24.3%) [n=152; 25.0%]	21,761 (24.3%)	0 (--%)	13 (17.8%)	34 (21.7%)	77 (27.0%)	19,180 (24.4%)	851 (23.1%)	216 (22.0%)	530 (21.6%)	1,108 (25.7%)	21,278 (%)	240 (23.7%)	51 (21.6%)	93 (25.8%)	223 (27.5%)
3rd Quartile	(n=20,054; 22.3%) [n=152; 25.0%]	19,935 (22.3%)	0 (--%)	16 (21.9%)	30 (19.1%)	73 25.5(%)	17,400 (22.1%)	870 (23.6%)	255 (26.0%)	552 (22.5%)	977 (22.7%)	19,509 (%)	250 (24.6%)	57 (24.2%)	66 (18.3%)	172 (21.2%)
Bottom Quartile	(n=29,885; 33.2%) [n=151; 24.8%]	29,742 (33.2%)	0 (--%)	24 (32.7%)	47 (29.9%)	72 (25.2%)	25,855 (32.9%)	1,342 (36.5%)	346 (35.3%)	915 (37.2%)	1,427 (33.1%)	29,138 (%)	326 (32.1%)	86 (36.4%)	116 (32.2%)	219 (27.0%)
3) By QE2 Total Scores of the Physicians Who Provided Care on the Index Visits																
Top Quartile	(n=21,414;23.8%) [n=154; 25.3%]	21,303 (23.8%)	0 (--%)	16 (21.9%)	28 (17.8%)	67 (23.4%)	18,643 (23.7%)	785 (21.3%)	210 (21.4%)	603 (24.5%)	1,173 (27.2%)	20,865 (23.8%)	229 (22.6%)	48 (20.3%)	73 (20.3%)	199 (24.6%)
2nd Quartile	(n=22,967;25.5%) [n=152; 25.0%]	22,793 (25.5%)	0 (--%)	29 (39.7%)	61 (38.9%)	84 (29.4%)	19,899 (25.3%)	1,060 (28.8%)	285 (29.1%)	662 (26.9%)	1,061 (24.6%)	22,244 (25.4%)	295 (29.1%)	72 (30.5%)	130 (36.1%)	226 (27.9%)
3rd Quartile	(n=22,844;25.4%) [n=151; 24.8%]	22,708 (25.4%)	0 (--%)	18 (24.7%)	43 (27.4%)	75 (26.2%)	20,106 (25.6%)	912 (24.8%)	232 (23.7%)	535 (21.8%)	1,059 (24.6%)	22,200 (23.5%)	254 (25.0%)	70 (29.7%)	84 (23.3%)	236 (29.1%)
Bottom Quartile	(n=22,853;25.4%) [n=152; 25.0%]	22,758 (25.4%)	0 (--%)	10 (13.7%)	25 (15.9%)	60 (21.0%)	20,004 (25.4%)	925 (25.1%)	254 (25.9%)	657 (26.7%)	1,013 (23.5%)	23,348 (25.5%)	237 (23.4%)	46 (19.5%)	73 (20.3%)	149 (18.4%)

Table ii.2.21. Outcome (3): ICS/ICS Plus FABA Ratio by National Licensing Examination Scores: *Medications Prescribed by Study MDs* (n=90,078) *(cont'd)*

		Baseline Period					Follow-up Period									
		Six months before the Index Visits					1st 6 months after the Index Visits					2nd 6 months after the Index Visits				
		Non-Users	FABA Only	FABA Main	1:1 User	ICS Main User	Non-Users	FABA only	FABA Main	1:1 User	ICS Main User	Non-Users	FABA only	FABA Main	1:1 User	ICS Main User
(4) By QE2 Communication Score of the Physicians Who Provided Care on the Index Visits																
Top Quartile	(n=21,753; 24.1%) [n=154; 25.3%]	21,620 (%)	0 (--%)	19 (26.0%)	38 (24.2%)	76 (26.6%)	18,814 (23.9%)	914 (24.8%)	263 (26.8%)	656 (26.7%)	1,106 25.7(%)	21,150 (24.1%)	233 (23.0%)	65 (27.5%)	92 (25.6%)	213 (26.3%)
2nd Quartile	(n=17,997; 20.0%) [n=157; 25.8%]	17,884 (%)	0 (--%)	21 (28.8%)	39 (24.8%)	53 (18.5%)	15,541 (19.8%)	739 (20.1%)	196 (20.0%)	519 (21.1%)	1,002 (23.3%)	17,426 (19.9%)	240 (23.7%)	54 (22.9%)	91 (25.3%)	186 (23.0%)
3rd Quartile	(n=23,852; 26.5%) [n=152; 15.0%]	23,717 (%)	0 (--%)	20 (27.4%)	32 (20.4%)	83 (29.0%)	21,198 (27.0%)	871 (23.7%)	205 (20.9%)	503 (20.5%)	1,075 (25.0%)	23,285 (26.6%)	236 (23.3%)	49 (20.8%)	76 (21.1%)	206 (25.4%)
Bottom Quartile	(n=26,476; 29.4%) [n=154; 25.3%]	26,341 (%)	0 (--%)	13 (17.8%)	48 (30.6%)	74 (25.9%)	23,099 (29.4%)	1,158 (31.5%)	317 (32.3%)	779 (31.7%)	1,123 (26.1%)	25,796 (29.4%)	306 (30.2%)	68 (28.8%)	101 (28.1%)	205 (25.3%)
(5) By QE2 Data Acquisition Score the Physicians Who Provided Care on the Index Visits																
Top Quartile	(n=24,258; 26.9%) [n=153; 25.1%]	24,136 (27.0%)	0 (--%)	20 (27.4%)	36 (22.9%)	66 (23.1%)	21,324 (27.1%)	869 (23.6%)	252 (25.7%)	627 (25.5%)	1,186 (27.5%)	23,644 (27.0%)	252 (24.8%)	57 (24.2%)	87 (24.2%)	218 (26.9%)
2nd Quartile	(n=27,115; 30.1%) [n=153; 25.1%]	26,926 (30.1%)	0 (--%)	27 (37.0%)	66 (42.0%)	96 (33.6%)	23,459 (29.8%)	1,239 (33.7%)	311 (31.7%)	815 (33.2%)	1,291 (30.0%)	26,331 (30.0%)	324 (31.9%)	73 (30.9%)	131 (36.4%)	256 (31.6%)
3rd Quartile	(n=21,621; 24.0%) [n=151; 24.8%]	21511 (24.0%)	0 (--%)	15 (20.6%)	26 (16.6%)	69 (24.1%)	18,811 (23.9%)	847 (23.0%)	237 (24.2%)	616 (25.1%)	1,110 (25.8%)	21,065 (24.0%)	232 (22.9%)	66 (28.0%)	74 (20.6%)	184 (22.7%)
Bottom Quartile	(n=17,084; 19.0%) [n=152; 25.0%]	16,889 (19.0%)	0 (--%)	11 (15.1%)	29 (18.5%)	55 (19.2%)	15,058 (19.2%)	727 (19.7%)	181 (18.5%)	399 (16.2%)	719 (16.7%)	16,617 (19.0%)	207 (20.4%)	40 (17.0%)	68 (18.9%)	152 (18.8%)
(6) By QE2 Problem Solving Score of the Physicians Who Provided Care on the Index Visits																
Top Quartile	(n=20,937;23.2%) [n=153; 25.1%]	20,827 (23.3%)	0 (--%)	11 (15.1%)	22 (14.0%)	77 (26.9%)	18,255 (23.2%)	847 (23.0%)	189 (19.3%)	540 (22.0%)	1,106 (25.7%)	20,356 (23.2%)	248 (24.4%)	45 (19.1%)	75 (20.8%)	213 (26.3%)
2nd Quartile	(n=23,537; 26.1%) [n=154; 25.3%]	23,339 (26.1%)	0 (--%)	22 (30.1%)	52 (33.1%)	64 (22.3%)	20,612 (26.2%)	966 (26.2%)	285 (29.1%)	620 (25.3%)	1,054 (24.6%)	22,901 (26.1%)	264 (26.0%)	73 (30.9%)	89 (24.7%)	210 (25.9%)
3rd Quartile	(n=21,042; 23.4%) [n=151; 24.8%]	20.914 (23.4%)	0 (--%)	17 (23.3%)	40 (25.5%)	71 (24.8%)	18,334 (23.3%)	831 (22.6%)	250 (25.5%)	585 (23.8%)	1,032 (24.0%)	20,457 (23.3%)	236 (23.3%)	62 (26.3%)	97 (26.9%)	190 (23.5%)
Bottom Quartile	(n=24,562; 27.3%) [n=151; 24.8%]	24,422 (27.3%)	0 (--%)	23 (31.5%)	43 (27.4%)	74 (25.9%)	21,441 (27.3%)	1,038 (28.2%)	257 (26.2%)	712 (29.0%)	1,114 (25.9%)	23,943 (27.3%)	267 (26.3%)	56 (23.7%)	99 (27.5%)	197 (24.3%)

Table ii.2.22. Outcome (3): ICS/ICS Plus FABA Ratio by Patient Characteristics: *Medications Prescribed by Study MDs*

STUDY MDs		Baseline Period					Follow-up Period									
		Six months before the Index Visits					1st 6 months after the Index Visits					2nd 6 months after the Index Visits				
		Non-Users	FABA Only	FABA Main	1:1 User	ICS Main	Non-Users	FABA only	FABA Main	1:1 User	ICS Main	Non-Users	FABA only	FABA Main	1:1 User	ICS Main
(1) By Patient Gender																
Female	(n=54,840; 60.9%)	54,506 (60.9%)	0 (--%)	48 (65.8%)	96 (61.2%)	190 (66.4%)	47,847 (60.8%)	2,198 (59.7%)	533 (54.3%)	1,464 (59.6%)	2,798 (65.0%)	34,210 (39.0%)	586 (57.7%)	137 (58.1%)	199 (55.3%)	471 (58.2%)
Male	(n=35,238; 39.1%)	35.056 (39.1%)	0 (--%)	25 (35.2%)	61 (38.9%)	96 (33.6%)	30,805 (39.2%)	1,484 (40.3%)	448 (45.7%)	993 (40.4%)	1,508 (35.0%)	53,447 (61.0%)	429 (42.3%)	99 (42.0%)	161 (44.7%)	339 (41.9%)
(2) By Patient Age																
Age>45	(n=21,328; 23.7%)	21,155 (23.6%)	0 (--%)	18 (24.7%)	45 (28.7%)	110 (38.5%)	18,932 (24.1%)	765 (20.8%)	147 (15.0%)	400 (16.3%)	1,084 (25.2%)	20,682 (23.6%)	233 (23.0%)	57 (24.2%)	67 (18.6%)	289 (35.7%)
Age≤45	(n=68,750; 76.3%)	68,407 (76.4%)	0 (--%)	55 (75.3%)	112 (71.3%)	176 (61.5%)	59,720 (75.9%)	2,197 (79.2%)	834 (85.0%)	2,057 (83.7%)	3,222 (74.8%)	66,975 (76.4%)	782 (77.0%)	179 (75.9%)	293 (81.4%)	521 (64.3%)
(3) By Index Visits were due to Referral																
Yes	(n=5,980; 6.6%)	5,968 (6.7%)	0 (--%)	1 (1.4%)	2 (1.3%)	9 (3.1%)	5,468 (7.2%)	81 (2.2%)	31 (3.2%)	59 (2.4%)	161 (3.7%)	5,833 (6.7%)	40 (3.9%)	11 (4.7%)	20 (5.6%)	76 (9.4%)
No	(n=84,098; 93.4%)	83,594 (93.3%)	0 (--%)	72 (98.6%)	155 (98.7%)	277 (96.9%)	73,004 (92.8%)	3,601 (97.8%)	950 (96.8%)	2,398 (97.6%)	4,145 (96.3%)	81,824 (93.4%)	975 (96.1%)	225 (95.3%)	340 (94.4%)	734 (90.6%)
(4) By Probability of Having Asthma*																
Probability≥0.6	(n=39,947;44.4%)	39,436 (44.0%)	0 (--%)	73 (100%)	157 (100%)	281 (98.3%)	28,759 (36.3%)	3,513 (95.4%)	979 (99.8%)	2,451 (99.8%)	4,245 (98.6%)	37,544 (42.8%)	1,004 (98.9%)	236 (100%)	360 (100%)	803 (99.1%)
Probability<0.6	(n=39,834; 44.2%)	39,830 (44.5%)	0 (--%)	0 (%)	0 (%)	4 (1.4%)	39,602 (50.4%)	167 (4.5%)	2 (0.2%)	6 (0.2%)	57 (1.3%)	39,817 (45.4%)	10 (1.0%)	0 (--%)	0 (--%)	7 (0.9%)
No	(n=10,297; 11.4%)	10,297 (11.5%)	0 (--%)	0 (--%)	0 (--%)	0 (--%)	10,291 (13.1%)	2 (0.1%)	0 (--%)	0 (--%)	4 (0.1%)	10,296 (11.8%)	1 (0.1%)	0 (--%)	0 (--%)	0 (--%)
(5) By Patient Socioeconomic Status																
Below Poverty Line	(n=29,632; 32.9%)	29,461 (32.9%)	0 (--%)	17 (23.3%)	47 (29.9%)	107 (37.4%)	25,876 (32.9%)	1,207 (32.8%)	361 (36.8%)	795 (32.4%)	1,393 (32.4%)	28,806 (32.9%)	338 (33.3%)	91 (38.6%)	116 (32.2%)	281 (34.7%)
Above Poverty Line	(n=60,446; 67.1%)	60,101 (67.1%)	0 (--%)	56 (76.7%)	110 (70.1%)	179 (62.6%)	52,776 (67.1%)	2,475 (67.2%)	620 (63.2%)	1,662 (67.6%)	2,913 (67.7%)	58,851 (67.1%)	677 (66.7%)	145 (61.4%)	244 (67.8%)	529 (65.3%)
(6)Continuity of Care (COC): Follow-Up Period By Continuity of Care During 1-year after the Index Visits: Asthma-Specific																
Number of Respiratory related Visits	0	--; (n=48,200; 53.5%)	48,033 (53.6%)	0 (--%)	21 (28.8%)	61 (38.9%)	85 (29.7%)	43,814 (55.7%)	1,490 (40.5%)	267 (27.2%)	1,051 (42.8%)	623 (14.5%)	47,620 (54.3%)	285 (28.1%)	46 (19.5%)	105 (29.2%)	144 (17.8%)
	>0	COC≤0.5 (n=35,256; 39.1%)	35,020 (39.1%)	0 (--%)	36 (49.3%)	65 (41.4%)	135 (47.2%)	29,734 (37.8%)	1,760 (47.8%)	548 (55.9%)	1,109 (45.1%)	2,105 (48.9%)	3,4091 (38.9%)	503 (49.6%)	113 (47.9%)	154 (42.8%)	395 (48.8%)
		COC>0.5 (n=6,622; 7.4%)	6,509 (7.3%)	0 (--%)	16 (21.9%)	31 (19.8%)	66 (23.1%)	5,104 (6.5%)	432 (11.7%)	166 (16.9%)	297 (12.1%)	1,578 (36.7%)	5,946 (6.8%)	227 (22.4%)	77 (32.6%)	101 (28.1%)	271 (33.5%)
By Continuity of Care During 1-year after the Index Visits: Asthma Outpatient-Specific																
# of Respiratory related Visits at outpatient	0	--; (n=51,599; 57.3%)	51,407 (57.4%)	0 (--%)	27 (37.0%)	65 (41.4%)	100 (35.0%)	46,769 (59.5%)	1,623 (44.1%)	316 (32.2%)	1,156 (47.1%)	1,735 (40.3%)	50,919 (58.1%)	334 (32.9%)	55 (23.3%)	121 (33.6%)	170 (21.0%)
	>0	COC≤0.5; (n=31,759; 35.3%)	31,558 (35.2%)	0 (--%)	28 (38.4%)	61 (38.9%)	112 (39.2%)	26,769 (34.9%)	1,604 (43.6%)	481 (49.0%)	988 (40.2%)	1,917 (44.5%)	30,766 (35.1%)	440 (43.4%)	84 (35.6%)	126 (34.7%)	344 (43.0%)
		COC>0.5; (n=6,720; 7.5%)	6,597 (7.4%)	0 (--%)	18 (24.7%)	31 (19.8%)	74 (25.9%)	5,114 (6.5%)	456 (12.4%)	184 (18.8%)	313 (12.7%)	654 (15.2%)	5,972 (6.8%)	241 (23.7%)	97 (41.1%)	114 (31.7%)	296 (36.5%)

Table ii.2.22. Outcome (3): ICS/ICS Plus FABA Ratio by Patient Characteristics: *Medications Prescribed by Study MDs(Cont'd)*

STUDY MDs		Baseline Period					Follow-up Period									
		Six months before the Index Visits					1st 6 months after the Index Visits					2nd 6 months after the Index Visits				
		Non-Users	FABA Only	FABA Main	1:1 User	ICS Main	Non-Users	FABA only	FABA Main	1:1 User	ICS Main	Non-Users	FABA only	FABA Main	1:1 User	ICS Main
(7) By Practice Year																
0	(n=4,992;5.5%)	4962 (5.5%)	0 (--%)	6 (8.2%)	8 (5.1%)	16 (5.6%)	4352 (5.5%)	223 (6.1%)	83 (8.5%)	92 (3.7%)	242 (5.6%)	4826 (5.5%)	60 (5.9%)	23 (9.8%)	19 (5.3%)	64 (7.9%)
1	(n=11,884;13.2%)	11812 (13.2%)	0 (--%)	12 (15.4%)	17 (10.8%)	43 (15.0%)	10302 (13.1%)	553 (15.0%)	209 (21.3%)	232 (9.4%)	588 (13.7%)	11476 (13.1%)	178 (17.5%)	47 (19.9%)	50 (13.9%)	133 (16.4%)
2	(n=12,756; 14.2%)	12661 (14.1%)	0 (--%)	17 (23.3%)	26 (16.6%)	52 (18.2%)	11136 (14.2%)	541 (14.7%)	162 (16.5%)	312 (12.7%)	551 (14.1%)	12324 (14.1%)	165 (16.3%)	47 (19.9%)	68 (18.9%)	152 (18.8%)
3	(n=13,704;15.2%)	13620 (15.2%)	0 (--%)	18 (24.7%)	23 (14.7%)	43 (15.0%)	12023 (15.3%)	520 (14.1%)	146 (14.9%)	371 (15.1%)	644 (15.0%)	13332 (15.2%)	152 (15.0%)	35 (14.8%)	60 (16.7%)	135 (16.7%)
4	(n=14,103; 15.7%)	14030 (15.7%)	0 (--%)	5 (5.5%)	26 (16.6%)	42 (14.7%)	12372 (15.7%)	529 (14.4%)	139 (14.2%)	390 (15.9%)	673 (15.6%)	13763 (15.7%)	149 (14.7%)	27 (11.4%)	44 (12.2%)	120 (14.8%)
5	(n=12,189;13.5%)	12132 (13.6%)	0 (--%)	4 (%)	19 (12.1%)	34 (11.9%)	10605 (13.5%)	497 (13.5%)	90 (9.2%)	364 (14.8%)	633 (14.7%)	11903 (13.6%)	133 (13.1%)	16 (6.8%)	55 (15.3%)	82 (10.1%)
6	(n=9,440;10.5%)	9382 (10.5%)	0 (--%)	7 (%)	20 (12.7%)	31 (10.8%)	8241 (%)	379 (10.3%)	76 (7.8%)	308 (12.5%)	436 (10.1%)	9243 (10.5%)	79 (7.8%)	20 (8.5%)	32 (8.9%)	66 (8.2%)
7	(n=6,096;6.8%)	6072 (6.8%)	0 (--%)	2 (%)	11 (7.0%)	11 (3.9%)	5318 (%)	265 (7.2%)	40 (4.1%)	216 (8.8%)	257 (6.0%)	5977 (6.8%)	52 (5.1%)	9 (3.8%)	18 (5.0%)	40 (4.9%)
8	(n=3,300;3.7%)	3284 (3.7%)	0 (--%)	2 (%)	5 (3.2%)	9 (3.2%)	2852 (%)	122 (3.3%)	24 (2.6%)	120 (4.9%)	182 (4.2%)	3228 (3.7%)	134 (3.4%)	10 (4.2%)	12 (3.3%)	16 (2.0%)
9	(n=1,364;1.5%)	1360 (1.5%)	0 (--%)	0 (--%)	1 (0.6%)	3 (1.1%)	1223 (%)	45 (1.2%)	10 (1.0%)	44 (1.8%)	42 (1.0%)	1349 (1.5%)	12 (1.2%)	1 (0.4%)	1 (0.3%)	1 (0.1%)
10	(n=250;0.3%)	247 (0.3%)	0 (--%)	0 (--%)	1 (0.6%)	2 (0.7%)	228 (%)	8 (0.2%)	2 (0.2%)	8 (0.3%)	3 (0.1%)	246 (0.3%)	1 (0.1%)	1 (0.4%)	1 (0.3%)	1 (0.1%)