ESSAYS ON PHYSICIAN INCENTIVES AND PHARMACEUTICAL OUTCOMES IN ASTHMATIC CHILDREN

by

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DEDICATION

This dissertation is dedicated to my dedicated wife (YoungSune June) and my family

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ABSTRACT

It is believed that health plans, reimbursement mechanisms and financial incentives led to health outcomes for health care utilization and medication adherence from pediatric populations. However, there is little empirical evidence about the effect of health plans, reimbursement mechanisms and financial incentives on asthmatic pediatric population.

The first study examined how sociological factors including financial incentives influenced whether asthmatic children received a controller medication, a reliever medication or both. The 2007 National Ambulatory Medical Care Survey was used for this analysis. Compared with physicians who received lower financial incentives, physicians who received medium (39%, $p<0.05$) or higher (42%, $p<0.01$) financial incentives from payers were more likely to prescribe controller medication than reliever medication for children with asthma.

The second study examined associations between the type of health plan (fee for service vs. capitated) and utilization-based outcomes in asthmatic Medicaid children. Subjects were 6435 Medicaid enrolled asthmatic children who newly started asthma pharmacotherapy and were followed 12 months before and 12 month after the index anti-asthmatic medication. Patient in capitated plans were associated with 77% more

hospitalizations and 34% increased incidence rates of emergency department visits, but 42% fewer outpatient visits compared to those in FFS plans (all $p<0.05$).

The third study examined the impact of the type of health plan (public vs. private) on health outcomes in pediatric asthmatic enrollees. Subjects were 11,027 asthmatic children (6,435 in Medicaid and 4,592 in a commercial HMO) who newly started asthma pharmacotherapy and were followed 12 months before after the index anti-asthmatic medication fill. Patients in Medicaid plans were also associated with 20% more inpatient hospitalizations and 50% increased odds of emergency department visits, but had 42% fewer outpatient visits compared to those in private plan (all $p<0.05$).

In sum, the results of this study provide an insight to clinicians, policymakers and health service researchers in evaluating policies related to insurance coverage of essential medications in indigent children with asthma. This, in turn, could help understand important factors that impact health care financing, design strategies to improve asthma related care, and improve health outcomes for needy and poor children in the United States.

CHAPTER 1

INTRODUCTION

1.1 Study Rationale

Epidemiology of Asthma

Asthma is one of the most commonly prevalent chronic medical conditions in US children, and indigent children (such as those covered by Medicaid) are at greater risk of poor asthma outcomes. Various demographic factors such as age, race, gender, ethnicity, socioeconomic status, weather, location of residence and surroundings have shown to play a role in asthma prevalence, morbidity and mortality. (Holmes 2005; Mannino 2002). Asthma mortality increased by 3.4% every year from 1979 to 1998 amounting to about 2.2 deaths per 100,000 people or about 4,200 deaths on a nationwide basis. (Akinbami and Schoendorf 2002; Casalino 2005). Recently, there has been a drop in the mortality rates due to successful implementation of clinical guidelines for asthma treatment (National Asthma Education and Prevention Program, 1997). Amongst the pediatric asthmatic population, female children, teenage children and African American children bear a disproportionate burden of asthma. Asthma mortality among African American children is about four times higher compared to Caucasian children (Akinbami et al. 2009). Levels of healthcare utilization and decrease in work productivity (restricted activities or school absences) are some of the measures used to determine asthma morbidity in this population. National estimates of these measures were available

systematically through patient surveys. According to the National Asthma Survey funded by the Centers for Disease Control and Prevention (CDC), as many as 45% had 1 missed school day due to asthma (CDC, 2005). On a national scale, this amounts to about 14 million lost school days.

Missed school days are associated with considerable direct and indirect costs. Children who were frequently absent show poor performance at school and impact their parent's work performance negatively since their parents might have to miss work when children decide to stay at home. The CDC reported that in 1998, the total indirect costs due to missed school and work along with untimely deaths in the US cost over 53 billion dollars (CDC, 2005; American Lung Association, 2005).

Asthma Burden on Poor Children

Disproportionate asthma prevalence rates have been reported widely among poor children. Some indicators of this trend were higher rates of hospitalization and emergency room visits for asthma, lower utilization of pharmaceutical agents known to improve control of asthma, higher prevalence, higher severity of disease, and lower rates of utilization of asthma related primary care services among poor and minority children (Akinbami and Schoendorf 2002; Ash 2005; Dougherty 2005; Gold and Wright 2005; Krishnan 2001; Lieu et al. 2002; Weiss, Sullivan, and Lyttle 2000). This trend has been attributed to the nature of medical care system in U.S., its financing mechanisms, its concomitant impact on access to medical care and the individual characteristics of the population (Basu and Cooper 2000; Bindman 1995; Friedman 2001; Homer 1996; Lynch

1997). Poor children are more vulnerable to poor health in general because they are likely to have multiple risk factors (Aday 2001). Investigation of single risk factors is useful but it does not reflect the real-world scenario where risk factors are often clustered, e.g., low education and low income (Stevens et al. 2006). Previous research suggests that multiple risk factors may produce an additive impact on children's mental, physical, and social health and school performance (Starfield 2002; Stevens et al. 2006). This interactive influence has also been observed in the case of asthma (Accordini et al. 2006; Wood 2002).

It is also likely that this higher burden is related to a web of economic, educational, ethnic, and cultural characteristics particular to the individual or family. Besides these factors, contextual factors related to the geographic location in which the family resides, works, and attends school may also be contributing factors towards the disproportionate prevalence of asthma among poor and minority children. All of the factors above are tightly associated with poverty and race in America. The disparity in resources between the poor and non poor, characteristics of their neighborhood, and organizational features of the medical care system lead to differences in the prevalence and severity of poor asthmatic children and to differences in the medical and family management of pediatric asthma (Akinbami and Schoendorf 2002; Ash 2005; Chang et al. 2011; Dougherty 2005; Gold and Wright 2005; Krishnan 2001; Lieu et al. 2002; Weiss et al. 2000).

Treatment and Medication in Asthmatic Children

In the US, asthma affects millions of people leading to high morbidity and mortality and a lower quality of life. The burden of asthma is high in children, especially poor children. In 1994, the aggregate direct cost of medical expenses borne by the society amounted to $6 billion (Weiss et al. 2000). Asthma led to indirect costs associated with missed school and work, thereby posing a financial burden on families, employers and the healthcare system. (Global Initiative for Asthma (GINA), 2006).

Asthma guidelines have been used widely since many years and had been known to prevent the emergency department (ED) visits and inpatient hospital stays. The process of asthma management is quite complicated. In order to assess asthma severity and persistence, it is necessary to perform symptomology assessments of patients regularly. Provision of patient education can help in successful asthma control since patients can practice self-management skills leading to regulation of pharmaceutical regimes, avoidance of attack triggering substances and behaviors and adherence to medication regimens. However, there is lack of adherence to recommended treatment guidelines by both the physicians and patients. (Global Initiative for Asthma (GINA), 2006).

Asthma medication is one of the key components for long-term asthma control. The National Asthma Education and Prevention Panel (NAEPP) report 2 (1997) emphatically recommended the use of steroid inhaler as the most effective long-term asthma control medication. Previous studies have shown the steroid inhalers when used daily, not only reduces asthma symptoms, severe exacerbations and use of quick-relief medications but also improves lung function, airway hyper responsiveness and FEV

(Cloutier et al. 2005; Cochrane 1999). The American Lung Association (2005) classified asthma medications for pediatric use under 5 different classes. These medications are prescribed as per their clinical use and are summarized in Table 1.1.

Table 1.1 Five Groups of Asthma Medications for Children

Type	Effect
Inhaled Bronchodilator Medications	Inhaled bronchodilator medications are highly effective in opening airways narrowed by asthma. In fact, they are the most effective. In addition, they have few severe side effects when used in the recommended dose and frequency. They are available by both metered dose inhaler and nebulizer
Anti-Inflammatory Medications	Anti-inflammatory medications are recommended by the National Heart, Lung, and Blood Institute (NHLBI) expert panel for children with mild intermittent, moderate and severe asthma as the cornerstone for daily routine medical management. This panel recommends that one of these medications be given daily to control airway inflammation. They are considered safe and effective for long-term use.
Systematic Bronchodilator Medications	Systematic bronchodilator medications, principally theophylline, are effective but have more associated side effects that can be unpleasant although rarely life threatening. These medications are available in slow release tablets or capsules that are effective for 12 to 24 hours. These are especially helpful for nocturnal or night-time asthma. They are also used for daily control of asthma symptoms
Systematic Corticosteroid Medications	Systematic corticosteroid medications are highly effective in controlling asthma and reversing severe episodes. Unfortunately they can cause serious side effects when used for prolonged periods, and their use is therefore limited to severe episodes or chronic severe asthma which cannot be controlled with the first three groups of medications listed above.
Leukotriene Modifiers	Leukotriene modifiers are a new class of oral anti-inflammatory asthma drugs recently

	approved by the U.S. FDA. Sold under the names Accolate, Singulair, and Zyflo, these are also available by prescription.

Adopted from American Lung Association (2005)

Inhaled bronchodilators have few side effects and effectively open airways. Anti-inflammatory medications are used for asthma with moderate severity and are recommended by NHLBI. Systematic corticosteroids effectively open airways but have many side effects if used for a long time. Leukotrine modifiers ware available by prescription only and are a relatively newer class of asthma medications (ALA, 2005).

Health Care Utilization by Children

Children in general use far fewer medical care resources than adults. In 2000, more than 25% of the general US population comprised of children aged 17 years or less but still represented only 18% of US hospitalizations. Average length of stay for children was only 3.3 days compared to 4.9 days for adults. The average annual expenditure per child in 1999 was $1013 although the most costly 20% of children accounted for 81% of the total medical expenditures for children. Children as a group accounted for only 10.3% of all medical care expenditure in 1999 (Simpson et al. 2004). The trend throughout the 1990s showed that children in general had far fewer hospitalizations, fewer hospital outpatient visits, and fewer ED visits than adults. There has been little or no change in the proportion of children with at least one office-based visit or at least one prescription filled in the US. These indicators vary across population subgroups, insurance and health status and show some geographic variation by U.S. region. For example, inpatient discharges are lower for publicly insured children but ED utilization

have declined substantially for those publicly insured. Between 1987 and 1999, the site of ambulatory care shifted from hospital outpatient and ED site toward office-based locations. Medicaid covered 37.8% of all pediatric hospitalizations (54.5% private and 5.1% uninsured) and length of stays were somewhat longer (3.7 days versus 3.1 days for private) in this insured population of Medicaid-enrolled children (Simpson et al. 2004).

Among children in Medicaid managed care plans, several studies have found lower utilization of emergency rooms in managed care compared to fee for service (FFS) plans. One study however additionally found that Medicaid children in managed care presented with higher disease severity than those in FFS plans (Davidson 1992; Freund and Hurley 1995; Szilagyi 2000). The use of primary care services was seen to increase if the comparison plan was FFS (Freund and Hurley 1995; Friedman 2001) but if the Medicaid managed care reimbursement method was capitation, then some lowered use of primary care services was seen among children in Medicaid managed care plans (Kaye 2005; Leibowitz 1992).

A number of studies have looked at utilization of specialist services, referrals to specialists, choice of providers, and breadth of available services between various managed care types and traditional FFS plans. Private insured children in managed care had no consistent difference in referrals and service use of medical specialist compared to children in private FFS plans although there was some evidence of restricted coverage for chronically ill children in MC plans (Szilagyi 2000). However, among Medicaid managed care plans there was evidence of fewer special visits and more restricted coverage as compared to FFS Medicaid plans (Szilagyi 2000).

According to a study by Hickson and colleagues, fee for service reimbursement received by physicians led to more scheduled physician visits among patients compared to physicians receiving reimbursement on a capitated basis. The same study also suggested that pediatricians belonging to fee for service plans that follow the guidelines suggested by the American Academy of Pediatrics are more likely to see patients for well-child care compared to physicians belonging to capitated plans because patients missed fewer recommended visits and fee for service physicians scheduled recommended visits. Fee for service physicians were also known to provide better continuity of care, attend to more patients and encourage fewer ED visits compared to physicians belonging to capitated plans (Pawaskar 2010). Medicaid uses capitation as a means to contain costs but they might not be cost effective in the long run.

Managed Care Organizations (MCO) in Healthcare

Managed care brought about a revolution in the US healthcare system in the 1990s by significantly bringing down the healthcare spending throughout the nation. MCOs aim to improve asthma quality of care and healthcare utilization cost-effectively through provision of a) equal access to care using shared provider networks, b) case management using patient support and c) shared management expertise for all plans. Plan characteristics and services provided in both FFS and capitation programs under Medicaid might share dissimilarities with regards to certain services like patient cost sharing or transportation assistance. During recent years, enrollees have expressed dissatisfaction with some of the restrictive policies of managed care and have shown preference for the less restrictive Preferred Provider Organizations (PPOs). PPOs have

managed cost controls using their negotiation power with regards to reimbursement rates. The evidence-based quality of care provided by MCOs has shown inconclusive results and evidence about quality of care provided by other plans such as PPOs is largely absent in Medicaid-enrolled populations. The hypothesis that long term financial incentives by MCOs (through delivery of evidence based quality health care and promotion of preventive care) outweigh short term incentives (through restricting utilization) lacks sufficient evidence (Dombkowski 2005; Donahue et al. 2000; Gavagan et al. 2010; Godard 2002; Karnick et al. 2007). This study will be amongst the first to examine the ramifications of managed care services on healthcare utilization, access / quality of pharmaceutical care and associated outcomes for both Medicaid and privately insured pediatric populations.

Insurance Coverage in Medicaid Managed Care

From its inception, the Medicaid program's costs have exceeded estimates (Freund and Hurley 1995; Gendo et al. 2003; Georgiou et al. 2003). The US congress authorized waivers to state Medicaid plans in 1981 that made it possible for states to experiment with managed care as a means to control costs (Stevens et al. 2006; Thomson et al. 2003). States commonly implemented one of two types of Medicaid managed care plans: 1) Capitation (pre-paid) and 2) Fee-For-Service ((Kaye 2005)). Under the capitation or prepaid model, managed care organizations (MCOs) received payment on a capitated basis (fixed payment) to deliver healthcare to enrollees. The fees under capitation remained constant irrespective of the number of services used by individual enrollees during any particular month in a year. The MCOs who function as contractors

bear the either partial or full burden of financial risk by delivering healthcare services to the enrollees. The financial risk may or may not be passed on to the providers by MCOs. However, this will depend solely on the contract. About 45% of the Medicaid managed care patients were enrolled under this model (Kaiser Family Foundation 2001). Fully-capitated plans may actually pay all or some of their provider network on a FFS basis. Partially capitated plans allowed for some risk-sharing between the Medicaid agency and the MMC plans (Casalino 2005; Çelik et al. 2004; Gendo et al. 2003; Godard 2002; Gold and Wright 2005). Under the Fee-For-Service Primary Care Case Management (PCCM) model, primary care practitioners (PCPs) act as gatekeepers to determine the eligibility of services being provided to beneficiaries. The gatekeepers do not bear any burden of financial risk by delivering healthcare services to the plan enrollees. PCPs are paid on a fee-for-service basis and are also eligible for an additional fee per enrollee per month for fulfilling case management responsibility associated with each enrollee. PCCM requires beneficiaries to choose a PCP from an approved list of contracted physicians. The PCP receives a monthly fee for coordinating care and issuing referrals plus reimbursement via the usual FFS mechanism for medical services provided.

1.2 Significance of the Study

Managed care and financial incentives programs are putting limits on physicians' autonomy in drug prescribing (Casalino 2005; Conrad 2004). As the services provided by physicians expand beyond a single managed care plan, physicians will have to develop skills for managing multiple formularies. The third party share of total outpatient

prescriptions is also increasing rapidly. In 2004, it was estimated that almost 61.4% of prescription costs were borne by third party payers (Jansson et al. 2007) .

Knowledge about incentives provided by the managed care plans to physicians can help in understanding physician prescribing behaviors. Pay for Performance (P4P) focuses more on preventive care and maximizing gains in patient outcomes. Children have substantially different medication regimens than adults. Additionally, conditions such as asthma are more prevalent in children. Thus one could potentially hypothesize that if P4P were to be focused on a younger population, there is more likelihood of greater returns over a lifetime. Also, one of the P4P indicators for medication prescribing is more usage of controller medication for symptom management in a chronic condition like asthma. There is likelihood of receipt of more incentives by the physician if he/she prescribes more controller medications used to control asthma as opposed to reliever medication which provides temporary relief to the patient. As far as disease severity is concerned, if asthma is controlled right from the childhood stage, there is a lower probability of increased asthma severity and deteriorated health due to the same in the adult stage. In addition, medication therapy for controlling asthma in children could be cost effective in the long run and could result in lower economic burden on the payer and society.

Factors affecting medication adherence in asthmatic children have been extensively examined in previous literature. There is scarcity of research evaluating the impact of payment mechanisms or the type of health plan (capitated vs. FFS) on medication adherence in asthma. Some studies have looked at outcomes in asthmatic patients with public or private insurance (Jackson et al. 2003; Janson and Weiss 2004;

Karnick et al. 2007). Studies have also looked at the role of capitation on preventive care or diagnostic testing (Karnick et al. 2007; Rittenhouse and Robinson 2006) in asthma. Studies evaluating the differences in Medicaid FFS and capitation have examined individuals with mental health issues or special health needs like sickle cell disease. However, studies have not compared FFS and capitated payment mechanisms under managed care in asthmatic children. Also previous studies have only looked at changes in healthcare utilization and cost containment (Gendo et al. 2003; Georgiou et al. 2003; Ungar 2008). Poor quality of care and lower medication adherence can potentially harm asthmatic children's health. Previous research did not explore the impact of the type of health plan on medication adherence behavior. This study was among the impact of capitated health plans vs. traditional FFS plans on the treatment of asthma in children. It can help policy makers design appropriate reimbursement policies that ensure effective allocation of scarce healthcare resources among vulnerable population.

Previous literature lacks evidence about the effect of different health plans on the medication outcomes of children with asthma. None of the prior studies have focused only on asthmatic children in Medicaid; none have evaluated asthmatic children in Medicaid and privately insured children for the same period. Thus, comprehensive concurrent information regarding Medicaid and commercial insurance related to asthma and relevant recent trends in health care utilization were needed.

Therefore, the results of our present study provide a unique insight to clinicians, policymakers and health service researchers with regards to examining policies related to coverage of essential medications in indigent children with chronic disease. It could also help in differentiating among medication outcomes and healthcare

utilization with respect to different payment mechanisms or health plans in children with asthma. This in turn can help understand the important factors that impact health care financing, design strategies to improve asthma related care, and improve health outcomes for needy and poor children.

1.3 Study Objectives and Hypothesis

The following objectives and hypothesis were addressed in the three manuscripts which will be elaborated in the Chapters 4, 5 and 6, respectively. Based on preliminary studies and the literature review, the specific objectives of this study were:

Objective 1: To determine the factors that may predict the prescribing of controller medications in the pharmacotherapeutic management of asthma under the financial incentive from P4P

H_1: Financial incentives under the Capitated health plans will be associated with more prescribing of controller medication compared to FFS plans in the asthmatic children of Ambulatory care (Manuscript #1)

Objective 2: To determine the association between medication adherence and healthcare utilization in asthmatic Medicaid children controlling for other covariates.

H_2: There will be difference in the patient characteristics between the type of health plan (Capitated vs. FFS) in the asthmatic children (Manuscript #2)

H_{2a}: Higher medication adherence will be associated with the lower likelihood of Healthcare utilization in the asthmatic children in Medicaid (Manuscript #2)

H_{2b}: Capitated health plans will be associated with the decreased likelihood of Healthcare utilizations such as hospitalization and emergency department visit compared to FFS plans in the asthmatic children in Medicaid (Manuscript #2)

H_{2c}: Capitated health plans will be associated with the higher medication adherence compared to FFS plans in the asthmatic children in Medicaid (Manuscript #2)

Objective 3: To examine association between type of health plan and healthcare costs controlling for medication adherence, demographic, and other covariates

H_3: There will be different healthcare costs between the types of health plan (Capitated vs. FFS) in the asthmatic children (Manuscript #2)

Objective 4: To examine the likelihood of an inpatient hospitalization due to asthma between publicly insured pediatric patients and privately insured patients from MarketScan Claims

H_4: The likelihood of an inpatient hospitalization due to asthma is higher among publicly insured pediatric patients than a privately insured patient all else being equal (Manuscript #3)

Objective 5: To examine the likelihood of an emergency department encounter due to asthma between publicly insured pediatric patients and privately insured patients from MarketScan Claims

H_5: The likelihood of an emergency department encounter due to asthma is higher among publicly insured pediatric patients than a privately insured patients all else being

equal (Manuscript #3)

Objective 6: To examine association between likelihood of health plan and healthcare costs adjusting for medication adherence, demographic, and other covariates

H_6: There will be different healthcare costs between the types of health plan (Private vs. Public) in the asthmatic children (Manuscript #3)

CHAPTER 2

LITERATURE REVIEW

2.1 Prevalence of Asthma in U.S.

Asthma is a chronic respiratory disease characterized by episodes or attacks of inflammation and narrowing of small airways in respiratory system. Asthma attacks can vary from mild to life-threatening and may involve shortness of breath, coughing, wheezing, chest pains or tightness, or a combination of these symptoms. Many factors like allergens, infections, exercise, abrupt changes in the weather, or exposure to airway irritants, such as a tobacco smoke can trigger an asthma attack (NCHS, 2005).

Some of the most established measures of prevalence of asthma are Center for Diseases Control's (CDC) Behavioral Risk Factor Surveillance Survey (BRFSS) and the National Health Interview Survey (NHIS) (CDC 2007; NCHS 2005). These surveys have the usual limitations associated with self-reported data like non-response bias, and low precision for state and sub-state estimates associated with surveys that used multistage sample selection with the goal of developing national estimates. Additionally, the BRFSS only surveys adults, and the NHIS have a relatively small sample of children that precludes state level estimation. A change in NHIS questionnaire language in 1997 concerning asthma prevalence made comparisons to periods before and after that date problematic. Given these limitations, estimates of the lifetime prevalence of asthma

among adults have ranged from 10-12% over the past 6 years while current asthma for adults is generally reported at approximately 7-8% (Mannino 2002). National estimates suggest that lifetime asthma prevalence for children less than 18 was approximately 12.5% with age specific prevalence of 7.5, 14, and 14.7 percent for children aged 0-4, 5-11, and 12-17 respectively (CDC 2005).

Another source for asthma prevalence data are local studies and surveys. These studies sometimes reported prevalence levels quite different from national estimates. For example, school-based studies of asthma in poor, low-income neighborhoods, reported life-time and 12-month prevalence as high as 24% of the student population (Andersen and Andersen 2005; Mvula et al. 2005). These large differences were probably due to the population studied and questionnaire design.

Finally, administrative claims data have also been used to estimate prevalence of pediatric asthma. This source has the advantage of being available for state and sub-state geographies, specific populations of interest (e.g., Medicaid), and was usually free or inexpensive to obtain (Andersen and Andersen 2005; Buescher and Jones-Vessey 1999; Dombkowski 2005; Gillespie 2002; Lynd 2002; Macy et al. 2005; Piecoro 1999; Twiggs et al. 2002). Administrative claims data can be difficult to use and sometimes may not accurately reflect underlying clinical diagnosis condition (Piecoro 1999; Twiggs et al. 2002). It may also not accurately reflect the population characteristics of the state or sub-state geography of interest. For example, Medicaid data may reflect benefit utilization only by less affluent population and commercial health insurance policies may only reflect utilization by families with working age adults insured through their employers.

In spite of these limitations, claims data (particularly Medicaid claims and encounter data) are used frequently to assess asthma prevalence and to monitor utilization-based measures of quality. Asthma prevalence in pediatric Medicaid populations have been reported to range from 1.4 to 14.9% depending on the case definition of asthma, the age of the children, and whether the Medicaid plan was of the Fee-for-Service, Health Maintenance Organization, or Primary Care Case Management type ((Buescher and Jones-Vessey 1999; Dombkowski 2005; Lynd 2002; Piecoro 1999; Schatz et al. 2005; Smith, Rascati, and Barner 2005).

2.2 Economic Burden of Asthma in the US Population

The economic burden related to asthma is one of the highest when compared to other chronic conditions. Asthma medications share a majority of this burden contributing to almost 38%–89% of the total costs (Accordini et al. 2006; Çelik et al. 2004; Cisternas et al. 2003; Gendo et al. 2003; Godard 2002; Jansson et al. 2007; Serra-Batlles 1998; Ungar 1998; Ungar and Coyte 2001). When the asthmatic pediatric and adult populations were compared, the cost of asthma medications for children was higher ($382.09 or 41.3% of total direct cost) and the cost of hospital care was higher in adults ($928.28 or 46.5% of total direct cost) (Szilagyi 2000).

Besides medications and hospital care, disease severity is another factor that contributes towards estimation of asthma economic burden. The cost distribution in asthmatic patients varies greatly with disease severity. A one year study showed that asthma patients with exacerbations shouldered 70% in medication costs and 10% in

hospital costs. On the other hand, asthma patients with exacerbations shouldered 28% in medication costs and 63% in hospital costs (Schwenkglenks et al. 2003). Asthma care behavior and asthma related costs varied with regards to differences in the perspective of patients, society and the government in a particular nation. In some studies looking at the asthma related costs, it was found that hospital costs comprised the highest proportion of asthma costs in adults when analyzed from a societal perspective (Jansson et al. 2007; Johnson and Dinakar 2010) and in children when analyzed from a societal and government perspective respectively (Ungar 2008). However, when the same studies looked at asthma related costs from patient's perspective, medication costs comprised to be the highest contributing factor (Ungar 2008).

2.3 Treatment Guidelines in Asthma

Pediatric asthma was associated with a heavy burden of morbidity in the US. In order to reduce this morbidity, there are evidence based guidelines in place for treating pediatric asthma. These guidelines have been made by the National Asthma Education and Prevention Program (NAEPP) in coordination with the National Heart, Lung, and Blood Institute (NHLBI) (National Asthma Education and Prevention Program, 2002). These asthma guidelines were a result of efforts of several researchers belonging to various clinical, academic, and governmental organizations. These guidelines were based on updated and most recent evidence available in the field (National Asthma Education and Prevention Program, 2002). The NAEPP was first established in 1989 and the first set of guidelines were released in 1991 (Williams et al., 2003). Later in 1997 and 2002,

two expert panel reports were released (National Asthma Education and Prevention Program, 1997b; National Asthma Education and Prevention Program, 2002). The guidelines were classified into different components of care: 1) assessing and monitoring; 2) controlling factors leading to asthma; 3) pharmacotherapy; and 4) education for building partnerships to deliver care. Each of the components was linked to clinical activities and other activities associated with the NAEPP guidelines as listed in Table 2.1 Components of Care, Key Clinical Activities, and Action Steps. However the asthma guidelines were designed for long term asthma care as opposed to acute asthma care generally seen in ED patients or inpatients. Table 2.1 presents a summary of the four components of care with associated clinical activities (Williams et al., 2003).

Table 2.1 Components of Care, Key Clinical Activities, and Action Steps

Components of Care	**Key Clinical Activities**	**Action steps**
Assessment and monitoring	Establish asthma diagnosis	Establish a pattern of symptoms and history of recurrent episodes
		Document reversible airflow using spirometry
		Rule out other conditions
	Classify severity of asthma	Follow the NAEPP* classification system and recheck at every visit
	Schedule routine follow-up care	See patients at least every 1-6 months according to severity
		Perform spirometry at least every 1-2 years for the stable patient, more often for the unstable patient
		Review medication use, care plan and self-management skills at every visit
	Assess for referral to specialty care	Refer to specialty care when referral criteria are met
Control of factors	Recommend	Determine exposures and sensitivities,

contributing to asthma severity	measures to control asthma triggers	including environmental and occupational triggers
		Review ways to reduce exposure to allergens and irritants that provoke asthma symptoms
		Discuss smoking avoidance with every patient who smokes or who is exposed to environmental tobacco smoke
		Assess for EIB* if symptoms occur during exercise, and provide medication and advice to enable physical activity
	Treat or prevent comorbid conditions	Consider, particularly, rhinitis, sinusitis, GERD*, COPD*
		Provide annual influenza vaccination for patients with persistent asthma
Pharmacotherapy	Prescribe medications according to severity	Reduce inflammation in patients with persistent asthma with anti-inflammatory medications
		Increase medications if necessary; decrease when possible
		Provide appropriate medication delivery and monitoring devices
		Recommend spacers, nebulizers, or both if needed and consider PFM* for patient with moderate to severe asthma or a history of severe exacerbations
	Monitor use of Beta 2 – agonist drugs	Reevaluate patients using more than one canister per month of short-acting beta 2 – agonist drug
Education for partnership in care	Develop a written asthma management plan	Agree on therapy goals
		Outline daily treatment and monitoring measures
		Prepare an action plan to handle worsening symptoms/exacerbations
	Provide routine education on patient self-management	Teach/review
		How and why to take long-term control and

		quick-relief medications
		Correct technique for inhaler, spacer, PFM*, and nebulizer as indicated
		Peak flow/symptom monitoring with patients when appropriate
		Factors that worsen asthma and actions to take
Acronyms: NAEPP National Asthma Education and Prevention Program; EIB exercise induced bronchoconstriction; GERD gastroesophageal reflux disease; COPD chronic obstructive pulmonary disease; PFM peak flow meter.		

Asthma treatment guidelines have been developed to measure the proposed outcomes of the MC industry (National Committee for Quality Assurance, 2000) as well as in concordance with the goals of Health People 2010, and the U.S. Department of Health and Human Services (DHHS) strategic plan for asthma (US Department of Health and Human Services, 2000; Williams et al., 2003; US Department of Health and Human Services Office of the Assistant Secretary for Planning, 2000).

2.4 Pharmacotherapy in Asthma

Therapeutic asthma drugs are summarized into four major types: 1) Bronchodilators, 2) Corticosteroids, 3) immunotherapy, and 4) anti-IgE antibodies in Table 4. Bronchodilators are available in long and short-acting formulations for opening constricted airways. They are also called rescue or reliever drugs. Corticosteroids are anti-inflammatory drugs that aid in preventing or decreasing the frequency of asthma attacks. They are also called controller drugs. Immunotherapy consists of allergy desensitization injections for desensitizing the body to allergens and anti-IgE monoclonal antibodies that prevent the immune system from attacking the allergens. Among all the

therapeutic asthma drugs, corticosteroids are the most effective for treating asthma (Mayo Clinic Staff, 2006). These therapeutic classes maybe used separately or in combination depending on the desired action. For example, reliever drugs provide quick relief whereas controller drugs provide long-term control in asthma. Also, many of the therapeutic drugs have different therapeutic classes and are available in different formulations like oral, inhaled, injectables and intravenous preparations. The dosage of the drugs is determined based on patient age and severity of the condition. Controller medications with their common names are summarized in Table 2.2.

Table 2.2 Controller Therapeutic Drugs by Class and Common Name

Therapeutic Class	Common Names			
Combination Inhalers (ICA/LABA)	Fluticasone Salmeterol	Budesonide Formoterol		
Inhaled Corticosteroid (ICS)	Beclomethasone CFC Beclomethasone HFA	Budesonide DPI	Flunisolide	Fluticasone
Inhaled Corticosteroid (ICS)	Mometasone	Triamcinolone Acetonide	Ciclesonide	
Leukotriene Modifiers	Montelukast	Zafirlukast	Zileuton	Pranlukast
Mast Cell Stabilizers	Cromolyn, Sodium Cromoglycate	Nedocromil /cromones		
Immunomodulators	Omalizumab	Anti-IgE		
Methylxanthines	Theophylline			
Systemic Corticosteroids (Tablet or Syrup)	Methylprednisolone	Prednisolone	Prednisone	Hydrocortisone
Theophylline SR				

Asthma reliever drugs and their common names appear in Table 2.3 (Mayo Clinic Staff, 2006).

Table 2.3 Reliever Therapeutic Drugs by Class and Common Name

Short-Acting Beta-2 Agonists (SABA)	Anticholinergics	Short-Acting Theophylline
Albuterol /Salbutamol	Ipratropium	Aminophylline
Pirbuterol	Ipratropium with Albuterol	
Bitolterol	Ipratropium bromide	
Fenoterol	Oxitropium bromide	
Levalbuterol		
Metaproterenol		
Terbutaline		
Epinephrine/adrenaline		

Stepwise treatment guidelines suggest that asthma attacks or triggers like exercise that lead to an asthma attack can be treated using a short-acting bronchodilator. In case of mild intermittent asthma characterized by severe but infrequent asthma attacks, the use of systemic corticosteroids along with short-acting bronchodilators is recommended. Increased use of reliever drugs such as short-acting beta2- agonists for more than 2 times a week or use more than 1 canister every month characterizes poorly controlled asthma (National Asthma Education and Prevention Program, 2002). Success of a proper asthma control program is associated with the appropriate use of reliever and controller asthma medications (Finkelstein 2002; Georgiou et al. 2003; Schatz et al. 2005; Schatz 2004; Simpson et al. 2004; Stanley J 2010).

The next step includes recommendations for utilization of inhaled corticosteroids (ICS) only or along with long-acting bronchodilator drugs based on disease severity and the desired level of asthma control to be achieved. Many previous studies have provided evidence of reduction in an ED visit or IP stay due to the use of ICS drugs (Agertoft and Pedersen 2000; Hoekstra 2004; Jadad et al. 2000).

Overall the 27 asthma recommendations and guidelines could potentially lead to numerous physician responses while treating asthma. Some of the physician behaviors which are part of important clinical activities are summarized as follows: 1) accurately diagnosing and assessing asthma based on its severity, 2) recommending follow up on regular basis for evaluating disease condition, 3) providing complicated asthma self-management information to children and care givers, 4) suggesting specialist referrals whenever necessary, 5) provide influenza vaccination, and 6) provide hand written asthma management plans as a resource for care givers and school personnel. On an average, a physician spent about 15 minutes with the patient (Mechanic 2001; Mechanic, McAlpine, and Rosenthal 2001; Østbye et al. 2005). In primary care, provision of all the necessary preventive care to the patients could amount to as much as 7.4 hours of advice per day to be delivered by the physician (Yarnall et al. 2003). Absence of medication adherence from many preventive care efforts is evident in the fact that counseling related to adherence can increase the amount of efforts on the part of the physicians (Stevens, Sharma, and Kesten 2003).

Previous studies have shown that physicians fail to follow the NAEPP recommendations (Ma and Stafford 2003; Piecoro 2001; Stafford et al. 2003). Many potential problems such as large physician case loads, failure to keep up with the latest guidelines, lack of incentives for educating patients, fear of potential adverse drug events, hassles posed by insurance companies to obtain expensive drugs and devices for the patients might be responsible for failure to follow asthma guidelines. Besides these issues, many physicians feel trapped in a healthcare system that believes more in the delivery of acute care rather than long term care for chronic disease management. Many practicing

physicians also faced the problem of "clinical inertia" characterized by lack of efforts to change existent systems or prevalent practice norms (Bodenheimer 2002; Phillips et al. 2001; Wagner 2001; Ziemer 2005).

2.5 Managed Care

According to the 106th US Congress, policy actions at multiple levels will be required within the social and health systems to effectively deal with issues related to asthma. The Public Health Services Act was amended by the Health Act of 2002 to include more preventive and healthcare services associated with asthma. The amendments also allowed for compilation of data and allowed NAEPP to recommend national coordination of asthma activities to the Congress (NHLBI, 2005). In 2002, absence of healthcare coverage was witnessed in about 4.3 million or 10.7% children (NCHS 2005). At the national level, about 63.9% children have private health insurance or any other healthcare coverage as a result of the employer-sponsored group health insurance. Low income children are mostly covered by State Children's Health Insurance Program (SCHIP) and Medicaid. Medicaid provides coverage to about 1 in every 5 children (about 20%) and SCHIP provides coverage to about 40% of poor children respectively (NCHS, 2004). SCHIP mostly provides free healthcare assistance without any copayments to children who are ineligible for Medical Assistance (Medicaid), private insurance and who fall within the SCHIP income guidelines. The income guidelines are relative to family size and change every year. Children aged 1-19 years below 200 % federal poverty level are eligible for free physician visits, vaccination,

surgical procedures, dental procedures, mental health services, preventive healthcare services, prescription drugs, hospital visits and stays.

There are numerous ways to describe managed care. The comprehensive definition of managed care includes strategies to control costs and amount of health care services rendered to the insured population. It also aims to improve administrative efficiency and deliver appropriate care. Managed care involved contractual agreement between the patient, the primary care physician and the health plan in order to provide medical care to the patients and ensure their proper medical management (Drake 1997; Miller and Luft 1994b; Torrens and Williams 1999).

Along with containing costs, managed care promotes preventive care for controlling healthcare expenditures associated with delivery of healthcare services. Medicaid managed care in particular, can play an important role for providing a medical home, continuous care, improved quality and quantity of care to beneficiaries who experience fragmented and uncoordinated care while they were undergoing treatment for chronic conditions like asthma (Christakis 2001; Lara et al. 2003; Lieu 2004; Mansour 2000).

Managed care was initiated by health maintenance organizations (HMOs) in 1970s. HMOs can be categorized based on organizational characteristics namely, 1) staff, 2) group, 3) network, or 4) independent practice association (IPA) models. Some of the widely used managed care practices include: 1) risk sharing by both the providers and insurers, 2) use of capitation or global ceiling to cover medical expenditures, 3) use of primary gatekeepers to constrain costs, 4) drug utilization review, and 5) limiting the

number of specialists the patients can choose from (Draper, Hurley, and Short 2004; Hurley, Strunk, and White 2004).

In order to reduce healthcare expenditures, managed care companies emphasize preventive care, and reduction of future expenditures. Risk sharing and capitation in case of physicians aid in supporting the managed care viewpoint of improving efficiency of the private enterprises and free market forces to curtail increasing healthcare expenditures. Managed care backlash from providers and patients in 1990s reduced capitated contracts due to a flourishing economy and lower healthcare price inflation (Hughes et al. 2004; Payne et al. 2000).

2.6 Managed Care Performance

Miller and Luft wrote many articles from 1993 to 2002 assessing the MC industry performance since its inception (Miller and Luft 1993; Miller and Luft 1994a, 1994b; Miller and Luft 1997, 2002). The authors reviewed the impact of MC plans on healthcare utilization and medical care, role of quality of care in HMO and FFS indemnity plans and the different types of MC designs. These reviews showed that HMO enrollees used less and cheaper resources with a focus on preventive services. This evidence was not surprising since the basis of HMO was cost containment even though it was achieved at the cost of restricted access to care and patient satisfaction. The researchers did not find evidence of lower quality of care offered by HMOs in the reviewed literature since examine studies had several shortcomings such as use of self-reported data only, shorter study duration, small sample size, insufficient data on care rendered to children and data

aggregated to the plan level. The researchers also could not control for characteristics related to patients, providers, market, and neighborhood while providing medical care ((Miller and Luft 1993; Miller and Luft 1994a, 1994b; Miller and Luft 1997, 2002).

2.7 Pay for performance measures in managed care (P4P)

There has been a strong interest in P4P reimbursement programs coupled with a hefty dose of optimism among policymakers and health care payers. However, there is little published research on the actual impact of P4P. At the heart of the P4P debate is whether to reward hospitals and other providers according the achievement of a predetermined level of performance or according to improvement in quality measures (Rodriguez et al. 2009; Rosenthal 2005, 2006). Both types of P4P programs had their critics. Some worry that hospitals that had historically performed above a target level will have no incentive to improve if they are able to receive the bonus simply for maintaining a status quo (Doran 2008, 2011; Rosenthal 2005, 2006). Others felt that paying for improvement may fail to reward those hospitals for whom improvement was likely to be more difficult because of their historically high baseline performance (Doran 2008, 2011; Rosenthal 2005, 2006). Within this type of the climate, Rosenthal and colleagues studied a P4P experiment conducted within PacifiCare Health Systems. This P4P plan paid a bonus for each fixed performance target met. Not surprisingly, they found that providers with initially low baseline performance improved the most; however, providers whose performance was already above the performance threshold captured the majority of the bonus money since payment was based on performance and not improvement (Mullen

2010; Rodriguez et al. 2009; Rosenthal 2005, 2006). They concluded that a P4P program with a common, fixed performance targets may produce little gain in quality for the money spent and will largely reward those providers with a higher baseline performance (Mullen 2010; Rodriguez et al. 2009; Rosenthal 2005, 2006).

P4P is a plan where financial incentives are given to healthcare providers for the provision of high quality of patient care. The American Medical Association (AMA) defined P4P as "a method of linking pay to a measure of individual, group, or organizational performance, based on an appraisal system. These types of bonus incentive schemes are based on the idea that work output, determined by some kind of measuring system, varies according to effort and that the prospect of increased pay will motivate improved performance (AMA, 2005)." There are three methodologies for P4P programs: competitive bonus payment; payment at risk; and quality tiered networks. Competitive bonus payments are awarded to top performers in a group of providers and bottom performer may or may not receive less compensation. In payment at risk models, a percentage of revenue is withheld by the payer until a review of quality scores is conducted. Providers who do not meet quality targets lost the percentage at risk. In quality-tiered networks, patients are incentivized to select high quality providers by offering discounted co-payments. Patients who prefer lower scoring hospitals on quality measures must pay higher co-payments (Clinical Advisory Board, 2005). Reimbursement is allocated based on providers' scores on specific quality measures as identified by the particular P4P program.

P4P focuses more on preventive care and where the gains are maximum. As examines previously, encouraging medication therapy for controlling asthma in children

as a part of P4P could be cost effective in the long run and also be associated with reductions in morbidity due to asthma. When one considers the types of performance measures for asthma care in P4P, one finds that financial incentives are given to those healthcare providers who provide high quality patient care. The four common types of performance measures that are used to measure quality of care: process measures, outcomes measures, structural measures and satisfaction measures (Johnson and Dinakar 2010). Among the four measures, P4P consisted of 2 main measures: process measures and outcome measures. Process measures consist of processes of care involving taking a history or prescribing medications like using inhaled corticosteroids for persistent asthma. On the other hand, outcomes measures consist of clinical results reflecting the actual health of patients. According to clinicians, process measures can be more controllable and attractive compared to outcomes measures. Factors like severity of illness, random events and adherence to therapy might affect the control of outcomes measures which make it challenging for the providers (Wachter et al. 2008; Werner et al. 2011).

2.8 Theory and Conceptual Framework

Eisenberg Model of Physician Decision Making

The Eisenberg model of physician decision making has been widely used to characterize physician decision making, physician prescribing and the sociological factors that influence physician decision making (Leffler 1981; Tamblyn et al. 2003). In this study, the Eisenberg model will be used to study the sociological factors that influence physician's behavior concerning the adoption of financial incentives and

prescription of anti-asthma medication. The factors that influence physician behavior are: (1) physician characteristics (e.g. age, gender, race, specialty); (2) patient characteristics (e.g. age, gender, race, educational level, insurance status, income); (3) physician's relationship with the health care system (e.g. practice setting, ownership); and (4) physician's relationship with the patient (e.g. patient demand, patient presentation of symptoms) (Eisenberg 1979). Studies have also shown that these 4 factors influence physician prescribing (Bradley and Bradley 1991; Gabe 1990). The influence of these four factors on physician decision making is illustrated in Figure 2.1 and described as follows:

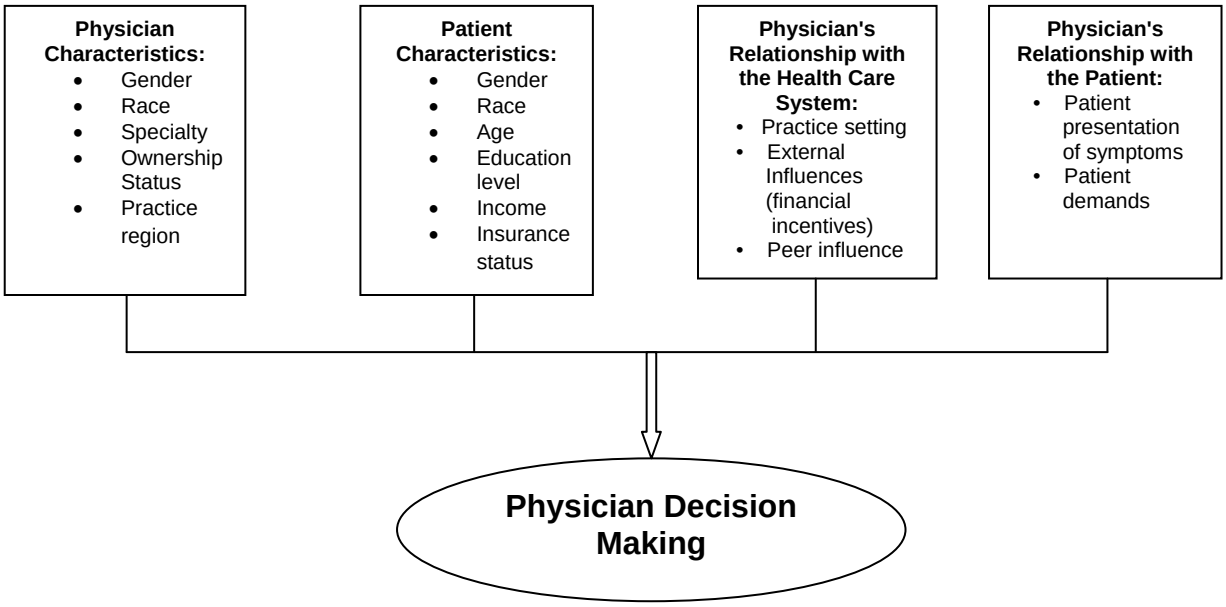

Figure 2.1 Eisenberg model of physician decision making

Physician characteristics: Various physician characteristics like their specialty, age, gender and personality influence their prescribing decisions. A study showed that specialty asthma physicians compared to non specialty physicians were 4.7 times more likely to prescribe LM agents and 3 times more likely to prescribe theophylline and inhaled steroids in adults respectively (Blanc 2003; Ma 2005). Another study by Janson, et al (2004) showed that specialty physicians have a higher likelihood of being aware about asthma guidelines, using spirometry to diagnose asthma, using peak flow monitoring for monitoring asthma and providing written asthma management plans to their asthma patients (Janson and Weiss 2004).

Patient characteristics: Physician's decision making concerning the diagnosis and treatment of the patient is influenced by patient's age, gender, educational level, insurance status and socioeconomic status. Another study using data from the 2002-2004 National Trauma Data Bank found that patients with lower socioeconomic status were being prescribed optimal care compared to their peers with a higher socioeconomic status (Mvula et al. 2005). Patient age also plays an important role in their medication management. A study conducted among Medicaid enrollees in Texas showed that emergency department visits and the rate of hospitalization is more than twice in pediatric patients compared to adults (Smith et al. 2005). There is some evidence of patient's insurance status affecting the quality of care received by them (Eisenberg 1979).

Physician's relationship with the health care system: According to the Eisenberg model, factors like advertising, pharmaceutical sales representatives, regulation, physician's practice setting and physician's interaction with other healthcare professionals can impact physician's prescribing behavior. A study showed that

physicians working for an HMO specifically for a Preferred Provider Organization (PPO) were less likely to prescribe LM agents to their patients compared to physicians working with other insurers (Blanc 2003). Another study looking at the asthma medication prescribing and healthcare utilization among pediatric population enrolled in Managed Care Organizations (MCOs) found that about less than 40% of the pediatric population was being prescribed controller medications compared to reliever medications (Donahue et al. 2000).

Physician's relationship with the patient: Physician patient interaction also influences decision making and physician prescribing. Patient's demands and symptom description might be different than physician's decision. A systematic review by Stewart in 1995 showed that a majority of the studies dated from 1983 to 1993 showed that effective patient physician interaction influenced physician's decision making which in turn led to better health outcomes (Stewart 1995). According to Eisenberg's model, patient physician interaction is classified into 3 categories: a) "activity passivity" where decisions are made primarily by physician and patients follow the decisions blindly, b) "guidance-cooperation" where the physician guides the patient and the patient accepts the physician's advice and c) "mutual-participation" where both the
patient and the physician participate and come to a mutual agreement (Eisenberg 1979).

Eisenberg's model includes different factors that influence physician decision making for prescribing anti-asthma medications. This model is also suitable for selecting independent variables for the study. Hence this model proves as a favorable choice for this study.

Aday-Anderson Model of Health Service Utilization

This conceptual idea resonates with a commonly used model proposed by Donabedian which posits that a complex set of underlying factors interact to impact health-related outcomes (Donabedian, 1974). In this study, applying this framework demonstrates that various factors (i.e., the structure) exert influence on the likelihood of anti-asthmatic medications' adherence (i.e., the process), which in turn impacts the risk of both all cause and asthma-related events and complications and associated resource use (i.e., the outcome).

The "structure" element of this conceptual model can further be subdivided into predisposing, enabling, and need-related factors. The predisposing factors include those variables that exist prior to the disease and which describe the propensity of individuals to use services. The enabling factors are the variables that indicate the resources that are available to the individuals so that they can make use of health services. The need based factors indicate the illness level or need for care received by the individual or the physician. In this study, predisposing factors will be included age, race and gender; enabling factors will be included health care system, treatment characteristics, and physician characteristics; and need factors will include asthma severity and asthma drug ratio. The asthma drug ratio is the ratio of the controller medication to total asthma medication. A higher asthma drug ratio is associated with less asthma related ED visits, better quality of care and better patient centered asthma outcomes (Schatz 2006). The "process" element of this framework is a measure of medication adherence. Finally, the "outcome" element will be included event and resource use parameters such as existence of likelihood of events, and healthcare utilization, all cause and asthma-related.

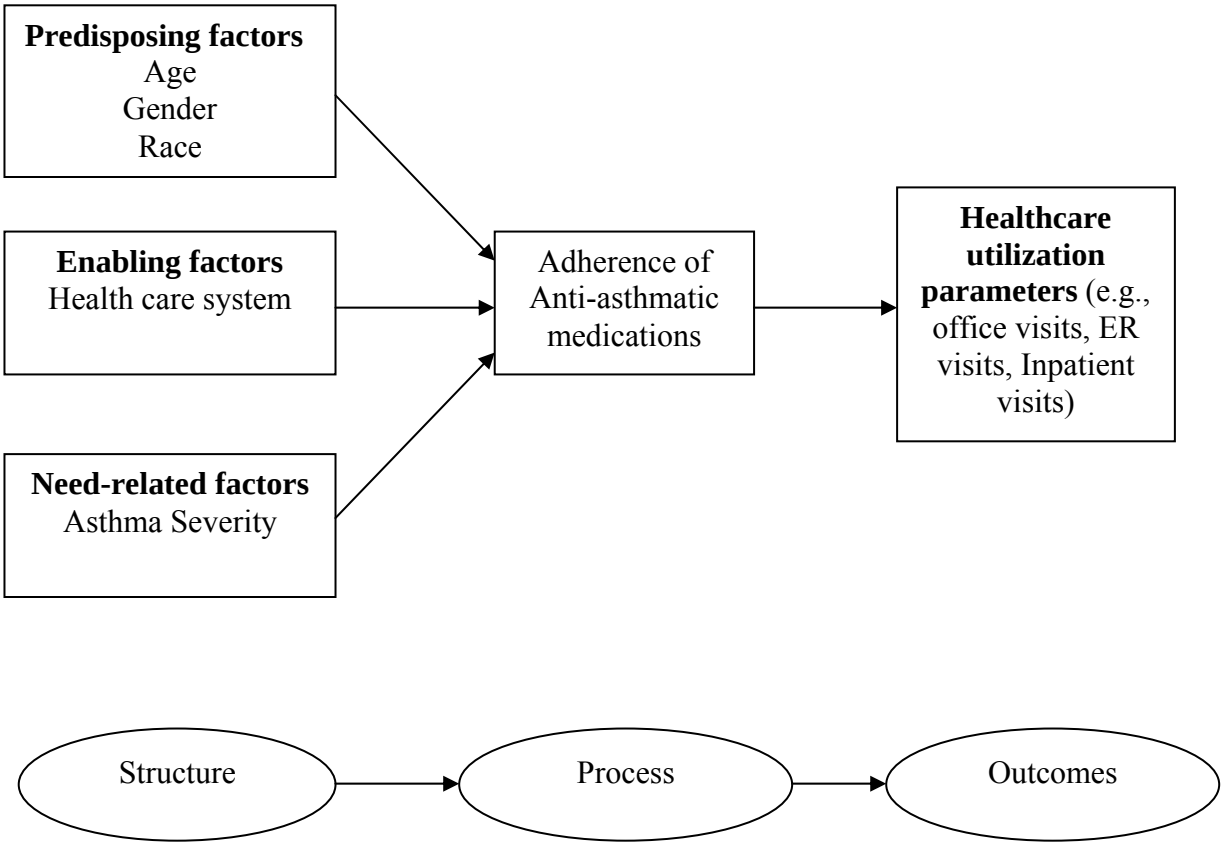

Figure 2.2 Aday-Anderson healthcare utilization model & SPO model

Proposed Conceptual Framework

To capture the physician prescribing behavior of anti-asthmatic medications and patient treatment choices, a proposed model of Eisenberg model of physician decision making as well as Anderson healthcare utilization model was proposed as a conceptual framework for this study which is shown as Figure 2.3

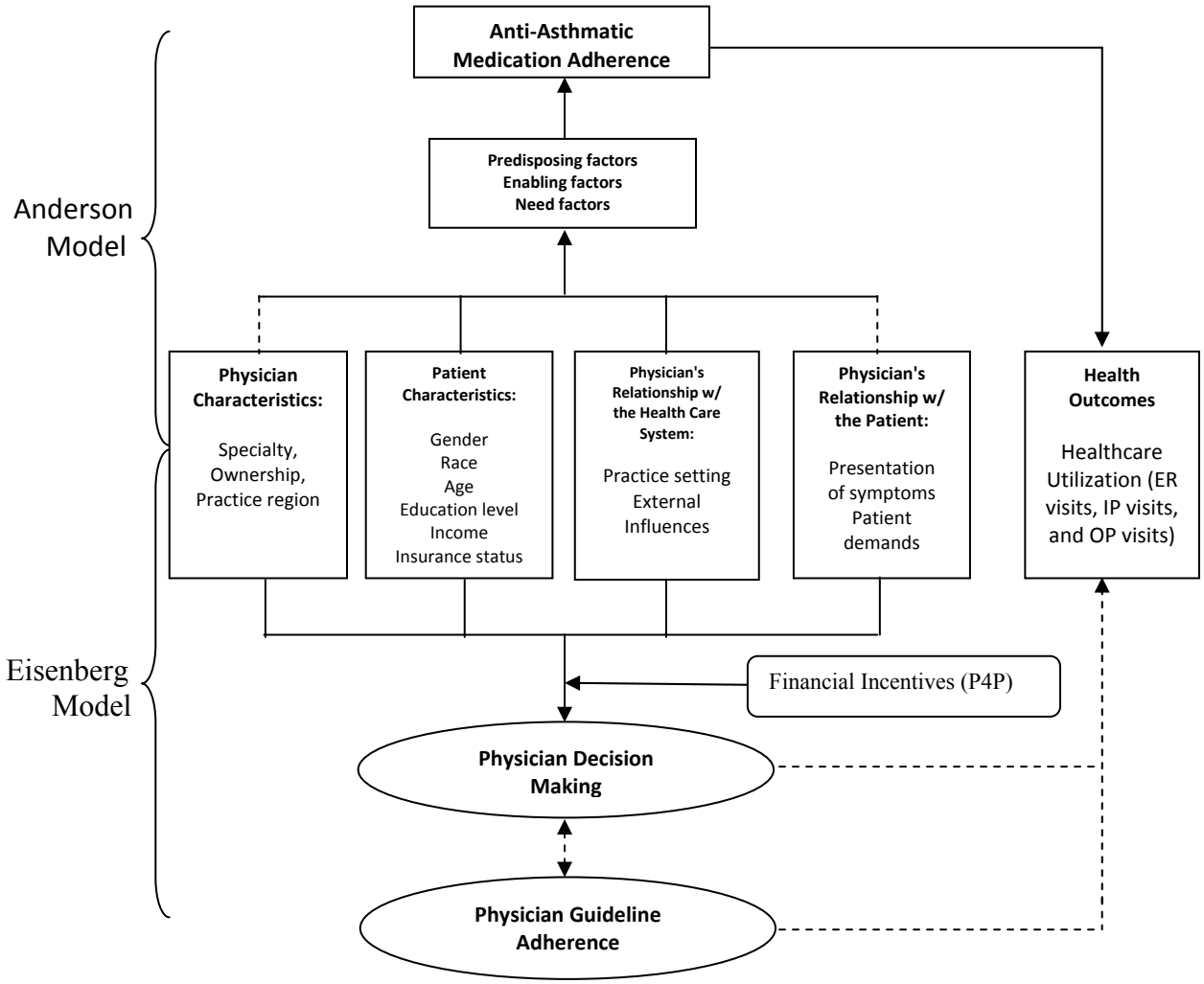

Figure 2.3 Proposed Conceptual model of this study

Note:

- The solid lines represents the associations this study attempted to address and the dashed lines imply an influencing effect that could not be directly measurable but had a strong theoretical association

The current study combined the tenets from the Anderson model and Eisenberg model. The concept of physician decision making about anti-asthma medication is based on the Eisenberg model and it is influenced by four sociological factors listed as follows:

patient characteristics, physician characteristics, health care system, and physician relationship with patients. The concept of children's medication adherence is based on the Anderson model and is considered to be influenced by predisposing, enabling, and need factors. The solid lines show associations that the proposed study addresses whereas the dashes show associations that indicate an influence rather than a direct impact on the outcome.

CHAPTER 3

RESEARCH METHODS

In this section, the statistical approaches that are implemented to investigate each objective of this study are described. All data management and analyses were performed using the SPSS® (version 15) and STATA® (version 10) statistical software packages.

3.1 Study Design

This study was a retrospective cross-sectional study which used the National Ambulatory Medical Care Survey (NAMCS) and MarketScan® Claims datasets. The first manuscript of this study aimed to disentangle physician's prescribing behavior for anti-asthmatic medications in asthmatic children, using logistic regression as well as the multinomial logistic regression model. The second manuscript of this study examined the impact of Medicaid payment system on healthcare utilization and medication adherence in asthmatic children enrollees, using quantile regression, logistic regression, and count regression models. The third manuscript of this study is compared health outcomes for Medicaid and privately insured children in a commercial insurance plan, using quantile regression, logistic regression, and count regression models. The NAMCS and MarketScan® claims datasets, study sample eligibility criteria, measures and the econometric models are introduced in the following sections.

3.2 Data Sources

National Ambulatory Medical Care Survey (NAMCS)

The first manuscript used the National Ambulatory Medical Care Survey (NAMCS) to study the impact of P4P based financial incentives on medication prescribing behavior of anti-asthmatic medications. The NAMCS is a national probability sample survey conducted by the Division of Health Care Statistics of the National Center for Health Statistics (NCHS) and the Centers for Disease Control and Prevention (CDC). The data for NAMCS has been archived on an annual basis for the years 1973-1981, for 1985 and from 1989-present. The sampling frame consists of records of physician names preserved by the American Medical Association and the American Osteopathic Association comprises the NAMCS data. The study involves visits to non-federally employed office-based physicians providing direct patient care and belonging to all specialties except anesthesiology, radiology, and pathology.

Data for the NAMCS is collected using a three-stage probability sampling design. The initial or the first probability sample is taken from primary sampling units (PSUs) (n=112 PSUs). These PSUs consists information on counties, county groups, towns, townships and county equivalents. The second stage probability sample involves data based on physicians' working within each of the PSUs whose data is archived in the master files. The third stage probability sample includes a random sampling of visits to physician offices. The reporting period for each physician lasts about a week whereby either the physician or any office staff of physician collects information about patient's

socio demographics, specialty of physician, reasons for physician visit, method of payment for the physician visit, patient symptoms, diagnosis of patient symptoms, complaints made by the patients, drugs prescribed by the physicians, first time or regular visit, preventive and therapeutic care provided of recommended. The encounter between physician and patient or outpatient visit comprises the basic sampling unit in the NAMCS database. In order to calculate national estimates, each data record is inflated using an inflation factor known as the patient visit weight. This weight helps researchers to determine the overall office visits that took place in US. There might be some sampling variability observed. However, an estimate is deemed reliable by NCHS standards if the relative sampling error is less than 30% of the estimate.

MarketScan® Medicaid/Employer sponsored Claims

The second and third manuscripts of this study (Chapter 5 & 6) use the MarketScan® Medicaid/employer-sponsored claims dataset licensed from Thomson-Reuters. It consists of data from 8 different states of varying size and dispersed all across the U.S (MarketScan® research database, 2008). The states are de-identified. However, the data consist of at least one state from each U.S. region. The database consists of medical (outpatient and inpatient services), drug, and long-term care claims and eligibility records for enrollees from these states. The prescription drug coverage was provided by all the states. The data are available from 2003 to 2007 representing around 7.4 million individuals in the United States (MarketScan® research database, 2008). For the purposes of this study, the Medicaid/Commercial database are updated and queried from January 1, 2005 to December 31, 2007. The database is HIPPA compliant and

features encrypted member and service provider identification numbers. The data from these states will provide a fairly large sample of the Medicaid/employer-sponsored enrollees in the U.S. The dataset also provides additional information on variables such as race/ethnicity, Medicare eligibility and Medicaid eligibility / federal aid category.

3.3 Study Population

For the first manuscript of this study, the study sample of the first manuscript were children with a primary diagnosis of asthma (ICD-9 code 493.XX) and the mentioned of the word 'asthma' in the office visit. There were age restrictions (less than 18 years old) for the target population but patients with co-morbid conditions that could confound study findings were excluded from the analysis.

For the remaining manuscripts of this study, the study population comprised of children aged 0 to 18 years of age. The patients with a diagnosis of asthma and a prescription of a new asthma medication (Inhaled Bronchodilator, Anti-Inflammatory, Systematic Bronchodilator, Systematic Corticosteroid and/or Leukotriene Modifiers) during the study time period were included. Subjects with a primary or secondary diagnosis of asthma were identified using the International Classification of Diseases Code 9th Revision (ICD-9: 493.XX) from the inpatient claims during the study test period. Only subjects who maintained continuous eligibility for 1 year period between January 1, 2005 and December 31, 2005 were included in the study. The date for the first prescription claim for anti-asthmatic medication use was designated as an index date, where the medication was identified using relevant National Drug Codes (NDC) recorded

in the claim records. Drug manufacturers provide the Food and Drug Administration (FDA) information about all the drugs manufactured, prepared, propagated, compounded, or processed by them which are to be distributed for commercial purposes. Each drug is identified using a specific 10 digit, three-segment number which is the National Drug Code (NDC). The NDC is a universal measure of identifying labeler, product, and trade package size of the drugs available for human consumption. The labeler code of the drug is the first segment of the NDC. It assigned by the FDA, indicates the firm that manufactures or repackages or re-labels or distributes (under its own name) the drug. The product code is the second segment of the NDC. It is assigned by the firm and it identifies the strength, dosage form, and formulation of the drug. The package code is the third segment of NDC. It is assigned by the firm and it identifies the package sizes and types. The annual consumption of the anti-asthmatic medications was defined as the claims received for each specific prescription identified using the NDC. (FDA 2012) The study required all patients to have continuous health plan enrollment for at least 1 year prior to and following their index date by insuring that each patient's index date presents a reasonable marker for treatment initiation as well as making sure that any observed lack of health care events is due to a lack of medical activity and not due to cessation of insurance. The identification period ranged from January 1, 2006 to December 31, 2007. During this time period, any patients who had an asthma diagnosis and who were prescribed an anti-asthmatic medication were included.

3.4 Covariates and Measures

Categories of Anti-asthmatic medications

The primary dependent variable for the first manuscript were the different asthma drug classes classified under the broad categories of controller versus reliever medications used in the management of asthma. These drugs are classified on the basis of their role in the management of asthma and fall into the general categories listed in Table 3.1. Based on the nature of the NAMCS dataset, it was difficult to ascertain whether these medications are in the CM or the RM group. Based on clinical knowledge, we decided to place this category in the RM group.

Table 3.1 Drug Classes in the Pharmacotherapy of Asthma

Controller Medication (CM)	**Reliever Medication (RM)**
Inhaled Corticosteroids (ICS)	Short Acting Beta Agonist bronchodilators **(SABA)**
Oral Corticosteroids **(OC)**	Oral Corticosteroids **(OC)***
Long Acting Beta Agonist inhalers **(LABA)**	Oral Short Acting Beta Agonists **(OSABA)**
Leukotriene Modifiers **(LM)**	Oral Short Acting Xanthines **(OSAX)**
Inhaled Cromones **(CI)**	Anti-Cholinergic Bronchodilators **(ACB)**
Oral Long Acting beta Agonists **(OLABA)**	Combination of SABA and ACB **(BAACB)**
Oral Long Acting Xanthines **(OLAX)**	
Combination of LABA and ICS **(LABIC)**	

Notes: *The issue of the oral corticosteroid (OC) class in the analysis was complicated.

Measurement for the Manuscript 1

This study used the Eisenberg physician decision making model as the structural framework. According to this model, the physician decision making is influenced by four social factors: (1) physician characteristics; (2) patients characteristics; (3) physician as a part of the health care system; and (4) physician's relationship with the patient. All the above factors are described in details in the previous sections.

The dependent variables of the study were physician prescribing of anti asthmatic medication and the type of anti-asthmatic medication prescribed. The dependent variables were taken from the NAMCS prescription data and classified as per the prescribed medications listed in table 6. Manuscript 1 analyzed the impact of financial incentives on physician's medication prescribing behavior in outpatient asthmatic children. The socio demographic characteristics of the children included age, gender, race/ethnicity, and payment structure. The race/ethnicity was classified as Hispanic and non Hispanic. The payment structure was classified by method of payment (capitation/no capitation) and by percentage of financial incentives from P4P. All the measures of the in dependent variables are summarized in Table 3.2.

Table 3.2 Study covariates for Manuscript 1

1. Physician Characteristics Provider: Pediatrician Non-Pediatrician	**3. Physician's Relationship with the Health Care System** Ownership status: Owner of solo practice Owner of non-solo practice, Non-owner Geographic region of practice: Northeast, Midwest, South, West Metropolitan area: yes
2. Patient Characteristics Gender: male Age Race/ethnicity: White, Black, Hispanic, Other Capitated payment: yes Financial incentives: % of bonus	**4. Physician's Relationship with the patient** Patient seen before: yes Asthma is the primary diagnosis listed for the visit: yes

In the first manuscript of this study, the patient characteristics included age, gender, race/ethnicity, and payment structure. A patient's race/ethnicity was categorized as Hispanic and non-Hispanic (Whites, Blacks and others), Payment structure included method of payment (capitated or not) and the percentage of bonus incentives. One of the limitations of NAMCS is that it provides limited information about physician characteristics. Among physician characteristics, it includes the physician specialty categorized as pediatricians and non-pediatricians. Physician's relation with the healthcare system was characterized by his/her geographic location of practice (Northeast, Midwest, South and West, metropolitan and non metropolitan areas) and physician's ownership of practice (solo, non solo and non owner). Patient physician relationship was categorized by first or routine visit and if asthma was the primary cause of physician visit.

Measurement for the Manuscript 2 and 3

The operational definitions and measurements of the variables utilized in manuscript 2 and 3 are discussed in this section. The dependent variables for this study were medication adherence, hospitalizations, emergency room (ER) visits and asthma-related healthcare costs. The independent variables tested in this study were payment mechanisms (capitated vs. fee for service) and types of patient claims (Medicaid vs. Commercial plans). Other independent covariates included age, gender, access to specialty care, and disease severity. The operational definition of each variable is described in the following sections:

Medication adherence

Medication adherence was used to measure medication usage by patients. Medication adherence is basically the act of conforming to the physician's recommendations about the timing, dosage, and frequency of medication intake. The International Society of Pharmacoeconomics and Outcomes research defines medication adherence as the extent to which a patient complies with the intended dosing regimen (Hess 2006). The unit of measure for medication adherence is administered doses per defined period of time, reported as a proportion (%) of prescribed doses (D) taken at the prescribed time interval (T) as measured by the period of time.

Medication adherence can be measured directly and indirectly by utilizing biological markers, blood and urine assays, patient interviews, pill counts, prescription refills, and electronic monitoring (Claxton, Cramer, and Pierce 2001; Hess 2006). Since the study used an insurance claims database, prescription refill patterns were used to

capture medication adherence. The information thus obtained recorded the frequency and timeliness of refills of prescribed medication and eliminates any Hawthorne effect. Also pharmacy records had predictive validity as measures of cumulative exposure and gaps in medication supply (Steiner 1998). On the other hand the method also had some limitations like presence of data on unusual refill patterns, multiple conflicting drugs and inability to capture all data about patients visiting multiple pharmacies. Also utilization of pharmacy records assumed that "a prescription filled is a prescription taken" (Balkrishnan 2005). The data cannot measure actual consumption but only estimates about actual medication consumption (Hess 2006).

Working Definition of Medication adherence

Medication adherence in this study indicated patient's intake of anti-asthmatic prescription medication. Data from the pharmacy claims database can be used to measure medication adherence by several ways. Medication possession ratio (MPR) is one such measure used to calculate medication adherence. For the purposes of this study, MPR was calculated as the days of anti-asthmatic medication supply dispensed divided by the number of days in the observation period (#365) minus the number of days in the hospital (Camargo 2007; Hess 2006; Sokol et al. 2005). Previous studies have shown that medication adherence measurement for the entire study period which is 365 days in this study, when used as a denominator, predicts hospitalization and healthcare costs in a more appropriate manner compared to adherence measures considering the period between the first and last refill (Camargo 2007; Mattke et al. 2010). Medication adherence measures like MPR, proportion of days covered (PDC), Continuous

Medication Gap (CMG) and Continuous Multiple interval of Oversupply (CMIOS), Medication Refill Adherence (MRA) use the entire study period as a denominator. Also measures like Refill compliance rate (RCR), compliance rate (CR), and modified medication possession ratio (MPRm) which measure the period between the first and last refill lack a consistent denominator value while calculating adherence (Hess 2006). The above measures fail to account for early medication discontinuation, thereby overestimating adherence for patients stopping their medication intake when they should be taking it. Therefore, MPR for this study is defined as

MPR= # of days supply of anti-asthmatic medication in the post-index period / # of days in the study period (365 days).

# of days supply of anti-asthmatic medication in the post-index period indicates the supply of the dispensed anti-asthmatic medications will last. The Marketscan Medicaid database had claims for a 30 days supply of anti-asthmatic medications. The days supply was calculated by dividing the total amount of dispensed anti-asthmatic medications by the maximum amount of anti-asthmatic medications used in one day. The observation period in this study included the post-index period or 12 month follow up period which was consistent for each patient. The number of hospital days was subtracted from the denominator because any drug taken during this period was given to the patient by the hospital and was not possible to capture in the pharmacy records. The information on each filled prescription included of dispensing, quantity dispensed, and days supply of medication.

Healthcare Service Utilization

Patients were followed during pre-index and post-index period (i.e. 12 month before and 12 months after the index date) to assess their healthcare utilization in terms of hospitalizations, ER visits, outpatient visits. The variables hospitalizations, ER visits and outpatient visits are used as a proxy for health care service utilization. To identify hospitalization event in patients, their admission and discharge dates recorded in inpatient service files are used. CPT codes as well as service codes were taken from the inpatient and outpatient services files for identifying events of ER visit and outpatient visits.

Sociodemographic Vaiables

The following sociodemographic variables were taken from the data: gender, birth year and race/ethnicity. Gender of the patients was categorized into males and females. Birth year of the patients was used to calculate their age. Race or ethnicity of patients was classified as whites, blacks, Hispanics and others. The Medicaid dataset also had information about the health plan (capitated or fee for service) patients were enrolled in.

Medication/Therapy related variables

The National Drug Code (NDC) code was used for identifying anti asthmatic prescription medications. Besides anti asthmatic prescription medications, the total consumption of different prescription medications was also noted. The specialty of the physicians whom the patients visited (e.g. pediatrician, internal medicine, family practitioner/general practitioner) was also identified.

Proxy for Asthma Severity

Based on the established relation between disease severity and intensity of treatment, severity of a condition in the current period was inferred by a risk of an exacerbation in a future. Some of the independent predictors widely used in the literature for ascertaining future asthma-related emergency hospital utilization (EHU) are hospitalizations, use of emergency department and use of oral corticosteroids (Roth 2004; Schatz 2004). Severity of asthma in the current period was assessed by determining high risk of EHU. Risk stratification schemes were developed using pharmacy claims or facility claims or a combination of both. Combination of pharmacy and facility claims are more successful in stratifying risk compared to using pharmacy or facility claims single-handedly (Roth 2004; Schatz 2004).

A popular type of risk stratification scheme used is a simple three-level risk stratification which ranks risk of future Emergency Hospital Utilization (EHU) based on a point system applied to a period portraying current utilization. Points are assigned to different indicators of future asthma related EHU. Asthma hospitalizations or ED encounters in the 12-month base period are assigned 2 points, 15 or more beta-agonist canisters in the base period are assigned 1 point and 1 or more filled prescriptions for oral corticosteroids are assigned 1 point. Members are differentiated on the basis of assignment of points. Members with 2 or more points, 1 point and 0 point are classified as high risk, medium risk and low risk groups respectively (Schatz 2004). This has been summarized in the following Table 3.3.

Table 3.3 Three-Level Risk Stratification of Asthma Severity

Event per 12-month base period	Potential Point Assignment	Low Risk 0 Points	Medium Risk 1 Points	High Risk 2 or more Points
A. ED visits asthma encounter	2	0	0	2
B. IP visits asthma encounter	2	0	0	2
C. 15 or more beta-agonist canisters dispensed	1	0	1	1
D. Any oral corticosteroid prescriptions dispensed	1	0	1	1
Required events for risk level		No listed events	Either C or D	Either A or B and/or C and D

Therefore, the measurement of asthma severity is the probability of an asthmatic member having a risk score (severity proxy) of 0,1, or 2.

Type of Health Plans (FFS vs. Capitation)

The Medstat MarketScan® Medicaid database provided patient level indicator variable for the type of health plan enrolled for by each patient. Medicaid has classified plans into 2 groups (MarketScan® Medicaid database user guide, 2005):

1. Capitation: it represented capitated managed care plan where MCOs receive a fixed amount of payment per enrollee per month. All or some services offered by MCOs are paid on a capitated basis.

2. Fee-for-service (FFS): it indicated health plans that pay providers or physicians on the basis of services rendered. There is no incentive for the patient to use a particular list of providers. Coverage is handled by only one policy, with a deductible and coinsurance. The patient level variable is coded as 1 for capitation and 0 for FFS health plan.

Table 3.4 Analytical Framework and study covariates for manuscript 2 and 3

Target population: Children aged 0 to 18 years with a diagnosis of asthma receiving care in a Medicaid Setting and/or Commercial plan
Outcomes: Medication Possession Rate, and Healthcare services utilization (ER, IP & OP)
Regressor of interest: Health plans (FFS vs. Capitated) – for the manuscript #2 Health plans (Medicaid vs. Commercial) – for the manuscript #3
Covariates:
Patient Characteristics: Patient's age, gender, and race/ethnicity (Predisposing factors)
Patient's Medical Conditions: Asthma severity (Need factors)
Physician Characteristics: Specialty (Enabling factors)
Asthma drug ratio: A controller to total asthma medication ratio of 0.5 or more

3.5 Statistical Analysis Plans

Manuscript # 1: To assess the influence of P4P financial incentives on anti-asthmatic medication prescribing behavior using the National Ambulatory Medical Care Survey (NAMCS) for the year 2007. National estimates on asthma-related ambulatory were estimated using 'patient visit weight' provided in the NAMCS dataset. For the first manuscript, logistic models will be built. The followings are descriptions of the models for the first study:

$$\Pr [Y \text{ [Only Controller Medication prescribed]} = 0 \text{ or } 1]$$

$$= f [ß_0 + ß_1 \text{ (patient factors)} + ß_2 \text{ (physician factors)}$$

$+ ß_3$ (physician - health care system interaction factors)

$+ ß_4$ (physician - patient interaction factors)] + e

where $Y = 0$ if no controller medication is prescribed, $Y = 1$ if controller medication is prescribed; $f(\bullet)$ is the cumulative density function (CDF) of logistic distribution and e is the error term.

Pr [Y [Controller & Reliever Medications (both) prescribed] = 0 or 1]

$= f [ß_0 + ß_1$ (patient factors) $+ ß_2$ (physician factors)

$+ ß_3$ (physician - health care system interaction factors)

$+ ß_4$ (physician - patient interaction factors)] + e

where $Y = 0$ if no medication is prescribed, $Y = 1$ if both medications are prescribed; $f(\bullet)$ is the cumulative density function (CDF) of logistic distribution and e is the error term.

Pr [Y [Only Reliever Medication prescribed] = 0 or 1]

$= f [ß_0 + ß_1$ (patient factors) $+ ß_2$ (physician factors)

$+ ß_3$ (physician - health care system interaction factors)

$+ ß_4$ (physician - patient interaction factors)] + e

where $Y = 0$ if no reliever medication is prescribed, $Y = 1$ if reliever medication prescribed; $f(\bullet)$ is the cumulative density function (CDF) of logistic distribution and e is the error term.

Manuscript # 2: To examine the impact on health care utilization and medication adherence in asthmatic children Medicaid enrollees using the MarketScan® Medicaid Claims for the year 2007. The following is the description of the models for the second study:

MPR (anti-asthmatic medication adherence-quantile regression)

$$= ß_0 + ß_1 \text{ (patient predisposing factors)} + ß_2 \text{ (patient enabling factors)}$$
$$+ ß_3 \text{ (patient need factors)} + ß_4 \text{ (type of anti-asthmatic medication)}$$
$$+ ß_5 \text{ (Capitated vs. FFS)} + e$$

Where MPR stands for the medication possession ratio to measure anti-asthmatic medication adherence and e is the error term.

$$\Pr [Y \text{ [health care utilization]} = 0 \text{ or } 1]$$
$$= f [ß_0 + ß_1 \text{ (patient predisposing factors)} + ß_2 \text{ (patient enabling factors)}$$
$$+ ß_3 \text{ (patient need factors)} + ß_4 \text{ (type of anti-asthmatic medication)}$$
$$+ ß5 \text{ (MPR)} + ß6 \text{ (Capitated vs. FFS)}] + e$$

where $Y = 1$ if some specific health care is utilized and Y = 0 if not; $f(\bullet)$ is the cumulative density function (CDF) of logistic distribution and *e* is the error term.

Asthma-related healthcare utilization (a count variable, the number of visits)
$$= ß_0 + ß_1 \text{ (patient predisposing factors)} + ß_2 \text{ (patient enabling factors)}$$
$$+ ß_3 \text{ (patient need factors)} + ß_4 \text{ (type of anti-asthmatic medication)}$$
$$+ ß_5 \text{ (MPR)} + ß_6 \text{ (capitated vs. FFS)} + e$$

Where count model consists of poisson regression and negative binomial regression, e is the error term.

Manuscript # 3: To examine the health outcomes for Medicaid and privately insured children in a commercial insurance plan for the year 2007. Before the main outcomes were examined, differences across the two populations studied were tested using a Chow test (Lo, 1985). The Chow test examines whether a regression function is different for one group (Medicaid) versus another (Privately Insured). It can be thought of as simply testing for the joint significance of the dummy and its interactions with all other covariates, to determine if the two

datasets can be combined for hypothesis testing purposes. Therefore, we estimated the model with all the interactions and without the interactions and form an F statistic to test if variables are jointly 0. In our case, the Chow test is used to examine if data for the two groups can be 'pooled.' After pooling data with Medicaid and private insurance, we computed the proper F statistic without running the unrestricted model with interactions with all the k continuous variables.

MPR (anti-asthmatic medication adherence-quantile regression)

$= ß_0 + ß_1$ (patient predisposing factors) $+ ß_2$ (patient enabling factors)

$+ ß_3$ (patient need factors) $+ ß_4$ (type of anti-asthmatic medication)

$+ ß_5$ (Medicaid vs. Commercial) + e

Where MPR stands for the medication possession ratio to measure anti-asthmatic medication adherence, and e is the error term.

Pr [Y [health care utilization] = 0 or 1]

$= f$ [$ß_0 + ß_1$ (patient predisposing factors) $+ ß_2$ (patient enabling factors)

$+ ß_3$ (patient need factors) $+ ß_4$ (type of anti-asthmatic medication)

+ ß5 (MPR) + ß6 (Medicaid vs. Commercial)] + e

where $Y = 1$ if some specific health care is utilized and Y = 0 if not; $f(\bullet)$ is the cumulative density function (CDF) of logistic distribution and e is the error term.

Asthma-related healthcare utilization (a count variable, the number of visits)

$= ß_0 + ß_1$ (patient predisposing factors) $+ ß_2$ (patient enabling factors)

$+ ß_3$ (patient need factors) $+ ß_4$ (type of anti-asthmatic medication)

$+ ß_5$ (MPR) $+ ß_6$ (Medicaid vs. Commercial) + e

Where count model consists of poisson regression and negative binomial regression, e is the error term. Additionally in all cases, a logistic regression was also used to determine predictors of the likelihood of a type of health care service utilization.

3.6 Regression Diagnostics

An OLS regression model has to meet several statistical assumptions like existence, linearity, independence, homoscedasticity, and normality so that the experimenter can obtain robust estimates. Existence indicates the dependent variable Y which is random with a finite mean and has it's variance in the population. The mean and the variance of Y depends on the value of the independent variable, X. Linearity means that the mean value of Y is a straight-line function of X. The study population meets the statistical assumption for existence and linearity. For example, the MPR is a linear function of the key independent variables and other covariates. In this study, the other statistical assumptions like independence, homoscedasticity and normality were met by implementing several regression diagnoses. This ensured that the OLS regression models performed in this study met the statistical assumptions. The statistical tests performed for fulfilling individual statistical assumptions are described in detail in the following sections.

Autocorrelation

Independence assumes that the value of each dependent variable is not correlated with the other independent variables. It means that each Y is independent of the other Ys in the study. Most of the cross sectional studies meet the statistical assumption of independence. In some cases, this assumption can be violated. When the values of multiple observations recorded over a period of time in the same subject are correlated, the phenomenon is called autocorrelation.

Autocorrelation might be common especially when studying medication adherence behavior in patients with chronic diseases. It is difficult to obtain robust estimates in the OLS regression model when autocorrelation exists. Autocorrelation can be detected in the regression model using the Durbin-Watson statistic test. The null hypothesis of the Durbin-Watson test is absence of autocorrelation over time. The value of the Durbin-Watson statistic test should be between 0 and 4. If the value of the Durbin-Watson statistic is 2, it means there is no autocorrelation exists between Y values over time. If the Durbin-Watson statistic is close to 0, then a positive autocorrelation exists. If the statistic is close to 4, a negative autocorrelation exists. Autocorrelation can be corrected using lagged variables in the OLS regression or GLS (general least squares) regression.

Heteroskedasticity

Heteroskedasticity means that the variance of Y (the dependent variable) is the same for any given X (the independent variable). It is a violation of the assumption with a constant variance. The presence of outliers and skewness can result in heteroskedasticity.

It can also result in a narrow range of the confidence interval which in turn can result in easy rejection of the null hypotheses in spite of the fact that the point estimates (OLS coefficients) are unbiased.

The statistical test that can detect the presence of heteroskedasticity in the OLS regression model is the Busch -Pagan-Godfrey test. This test examines the dependence of the estimated variance of the residuals in an OLS regression model on the values of the independent variables. If heteroskedasticity exists in the OLS regression model, there is a possibility that there is correlation between the estimated variance of the residuals and the independent variables. Heteroskedasticity can be rectified with GLS regression which attaches equal weights to each observation.

Normality

Normality indicates normal distribution given any fixed value of X and Y. In order to obtain robust point estimates and confidence intervals, it is important to ensure that an OLS regression model meets the normality assumptions. This also makes the OLS regression model accurate and reliable. Normality can be detected using the Shapiro-Wilk test and a plot histogram of residuals. To make the model normal, a log-transformation of the Y (dependent)-value can be performed sometimes. The log transformation also makes the model homoskedastic.

Multicollinearity

Multicollinearity in the model can be detected by using the variance Inflation Factor (VIF). VIF is an index that measures the magnitude of the change in variance of

an estimated coefficient that might be a consequence of multicollinearity. The VIF value is directly proportional the magnitude of multicollinearity in the model. If the VIF value is more than 10, it indicates that there is severe mutlicollinearity in the OLS regression model. The re-specification of the OLS regression model can correct mutlicollinearity. This study had no multicollinearity issues.

3.7 Conducting Overall Conclusions

With reference to the previous chapters and sections, this dissertation discusses 3 different but interlinked objectives. Statistical analyses have been conducted differently for each of the objectives and have been reported in three different chapters. Overall, all the three chapters try to study the impact of use of anti-asthmatic medications from patient and physician perspective, on patient health outcomes. The outcome of this dissertation was drawn from the proposed model described in Figure 2.3.

CHAPTER 4

DISSERTATION MANUSCRIPT #1: ASSOCIATIONS BETWEEN PHYSICIAN FINANCIAL INCENTIVES AND PRESCRIBING OF ANTIASTHMATIC MEDICATIONS IN CHILDREN IN US OUPTIENT SETTINGS

ABSTRACT

This study examined how sociological factors including financial incentives influenced whether asthmatic children received a controller medication, a reliever medication or both. The 2007 National Ambulatory Medical Care Survey (NAMCS) was used for this analysis. A logistic regression was applied to capture the physician's decision making and to analyze anti-asthmatic medication choice. Children with asthma seeing a pediatrician were approximately 69% more likely than children seeing a family doctor to receive a controller medication than reliever medication ($p<0.01$). Children with asthma enrolled in a capitated plan were 23% more likely to receive controller medications than reliever medications ($p<0.01$). Children with asthma of Hispanic ethnicity were 28% less likely to receive controller medication compared to Non-Hispanic White ($p<0.05$) children. Compared with physicians who received lower financial incentives, physicians who received medium (39%, $p<0.05$) or higher (42%, $p<0.01$) financial incentives from payers were more likely to prescribe controller medication than reliever medication for children with asthma. An important finding of this study is that physicians who had medium or higher financial incentives from payers were about 40 % more likely to prescribe a controller medication in children with asthma. Findings suggest that physician incentives and capitated plans are associated with increase in physicians prescribing controller medications or preventive care in children with asthma.

Introduction

Asthma is a chronic respiratory disease characterized by episodes or attacks of inflammation and narrowing of small airways in respiratory system. (Akinbami et al. 2009; Chang et al. 2011). Some of the most established measures of prevalence of asthma are the Center for Diseases Control's (CDC) Behavioral Risk Factor Surveillance Survey (BRFSS) and the National Health Interview Survey (NHIS) (Crosson et al. 2009). These surveys had the usual limitations associated with self-reported data like non-response bias, and low precision for state and sub-state estimates associated with surveys that used multistage sample selection with the goal of developing national estimates. Given these limitations, estimates of the lifetime prevalence of asthma among adults had ranged from 10-12% over the past 6 years while current asthma for adults is generally reported at approximately 7-8% (Mannino 2002). National estimates suggested that lifetime asthma prevalence for children less than 18 was approximately 12.5% with age specific prevalence of 7.5, 14, and 14.7 percent for children aged 0-4, 5-11, and 12-17 respectively (Mosen 2005). Therapeutic asthma drugs were summarized into four major types: 1) Bronchodilators, 2) Corticosteroids, 3) immunotherapy, and 4) anti-IgE antibodies. Among all the therapeutic asthma drugs, corticosteroids were the most effective for controlling asthma symptoms and serving as evidence of preventive asthma care (Cisternas et al. 2003; Dougherty 2005; Finkelstein 2002).

Pay for performance (P4P) is a physician incentive mechanism where financial incentives are given to healthcare providers for the provision of high quality of patient care. The American Medical Association (AMA) defines P4P as "a method of linking pay to a measure of individual, group, or organizational performance, based on an appraisal

system. These types of bonus incentive schemes are based on the idea that work output, determined by some kind of measuring system, varies according to effort and that the prospect of increased pay will motivate improve performance (Rodriguez et al. 2009)." There is strong interest in pay for performance (P4P) reimbursement programs coupled with a hefty dose of optimism among policymakers and health care payers. However, there is little published research on the actual impact of P4P. At the heart of the P4P debate is whether to reward health care providers according the achievement of a predetermined level of performance or according to improvement in quality measures (Doran 2011; Rosenthal 2005, 2006; Sempowski 2004). Both types of P4P programs had their critics. Some worry that healthcare providers that had historically performed above a target level will have no incentive to improve if they were able to receive the bonus simply for maintaining a status quo (Conrad 2004; Doran 2008; Ho 2010; Rosenthal 2005, 2006). Others felt that paying for improvement may fail to reward those providers for whom improvement was likely to be more difficult because of their historically high baseline performance (Hartert et al. 2010; Ho 2010; Jansson et al. 2007; Johnson and Dinakar 2010; Rosenthal 2005, 2006). Another set of studies concluded that a P4P program with a common, fixed performance target may produce little gain in quality for the money spent and will largely reward those providers with a higher baseline performance (Ho 2010; Mullen 2010; Rosenthal 2006; Stanley J 2010).

However no published study exists which has examined the impact of physician financial incentives on prescribing controller medications in children with asthma. This could be an important factor in examining whether such financial incentives incentivize physicians to promote more preventive medicine. This study used the National

Ambulatory Medical Care Survey (NAMCS) along with Eisenberg model of physician prescribing as the conceptual framework to examine the impact of the financial incentives on physician's medication prescribing behavior in asthmatic children of outpatient care in the U.S.

Materials and Methods

The NAMCS is a national probability sample survey conducted by the Division of Health Care Statistics of the National Center for Health Statistics (NCHS) and the Centers for Disease Control and Prevention (CDC). The sampling frame consists of records of physician names preserved by the American Medical Association and the American Osteopathic Association comprises the NAMCS data. The study involves visits to non-federally employed office-based physicians providing direct patient care and belonging to all specialties except anesthesiology, radiology, and pathology

Data in NAMCS was collecting using a three-stage probability sampling design. The initial or the first probability sample is taken from primary sampling units (PSUs) (n=112 PSUs). These PSUs consists information on counties, county groups, towns, townships and county equivalents. The second stage probability sample involves data based on physicians' working within each of the PSUs whose data is archived in the master files. The third stage probability sample includes random sampling of visits to physician offices. The reporting period for each physician lasts about a week whereby either the physician or any office staff of physician collects information about patient's socio demographics, specialty of physician, reasons for physician visit, method of payment for the physician visit, patient symptoms, diagnosis of patient symptoms,

complaints made by the patients, drugs prescribed by the physicians, first time or regular visit, preventive and therapeutic care provided of recommended. The encounter between physician and patient or outpatient visit comprises the basic sampling unit in the NAMCS database. In order to calculate national estimates, each data record is inflated using an inflation factor known as the patient visit weight. This weight helps researchers to determine the overall office visits that took place in US. There might be some sampling variability observed. However, an estimate is deemed reliable by NCHS standards if the relative sampling error is less than 30% of the estimate.

According to the inclusion criteria, the study sample of this study consisted of children aged 0 – 18 years with a current diagnosis of asthma (ICD-9 code 493.XX) and the mentioned of the word 'asthma' in the office visit who were a part of the 2007 NAMCS (latest round available at the time of analyses). Patients with co-morbid conditions that confounded the study findings such as cystic fibrosis were excluded from the analysis.

Covariates and Measures

The primary dependent variable was the specific drug classes used in the management of asthma with a view of examining predictors of physician prescribing of controller versus reliever medications in children with asthma. These drugs were classified on the basis of their role in the management of asthma and fall into the general categories listed in following Table 4.1.

Table 4.1 Drug Classes in the Pharmacotherapy of Asthma

Controller Medication (CM)	**Reliever Medication (RM)**
Inhaled Corticosteroids (ICS)	Short Acting Beta Agonist bronchodilators **(SABA)**
Oral Corticosteroids **(OC)**	Oral Corticosteroids **(OC)***
Long Acting Beta Agonist inhalers **(LABA)**	Oral Short Acting Beta Agonists **(OSABA)**
Leukotriene Modifiers **(LM)**	Oral Short Acting Xanthines **(OSAX)**
Inhaled Cromones **(CI)**	Anti-Cholinergic Bronchodilators **(ACB)**
Oral Long Acting beta Agonists **(OLABA)**	Combination of SABA and ACB **(BAACB)**
Oral Long Acting Xanthines **(OLAX)**	
Combination of LABA and ICS **(LABIC)**	

Notes: *The issue of the oral corticosteroid (OC) class in the analysis was complicated. Based on the nature of the NAMCS dataset, the drugs were categorized into the CM and RM group.

This study used the Eisenberg physician decision making model as the structural framework for variable selection. According to this model, the physician decision making is influenced by four social factors: (1) physician characteristics; (2) patients characteristics; (3) physician as a part of the health care system; and (4) physician's relationship with the patient. Physician characteristics included specialty, age, gender and type of practice which could influence their prescribing decisions. Previous studies have found associations between physician characteristics and prescription of certain medications such as leukotriene modifiers and theophylline (Blanc 2003; Ma 2005). Another study by Janson, et al showed that specialty physicians (such as respiratory

specialists) were more aware of asthma guidelines, and used evidence–based techniques to diagnosis, monitor and treat asthma (Janson and Weiss 2004). Studies have also shown that patient characteristics such as age, gender, educational level, insurance status and socioeconomic status. Influence prescribing decisions. Patients with lower socioeconomic status were shown to receive less optimal asthma emergency department care (Mvula et al. 2005). A study on Texas Medicaid enrollees found that emergency department visits and the rates of hospitalization was more than twice in pediatric patients compared to adults (Smith, Rascati, and Barner 2005).

The physicians' relationship with the healthcare system may also drive asthma care. A study showed that physicians working for an HMO specifically for a Preferred Provider Organization (PPO) were less likely to prescribe leukotriene modifiers to their patients compared to physicians working with other insurers (Blanc 2003). Another study examining asthma medication prescribing and healthcare utilization among pediatric population enrolled in Managed Care Organizations (MCOs) found that about less than 40% of the pediatric population was being prescribed controller medications compared to reliever medications (Donahue et al. 2000). The physician's relationship with the patient may influence physician prescribing, by patient/caregivers demands and symptom description. A systematic review has found that effective patient physician interaction influenced physician's decision making which in turn led to better health outcomes (Stewart 1995). According to the Eisenberg's model, patient physician interaction is classified into 3 categories: a) "activity passivity" where decisions are made primarily by physician and patients follow the decisions blindly, b) "guidance cooperation" where the physician guides the patient and the patient accepts the physician's advice and c) "mutual

participation" where both the patient and the physician participate and come to a mutual agreement (Eisenberg 1979). This model included different factors that influence physician decision making for prescribing anti-asthma medications. This model was also suitable for selecting independent variables for the study. Hence this model proved as a favorable choice for this study.

The dependent variables of the study were physician prescribing of anti asthmatic medication and the type of anti-asthmatic medication prescribed. The dependent variables are taken from the NAMCS prescription data and classified as per the prescribed medications listed in Table 1.1. Sociodemographic characteristics of the children included age, gender, race/ethnicity, and payment structure. Ethnicity was classified as Hispanic and non Hispanic. The payment structure is classified by method of payment (capitation/no capitation) and by percentage of financial incentives from P4P. All the measures of the independent variables are summarized in Table 4.2.

Table 4.2 Study Covariates

1. Physician Characteristics Provider: Pediatrician Non-Pediatrician	**3. Physician's Relationship with the Health Care System** Ownership status: Owner of solo practice Owner of non-solo practice, Non-owner Geographic region of practice: Northeast, Midwest, South, West Metropolitan area: yes Financial incentives: % of bonus
2. Patient Characteristics Gender: male Age Race/ethnicity: White, Black, Hispanic Capitated payment: yes	**4. Physician's Relationship with the patient** Patient see before: yes Asthma is the primary diagnosis listed for the visit: yes

One of the limitations of NAMCS is that it provides limited information about physician characteristics. Among physician characteristics, it includes the physician specialty categorized as pediatricians and non-pediatricians. Physician's relation with the healthcare system is characterized by his geographic location of practice (Northeast, Midwest, South and West, metropolitan and non metropolitan areas) and physician's ownership of practice (solo, non solo and non owner). Patient physician relationship was categorized by first or routine visit and if asthma was the primary cause of physician visit.

Statistical Analysis

The sample consisted of 1041 children with current asthma diagnosis aged 0-18 years and was classified under two categories, ie, ever been told they had asthma and still had asthma. These 1041 observations represented a total of 35,043,953 weighted visits related to asthma for the year 2007 in US outpatient settings. Chi-squared tests were used to examine bivariate associations between the predictor variables and the uses of control medication only, reliever medication only, as well as both.

Multivariate analyses were also conducted in order to examine the effects of financial incentives on asthma-related medication use among children with asthma, using separate logistics regression analyses and simultaneously controlling for physician/patient characteristics, physician's relationship with the health care system and physician's relationship with patients. All odds rations (OR) and *P* values were reported.

Weighting was used in the NAMCS dataset to measure collective statistics representative of the entire population. In particular, sample weighting compensated for

differences in probabilities of sample selection and differences in the sampling rates of the persons interviewed. Weighting also reduced any bias arising from different characteristics of respondents and nonrespondents. Weighting reduced variance among the data collected, as well as compensating for undercoverage of the sample population while administrating the survey. The sample weights ('patient visit weigit') used for statistical analysis in the study created by NAMCS.

The following were descriptions of the model for this study:

$$\Pr [Y \text{ [Only Controller Medication prescribed]} = 0 \text{ or } 1]$$

$$= f [ß_0 + ß_1 \text{ (patient factors)} + ß_2 \text{ (physician factors)}$$

$$+ ß_3 \text{ (physician - health care system interaction factors)}$$

$$+ ß_4 \text{ (physician - patient interaction factors)}] + e$$

where $Y = 0$ if no controller medication is prescribed, $Y = 1$ if controller medication is prescribed; $f(\bullet)$ is the cumulative density function (CDF) of logistic distribution and e is the error term.

$$\Pr [Y \text{ [Controller \& Reliever Medications (both) prescribed]} = 0 \text{ or } 1]$$

$$= f [ß_0 + ß_1 \text{ (patient factors)} + ß_2 \text{ (physician factors)}$$

$$+ ß_3 \text{ (physician - health care system interaction factors)}$$

$$+ ß_4 \text{ (physician - patient interaction factors)}] + e$$

where $Y = 0$ if no medication is prescribed, $Y = 1$ if both medications are prescribed; $f(\bullet)$ is the cumulative density function (CDF) of logistic distribution and e is the error term.

$$\Pr [Y \text{ [Only Reliever Medication prescribed]} = 0 \text{ or } 1]$$

$$= f [ß_0 + ß_1 \text{ (patient factors)} + ß_2 \text{ (physician factors)}$$

$$+ \beta_3 \text{ (physician - health care system interaction factors)}$$

$$+ \beta_4 \text{ (physician - patient interaction factors)}] + e$$

where $Y = 0$ if no reliever medication is prescribed, $Y = 1$ if reliever medication prescribed; $f(\bullet)$ is the cumulative density function (CDF) of logistic distribution and e is the error term.

Results

Table 4.3 presents the descriptive statistics of the children being seen for asthma. A total weighted number of 35,043,953 subjects (unique patient visits) were examined for the year 2007. The mean age of asthmatic children in the sample was 8.7 years (range from 1 to 18). There were more female (56%) compared to male subjects. A majority of the study population comprised of non-Hispanic white (82%) asthmatic patients. More than half of the study population (62%) was covered by private insurance for their asthma-related healthcare. Around one-third patient (34%) asthma related visits were capitated. More than two-thirds of physician received the medium or high financial incentives from payer (87%). A majority of physicians (88%) practiced in metropolitan areas. In 86% of the visits, asthma was listed as the primary reason for the outpatient visit.

[Table 4.3 goes about here]

Table 4.4 presents the weighted logistic regression results examining predictors of the type of anti-asthmatic medications prescribed. The weighted odds ratios (OR) and the 95% confidence intervals are reported in Table 4.4. First we examined whether factors that predicted whether patients received a controller medication differed compared to

those receiving reliever medications only or both medications. Patients age 5-18 years were significantly more likely to be prescribed the controller medication than reliever medication compared to age 1-4 years (71%, $p<0.01$). Patients seeing a pediatrician were approximately 69% more likely than patients seeing a family doctor to receive a controller medication than reliever medication ($p<0.01$). Patients covered by capitated plans were 23% more likely to receive controller medications than reliever medications ($p<0.01$). Patients belonging to the Hispanic race were 28% less likely to receive controller medication compared to Non-Hispanic White ($p<0.05$) subjects. Compared with physicians who received the lower financial incentives, the physicians who received medium (39%, $p<0.05$) or high (42%, $p<0.01$) financial incentives from payers were more likely to prescribe controller medication than reliever medication.

Next we examined which factors influenced whether patients received a reliever medication compared to those receiving both a controller and reliever medication. Patients seeing a pediatrician were approximately 67% less likely than patients seeing a family doctor to receive a reliever medication. Patients aged 5-18 years were significantly less likely to receive the controller medication (47%, $p<0.01$). Physicians who received medium (35%, $p<0.05$) or high (30%, $p<0.05$) financial incentives were significantly less likely to prescribe the reliever medication to children. Patients in the Midwest were significantly less likely than patients in the west to receive the reliever medication (71%, $p<0.05$).

[Table 4.4 goes about here]

Discussion

The Eisenberg model of physician decision making has been widely used to characterize physician decision making, physician prescribing and the sociological factors that influence physician decision making (Tamblyn et al., 2003; Leffler 1981). In this study, the model was used to study the sociological factors that influence physician's behavior concerning the adoption of financial incentives and prescription of anti-asthmatic medication in children. The factors that could potentially influence physician behavior are: (1) physician characteristics (e.g. age, gender, race, specialty); (2) patient characteristics (e.g. age, gender, race, educational level, insurance status, income); (3) physician's relationship with the health care system (e.g. practice setting, ownership); and (4) physician's relationship with the patient (e.g. patient demand, patient presentation of symptoms) (Eisenberg 1979). There were several strong associations found between these characteristics and prescribing that could have great interest for policymakers.

In terms of patient characteristics, children whose outpatient visits were covered by public insurance (like Medicare & Medicaid) were more likely to receive the reliever medication compared to publicly insured patients. This suggests that asthmatic children with public health insurance may not be receiving appropriate controller anti-asthmatic medication that could improve their asthmatic symptoms and quality of life. Also from the study results, Hispanic children with asthma were less likely to receive controller medication for asthma treatment. Another patient characteristic that influenced prescribing was patient age. Patients aged 5-18 years were significantly more likely to receive a controller medication than reliever medication than patients age 1-4 years. This finding could suggest both stabilization of asthma symptoms with increasing age that

require controller medications, as well as reluctance on the part of physicians to use corticosteroids in very young asthmatic patients.

Physician specialty was significantly related with prescribing controller medication for asthmatic children. Patients whose providers were a pediatrician were more likely to receive controller medication compared to patients seeing family physicians. These findings also suggest that pediatricians are being visited by patients for getting asthma treatment which might involve multiple medications. Also, patients in whom single medication therapy has failed, comprise more complicated cases and could more likely to visit their pediatricians for getting asthma care.

The physician's relationship with health care system also influenced anti-asthmatic medication prescribing. An import finding of this study is that physicians who had medium or high financial incentives from insurance plans or payers were about 40 % more likely to prescribe a controller medication. Asthma "controller" drugs are used to reduce inflammation and are the most import component of long-term control in children with mild or severe diseases. In clinical practice, the ratio of controller medications to total asthma medications has proven to be a quality-of-care measure used frequently in asthma. A controller to total asthma medication ratio of .5 or more may be more reflective of adequate asthma quality of care (Schatz 2004). Finally, we found that patients in the Midwest and Northeast were more likely to receive a reliever medication than just a controller medication than patients in the West. These geographical variations in physician prescribing could be due to differences in: (a) physician adoption of prescribing guidelines, and (b) cultural norms in the physicians' respective practice areas. Future research is needed to better understand these geographical differences.

This study has several limitations. First, since we used a public access database (NAMCS), it does not provide all the relevant physician and patient variables which may affect prescribing behavior. Second, we do not know the exact severity of a child's asthma in this database so we could not control for this when examining which subjects receive an anti-asthmatic medication and what types of anti-asthmatic medication they received. Third, the database is based on self-report of physician and their staff and therefore it may be subject to some recall bias. Fourth, the study database does not provide health care utilization such as ER visit and Inpatient visits and outpatient patients may not represent the most severe asthma cases. Finally, the NAMCS database lacks specific variables that explain the impact of medication adherence and self-monitoring behaviors, as well as variables examining barriers to physician guideline adherence.

Even though there were some limitations of our study, our results indicate that all four domains (patient characteristics, physician characteristics, the physician's relationship with the health care system, and the physician's relationship with the patient) that could influence physician care influence anti-asthmatic medication prescribing in children in the United States. Our results also indicate that provider pharmaceutical care in public insured children as well as other underserved populations such as ethnic minorities is needed so that these children can receive better asthma treatment and in turn, have improved quality of life.

Table 4.3 Descriptive Statistics of the Children being seen for Asthma

Variables	% or mean
Provider Characteristics	
General practitioner/Family medicine	20
Internal Medicine	14
Pediatrics	27
Pulmonary specialties	34
Other	4
Patient characteristics	
Gendar: Male	44
Age	8.7 (mean)
Race/ethnicity:	
Non-Hispanic: White	82
Non-Hispanic: Black	7
Hispanic:	9
Other	2
Primary source of payment	
Private insurance	62
Public insurance (Medicare & Medicaid)	27
Other	11
Capitated visit: yes	34
Patient belong to HMO: yes	11
Capitated HMO	4
Taking Anti-asthmatic medication: yes	68
Physician's Relationship with Health Care System	
Incentive Status:	
Lower financial incentives	13
Medium financial incentives	49
Higher financial incentives	38
Ownership status:	
Owner of solo practice	53
Owner of non-solo practice	19
Non-owner	28
Geographical area	
MSA	88
Non-MSA	12
Geographic region	
Northeast	27
Midwest	19
South	33
West	21
Physician's Relationship with Patient	
Patient seen before	89
Asthma is primary diagnose	86

N (weighted) = 35,043,953

Table 4.4 Odds ratios for anti-asthmatic medication use using logit models

Variable	Controller only		Reliever only		Both	
	Weighted OR	95% CI	Weighted OR	95% CI	Weighted OR	95% CI
Provider Characteristics						
Family medicine	Ref		Ref		Ref	
Internal Medicine	0.64	(0.18, 1.24)	1.05	(0.49, 1.91)	0.67	(0.19, 2.18)
Pediatrics	1.69**	(1.23, 2.34)	0.33**	(0.22, 0.49)	0.46**	(0.34, 0.63)
Pulmonary specialties	1.12	(0.56, 3.98)	0.77	(0.46, 1.27)	0.84	(0.57, 1.94)
Other	1.07	(0.39, 2.91)	1.01	(0.27, 2.08)	1.08	(0.39, 2.95)
Patient characteristics						
Gendar: Male	1.00	(0.46, 1.27)	1.36	(0.89, 2.06)	1.69	(0.84, 3.41)
Age: 1-4	Ref		Ref		Ref	
Age: 5-18	1.71**	(1.16,2.32)	0.53**	(0.36, 0.76)	0.56**	(0.40, 0.81)
Race/ethnicity:						
Non-Hispanic: White	Ref		Ref		Ref	
Non-Hispanic: Black	1.12	(0.46, 3.69)	1.36	(0.43, 3.32)	0.71	(0.14, 3.59)
Hispanic:	0.72*	(0.49, 0.87)	1.42*	(1.04, 2.16)	1.45*	(1.12, 1.78)
Other	0.57	(0.11, 1.96)	1.95	(0.38, 3.76)	1.01	(0.31, 2.17)
Primary source of payment						
Private insurance	Ref		Ref		Ref	
Public insurance	0.94*	(0.56, 0.99)	1.17*	(1.05, 4,59)	1.22	(0.72, 2.24)
Other	0.64	(0.28, 1.38)	1.41	(0.35, 5.69)	1.13	(0.59, 2.11)
Capitated visit: yes	1.23**	(1.02, 1.73)	0.62*	(0.38, 0.99)	0.74*	(0.54, 0.98)
Patient belong to HMO: yes	1.41	(0.71, 2.79)	0.64	(0.27, 1.53)	0.41	(0.21, 1.83)
Capitated HMO	1.16	(0.35, 3.49)	0.61	(0.16, 2.31)	1.31	(0.84, 2.16)
Taking Anti-asthmatic medication: yes	0.75	(0.51, 1.13)	0.78	(0.45, 1.32)	0.77	(0.51, 1.23)
Physician's Relationship with Health Care System						
Incentive Status:						
Lower financial incentives	Ref		Ref		Ref	
Medium financial incentives	1.39*	(1.03, 1.89)	0.65*	(0.43, 0.99)	0.74*	(0.54, 0.92)
Higher financial incentives	1.42**	(1.12, 2.17)	0.70*	(0.49, 0.64)	0.61**	(0.35, 0.89)
Ownership status:						
Non-owner	Ref		Ref		Ref	
Owner of solo practice	0.85	(0.53, 1.39)	0.67	(0.39, 1.15)	0.79	(0.47, 1.36)
Owner of non-solo practice	1.21	(0.67, 2.09)	1.21	(0.66, 2.26)	1.12	(0.61, 2.01)
Geographical area						
Non-MSA	Ref		Ref		Ref	
MSA	1.31	(0.70, 2.45)	0.61	(0.22, 1.65)	1.01	(0.53, 1.92)
Geographic region						
West	Ref		Ref		Ref	
Northeast	0.85	(0.51, 1.37)	0.43	(0.24, 1.98)	0.57*	(0.34, 0.97)
Midwest	0.82	(0.42, 1.61)	0.29*	(0.29, 0.85)	0.71	(0.39, 1.36)
South	1.01	(0.64, 1.67)	0.52	(0.16, 1.57)	0.67	(0.48, 1.29)
Physician's Relationship with Patient						
Patient seen before	1.15	(0.49, 2.66)	1.00	(0.99, 1.01)	0.88	(0.49, 1.76)
Asthma is primary diagnosis	0.71	(0.35, 1.46)	1.04	(0.48, 2.41)	0.94	(0.38, 1.72)

*: $p<0.05$ **: $p<0.01$

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CHAPTER 5

DISSERTATION MANUSCRIPT #2: PHYSICIAN PAYMENT INCENTIVES AND ASSOCIATED HEALTHCARE UTILIZATION OUTCOMES IN MEDICAID ENROLLED ASTHMATIC CHILDREN

ABSTRACT

The purpose of this retrospective cohort study was to examine associations between the type of health plan (fee for service vs. capitated) and utilization-based outcomes (health care services and medication adherence) in asthmatic Medicaid children. Subjects were 6435 Medicaid enrolled asthmatic children who newly started asthma controller pharmacotherapy and were followed 12 months before and 12 month after the index anti-asthmatic medication. Data was collected on health care utilization and medication adherence was calculated from the Medicaid Marketscan® database for the years 2005-2007. Quantile regression analysis was used to examine predictors of medication adherence while poisson regressions were used to examine incidence of health care service utilization. Patients in FFS plan had significantly associated with higher medication adherence rates ($p<0.01$) compared to those in capitated plans. Moreover, patient in capitated plans were associated with 77% more inpatient hospitalizations and 34% increased incidence rates of emergency department visits, but 42% fewer outpatient visits compared to those in FFS plans (all $p<0.05$). Although Medicaid programs use capitated managed care plans primarily as a cost-containment strategy, these plans may not be cost-effective for the long-term management of asthma.

Introduction

Asthma is a chronic respiratory disease characterized by episodes or attacks of inflammation and narrowing of small airways in respiratory system (NCHS, 2005). Some of the most established measures of prevalence of asthma are Center for Diseases Control's (CDC) Behavioral Risk Factor Surveillance Survey (BRFSS) and the National Health Interview Survey (NHIS) (CDC 2007; NCHS 2005). Estimates of the lifetime prevalence of asthma among adults have ranged from 10-12% over the past 6 years while current asthma for adults is generally reported at approximately 7-8% (Mannino 2002). National estimates suggested that lifetime asthma prevalence for children less than 18 was approximately 12.5% with age specific prevalence of 7.5, 14, and 14.7 percent for children aged 0-4, 5-11, and 12-17 respectively (CDC 2005).

Poor and minority children bear a disproportionate share of the population burden of asthma. This is reflected in higher rates of hospitalization and emergency room visits for asthma, lower utilization of pharmaceutical agents known to improve control of asthma, higher prevalence and severity of the disease, lower rates of utilization of primary care services related to asthma (Akinbami et al. 2009; Akinbami and Schoendorf 2002; Ash 2005; Dougherty 2005; Gold and Wright 2005; Krishnan 2001; Lieu et al. 2002; Weiss, Sullivan, and Lyttle 2000). These trends have been attributed to the characteristics and financing of the US medical care system and their associated impact on access to medical care (Bindman 1995; Friedman 2001; Homer 1996) and to individual characteristics of the population (Lynch 1997).

Poor children are more vulnerable to poor health in general because they are apt to have multiple risk factors (Aday 2001; Chang et al. 2011). Investigation of single risk factors is useful but perhaps does not reflect the real-world scenarios where risk factors often cluster, e.g., low education and low income (Min, Chang, and Balkrishnan 2010; Patel et al. 2010; Stevens et al. 2006). Previous research has suggested that multiple risk factors may produce an additive impact on children's mental, physical, and social health and school performance (Starfield, Robertson, and Riley 2002; Stevens et al. 2006) especially in conditions such as asthma (Wood 2002).

One of the key components in long-term control of asthma is pharmacotherapy, and the present study is focused on whether children received recommended medication by the guidelines of National Asthma Education and Prevention Panel (NAEPP) through the analysis of the Medicaid pharmacy data. According to the NAEPP report (1997), the most effective long-term control medication for asthma was the corticosteroid inhaler. Several studies confirm that the daily use of steroid inhalers greatly reduce asthma symptoms, occurrence of severe exacerbations, use of quick-relief medications, and lung function measured by peak flow, FEV and airway hyper responsiveness (Cloutier et al. 2005; Cochrane 1999).

Several factors affect patient adherence to medications. Insurance coverage/type of health plan plays a key role in providing access to essential health care services. With no or limited insurance coverage, patients who use more drugs face increasing out-of-pocket costs, which may result in decreased adherence (Janson and Weiss 2004; Jansson et al. 2007). Access to pharmaceutical innovation is also mediated by the patient's primary source of health insurance coverage. Patients with public insurance (Medicare

and Medicaid) are less likely to receive newer medications for the management of chronic diseases (Cloutier et al. 2005).

From its inception, the Medicaid program's costs had exceeded estimates (Freund and Hurley 1995). Congress authorized waivers to state Medicaid plans in 1981 that made it possible for states to experiment with managed care as a means to control costs (Stevens et al. 2006). States commonly implemented one of two types of Medicaid managed care plans: 1) Capitation (pre-paid) and 2) Fee-For-Service (Kaye 2005). Under the capitation or prepaid model, the managed care organizations (MCOs) got payment on a capitated basis (fixed payment) to deliver health care. Data are lacking on health outcomes for patients with chronic conditions (eg, asthma) in capitated plans in the Medicaid population (Karnick et al. 2007; Kozyrskyj, Mustard, and Becker 2003; Lara et al. 2003; Wagner 2005). Particularly, the effect of type of health plan (such as capitation) on medication adherence and health care service utilization on asthmatic children is unknown. Taking into account the limited amount of health care resources and growing health care expenditures, examining the effect of type of health plan on outcomes will be helpful to policy makers to make informed decisions regarding appropriate adoption of reimbursement policies and effective allocation of limited health care resources for this vulnerable population. Hence, the primary objective of this study was to examine the association between type of health plan (FFS vs. capitated) and economic outcomes (health care utilization and medication adherence) in asthmatic Medicaid-enrolled children.

Materials and Methods

This study used the MarketScan® Medicaid claims dataset licensed from Thompson Medstat. It consisted of the data from 8 different states of varying size and dispersed all across the U.S (MarketScan® research database, 2008). The states are de-identified; however, data consist of at least one state from each U.S. region. The database consisted of medical (outpatient and inpatient services), drug, and long-term care claims and eligibility records for enrollees from these states. The prescription drug coverage was provided by all the states. The data were available from 2005 to 2007 representing around 5.4 million individuals in the United States (MarketScan® research database, 2008). For the purpose of this study, the Medicaid database were updated and queried from January 1, 2005 to December 31, 2007. The database was HIPPA compliant and features encrypted member and service provider identification numbers. The data from these states provided a fairly large sample of the Medicaid enrollees in the U.S. The dataset also provided additional information on variables such as race/ethnicity, Medicare eligibility and Medicaid eligibility / federal aid category.

The study population comprised of children aged 0 to 18 years of age. The patients with a diagnosis of asthma and a prescription of a new asthma medication (Inhaled Bronchodilator, Anti-Inflammatory, Systematic Bronchodilator, Systematic Corticosteroid and/or Leukotriene Modifiers) during the study time period included. Subjects with a primary or secondary diagnosis of asthma identified using the International Classification of Diseases Code 9th Revision (ICD-9: 493.XX) from claims data during the study test period. Only subjects who have maintained continuous eligibility for 1 year period between January 1, 2005 and December 31, 2005 included in

the study. The date for the first prescription claim for anti-asthmatic medication use designated as an index date, where the medication identified using relevant National Drug Codes (NDC) recorded in the claim records. The study required all patients to have continuous health plan enrollment for at least 1 year prior to and following their index date. This was to ensure that each patient's index date presents a reasonable marker for treatment initiation as well as making sure that any observed lack of health care events was due to a lack of medical activity and not due to cessation of insurance. The identification period ranged from January 1, 2006 to December 31, 2007. During this time period, any patients who have an asthma diagnosis and who were prescribed an anti-asthmatic medication were included.

Measurement and Outcomes

The operational definitions and measurements of the variables utilized in this study discussed in this section. The dependent variables for this study are medication adherence, hospitalizations, emergency room (ER) visits and asthma-related healthcare costs. The independent variables tested in this study are payment mechanisms (capitated vs. fee for service). Other independent covariates include age, gender, access to specialty care, and disease severity. The operational definition of each variable described in the following sections:

Medication adherence

Medication adherence signified medication usage by patients. It was basically the act of conforming to the physician's recommendations about the timing, dosage, and

frequency of medication intake. The International Society of Pharmacoeconomics and Outcomes research defined medication adherence as the extent to which a patient complies with the intended dosing regimen (Hess 2006). The unit of measure for compliance was administered doses per defined period of time, reported as a proportion (%) of prescribed doses (D) taken at the prescribed time interval (T) as measured by the period of time.

Medication adherence can be measured directly and indirectly by utilizing biological markers, blood and urine assays, patient interviews, pill counts, prescription refills, and electronic monitoring (Claxton, Cramer, and Pierce 2001; Hess 2006). Since the study uses an insurance claims database, prescription refill patterns can be used to capture medication adherence. The information thus obtained records the frequency and timeliness of refills of prescribed medication and eliminates any Hawthorne effect. Also pharmacy records had predictive validity as measures of cumulative exposure and gaps in medication supply (Steiner 1998). On the other hand this method also had some limitations like presence of data on unusual refill patterns, multiple conflicting drugs and inability to capture all data about patients visiting multiple pharmacies. Also utilization of pharmacy records assumes that "a prescription filled is a prescription taken" (Balkrishnan 2005). The data cannot measure actual consumption but only estimates about actual medication consumption (Hess 2006).

Medication adherence in this study indicated patient's intake of anti-asthmatic prescription medication. Data from the pharmacy claims database can be used to measure medication adherence by several ways. Medication possession ratio (MPR) is one such measure used to calculate medication adherence. For the purposes of this study, MPR is

calculated as the days of anti-asthmatic medication supply dispensed divided by the number of days in the observation period (#365) minus the number of days in the hospital (Camargo 2007; Hess 2006; Sokol et al. 2005). Previous studies have shown that medication adherence measurement for the entire study period which is 365 days in this study, when used as a denominator, predicts hospitalization and healthcare costs in a more appropriate manner compared to adherence measures considering the period between the first and last refill (Camargo 2007; Mattke et al. 2010). Medication adherence measures like MPR, proportion of days covered (PDC), Continuous Medication Gap (CMG) and Continuous Multiple interval of Oversupply (CMIOS), Medication Refill Adherence (MRA) use the entire study period as a denominator. Also measures like Refill compliance rate (RCR), compliance rate (CR), and modified medication possession ratio (MPRm) which measure the period between the first and last refill lack a consistent denominator value while calculating adherence (Hess 2006). The above measures fail to account for early medication discontinuation, thereby overestimating adherence for patients stopping their medication intake when they should be taking it. Therefore, MPR for this study is defined as

MPR= # of days supply of anti-asthmatic medication in the post-index period / # of days in the study period (365 days).

The observation period in this study included the post-index period or 12 month follow up period which was consistent for each patient. The number of hospital days was subtracted from the denominator because any drug taken during this period was given to the patient by the hospital and was not possible to capture in the pharmacy records. The information on each filled prescription included of dispensing, quantity dispensed, and

days' supply of medication. Medications used were placed into 2 categories: asthma controller medications and reliever medications. Controller medications consisted of ICSs, ICSs/LABAs, LABAs, LTRAs and theophylline. Reliever medications included short-acting β-agonists (SABAs) and systemic corticosteroids. We examined the distribution of the day of supply for the asthma medications, summing for each patient the number of days supplied by their prescriptions for the 365 days of follow-up. The MPR was calculated for any asthma medication possession on a given day of the year and avoided double counting of multiple asthma medication use on the same day by the same patient.

Healthcare Service Utilization

Patients were followed during pre-index and post-index period (i.e. 12 month before and 12 months after the index date) to assess their healthcare utilization in terms of hospitalizations, ER visits, outpatient visits. Variables related to hospitalizations, ER visits and outpatient visits were used as a proxy for health care service utilization. To identify hospitalizations in patients, their admission and discharge dates recorded in inpatient service files are used. CPT codes as well as service codes were taken from the inpatient and outpatient services files for identifying events of ER visit and outpatient visits.

Sociodemographic variables

The following sociodemographic variables were taken from the Medicaid data: gender, birth year and race/ethnicity. The gender of the patients was categorized into males and females. Birth year of the patients was used to calculate their age. Race or

ethnicity of patients was classified as whites, blacks, Hispanics and others. The Medicaid dataset also had information about the health plan (capitated or fee for service) that patients were enrolled in.

Proxy for asthma severity

Based on the established relationship between disease severity and intensity of treatment, severity of a condition in the current period was inferred by a risk of an exacerbation in a future. Some of the independent predictors widely used in the literature for ascertaining future asthma-related emergency hospital utilization (EHU) are hospitalizations, use of emergency department and use of oral corticosteroids (Roth 2004; Schatz 2004). Severity of asthma in the current period is assessed by determining high risk of EHU. Risk stratification schemes are developed using pharmacy claims or facility claims or a combination of both. Combination of pharmacy and facility claims are more successful in stratifying risk compared to using pharmacy or facility claims single-handedly (Roth 2004; Schatz 2004). A popular type of risk stratification scheme used is a simple three-level risk stratification (Table 5.1) which ranks risk of future EHU based on a point system applied to a period of current utilization. Points are assigned to different indicators of future asthma related EHU. Asthma hospitalizations or ED encounters in the 12-month base period are assigned 2 points, 15 or more beta-agonist canisters in the base period are assigned 1 point and 1 or more filled prescriptions for oral corticosteroids are assigned 1 point. Members are differentiated on the basis of assignment of points. Members with 2 or more points, 1 point and 0 point are classified as high risk, medium risk and low risk groups respectively (Schatz 2004).

Table 5.1 Three-Level Risk Stratification of Asthma Severity

Event per 12-month base period	Potential Point Assignment	Low Risk 0 Points	Medium Risk 1 Points	High Risk 2 or more Points
A. ED visits asthma encounter	2	0	0	2
B. IP visits asthma encounter	2	0	0	2
C. 15 or more beta-agonist canisters dispensed	1	0	1	1
D. Any oral corticosteroid prescriptions dispensed	1	0	1	1
Required events for risk level		No listed events	Either C or D	Either A or B and/or C and D

Therefore, the measurement of asthma severity is the probability of an asthmatic member having a risk score (severity proxy) of 0,1, or 2.

Type of health plan (FFS vs. Capitation).

The Medstat MarketScan® Medicaid database provides patient level indicator variable for the type of health plan enrolled for by each patient. Medicaid has classified plans into 2 groups (MarketScan® Medicaid database user guide, 2005):

1. *Capitation:* represents capitated managed care plan where MCOs receive a fixed amount of payment per enrollee per month. All or some services offered by MCOs are paid on a capitated basis.

2. *Fee-for-service (FFS):* indicates health plans that pay providers or physicians on the basis of services rendered. There is no incentive for the patient to use a particular list of providers. Coverage is handled by only one policy, with a deductible and coinsurance. The patient level variable is coded as 1 for capitation and 0 for FFS health plan.

Table 5.2 Analytical Framework and study covariates for Chapter 5.

Target population: Children aged 0 to 18 years with a diagnosis of asthma receiving care in a Medicaid Setting
Outcomes: Medication Possession Rate, and Healthcare services utilization (ER, IP & OP),
Regressor of interest: Health plans (FFS vs. Capitated)
Covariates:
Patient Characteristics: Patient's age, gender, and race/ethnicity (Predisposing factors)
Patient's Medical Conditions: Asthma severity (Need factors)
Physician Characteristics: Specialty (Enabling factors)
Asthma drug ratio: A controller to total asthma medication ratio of 0.5 or more

Statistical Analysis

Descriptive statistics were performed to compare baseline characteristics in the cohort of study patients. Continuous data were described by means and standard deviations, and nominal and categorical data were described by frequencies and percentages. Unadjusted demographic, clinical, and medication characteristic comparisons between groups were completed using independent sample t tests for evaluation of continuous variables and chi-square tests for categorical variables. The data were analyzed using STATA software version 10 (Stata Corp, College Station, TX). All univariate, bivariate, and multivariate analyses were conducted at a set a priori level of significance (0.05).

Quantile regression was used to evaluate the relationship between the type of health plan and medication adherence after controlling for potential covariates. Quantile regression provided a convenient linear framework for examining how the quantiles of a dependent variable change in response to a set of independent variables using linear conditional quantile functions. The primary independent variable was the type of health plan (FFS vs. capitation). Other covariates included in the model were demographic (age,

sex, race/ethnicity), clinical variables such as severity index including health care resource utilization in pre-index period (hospitalizations, ER visits), and therapy-related variables (appropriate medication choice). The normality was determined using the Shapiro–Wilk test. The heteroskedasticity was determined using the White test. The data were also examined for multicollinearity (ie, a linear relationship between predictor variables). A variation inflation factor of <10 was considered to indicate absence of multicollinearity.

Logistic regression model was used to predict the likelihood of healthcare utilizations (outpatient, inpatient, and ER visits). Also, the poisson regression model was used to model predictors of the frequency of healthcare utilizations (outpatient, inpatient, and ER visits) while the zero-inflated poisson regression model was used to predict the number of hospitalizations. The adequacy of model was examined using the Vuong test. The following were the description of the models for this study:

$$\text{MPR (Asthma Controller medication adherence-quantile regression)}$$

$$= ß_0 + ß_1 \text{ (patient predisposing factors)} + ß_2 \text{ (patient enabling factors)}$$

$$+ ß_3 \text{ (patient need factors)} + ß_4 \text{ (type of anti-asthmatic medication)}$$

$$+ ß_5 \text{ (Capitated vs. FFS)} + e$$

Where MPR stands for the medication possession ratio to measure anti-asthmatic medication adherence, and e is the error term.

$$\Pr [Y \text{ [health care utilization]} = 0 \text{ or } 1]$$

$$= f [ß_0 + ß_1 \text{ (patient predisposing factors)} + ß_2 \text{ (patient enabling factors)}$$

$$+ ß_3 \text{ (patient need factors)} + ß_4 \text{ (type of anti-asthmatic medication)}$$

$$+ ß5 \text{ (MPR)} + ß6 \text{ (Capitated vs. FFS)}] + e$$

where $Y = 1$ if some specific health care is utilized and Y = 0 if not; $f(\bullet)$ is the cumulative density function (CDF) of logistic distribution and e is the error term.

Asthma-related healthcare utilization (a count variable, the number of visits)

$$= ß_0 + ß_1 \text{ (patient predisposing factors)} + ß_2 \text{ (patient enabling factors)}$$

$$+ ß_3 \text{ (patient need factors)} + ß_4 \text{ (type of anti-asthmatic medication)}$$

$$+ ß_5 \text{ (MPR)} + ß_6 \text{ (capitated vs. FFS)} + e$$

Where count model consists of poisson regression and negative binomial regression, e is the error term.

Results

The study cohort consisted of a total of 6435 children with asthma. The mean age of the cohort was 8.1 years (standard deviation [SD]: 6.7) and comprised 61.8% females (n=3966). The majority of children were white (49.8%) followed by black (43.8%); only 6.3 percent were of Hispanic ethnicity. A total of 2607 (40.5%) children were enrolled in capitated health plans and the remaining children (59.5%) were enrolled in traditional FFS plans.

Bivariate analysis showed that the mean age of patients enrolled in capitated plans (7.5 years [SD: 6.4]) was a little lower than that of patients enrolled in FFS plans (8.7 [SD: 7.1]; P<0.01). The proportion of females (62.5%) was slightly higher in capitated plans compared to FFS plans (61.2%; P<0.01). Capitated plans had a little lower percentage of black (43.4%) than FFS plans (44.3%; P<0.01). When medication adherence was examined, patients in FFS plans had a somewhat higher medication

possession ratio (45.49%) than those in capitated plans (34.72%; $p<0.01$). When we examined health care service utilization in the pre-index period, visits to pediatricians were somewhat higher in FFS plans than in capitated plans (77.7% vs. 75.9%; $P<0.01$). When compared to patients in capitated plans, patients in FFS plan had significantly higher MPR values (34.72 vs. 45.49, $p<0.01$). The number of ER visits were much higher in capitated plans compared to FFS plans (76.0% vs. 46.4%; $P<0.05$); however there was no significant difference in number of hospitalizations.

[Table 5.3 goes about here]

Table 5.4 shows the comparison of medication adherence rates to asthmatic medication in asthmatic children across the health plans. Quantile regression analysis was conducted to measure the association between the type of health plan and medication possession ratio. The dependent variables were two quantile points (40% vs. 80%) which indicated low and high rates of medication adherence. In the case of quantile 40% of medication adherence, there were several factors associated with medication adherence. First, female, African American Race, and being Hispanic were negatively associated with medication adherence rates of quantile 40% ($p<0.05$). Second, asthma drug ratio (ratio of controller to total medication) was negatively associated with medication adherence rates ($p<0.01$). Third, total expenditure was positively associated with medication adherence rates ($p<0.01$). There was no significant difference in adherence between severity index, age, and total number of prescriptions.

We also evaluated the effect of the type of health plan on medication adherence rates on quantile 80%. There were several factors that influenced on medication adherence of 80%. First, patients with capitated plans had negatively associated with

medication adherence of 80% ($p<0.01$). Second, patients aged 5-18 years had positive associations with medication adherence rates of 80%. Third, patients belonging to African American race or Hispanic ethnicity were negatively associated with higher medication adherence. Fourth, patients with more risk of asthma severityhad a positive association with medication adherence rates ($p<0.05$). Finally, patients with prior outpatient visits were positively associated with medication adherence of 80% ($p<0.01$).

[Table 5.4 goes about here]

Table 5.5 shows the results of logistic regression measuring the association between type of Medicaid payment mechanisms and likelihood of health care utilization. In this case, the dependent variables were the likelihood of health care utilization (office visit, hospitalization, and ER visit). Regarding with likelihood of office visit, patients on capitated plans were 26% less likely to visit outpatient clinics as compared to those with FFS ($p<0.01$). Female children were 100% more likely to visit outpatient clinics as compared to male children. African American and Hispanic children were less likely to visit outpatient clinics than white patients (44% and 11% respectively, $p<0.05$). Patients with higher medication possession rates were 31% less likely to visit to the outpatient clinics. Patients with more risk of asthma severitywere 92% more likely to visit the outpatient clinic than those with no conditions ($p<0.01$). There were no significant effects of total number of prescriptions, prior number of outpatient visits and total expenditure on the number of office visits.

We also performed poisson regressions to find the association between type of Medicaid payment mechanisms and the number of outpatient visits. Table 5.5 shows that patients in capitated health plans had 52% lower number of outpatient visits compared

with those on FFS ($p<0.05$). Female patients had 18% higher number of outpatient visits compared with male patients ($p<0.05$). African American and Hispanic patients (18% and 31% respectively, $p<0.01$) were less likely to visit the outpatient clinic than White patients.

When predictors of hospitalizations were examined, patients in capitated health plans had 34% more likelihood of hospitalizations when compared to those in FFS ($p<0.01$). Hispanic children were 43% more likely to get hospitalized than White ($p<0.01$) children with asthma. Patients who had a higher medication possession rates were 18% less likely to have a hospitalization ($p<0.05$). The patients who had a prior outpatient visit were 19% less likely to get hospitalized than those who had not ($p<0.05$).

Examining frequency of hospitalizations, patients enrolled in capitated plans were 52% higher frequency of being hospitalized as compared to those with FFS. Hispanic children had 9% more frequently hospitalized compared to White ($p<0.05$) children with asthma. Patients who had a higher controller asthma drug ratio (the ratio of controller medication to total medications >0.5) were 41% less frequently hospitalized compared to those who did not ($p<0.01$). Patients who had a higher medication possession rates were 44% less frequently hospitalized ($p<0.01$). There were no significant effects of prior number of outpatient visits and total expenditures on the number of hospitalizations.

Results of logistic regression (Table 5.5) showed that asthmatic children enrolled in capitated health plans had 25% increased likelihood of having an emergency room visit when compared to those in FFS ($p<0.01$). Children who were in the age group 5-18 years were 61% less likely to have an emergency room visit when compared to those aged between 1-4 years ($p<0.01$). African American and Hispanic children with asthma

were (7% and 16% respectively, $p<0.01$) more likely to visit the ER department than White children. Children with asthma who took more controller medication were 61% less likely to visit the ER department than those who took more reliever medications ($p<0.01$). Children with prior either event of hospitalization or event of ER visit were 79% more likely to have ER visits in follow up period ($p<0.01$). Increase in one total number of prescriptions was associated with 61% increase in likelihood of emergency room visit ($p<0.01$).

Patients with capitated plans had 32% more frequently to have ER visits compared in FFS plan ($p<0.01$). African American and Hispanics had more (23% and 19%, respectively) frequent ER visits compared with White ($p<0.01$) children. Patients who had higher controller use (the ratio of controller medication to total medications >0.5) had 52% less frequent ER visits ($p<0.01$). Children with more risk of asthma severitywere more (7% and 57%, respectively) frequently seen in ERs ($p<0.01$). However, patients who had prior outpatient visits were 53% less frequent ER visits ($p<0.01$). There was no significant effect of total expenditure on the number of ER visits.

[Table 5.5 goes about here]

Discussion

There was a significant difference in anti-asthmatic medication adherence across different health plans. The cutoff for the medication possession rate (MPR) was 80%. At quantile of 80% MPR, compared to FFS plans, captitated plan enrollees had significantly lower medication adherence. Captitated plans provide fixed dollar amount per member per month for all pharmaceutical services which limits the prescription drug benefits for

captitated plan enrollees. These plans have caps where the plan enrollees get some benefits on the basis of a predictable level of total expenditure in a market where medication costs are increasing rapidly. Once the limit is reached, the plan enrollees have to bear out of pocket expenses for covering their pharmaceutical care. Also, patients enrolled in capitated plans were more likely to have hospitalizations and ER visits compared to FFS plan. Some of the negative aspects associated with enrolling in capitated plans are under-treatment, substitution due to inadequate health service coverage, cost shifting to other services, and poor treatment provision. Our study also showed that children enrolled in capitated plans had lower medication adherence compared to children enrolled in FFS plans which indicates that poor healthcare outcomes and excessive healthcare utilization might be associated with capitated plans.

Even though capitated plans have some negative aspects, they motivate providers and health plans by providing direct financial incentives to manage utilization. On the other hand, this might lead to limited patient follow-up or shorter treatment duration. This could also drive lower medication adherence in captitated patients. Higher medication adherence is associated with lower hospitalizations and ED visits in asthma patients. So, it is important to maintain medication adherence in pediatric asthma patients.

There are several limitations for this study. First, the states from which the Medicaid sample was drawn were not individually identified due to patient privacy reasons. Thus, we could not explore how eligibility requirements could vary study outcomes across the states. Second, like most studies that use claims data, specific clinical information that is only available from patient chart review or electronic medical

records was not obtainable. As such, data concerning physician adherence to guidelines was incomplete, and patients' severity of asthma and health beliefs were not included. So, asthma severity scores in the pre-index period were used as a proxy for patient risk. Finally, administrative data can also suffer from data entry errors or omissions that can be difficult to detect or evaluate.

Despite limitations of this study, further research is needed to understand the reasons for the higher health care utilization but lower medication adherence for capitated plan enrolled children with asthma compared to similarly placed children in FFS plans. In particular, it is important to decide whether lower medication adherence for capitated plan-enrolled asthmatic children influences higher health care utilization (hospitalizations and ER visits) for the same services provided in the long run. Lower medication adherence could have potentially adverse outcomes related to health care utilization. Alternatively, fixed payments could reflect less intensive or lower quality services provided to capitated plan enrolled children with asthma. Further research is needed to assess the type of quality of care delivered to children with asthma and its relation to health outcomes in capitated plan- enrolled children with asthma.

Table 5.3 Patient characteristics across the Health Plans

Variables	Measure	Capitation (n=2607) N (%) / mean (SD)	FFS (n=3828) N(%)/ mean (SD)	P-value
Age in years	Continuous	7.5 (6.4)	8.7 (7.1)	<0.01
Sex	Male	980 (37.5%)	1489 (38.8%)	<0.01
	Female	1627 (62.5%)	2339 (61.2%)	
Race/ethnicity	White	1320 (50.6%)	1872 (48.9%)	<0.01
	Black	1132 (43.4%)	1698 (44.3%)	
	Hispanic	155 (6.0%)	258 (6.7%)	
Visit to pediatrician	(yes/no)	1980 (75.9%)	2976 (77.7%)	<0.01
Hospitalization	(yes/no)	960 (36.8%)	1172 (30.6%)	0.187
ER visit	(yes/no)	1982 (76.0%)	1779 (46.4%)	<0.05
Medication Possession Ratio	Continuous	34.72 (29.53)	45.49 (41.11)	<0.01
MPR	Categorical			<0.05
<40%		1987 (76.2%)	2234 (58.3%)	
<80%		459 (17.6%)	689 (18%)	
>80%		161 (6.2%)	905 (23.7%)	
Asthma drug ratio > 0.5	(yes/no)	1182 (45.3%)	2367 (61.8%)	<0.01
Severity Index	Categorical			<0.01
1		860 (32.9%)	1362 (35.6%)	
2		884 (33.9%)	1287 (33.4%)	
3		863 (33.2%)	1179 (31.0%)	
Total number of prescriptions	Continuous	22.3 (19.3)	29.4 (26.4)	<0.01
Number of outpatient visits	count	7.2 (11.2)	10.7 (14.6)	<0.01

*: p<0.05 **: p<0.01

Severity index:

1: No events,

2: 15 or more beta- Agonist canisters or 1 or more filled prescriptions for oral corticosteroids,

3: Hospitalization or Emergency Department encounters

Table 5.4 Comparison of Predictors of Medication Adherence Rates across Health Plans using Quantile Regression.

	MPR – 40 % (quantile)		MPR – 80% (quantile)	
Variables	B (SE)	95% CI	B(SE)	95% CI
Type of health plan				
FFS	Ref		Ref	
Capitated	0.08 (0.52)	(-0.93, 1.10)	-1.14(0.58)**	(-2.28, -0.01)
Age group:				
1-4	Ref		Ref	
5-18	2.01 (0.53)	(0.97, 3.03)	2.35 (0.72)**	(0.94, 3.77)
Sex				
Male	Ref		Ref	
Female	-0.84 (0.43)*	(-1.68, -0.01)	-0.02(0.44)	(-0.88, 0.84)
Race/ethnicity				
White	Ref		Ref	
Black	-1.21 (0.44)**	(-2.08, -0.34)	-0.23 (1.57)	(-3.32, 2.85)
Hispanic	-1.81 (0.98)*	(-3.74, 0.13)	-0.88 (0.37)*	(-1.89, -0.11)
Visit to pediatrician	6.75 (1.04)**	(4.71, 8.79)	7.71(0.87)**	(6.00, 9.42)
Asthma drug ratio > 0.50	-13.08 (1.45)**	(-15.92, -10.24)	27.74 (1.43)**	(24.92, 30.56)
Severity Index				
1	Ref		Ref	
2	-1.99 (1.36)	(-4.66, 0.66)	0.06 (0.01)**	(0.05, 2.07)
3	-1.55 (1.41)	(-4.31, 1.27)	0.09 (0.04)*	(0.01. 3.18)
Total number of prescriptions	0.18 (0.28)	(-0.38, 0.72)	0.19 (0.04)*	(0.11, 1.26)
Number of outpatient visits	-0.03 (0.06)	(-0.22, 0.03)	0.02 (0.002)**	(0.01, 2.03)
Total Expenditure	0.18 (0.01)**	(0.15, 0.19)	0.15 (0.04)**	(0.06, 1.24)
Constant	21.97 (2.80)	(16.48, 27.46)	41.64(3.44)	(34.88, 48.41)

*: p<0.05 **: p<0.01

Severity index:

1: No events,

2: 15 or more beta- Agonist canisters or 1 or more filled prescriptions for oral corticosteroids,

3: Hospitalization or Emergency Department encounters

Table 5.5 Comparison of Health Care Utilization across Health Plans using Logistic and Poisson Regressions

	Office visit				Hospitalization				ER visits			
Variables	**OR**	95% CI	**IRR**	95% CI	**OR**	95% CI	**IRR**	95% CI	**OR**	95% CI	**IRR**	95% CI
Type of health plan												
FFS	Ref		Ref		Ref		Ref		Ref		Ref	
Capitated	0.74*	(0.59, 0.98)	0.48*	(0.28, 0.67)	1.34**	(1.07, 1.59)	1.52**	(1.16, 1.89)	1.25**	(1.03, 1.57)	1.32**	(1.22, 1.46)
Age group												
1-4	Ref		Ref		Ref		Ref		Ref		Ref	
5-18	0.79	(0.61, 1.03)	0.89	(0.72, 1.04)	1.29	(0.71, 2.33)	1.16	(0.91, 1.52)	0.39**	(0.13, 0.67)	0.78	(0.52, 1.15)
Sex												
Male	Ref		Ref		Ref		Ref		Ref		Ref	
Female	2.14**	(1.69, 2.87)	1.18*	(1.07, 1.31)	0.84	(0.65, 1.09)	0.93	(0.76, 1.18)	0.84	(0.53, 1.39)	0.96	(0.73, 1.26)
Race/Ethnicity												
White	Ref		Ref		Ref		Ref		Ref		Ref	
Black	0.56*	(0.27, 0.89)	0.82**	(0.70, 0.89)	0.79	(0.54, 1.07)	0.94	(0.75, 1.23)	1.07**	(1.02, 1.35)	1.23**	(1.10, 1.37)
Hispanic	0.89*	(0.62, 0.97)	0.69**	(0.44, 0.87)	1.43**	(1.02, 1.98)	1.09*	(1.07, 1.11)	1.16**	(1.04, 1.47)	1.19**	(1.04, 1.39)
Visit to Ped. Doctor	1.27	(0.73, 2.22)	1.06	(0.88, 1.21)	0.76*	(0.62, 0.98)	0.88	(0.56, 1.37)	1.01	(0.91, 1.23)	0.91	(0.54, 1.53)
Asthma drug ratio > 0.5	1.11	(0.74, 1.76)	1.01	(0.99, 1.02)	0.23**	(0.04, 0.42)	0.59**	(0.42, 0.72)	0.39**	(0.24, 0.59)	0.48**	(0.40, 0.54)
MPR	0.69*	(0.27, 0.99)	0.34**	(0.24, 0.45)	0.82*	(0.71, 0.99)	0.56**	(0.46, 0.69)	0.64**	(0.48, 0.75)	0.58**	(0.45, 0.73)
Severity Index												
1	Ref		Ref		Ref		Ref		Ref		Ref	
2	1.92**	(1.43, 2.49)	1.23**	(1.07, 1.38)	1.46**	(1.08, 1.89)	1.12	(0.79, 1.54)	1.24**	(1.06, 1.53)	1.07**	(1.02, 1.09)
3	1.27	(0.89, 1.75)	1.19**	(1.06, 1.31)	1.39**	(1.03, 1.76)	1.58**	(1.12, 2.64)	1.79**	(1.42, 2.31)	1.57**	(1.14, 2.34)
Total # of Prescriptions	1.05	(0.65, 1.46)	1.02	(0.89, 1.16)	1.42**	(1.18, 1.74)	1.06**	(1.02, 1.12)	1.61**	(1.29, 1.97)	1.11**	(1.04, 1.18)
# of Outpatient visits	1.01	(0.79, 1.37)	1.36	(0.72, 2.43)	0.81*	(0.66, 0.98)	1.10	(0.88, 1.44)	0.57**	(0.32, 0.86)	0.47**	(0.38, 0.57)
Total Expenditure	0.91	(0.64, 1.28)	0.99	(0.91, 1.08)	0.84	(0.63, 1.04)	0.91	(0.74, 1.13)	0.61	(0.21, 1.83)	0.76	(0.48, 1.19)

*: $p<0.05$ **: $p<0.01$

Severity index:

1: No events,

2: 15 or more beta- Agonist canisters or 1 or more filled prescriptions for oral corticosteroids,

3: Hospitalization or Emergency Department encounters

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CHAPTER 6

DISSERTATION MANUSCRIPT #3: COMPARISONS OF HEALTHCARE UTILIZATION OUTCOMES IN COMMERCIAL VERSUS MEDICAID-ENROLLED ASTHMATIC CHILDREN

ABSTRACT

The purpose of this retrospective cohort study was to examine the impact of the type of health plan (public insurance vs. private insurance) on outcomes (health care utilization and medication adherence) in pediatric asthmatic enrollees. Subjects were 11,027 asthmatic children (6,435 enrolled in Medicaid and 4,592 enrolled in a commercial HMO) who newly started asthma pharmacotherapy and were followed 12 months before after the index anti-asthmatic medication fill. Data on health care utilization and medication adherence were examined to compare health care utilization-based outcomes. Quantile regression analysis was used to examine predictors of medication adherence while logistic and poisson regressions were used to examine health care utilization predictors. Patients in private insurance plan had significantly higher medication adherence rates. ($p<0.01$) compared to those in Medicaid plans. Patients in Medicaid plans were also associated with 20% more inpatient hospitalizations and 50% increased odds of emergency department visits, but had 42% fewer outpatient visits compared to those in private plan (all $p<0.05$). Although children with asthma enrolled in Medicaid receive fairly comprehensive coverage of medical services, further research is needed to determine the reasons for poor healthcare utilization related outcomes in this population.

Introduction

Asthma is a chronic respiratory disease characterized by episodes or attacks of inflammation and narrowing of small airways in respiratory system. Asthma attacks can vary from mild to life-threatening and may involve shortness of breath, coughing, wheezing, chest pains or tightness, or a combination of these symptoms. Many factors like allergens, infections, exercise, abrupt changes in the weather, or exposure to airway irritants, such as a tobacco smoke can trigger an asthma attack (NCHS, 2005).

Some of the most established measures of prevalence of asthma are the Center for Diseases Control's (CDC) Behavioral Risk Factor Surveillance Survey (BRFSS) and the National Health Interview Survey (NHIS) (CDC 2007; NCHS 2005). These surveys have the usual limitations associated with self-reported data like non-response bias, and low precision for state and sub-state estimates associated with surveys that used multistage sample selection with the goal of developing national estimates. Additionally, the BRFSS only surveys adults, and the NHIS had a relatively small sample of children that precludes state level estimation. A change in NHIS questionnaire language in 1997 concerning asthma prevalence made comparisons to periods before and after that date problematic. Given these limitations, estimates of the lifetime prevalence of asthma among adults had ranged from 10-12% over the past 6 years while current asthma for adults is generally reported at approximately 7-8% (Mannino 2002). National estimates suggested that lifetime asthma prevalence for children less than 18 was approximately 12.5% with age specific prevalence of 7.5, 14, and 14.7 percent for children aged 0-4, 5-11, and 12-17 respectively (CDC 2005).

Poor and minority children bear a disproportionate share of the population burden of asthma. This is reflected in higher rates of hospitalization and emergency room visits for asthma, lower utilization of pharmaceutical agents known to improve control of asthma, higher prevalence and severity of the disease, lower rates of utilization of primary care services related to asthma (Akinbami and Schoendorf 2002; Ash 2005; Dougherty 2005; Gold and Wright 2005; Krishnan 2001; Lieu et al. 2002; Weiss, Sullivan, and Lyttle 2000). This is likely due to characteristics of the U.S. medical care system (especially financing), and its concomitant impact on access to medical care (Bindman 1995; Friedman 2001; Homer 1996) and to individual characteristics of the population (Lynch 1997). Poor children are more vulnerable to poor health in general because they are apt to have multiple risk factors (Aday 2001; Chang et al. 2011). Investigation of single risk factors is useful but is perhaps does not reflect the real-world scenarios where risk factors often cluster, e.g., low education and low income (Stevens et al. 2006). Previous research has suggested that multiple risk factors may produce an additive impact on children's mental, physical, and social health and school performance (Starfield, Robertson, and Riley 2002; Stevens et al. 2006) and with asthma health in particular (Wood 2002). This study examined the differential impact of managed care services on healthcare utilization, access to care and quality of pharmaceutical care and associated outcomes in both Medicaid (poorer) and privately insured (richer)pediatric populations with asthma.

One of the key components for long-term control of asthma is pharmacotherapy, and previous studies confirm that the daily use of steroid inhalant would greatly reduce asthma symptoms, occurrence of severe exacerbations, use of quick-relief medications,

and lung function measured by peak flow, FEV and airway hyper responsiveness (Cloutier et al. 2005; Cochrane 1999). Several factors affect patient adherence to medications. Insurance coverage/type of health plan plays a key role in providing access to essential health care services. With no or limited insurance coverage, patients who use more drugs face increasing out-of-pocket costs, which may result in decreased adherence (Janson and Weiss 2004). The access to pharmaceutical innovation is also mediated by the patient's primary source of health insurance coverage. Patients with public insurance (Medicare and Medicaid) are less likely to receive newer medications for the management of chronic diseases (Cloutier et al. 2005). Managed care organizations provide services to both types of populations in order to improve asthma quality of care and healthcare utilization through provision of a) equal access to care using shared provider networks, b) case management using patient support and c) shared management expertise for all plans. The plan characteristics and services provided in both the programs might share dissimilarities with regards to certain services like patient cost sharing or transportation assistance.

The managed care brought about a revolution in the US healthcare system in the 1990s by significantly bringing down the healthcare spending throughout the nation. During the recent years, people had been unhappy about some of the restrictive policies of managed care and had shown preference for the less restrictive Preferred Provider Organizations (PPOs). PPOs have managed cost controls using their negotiation power with regards to reimbursement rates. The evidence quality of care provided by MCOs showed inconclusive results and the evidence about quality of care provided by other plans is absent. Evidence of gaining long term financial incentives through delivery of

evidence based quality health care and promotion of preventive care by MCOs over gaining short term incentives through restricting utilization lacks sufficient evidence (Miller and Luft 1993; Miller and Luft 1994a, 1994b; Miller and Luft 1997, 2002). Previous studies have examined health services utilization and expenditures in children with asthma by individual states or individual health plans (Draper, Hurley, and Short 2004; Twiggs et al. 2002; Wagner 2005). These studies had smaller sample sizes (Lapolla et al. 2004) and looked at study periods when patients had hospital stays (Ash 2005; Bodenheimer 2002).

The purpose of our study was to compare prevalence and estimates of health care utilization and expenditures associated with asthma in children aged 1–18 years across those enrolled in commercial (HMO) plans and those enrolled in public (Medicaid) plans to determine potential differences in quality and access to asthma heath care in inpatient or outpatient settings.

Materials and Methods

This study used the MarketScan® Medicaid/Commercial claims dataset licensed from Thomson Medstat for the period 2005-2007. In 2007, the Medicaid database included claims for approximately 5.4 million pediatric enrollees in eight unidentified states, and the Commercial database included claims for 15.5 million enrollees from 100 payers across the U.S. We refer to children in the commercial database as privately insured. The states were de-identified. However, the data consisted of at least one state from each U.S. region. The database consisted of medical (outpatient and inpatient services), drug, and long-term care claims and eligibility records for enrollees from these

states. The prescription drug coverage was provided by all the states. The data were available from 2005 to 2007 representing around 5.4 million individuals in the United States (MarketScan® research database, 2008). For the purpose of this study, the research database were updated and queried from January 1, 2005 to December 31, 2007. The database was HIPPA compliant and features encrypted member and service provider identification numbers. The data from these states provided a fairly large sample of the enrollees in the U.S. The dataset also provided additional information on variables such as race/ethnicity, Medicare eligibility and Medicaid eligibility / federal aid category.

The study population comprised of children aged 0 to 18 years of age. The patients with a diagnosis of asthma and a prescription of a new asthma medication (Inhaled Bronchodilator, Anti-Inflammatory, Systematic Bronchodilator, Systematic Corticosteroid and/or Leukotriene Modifiers) during the study time period included. Subjects with a primary or secondary diagnosis of asthma identified using the International Classification of Diseases Code 9th Revision (ICD-9: 493.XX) obtained from the inpatient claims during the study test period. Only subjects who have maintained continuous eligibility for 1 year period between January 1, 2005 and December 31, 2005 included in the study. The date for the first prescription claim for anti-asthmatic medication use designated as an index date, where the medication identified using relevant National Drug Codes (NDC) recorded in the claim records. The study required all patients to have continuous health plan enrollment for at least 1 year prior to and following their index date by insuring that each patient's index date presents a reasonable marker for treatment initiation as well as making sure that any observed lack of health care events was due to a lack of medical activity and not due to cessation of insurance.

The identification period ranged from January 1, 2006 to December 31, 2007. During this time period, any patients who have an asthma diagnosis and who were prescribed an anti-asthmatic medication were included.

Measurement and Outcomes

The operational definitions and measurements of the variables utilized in this study discussed in this section. The dependent variables for this study are medication adherence, hospitalizations, outpatient visits, and emergency room (ER) visits. The main independent variable tested in this study is the type of health plan (public vs. private). Other independent covariates include age, gender, access to specialty care, and disease severity. The operational definition of each variable described in the following sections:

Medication adherence

Medication adherence signified medication usage by patients. It was basically the act of conforming to the physician's recommendations about the timing, dosage, and frequency of medication intake. The International Society of Pharmacoeconomics and Outcomes research defined medication adherence as the extent to which a patient complies with the intended dosing regimen (Hess 2006). The unit of measure for compliance was administered doses per defined period of time, reported as a proportion (%) of prescribed doses (D) taken at the prescribed time interval (T) as measured by the period of time.

Medication adherence can be measured directly and indirectly by utilizing biological markers, blood and urine assays, patient interviews, pill counts, prescription

refills, and electronic monitoring (Claxton, Cramer, and Pierce 2001; Hess 2006). Since the study uses insurance claims database, prescription refill patterns can be used to capture medication adherence. The information thus obtained records the frequency and timeliness of refills of prescribed medication and eliminates any Hawthorne effect. Also pharmacy records had predictive validity as measures of cumulative exposure and gaps in medication supply (Steiner 1998). On the other hand the method also had some limitations like presence of data on unusual refill patterns, multiple conflicting drugs and inability to capture all data about patients visiting multiple pharmacies. Also utilization of pharmacy records assumed that "a prescription filled is a prescription taken" (Balkrishnan 2005). The data cannot measure actual consumption but only estimates about actual medication consumption (Hess 2006).

Medication adherence in this study indicates patient's intake of oral anti-asthmatic prescription medication. Data from the pharmacy claims database can be used to measure medication adherence by several ways. Medication possession ratio (MPR) is one such measure used to calculate medication adherence. For the purposes of this study, MPR is calculated as the days of anti-asthmatic medication supply dispensed divided by the number of days in the observation period (#365) minus the number of days in the hospital (Camargo 2007; Hess 2006; Sokol et al. 2005). Thus, MPR for this study is defined as

MPR= # of days supply of anti-asthmatic medication in the post-index period / # of days in the study period (365 days).

The observation period in this study included the post-index period or 12 month follow up period which was consistent for each patient. The number of hospital days was subtracted from the denominator because any drug taken during this period was given to

the patient by the hospital and was not possible to capture in the pharmacy records. The information on each filled prescription included of dispensing, quantity dispensed, and days supply of medication. We were placed into 2 categories: asthma controller medications and reliever medications. Controller medication consisted of ICSs, ICSs/LABAs, LABAs, LTRAs and theophylline. Reliever medication included short-acting β-agonists (SABAs) and systemic corticosteroids. We examined the distribution of the day of supply for the medications, summing for each patient the number of days supplied by their prescriptions for the 365 days of follow-up. The MPR was calculated for asthma medication possession on a given day of the year and avoided double counting of multiple asthma medication use on the same day by the same patient.

Healthcare Service Utilization

Patients were followed during pre-index and post-index period (i.e. 12 month before and 12 months after the index date) to assess their healthcare utilization in terms of hospitalizations, ER visits, outpatient visits. The variables hospitalizations, ER visits and outpatient visits are used as a proxy for health care service utilization. To identify hospitalization event in patients, their admission and discharge dates recorded in inpatient service files are used. CPT codes as well as service codes were taken from the inpatient and outpatient services files for identifying events of ER visit and outpatient visits.

Sociodemographic variables

The following sociodemographic variables were taken from the Medicaid data: gender, birth year and race/ethnicity. Birth year of the patients is used to calculate their age. Race or ethnicity of patients is classified as whites, blacks, Hispanics and others.

Proxy for asthma severity

Based on the established relation between disease severity and intensity of treatment, severity of a condition in the current period is inferred by a risk of an exacerbation in a future. Some of the independent predictors widely used in the literature for ascertaining future asthma-related emergency hospital utilization (EHU) are hospitalizations, use of emergency department and use of oral corticosteroids (Roth 2004; Schatz 2004). Severity of asthma in the current period was assessed by determining high risk of EHU. A popular type of risk stratification scheme used is a simple three-level risk stratification which ranks risk of future EHU based on a point system applied to a period portraying current utilization. Points are assigned to different indicators of future asthma related EHU. Asthma hospitalizations or ED encounters in the 12-month base period are assigned 2 points, 15 or more beta-agonist canisters in the base period are assigned 1 point and 1 or more filled prescriptions for oral corticosteroids are assigned 1 point. Members are differentiated on the basis of assignment of points. Members with 2 or more points, 1 point and 0 point are classified as high risk, medium risk and low risk groups respectively (Schatz 2004). This has been summarized in the following Table 6.1.

Table 6.1 Three-Level Risk Stratification of Asthma Severity

Event per 12-month base period	Potential Point Assignment	Low Risk 0 Points	Medium Risk 1 Points	High Risk 2 or more Points
A. ED visits asthma encounter	2	0	0	2
B. IP visits asthma encounter	2	0	0	2
C. 15 or more beta-agonist canisters dispensed	1	0	1	1
D. Any oral corticosteroid prescriptions dispensed	1	0	1	1
Required events for risk level		No listed events	Either C or D	Either A or B and/or C and D

Therefore, the measurement of asthma severity is the probability of an asthmatic member having a risk score (severity proxy) of 0,1, or 2.

Table 6.2 Analytical Framework and Study Covariates for Chapter 6

Target population: Children aged 0 to 18 years with a diagnosis of asthma receiving care in a Medicaid Setting and Commercial plan
Outcomes: Medication Possession Rate, Healthcare services utilization (ER, IP & OP),
Regressor of interest: Health plan (Public vs. Private)
Covariates:
Patient Characteristics: Patient's age, gender, and race/ethnicity (Predisposing factors)
Patient's Medical Conditions: Asthma severity (Need factors)
Physician Characteristics: Specialty (Enabling factors)
Asthma Drug Ratio: A controller to total asthma medication ratio of 0.5 or more

Statistical Analysis

Descriptive statistics were performed to compare baseline characteristics. Continuous data were described by means and standard deviations, and nominal and categorical data were described by frequencies and percentages. Unadjusted demographic, clinical, and medication characteristic comparisons between groups were completed using independent sample t tests for evaluation of continuous variables and chi-square tests for categorical variables. The data were analyzed using STATA software version 10 (Stata Corp, College Station, TX). All univariate, bivariate, and multivariate analyses were conducted at a set a priori level of significance (0.05).

Quantile regression was used to evaluate the relationship between the type of health plan and medication adherence after controlling for potential covariates. Quantile regression provides a convenient linear framework for examining how the quantiles of a dependent variable change in response to a set of independent variables, allowing the estimation of linear conditional quantile functions. The primary independent variable was the type of health plan (public vs. private). Other covariates included in the model were demographic (age, sex, rac/ethnicity), clinical variables such as severity index including health care resource utilization in pre-index period (hospitalizations, ER visits), and therapy-related variables (appropriate medication choice).

The normality was determined using the Shapiro–Wilk test. The heteroskedasticity was determined using the White test. The data were also examined for multicollinearity (ie, a linear relationship between predictor variables). A variation inflation factor of <10 was considered to indicate absence of multicollinearity.

Logistic regression model was used to predict the likelihood of healthcare utilization (outpatient, inpatient, and ER visit). Additionally, the poisson regression model was used to predict the frequency of healthcare utilization (outpatient, inpatient, and ER visit) while the zero-inflated poisson regression model was used to predict the number of hospitalizations. The adequacy of model was examined using the Vuong test.

The following were the description of the models for this study. Before we examined the main outcomes, we tested for differences across groups by Chow test. The Chow test examines whether a regression function is different for one group (Medicaid) versus another (Private); it can be thought of as simply testing for the joint significance of the dummy and its interactions with all other covariates, thus providing evidence that we can merge two data sources (in this case, two sets of claims data). After pooling data with Medicaid and private insurance, we computed the proper F statistic without running the unrestricted model with interactions with all k continuous variables. The results of this test indicated that the data could be pooled for analysis ($F= 46.14$, $p<0.000$).

We then examined predictors of medication adherence using the quantile regression and the following model:

MPR (anti-asthmatic medication adherence-quantile regression)

$= ß_0 + ß_1$ (patient predisposing factors) $+ ß_2$ (patient enabling factors)

$+ ß_3$ (patient need factors) $+ ß_4$ (type of anti-asthmatic medication)

$+ ß_5$ (Medicaid vs. Commercial) + e

Where MPR stands for the medication possession ratio to measure anti-asthmatic medication adherence, and e is the error term.

We then examined the likelihood and frequency of health care service utilization using a series of logistic and poisson regression models which can be delineated as follows:

$$\Pr[Y\ [\text{health care utilization}] = 0 \text{ or } 1]$$

$$= f[\beta_0 + \beta_1\ (\text{patient predisposing factors}) + \beta_2\ (\text{patient enabling factors})$$

$$+ \beta_3\ (\text{patient need factors}) + \beta_4\ (\text{type of anti-asthmatic medication})$$

$$+ \beta_5\ (\text{MPR}) + \beta_6\ (\text{Medicaid vs. Commercial})] + e$$

where $Y = 1$ if some specific health care is utilized and $Y = 0$ if not; $f(\bullet)$ is the cumulative density function (CDF) of logistic distribution and e is the error term.

$$\text{Asthma-related healthcare utilization (a count variable, the number of visits)}$$

$$= \beta_0 + \beta_1\ (\text{patient predisposing factors}) + \beta_2\ (\text{patient enabling factors})$$

$$+ \beta_3\ (\text{patient need factors}) + \beta_4\ (\text{type of anti-asthmatic medication})$$

$$+ \beta_5\ (\text{MPR}) + \beta_6\ (\text{Medicaid vs. Commercial}) + e$$

Results

The study cohort consisted of a total 11,027 children with asthma. The characteristics of this cohort with a mean age 8.2 years (standard deviation [SD]: 6.9) are shown in Table 6.3. A total of 6,435 children were enrolled in Medicaid and 4,592 children were enrolled in private insurance, reflecting the lower prevalence of children in the commercial claims data. Among the population captured in the commercial claims dataset, Medicaid enrollees were slightly more likely than privately insured children to have had a hospitalization in 2007, 33.1% vs. 28.7% ($p<0.05$). When compared to Medicaid patients, children enrolled in private insurance had a significantly higher MPR

value (40.11 vs. 45.74; $p<0.01$). Medicaid enrollees were more likely than privately insured children to have had an ER visit in 2007, 58.4% vs. 32.6% ($p<0.01$). Also, 77.0% of Medicaid and 83.9% of privately insurance enrollees had at least one pediatrician visit ($p<0.01$). The mean number of outpatient visits was 8.9 for Medicaid and 11.5 for private insurance enrollees ($p<0.01$). The total number of asthma medications prescribed were more in Medicaid enrollees compared to private insurance enrollees, 25.9 vs. 12.8 ($p<0.01$). Mean total expenditure were $11,075 for Medicaid and $14,722 for private insurance enrollees with asthma; that is, 25% lower for Medicaid.

[Table 6.3 goes about here]

Table 6.4 showed the comparison of predictors of medication adherence rates to asthmatic medication in asthmatic children across the health plans (public vs. private). We examined predictors using two cutoff rates of medication possession (40% vs. 80%). In this case of quantile 40% of medication adherence, there were several factors associated with medication adherence. First, female children were positively associated with medication adherence of 40% (1.13, $p<0.01$). Second, the patients aged 5-18 years had a positive association with low medication adherence (0.36, $p<0.05$) as well compared to the very young children. Third, Hispanic children had a slightly positive association with low medication adherence (0.13, $p<0.05$). Fourth, total expenditure is a little positively associated with low medication adherence (0.03, $p<0.01$). There were no significant differences in adherence between severity index, total number of prescription and number of outpatient visits.

We also examined the effect of the type of health plan (public vs. private) on higher medication adherence rates (quantile 80%). There were again several factors that

were associated with higher medication adherence. First, children with private insurance plan had strong positively associations with higher medication adherence (β=4.79, $p<0.01$). Second, children aged 5-18 years had positively associated with higher medication adherence (β=4.94, $p<0.01$). Third, patients who saw pediatricians were significantly positively associated with higher medication adherence (β=6.51, $p<0.01$). Fourth, asthma controller ratio > 0.5 (ratio of controller medication to total medication) was positively associated with higher medication adherence (β=1.08, $p<0.01$). Fifth, children with more risk of asthma severitywere positively associated with higher medication adherence (β=0.07, $p<0.01$). Finally, children with prior outpatient visits were positively associated with higher medication adherence (β=0.02, $p<0.05$).

[Table 6.4 goes about here]

Table 6.5 shows the results of logistic regression measuring the association between type of insurance and likelihood of health care service utilization. In this case, the dependent variables were the likelihood of health care utilization (office visit, hospitalization, and ER visit). When likelihood of office visit was examined, patients with private insurance plans were 23% more likely to visit the outpatient clinics as compared to those with public insurance ($p<0.01$). Female children were 32% more likely to visit the outpatient clinic as compared to male children. African American and Hispanic children were (46% and 38% respectively, $p<0.05$) less likely to visit the outpatient clinic than White children. There were no significant effects of total number of prescriptions, prior number of outpatient visits and total expenditure on the number of office visits. From the results of poisson regressions (Table 6.5), examining the number of office visits, there was evidence of higher frequency of office visits among private

children (1.42, $p<0.01$) and as expected increased frequency of office visit with increasing age group (1.29, $p<0.01$). Unsurprisingly, African American and Hispanic children had lower (37% and 24%, respectively) frequencies of office visits ($p<0.05$).

When hospitalizations were examined, patients with private insurance plans had 68% lower likelihood of hospitalization when compared to those with public insurance ($p<0.01$). African American and Hispanic children were (82% and 22% respectively, $p<0.01$) more likely to get hospitalized compared to White children ($p<0.01$). Patients who had higher medication possession rates were 41% less likely to have a hospitalization ($p<0.05$). Patients who had a prior outpatient visit were 38% less likely to get hospitalized than those who did not have one ($p<0.05$). Next when we examined hospitalization frequency, children with private insurance plan were 20% less likely to be getting hospitalized as compared to those with public insurance plan. Hispanic children were 52% more likely to have a hospitalization compared with White ($p<0.05$). Patients who had a good medication adherence rates were 18% less likely to have a hospitalization (0.82, $p<0.01$). As expected, higher asthma severity was associated with higher likelihood of the hospitalization (1.41, $p<0.05$). There were no significant effect of total expenditure, total number of prescription, and asthma drug ratio on the number of hospitalizations.

When the likelihood of emergency room visits was examined, children with private insurance plans had 28% lower likelihood of having an emergency room visit when compared to those who with public insurance ($p<0.01$). African American and Hispanic children were (8% and 52% respectively, $p<0.01$) more likely to visit the ER department compared to White children. Patients who took more controller medication

were 47% less likely to visit the ER department than those who took more reliever medicationS ($p<0.01$). Children with prior either event of hospitalization or event of ER visit were 24% more likely to have ER visits in follow up period ($p<0.01$). A unit Increase in total number of prescriptions was associated with 13% increase in likelihood of emergency room visit ($p<0.01$). The patients who had a prior outpatient visit were 61% less likely to have an ER visit than those who had not ($p<0.05$). When frequency of ER visits was examined, privately insured children has a lower frequency of an ER visit compared to publicly insured children (0.50, $p<0.01$). African American and Hispanic children were more (17% and 41%, respectively) likely to have the ER visits compared to White ($p<0.05$ and $p< 0.01$) children. Children who were seen by pediatricians had 61% less frequent ER visits ($p<0.01$). Unsurprisingly, higher asthma severity was associated with higher frequency of ER visits (1.28, $p<0.01$; 1.06, $p<0.05$). Patients who had visits to outpatient clinics were 55% less frequent ER visits ($p<0.01$).

[Table 6.5 goes about here]

Discussion

This study provides the first comparison of pharmaceutical care and health care utilization and cost among publicly and privately insured children with asthma. We found that asthmatic children enrolled in Medicaid had significantly more likely to have an ED visit and inpatient hospital visits. Higher health care service utilization (ER visits and Hospitalization) by asthmatic children enrolled in Medicaid may reflect differences in quality of care because many of these children with asthma were not seen by specialists in spite of medical insurance. Though the public insurance enrollees have access to a

medical home and other support mechanisms such as transportation and translation services, there was a notable disparity between the public and private insurance enrollees with regards to use of ER for pediatric asthma care. The higher use of ER for asthma related visits might be due to several reasons. The ER might be a regular source of care among the Medicaid enrollees or there might a failure on the part of the physicians and parents adhere to optimal asthma management practices for asthmatic children. There is requirement of better coordination between the government, private payers, various physicians, facility providers and other stakeholders to reduce the unnecessary use of ER.

The Aday Anderson model of healthcare utilization was used as the theoretical framework for this study. Only some of the variables from the model were significant predictors of asthma in children. Among the predisposing variables, age and race/ethnicity were considered to be significantly associated with ER visits and hospitalizations. Gender was not a significant predictor of either ER visits or hospitalization which indicates that gender is not relevant after fully adjusting for other factors. The need factors in the model were measured using the well-validated asthma severity index. Disease severity was one of the need factors and children with higher asthma severity had a greater likelihood of having ER visits and hospitalizations. One of the enabling factors was physician specialties. Our study showed that children who regularly had a pediatrician visit had a less likelihood of having ER visits and hospitalizations.

This study has some limitations. First, the Marketscan Medicaid dataset did not allow the state identification so it was not possible to identify trends specifically by individual states. Also patient enrollment before the study period was not known which

might change the impact of managed care environment on the patients who had a longer exposure to the same. A longer follow up time might have improved the models. The time to event modeling technique was used which gave a more direct measure of the influence of time on asthma health outcomes. The frequency of short periods of disenrollment was more common in publicly insured population compared to privately insured population. This happened when the eligibility of publicly insured population expired or when they failed to meet recertification requirements on a timely basis. The disenrollment period did not impact the average length of enrollment of the participants in the study but it was not possible to capture the source of care of the participants during the disenrollment. There might be loss of coverage due to actual change in eligibility status but continuity of care can be enhanced by reducing loss of coverage occurring because of administrative reasons.

Even though this study has several limitations, the study has some important implications for health care providers and policy makers. The delivery of healthcare among the publicly and privately insured enrollees is mainly associated with a SES disparity. This disparity in the delivery of healthcare is characterized by lost productivity in the workforce and higher medical costs resulting from untreated chronic conditions for a long time. Even though concerns for equity in healthcare go beyond health care providers and health plans involved in case management, they too, to an extent, contribute to some of the disparities. Some physicians or facilities might show resistance towards changing the traditional methods of practice due to lack of motivation resulting from inadequate incentives to optimize treatment and services. Lack of incentives to provide quality care might also be one of the reasons. The financial incentives created by

the current financing mechanism in the US are being discussed in detail elsewhere. In summary, there are no major incentives above and beyond financial incentives that motivate healthcare providers to make patients change their health providers. The improvement in quality brought about by providers and health plans is mainly driven by financial incentives.

Table 6.3 Patient Characteristics across the Health Plans

Variables	Measure	Public (n=6435) N (%) / mean (SD)	Private (n=4592) N(%)/ mean (SD)	P-value
Age in years	Continuous	8.1 (6.8)	8.3 (7.1)	0.365
Sex	Male	2469 (38.3%)	2280 (49.6%)	<0.01
	Female	3966 (61.7%)	2312 (50.4%)	
Race/ethnicity	White	3192 (49.6%)	2287 (49.8%)	0.12
	Black	2830 (43.9%)	1565 (34.1%)	
	Hispanic	413 (6.5%)	740 (16.1%)	
Visit to pediatrician	(yes/no)	4956 (77.0%)	3854 (83.9%)	<0.01
Hospitalization	(yes/no)	2132 (33.1%)	1320 (28.7%)	<0.05
ER visit	(yes/no)	3761 (58.4%)	1498 (32.6%)	<0.01
Medication Possession Ratio	Continuous	40.11 (35.32)	45.74 (31.52)	<0.01
MPR	Categorical			<0.01
<40%		4839 (75.1%)	2608 (56.7%)	
<80%		1299 (20.1%)	1446 (31.5%)	
>80%		297 (4.6%)	538 (11.8%)	
Asthma drug ratio > 0.50	(yes/no)	3549 (55.1%)	3198 (69.6%)	<0.01
Severity Index	Categorical			<0.05
1		2042 (31.7%)	1265 (27.5%)	
2		2171 (33.7%)	1788 (38.9%)	
3		2222 (34.5%)	1539 (33.6%)	
Total number of prescriptions	Continuous	25.9 (22.9)	12.8 (9.6)	<0.01
Number of outpatient visits	Count	8.9 (12.9)	11.5 (10.6)	<0.05
Total Expenditure	Continuous	$11,075 (29,587)	$14,722 (35,276)	<0.01

*: p<0.05 **: p<0.01

Severity index:

1: No events,

2: 15 or more beta- Agonist canisters or 1 or more filled prescriptions for oral corticosteroids,

3: Hospitalization or Emergency Department encounters

Table 6.4 Comparison of Medication Adherence Rates across Health Plans

	MPR – 40 % (quantile)		MPR – 80% (quantile)	
Variables	B (SE)	95% CI	B(SE)	95% CI
Type of health plan				
Public	Ref		Ref	
Private	3.30 (2.54)	(-1.69, 8.29)	4.79 (0.95)**	(2.92, 6.66)
Age group:				
1-4	Ref		Ref	
5-18	1.13 (0.33)**	(0.47, 1.79)	4.94 (0.59)**	(3.79, 6.11)
Sex				
Male	Ref		Ref	
Female	0.36 (2.02)*	(0.03, 0.76)	2.22 (0.46)**	(1.31, 3.13)
Race/ethnicity				
White	Ref		Ref	
Black	0.05 (0.18)	(-0.31, 0.42)	-0.0002 (0.69)	(-1.36, 1.36)
Hispanic	0.13 (0.05)*	(0.02, 0.23)	-2.43 (1.96)	(-6.27, 1.41)
Visit to pediatrician	2.31 (0.78)**	(0.77, 3.85)	6.51 (0.94)**	(4.66, 8.35)
Asthma drug ratio > 0.50	0.39 (1.28)	(-2.11, 2.91)	1.08 (0.31)**	(0.48, 1.68)
Severity Index				
1	Ref		Ref	
2	0.09 (0.69)	(-1.25, 1.45)	-1.87 (2.19)	(-6.18, 2.42)
3	0.21 (0.74)	(-1.24, 1.67)	0.07 (0.02)**	(0.01, 1.43)
Total number of prescriptions	0.18 (0.28)	(-0.38, 0.72)	-0.11 (0.02)**	(-0.16, -0.07)
Number of outpatient visits	-0.06 (0.05)	(-0.13, 0.08)	0.02 (0.01)*	(0.02, 0.02)
Total Expenditure	0.03 (0.007)**	(0.02, 0.04)	0.04 (0.004)**	(0.03, 0.06)
Constant	6.44 (1.22)	(4.05, 8.84)	21.66 (2.77)	(16.23, 27.09)
Chow-test Asthma drug ratio and Private insurance F(4, 10801) = 46.14 P> F = 0.0000				

*: p<0.05 **: p<0.01

Severity index:

1: No events,

2: 15 or more beta- Agonist canisters or 1 or more filled prescriptions for oral corticosteroids,

3: Hospitalization or Emergency Department encounters

Table 6.5 Comparison of Health Care Utilization across Health Plans

	Office visit				Hospitalization				ER visits			
Variables	**OR**	95% CI	**IRR**	95% CI	**OR**	95% CI	**IRR**	95% CI	**OR**	95% CI	**IRR**	95% CI
Type of health plan												
Public	Ref		Ref		Ref		Ref		Ref		Ref	
Private	1.23**	(1.02, 1.74)	1.42**	(1.15, 1.75)	0.32**	(0.16, 0.68)	0.80*	(0.71, 0.91)	0.72**	(0.41, 0.99)	0.50**	(0.39, 0.65)
Age group												
1-4	Ref		Ref		Ref		Ref		Ref		Ref	
5-18	2.12**	(1.62, 2.64)	1.29**	(1.04, 1.80)	1.04	(0.56, 1.75)	0.99	(0.63, 1.54)	1.21	(0.92, 1.66)	1.03	(0.81, 1.31)
Sex												
Male	Ref		Ref		Ref		Ref		Ref		Ref	
Female	1.32*	(1.04, 1.69)	1.12	(0.96, 1.37)	1.89**	(1.57, 2.36)	1.05*	(1.01, 1.43)	1.31	(0.94, 1.79)	1.27	(0.67, 2.18)
Race/Ethnicity												
White	Ref		Ref		Ref		Ref		Ref		Ref	
Black	0.54**	(0.28, 0.69)	0.63*	(0.54, 0.97)	1.82**	(1.21, 2.64)	1.04	(0.58, 2.23)	1.08*	(1.01, 1.18)	1.17*	(1.05, 1.28)
Hispanic	0.62**	(0.49, 0.85)	0.76*	(0.63, 0.98)	1.22**	(1.09, 1.42)	1.52*	(1.05, 2.09)	1.52*	(1.05, 2.19)	1.41**	(1.17, 1.69)
Visit to Ped. Doctor	1.11	(0.93, 1.23)	1.09	(0.88, 1.55)	0.78**	(0.55, 0.96)	0.91*	(0.82, 0.99)	0.96**	(0.93, 0.99)	0.39**	(0.32, 0.48)
Asthma drug ratio > 0.5	1.43	(0.47, 2.15)	1.16	(0.51, 1.63)	0.95*	(0.86, 0.99)	1.01	(0.96, 1.05)	0.53**	(0.39, 0.73)	0.77**	(0.52, 0.99)
MPR	1.02	(0.84, 1.49)	0.95	(0.80, 1.12)	0.59**	(0.34, 0.86)	0.82**	(0.59, 0.91)	0.61**	(0.31, 0.93)	0.88**	(0.56, 0.99)
Severity Index												
1	Ref		Ref		Ref		Ref		Ref		Ref	
2	1.09	(0.88, 1.36)	1.06	(0.86, 1.52)	1.15*	(1.07, 1.25)	1.41*	(1.05, 1.89)	1.92**	(1.50, 2.45)	1.28**	(1.15, 1.42)
3	1.29*	(1.01, 1.69)	1.12*	(1.01, 1.45)	1.72*	(1.12, 2.63)	1.19	(1.09, 1.28)	1.24**	(1.08, 1.42)	1.06*	(1.02, 1.20)
Total # of Prescriptions	1.22	(0.83, 1.58)	1.04	(0.89, 1.18)	0.95**	(0.91, 0.99)	0.94	(0.76, 1.16)	1.13**	(1.02, 1.25)	1.10**	(1.05, 1.18)
# of Outpatient visits	1.28	(0.98, 1.53)	1.05	(0.93, 1.21)	0.62*	(0.47, 0.79)	0.64*	(0.49, 0.87)	0.39**	(0.19, 0.63)	0.45**	(0.33, 0.61)
Total Expenditure	0.99	(0.75, 1.22)	1.03	(0.81, 1.35)	1.05	(0.88, 1.26)	1.01	(0.89, 1.21)	1.06	(0.88, 1.29)	0.81	(0.66, 1.00)

*: $p<0.05$ **: $p<0.01$

Severity index:

1: No events,

2: 15 or more beta- Agonist canisters or 1 or more filled prescriptions for oral corticosteroids,

3: Hospitalization or Emergency Department encounters

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CHAPTER 7

OVERALL CONCLUSION

7.1 Major Findings of Studies

The overarching topic of this research was to examine the effect of physician payment incentives on the medication-based outcomes in children with asthma. The study aimed to objectively examine some of the gaps in the current knowledge with regards to the potential effects of such incentives on physician prescribing and patient utilization, comparing effects in commercial and Medicaid plans to assist in the formulation of evidence-based cost-effective asthma care for children in an era of growing needs for cost-containment and scarce resource access. First, this study focused on trying to jointly understand the patterns of prescribing and access to controller/reliever medications for asthmatic children. Next the study focused on examining health care utilizations such as office visit, inpatient visit, and ER visits associated with the use of controller/reliever medications. Understanding how sociological factors including financial incentives affect physician prescribing behavior related to anti-asthmatic medications and in turn, pediatric medication adherence for anti-asthmatic treatments were some of the novel directions explored by this research. Assisting policy makers identify sources of variation in asthma healthcare while reducing underuse of treatment was the key objective of this research. The study results indicated and implied the following concerns and corresponding policy implications which are discussed below.

First, significant disparities in Hispanic children were clearly noted in these studies with regards to both physician prescribing and patient utilization of anti-asthmatic medication. Hispanic children were less likely to receive the controller medication for asthma treatment compared to white children and also had poorer health care utilization-related outcomes. Even though racial/ethnic health disparities have been documented substantially, effective policy interventions are still needed to deal with this issue of significant concern (such as medication therapy management and community health worker for special populations).

Second, reimbursement mechanism (Capitated vs. FFS) of Medicaid had a strong association with patients' medication adherence as well as health care utilization. Our study indicated significant differences in anti-asthmatic medication adherence between capitated plans and FFS. The findings of this study showed that patients under the capitated plan had lower medication adherence compared to patients under the FFS. Patients enrolled in capitated plan were more likely to have limited prescription benefit for asthma, which one could potentially attribute to capitated plans providing a fixed dollar amount per member per month for all pharmacy services. Thus study findings clearly implied that there were certain pediatric populations that might be at higher risk for improper health care due to type of insurance plans they were enrolled in. Thus findings reconfirmed that the mechanism of reimbursement in Medicaid could play an important role in asthmatic children's access to appropriate pharmacotherapy.

Third, health plans (public vs. private) had a strong association with patients' medication adherence as well as health care utilization patterns in pediatric asthma. Our study highlighted significant differences in anti-asthmatic medication adherence between

publicly insured and privately insured children. Pediatric asthma patients enrolled in public insurance had lower medication adherence compared to patients under the private insurance. Asthma has well-developed, evidence-based clinical guidelines which requires structured behavior on the part of physicians, patients and their parents to manage it. According to asthma guidelines, asthma severity can be determined by regular physical check-up and monitoring patient history. To control asthma, physicians are required to ascertain the degree of damage to tissues and loss of function in the relevant organ systems. Physicians should ensure that the patients are following asthma guidelines, getting the appropriate tests, having a routine follow up to monitor their asthma and are aware of asthma management strategies. Physicians might sometimes fail to follow the enlisted procedures due to a variety of reasons like lack of knowledge or appreciation of the importance of clinical guidelines, indifference or non-coverage on the part of health plans, short duration of patient visits due to low reimbursement from health plans and rising health care costs. Health plans also should extend their support towards physician's efforts to encourage asthma management among patients. They can do so by offering training and performance feedback to physicians based on administrative records and chart reviews as well as reminder services to patients. However, the efforts of different health plans might vary and this might result in many missed opportunities to improve care.

In summary, asthma management can be mandated by health plans by implementing the chronic disease model of care for asthma patients and patients with other ailing conditions. The services recommended by the asthma guidelines can be provided individually or in a group by nurses, respiratory therapies, or certified health

education specialists, provided it is being supervised by a physician. The important point is that the initiative should be collective and not individualized.

7.2 Implications of Study results for Medicaid policymaking

The federal and state government holds the responsibility for managing the publicly funded health programs like Medicare and Medicaid. The framing of any health policy at the state or the federal level requires taking into account several factors like public cost, access to care and quality of care. Generally, it is possible to achieve high quality if care and improve access to this care by increasing the budget required for financing the public healthcare programs. The additional costs pose an undue burden on the government. The challenge therefore is to achieve high quality of care and equal access with contained costs. The concept of chronic disease management as a means to cost containment is gaining popularity but the execution of the same needs an outlook that is lacking.

The failure of the Medicaid to reduce asthma specific disparities over the time period of this study might be attributable to insufficient management of the condition in a managed care environment. More resources may need to be applied to case management, to an expanded asthma specialist networks, or to improved monitoring and feedback to physician regarding asthma care guidelines. The fact is that MCOs are limited in the quantity and quality of care they provide based the contracted price received from the state Medicaid. They are likewise constrained from providing too little quality and quantity of care by state. Compared to FFS plans, children enrolled in capitated health plan had significantly lower medication adherence and significantly lower number of

outpatient visits. Lower medication adherence is associated with higher hospitalization and ER visits. Lower number of outpatient visits limits access to healthcare and continuous care for asthma. Though capitation is one of the techniques used most successfully to contain costs in the Medicaid population, study findings suggest that this might not be cost effective for long term asthma management among children. Children with asthma might have specific needs that need to be accounted for if the policy makers and the third party payers may need to facilitate better access to quality healthcare and improved medication adherence for optimum asthma management among children.

7.3 Test of Theoretical Model

As mentioned previously, the theoretical model of the study was based on the constructs of the Eisenberg and Aday-Anderson Model. The theoretical model is outlined in figure 2.3. We faced some limitations using the NAMCS dataset in terms of availability of variables and could not measure the influence of some of the physician behavior related constructs which are a significant part of the Eisenberg model such as the level of patient adherence and self-management behavior in the model associated with prescribing asthma pharmacotherapy medications. However, the influence of constructs like patient (age and race) and physician characteristics (specialty), and percentage of financial incentives could be determined. Our findings primarily suggest that Hispanic children might be at higher risk for sub-optimal asthma care validating that age and race are important predictors of asthma pharmacotherapy. Only some of the variables from the Aday-Anderson model were significant predictors of asthma health care utilization in children in our cohort. Among the predisposing variables, age and race/ethnicity were

found to be significantly associated with ER visits and hospitalizations. Gender was not a significant predictor of either ER visits or hospitalization which indicates that gender is not relevant after fully adjusting for other factors. The need factors in the model were measured using a validated asthma severity index. Not surprisingly the study found that children with higher asthma severity had a greater likelihood of having ER visits and hospitalizations. Another enabling factor was physician specialty, and this study showed that children who regularly had a pediatrician visit had a lower likelihood of both ER visits and hospitalizations. In sum, the Eisenberg and Aday-Anderson models proved to be suitable models to develop our final framework for this study. However, further research should incorporate additional predictors which are suggested by these models.

7.4 Limitations and Contributions

There are several limitations of this study which deserve note. In our analysis of physician prescribing of anti-asthmatic medications we used a public access database the NAMCS which unfortunately, does not provide all the relevant physician and patient variables that are needed to test our theoretical model for the study influenced by the one proposed by Eisenberg (1979). Additionally there is no measure of clinical severity of a child's asthma within the database; so we could not control for this when examining which children received an anti-asthmatic medication and what type of anti-asthmatic medication they received. Third, the database is based on self-report by physicians and their staff and so it is subject to some recall bias. Fourth, the database does not provide health care utilization (ER visit and Inpatient visit) details of the patient and the primarily

outpatient sample of visits could exclude severe cases of asthma who may not be seen in these settings. Finally, the database lacks specific variables that explain the impact of medication adherence and self-monitoring behaviors, as well as variables that measure barriers to physician guideline adherence.

For the second and third analyses, first, we could not examine geographical variations in utilization rates as specific states from which the sample was drawn were not identified. Thus we could not explore how eligibility requirements affect differences in study outcomes across the states. Additionally, like most studies that use claims data the final analytical datasets lacked specific clinical information that is only available from patient chart review or electronic medical records. As such, data concerning physician adherence to guidelines was incomplete, and patients' severity of asthma and health beliefs was not explicitly measured. Therefore severity index scores calculated from claims in the pre-index period were used as a proxy for the severity of asthma. We attempted to control for sample selection using multivariate analyses, but we could be limited in this approach because of insufficient variable detail. Administrative data can also suffer from data entry errors or omissions that can be difficult to detect or evaluate. Medication adherence calculations from the claims dataset assume that patients utilize all the medications that are being dispensed to them. The medication adherence rate does not provide direct information about the medication utilization by a patient but provides an estimate of the maximum possible medication utilization. MPR also fails to capture medication utilization characteristics of inhaler medications like timeliness, prescribing directions and consistency of medications. Hence it is possible that the prescribed

medication might be used with more or less frequency which might over estimate or under estimate medication adherence (Erickson 2001).

Even though the study has several limitations, these limitations do not overweigh the contribution of this study. Previous literature had not explored the impact of the type of health plan (based on financial incentive) on medication adherence behavior. This study provided insight about the impact of capitated health plans versus traditional FFS plans on the pharmacological treatment of asthma in children. Study results could help policy makers design appropriate reimbursement policies that ensure effective allocation of scarce healthcare resources among vulnerable population. Also, previous literature lacked evidence about the effect of different health plans on the medication adherence outcomes of asthmatic children. None had evaluated differences in pharmaceutical outcomes between asthmatic children in Medicaid and privately insured children for the same time periods. Additionally, study results provide fairly comprehensive and concurrent information regarding Medicaid and commercial insurance related-care in asthmatic children and relevant recent trends in pediatric asthma health care utilization.

In sum, the results of this study provide an insight to clinicians, policymakers and health service researchers in evaluating policies related to insurance coverage of essential medications in indigent children with asthma. Also, it helps in differentiating among medication adherence outcomes and health care utilization with respect to different payment mechanisms or health plans in asthmatic children in the United States. This, in turn, could help understand important factors that impact health care financing, design strategies to improve asthma related care, and improve health outcomes for needy and poor children in the United States.

7.5 Future Research

Although this study explored important issues related to insurance coverage and pharmaceutical care in pediatric asthma care in the US, there are several topics in this field that require further research. First, future research needs to focus on health policy evaluation in specific cost constrained environments [such as pay for performance (P4P) in Medicaid] related to health care reform. Additionally future studies need to better highlight healthcare outcomes across socio-demographic variants in truly underserved areas in the United States such as rural Appalachia. Finally, future studies need to emphasize comparative effectiveness research (explicitly comparing treatment alternatives for their effectiveness in asthma) using techniques such as meta-analyses, geospatial analyses and instrumental variables.

APPENDIX

INSTITUTION REVIEW BOARD (IRB) EXEMPTION FOR DATA ACCESS

Health Sciences and Behavioral Sciences Institutional Review Board • 540 East Liberty Street, Suite 202, Ann Arbor, MI 48104-2210 • phone (734) 936-0933 • fax (734) 998-9171 • irbhsbs@umich.edu

To:

Rajesh Balkrishnan
Jongwha Chang

Subject: Notice of Determination of "Not Regulated" Status for [HUM00052699]

SUBMISSION INFORMATION:

Title: Essay on Child Health Outcomes
Full Study Title (if applicable):
Study eResearch ID: HUM00052699
Date of this Notification from IRB: 7/26/2011
Date of IRB Not Regulated Determination : 7/26/2011

IRB NOT REGULATED STATUS:

Category	Description	Sort Order
Research Using Publicly Available Data Sets	Based on the information provided, the proposed study falls under the University of Michigan's policy for research using publicly available data sets (http://www.research.umich.edu/hrpp/Documents/datasets.html). Under this policy and in accordance with federal regulations for human subjects research (45 CFR Part 46) IRB approval is not required as the data cannot be tracked to a human subject.	13

Richard Redman
Chair, IRB HSBS

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