University of Alberta

Physician Specialty Influences
Tertiary Care Pediatric Asthma Management

by

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A thesis submitted to the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Master of Science
in
Clinical Epidemiology

Department of Public Health Sciences

Fall 2013
Edmonton, Alberta

ABSTRACT

Physician training influences the care that a patient receives. A retrospective cohort of children over 6 years of age, seen in a multi-disciplinary asthma clinic between 2009 and 2010 and followed to 2012, was completed to identify differences in pediatric asthma management by physician specialty. Multilevel logistic regression analysis examined differences by physician specialty for prescribed inhaled corticosteroids (ICS). Over 56% of the patients were seen by pediatric respirologists, 26% by pediatric allergists and 18% by pediatricians. Differences in investigations by specialty reflected on co-morbid diagnoses and treatment. Pediatricians were less likely to prescribe ICS (OR: 0.39; 95% CI: 0.15 – 0.96, $p<0.05$) than pediatric allergists with the greatest difference in ICS prescription among children with a $\%FEV_1$ greater than 80%. Treatment with ICS among children with mild asthma is most heavily influenced by physician specialty. The results of this study have implications for asthma management in future asthma practice guidelines.

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LIST OF ABBREVIATIONS

Airway hyper-responsiveness	AHR
Allergic bronchopulmonary aspergillosis	ABPA
Alpha-1 antitrypsin deficiency	AATD
Anti-immunoglobulin E (Omalizumab, anti-IgE)	Anti-IgE
Asthma Control Questionnaire	ACQ
Asthma Control Test	ACT
Asthma Therapy Assessment Questionnaire	ATAQ
Atopic dermatitis	AD
Attention deficit hyperactivity disorder	ADHD
Beclomethasone diproprionate	BDP
Body mass index	BMI
British Thoracic Society	BTS
Bronchial alveolar lavage	BAL
Canadian Thoracic Society	CTS
Chest X-ray	CXR
Child Health Questionnaire	CHQ
Complete Blood Count	CBC
Computed Tomography	CT
Confidence Interval	CI
C-Reactive Protein	CRP
Cytoplasmic antineutrophil cytoplasmic antibodies	cANCA
Electronic prescription database	Netcare
Emergency department	ED
Eosinophil	eos
Epidemiology and Natural History of Asthma Outcomes and Treatment Regimens study	TENOR
Exhaled Nitric Oxide	eNO
Forced expiratory Vital Capacity	FVC

Forced Expiratory Volume in one second	FEV_1
Gastro-esophageal reflux disease	GERD
Global Initiative for Asthma	GINA
Health Research Ethics Board	HREB
Immunoglobulin E	IgE
Inhaled corticosteroids	ICS
Leukotriene receptor antagonists	LTRA
Long acting beta agonist	LABA
National Heart Lung Blood Institute	NHLI
Obstructive sleep apnea	OSA
Pediatric allergists	PedAll
Pediatric respirologist	PedResp
Pediatrician	Peds
Peak expiratory flow	PEF
Percentage of predicted normal FEV_1	$\%FEV_1$
Perinuclear antieutrophil cytoplasmic antibodies	pANCA
Polysomnography	PSG
Public Health Agency of Canada	PHAC
Pulmonary function test	PFT
Radioallergosorbent test	RAST
Research Electronic Data Capture	REDCap
Short acting beta agonist	SABA
Skin Prick Test	SPT
Sleep disordered breathing	SDB
Video fluoroscopic swallowing studies	VFSS
Vocal cord dysfunction	VCD

CHAPTER 1: INRODUCTION

Asthma is one of the most common chronic diseases of childhood[1] imposing a significant economic and human resource burden on individuals, families, and society. Up to 300 million people are estimated to be suffering from asthma[2] with a higher prevalence observed among children aged 0-17 years compared to adults aged 18 and over.[3] A sentinel surveillance survey conducted in 2000/2001 by the Public Health Agency of Canada (PHAC) determined that approximately 13% of students in Canada have asthma.[4] Asthma prevalence has risen over the last 40 years with the greatest increase seen in western societies.[5] The prevalence in Canadians over the age of 12 years estimated to be 8.3%[6] which is double the global average. In 2004, childhood asthma accounted for nearly 6.5 million outpatient visits, more than 750,000 emergency department (ED) visits, and over 198,000 hospitalizations;[7] together these represent health care costs exceeding $3 billion annually and over 14 million missed school days.[7]

Asthma is treated by various health care professionals resulting in diverse management. Family physicians or asthma nurse practitioners provide primary care management for asthma. Pediatricians (Peds), pediatric respirologists (PedResp), and pediatric allergists (PedAll) provide asthma management at secondary and/or tertiary care facilities. Diette et al. demonstrated that asthma management between generalists and specialists differed in all domains of care including treatment, investigation, health education, and monitoring of control.[8] There were significant differences between the asthmatic patients treated by pulmonologists and those treated by allergists in the Epidemiology and Natural History of Asthma: Outcomes and Treatment Regimens (TENOR) study. Patients of allergists had higher socioeconomic status than those seen by a pulmonologist while patients treated by pulmonologists had more severe asthma and required more medication than those treated by allergists.[9] These differences in asthma management persist despite the existence of numerous asthma guidelines.[8-10]

The Global Initiative for Asthma (GINA) introduced asthma guidelines in 1989 in an effort to standardize asthma management.[11] In addition to the GINA guidelines, there are several country-specific asthma practice guidelines including those developed by the Canadian Thoracic Society (CTS), the British Thoracic Society (BTS), the US National Heart Lung Blood Institute (NHLI), and the National Asthma Council of Australia. The first CTS asthma guideline was published in 1990 to promote more consistent asthma management across the country.[11]

The purpose of this study was to compare differences in asthma management (diagnostic and therapeutic) between Peds, PedResp and PedAll at a tertiary-care asthma clinic. Our primary objective was to identify the existence of any differences in the use and dose of inhaled corticosteroids (ICS) by the physician specialties. The secondary objective was to compare between specialties the differences in co-morbid diagnoses identified for patients referred for asthma. Additional objectives were to compare the specialties by choice of step-up asthma medications, investigations and identification of co-morbidities.

CHAPTER 2: LITERATURE REVIEW

2.1. Asthma Pathophysiology

Asthma is a chronic inflammatory disorder characterized by reversible airflow obstruction and airway hyper-responsiveness (contraction of small muscles surrounding the airways) to a specific stimulus. Among children with asthma, an inflammatory cascade in the lungs is activated when they are exposed to a stimulus to which they are sensitive. Eosinophils are inflammatory cells associated with asthma[12] and often serve as an indicator of disease activity. The proportion of eosinophils in sputum is a more sensitive marker of asthmatic airway inflammation than is their proportion in blood.[13] Airway remodelling is a major pathological change associated with asthma. Chronic inflammatory processes of asthma cause airway remodelling, with marked structural changes in the bronchi from mucous gland hyperplasia, neovascularization, fibrosis, and an increase in smooth muscle mass.[14] These pathological changes together can result in narrowing of the airway and the appearance of the asthma symptoms such as wheeze, shortness of breath, tightness of chest, and cough.[15]

2.2. Determinants of asthma

The development of asthma is hypothesized to be a result of a combination of environmental factors in individuals with a genetic predisposition. Both personal and family histories of allergy are associated with the development of asthma. Atopy, which includes allergies, hyper-reactivity and atopic dermatitis,[16] is found in as many as 85% of asthmatic children and young adults. The presence of allergy or atopy is strongly associated with asthma although many allergic individuals do not have asthma and not all asthmatic patients are atopic.

Environmental exposure to potential allergens, such as tobacco smoke and family pets is associated with bronchial hyper-responsiveness. Maternal smoking during pregnancy[6] and environmental tobacco smoke exposure in early childhood[17] can increase the risk of asthma in children. Other factors associated with asthma include: recurrent respiratory infection in early life [18,19] , low birth

weight,[20] obesity,[21,22] respiratory distress syndrome,[23] and exposure to pets.[24,25] Identifying the probable risk factor(s) for asthma exacerbations and effective environmental control measures are essential components of asthma management.

2.3. Clinical presentation of asthma

The most salient symptom of asthma is recurrent wheezing. However, not all asthma produces wheezes and not all wheezes herald asthma.[15] A presumptive diagnosis of asthma can be made with a history of recurrent wheezing, cough, breathlessness and tightness of chest. Asthma symptoms can be nocturnal or diurnal, perennial or seasonal, continual or episodic. Children with asthma are asymptomatic most of the time. An asthma exacerbation may occur after an asthmatic child is exposed to a trigger. Stimuli inducing or triggering asthma exacerbations can be avoided or eliminated by appropriate environmental control measures. Possible triggers for asthma exacerbations include viral respiratory tract infections, exercise, cold air, emotional arousal, certain medications, tobacco smoke, air pollution, and indoor and outdoor allergens. Respiratory infection increases asthma exacerbations and hospitalization.[26, 27] Viral infections account for 85% of wheezing attacks[28] while commensal bacteria of the upper respiratory tract play only a minor role in asthma exacerbation in children.[29,30] Antibiotic use for asthma exacerbation is not recommended in children because this treatment has been shown to have no or negligible benefit with only temporary effects.[31]

2.4. Conditions associated with asthma

Identifying and treating co-morbidities are important parts of asthma management.[32] Rhinitis and sinusitis, particularly, are common conditions that can impede the achievement of successful asthma control. Recurrent asthma symptoms frequently cause sleep or cognitive impairment,[33] psychological problems,[34] daytime fatigue, reduced activity levels, and school or work absenteeism.[35] A number co-morbidities or conditions are frequently observed in asthma patients and may have a negative effect on asthma control.

2.4.1. Eczema and atopic dermatitis (AD)

Eczema, allergic rhinitis, and asthma are examples of atopic diseases. Physician-diagnosed allergic rhinitis, blood eosinophilia greater than or equal to 4%, and AD are conditions associated with the development of asthma.[16] Studies have shown that 80% of children with AD develop allergic airway diseases in their youth[36] and of these 40-50% are asthma cases.[37] Many children with eczema progress to develop asthma and finally allergic rhinitis, a condition known as atopic march.[38] A combination of AD and recurrent respiratory symptoms in young children signals an increased risk for developing asthma. In addition, AD is also associated with an increased severity of asthma.[39, 40] The influence of managing AD on asthma control is yet proven.

2.4.2. Rhino-sinusitis

Strong epidemiological and pathogenic relationships are observed between rhinosinusitis and asthma.[41,42] Significant improvement in asthma control can occur when sinus disease is recognized and treated. Risk of being diagnosed with asthma is higher among allergic rhinitis patients[43-45] and as many as 95% allergic asthmatic patients have rhinitis.[45-47] Adequate treatment of rhinitis can reduce asthma severity, control asthma symptoms, and improve quality of life.[41,42,48-53] An improvement in lower airway hyper-reactivity in asthmatic children is observed with treatment with nasal glucocorticoids.[54,55]

2.4.3. Gastro-esophageal reflux diseases (GERD)

Prevalence of GERD in asthma cases varies from 19.3% to 80%, with an average prevalence 22.8%.[56] Among school-aged asthmatic children, between 47% and 75% have GERD.[57] Two studies that used symptom-based methodologies to define GERD[58-60] provided similar estimates for GERD prevalence, 19.3% and 19.7% in asthma cases and 2.5% and 8.5% in controls. On the other hand, asthma is identified in 13.2% of children with GERD and only 6.8% of controls.[61] Improvement of asthma following GERD treatment is inconsistent.[62-66]

2.4.4. Sleep disordered breathing (SDB)

Sleep disordered breathing (SDB) is a group of disorders where the patient has difficulty in breathing while asleep. Obstructive sleep apnea (OSA) is one of the most common SBD disorders. OSA is an independent risk factor for asthma exacerbations.[67] Asthma and OSA have common epidemiologic risk factors and share a similar inflammatory mechanism. Habitual snorers and children/adolescents with OSA produce significantly higher concentrations of exhaled Nitric Oxide (eNO).[68] A marked increase in the prevalence of OSA is noticed among poorly controlled asthmatic children, and treatment of OSA has resulted in substantial improvements asthma severity.[69]

2.4.5. Obesity and overweight

Though asthma and obesity tend to co-occur[70], their relationship is still unclear.[71] Elevated body mass index is associated with childhood asthma[70,72] and children with asthma are more often to be obese than normal weight or underweight.[73,74] Normal weight children have better lung function and asthma-related outcomes compared to underweight and obese children.[74] Reduction in weight among obese asthmatics improves asthma symptoms, control and medication need.[75-77]

2.4.6. Mental health

Mental health (anxiety, depression, and panic disorders) and behavioural difficulties are more frequently observed in asthma cases than in the general population.[32,78] Analysis of data from the Norwegian Prescription Database for 2006 showed an age-dependent association between prescriptions for attention deficit hyperactivity disorder (ADHD) and asthma.[79] Other studies have shown inconsistent results to establish the potential relationship between ADHD and asthma.[80-84] A Cochrane meta-analysis could not confirm the efficacy of psychological intervention in children with asthma.[85]

2.4.7. Vocal cord dysfunction (VCD)

Vocal cord dysfunction (VCD) is a condition characterized by abnormal closure of the vocal cords and subsequent airway obstruction. VCD is often misdiagnosed as "refractory asthma" due to similarity in symptoms,[86] or overlooked when coexisting with asthma. Several guidelines recommend an investigation into VCD when asthma therapy is not effective.[87]

2.4.8. Alpha-1 antitrypsin deficiency(AATD)

Alpha-1 antitrypsin deficiency predisposes an individual to airway hyper-responsiveness, a mechanism for reversible airflow obstruction which results in signs and symptoms similar to asthma.[88]

2.4.9. Allergic bronchopulmonary aspergillosis (ABPA)

Allergic bronchopulmonary aspergillosis (ABPA) complicates asthma [89] and is associated with frequent asthma exacerbation.[90] A positive association was found between the level of Aspergillus antibodies and asthma severity.[90]

2.5. Investigations associated with asthma management

Investigations have an important role in asthma management. Investigations monitor the health status of patients, identify co-morbid conditions, and help the physician to provide appropriate treatment. Investigations are often also used to exclude other diagnoses in patients who do not respond to asthma medications and prior to starting systemic asthma treatments.

2.5.1. Pulmonary function tests (PFTs)

Pulmonary function tests (PFTs) measure lung volume and function by assessing the elasticity and resistance of the airways and identifying restrictive and obstructive lung disease. Spirometry can provide components within a PFT including forced expiratory vital capacity (FVC) and forced expiratory volume in one second (FEV_1). FVC measures the amount of air that can be forcibly exhaled from the lungs after full inspiration. FEV_1 measures the volume of air that can be

forcibly blown out in the first second, after a full breath. Both measures are accepted variables associated with asthma control.[91] An FEV_1 of more than 80% of the predicted value is considered normal. A low FEV_1 indicates the presence of airway obstruction and/or poor pulmonary elastic recoil pressure. The percentage of predicted normal FEV_1 value is a standardized measurement of FEV_1 that controls for age, sex, height and ethnicity. The FEV_1/FVC ratio is commonly used to assess lung function. An FEV_1/FVC ratio of less than 80% is an indicator of an obstructive airway disease.[57] Restrictive pulmonary disorders result in reductions of both FEV_1 and FVC, leaving a normal FEV_1/FVC ratio. The FEV_1/FVC ratio is higher in young children (>90%) and decreases with increasing age. FEV_1/FVC ratio of less than 80% signifies the presence of airflow limitation.

Asthma is an obstructive lung disorder where airway hyper-responsiveness increases the airway's resistance to exhaled airflow, resulting in significant reduction in FEV_1 without effecting on FVC. Percent predicted FEV_1 result, an effort-independent measure of airway obstruction, is used to classify asthma as intermittent (>80% and normal between exacerbations), mild persistent (>80%), moderate persistent (60-80%) and severe persistent asthma (<60%).[92] A change in FEV_1 pre and post-bronchodilator can help confirm an asthma diagnosis. The change in FEV_1 overtime is also used as an asthma outcome in randomized control trials,[93] longitudinal cohort studies, and systematic reviews.[94, 95]

Measurements of FEV_1 are used to estimate a patient's asthma control.[96] Tibosch et al.'s multicentre observational study failed to detect an association between FEV_1 and asthma control in adolescents.[97] A post hoc analysis of data from a multicenter, double-blind, randomized, placebo-controlled clinical trial for Phase 2 study of an IL-4R alpha antagonist (AMG 317) discovered a trend of decreasing risk of exacerbation with higher FEV_1 value but a non-significant association between FEV_1/ percent predicted FEV_1 and risk of exacerbation in adults.[98] Wu also conducted an analysis using data from another multicenter, randomized, double-blinded clinical trial, known as Childhood Asthma Management Program (CAMP) trial, designed primarily to compare the long-term safety and effectiveness of budesonide or nedocromil. Wu's analysis found that

percent predicted FEV_1 in children was associated with hospitalizations, ED visits, and need for oral corticosteroid therapy.[99] Most children with asthma have normal percent predicted FEV_1 values;[100,101] the FEV_1/FVC ratio is considered as a more sensitive measure.[57] Ramsey suggested that FEV_1 /FVC ratio is a useful indicator of asthma severity in children.[102]

2.5.2. Tests for airway hyper-responsiveness (AHR)

Airway hyper-responsiveness, a characteristic feature of asthma, is assessed with bronchial provocation either directly using methacholine or indirectly through exercise challenge. A 20% fall in FEV_1 after methacholine administration is considered a positive reaction indicating AHR. The provocative concentration required to cause a positive reaction is known as the PC20. Methacholine tests are considered highly sensitive but not very specific for diagnosing asthma.[103] Exercise challenge testing is an indirect method to test for AHR using the changes in spirometry findings before and after 1, 5, 10 and 15 minutes of exercise. Exercise challenge is more specific than methacholine for identifying the presence of inflammation.[104]

2.5.3. Allergy testing

Atopy is strongly associated with asthma development.[105] Allergy tests can help identify triggering stimuli for asthma symptoms and are useful in environmental control of asthma triggers. Skin prick testing (SPT), a method evaluating the reaction of a person's skin to different substances, is the most commonly used allergy test. An alternative to SPT is the radioallergosorbent test (RAST) using blood samples. A RAST measures specific IgE antibodies produced in response to a specific allergen.[105] RAST, although more expensive than SPT, is considered when an SPT may pose a threat of a very severe allergic reaction.[106] Aero-allergens and food-allergens are commonly tested by either SPT or RAST.

2.5.4. Radiology

Chest radiography includes chest x-rays (CXR) and chest computed tomography (CT). CXR are usually normal in asthma patients, or may demonstrate hyper-inflation due to gas trapping secondary to small airway obstruction. Both CXR and chest CT are occasionally performed to identify structural abnormalities and/or other conditions of the lung and heart. The presence of infiltrates, nodules, and consolidation of effusions suggests the possibility of an alternate diagnosis such as infection and interstitial lung diseases including pulmonary fibrosis, sarcoidosis, and bronchiolitis obliterans. Chest CT scans are useful primarily when emphysema, pulmonary embolism, or interstitial lung disease are considered for a differential diagnosis.

Radiographic evidence of sinus disease is often noted in children with asthma. An x-ray of the sinus used to be the standard method for diagnosing acute sinusitis of maxillary sinuses or frontal sinuses. A CT scan of the sinuses provides greater resolution and thus better sensitivity than conventional sinus radiographs. For this reason, CT has become more popular than standard x-rays and is recommended for evaluating sinusitis, especially when complications of sinusitis develop or if it becomes necessary to view more of the sinuses or surrounding bones.[107] Mucosal thickening in the nasal passages and sphenoidal, ethmoidal, and frontal sinuses is more common in patients with acute asthma.[108] Ninety percent of mild-to-moderate asthma and almost 100% of severe asthma cases have radiologic abnormalities of the sinuses.[109]

2.5.5. Complete blood count with eosinophils

Patients with asthma may have an elevated blood eosinophil level. Usually, a high eosinophil (eos) count is defined as eos $\geq$300/μL.

2.5.6. Bronchial alveolar lavage (BAL)

Bronchoscopy, BAL and bronchial biopsy, while of limited utility in the management of asthma, are beneficial in the differential diagnosis of asthma-like syndromes. BAL is used to diagnose lung diseases such as pulmonary infection,

some types of lung cancer, and interstitial lung diseases. In order to obtain a BAL sample, a bronchoscope is passed through the mouth or nose into the lung and a small part of the lung is injected with fluid which is then recollected for examination. The recovered fluid is sent for cytology and culture depending on the physician's requirement.[110] Lipid-laden macrophages, consistent with gastro-esophageal reflux, can be revealed through a BAL.

2.5.7. pH-probe:

Twenty-four hour pH monitoring is considered the gold standard for documenting the presence of GERD. Other tests, such as barium swallow and endoscopy, while providing important data, are neither sensitive nor specific enough for the diagnosis of GERD. Gastric emptying scans and video fluoroscopic swallowing studies (VFSS) are two other investigations used during diagnostic work-up for GERD.

2.5.8. Oximetry and polysomnography (PSG):

The presence of OSA is usually screened using overnight oximetry. Although an overnight oximetry is easy to conduct and enables expedient results, these studies are not cost-effective because of poor diagnostic accuracy despite increased sensitivity.[111] Polysomnography, the gold standard test for OSA, is a comprehensive study that records the biophysiological changes occurring during sleep[112] and identifies obstructive apneas, hypopneas, and arousals.

2.6. Management of Asthma

Asthma severity and control, two important aspects in asthma management, help determine asthma therapy. Although asthma severity and asthma control are related, each describes different aspects of a patient's clinical status. Asthma severity describes the inherent level of abnormality and determines the extent of treatment required to control asthma symptoms and maintain optimal lung function [113]. Asthma severity can only be determined before initiation of treatment.[91] Asthma severity can be influenced by obesity, GERD, environmental

exposure to triggers, corticosteroid insensitivity, sinusitis, aspirin sensitivity and genetics.[113] As a result, asthma severity may change slowly over time. Asthma severity is assessed through a combination of pulmonary function and clinical symptoms. The main clinical endpoints used in Canada to characterize asthma severity (into 5 levels of increasing severity) are night-time symptoms, pulmonary function status, day-time symptoms, and requirements for short-acting beta agonists. (Table 2.1) Limitation exists in classifying asthma severity because pulmonary function tests are poorly correlated with asthma symptoms, and both accuracy of asthma symptoms and requirement of rescue medicine depend on patient recall. However, severity classifications are of value in characterizing the burden of disease and predicting outcomes.[113]

Asthma control reflects the effectiveness of the patient's current therapy.[113] The primary goal of asthma therapy is to control the disease and to minimize asthma-related morbidity and mortality.[114] Changes in asthma control can occur in response to asthma triggers or therapy.[115] Uncontrolled asthma is defined as one of (i) having asthma symptoms at least 4 days per week, (ii) being awake during the night due to symptoms at least once weekly, (iii) limitations in daily activity, (iv) the need to use more than four doses per week of short-acting beta agonists to control symptoms, and (v) less than 90% FEV_1.[114,116] In addition to the above criteria, a number of instruments have been validated to measure the level of asthma control, namely the Asthma Control Questionnaire (ACQ), the Asthma Therapy Assessment Questionnaire (ATAQ), the Asthma Control Test (ACT) and Health-related Quality of Life. Although the contents of each instrument are not exactly the same, all of them quantify the level of asthma control with a patient derived composite approach.

Table 2.1 Clinical endpoints used in Canada by severity [11]

Severity	Clinical Endpoints
Level 1	**Very mild**
Night-time symptoms	Infrequent symptoms
PEF/FEV_1 predicted, other lung function	Normal
Daytime symptoms	Infrequent symptoms
Other criteria	Need SABA <3 times/week
Level 2	**Mild**
Night-time symptoms	0 to +
PEF/FEV_1 predicted, other lung function	>80% predicted
Daytime symptoms	
Other criteria	Need SABA every 8 h or more 0 to + limitation of daily activates 0 previous near fatal episodes 0 recent hospital admissions
Level 3	**Moderate**
Night-time symptoms	+
PEF/FEV_1 predicted, other lung function	60-80% predicted
Daytime symptoms	
Other criteria	Need SABA every 4-8 h + to ++ limitation of daily activates 0 previous near fatal episodes 0 recent hospital admissions
Level 4	**Severe**
Night-time symptoms	+++
PEF/FEV_1 predicted, other lung function	<60% predicted
Daytime symptoms	
Other criteria	Need SABA every 2-4 h +++ limitation of daily activates + previous near fatal episodes + recent hospital admissions
Level 5	**Very Severe**
Night-time symptoms	
PEF/FEV_1 predicted, other lung function	<60% predicted
Daytime symptoms	Frequent symptoms
Other criteria	Need SABA every 2-4 h +++ limitation of daily activates + previous near fatal episodes + recent hospital admissions

Comprehensive asthma care includes confirmation of asthma diagnosis, environmental control of trigger stimuli, education, development of a written action plan, and pharmacotherapy.[11] Pharmacotherapy is considered a critical component of asthma care. Asthma medicines can be classified into whether they relieve symptoms or control the disease. Reliever medications are used to treat acute asthma symptoms. Controller medications are used daily over a longer term to control the underlying inflammation associated with asthma and prevent symptoms and exacerbations. The Canadian Asthma Consensus Guidelines recommend the regular use of controller medications together with environmental control measures in order to reduce airway inflammation, rather than intermittent therapy focusing on short-term relief of symptoms.[117] Different asthma treatment options are available with a goal of achieving asthma control using the lowest doses and fewest numbers of medications (Fig. 2.1). Utilization of proper and adequate pharmacotherapy can reduce asthma exacerbations,[118] subsequent ED visits and /or hospitalizations (asthma morbidity) and asthma related death.

Reliever medications: An asthma reliever medicine is provided on demand for immediate symptomatic relief for all steps of asthma management (Fig. 2.1). Short-acting beta agonists (SABA) are the most commonly used and most effective reliever medicines and are used for very mild intermittent asthma. SABA use is limited to as needed symptom relief only.[114] Frequent use of SABA is associated with increased drug tolerance and airway responsiveness and an increase in asthma-related morbidity and mortality. Patients may need to use an asthma controller medication regularly to reduce frequent requirement of as needed reliever medicine (e.g SABA) (a sign of poor asthma control) and prevent symptoms and attacks from starting. During management with controller medicines, reliever (rescue) medicine can be used as required.

While SABA relax tight airway smooth muscle, anticholinergics, such as ipratropium bromide and tiotropium bromide, can prevent the smooth muscle from constricting.[119] Anticholinergics, although not listed in Canadian Asthma Guidelines or in GINA guidelines, are occasionally prescribed as an alternative reliever medicine in asthma management.

Controller medications: Examples of asthma controller medications include inhaled corticosteroids (ICS), long acting beta agonist (LABA) and leukotriene receptor antagonists (LTRA). ICS are the most effective controller medicines currently available and are the first choice for maintenance pharmacotherapy.[120] They reduce inflammation, airway oedema, and mucus production in the airways of a person with asthma. As a result, individuals with asthma on ICS have reduced airway inflammation and are less likely to react to asthma triggers. Pediatric ICS users have demonstrated improvements in: day- and night-time symptoms,[121,122] reductions in exercise-induced bronchoconstriction,[123] number of asthma exacerbations,[121,122] and reduced bronchial hyper-responsiveness.[122] Use of ICS as maintenance therapy should be considered early, even in those who report asthma symptoms fewer than three times per week.[114,116,124] The number of asthma controlled days when using a low dose of ICS has shown to improve from 35% in the early weeks to 64% after a longer period of use.[125,126] A decrease in linear growth velocity has been observed in children with mild to moderate asthma taking moderate doses of ICS.[127] As a result, children with asthma should be on the lowest possible dose of ICS to achieve asthma control.[128]

LTRAs, which interfere with leukotriene activity at the receptor level, can serve as an alternative monotherapy to ICS in the management of mild asthma in children and adults. In children, LTRAs are recommended for use as a substitute medicine only for those who cannot or will not use ICS due to their inferior effect in asthma control; children on LTRAs have a 51% higher chance of requiring systemic steroids and a 3.3 times higher risk of hospitalization compared to low dose ICS.[94]

Increasing numbers of asthma drugs are required when asthma is uncontrolled; 50% of children experience uncontrolled asthma on low doses of ICS and 39% are required to take an oral corticosteroid due to asthma exacerbations.[125] To achieve control of asthma, the CTS guideline recommends doubling the dose of ICS for children aged 6-11 years, and adding LABA to low doses of ICS for those 12 years and older.[124] The GINA guidelines suggest using

a combination of low-dose ICS and LABA as a first choice for children over 5 year of age rather than increasing the dose of ICS.[120,128]

Systemic medicines become an option when asthma control is not achieved with inhaled medicines. Suggested systemic drugs include systemic corticosteroids and anti-immunoglobulins. Systemic corticosteroids are broad anti-inflammatory agents and are used for management of asthma for two indications: severe acute exacerbations and chronic management of refractory asthma. Early introduction of systemic steroids for acute asthma exacerbations may reduce the risk of hospitalization by 25%.[129] Chronic oral steroid therapy is not recommended due to an increased risk of osteoporosis, growth suppression and gastritis.[114]

Anti-immunoglobulin E (Omalizumab, anti-IgE) is a monoclonal antibody that binds at the high affinity receptors of Immunoglobulin E (IgE). Basophils are no longer able to bind with IgE bound to Omalizumaub, which attenuates their degranulation and reduces allergic symptoms.[130] The use of Omalizumab can reduce requirement of ICS and rescue medicine and improve asthma control.[131-134] Omalizumab is approved for children 12 years of age and older having moderate-to-severe persistent allergic asthma.

Theophylline, a methylxanthine derivative, has some anti-inflammatory activity and relaxes bronchial smooth muscles. Theophylline has a narrow therapeutic index and produces side effects frequently. For this reason, the xanthine derivatives are considered as third or fourth line therapy after ICS, LABA and/or LTRAs. The Canadian asthma guidelines suggest only using theophylline in adults and under the management of specialists.

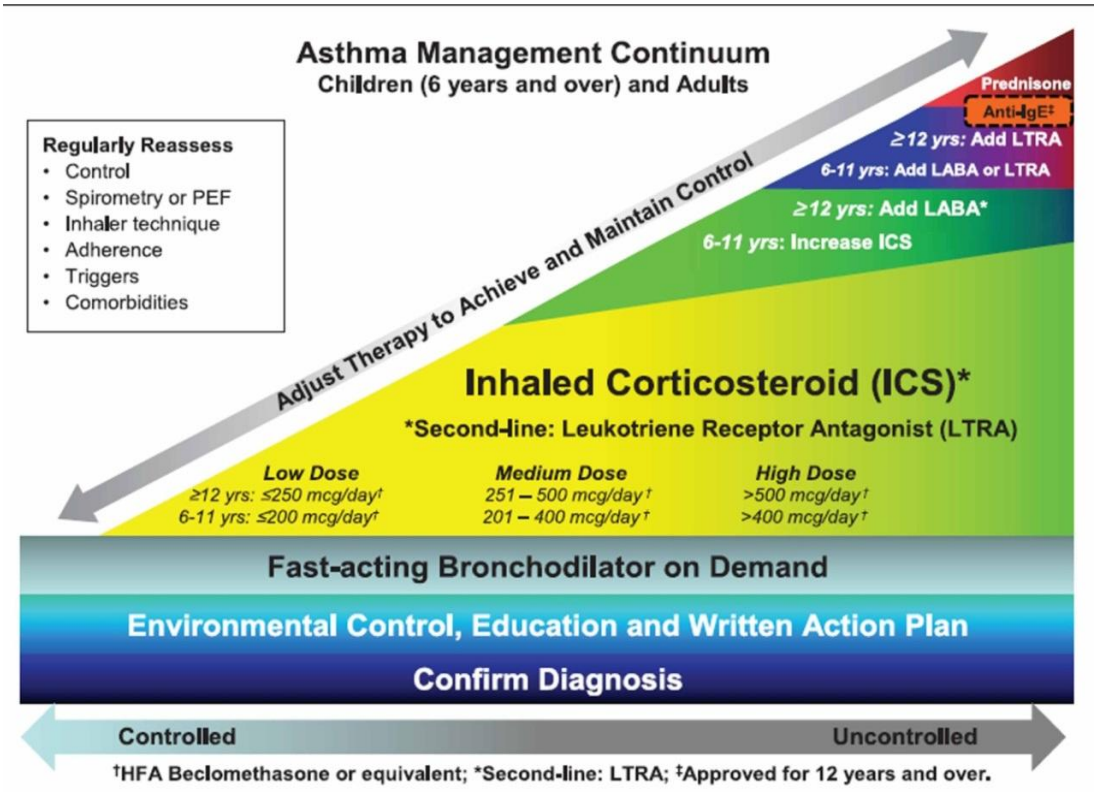
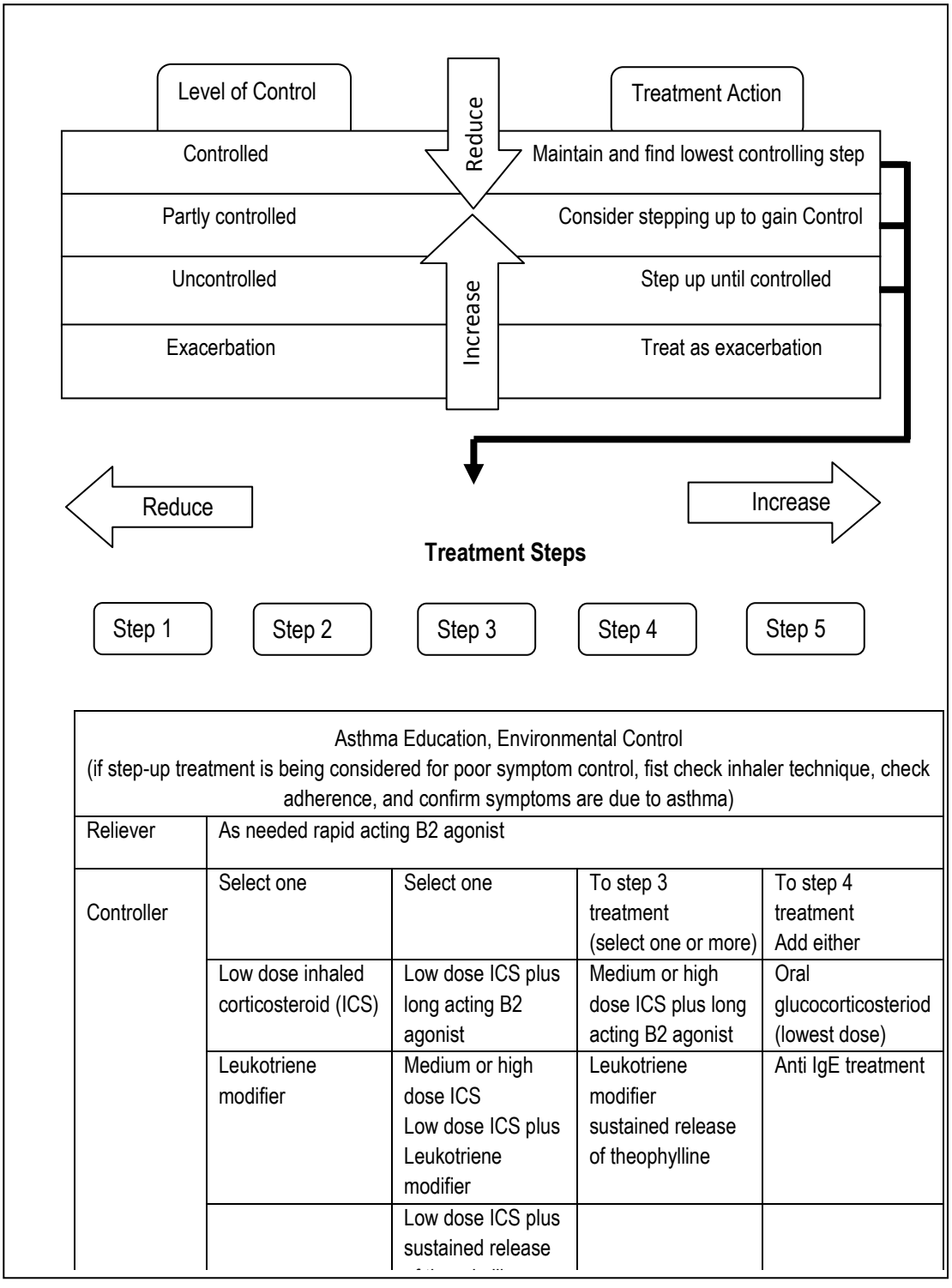


Figure 2.1. Canadian Thoracic Society 2012 Asthma Management Guidelines[1]

[1] Taken from Canadian Thoracic Society Asthma Management Continuum--2010 Consensus Summary for children six years of age and over, and adults. [(114)]



Asthma Education, Environmental Control (if step-up treatment is being considered for poor symptom control, fist check inhaler technique, check adherence, and confirm symptoms are due to asthma)				
Reliever	As needed rapid acting B2 agonist			
Controller	Select one	Select one	To step 3 treatment (select one or more)	To step 4 treatment Add either
	Low dose inhaled corticosteroid (ICS)	Low dose ICS plus long acting B2 agonist	Medium or high dose ICS plus long acting B2 agonist	Oral glucocorticosteriod (lowest dose)
	Leukotriene modifier	Medium or high dose ICS Low dose ICS plus Leukotriene modifier	Leukotriene modifier sustained release of theophylline	Anti IgE treatment
		Low dose ICS plus sustained release		

Figure 2.2 Management approach based on control for adults and children older than 5 years[2]

[2] Taken from Pocket Guide for Asthma Management and Prevention. 2012 [135]

2.7. Influences of physician training upon medical management of asthma patients

Similarities and differences in management have been observed in several specialty areas.[136,137] A study by Zanetta et al. on management differences in prenatal hydronephrosis among maternal-fetal medicine obstetricians, and pediatric urologists and radiologists and found differences between subspecialty in both diagnosis and management.[138] A generalist or a nurse practitioner can provide comparable care to sub-specialist under certain circumstances.[139,140] A study investigating care of patients with HIV indicated that an expert generalist may provide comparable quality of care to that of a specialist.[139]

Asthma control in children with mild asthma is similar whether managed by an asthma nurse or a primary or secondary care physician when following standardized management guidelines.[140] Management by a hospital-based specialized asthma nurse was found to be not inferior to that provided by a general practitioner (GP) or a pediatrician.[140] Pediatric asthma cases are routinely managed by family physicians who may be more likely to underestimate asthma severity than actual condition,[141] which can potentially result in under-prescribing of appropriate drug regimes. Severe or difficult-to-treat asthma, as well as patients with substantial morbidity require more complex management[142] and these patients are usually referred for specialist consultation by a PedResp, PedAll, or Peds with special training in asthma.

2.7.1. Types of physician specialty

2.7.1.1. General practitioners (GP)

General practitioners are the first professional contact for more than 90% of Canadians. General practitioners are required to complete a minimum of 24 months of a postgraduate family medicine training program, meeting the standards for accreditation judged acceptable to the College of Family Physicians of Canada, and successfully complete a certification examination in family medicine.[143]

2.7.1.2.Pediatrician (Peds)

A Peds is a specialist trained in the diagnosis and treatment of a broad range of diseases involving children based on a sound knowledge of normal growth and development and of the wide range of clinical conditions encountered in infants, children, and youth. Training duration is 4 years.[144]

2.7.1.3.Pediatric allergist/immunologist (PedAll)

Clinical immunology and allergy is a medical subspecialty concerned with the investigation, diagnosis and medical management of conditions involving the immune system, with an emphasis on allergic, autoimmune and immunodeficiency diseases.[144] The subspecialty encompasses three major clinical areas: allergic diseases and asthma, immune-regulatory disorders, and immunodeficiency. Certification requires Royal College certification pediatrics, completion of a 2-year accredited program in Clinical Immunology and Allergy, and successful completion of the certification examination in Clinical Immunology and Allergy.[144]

2.7.1.4.Pediatric respirologist (PedResp)

Pediatric respirology is a branch of medical practice concerned with the diagnosis and treatment of lung disease affecting the infant, child and adolescent.[144] Certification requires Royal College certification in pediatrics, completion of a 2-year Royal College accredited program in pediatric respirology, and completion of the certification examination in Respirology.[144]

2.7.2. Asthma management differences

Several studies have shown that physician training influences care.[9,145-147] Training and sub-specialization influence the understanding and interpretation of asthma guidelines.[148] A study assessing physician understanding of asthma guidelines and practice found that asthma specialists (fellows/faculty) scored higher on asthma knowledge tests compared to internal and family medicine residents/faculty. Residents in medicine had improved test results with increased

duration of training. The same study also found that subspecialists (pulmonologist and allergist) caring for adult asthma patients have the best overall understanding of the guidelines supporting the positive impact of training on asthma understanding.

Differences in asthma management persist[149,150] despite the presence of asthma management guidelines.[148] Asthma management between generalists and specialists was found to be different.[8] Diette et al. compared quality of asthma care for children by specialists (pulmonologist and allergist) and generalists (pediatrician, family/general practitioner and internist) in the United States in 1997-98 among children enrolled to Managed Care Organization. The study reported that specialists consistently adhered to asthma guidelines in all four domains of asthma care (proper use of medication, environmental control, health education and physical assessment and monitoring). The main difference was observed in the use of controller medicine.[8] A subsequent review paper supported the observation that specialists are more knowledgeable, comply with health screening guidelines, and utilize more resources for diagnostic tests and procedures.[151] Diette's study did not account for the factors that caused the patients to seek specialist care. In addition, the study used patient reported outcomes, which could raise the concern for bias. Being a cross-sectional study, association between quality of care and patient outcomes could not be explored. Further, the important differences contributed by subspecialty cannot be identified from this study as allergists and pulmonologists were clustered together.[8] A second study by Diette with adult asthma patients found that patient-reported drug use pattern was different by specialty of the patient's provider (generalist, allergist and pulmonologist).[152] Donohoe reported that generalists, compared to specialists tended to underutilize long-term ICS and high-dose oral steroids for asthma exacerbations while over-utilizing long-term oral steroids.[153] A number of studies have explored the differences in asthma outcomes of adult patients provided with care by immunologists and generalist/primary care physicians, but these preclude any comparison with pulmonologists.[154-157] Although Schatz et al included pulmonologist as a comparison group in their study, the authors warned to

interpret the finding cautiously due to the limited number of patients who received care by the pulmonolgists.[158]

There are several possible reasons for these differences in patient management by physician specialty. Apart from training, management differences could be affected by difference in disease severity, simplicity of protocol, and patient characteristics.[9,147] An example of the latter is that patients seen by allergists have been shown in one study to have a higher socioeconomic status than those treated by a pulmonologist. Moreover, patients treated by the pulmonologist had more severe asthma and required more medication than those under an allergist's care.[9]

2.8. Summary

Several health professionals treat children with asthma. The Canadian Thoracic Society has developed asthma guidelines for management consistency since 1990. Despite the publication of numerous guidelines, significant variation asthma management persists.[159] Differences in asthma management may be the consequence of differences in specialty and sub-specialty training of physicians as well as other factors. Earlier studies used patient reported outcomes which are subjective and dependent on patients having an adherent personality. Some studies have identified treatment outcome differences between physician specialties; however, the actual comparison was between primary care and tertiary care settings; where any difference could be inevitable. The difference in asthma management and outcome between physician specialties working at a tertiary care center is more important than the difference between physicians at different level of health care services. Children should receive comparable treatment and should have comparable asthma outcomes at a tertiary center regardless of whom they seen. The above issues warrant further investigation of pediatric asthma management differences by physician specialty.

CHAPTER 3: OVERARCHING OBJECTIVES

This study aimed to identify the influence of specialist training on pediatric asthma management. Our primary and secondary objectives were derived to explore the diagnostic and therapeutic aspects of asthma management.

3.1. Objectives

Primary Objective: To compare the difference in therapeutic choices, with a focus on ICS use, for asthma management between Peds, PedResp, and PedAll.

Secondary Objectives: To compare between specialties the differences in diagnosing comorbid conditions for patients referred for asthma.

3.2. Hypotheses

Primary Hypothesis: There is a significant difference between Peds, PedResp and PedAll in prescribing ICS for children over 6 years of age with asthma referred to pediatric respiratory medicine and seen at least once between January 2009 and December 2010.

Secondary Hypothesis: There is a significant difference in the doses of ICS prescribed between Peds, PedResp and PedAll for children over 6 years old with asthma referred to the pediatric respiratory medicine and seen at least once between January 2009 and December 2010.

Tertiary Hypotheses: There is a significant difference between specialties (Peds, PedResp, and PedAll) in the diagnostic practice of co-morbid conditions in children over 6 year old with asthma referred to the pediatric respiratory medicine and seen at least once between January 2009 and December 2010.

CHAPTER 4: MATERIALS AND METHODS

4.1. Study design

A retrospective chart review was conducted of children seen at least once between 1 January 2009 and 31 December 2010 in a multi-disciplinary asthma clinic at a tertiary-care centre (Stollery Children's Hospital, Edmonton, Alberta).

4.2. Setting and time frame

The Stollery Children's Hospital asthma clinic accepts children aged 0 to 17 years on a referral-only basis from community and hospital-based physicians from all specialties. Children may be referred for consultation, assessment of asthma, confirmation of suspected asthma, or management of asthma. The clinic is staffed by one to two clinical nurse specialists (certified asthma educators) and up to 10 physicians. There were 5 PedResp, 3 PedAll and 2 Peds at the time of study. The Peds physicians had completed at least one year of a pediatric pulmonary fellowship and thus may not be representative of all community based pediatricians. However, Peds were included in the study because children referred to a tertiary centre should receive a similar quality of care regardless of the physicians' training. The physicians provide services in the clinic during a different half-day periods which results in minimal interactions between physicians (no multi-disciplinary care) although patients may be referred between specialties.

When the referral was from a Peds, the children were triaged to a PedResp or PedAll, while uncomplicated referrals from a family physician were assigned to any doctor. The triaging between PedAll and PedResp is inconsistent and primarily based on availability. Although there was no consistent triaging of patients between the PedAll and PedResp, allocation was not random. All physicians have access to the certified nurse asthma educators who provide in-clinic, point-of-care SPT and spirometry with or without bronchodilator.

4.3. Ethics and administrative approvals

Ethical approval of the protocol was obtained from the Health Research Ethics Board (HREB) which provides combined ethical approvals for the University of Alberta and Alberta Health Services. Concurrent with obtaining HREB approval, we obtained administrative approval from the pediatric department and consent from participating physicians for accessing, reviewing and recording data from their medical records. (Appendix I)

4.4. Study Population

Initially, we proposed to collect data only from new consults in order to limit potential biases of prior treatment related to our primary and secondary outcomes. However, a limited number of charts were available. As a result, we modified our inclusion criteria to include any patients with asthma seen during the study time frame (i.e. new and continuing patients). Our final inclusion and exclusion criteria are listed below.

Potentially eligible patients were identified through the asthma clinic booking and physician billing records. We identified sub-specialty patients based on billing information available from the electronic database (RISE) used by Alberta Health Services. Pediatricians do not bill through the RISE database, so we identified Peds patients mainly from booking records rather than billing information. Upon receipt of administrative approval, we were provided with lists for the study time period 1 January 2009 to 31 December 2010, of patients who were booked for an appointment at the asthma clinic and of billings for patients with asthma. Charts of the patients identified were gathered from the chart room for the clinic located in the Edmonton Clinic Health Academy. Missing charts were noted and a second attempt to locate them was performed in case the charts were unavailable (e.g., with the physician for follow-up or other reasons).

4.4.1. Inclusion Criteria

a) Children who were seen at least once in a tertiary care ashtma clinic between 1 January 2009 to 31 December 2010

b) Children at least 6 years of age at the most recent visit censored at October 31 2012.

c) Children with physician-diagnosed asthma

- PedAll and PedResp: Physician submitted an International classification of diseases-9 (ICD-9) asthma billing code for any clinic visit
- Peds: Booked and seen as an asthma patient in asthma clinic

4.4.2. Exclusion Criteria

a) Conditions that could deviate treatment away from regular asthma management:

- Cystic Fibrosis: Individuals with either physician-diagnosed Cystic Fibrosis (ICD-9 billing code) or two positive sweat chloride results
- Immune deficiency: Individuals with a documented immune deficiency (ICD-9 billing code or from consultation notes)

b) Specialist confirmed non–asthma cases

4.4.3. Case confirmation for ambiguous cases

Ambiguous charts, when the diagnosis of asthma was unclear, were reviewed by Dr. Mandhane, a PedResp. An example of an ambiguous case was a patient who was billed as having asthma but had other medical conditions apart from asthma diagnosed during the visits. These cases were excluded if Dr. Mandhane classified the patient as not having asthma despite the billing code. Additionally, patients that were not on any asthma medication at the most recent visit were reviewed independently by Dr. Mandhane and Dr. Majaesic. A diagnosis of asthma was arrived at independently and discrepancies were discussed until a consensus was reached. The decision of these pediatric

pulmonologists was final. Appendix II details the Data Collection Flow Diagram outlining these procedures.

4.5. Data Extraction

A preliminary list of variables to be extracted from the clinic database was created based on the existing adult pulmonary division database. The list was finalized after discussion with and consensus from some of the pediatricians/subspecialty specialists. Patient information was gathered from several sources: patient registration form, referral letter, hand-written physicians notes, dictated notes from the first and the most recent visit, prescription records, investigation request letters, and investigation results. The patient charts obtained from the chart room were first screened for eligibility and then the charts from eligible patients were reviewed from cover to cover. The required information was extracted and recorded directly into a study database. We did not assume an absence of a condition if there was no reported evidence. For example, wheezing symptoms was recorded as missing rather than being recorded as absent if there was no explicit charting (presence or absence). The final consultation was censored at 31 October 2012.

4.6. Study Variables

Study variables included physician specialty (independent variable of interest), prescription of ICS (primary outcome), dose of ICS (secondary outcome), other variables related to management (tertiary outcomes) and possible confounding variables for adjustment. The collected variables included: demographics, referral information, medical history based on initial consult letter, environmental history, family history of allergy and asthma, management (medication prescribed by each physician at first and final consultation, physician observing the patient, date and number of visit), allergy investigations, pulmonary tests, sleep tests, inflammatory markers, laboratory results, radiology and cytology. Variables extracted from the patients chart and source of extraction are listed in Table 4.1.

Table 4.1 List of variables extracted from the patients' chart

Variables	Entire Chart	First Consultation	Final Consultation
Sex [F (%)]	x		
Age		x	x
BMI		x	x
Referral reason		x	
Examples of some of the Co-morbidities			
Atopic conditions (Allergic Rhinitis, Atopic Dermatitis)	x		
Sleep disorders	x		
GERD	x		
VCD	x		
Neuromuscular diseases, Developmental delay	x		
Cardiac diseases	x		
History			
Symptoms (e.g. wheeze, cough)		x	
Asthma severity (systemic steroid use, ED visit, Hospitalization)		x	
Smoke Exposure (prenatal, in family, second hand)		x	
Family structure (siblings, first-born)	x		
Birth (e.g. Early, Late, Term, Gestational Age)	x		
NICU (admission, intubation)	x		
Early childhood (Breast fed, Immunization)	x		
Housing (e.g. Apartment, House, Farm, Acerage)		x	
Any Pets at home (e.g. Cat, Dog, Other)		x	
Family history of atopy (e.g. asthma, hay fever, eczema, allergies) Paternal, Maternal, Sibling		x	
Investigations (requests and results recorded)			
RAST and Skin prick test: Inhalant, Food	x		
Full PFT, Sweat Chloride, Methacholine and Exercise challenge test	x		
Max Cardiopulmonary exercise test	x		
Spirometry: pre and post FEV1, FVC		x	X
Sleep testing (Overnight Oximetry, PSG)	x		
Blood work (requested and all results) Immunoglobulin, CRP, ANCA, Eosinophils, Alpha1 anti-trypsin, Aspergillous)	x		
Bronchoscopy, Sputum culture	x		
Radiology (CT sinus, XR Sinus CT Chest, CXR, Bone density test)	x		
Gastric emptying scan, VFSS	x		
Treatment			
Asthma Medication alone and in combination SABA, LABA, ICS, LTRA, Systemic steroid, Anticholinergic, Theophylline, Biologics		x	x
Antihistamine Nasal steroid, Nasal decongestant		x	x
Antibiotics, Anti-fungal		x	x
Anxiolytic, Anti-epileptics, Neuroleptics		x	x
Antacids, Anti-gastritis, Anti-reflux, Anti-emetics		x	x
Cold medicine, Dietary supplement/ vitamins, Eye or Ear drops, Antitussive		x	x
Disease specific medication (insulin, CF–related medicine, Topical steroid, NSAID)		x	x

No patient identifiable information (such as name, ULI number) was collected. Data on patient characteristics and demography were obtained from registration forms. We also recorded the date of referral (if available), date of first visit, any first visit around age 6, and the most recent visit The total number of visits was also counted and recorded. The referral letter provided the reason for referral and history (if available). Birth history, family history, co-morbidities and medications prescribed were collected from the initial consultation visit and the most recent clinic visit (hand written and dictated letters were used). Results of any investigations performed were documented from the entire chart (any visit).

4.6.1. Physician specialty (Independent variable of interest)

The criteria set by Royal College of Physicians and Surgeons of Canada were used to differentiate between physician specialties. The physicians were classified as Peds, PedResp or PedAll based on their previous training.

4.6.2. Prescription of ICS (Primary outcome variable)

Prescription of ICS was gathered from the dictated notes, hand written notes, and prescription records. Dictated notes were used as the main source of information if all of these notes were available. Incomplete drug information from the physician notes (dictated or written) was confirmed with the prescription records. If an additional medicine was recorded in the prescription notes, then that medication was considered as being prescribed regardless of whether it was not recorded in a dictated letter. The patient was considered to be on ICS when it was prescribed either alone or in combination with others (LTRA/LABA). ICS included in this analysis included: Beclomethasone diproprionate (BDP) HFA, Budesonide, Ciclesonide, Fluticasone, and Mometosone. Nasal steroids and systemic steroids were not considered ICS.

4.6.3. Dose of ICS (Secondary outcome variable)

A number of ICS with different steroid formulations are available in the market. For all patients on ICS, the total daily ICS dose was converted into BDP

equivalents for standardization based on Canadian Thoracic Society (CTS) consensus asthma guidelines.[114] (Table 4.2)

Table 4.2: Comparative inhaled corticosteroid (ICS) dosing categories in children and adults[114]

		Dosing ICS dose, mcg					
		Pediatric (6-11 year of age)			Adult (12 year of age and over)		
Corticosteriod	Trade name	Low	Medium	High	Low	Medium	High
Beclomethasone diproprionate HFA	QVAR	≤ 200	201-400	>400	≤250	251-500	>500
Budesonide	Pulmicort Turbuhaler	≤400	401-800	>800	≤400	401-800	>800
Ciclosonide	Alvesco	≤200	201-400	>400	≤200	201-400	>400
Fluticasone	Flovent MDI and spacer Flovent diskus	≤ 200	201-400	>400	≤250	251-500	>500
Momentasone	Asmanex Twisthaler				200	400-800	>800

4.6.4. Confounding variables:

Confounding variables that may influence treatment decisions include asthma control/severity, demographic characteristics, co-morbid conditions, pulmonary function status, allergy status, family history, environmental factors, and birth history.

4.6.4.1. Personal and Family History

a) Allergen sensitivity

The presence of an allergic condition was identified by SPT or RAST. A positive SPT was defined as a wheal size > 3 mm larger than a negative control. A RAST test was considered positive if the result was greater than the upper value for the normal range as provided by the laboratory (0.35 IU/ml). We classified a child as atopic if they had a positive allergic reaction to any allergen using either test. Similarly, the child was considered non-atopic when the result to allergy testing (RAST or SPT) was negative for the allergens tested. Data for children who had never undergone an allergen test were categorized as missing.

b) AD/Eczema

The patient was classified as having AD/eczema if the physician noted the presence of these conditions in the dictated notes or in the written notes of the history section of the chart. Otherwise the patient was considered not to be diagnosed as having AD/eczema.

c) Allergic rhinitis (AR)

Patients were considered to have AR if the history revealed that the patient had AR prior to the first visit, or if the physician diagnosed the patient as having AR at the first or at the most recent visit. Any of the following terms: rhinitis, chronic rhinosinusitis, allergic rhinosinusitis, chronic sinusitis, or allergic sinusitis found in the history were coded as presence of AR. Otherwise, we categorized the child as not having AR.

d) Family history of atopy

A family history of asthma and other atopic disease such as AR, food allergy, and eczema was reviewed from the history page. Based on the physician's notes, we identified the family as atopic, non-atopic, or unknown.

4.6.4.2. Asthma control/Disease severity

a) Change in percent-predicted FEV_1 (%FEV_1)

Change of % predicted FEV_1 was calculated the difference of pre-bronchodilator % predicted FEV_1 between the first visit after turning 6 years and the most recent visit.

b) FEV_1/FVC ratio

FEV_1/FVC ratio of more than or equal to 80% was considered normal, a value less than 80% was abnormal. The information for the pulmonary function data was gathered from dictated notes, handwritten notes, and investigation results.

c) Airway hyper-responsiveness

Investigations for AHR included: methacholine challenge test, bronchial hyper-responsiveness using indirect test (exercise), and post-bronchodilator spirometry after aged 6 (either in clinic or through the pulmonary function laboratory). Presence of AHR was estimated from a positive bronchial challenge test (methacholine challenge or exercise tolerance test) or a 10% change in FEV_1 between pre- and post-bronchodilator pulmonary function testing, either at the initial or at the most recent visit, or from any full pulmonary function testing.

d) Prior use of systemic steroid

` The prior use of systemic steroid was categorized as one of: ever used, never used, and unknown. This information was obtained from the patient history (dictated notes and hand written notes)

e) Asthma emergency history

A prior asthma emergency history was defined when a patient had an ED visit and/or a hospital admission due to asthma. Those cases with insufficient information were considered having missing data. We gathered this information also from history sections.

4.6.4.3. Environmental history

a) Maternal smoking during pregnancy

Maternal smoking during pregnancy was identified from the initial visit note or referral note. Maternal smoking during the prenatal period was recorded as unknown (missing) unless otherwise stated in any section/record of the chart.

b) Exposure to household smoke (second-hand smoke)

Household smoke exposure included any family member (e.g. grandparents, separated/divorced parents) who may smoke on a regular basis either indoors or outdoors. Exposure status of second-hand smoke was considered

as either present or absent based on the recorded notes. The case was considered as having missing information if there was no information documented on smoking history of a family member.

c) **Presence of siblings**

We recorded the presence of one or more siblings from the history of first visit. We considered the child as only child / first born child if there was no written information on having siblings at later visit.

d) Presence of pets at home

The presence or absence of pets at home was record from all areas of the patient chart. The case was categorized as missing data when there was no evidence of whether or not the family had a pet.

4.6.4.4. Co-morbidity

a) Gastroesophageal reflux disease

Presence of GERD was recorded if the physician noted the existence of reflux oesophagitis, gastroesophageal reflux, or diaphragmatic hernia in their dictated letter or written notes of either the initial or the most recent visit. We did not include non-specific symptoms as GERD without a physician's confirmation.

b) Prematurity

The child was classified as born premature when the physician recorded their birth as preterm or a gestational age of less than 37 weeks.

c) Sleep disorders

The child was classified as having a sleep disorder if sleep disorders, sleep apnea, obstructive sleep apnea or OSA or sleep disordered breathing or SDB was recorded in the history.

4.6.5. Concurrent medicines

4.6.5.1. SABA

We classified the patient as being on a SABA if the record indicated that the patient was on Airomir, Bracanyl, Salbultamol or Ventolin.

4.6.5.2. LABA

We classified the patient as being on a LABA if the record indicated that the patient was on a LABA alone (Formoterol) or a LABA in combination with an ICS (Symbicort, Zenhale or Advair).

4.6.5.3. LTRA

We classified the patient as being on a LTRA if the record indicated that the patient was on Singulair or Accolate.

4.6.5.4. Anti-cholinergic

The patient was categorized as being on an anti-cholinergic if the patient was prescribed Atrovent or Spiriva.

4.6.5.5. Anti-immunoglobulin

Any information on provision of Xolair or intravenous immunoglobulin (e.g. IVIG) was considered in classifying an individual as being on immunoglobulin therapy.

4.6.6. Investigations

4.6.6.1. Overnight oximetry (sleep study)

We classified an individual as having a sleep test requested if there was a request for an overnight oximetry study. This information was gathered from the investigation section as well as from the history section. We categorized the patient as not having a sleep test requested if there was no information on a sleep

test request. The overnight oximetry investigation test was considered positive if any of the results were abnormal.

4.6.6.2. C-reactive protein

C-reactive protein (CRP) was coded as ordered if there was any request / result stated in the history or investigation section. The CRP result was considered abnormal (high) if blood CRP was >1.0 mg/L.

4.6.6.3. Eosinophil

The eosinophil count was extracted from the findings of the complete blood count (CBC), total white cell, and differential count (TBDC). We recorded the percentage of white blood cells contributed by eosinophil. The patient was considered eosinophilic when the blood eosinophil level was greater than 2.5%.

4.6.6.4. Alpha-1 antitrypsin deficiency (AATD)

The physician request for AATD was identified from the physician's note as well as from the investigation record. Normal blood level of apha-1 antitrypsin is 1.5-3.5 g/l [(160)]. A child was considered to be AATD if their alpha-1 antitrypsin level was less than 1.5 g/l [(160)].

4.6.6.5. Aspergillosis serum

The aspergillous serology was coded as tested if aspergillous Ig was tested for in the RAST inhalant screen. The aspergillous serology was positive if the aspergillus Ig result was more than 0.35 iu/ml.

4.6.6.6. Sinus radiography

Both sinus X-ray and sinus CT were recorded in our database. The case was considered as having a request for sinus X-ray if the physician had requested and /or tested for radiographic examination of the paranasal sinuses. The sinus X-ray finding was considered to be abnormal if there was any finding which was not normal including thickening of the nasal mucosa. We recorded for sinus CT

requests/results in a similar manner. The tests requested and results were recorded separately.

4.6.6.7. Chest radiography

A request for CXR was considered to be present if there was any request form or a CXR result present in the patient file; otherwise, a CXR was considered not requested. A CXR was coded as abnormal if the patient's first CXR result was found to be abnormal regardless of a normal CXR finding at a later visit. Similarly, a CXR was reported as normal if the initial CXR was normal despite a subsequent test being abnormal. Similar methods were used for chest CT results.

4.6.6.8. Bone Scan

Bone scan requests were identified from the physician request letter or the findings from bone scan investigation. The report from the bone scan study was used to determine if the bone scan was normal or abnormal.

4.6.6.9. Bronchial alveolar lavage

The request for a BAL by a physician was usually obtained from the investigation section. The percentages of macrophages, lymphocytes, epithelial cells, neutrophils and eosinophils in the BAL were recorded. The presence of lipid-laden macrophages was recorded. Bacterial, fungal and viral cultures were recorded from the BAL culture results.

4.6.7. Clinic Organization

4.6.7.1.Wait time

Wait time was calculated as the interval between the referral date and the patient's first visit at the asthma clinic.

4.6.7.2.Time between visits

Time between visits was calculated from the total duration between the initial and most recent visits divided by the total number of visits.

4.7. Statistical analysis

4.7.1. Data collection

A data dictionary was developed for the selected variables using a secure web application for building and managing databases (REDCap; Research Electronic Data Capture). The REDCap system provides branching logic, data validation tools, audit trails for tracking data manipulation and user activity, and a variety of data download options (SPSS, SAS, STATA, R). The database was tested several times to ensure that the data could be entered without any difficulties. The information recorded in REDCap remained in the secure RedCap server on the password-protected University of Alberta Faculty of Medicine's server.

4.7.2. Statistical methods:

Exploratory data analysis was performed using a Chi-square test for categorical data and ANOVA for continuous data to identify any significant difference in baseline distribution by physician specialty. Factors that may influence the use or dosing of ICS were first tested using univariate analysis. Variables examined in univariate analysis are presented in Table 4.3. Variables found to be statistically significant in this univariate analysis were included in the multivariate analysis to adjust for their effect between physician specialty and asthma management.

For both primary and secondary outcomes, we used multilevel regression analysis. Asthma management by physician specialty was correlated at two levels: the individual physician level and the physician specialty group level. Cases were nested within the individual physician. Physicians were nested within the cluster of physician specialty. There could be some influence of within cluster correlation

while observing the effect of specialty group. By using a multilevel model, we were able to adjust for correlation within the physician level. In addition to the above within cluster correlation, we also had a number of cases where a patient was seen by two physicians from same or different specialties. This multiple physician scenario may result in cross-cluster correlation. As there were few cases that met this scenario and for statistical simplicity and accuracy, we decided to use only one case from the duplicates with the case selected based on physician providing care at the most recent visit. For both primary and secondary analyses, we compared the findings of including all cases and omitting the duplicate cases as a sensitivity analysis.

Table 4.3 Variables considered for univariate analysis

Demographic characteristics	Age, Sex,
Asthma severity	Prior history of systemic steroid requirement, Prior history of ER visit and / or hospitalization due to asthma, baseline %predicted FEV_1 and FEV_1/FVC ratio
Co-morbid diagnoses	Eczema / AD, AR, GERD, and SDB
Personal and family history of atopy	
Environmental exposures	Pets, Smoke
Birth history	Prematurity, Neonatal hospitalization history
Laboratory results	Pulmonary function results, Laboratory-confirmed allergic conditions, and airway hyper-responsiveness

We had originally intended to compare the outcomes at two time points: the initial visit and the most recent visit. During the data collection process, we noticed that some physician did not start providing treatment at the first visit or did not change the existing management at the time of referral. They rather started

/changed the treatment protocol only at the second visit when they received all the investigation findings. Comparing the treatment at the first visit would not actually reflect the physician's decision. Thus, we decided to use the most recent visit as the point of comparison for asthma management by physician specialty.

The primary objective of this study was to compare the difference in therapeutic choices for asthma between specialties (Peds, PedAll, PedResp). Our primary outcome was the use of ICS and the secondary outcome was the dose of ICS, among those patients prescribed ICS. Multilevel logistic regression was used to assess the association between ICS used and physician specialty, after adjusting for other potential explanatory factors identified in the univariate analyses. Multilevel linear regression analysis was used to determine if there was any difference in the dose of ICS between specialties, adjusting for asthma medications in addition to other covariates. We did not include the systemic steroid dose to calculate the dose of ICS. Instead, the effect of systemic steroid use was tested and adjusted like any other explanatory variables. We explored factors that determined management decisions, especially those that influenced the use and dose of ICS and their extent of contribution in determining the outcome.

We explored a difference between physician specialties in their choice of step-up therapy when low-dose ICS was not sufficient to achieve asthma control (add-on therapy). The outcome was polytomous in nature (LABA, LTRA, LABA+LTRA). Unfortunately, the mixed-effect model in polytomous logistic regression, using STATA and SAS, failed to converge. Thus, a simple polytomous regression was performed without taking into consideration the mixed-effect of physician level correlation.

Additional analyses compared the investigation procedures ordered by specialty group using univariate logistic regression and multilevel analysis. Differences in physician specialty for changes in % predicted FEV_1 from the first spirometry test to the most recent visit was also used as an intermediate outcome measure for asthma control. Additionally, we compared the identification of co-morbid conditions, total number of visits, average duration between visits, waiting

time, and the type of investigation preferred by specialty using logistic or linear regression, depending on the outcome measure.

4.7.3. Sample size and post-hoc power

Two Peds, three PedAll, and five PedResp staffed the asthma clinic during the 24-month study period. We approximated the patient population to be at a ratio of 2:3:5 by physician specialty. ICS use among PedAll was estimated at 90%. Using this estimate, we forecasted that we would require 2560 patients (alpha 0.05, power 90%) to identify an odds ratio (OR) of 1.5 for ICS use among PedAll compared to Peds, and 794 patients to identify an OR of 2 (Table 4.4). Similarly, to detect an OR of 1.5 or 2 (alpha 0.05, power 90%) for ICS use between PedAll to PedResp, we would require 2584 and 794 participants respectively (Table 4.4).

Table 4.4 Sample size requirement for the study

	Estimated patient ratio	OR 1.5	OR 2	OR 2.5
PedAll vs. Peds	3:2	N = 2560	N = 794	N = 424
PedAll vs. PedResp	3:5	N = 2584	N = 792	N = 422

A post-hoc power calculation was performed using our actual data (Table 4.5). With the available number of cases and patient ratios by specialty, our study could detect an OR for ICS use of 2.9 when comparing PedAll and Peds, and an OR of 2.4 for the PedAll-PedResp comparison (alpha 0.05, power 90%)

Table 4.5 Results from post-hoc power calculation

	Total	Patients ratio	Detectable OR	Power estimates		
				OR-1.5	OR-2	OR-2.5
PedAll vs. Peds	221	0.56 : 0.44	2.9	29%	50%	76%
PedAll vs. PedResp	418	0.29 : 0.71	2.4	30%	72%	93%

CHAPTER 5: RESULTS

During the 24-month study period, from 1 January 2009 to 31 December 2010, 1004 children were billed as asthma patients by subspecialty pediatricians and 177 children were booked with pediatricians for a Stollery hospital asthma clinic visit (Appendix III). Of these, 55 cases were not yet 6 years of age at the final visit or their charts were archived and 42 cases were excluded because of a non-asthma condition. The charts of 550 patients were not found. One major contributor to this is that the billing information we received was not exclusive to Stollery asthma clinic, and thus patients seen elsewhere would not have charts available to us. Other possibilities would be that charts were archived if the patient had not been seen in the prior two years (inactive) or that the charts were misplaced. Of the 566 cases of asthma for which we had data, 533 were seen by a single specialist and 33 were seen by more than one specialist, resulting in 566 cases of asthma. Of 47 patients who were not on asthma medication at their most recent visit, 37 charts were available for a second chart review which resulted in 17 patients (18 cases) being considered as not having asthma. Of the 548 cases remaining for analysis, 98 were seen by Peds, 141 were seen by PedAll, and 309 were seen by PedResp. Thirty-one patients were seen by at least two different specialists leaving a total of 516 patients in our study.

5.1. Descriptive Analysis

5.1.1. Reason for referral

Patients were referred to the tertiary care clinic for several reasons. In total, 87% of all cases had a clearly written reason for referral: 84% of cases referred to PedAll had a referral reason in their referral note compared to 88% of cases referred to PedResp, and 87% of cases referred to Peds. From the available information, 47% of patients were referred for confirmation of asthma or some other condition, whilst the purpose for 32% of the clinic visits was disease

management. There were no significant differences across the three-physician groups (Figure 5.1).

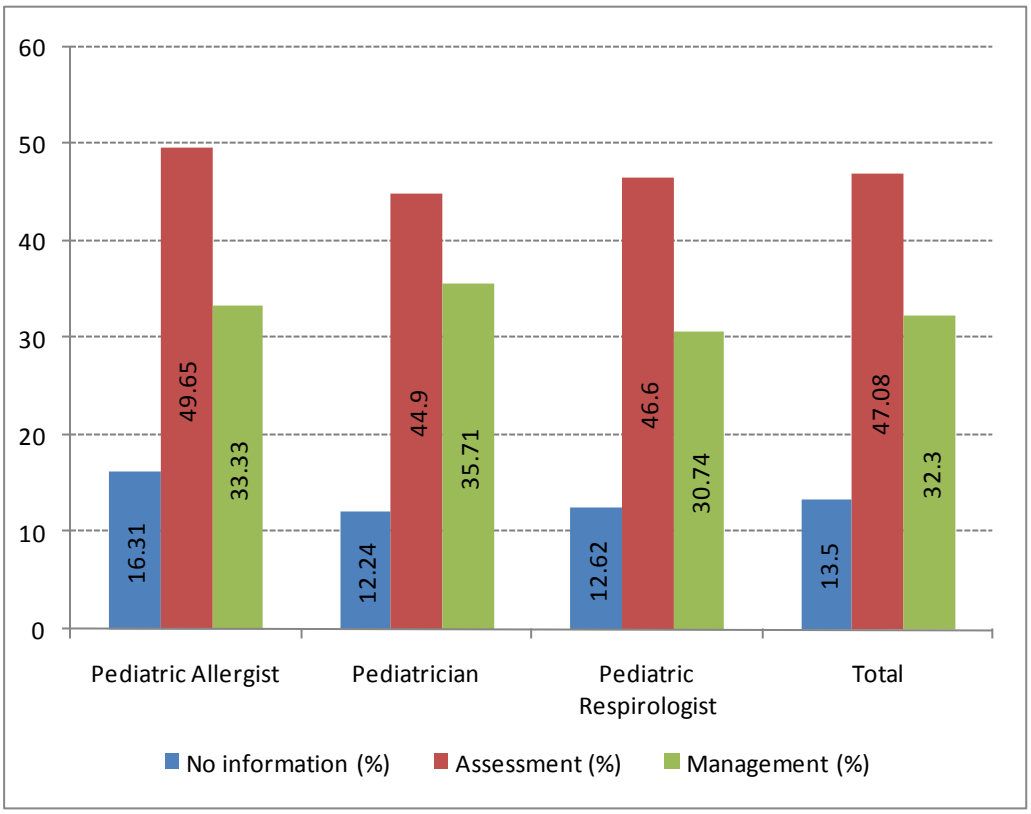


Figure 5.1 Reason for referral between specialties

5.1.2. Difference in pattern of practice by physician specialty

Wait time, total duration of treatment, average number of visits and the average interval between visits reflect the monitoring pattern of the physicians. We observed that the waiting time was longest for seeing a PedAll (27 weeks) and shortest for a Peds (14 weeks). Peds usually offered more visits (an average of 10 visits per patient) which were two times more frequent than visits required by subspecialty specialists. As expected from the above findings, the interval between visits among Peds patients (12 weeks) was approximately half of that for the PedAll (21 weeks) and PedResp (27 weeks) groups. (Fig 5.2)

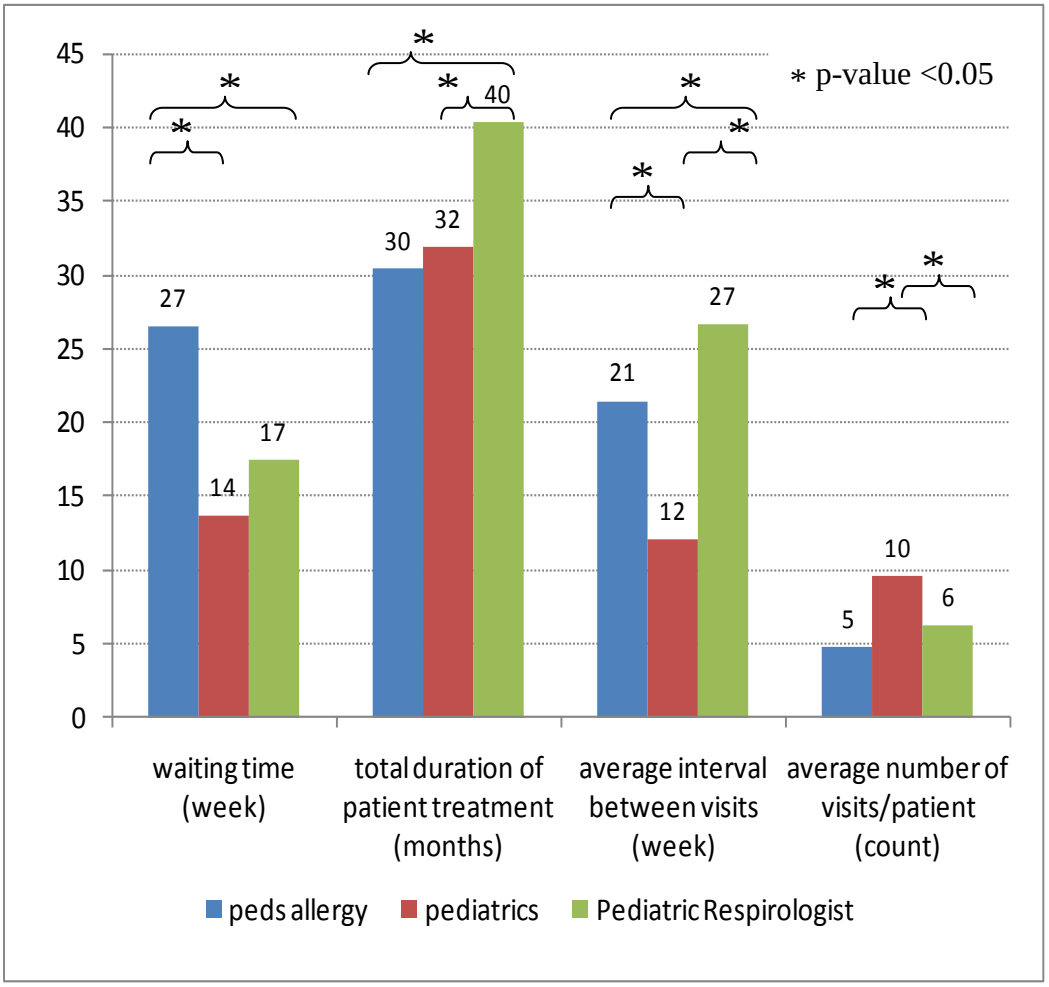


Figure 5.2 Waiting time, duration of visit, and interval between and number of visits by specialty

5.1.3. Frequency distributions of baseline information

There were no significant differences by specialty for most of the major demographic characteristics, markers of asthma severity, family history of atopy, and environmental exposures to allergen (Table 5.1).

Table 5.1 Baseline characteristics of patients by physician specialty

	PedAll	Peds	PedResp	Total	p -value
Demographic characteristics					
N	141	98	309	548	
Sex (Female, %)	39.0	43.9	35.6	38.0	0.32
Age (months) at very first visit (mean (SD))	93 (41)	114 (44)	95 (47)	98 (46)	<0.001
(<12yr , %)	85.8	73.5	81.2	81.0	0.056
Age (months) at most recent visit (mean (SD))	123 (37)	145 (41)	135 (37)	134 (39)	<0.001
(<12yr , %)	68.8	51.0	58.6	59.9	0.018
History					
Prior use of systemic steroid (Yes,%)*	45.8	55.6	65.1	55.0	0.015
Emergency room visit due to asthma (yes,%)	65.9	62.0	67.7	66.2	0.76
Hospital admission due to asthma (yes,%)	34.4	40.4	30.3	33.2	0.40
Ever had asthma emergency (yes, %)	64.5	61.7	58.8	61.1	0.56
History of wheeze (yes, %)*	76.0	92.7	82.5	81.8	0.024
History of cough (yes, %)*	97.1	96.0	88.2	91.9	0.003
Maternal smoke during pregnancy (yes,%)	12.5	18.75	12.86	13.64	0.81
Biological siblings (present, %)	85.5	88.9	90.7	88.9	0.30
Prematurity (<37 weeks gestation, %)	17.7	11.8	15.3	15.4	0.74
Immunization (complete,%)	100.0	100.0	97.3	98.6	0.16
Environmental history					
Housing (house, %)	96.8	96.3	97.0	96.9	0.99
Smokers in the family (present, %)	30.8	27.5	24.7	26.9	0.44
Presence of pets (yes, %)*	54.1	72.6	53.7	56.7	0.012
Family history of atopy					
Dad (%)	48.5	32.9	40.7	41.7	0.09
Mom (%)	57.8	50.7	50.6	52.6	0.36
Sibling (%)	37.4	26.1	38.7	36.4	0.15

5.1.3.1.Gender

As shown in Table 5.1, our study showed that boys required asthma care more than girls. (62.0% vs. 38%, p <0.001) The gender difference was not significantly different in the Peds group (43.9% female, p=0.225) whereas, the difference is significant in the PedAll (39% female, p =0.009) and PedResp

(35.6%, p <0.001) groups. However, the gender distribution pattern was not different by physician specialty (p = 0.324; Fig. 5.3).

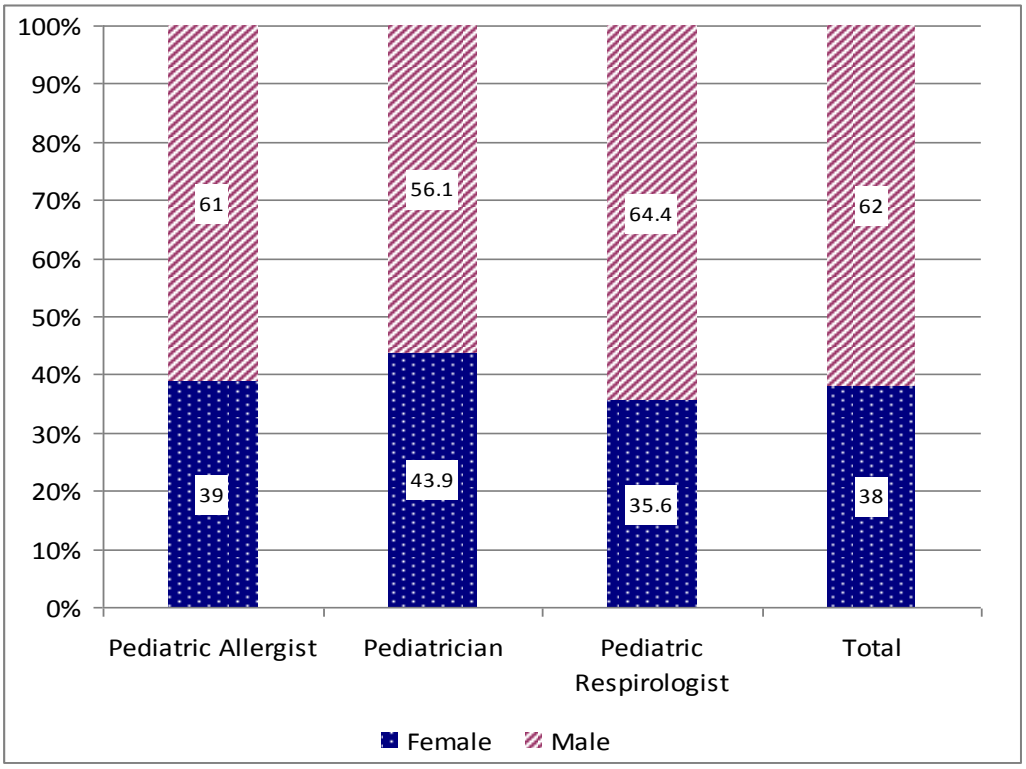


Figure 5.3 Gender distribution of patients seen by physician specialty

5.1.3.2. Age

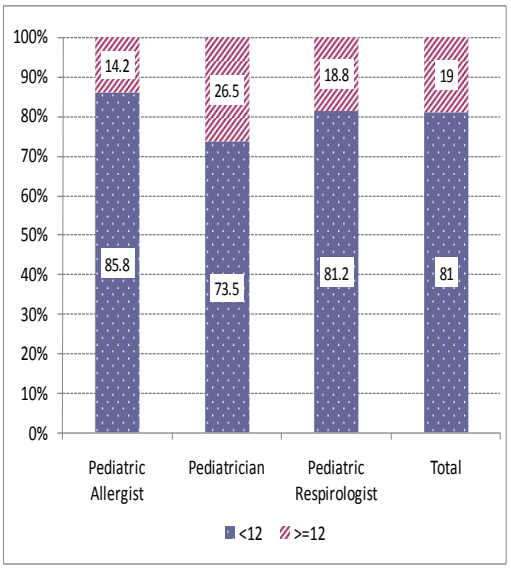
At their first visit, 81% of asthma patients were less than 12 years old, with a mean age of 8.17 years (SD: 3.83). At their final clinic visit, 59.9% remained under 12 with a mean age of 11.17 years (SD: 3.25). The children seeing Peds were the oldest at the both their first and most recent visit, whereas children visiting PedAll were the youngest at both time points (p <0.001, p <0.001; Fig. 5.4).

5.1.3.3. Body Mass Index (BMI)

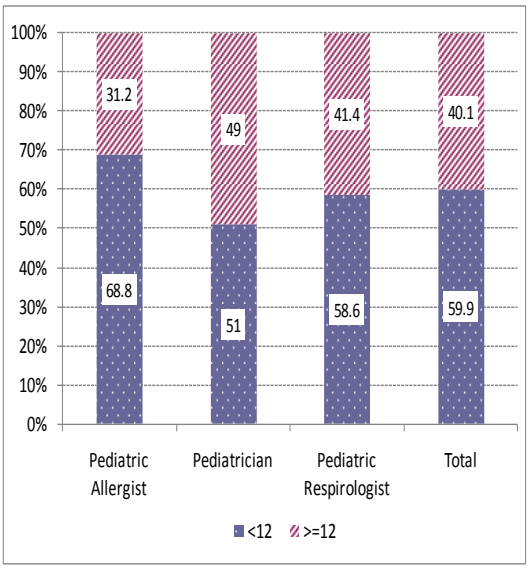
We also compared the BMI of 496 patients whose charts contained this data at the most recent visit. Mean BMI at the most recent visit was also the

highest among the children seen by Peds (p=0.04) which corresponds with the higher mean age of children seen by Peds. (Fig 5.5)

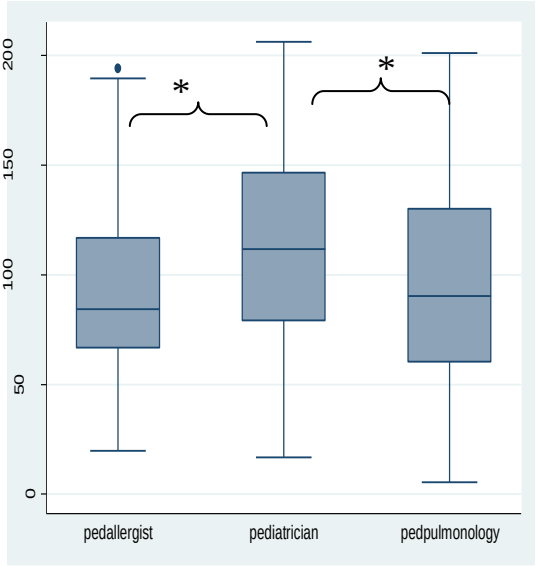
(a) Age distribution at first visit



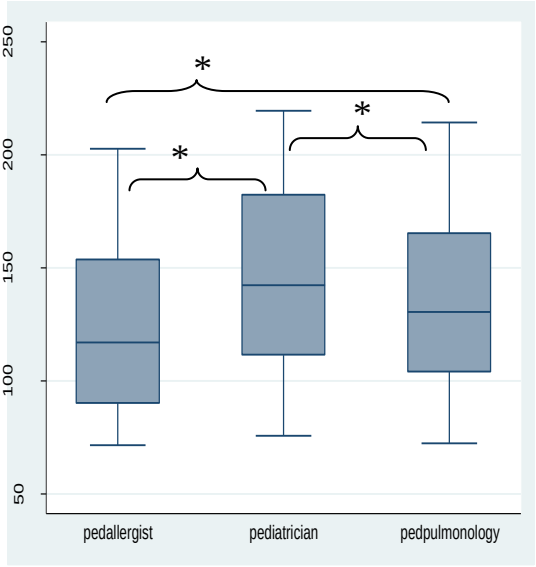
(b) Age distribution at most recent visit



(c) Mean age (month) at first visit

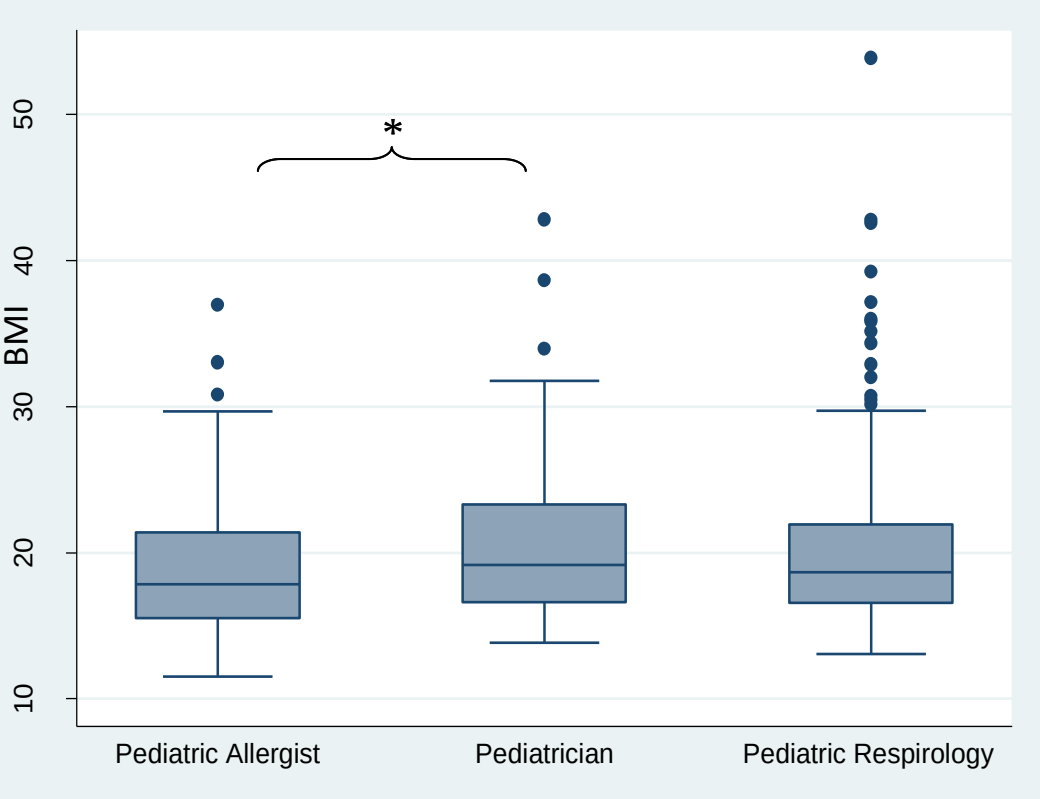


(d) Mean age (month) at most recent visit



∗ p-value <0.05

Figure 5.4 Age distribution and mean age of children by physician specialty at first and most recent visit



∗ p-value <0.05

Figure 5.5 BMI distributions by physician specialty at the most recent visit

5.1.3.4. Severity Markers

a) Asthma emergency

The severity of the asthma was assessed using spirometry, use of systemic steroids, evidence of being to the ED, and requirement of hospitalization due to asthma. Both the number of patients reported as using systematic steroids (presence or absence) and the proportion of patients with prior use of systemic steroids were different by physician specialty. Only 46% of the patient charts had information about prior systemic steroid use and the distribution was different across physician specialty: 28% of the cases seen by Peds, 34% seen by PedResp, and 84% seen by PedAll had information on prior usage of systemic steroids (p <0.001). Among the cases where information was available, 55% had prior systemic steroid use and this use differed by specialty (56 % Peds, 46% PedAll

and 65% PedResp p=0.015). Information on prior ED visits for asthma was known in 63% of children. Sixty-six percent were reported as having a prior ED visit for asthma (66% of PedAll, 62% of Peds and 68% of PedResp cases; p=0.76). Similarly, of 66% of cases having information on prior hospitalization for asthma, 33% were reported as having a prior hospitalization and this did not differ by physician training (p=0.40). Evidence of an asthma emergency, thus requiring either an ED visit or hospitalization, was present in 62%, 65% and 59% of patients charts seen by a Peds, PedAll and PedResp, respectively (p-value=0.56) (Fig 5.6). However, the level of information missing on an incidence of an asthma emergency differed by physician type (2% PedAll, 39% Peds, and 30% PedResp (p<0.001).

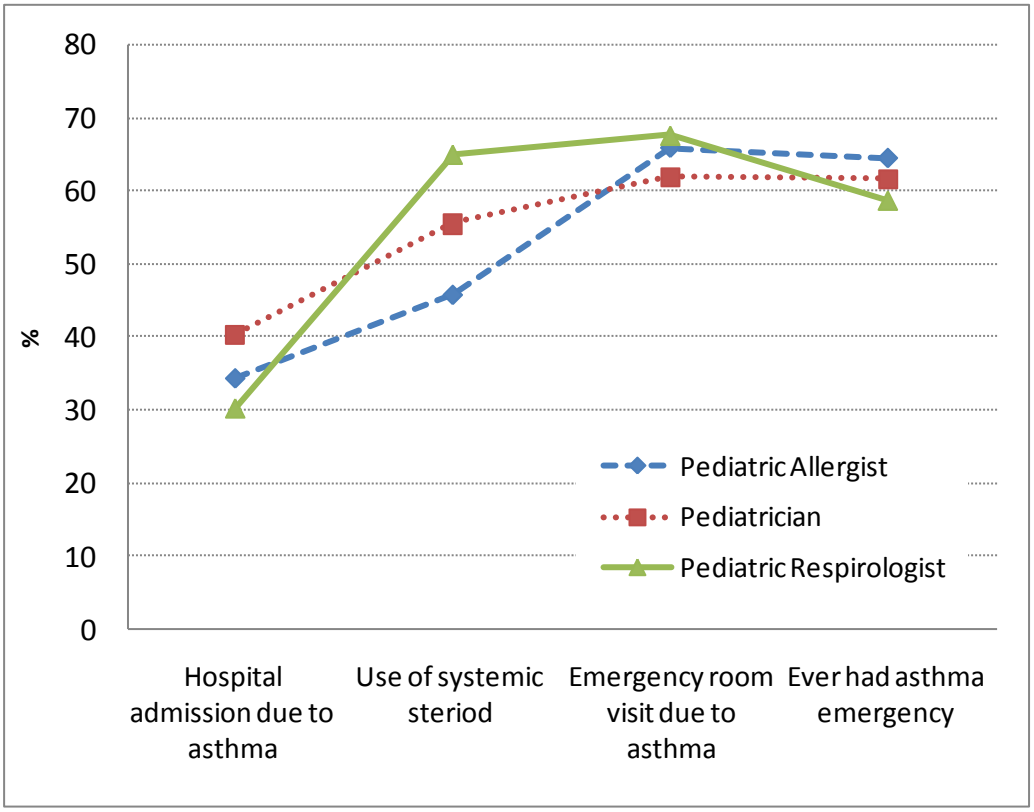


Figure 5.6 Presence of disease severity by physician specialty

b) Pulmonary function status

Data on FEV_1/FVC ratio and $\%FEV_1$, using as alternative markers of asthma control/severity, were compared by specialty. Almost 89% of the children had a pre-bronchodilator FEV_1/FVC measurement at their most recent visit, with a mean FEV_1/FVC ratio of 81% (SD: 8.8%). Mean FEV_1/FVC was more than 80% for all three physician specialties (5.7(a)). Mean FEV_1/FVC ratio was higher in the PedAll group at both initial and final visits (p = 0.04, p = 0.004; Fig. 5.7 (a)).

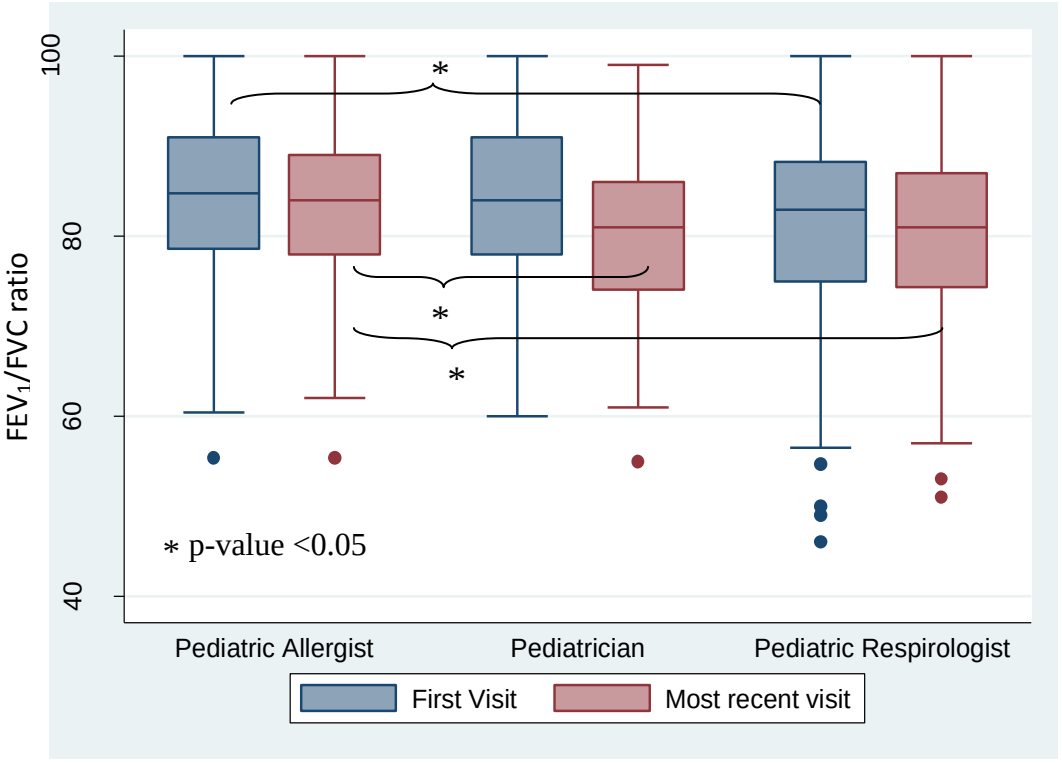


Figure 5.7(a) Distribution of FEV_1/FVC ratio at first and most recent visits by physician specialty

However, the distribution of FEV_1/FVC among PedResp patients was non-normal with a left skew resulting in differences between physician specialties for the proportion of patient having abnormal FEV_1/FVC (<80%) Figure 5.7(b). Although the proportions of children with FEV_1/FVC ratio < 0.8 between specialties was not significantly different at the initial visit (p = 0.08), significant differences were noted at the most recent visit (p =0.015; Fig. 5.7 (b)).

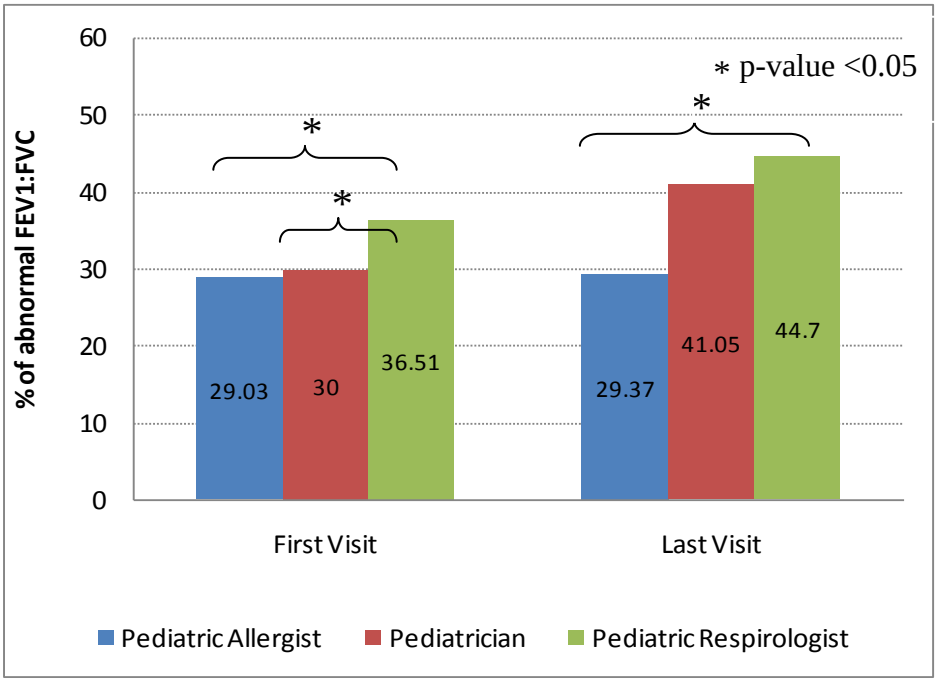


Figure 5.7 (b). Percentage of patients having FEV_1/ FVC ratio of <80% by physician group at the first and most recent visits

The mean % predicted FEV_1 of the three groups was different between initial and final visits (p = 0.004, p <0.001). The highest mean $\%FEV_1$ was observed among children seen by Peds at their initial visit, and among those children seen by PedAll at their most recent visit. The children from the PedResp group had the lowest mean $\%FEV_1$ at both initial and final visits (Fig. 5.7 (c)).

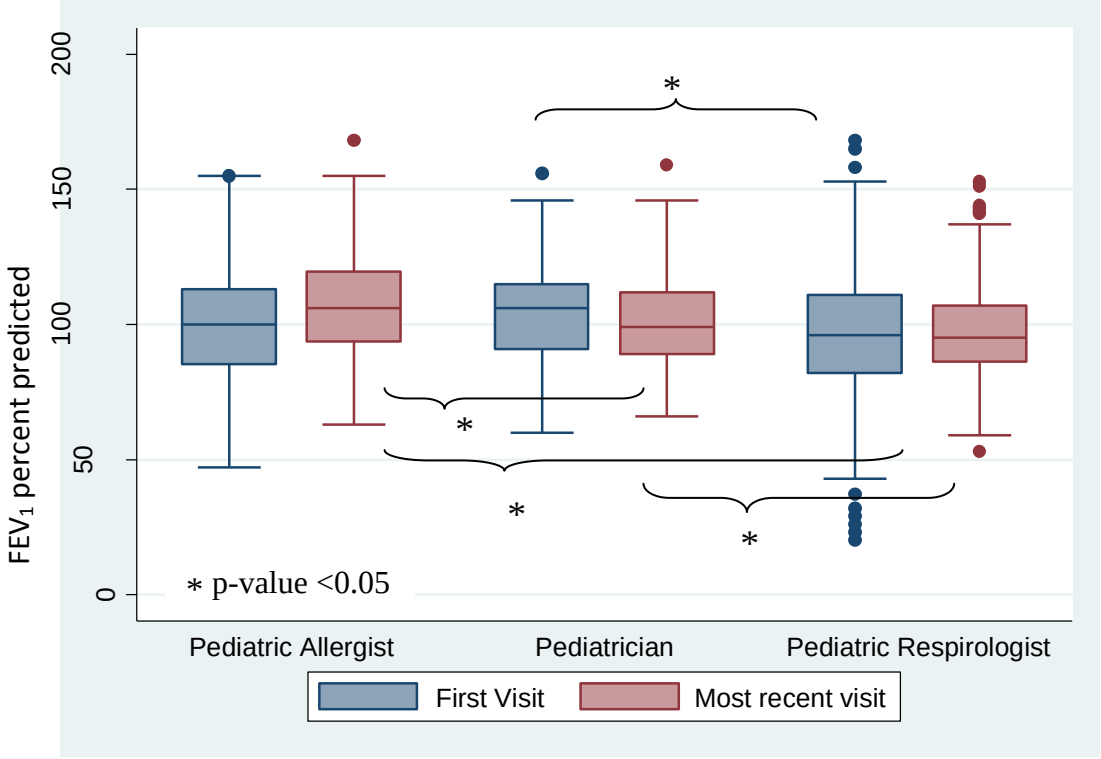


Figure 5.7(c) Distribution of % predicted FEV_1 at first and most recent visit by physician specialty

5.1.3.5. Birth and Other Personal History

Presence or absence of a sibling was reported in 84% of cases, and in all specialty groups between 86% and 91% of children had a sibling. The difference between specialty groups was not statistically significant. Missing information on birth-order was found for 40% of cases overall (37% in PedResp, 51% in PedAll and 31% in Peds). Among those patients with recorded information, an average of 44.5% of cases were the first born child, with a range of 40 – 54% by physician group ($p>0.05$).

Fewer children seen by Peds (11.8%) was reported to be born prematurely compared to cases seen by PedAll and PedResp (17.7% and 15.3 % respectively; $p=0.74$). However, there was a significant difference in recording the gestational information (Peds 35%, PedAll44 %, and PedResp 72%; $p < 0.001$). Peds failed to record whether the child was admitted to the neonatal intensive care unit (NICU) in 84% of situations, while PedAll and PedResp failed to record presence

or absence of an NICU admission in 74% and 57% of cases, respectively (p <0.001). Twenty percent of the reported cases were admitted to the NICU with the rates by specialty not being significantly different: 25% (Peds), 17% (PedAll), and 21% (PedResp).

Breast-feeding history was missing in the majority (94%) of cases. The proportion of non-recorded immunization history was different by physician group (p <0.001). In the Peds group, only 11% of children were reported to be immunized and the status for the remaining 89% of patients was unknown. In contrast, only 12% of the children seen by PedAll had missing immunization information and the rest (88%) were recorded as being immunized. Of the children seen by the PedResp group, 46.3% was immunized, 1.3% was not immunized, and information was missing for 52.4%.

5.1.3.6. Environmental history

Information on housing status was not available in 36% of cases; PedAll had the least (12%) and Peds had the highest proportion of missing information (72%). Based on available information, 96.9% (ranging from 96.3% to 97.0% by physician specialty) of the children lived in a single-family house (P = 0.98). Most charts (83.6%) had information on household smokers, with Peds recording the least on environmental smoke exposure status (70.4%; p<0.001). Almost 27% of the children had smokers as family members and this did not differ across groups (p=0.44). Almost 50% were reported to have pets in the home and pet exposure was observed more in Peds compared to PedAll and PedResp (72.6% vs. 54.1% and 53.7%; p=0.012).

5.1.3.7. Family History of Atopy

Several (24.5%) cases did not have information on atopic status of one of the family members and 9.3% did not have information on atopic status of any family members. Higher data completeness was observed in the PedAll group, followed by the PedResp group. Among patients with a known family history of atopy, 42% had a paternal history of atopy, 53% had a maternal history of atopy,

and 36% had an atopic sibling. For PedAll, Peds and PedResp, respectively, the percentages of atopy in fathers were 48.48%, 32.86%, and 40.68% (p=0.09), in mothers were 57.78%, 50.68%, and 50.55% (p=0.36), and in siblings were 37.40%, 26.09%, and 38.71% (p=0.15). Although collecting information on family history of atopy differed by physician group, the difference in presence of atopy between family members was not significant.

5.1.4. Investigation of choice

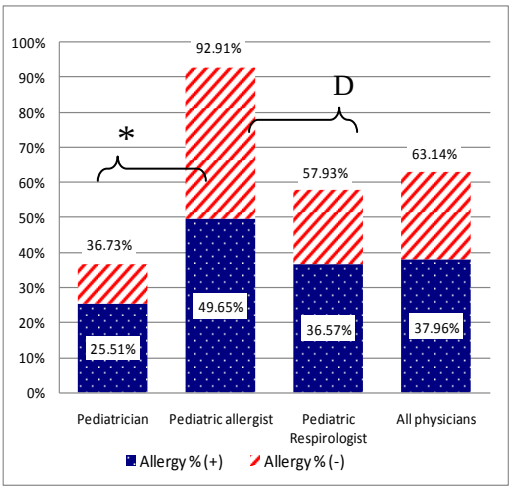
Differences were observed between the physicians in investigations ordered and performed. Overnight oximetry tests, CXR, and spirometry/PFT were performed in more than 20% of cases. Polysomnography and blood immunoglobulin and eosinophil counts were completed in approximately 15% of cases. Sweat chloride, sinus x-rays and bronchoscopy were requested less frequently, in approximately 10% of cases.

Significant differences were found between physician specialties for allergies testing, AHR testing, sleep tests, and CXR. As shown in Figure 5.8, allergy testing was performed in 63.1% of cases and was most frequently requested by PedAll (92.9%), followed by PedResp (57.9%) and then Peds (36.7%; p< 0.001). PedResp were the most likely to order a CXR (38.2%) compared to Peds (23.5%) and PedAll (8.5%; p<0.001). A similar trend was observed with tests for AHR and oximetry. Indicators for AHR were measured in 78.6% of PedResp cases, 53.1% of Peds cases, and 31.2% of PedAll cases (p<0.001). Overnight oximetry tests were performed in 35.3% of patients seen by PedResp compared with 2.8% of PedAll and 1% of Peds cases (p<0.001). These findings were statistically significant in univariate analysis and in multivariate analysis after adjustment for variability in physician level (Table 5.2).

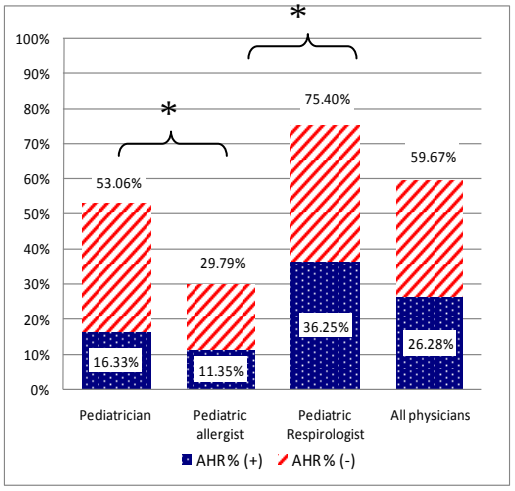
We do have concerns whether these differences were caused by the tests done prior to initial consults. For this reason, we have separated the tests into two groups (those test dates was prior to the initial consults and those tests were requested on or after the initial consult. We have conducted a sensitivity analysis by excluding those investigations requested prior to the initial consults, the

differences remained statistically significant in all four procedure (p<0.001)(Fig 5.9)

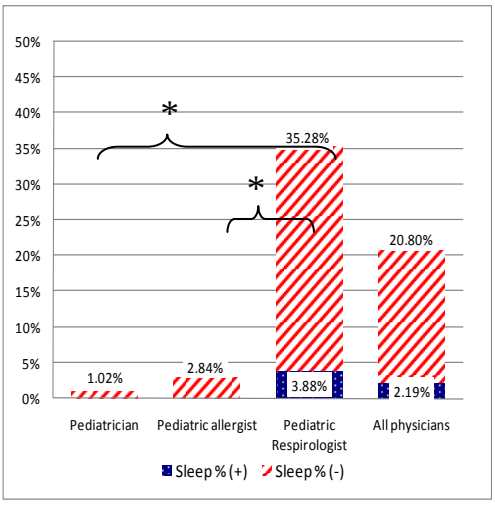
(a) Allergy test



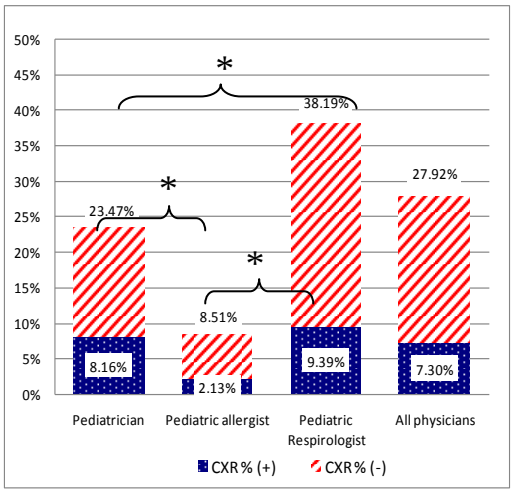
(b) Airway hyperresponsivenss



(c) Overnight oximetry



(d) Chest X-Ray (CXR)

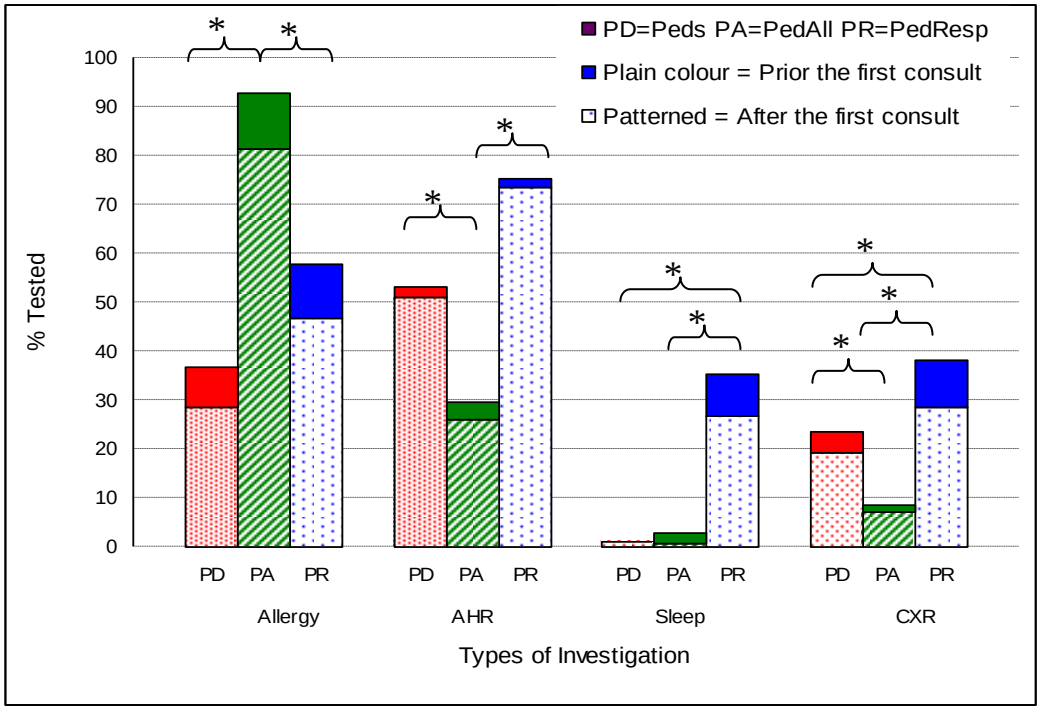


∗ p-value <0.05

Figure 5.8 Investigation requested and positive test results by physician specialty

Table 5.2 Odds of doing an investigation by physician (univariate analysis using multilevel)

		Odds Ratio	p-value
Allergy	PedResp	1.00	
	PedAll	8.44 (3.51 - 20.33)	<0.001
	Peds	0.41 (0.20 - 0.85)	0.016
AHR	PedResp	1.00	
	PedAll	0.14 (0.08 - 0.24)	<0.001
	Peds	0.35 (0.19 - 0.64)	0.001
Oximetry	PedResp	1.00	
	PedAll	0.04 (0.01 - 0.20)	<0.001
	Peds	0.01 (0.00 - 0.14)	<0.001
CXR	PedResp	1.00	
	PedAll	0.14 (0.06 - 0.35)	<0.001
	Peds	0.41 (0.17 - 1.00)	0.05



∗ p-value <0.05

Figure 5.9 The investigation requested/performed before and after the first consult

Table 5.3 details the investigations requested by physician specialty. X-ray examination of the sinuses was most often ordered by Peds (20.4%), followed by PedResp (11.6%) and PedAll (1.4%; $p < 0.001$). Sputum cultures were examined in 0.65% and aspergillous serology in 2% of cases seen by PedResp. Neither of these was ordered by the other physician groups. PedResp requested a bronchoscopy examination in 14.2% of the cases, whereas Peds and PedAll ordered this for less than 1% of their patients. Immunoglobulin testing was completed in 14.4% of cases with lowest numbers in the PedAll group (5%) versus the Peds (24.5%) and PedResp (15.9%) groups. Similar estimates were observed for the blood eosinophil testing; 15.33% of all children had a test for blood eosinophil count and the numbers tested by PedAll, Peds and PedResp were 4.3%, 20.4%, and 18.8% respectively ($p < 0.001$).

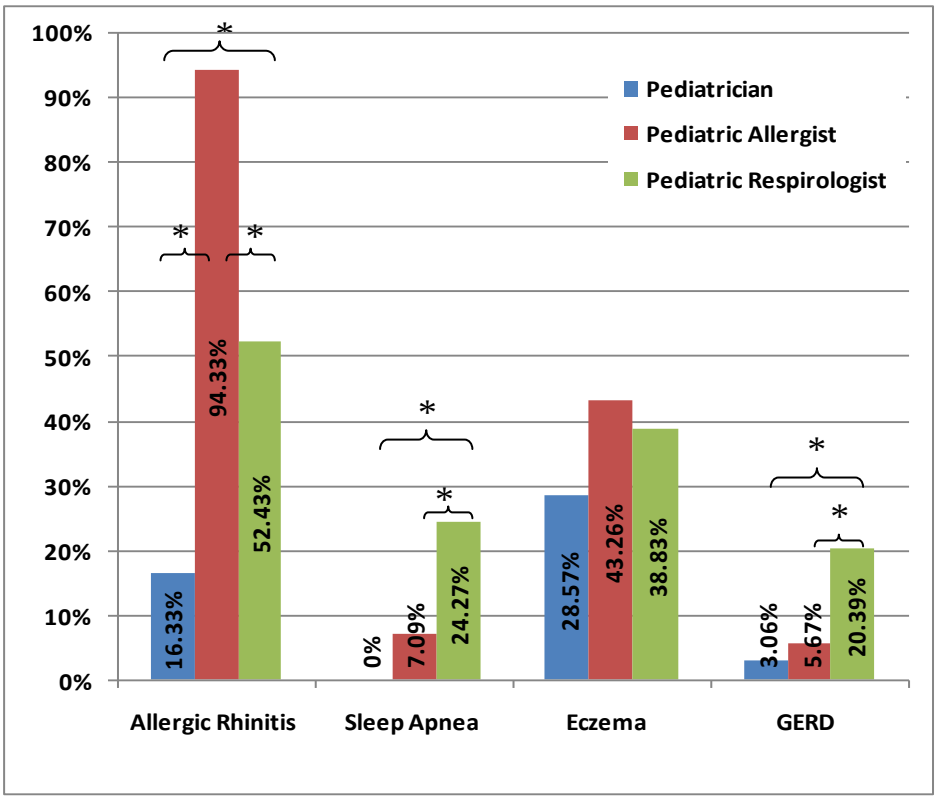
Some investigations were rarely requested by any of the physician specialties. CRP, cytoplasmic antineutrophil cytoplasmic antibodies (cANCA), perinuclear antineutrophil cytoplasmic antibodies (pANCA), alpha-1 antitrypsin, sputum culture, sinus CT, chest CT, gastric emptying time, VFSS and bone scan were each requested in less than 4% of patients. An AATD test was requested for 2% of the Peds cases and none of the PedAll and PedResp cases; all requested cases turned out to be positive. Gastric emptying scans or VFSS were never requested by a Peds. PedAll did not request gastric emptying scans and requested VFSS in less than 1% of the cases. Of the patients under the care of a PedResp, 6.1% underwent VFSS and 2.9% completed a gastric emptying scan. CRP, pANCA, cANCA, CT chest, sinus CT, and bone scan were uncommon tests and were never ordered by a Peds or PedAll.

Table 5.3 Investigation requested by physician specialty (%)

	Pediatric Allergist	Pediatrician	Pediatric Respirologist	Total
RAST - inhalant	6.38	25.51	3.56	8.21
RAST - food	7.80	22.45	2.59	7.48
SPT - environment	90.78	14.29	55.66	57.30
SPT - food	5.67	1.02	0.65	2.01
Methacholine challenge	2.13	5.10	7.12	5.47
Exercise challenge test	2.84	0.00	15.21	9.31
Max cardiopulmonary exercise test	0.00	0.00	2.59	1.46
Spirometry at visit 1 (after aged 6)	91.49	92.86	84.14	87.59
Spirometry at visit 9	67.38	86.73	74.11	74.64
Full PFT	6.38	4.17	36.57	23.08
Overnight oximetry	2.84	1.02	35.28	20.80
Polysomnography	0.71	0.00	24.92	14.23
Immunoglobulin requested (IgG, IgM, IgA, IgE)	4.96	23.47	15.86	14.42
C-reactive protein	0.00	0.00	2.91	1.64
p-ANCA	0.00	0.00	0.32	0.18
c-ANCA	0.00	0.00	0.32	0.18
Blood eosinophil	4.26	20.41	18.77	15.33
Alpha 1 anti-trypsin	0.00	2.04	0.00	0.36
Sweat chloride	3.55	4.08	15.53	10.58
Sputum culture	0.00	0.00	0.65	0.36
Sinus x-ray	1.42	20.41	11.65	10.58
Sinus CT	0.00	0.00	0.65	0.36
Chest x-ray	8.51	23.47	38.19	27.92
Chest CT	0.00	0.00	5.83	3.28
Gastric emptying time	0.00	0.00	2.91	1.64
VFSS	0.71	0.00	6.15	3.65
Bone scan	0.00	0.00	0.97	0.55
Bronchoscopy	0.71	1.02	15.86	9.31

5.1.5. Co-morbid Diagnosis

Differences were observed in the diagnoses of AR, SDB, and GERD between physician specialties (Fig.5.10). An average of 56.8% of all children (94.3% PedAll, 52.4% PedResp, and 16.3% Peds) were diagnosed as having an AR ($p<0.001$). PedResp diagnosed SDB and GERD in 24.3% and 20.4% of their cases, compared to the few cases diagnosed by Peds (SDB 0% and 3% GERD) and PedAll (SDB 7% and GERD 5.7%)($p< 0.001$ (SBD), $p< 0.001$ (GERD)). Differences between physician specialties was not observed for AD/eczema (28.6% Peds, 43.3% PedAll and 38.8% PedResp; $p =0.066$).



∗ p-value <0.05

Figure 5.10 Co-morbid diagnoses by specialty

5.1.6. Asthma prescription treatment pattern

Specialty prescription patterns were similar at both first and most recent visits. Peds preferred use of an ICS+LABA combination (30% at first visit and 37% at most recent visit) over ICS alone (18% at both first and most recent visit). PedAll used ICS with or without SABA in the majority of cases (50% at the first visit and 40% at the most recent visit). PedResp used ICS with or without SABA in 33% at the first visit and 27% at the most recent visit although the treatment choices were more evenly distributed for PedResp. PedAll were more likely than Peds to prescribe ICS (87% vs. 75%, p=0.02; Table 5.4) in univariate chi-squared analysis.

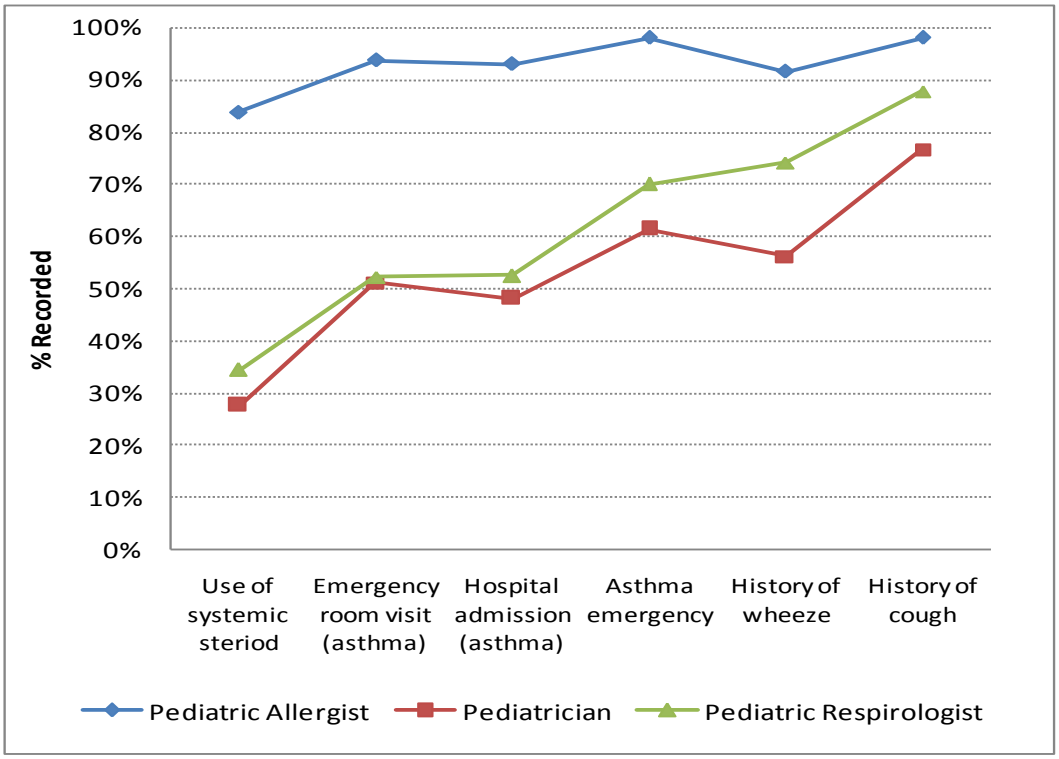
5.1.7. Missing Data

The extent of missing data depended on the nature of the variable and the physician specialty, and varied between 85-90% and 10-20% for some variables between different specialties. The charts of PedAll had the least missing variables apart from the peri-natal information. PedAll used a structured format (Appendix III) and recorded more detailed information in their handwritten and dictated notes compared to PedResp and Peds (Figure 5.11). Table 5.5 further detailed the percentage of under-reporting in the history by physician specialty.

Table 5.4 Treatment choices amongst specialties (%)

	Pediatric Allergist N=141		Pediatrician N=98		Pediatric Pulmonology N=309		Total N = 548	
	First visit	Last visit	First visit	Last visit	First visit	Last visit	First visit	Last visit
No asthma medication	1.42	0	18.37	5.1	12.62	5.83	10.77	4.2
Asthma medications								
SABA	5.67	9.93	7.14	15.31	1.62	4.85	3.65	8.03
LTRA ± SABA	2.84	2.13	3.06	2.04	5.18	3.88	4.2	3.1
ICS ± SABA	50.35	39.72	18.37	18.37	30.1	24.6	33.21	27.37
ICS +LABA	9.22	12.06	29.59	37.76	13.59	21.68	15.33	22.08
ICS +LTRA	19.86	22.7	5.1	3.06	21.04	16.83	17.88	15.88
ICS + LABA + LTRA	7.8	11.35	11.22	13.27	10.36	17.48	9.85	15.15
Immunotherapy, systemic steroid , or anticholinergic	2.84	2.13	7.14	5.1	5.5	4.85	5.11	4.2
Other medications								
Eye drop	7.09	9.93	0	0	0	0	1.82	2.55
Cold medicine	13.48	9.93	0	0	0.32	0	3.65	2.55
Antibiotics	0	0	9.18	8.16	5.18	2.59	4.56	2.92
Anti-gastritis	1.42	0.71	0	1.02	11	7.44	6.57	4.56
Antihistamine	34.04	31.91	1.02	4.08	5.18	10.36	11.86	14.78

(a) Symptoms and severity



(b) Risk factors and environmental factors

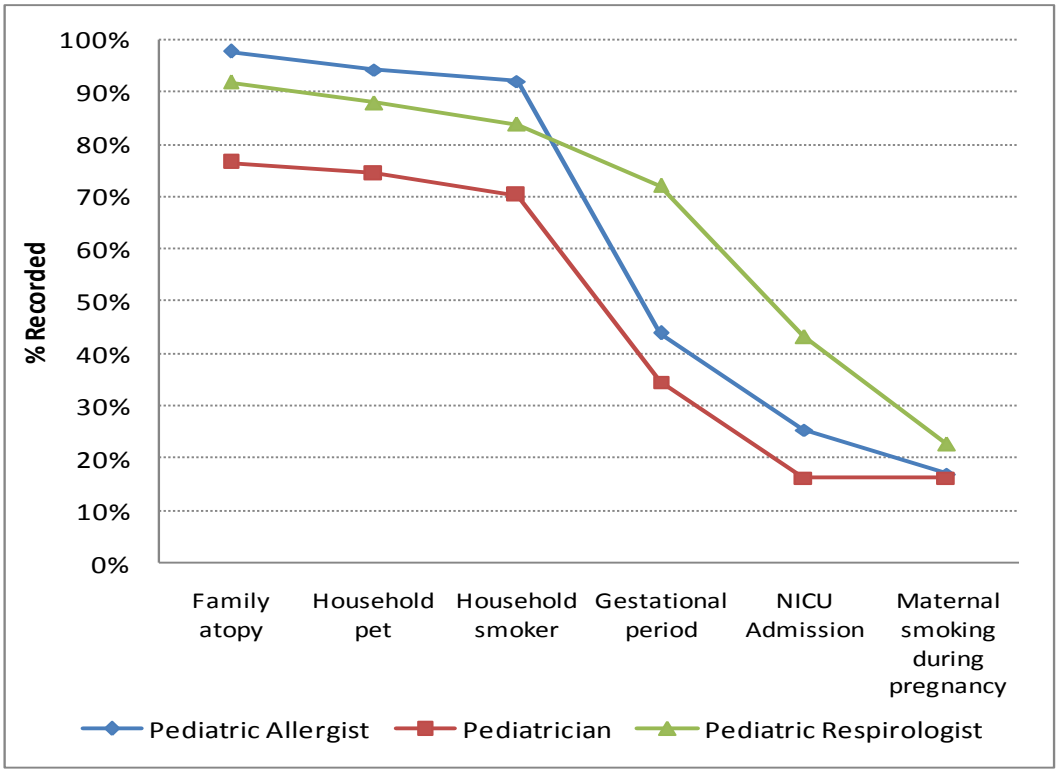


Figure 5.11 Level of information recorded on different variables by physician group

Table 5.5 Extent of information missed in the data in history (%)

	PedAll	Peds	PedResp
Symptoms (e.g. , cough)	2.13	21.57	12.11
Symptoms (wheeze)	7.86	42.72	25.47
AR history	10.64	71.57	44.72
GERD history	88.65	85.15	38.2
Eczema history	28.37	50.49	30.75
Sleep Disorder history	58.87	86.41	67.08
Asthma severity (systemic steroid use)	16.31	73.53	66.15
Asthma severity (ED visit)	6.38	49.5	48.76
Asthma severity (Hospitalization)	7.09	53.92	47.2
Smoke Exposure (prenatal, in family, second hand)	7.8	29.59	16.18
Maternal smoking during pregnancy	82.98	84.31	77.33
Family structure (siblings, first-born)	7.09	25.24	16.15
Birth (e.g. Early, Late, Term, Gestational Age)	56.03	64.08	27.33
NICU (admission, intubation)	74.47	83.33	55.59
Early childhood (Breast fed)	96.45	93.2	93.17
(Immunization)	87.94	11.65	46.27
Housing (e.g. Apartment, House, Farm, Acreage)	12.06	72.45	35.28
Any Pets at home (e.g. Cat, Dog, Other)	5.67	25.51	11.97
Family history of atopy (e.g. asthma, hay fever, eczema, allergies) Paternal, Maternal, Sibling (all missing)	2.13	23.47	8.09
Paternal	6.38	28.57	14.89
Maternal	4.26	25.51	11.65
Sibling	6.38	29.59	18.45

5.2. Multiple Regression Analysis

5.2.1. Prediction of a patient being prescribed ICS at the patient's most recent clinic visit by physician specialty (Primary outcome)

The multivariate analysis regression model showed that PedAll prescribed ICS 2.6 times more often than Peds (OR 0.376, 95% confidence interval (CI) 0.15-0.96, p = 0.041) and 1.4 times more frequently than PedResp (OR: 0.70, 95% CI: 0.31-1.55, p = 0.375) . Additional variables that had a significant role in determining the use of ICS included pulmonary function status (FEV_1/FEV of < or ≥ 0.80), presence of allergy (confirmed by either SPT or RAST), prior experience of an asthma emergency (either ED visit or hospitalization due to asthma), being admitted to the NICU, and the presence of AD or eczema. The odds of ICS use among those physicians with patients having had an NICU admission was 5.72 (95% CI: 1.2–26.4, p = 0.03). Other important determinants of ICS use included experience of an asthma emergency (OR: 2.85, 95% CI: 1.6 – 5.1, p < 0.001), an FEV_1/FVC ratio of less than 0.80 (OR: 2.39, 95% CI: 1.3–4.3, p = 0.004), and having a laboratory-confirmed allergic condition (OR: 2.18, 95% CI: 1.1–4.2, p = 0.022) (Table 5.6).

Four hundred and seventy patients had FEV_1 information at their first visit (90 by Peds, 127 by PedAll and 253 by PedResp). In an analysis stratified by $\%FEV_1$ at the first patient visit, all specialties had similar ICS prescription patterns among children with poor $\%FEV_1$ status, and ICS usage ranged between 85-95%. When the child's $\%FEV_1$ was ≥80, Peds were less likely to prescribe ICS than PedAll (76.3% by Peds vs. 86.7% by PedAll); but ICS use was not lower when the child's $\%FEV_1$ was <80 (90% by Peds vs. 91.7% by PedAll). The odds of ICS use by PedResp were less than PedAll. (OR: 0.70) The odds ratio estimates of ICS use between PedResp and PedAll remained similar when the analysis was stratified by $\%FEV_1$ ≥80 or <80 (OR: 0.69 at $\%FEV_1$ ≥80; 0.71 at <80). However, the estimate was not stable when a child's $\%FEV_1$ was stratified at 90%, possibly most variable when $\%FEV_1$ was between ≥80 and <90. (Table 5.7 (a); 5.7(b); 5.7(c); Figure 5.12)

Table 5.6 Predictors of a patient being prescribed ICS at the patient's most recent clinic visit by physician specialty (n=516) *

Predicators	Odds Ratio (95% Conf. Interval)	p-value
Specialty		
Pediatric Allergy	1.00	
Pediatric Respirology	0.70 (0.31 - 1.55)	0.38
Pediatrics	0.38 (0.15 - 0.96)	0.04
FEV_1/FVC ratio		
≥ 0.8	1.00	
< 0.8	2.39 (1.33 - 4.29)	<0.001
Missing	1.36 (0.56 - 3.30)	0.49
Allergy status (SPT or RAST)		
Negative	1.00	
Positive	2.18 (1.12 - 4.24)	0.02
Not completed	1.50 (0.76 - 2.94)	0.24
Prior history of an ED visit for asthma		
Absent	1.00	
Present	2.85 (1.60 - 5.07)	<0.001
Missing	2.07(1.08 - 3.98)	0.03
Prior admission to NICU		
Absent	1.00	
Present	5.72 (1.24 - 26.39)	0.03
Missing	1.61 (0.93 - 2.79)	0.09
History of Eczema / AD		
Absent	1.00	
Present	1.92 (1.10 - 3.35)	0.02

Table 5.7 (a) Proportion of patients provided with an ICS prescription stratified by %FEV_1 at the first visit by physician specialty

Pediatrician		Pediatric Allergist		Pediatric Respirologist	
FEV_1<80%	FEV_1≥80%	FEV_1<80%	FEV_1≥80%	FEV_1<80%	FEV_1≥80%
9/10	61/80	20/22	91/105	49/56	164/197
90%	76.3%	91.7%	86.7%	87.5%	83.3%
FEV_1<85%	FEV_1≥85%	FEV_1<85%	FEV_1≥85%	FEV_1<85%	FEV_1≥85%
13/14	57/76	28/30	83/97	68/79	145/174
92.9%	75%	93.3%	85.6%	86.1%	83.3%
FEV_1<90%	FEV_1≥90%	FEV_1<90%	FEV_1≥90%	FEV_1<90%	FEV_1≥80%
20/22	50/68	38/40	73/87	89/104	124/149
90%	73.5%	95%	83.9%	85.6%	83.3%

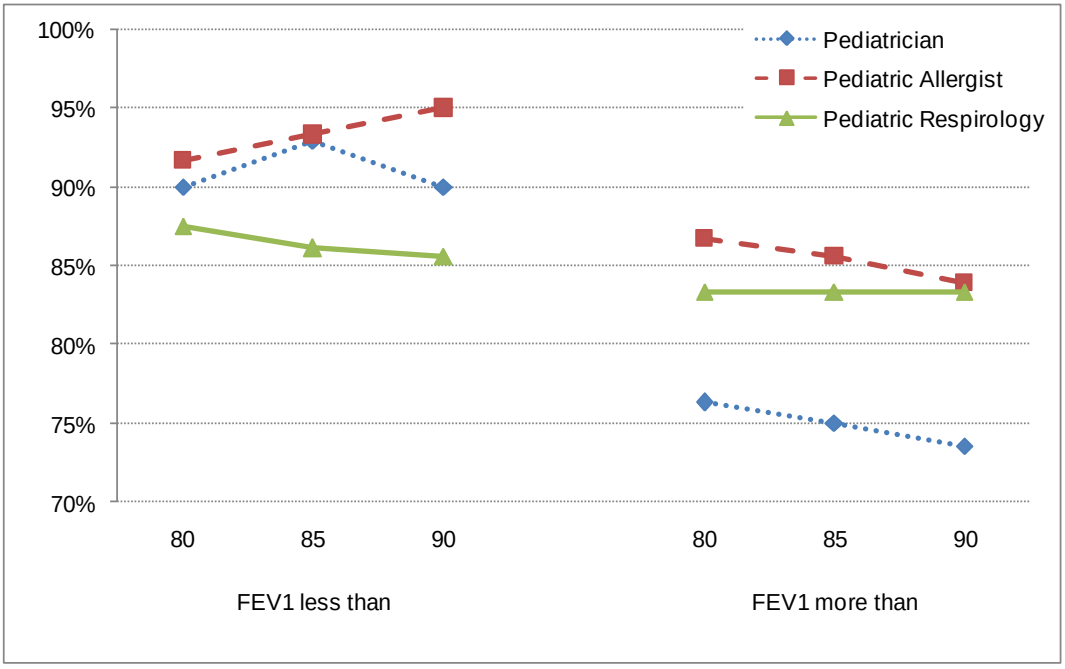


Figure 5.12 ICS usage by physician type, stratified with FEV_1 level

Table 5.7(b) Multilevel regression of ICS prescription according to %FEV_1 by physician specialty (stratified at 80 % FEV1 predicted)

	FEV_1<80 at first visit		FEV_1≥80 at first visit	
	Odds Ratio (95% Conf. Interval)	p-value	Odds Ratio (95% Conf. Interval)	p-value
Specialty				
Pediatric Allergy	1.00		1.00	
Pediatric Respirology	0.71 (0.08 - 6.20)	0.75	0.69 (0.30 - 1.62)	0.40
Pediatrics	1.56 (0.07 - 32.71)	0.77	0.43 (0.16 - 1.17)	0.10
FEV_1/FVC ratio				
≥ 0.8	1.00		1.00	
< 0.8	1.76 (0.40 - 7.79)	0.46	2.61 (1.25 - 5.43)	0.01
Missing	Undefined	1.00	1.41 (0.48 - 4.16)	0.53
Allergy status (SPT or RAST)				
Negative	1.00		1.00	
Positive	1.53 (0.18 -13.01)	0.70	2.41 (1.11 - 5.26)	0.027
Missing	0.54 (0.08 - 3.85)	0.54	1.59 (0.71- 3.54)	0.26
Prior history of an ED visit for asthma				
None	1.00		1.00	
Prior history	3.48 (0.59 - 20.51)	0.17	2.40 (1.23 - 4.69)	0.01
Missing history	2.89 (0.39 - 21.32)	0.30	1.32 (0.62 - 2.84)	0.47
Prior admission to NICU				
Absent	1.00		1.00	
Present	Undefined	0.99	4.43 (0.92 - 21.35)	0.063
Information missing	1.12 (0.21 - 6.07)	0.89	1.66 (0.87 - 3.15)	0.122
History of Eczema/AD				
Absent	1.00		1.00	
Present	2.94 (0.40 - 21.64)	0.29	2.12 (1.10 - 4.09)	0.025

Table 5.7 (c) Multilevel regression of ICS prescription according to %FEV_1 by physician specialty (stratified at 90 % FEV1 predicted)

	FEV_1<90 at first visit		FEV_1≥90 at first visit	
	Odds Ratio (95% Conf. Interval)	p-value	Odds Ratio (95% Conf. Interval)	p-value
Specialty				
Pediatric Allergy	1.00		1.00	
Pediatric Respirology	0.32 (0.06 - 1.82)	0.20	0.89 (0.36 - 2.18)	0.79
Pediatrics	0.52 (0.05 - 5.60)	0.59	0.52 (0.18 - 1.47)	0.22
FEV_1/FVC ratio				
≥ 0.8	1.00		1.00	
< 0.8	2.62 (0.82 - 8.34)	0.10	2.29 (0.99 - 5.32)	0.054
Missing	2.12 (0.19 - 24.05)	0.54	1.28 (0.38 - 4.34)	0.69
Allergy status (SPT or RAST)				
Negative	1.00		1.00	
Positive	3.06 (0.72 - 12.99)	0.13	2.08 (0.88 - 4.93)	0.10
Missing	1.70 (0.44 - 6.59)	0.44	1.29 (0.52 - 3.16)	0.58
Prior history of an ED visit for asthma				
None	1.00		1.00	
Prior history	3.78 (1.03 - 13.88)	0.046	2.23 (1.09 - 4.57)	0.028
Missing history	2.36 (0.58 - 9.57)	0.23	1.27 (0.55 - 2.89)	0.58
Prior admission to NICU				
Absent	1.00		1.00	
Present	Undefined	0.99	2.90 (0.58 - 14.57)	0.20
Information missing	2.03 (0.64 - 6.45)	0.23	1.46 (0.74 - 2.90)	0.27
History of Eczema/AD				
Absent	1.00		1.00	
Present	2.72 (0.68 - 10.94)	0.16	1.99 (1.00 - 3.96)	0.05

5.2.2. Prediction of ICS dose at a patient's most recent clinic visit by physician specialty (Secondary outcome)

The doses of BDP-equivalent ICS were not statistically different between physician specialties among children prescribed ICS (Table 5.8). PedAll prescribed 82.70 μg/day more ICS than PedResp (95%CI -178.76-13.35, p=0.091) and 95.86 μg/day more ICS than Peds (95% CI – 22.03 – 213.75, p =0.111). In addition to physician specialty, lung function, and asthma add-on therapies were the biggest predictors for ICS dose. Patients with a FEV_1/FVC ratio of <0.8 were prescribed greater doses of BDP equivalents per day (102.99 μg/day, 95%: CI 57.0 – 148.9) than were patients with an FEV_1/FVC ratio ≥0.8. Children on an LTRA were also on higher doses of ICS (45.6 μg/day, 95% CI 1.7–89.5, p = 0.004).

Table 5.8: Multiple regression analysis of dose of ICS (beclomethasone dipropionate equivalents) prescribed at the patients' last clinic visit by physician specialty

	Beclomethasone dipropionate equivalent (μg/day) (95% Conf. Interval)	p-value
Specialty		
Pediatric Allergy	0.00	
Pediatric Respirology	-82.70 (-178.76 - 13.35)	0.091
Pediatrics	-95.86 (-213.75 - 22.03)	0.111
FEV_1/FVC ratio		
≥ 0.8	0.00	
< 0.8	102.99 (57.04 - 148.94)	<0.001
Information missing	69.38 (-4.36 - 143.11)	0.065
LTRA		
Not prescribed	0.00	
Prescribed	45.63 (1.71 - 89.55)	0.042
Age (one year increase)	8.55 (1.83 - 15.27)	0.013
Constant	209.02 (101.13 - 316.91)	<0.001

LTRA: Leukotriene-receptor antagonist
FEV_1: Forced Expiratory Volume in 1 sec
FVC: Forced Vital Capacity

5.2.3. Add-on Therapies

We compared the use of ICS plus LABA, ICS plus LTRA and ICS plus both LABA and LTRA by physician specialty, with ICS use as a reference (Table 5.9). Polytomous logistic regression was used for this analysis. Several differences by specialty were noted for the choice of add-on asthma therapy. Children on ICS + LABA were more likely to be 12 years of age or older (OR 4.88, 95% CI: 2.8–8.6, p<0.001) and have a household history of smoke exposure (OR: 1.95, 95% CI: 1.4–2.8, p<0.001). Both Peds (OR: 5.06, 95% CI: 2.1–11.9, p<0.001) and PedResp (OR: 2.72, 95% CI: 1.3–5.6, p=0.007) were more likely to prescribe ICS + LABA compared to PedAll.

Children on ICS+LTRA compared to ICS alone were more likely to be male (OR: 1.78, 95% CI: 0.99–3.19, p=0.055). When comparing ICS to ICS+ LTRA, Peds were 77% less likely than PedAll to prescribe an ICS +LTRA (OR: 0.23, 95% CI: 0.06-0.84, p =0.026) while no significant difference was observed between PedResp and PedAll.

Children on ICS+LABA+LTRA were more likely to be 12 years of age or older (OR: 4.65, 95% CI: 2.5–8.5, p<0.001), have a household history of smoke exposure (OR: 1.58, 95% CI: 1.06–2.36, p=0.024), and have a personal history of a sleep disorder (OR: 2.63, 95% CI: 1.18–5.85, p=0.018). Both PedResp and Peds were more likely to use ICS+LABA +LTRA compared to PedAll although the differences were not statistically significant.

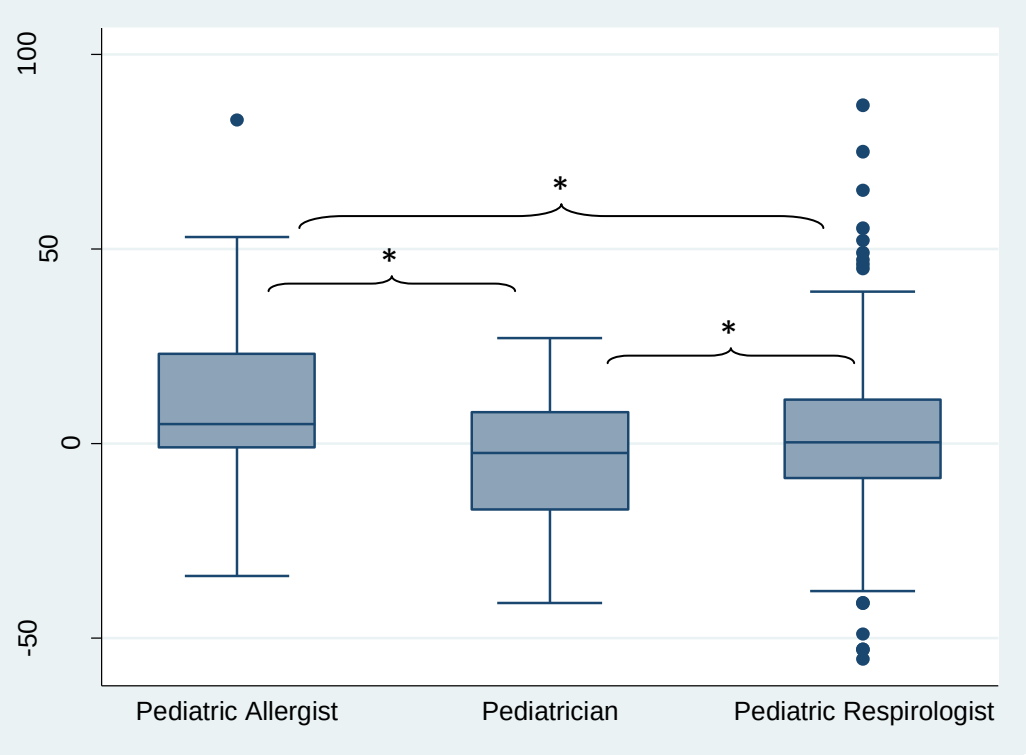
Table 5.9: Predictors of a patient being prescribed an add-on therapy at the patient's most recent clinic visit by physician specialty (n=428)

	Long Acting Beta-Agonist (LABA)		Leukotriene Receptor Antagonist (LTRA)		Long Acting Beta-Agonist (LABA) and a Leukotriene Receptor Antagonist (LTRA)	
	Odds Ratio (95% Conf. Interval)	p-value	Odds Ratio (95% Conf. Interval)	p-value	Odds Ratio (95% Conf. Interval)	p-value
Physician Specialty						
Pediatric allergy	1.0		1.0		1.0	
Pediatric Respirology	2.72 (1.32 - 5.60)	0.007	1.26(0.70 - 2.28)	0.441	1.66 (0.82 - 3.38)	0.162
Pediatrics	5.06 (2.14 - 11.94)	<0.001	0.23(0.06 - 0.84)	0.026	1.78 (0.70 - 4.56)	0.227
Age						
< 12 years of age	1.0		1.0		1.0	
> 12 years of age	4.88 (2.78 - 8.56)	<0.001	0.93(0.49 - 1.76)	0.825	4.65(2.54 - 8.52)	<0.001
Gender						
Female	1.0		1.0		1.0	
Male	1.33 (0.76 - 2.32)	0.314	1.78(0.99 - 3.19)	0.055	1.20 (0.66 - 2.19)	0.552
History of household smoke						
Unexposed	1.0		1.0		1.0	
Exposed	1.95 (1.36 - 2.80)	<0.001	1.21 (0.81 - 1.81)	0.346	1.58 (1.06 - 2.36)	0.024
History of Eczema / AD						
Absent	1.0		1.0		1.0	0.686
Present	0.53 (0.30 - 0.92)	0.025	1.09 (0.63 - 1.89)	0.746	0.89 (0.49 - 1.60)	
History of SDB / OSA						
Absent	1.0		1.0		1.0	
Present	1.85 (0.84 - 4.06)	0.127	0.92 (0.40 - 2.14)	0.853	2.63 (1.18 - 5.85)	0.018

5.2.4. Change in % predicted FEV_1 from first to most recent visit by physician specialty

We observed that there were differences between physician specialty for changes in their patients' pre-bronchodilator % predicted FEV_1 (Figure 5.13). As shown in Table 5.10, PedResp had over an 8% lower change in $\%FEV_1$ between the first and most recent visit compared to PedAll (-8.02%, 95% CI: 13.66%- -2.38%, p=0.005). Peds had over a 13% lower change in $\%FEV_1$ from first to most recent visit compared to PedAll (-13.46%, 95% CI: -20.69% - 6.23%, p<0.001). The differences were significant after controlling for pre-treatment lung function (FEV_1/FVC ratio at the patient's first visit), age, medication use (systemic steroids), atopic status, household smoke exposure, and differences between individual physicians. Co-morbid conditions (GERD, SDB, AR), asthma medications (e.g. ICS, LABA, LTRA) and other medical therapy (e.g. nasal steroids) were not significant predictors of changes in $\%FEV_1$ when physician specialty was included in the model.

In a stratified analysis for patients with an initial visit $\%FEV_1$ > 80% or 90%, Peds and PedResp continued to have similarly lower changes in $\%FEV_1$ (direction and magnitude), although these did not reach statistical significance. We explored whether asthma management and other factors that differed by physician group may have contributed to the differences in improvement in % predicted FEV_1. In this analysis, physician group was not included as a variable of interest. Using purposeful regression, we assessed factors which were different by specialties as well as other factors possible of influencing asthma outcomes. When a multilevel linear regression model was completed, only initial and final use of LTRA was significantly associated with a change in $\%FEV_1$ (Table 5.11) Use of LTRA at the initial visit had an almost 5% negative effect on $\%FEV_1$ (-4.69%, 95% CI: -9.22% - -0.16%, p=0.04) while an improvement in $\%FEV_1$ of 6% was observed among children prescribed LTRA at the most recent visit (6.37%, 95% CI: 1.78%–10.97%, p<0.01). Co-morbid conditions, asthma medications including ICS (any and dose) and other drug therapies were again not significant predictors of a change in $\%FEV_1$.



∗ p-value <0.05

Figure 5.13 Change in % predicted FEV_1 between first and most recent visit by physician specialty

Table 5.10 Predictors of change in % predicted FEV_1 from a patient's first clinic visit to their most recent clinic visit by physician specialty (n = 352)

	Change of % predicted FEV_1 (95% Conf. Interval)	p-value
Physician Specialty		
Pediatric Allergist	0.00	
Pediatric Respirologist	-8.02 (-13.66 - -2.38)	0.005
Pediatrician	-13.46 (-20.69 - -6.23)	<0.001
FEV_1/FVC ratio at first visit after 6 yr of age		
≥80%	0.00	
<80%	6.94 (2.51 - 11.38)	0.002
missing	15.32 (-11.10 - 41.74)	0.26
Systemic steroid at first visit		
Not prescribed	0.00	
Prescribed	19.43 (9.52 -29.33)	<0.001
Systemic steroid at most recent visit		
Not prescribed	0.00	
Prescribed	-13.73 (-29.28 - 1.81)	0.08
Allergy status (SPT of RAST)		
Negative	0.00	
Positive	-3.04 (-8.27 - 2.20)	0.26
SPT or RAST testing not completed	-7.07(-13.04 - -1.11)	0.02
History of household smoke exposure		
Unexposed	0.00	
Exposed	-4.89 (-9.90 - 0.12)	0.06
Missing	-1.18 (-6.95 - 4.60)	0.69
Age (one year increase)	1.01 (0.34 - 1.69)	0.003
Constant	0.22 (-8.65 - 9.08)	0.96

Table 5.11 Change in % predicted FEV_1 from a patient's first to most recent clinic visit excluding physician specialty

	Change of %predicted FEV_1 (95% Conf. Interval)	p-value
LTRA at first visit		
Not prescribed	0.00	
Prescribed	-4.69 (-9.22 - -0.16)	0.04
LTRA at most recent visit		
Not prescribed	0.00	
Prescribed	6.37 (1.78 - 10.97)	0.007
FEV_1/FVC ratio at first visit after 6 yr of age		
>= 80%	0.00	
<80%	6.88 (2.47 - 11.29)	0.002
missing	13.33 (-13.06 - 39.72)	0.32
Systemic steroid at first visit		
Not prescribed	0.00	
Prescribed	18.94 (9.09 - 28.78)	<0.001
Systemic steroid at most recent visit		
Not prescribed	0.00	
Prescribed	-13.03 (-28.61 - 2.54)	0.101
Allergy status (SPT or RAST)		
Negative	0.00	
Positive	-4.36 (-9.67 - 0.95)	0.11
SPT or RAST testing not completed	-9.63 (-15.37 - -3.90)	0.001
History of household smoke exposure		
Unexposed	0.00	
Exposed	-4.18 (-9.15 - 0.79)	0.10
Missing	-1.90 (-7.58 - 3.78)	0.51
Age (one year increase)	0.91 (0.24 - 1.58)	0.008
Constant	-5.66 (-14.88 - 3.55)	0.23

CHAPTER 6: DISCUSSION AND CONCLUSION

6.1. Major findings

This thesis work used clinical data and multilevel regression methods to examine the association and describe the factors determining differences in asthma management and asthma outcome by physician specialty. This research answered the following questions in a tertiary care setting:

- Is physician specialty associated with the use of ICS?
- Does physician specialty influence the dose of ICS if it is prescribed?
- What are the preferred choices of asthma medications by physician specialty?
- Are there any differences by specialty in co-morbid conditions and ancillary investigations in patients?
- Were asthma outcomes controlled by any of the observed differences by physician specialty?

Our study confirmed that physician specialty impacts all aspects of pediatric asthma management including: ancillary testing, co-morbid diagnoses, use of ICS, choice of add-on asthma medications, and most importantly, asthma control as evidenced by changes in lung function over time. ICS use was found to be significantly lower among the Peds group. Although the difference was not statistically significant, PedAll used a higher dose of ICS (by almost one puff (100 mcg)/ day) than Peds and PedResp.

We found that pharmacotherapy, a major aspect of asthma management, differed by specialty. With the presence of standardized management guidelines, asthma treatment plans were expected to be fairly consistent. Percentage of ICS use was higher among PedAll than PedResp and Peds. After stratifying by pulmonary function status (%FEV_1), all specialties tended to prescribe ICS to most children with poor FEV_1 status and PedAll more often prescribe ICS for children with normal FEV_1. This seems to signify that the choice to use ICS is more variable for patients having milder disease where the risk/benefit ratio is more balanced.

In both univariate and multivariate analysis, PedAll prescribed ICS doses representing about one puff per day more than the other two specialties. However, the difference in ICS dose was not statistically significant. These results suggest that physician training may not be as important determinant on ICS dose as FEV_1/FVC status, use of LTRA, and the age of the child. Specialty influenced the choice of medicines in both adjusted and unadjusted models. PedAll and PedResp preferred to use ICS+LTRA, whereas, Peds were found to have greater preference for ICS+LABA. PedResp had a preference to using LTRA, alone or in combination with ICS+LABA.

Investigation, identification and treatment of co-morbidities are important in the management and control of asthma.[41,42] The area for physician discretion, and most heavily influenced by physician specialty, was around ancillary testing and identification and management of co-morbid diagnoses. Similar to the TENOR study, we also found differences in investigation requests between specialties. Not surprisingly, the choice and identification of co-morbid conditions reflected the specific interests and concern of the specialties: PedAll concerned with allergic conditions, completed more allergy testing, while PedResp were interested to identify other pulmonary conditions, SBD, airway reactivity and therefore, requested more CXR, sleep investigations, and AHR tests. Allergists requested CXR in less than a tenth of cases, while Peds requested them for a quarter and PedResp for more than a third of their patients. The chance of finding an abnormal CXR was double amongst PedAll than for the other two subspecialties. Peds, having a more generalist approach, requested certain investigations (e.g. alpha-1 antitrypsin) which both PedAll and PedResp did not. Although not significant, Peds identified two cases of alpha-1 antitrypsin deficiency whereas no such investigation was completed by PedAll and PedResp.

Asthma is a multi-factorial disease, and its' control is influenced by co-existing morbidities. AR has been found to be highly prevalent (80-95%) in asthmatic patients,[42,46] and adequate treatment of AR and GERD[114] can reduce asthma severity, improve asthma control, and improve quality of life.[41,42,48-53] Result of more allergy testing request, PedAll diagnosed more atopic diseases

such as AR (94%), and start patients on higher doses of ICS than other specialties. Nasal steroids, anti-cold medicines and antihistamines were the most commonly used medications by PedAll. The use of nasal steroids was also common among PedResp but not as common as for PedAll. Similarly, PedResp had diagnosed of GERD (20%) and SBD (24%) after requesting more CXR, sleep testing and had a preference of using anti-gastritis medications. This finding may reflect the relative value each specialty places on identifying and treating AR and other co-morbid conditions. When considering these findings on co-morbidities, it is important to reflect on how our study-design and hence data limitations may have impacted the results.

As part of this analysis, we also explored whether difference in practice pattern by physician specialty led to any significant impact on asthma control status. Asthma control is ideally assessed using either the ACQ or ACT, both of which have questionnaires developed and validated to measure asthma control. The ACQ contains questions on asthma symptoms plus pre-bronchodilator % predicted FEV_1.[161] Juniper and colleagues have proposed that the ACQ can be completed without the use of spirometry.[162] The ACT, inexpensive and easy to perform, requires patients to properly report their symptoms and use of rescue medicine. When spirometry is not available, ACT by itself is a good screening tool to assess asthma control.[163] Asthma symptoms such as cough, wheeze, and number of required rescue medicines are important determinants of the extent of asthma control.

Asthma control has two separate domains: impairment and risk. Wu conducted a longitudinal study to identify the relationship between symptoms and severe asthma exacerbation and to compare the predictors of persistent asthma symptoms and predictors of severe asthma exacerbations in children.[164] The study found that laboratory findings offer different prediction on asthma symptoms (asthma control) and asthma exacerbation (asthma risk).[164] ICS use, the FEV_1/FVC ratio, and a natural logarithm PC20 methacholine challenge test predict asthma symptoms. In addition to the above predictors of asthma symptoms, younger age, history of hospitalization or ED visit in the prior year,

use of oral corticosteroids, and Log_{10} eosinophil counts also predict severe asthma exacerbations in children.

Being a retrospective study, our study did not have standardized recording of asthma control symptoms at the time of visit. Some physicians recorded asthma symptoms whereas some physicians did not. As a result, we were not able to capture asthma control for the most recent visit, which was our time point of comparison. We used change in % predicted FEV_1 over time as an indicator of asthma control due to a proven association between % predicted FEV_1 and hospitalizations, ED visits, and need for oral corticosteroid therapy in children.[99] Interestingly, our study found a difference in improvement of % FEV_1 between the physician groups where children seen by PedAll attained the best improvement in $\%FEV_1$.

Several studies have assessed the impact of asthma management between specialties. Kanter found that children seeing an allergist compared to a pediatrician had significantly higher improvement in nasopharyngeal symptoms, family impact scale, and 3 out of 15 Child Health Questionnaire (CHQ-28) scales (bodily pain and discomfort, parent time impact, health transition).[165] Although this study was structured as a prospective cohort design, parent-reported endpoints were collected retrospectively and as a result, are subject to recall bias.

Other adult studies have reported improvement in asthma outcomes (reduced ED visit, hospitalization) among patients seen by allergist compared to generalist / primary care physicians.[154-157] Mahr followed a number of cases who were seen for asthma in 1986. At follow-up (1988), a significantly higher hospitalization rate was observed among the group receiving non-allergist care (35%) compared to the group under the allergists' care (13%). Zeiger et al conducted a prospective, controlled study by assigning the cases seen at an ED either to asthma-specialist care or generalist care. Compared to generalist care, cases seen by the asthma-specialists had an almost 50% reduction in asthma ED relapses. Sperber had similar findings of reduced walk-in visits, ED visits and hospitalization when cases were seen by an asthma specialist (allergist/ immunologist) compared to a general internist. Similarly, Vilar reviewed medical

records of persistent asthma cases seen at an allergy and asthma center and found significant reduction in frequency of hospitalization and ED visits and significant improvement in disease severity in patients treated in an allergy versus non-allergy clinic.[157] Schatz et al. have compared improvement in asthma outcomes in adult asthma patients provided care by allergists, pulmonologists and primary care providers.[158] Unfortunately, this study suffers from several limitations. It relied on subjective patient reported outcomes and dependent on patient adherence to their prescriptions. The number of patients who reported to receive care from a pulmonologist was small compared to other groups, and the authors have warned to interpret their findings related to pulmonologists cautiously. Our study expanded and confirmed that better improvement of pulmonary function can be contributed by pediatric allergist.

The more frequent use and higher dose of ICS prescribed by PedAll raises the question of whether ICS use has significant control over $\%FEV_1$. Although PedAll showed the greatest improvement in $\%FEV_1$, neither ICS nor ICS dose were significant predictors of improved $\%FEV_1$. An earlier study by Schatz found that use of 7 or more canisters of ICS and receiving treatment by an allergist were associated with reduced subsequent emergency asthma hospital use.[166] This study used data from all age groups with the mean ages of those using 7 or more canisters of ICS was 42.5 years and those allergist specialist treatment was 31.0 years. We were not able to identify from this study's article the exact role of ICS/ seeking allergy specialty care upon emergency hospital use among children, although the study included 3-5 year olds (7%) as well as 6-17 year olds (27.4%). The PEAK and START studies[167,168] showed that ICS did not result in a sustained change in lung function after patients discontinue their ICS therapy. Similarly, observed differences in practice patterns were not actually determinants of the changes in pulmonary function testing.

Environmental control of allergens, characteristics of the asthma control action plan, monitoring of appropriateness of inhaler device, and counseling for adherence to medicine, may impact changes in $\%FEV_1$. Suboptimal adherence to prescribed medication regimens is commonly observed in most chronic

diseases.[169] A recent study among adult patients demonstrated that patient's with difficult-to-control asthma having suboptimal ICS adherence had a lower post-bronchodilator FEV_1.[170] Many of these factors are not recorded within the patient record. We hypothesize that the main reason for the observed differences in change in $\%FEV_1$ may be related to uncharted differences in physician practice, specifically in asthma control action plans and ensuring patient adherence.

Although few charts had evidence of an asthma action plan (e.g. photocopy), PedAll records more consistently provided details as to what advice was given regarding increasing medication with increasing asthma symptoms. Patient adherence was not recorded except in cases of clear non-adherence. Anecdotally, the asthma clinic nurses observed that the PedAll used the electronic prescription database (Netcare) more than the other specialties to verify patient adherence through prescription refills. It was not feasible for us to obtain Netcare access to compare patient compliance by specialty, because this requires consent from all study participants. If accessible, these patient follow-up systems may have enabled us to identify other variables that are different by specialty and have impact on asthma outcome.

6.2. Strength

Results from this study expand upon the results from Diette et al. who demonstrated that pediatric asthma management differs between generalists and specialists in all domains of care including treatment, investigations, and monitoring of control.[8] The design of the Diette study (cross-sectional parent-report survey) precluded an examination of management differences between subspecialties and the impact of physician specialty on patient outcomes. Our retrospective cohort study did not suffer from either of these limitations and has shown differences between specialties for both of these outcomes.

The Diette study also suffered from referral, non-response, and recall biases.[8] Parent respondents (potentially having recall bias) would be systematically different from non-respondents (non-response bias). Moreover, the children seen by specialists versus generalists differed significantly by symptom

severity, age, race, and the education and work status of their parents. In our study, all patients within one clinic were included and all uncomplicated patients were randomly allocated to any physician while complicated patients were randomly allocated to either physician subspecialty. The clinic's random allocation and inclusion of all cases is reflected in the minimal demographic differences between patients treated by the three physician specialties and reduces the possibility that our results are due to either a referral or non-response bias.

Our study also supplements findings of another study by Diette where adult patient reported asthma medicine use was found to be different by specialty.[152] The study compared the use of asthma medicine reported by patients without referencing the patient's records or prescription notes. This reported use of asthma medicine may or may not be reflecting the physician's prescription, making difficult to know if the difference in use was actually related to prescription patterns by physician specialty.

Chen found that adult patients seeing pulmonologists used ICS more than those seeing allergists, especially when the patient had severe asthma. Our observation of ICS use among children contradicts with Chen's finding. We noted that PedAll prescribed ICS more often than PedResp and Peds, and the use was more variable when the child's condition was less severe. Chen's study applied physician-defined severity as a cut-off point for stratification; we used $\%FEV_1$ to demarcate the severity level of asthma. Although a physician's decision is usually considered a gold standard, defining asthma severity based on physician assessment can introduce bias. On the other hand, our study did not have other asthma control variables and could only stratify ICS use based on pulmonary function status. Although, use of spirometric findings could not introduce systematic bias, these alone cannot be a comprehensive indicator for asthma severity. Reproducibility of FEV_1 lies within acceptable limits[171] but FEV_1 values may change with effort.[172]

6.3. Limitations

One of the major limitations of this retrospective cohort study was an insufficient amount of recorded information in the patient charts. Although data for the primary and secondary outcome variables of interest were available in most cases, many independent variables, especially related to history, were missing. We cannot be sure that missing values were missing completely at random. Some information may have been missing at random while some may have been missing at non-random; it was hard to differentiate between these two.

The proportion of missing data was variable between physician groups. Both PedAll and PedResp had a standardized form to record patient history although the form used by PedAll was more comprehensive compared to that of the PedResp. Pediatricians rarely used a form as a guide to record patient history. Of the three specialty types, PedAll had the least missing variables, with the exception of prenatal and peri-natal information for which PedResp had more data. We did not impute missing variables because the extent of missing was high. We created a missing category in the analysis instead of keeping them as a missing value, in order to maintain the sampling population. By doing so, some but not complete information on the effects of certain variables on our outcome of interest was available. Co-existence of certain medical conditions was identified from the patient history information as well as from the physician's provisional diagnosis. We were not able to confirm the validity of these conditions.

Initially, we intended to verify whether or not the cases were in fact asthma cases by using other sources such as actual billing reports to Alberta Health and Wellness. Unfortunately our request to access billing information and eClinician data was declined. To overcome this lack of billing information, all of the ambiguous cases were reviewed by Dr. Mandhane, a pediatric respirologist; 37 cases without any asthma medication at the most recent visit were again reviewed by Drs. Mandhane and Majaesic individually and in cases of disagreement the charts were re-reviewed until consensus was obtained.

Chen et al observed a difference in socioeconomic status of the adult patients seen by PedResp and PedAll.[9] We could not capture the specific

socioeconomic conditions of the clinic patients through this retrospective study, as the socioeconomic status data (e.g. income) is rarely recorded. We observed that the distribution of patients living in single family dwelling was not different by physician specialty. The Statistics Canada postal code income quintile conversion database is another possible proxy indicator for socioeconomic status. The postal code database was not used in this study as the limited geographic variation of our patients, modeled on physician specialty, was unlikely to result in sufficient power to identify a difference.

Another study limitation was that data was extracted by a single person without independent verification of accuracy by a second individual. Because of this, possible data entry errors were counter-checked using several means. BMI was calculated from weight and height and compared with the entered data to identify any discrepancy. Waiting time, age at first visit, age at last visit and duration of visits were calculated to observe existence of any impossible numbers. If any outliers or strange numbers existed, the chart was pulled again and the information was verified.

All patients were seen in a single tertiary care center, which may limit the generalizability of our results to other centers. The Peds in our clinic each had extra training in pediatric respirology, and as a result their practice may not be representative of all community-based pediatricians. The sub-specialty physicians who practiced at the asthma clinic were trained at different locations across North America. The PedAll completed their fellowship training at Manitoba Children's Hospital (Winnipeg) and at the National Jewish Medical and Research Center (Denver). The PedResp completed their fellowship training at The Hospital for Sick Children (Toronto), Alberta Children's Hospital (Calgary) and John Hopkins (Baltimore). We do not believe that the differences observed between sub-specialties are a result of a bias in training between institutions.

We could not identify whether the observed differences in reported co-morbid cases were actual differences or due to failure of certain physician groups to recognize or to note down the condition. The trends between percentages of reported conditions and percentages of missing data were inversely related. The

existence of missing information and under-recording warrants caution when interpreting the observed variations in practice patterns. The profound diagnosis of AR amongst PedAll cannot be attributed only to under-reporting by the other two specialties. The higher use of nasal steroids amongst PedAll matched this higher diagnosis of AR. Similarly, PedResp requested more radiologic investigation for reflux, diagnosed more cases of GERD, and prescribed most likely antacid medicines. The same trend was observed with the SDB scenario. The investigations, diagnoses and prescriptions were proportionately different between specialties. Physician diagnosis was not different in a more evident condition like AD/eczema. These considerations signify that the observed differences were caused not by selective reporting but by the physician specialties and their relevant discretionary management. There could be an argument that our finding of difference in investigations requested may be due to multiple testing. This is unlikely, because even if we had also used Bonferroni correction, one of the most stringent methods, all of the p-values obtained were less than the corrected p-value of 0.0127 for all four investigations that we compared.

When physician specialty was excluded in the model, LTRA became associated with a change in $\%FEV_1$ and direction of the differences varied by whether LTRA was used on the first visit or the most recent visit. As mentioned earlier, some physicians did not start prescribing medicines at the first visit and we did not have information on medicine use between first and most recent visits. Because of this limitation, the actual effect of medicines causing a significantly better improvement in lung function status among children seen by PedAll cannot be confirmed.

Our initial intention was to identify all patients from the central booking registry. Upon approval, we obtained two separate patient lists: one list of patients booked for initial consults and another list of patients who were billed with the asthma ICD-9 code. 414 children booked for an asthma consultation, and of these, some charts were missing partly due to patients missing appointments. 1004 children were billed with asthma. Since booking registry appeared to be an inadequate source to obtain our sample size, we decided to use billing information

instead to source eligible children. About half of the patients charts from billing list could not be located, possibly because they were archived or had been misplaced, or because the children were seen at somewhere else other than Stollery hospital asthma clinic. Children who had been seen by a physician with an asthma billing code were not only seen at the Stollery asthma clinic, but also at other health centre (e.g Clareview asthma clinic). Further, while collecting the data, we observed that a certain proportion of children were follow-up cases during the time frame of our study. Using our original criteria, we would miss collecting data from those children who started their clinic visit prior to aged 6 but turned six sometime later. Thus, again to increase our sample size, we decided to expand our inclusion criteria from children who were six at initial consult to children who were six at a point prior to censoring the data. An ethical amendment was approved for this change. (Appendix I)

Although the children were seen at the Stollery children hospital asthma clinic, physicians billed differently. Few patients in the billing list were seen by pediatricians; upon communication with the administrative team, we learnt that the pediatricians billed Alberta Health and Wellness directly. Without access to this billing database, we used the clinic booking information to identify patients of pediatricians. The list provided by the central booking department included only the children booked for initial consults, this made children seen by pediatrician were older since the list excluded the children who were seen prior to 2009 and turned 6 at later visits. We made another request for the list of children who came for follow up during the study period and included in the study to expand the number of eligible children seen by pediatrician. However, we were not able to confirm the billing information of these patients.

6.4. Recommendations

Differences in asthma management including prescribed medications, investigations, or frequency of visits can have individual, social as well as economic impact. Our study supports a need for more structured guidelines for investigative procedures, diagnoses, and management of co-morbid conditions.

Asthma guidelines tend to focus on pharmacological aspects of asthma management. Our findings suggest that asthma management is influenced by a significant amount of physician judgment and less by the presence of pediatric asthma guidelines. Regardless of recommendations in the CMAJ pediatric asthma guidelines for providing ICS as a first-line controller therapy, prescriptions for ICS were provided to patients considerably less often by Peds than by PedResp and PedAll. Once the child was on ICS therapy, Peds seemed to prefer using ICS together with LABA rather than ICS monotherapy, despite the guideline's recommendation to increase ICS dose among children less than 12 years old. Similarly, use of LTRA as an adjunct therapy was preferred more than ICS+LABA among PedAll yet ICS+LTRA was not favored by Peds. Our study results indicate that there may be room for improvement in asthma treatment strategies, investigation procedures, and identification of co-morbid conditions in order to ensure the most evidence-based care.

There continues to be significant variation between physician specialties in the management of asthma despite the publication of asthma guidelines for over 20 years and the identification over 15 years ago of differences in asthma management. However, the observed difference in patient outcomes (change in lung function) in this study was not associated with the documented differences in physician practice (medications, investigations, co-morbid diagnoses). Future studies are warranted to determine if either improving patient adherence or asthma education/action plans can help explain our observed improvement in lung function in children.

Further study is also recommended to specifically determine the factors that produce differences in pulmonary function observed by physician specialty. Specific areas of inquiry include determining if either improving patient adherence or providing asthma education can result in long-term improvements in lung function in children. Our study cannot determine if similar differences by specialty would be found in a multi-disciplinary asthma clinic where more than one physician sees the patient. Results from this study can help inform the content of future asthma guidelines related to the identification and management of co-

morbid conditions associated with pediatric asthma. Finally, this study supports the existing practice of having medical sub-specialty residents (fellows) rotate through complementary specialties to observe, learn, and appreciate alternate perspectives of managing multi-dimensional diseases such as asthma.

6.5. Conclusions

Asthma management has been shown to be variable despite, the existence of asthma guidelines [159]. This thesis attempted to identify the existence of asthma management differences by physician specialty and to explore the relationship between asthma outcomes in children referred to a tertiary care centre, the Stollery Children's Hospital Asthma Clinic in particular, and physician training / asthma management.

Why is it important to recognize the diversity in asthma management? Asthma is one of the most common childhood chronic illnesses, so difference in its management or outcomes can produce differences in economic and human resource burdens on individuals, families, and society. Differences in asthma management and asthma outcome may be expected between different levels of health care settings, such as primary versus tertiary, but there should theoretically be a consistent treatment and comparable asthma outcomes at a tertiary referral centre.

This study used a retrospective chart review to explore the difference in asthma management and in asthma outcomes by physician specialty. Findings suggest that specialty and subspecialty training have a significant role in determining ICS use, ICS dose, and choice of step-up management from ICS. Treatment with ICS among children with mild asthma is most heavily influenced by physician specialty. More interestingly, although most differences we observed did not influence asthma outcome, physician specialty remained a strong determinant for change in $\%FEV_1$. This preliminary finding on asthma outcome differences calls for future research to determine the factors related to physician specialty that produce differences in pulmonary function observed. In addition, the study highlights the need to observe, learn, and appreciate alternate

perspectives of managing asthma, a multi-dimensional disease, by different specialties and subspecialties. The present research has implication for asthma management at the patient level, and for future practice guidelines.

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APPENDIX I Ethics approval

Health Research Ethics Board

308 Campus Tower
University of Alberta, Edmonton, AB T6G 1K8
p. 780.492.9724 (Biomedical Panel)
p. 780.492.0302 (Health Panel)
p. 780.492.0459
p. 780.492.0839
f. 780.492.9429

Approval

Date:	March 14, 2012
Study ID:	Pro00029528
Principal Investigator:	Piushkumar Mandhane
Study Title:	Factors influencing asthma management in Tertiary-care pediatric academic hospital
Approval Expiry Date:	March 13, 2013

Thank you for submitting the above study to the Health Research Ethics Board - Health Panel. Your application has been reviewed and approved on behalf of the committee.

The Health Research Ethics Board assessed all matters required by section 50(1) (a) of the Health Information Act. It has been determined that the research described in the ethics application is a retrospective chart review for which subject consent for access to personally identifiable health information would not be reasonable, feasible or practical. Subject consent therefore is not required for access to personally identifiable health information described in the ethics application.

In order to comply with the Health Information Act, a copy of the approval form is being sent to the Office of the Information and Privacy Commissioner.

A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date (March 13, 2013), you will have to re-submit an ethics application.

The membership of the Health Research Ethics Board - Health Panel complies with the membership requirements for research ethics boards as defined in

Division 5 of the Food and Drug Regulations and the Tri-Council Policy Statement. The HREB - Biomedical Panel carries out its functions in a manner consistent with Good Clinical Practices.

Approval by the Health Research Ethics Board does not encompass authorization to access the patients, staff or resources of Alberta Health Services or other local health care institutions for the purposes of the research. Enquiries regarding Alberta Health approvals should be directed to (780) 407-604. Enquiries regarding Covenant Health approvals should be directed to (780) 735-2274.

Sincerely,

Doug Gross, Ph.D.
Associate Chair, Health Research Ethics Board - Health Panel

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Health Research Ethics Board

308 Campus Tower
University of Alberta, Edmonton, AB T6G 1
p. 780.492.9724 (Biomedical Panel)
p. 780.492.0302 (Health Panel)
p. 780.492.0459
p. 780.492.0839
f. 780.492.9429

Notification of Approval - Amendment

Date:	August 13, 2012
Amendment ID:	Pro00029528_AME2
Principal Investigator:	Piushkumar Mandhane
Study ID:	MS1_Pro00029528
Study Title:	Factors influencing asthma management in Tertiary-care pediatric academic hospital
Approval Expiry Date:	March 13, 2013

Thank you for submitting an amendment request to the Health Research Ethics Board - Health Panel. The following has been reviewed and approved on behalf of the committee:

- Expansion of the inclusion criteria to any child 6 years of age or older between January 2009 and December 2010.

Note: Approval for an amendment does not change the original approval date.

Sincerely,

Dr., Jana Rieger
Chair, Health Research Ethics Board - Health Panel

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Health Research Ethics Board

308 Campus Tower
University of Alberta, Edmonton, AB T6G 1K8
p. 780.492.9724 (Biomedical Panel)
p. 780.492.0802 (Health Panel)
p. 780.492.0459
p. 780.492.0839
f. 780.492.9429

Notification of Approval (Renewal)

Date:	March 18, 2013
Amendment ID:	Pro00029528_REN1
Principal Investigator:	Piushkumar Mandhane
Study ID:	MS2_Pro00029528
Study Title:	Factors influencing asthma management in Tertiary-care pediatric academic hospital
Approval Expiry Date:	April 18, 2014

Thank you for submitting this renewal application. Your application has been reviewed and approved.

This re-approval is valid for another year. If your study continues past the expiration date as noted above, you will be required to complete another renewal request. Beginning at 30 days prior to the expiration date, you will receive notices that the study is about to expire. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

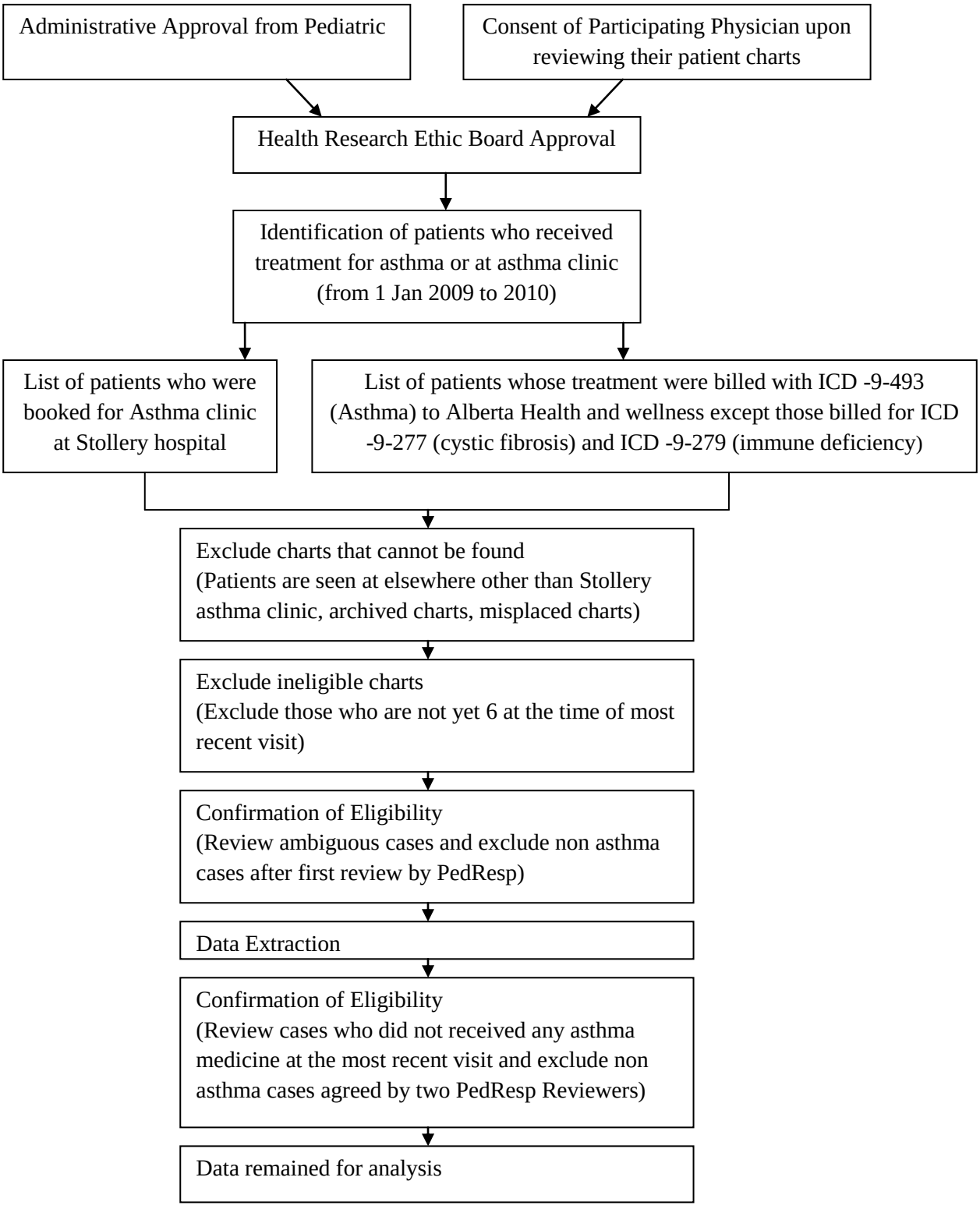
All study related documents should be retained so as to be available to the Health REB upon request. They should be kept for the duration of the project and for at least 5 years following study completion.

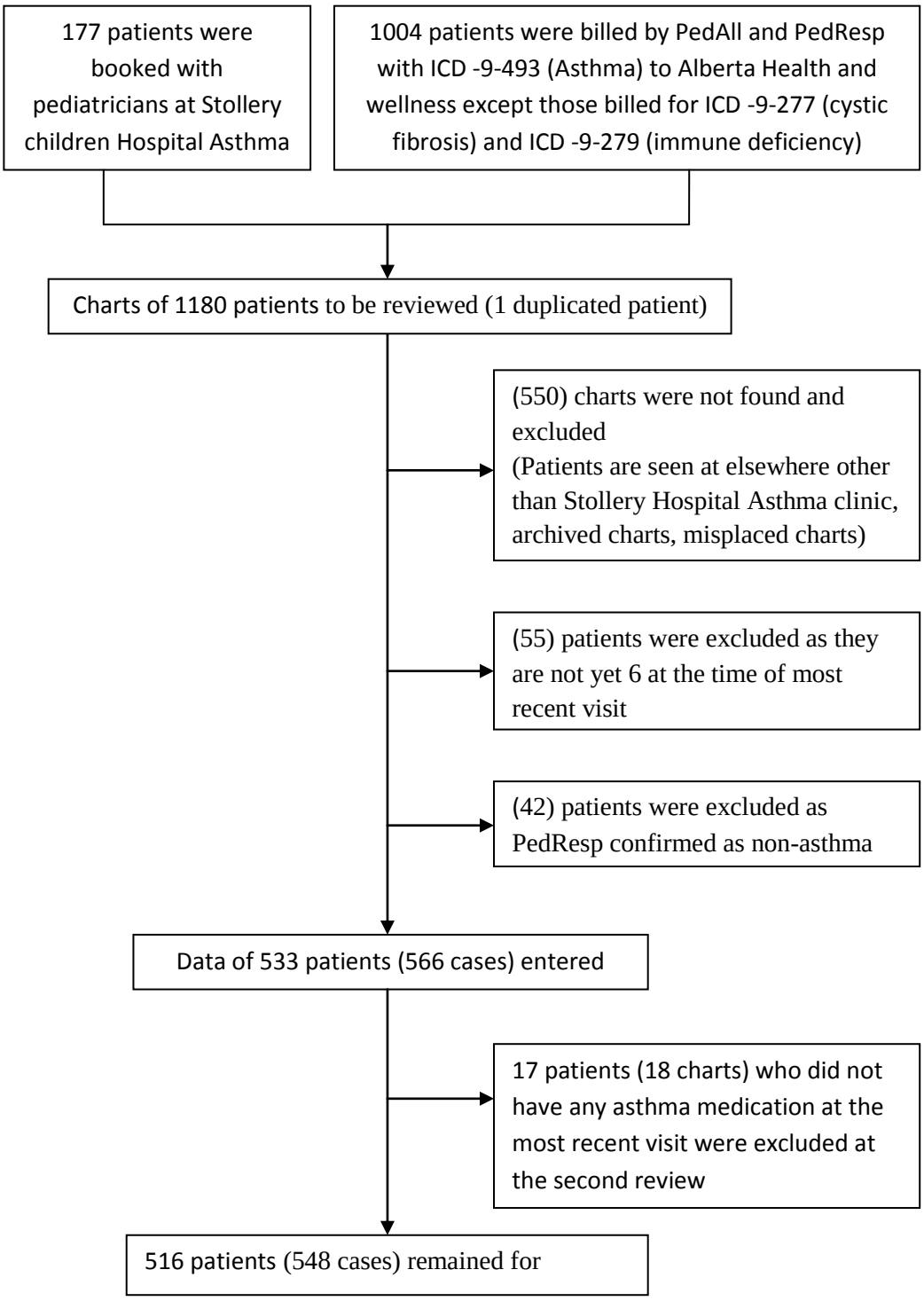
Sincerely,

Dr. Jana Rieger
Chair, Health Research Ethics Board - Health Panel

Note: This correspondence includes an electronic signature (validation and approval via an online system).

APPENDIX II Data collection process flow diagram




177 patients were booked with pediatricians at Stollery children Hospital Asthma
1004 patients were billed by PedAll and PedResp with ICD -9-493 (Asthma) to Alberta Health and wellness except those billed for ICD -9-277 (cystic fibrosis) and ICD -9-279 (immune deficiency)
Charts of 1180 patients to be reviewed (1 duplicated patient)
(550) charts were not found and excluded
(Patients are seen at elsewhere other than Stollery Hospital Asthma clinic, archived charts, misplaced charts)
(55) patients were excluded as they are not yet 6 at the time of most recent visit
(42) patients were excluded as PedResp confirmed as non-asthma
Data of 533 patients (566 cases) entered
17 patients (18 charts) who did not have any asthma medication at the most recent visit were excluded at the second review
516 patients (548 cases) remained for

APPENDIX III: Standard history forms used by pediatric allergists

Asthma Clinic Work Sheet

Name:_____
Hosp #: _____
Date: _____
DOB:_____
Referring Dr: _____
CC: _____ Age:_____

ASTHMA: ☐ **Yes** ☐ **No**

Duration: _____

Symptoms:

Y N Persistent: Year-round / Sp / Su / F / W
Y N Intermittent Year-round / Sp / Su / F / W

Colds # _____/ year; Duration _____

Y N Wheeze:
With colds / Between colds
Y N Responds to B-agonist
Y N Cough: Dry / Productive
Y N Fits (Gag / Vomit)
Y N Nocturnal ☐ Waken from sleep
Y N Responds to B-agonist
Y N SOB / Chest tightness
Y N With colds/ Between colds
Y N Responds to B-agonist

Triggers:

Y N Activity-induced (during / after)
Y N Limit activities
Frequency: occasional / regularly / heavy exertion
Level of activity _____
Y N Hyperpnea-induced (laugh / cry)
URTIs / Cold Air
Smoke / Perfumes / Strong odors
Cats / Dogs / Horse / Grass / Trees
NSAIDs / Aspirin / _____

Severity:

Y N Exacerbations: Frequency: _____ last:____
☐ current exacerbation
Y N ER _____ last:_____
Y N Hospitalized _____
☐ ICS / Intubated _____
Y N Prednisone_____ last:_____
Y N Missed school:_____ days/year
Y N Symptom-free periods _____

Typical Symptoms (when well):

Y N Nocturnal: _____ x/week
Y N Daytime: _____ x/week

Medications:

Y N Ventolin / Bricanyl / _____ (average doses/week: _____)
1 / 2 puffs / nebs prn / od / bid / _____ (regularly / colds / exacerbations / seasonal)
Y N Flovent / Qvar / Alvesco / Pulmicort / Symbicort / Advair _____
1 / 2 puffs / nebs od / bid / prn X _____ days / weeks / months / years
Y N aerochamber (O / Y / B)
Y N compliance _____ (forget / fear / _____)
Y N Singulair 4 / 5 / 10 mg od X _____ days / weeks / months / years

Rhinosinusitis: ☐ Yes ☐ No

Duration: _____

Symptoms between colds:

Y N Persistent: Year-round / Sp / Su / F / W
Y N Intermittent: Year-round / Sp / Su / F / W

Y N Nasal congestion (Stuffy)
Y N Rhinorhea: Clear / Purulent
  Y N Sniff / snort
  Y N PND / Throat-clearing
  Y N Throat-clearing cough
  Y N Early night-cough

Y N Sneezing
Y N Rubs / wipes / Allergic salute
Y N Itchy nose / palate / throat

Y N Mouth-breathing: Nighttime / Daytime
  Y N Bad breath / taste
  Y N Sore throat
Y N Snore
  Y N Sleep disruption
  Y N Apneas
Y N Fatigue
Y N Nasal Speech
Y N Dark circles under eyes
Y N Decreased sensation of smell / taste
Y N Facial pressure / Headaches

Conjunctivitis: ☐ Yes ☐ No

Y N Tearing / Discharge (watery / purulent)
Y N Red eyes
Y N Itchy / burning eyes
Y N Puffy eyes
Y N Chemosis (gelatin-like)

Complications:

Y N OM # _____ /year
  Y N Hearing problems
  Y N Language delay
  Y N T-tubes _____
  Y N T & A _____
Y N Sinusitis / pharyngitis
Y N Nosebleeds
Y N Polyps

Triggers:

URTIs / Cold Air / Exertion
Smoke / Perfumes / Strong Odors
Cats / Dogs / Horse / Grass / Trees / _____
Heat / Spicy foods / _____
NSAIDs / ASA / _____

Medications:

Response:

Y N Saline spray
Y N Nasonex / Avamys / Flonase / Rhinocort / Omnaris
  1 / 2 sprays od / bid X _____ days / weeks / months / prn — Y N
Y N Reactine / Aerius / Claritin / Benadryl / _____
  _____ prn / od / bid _____ — Y N
Y N Singulair 4 / 5 / 10 mg od — Y N
Y N Decongestants _____
Y N Patanol / Zaditor / _____ — Y N

Eczema: ☐ Yes ☐ No **Age of Onset:** _____

Exacerbations:
Y N Itchy (Scratch / Bleed / Night / Painful)
Y N Red
Y N Patches / Maculopapular / Vesicles
Y N Weeping / purulent / infected
Distribution:
Typical:
Onset:
Current
Non-inflammed skin:
Y N Dry
Y N Scaley
Y N Thickened
Frequency: _____
Duration: _____
Year-round / Winter / Summer / Spring / Fall

Treatment:
☐ Moisturizers _____
☐ Topical Steroids _____
☐ AntiHistamines _____
☐ Antibiotics _____
☐ Other _____

Between Exacerbations:
Duration _____ days / weeks / months
Normal / Dry / Scaley / Thickened / Inflammed (mild / moderate)
Best: Spring / Summer / Fall / Winter
Treatment:
☐ Moisturizers _____
☐ Topical Steroids _____
☐ Other _____

General:
☐ Bathes / Shower _____ (_____ min)
☐ Soap _____; ☐ Shampoo ☐ Bubble bath
Clothes washed in _____ liq / powder / double rinse; ☐ Fabric Softener _____
Diet restrictions _____

Triggers: Citrus / Tomato / _____
Heat / Sweat / Chlorine / Swimming
Soaps / Detergents / Cosmetics / Fabrics / Gloves / Shoes
Cats / Dogs / Grass / Trees / _____ Latex /

Food Allergy / Urticaria: ☐Yes ☐No Duration _____ Number of Episodes: _____

Date:
Trigger:

☐ EpiPen / Twinject (Jr / Regular)
☐ Medic Alert

Onset: _____; Duration: _____
Symptoms:
- ☐ Skin:
- ☐ Upper Resp:
- ☐ Lower Resp:
- ☐ GI:
- ☐ CVS:
- ☐ Other:

Management:
☐ ER ☐ Epinephrine ☐ Antihistamine ☐ Ventolin ☐ Prednisone

Tolerate:
- **Y N ?** Milk
- **Y N ?** Soy
- **Y N ?** Egg
- **Y N ?** Wheat
- **Y N ?** Peanuts
- **Y N ?** Nuts
- **Y N ?** Seeds
- **Y N ?** Fish
- **Y N ?** Seafood
- **Y N ?** Fruit

Triggers: Scratching / Pressure / Heat / Cold / Water / Exercise / _____

Drugs: _____ po / IV / IM / Top **for** OM / URTI / Sinusitis / _____
Onset: _____doses / days; Duration after d/c: _____
Symptoms:
Management:

Past Medical History:

Birth History:
Gestation _____ Birthweight _____ Labor & Delivery _____
Complications: _____ ☐ Smoke during pregnancy

Y N Medical Conditions _____
Y N Hospitalizations _____
Y N Surgery _____

Y N Medications (other):_____
Y N Immunizations UTD _____
Y N Drug Allergies: _____
Y N Insect Allergy ☐ Large local reactions
Y N Previous skin testing: _____
Y N Growth and development normal

Review of Systems: ☐ noncontributory / otherwise healthy

Y N **Dysphagia**: odynophagia / choke / gag / cough / bolus sensation / food impaction /
Y N **Abnormal Eating Habits:** slow eater / chew excessively / cut food into small pieces / drinks to help swallow / uses excess sauces / food avoidance (meats / coarse foods)
Y N **Reflux Symptoms**: heartburn / acid brash / Regurgitation
Y N **Other Symptoms**: chest pain / abdominal pain
Y N **Frequent or unusual Infections**: _____
Y N **Other**: _____

Family / Environmental History:

Primary Residence: (City) _____ with: Mom / Dad / Siblings / _____
Secondary Residence: _____ with: Mom / Dad / Siblings / _____

Mother: Age _____ Employment _____
Health _____
☐ No Atopy
☐ Asthma ☐ Rhinitis ☐ Conjunctivitis ☐ Eczema ☐ Food allergy ☐ _____

Father: Age _____ Employment _____
Health _____
☐ No Atopy
☐ Asthma ☐ Rhinitis ☐ Conjunctivitis ☐ Eczema ☐ Food allergy ☐ _____

Siblings: Brother / Sister _____
Brother / Sister _____
Brother / Sister _____
Brother / Sister _____
Brother / Sister _____
Brother / Sister _____

Examination:

Weight _____ kg _____ %ile
Height _____cm_____ %ile

Eyes: ☐ Normal; ☐ Infraorbital Venous Stasis ☐ Dennie's Lines ☐ _____
☐ Conjunctivitis ☐ Discharge _____

Ears: ☐ Normal; Right ☐ Cerumen ☐ MEE ☐ AOM ☐ _____
Left ☐ Cerumen ☐ MEE ☐ AOM ☐ _____

Nose: ☐ Normal; Right ☐ Edema mild / mod / sev ☐ Red ☐ Pale ☐ Discharge _____
Left ☐ Edema mild / mod / sev ☐ Red ☐ Pale ☐ Discharge _____
☐ Nasal crease ☐ Decreased Patency

Mouth ☐ Normal; ☐ Tonsils Enlarged ☐ High Palate ☐ Mouth breathe
☐ Cobblestoning ☐ PND ☐ Red ☐ _____

Chest: ☐ Normal; ☐ Indrawing (IC / SC / TT) ☐ Tachypneic RR _____ ☐ Hyperinflated
☐ ↓ B/S _____ ☐ Prolonged expiration ☐ Wheeze (insp / exp / forc)
☐ Creps ☐ Transmitted sounds

Heart: ☐ Normal; ☐ Murmer: _____ ☐ _____
Skin: ☐ Normal; ☐ Urticaria _____
☐ Dermatographism
☐ Dry (Generalized / Patches)
☐ Eczema Generalized / Chest / Back / Abd
Face: perioral / periocular / cheeks / behind ears
Arms: ext / flex / wrists / hands / fingers
Legs: ext / flex / ankles / feet
With: ☐ Lichenification ☐ Scarring ☐ Excoriation
☐ Weepy _____

Other: _____

Problem List:

Y N Atopic _____
☐ **Asthma ____: Persistent / Intermittent;** ☐ **Rhinitis ____: Persistent / Intermittent**
☐ **Eczema ____;** ☐ **Food Allergy ____;** _____
☐ **Urticaria ____;** ☐ **Drug rxn ____;** ☐ **Venom allergy ____;** _____

Recommendations:

☐ Ventolin / Airomir / Bricanyl / _____ prn
☐ Flovent / Qvar / Alvesco / Pulmicort / Symbicort / Advair: 50 / 100 / 125 / 200 / 250 / 400
Baseline: none / 1 / 2 puffs od / bid Year-round / Spring / Summer / Fall / Winter
Increased Sx: 1 / 2 / 4 puffs od / bid / ___ Exacerbations / Spring / Summer / Fall / Winter

☐ Nasonex / Avamys / Flonase / Rhinocort Aq / Rhinocort Turb / Omnaris / _____
Baseline: none / 1 / 2 sprays od / bid Year-round / Spring / Summer / Fall / Winter
Increased Sx: 1 / 2 sprays od / bid / ___ Exacerbations / Spring / Summer / Fall / Winter

☐ Singulair 4 gran / 4 tab / 5 / 10 mg od
☐ Reactine / Aerius / Hydroxyzine / Benadryl / _____
☐ Patanol / Zaditor / _____
☐ Skin Care ☐ Bleach bath ☐ Bactroban / Fucidin _____
☐ Hydrocortisone _____ / Elidel / Protopic / Mometasone / Dermatop / _____
☐ EpiPen /Twinject Junior / Regular
☐ Medic Alert

Investigations:

☐ **Methacholine challenge**
☐ **RAST** _____
☐ **CXR / Sinus X-ray / CT**

Follow-up: **Referral**: ☐ ENT ☐ GI ☐ Pulm ☐ Sleep

Asthma Clinic - Worksheet

Name_____ **Date**_____

Chart #_____ **Referring MD**_____

Asthma

Main Complaint: _____

Duration: _____

Cough: colds ___ ; at night ___ (nights/week); activity ___; cold air ___;
laugh/cry ____; fits ___; gag/vomit ___; SOB ___; wheeze ___; resp distress ___

Seasonal: worst months _____ best months _____

Triggers: colds ____; activity ___; animals _____; pollens _____; dust ___;
smoke _____; strong odors _____; foods _____;
aspirin _____; latex _____; other _____

Severity: admissions _____; ER visits _____; prednisone _____;
school missed _____; exercise tolerance _____;
pneumonia/bronchitis _____; colds → ____ / year, lasting ____ days

Investigations: chest x-ray ___; spirometry/PFT ___; methacholine ___; sweat Cl^- ___

Treatment:

β-agonists_____

inhaled steroids_____

LABA_____

LTR antagonists_____

other_____

Rhinitis

Main Complaint: _____

Duration: _____

Symptoms:

Nasal: congestion ____; itch ____; discharge (clear/cloudy/yellow/green) ____;

sneeze ____ (fits); bleeding ___; mouth breathing ____; snoring ____

Eyes: itch ____; discharge ____; swelling ____; redness ____; dark/puffy ____

Sinuses: pain ___; cough ___; throat clearing ___; bad breath ___; foul taste ___

Seasonal: worst months _____ best months _____

Triggers: colds ____; activity ____; animals _____; pollen _____; dust ___;

smoke _____; strong odors _____; foods _____; aspirin _____;

latex _____; cold/dry air ____; hot/spicy food _____; other _____

Complications: otitis _____; t-tubes _____; T & A _____; sinusitis _____ (x-ray/CT);

polyps _____; colds ➔ ____ / year, lasting ____ days

Treatment:

decongestants_____

antihistamines_____

eye drops_____

nasal sprays_____

intranasal steroids_____

Past Medical History

Birth: delivery _____ @ ____ weeks; BW _____; health _____

pregnancy _____

Diet: breast _____; formula _____; intolerances _____

Medical Conditions: _____

_____

Medications: _____

Immunizations: _____ **Drug Reactions:** _____

Hospitalizations: _____

Surgeries: _____

Development: _____

Family / Social History

Residence: _____

Mother: employment _____; age _____; health _____; atopy _____

Father: employment _____; age _____; health _____; atopy _____

Siblings: _____

_____

Extended: _____

_____

Pets: _____ **Smokers:** _____

Systems Review

CNS: _____

CVS: _____

GI: _____

GU: _____

MSK: _____

Other: _____

Physical Examination

General: Ht ____ cm (___% ile); Wt ____ kg (___% ile)

HE/ENT: venous stasis / Dennie lines / conjunctivitis / cobblestoning _____

TM's - R L B - retracted / dull / AOM / OME / t-tubes / obscured / normal ____

nasal mucosa - R L B - swollen / red / pale / boggy / polyps _____

discharge – clear / cloudy / mucopurulent / purulent / crusted / bloody _____

tonsils - injected / enlarged / exudate / post-nasal drip _____

RESP: hyperinflated / accessory muscle use / indrawing _____

air entry - normal / decreased R L B bases _____

prolonged expiration / stridor / wheezes / crackles / transmitted sounds _____

CVS: _____

GI: _____

Skin: cheeks / ears / scalp / abd / back / ante / wrists / hands / popl / ankles / feet

dry / scaling / excoriations / inflammation / weeping / urticaria / dermatographism

Investigations

X-rays: chest / sinuses / other_____ **PFT:** volumes / methacholine / exercise

Other: _____

Problem List

1. _____ 3. _____

2. _____ 4. _____

Treatment

_____

_____

_____

_____

ENVIRONMENTAL HISTORY

(please print, check or circle where appropriate)

Patient's name: _____ **Date:** _____

Residence: house / appt / condo / town home / mobile home

Years at present home_____ Age of home (years) _____

Heating: gas (forced air) /oil / electric / water-radiator / wood stove / other_____

Air-conditioning: central / room **Humidifier/Dehumidifier**: central / room

Vacuum: canister / central (venting: outdoor /indoor) / HEPA-equipped / water-trap

Molds: condensation / visible mildew / "moldy" odor / basement flooding

Patient's bedroom:

flooring: carpeting / area rug / hardwood / laminate / vinyl / tile

mattress cover: cotton / plastic / none / "allergy-proof" (zips closed)

pillows: feather / synthetic / foam / none / "allergy-proof" cover (zips closed)

other: duvet / comforter / books / stuffed animals / stored clothes / HEPA filter

PETS: _____ Indoors___ Outdoors____ Patient's Room___

Misc: horses / cattle / grain dust / other_____

Smokers _____ Indoors___ Outdoors___ Automobile_____

School / Work / Day Care: carpeting / pets/ /mold/ /strong odors/ /fumes

Is patient exposed to pets, smokers, or other concerning elements at school / daycare / babysitters / work / relatives (*please specify*) _____

_____

_____

Preferred pharmacy you usually deal with (*name, location and phone number is possible*):

_____

_____

Standard history form used by pediatric respirologist

Stollery Childrens Pediatric Asthma Clinic
Patient History Form

ID:

ENV:

CC:

HPI:

Allergy
Eczema
Sinusitis
Nasal

Med:

PMHx:

Fam. Hx:

Soc:

FI:

O/E:

Imp:

Plan: