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Factors Associated with Asthma Readmissions in Children's Hospitals

Maria Acedo Kronenburg
Old Dominion University

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By
Maria Acedo Kronenburg
B.S. May 1996, The College of William and Mary
M.B.A. December 1990, Old Dominion University

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Approved by:

Clare Houseman, Ph.D., Dissertation Concentration Area Graduate Program Director	Richardean Benjamin-Coleman, Ph.D
Cheryl Samuels, Ph.D. Dean, College of Health Sciences	Brenda Nichols, DNSc.

ABSTRACT

FACTORS ASSOCIATED WITH ASTHMA READMISSIONS IN CHILDREN'S HOSPITALS

Maria Acedo Kronenburg
Old Dominion University, 2000
Director: Dr. Clare Houseman

Asthma is the most common chronic illness of childhood. Pediatric asthma hospitalization rates and costs of care have risen in recent years. Readmissions, an adverse outcome often used to monitor quality of care, may account for the increase in asthma hospitalization rates. This research examined selected hospital and patient risk factors related to asthma readmissions, using Donabedian's framework for structure, process, and outcomes to assess the quality of care for children with asthma. Outcome measures included readmission for asthma within one year of initial hospitalization, readmission within 30 days, and multiple readmissions within one year. Structure factors measured were insurance type, hospital size, and hospital volume of annual admissions, while process factors measured were length of stay, previous admissions for asthma in the prior year, and use of inhaled steroids during the initial hospitalization.

This study used hospital discharges for asthma from 21 children's hospitals, which included 7,848 children admitted at least once for asthma in 1996. Logistic regression was used to determine significant structure and process factors associated with asthma readmission. Adjusting for age, gender, race, and APR-DRG severity of illness, insurance type was a significant predictor

of asthma readmission within one year. Hospital volume was a significant predictor of asthma readmission within one year, multiple asthma readmissions, and readmission within 30 days of initial hospitalization. Length of stay was a significant predictor of asthma readmission within one year and multiple asthma readmissions. Previous admission for asthma was a significant predictor of asthma readmission within one year, multiple asthma readmissions, and readmission within 30 days. Use of inhaled steroids in the initial hospitalization was a significant predictor of asthma readmission within one year. Hospital size was not a significant predictor of asthma readmission within one year, multiple asthma readmissions, or readmission within 30 days.

Children admitted for asthma with public insurance, children admitted to large volume hospitals, children with over one day length of stay, children who had at least one previous admission for asthma, and children who used inhaled steroids in the initial hospitalization were more likely to be readmitted for asthma within one year of initial hospitalization. Children admitted for asthma to large volume hospitals, children with over one day length of stay, and children who had at least one previous admission for asthma were more likely to have multiple readmissions for asthma within one year. Children admitted for asthma to large volume hospitals and children who had at least one previous admission for asthma were more likely to be readmitted for asthma within 30 days. Preventable hospitalizations and inpatient costs may be reduced by monitoring outcomes of care for pediatric asthma, and quality of care can be improved by targeting interventions to children at risk for asthma readmission.

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CHAPTER I: INTRODUCTION

Research Overview

Quality of care has received much attention as health care costs have risen in recent years. The demand for health care quality has increased the need to identify factors that impact outcomes of care. Hospital readmission is an important indicator of quality of care for patients with chronic diseases. Hospitalization rates for asthma, an inflammatory disease of the airways and the most common chronic disease in children, have risen in recent years even though many hospitalizations for asthma are avoidable with appropriate outpatient care. Hospital readmission, or repeated hospitalizations, for children with chronic diseases may indicate deficiency in the quality of outpatient care or poor ambulatory health care outcomes. The relationship between structure or organizational factors, process factors, and asthma readmissions is unclear. Using Donabedian's framework for quality assessment, this study examined the relationship between structure factors, process factors, and asthma outcomes, by identifying hospital and patient factors associated with pediatric asthma readmission. Understanding what structure and process factors are associated with pediatric asthma readmission may help develop interventions to reduce unnecessary hospitalizations, high costs, and improve the quality of care for children with chronic diseases.

Background

Increased health care costs have become a major concern among employers, payors, health care providers and consumers (Chassin, 1996; Blaiss, 1997). It is estimated that health care costs will rise at an annual rate of 6.5% in the next decade (Future of Children, 1998). In 1990, health care expenditures in the U.S. reached $662 billion. In response to growing costs, the health care industry began to provide less costly health insurance plans as an alternative to traditional fee-for-service plans. Employers still offered traditional fee-for-service plans, but provided managed care alternatives in the form of Health Maintenance Organization (HMO) plans, Preferred-Provider-Organization (PPO) plans, and Point-Of-Service (POS) plans. The number of people enrolled in managed care plans grew to 21,300 enrollees per 100,000 in 1997 (Modern Health care, 1997). Increased competition among health care plans helped to reduce health care costs.

Managed care plans were developed to implement new ways to control health care costs. These plans provide financial incentives to health care providers to economize and control utilization of services. They often monitor providers, health care costs, and resource utilization. These plans encourage the use of preventive care for enrolled plan members. Managed care plans also attempt to reduce costs by negotiating large volume discounts with providers, hospitals, and suppliers. These plans may achieve lower health care costs, but often limit the patient's choice of health care providers and restrict the range of health care services.

It is uncertain whether cost reduction efforts by the health care industry have impacted the quality of care (Blais, 1997). Quality of care is defined by the Institute of Medicine as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes" (Future of Children, 1998). There is some fear that reduction of health care costs results in the elimination of health care services and poor outcomes, such as poor health status, patient dissatisfaction, increased mortality, readmissions, and complications. There is concern over the possible effects of managed care, since financial incentives or methods of provider reimbursement may affect quality of care (Glied, 1998). In the past, government agencies have published outcomes of care, such as hospital mortality rates and readmission rates, in order to increase pressure on organizations to evaluate outcomes. The growth of enrollment in Medicaid managed care plans have directed states to implement quality oversight systems and effectiveness of care measures (McManus, Graham, Fox, Mercil, & Irwin, 2000). Such monitoring of outcomes and resource use to control costs may improve the quality of care.

Readmissions and Quality of Care

Frequent hospital readmission may indicate a need to improve quality of care. Readmission rates serve as adverse outcome indicators, and may flag high utilization of services and high morbidity (Thomas & Holloway, 1991). Readmission rates can be identified using standard hospital discharge data

(Rosenheck, Fontana, & Stolar, 1999), and are often gathered easily and inexpensively by hospital staff. By monitoring readmissions, providers can determine if quality of care is impacted by specific factors that can be identified and changed, in order to prevent unnecessary hospitalizations.

Some hospitalizations may be preventable. Preventable hospitalizations and readmissions may be caused by various factors. Lack of documentation for discharge planning (Wei, Mark, Hart, & Campbell, 1995), lack of pre-discharge review and post-discharge care (Safron & Phillips, 1989), patient difficulty in accessing primary care, lack of community-based support (Thomas & Holloway, 1991; Oddone et al., 1996), and poor inpatient care during the initial hospitalization may increase the risk of subsequent readmission (Ashton, Del Junco, Souchek, Wray, & Mansyur, 1997). Even though some readmissions may be prevented or controlled, other readmissions cannot be avoided because of the severity of the patient's illness, life-threatening circumstances or medical necessity (Oddone et al., 1996).

Readmissions and Chronic Illnesses

Chronic illnesses account for many hospitalizations and readmissions. A chronic condition is often defined as a condition that has a duration of more than three months (Newacheck & Taylor, 1992). Common chronic diseases include diabetes, sickle cell, cerebral palsy, seizures, congenital heart disease, cancer, autoimmune disease, major organ diseases, mental retardation, congenital anomalies, depression, schizophrenia, and asthma. Patients with chronic

illnesses are often rehospitalized due to their persistent conditions. Health care services for chronically ill patients may use more resources because specialized services may be needed over a long period of time.

Children and Chronic Illnesses

About 10 million children have chronic diseases or are disabled (Future of Children, 1998). Medical care for children with chronic diseases is about 2.5 to 3.0 times more expensive than health care for other children (Ireys, Anderson, Shaffer &Neff, 1997; Silber, Gleeson, & Zhao, 1999), with inpatient stays accounting for the majority of these costs. In 1988, chronic diseases accounted for an estimated $ 7.5 billion annually in physician and hospital care costs and 41 million school absences (Newacheck & Taylor, 1992).

Pediatric Asthma As A Chronic Ilness

The most common childhood chronic illness is asthma, an inflammatory disorder of the airways that affects 5 million children (CDC, 1995). Inflammation of the airways often causes recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, often at night or early morning. These attacks are associated with airflow obstruction that may be reversible either spontaneously or with treatment (National Institutes of Health, 1997).

The appropriate use of maintenance medications and medical therapy can help patients control their asthma, prevent unnecessary hospitalizations, and avoid readmissions (Smith, Malone, Lawson, Okamoto, Battista, & Saunders, 1997). Medications also are used to reduce the frequency and severity of

asthma exacerbations and reverse airflow obstruction (National Institute of Health, 1997).

Asthma medications are classified into two general classes: long-term control medications and quick-relief medications. Long-term preventive, controller or maintenance medications are often taken to control persistent asthma. Long-term control medications include corticosteroids, cromolyn sodium and nedocromil, long-acting $beta_2$–agonists, methylxanthines (theophylline), and leukotriene modifiers. Asthma medications, such as reliever or acute rescue medications, are taken to provide prompt reversal of acute airflow obstruction. These medications include short-acting $beta_2$–agonists, anticholinergics, and systemic corticosteroids. Patients with persistent asthma require both classes of medications (National Institute of Health, 1997).

Hospital management of an acute asthma attack often includes the use of systemic anti-inflammatory medications such as corticosteroids and bronchodilators (including beta-agonists). The use of inhaled steroids, a common anti-inflammatory medication, can decrease the need for hospitalization for asthma (Wennergren, Kristjanssons, & Strannegard, 1996; Afifalo, Guttman, Colacone, Dankoff, Tselios, Stern, Wolkene, & Kreisman, 1999). Most asthma hospitalizations are considered avoidable, since asthma symptoms can be prevented and controlled with the appropriate medications, proper asthma management at home and proper outpatient care (Mackinon, Flagstad, Peterson, & Mesch-Beatty, 1996). The use of asthma education programs and practice

guidelines may also decrease hospital admissions for asthma and reduce emergency room visits (Homer et al., 1996).

Asthma Morbidity, Costs, and Mortality

Pediatric asthma hospitalization rates have increased over the past two decades, along with prevalence and mortality (CDC, 1996). Children with asthma are often hospitalized for their chronic condition. In 1982, asthma hospitalization rates were 2.84 per 1,000, and in 1994, the national pediatric hospitalization rate for asthma for those ages 0 to 14 reached 2.95 per 1000. These rates fall short of the U.S. government's Healthy People 2000 goal of 2.25 discharges per 1,000 for children ages 0 to 14 in the year 2000 (National Center for Health Statistics, 1996), and are also short of the Healthy People 2010 goal of 25 discharges per 10,000 for children of ages 0 to 4 in the year 2010.

Costs for asthma hospitalizations can be high. In 1987, hospitalization costs for asthma for those ages 0 to 4 were $586.2 million and $286.2 million for those ages 5 to 17 (Smith, Malone, Lawson, Okamoto, Battista, & Saunders, 1997). In addition to having high health care costs, uncontrolled asthma may also cost lives. From 1993 to 1995, mortality rates from asthma for children ages 0-4 were 1.8 per 1,000,000 population, and 3.7 for those ages 5 to 14 (MMWR, April, 1998).

There are various explanations for the increase in asthma hospitalizations. Observed increases in hospital admission rates for asthma could be attributed to increased asthma morbidity in the population as a whole, since self-reported

asthma in the U.S. population increased from 10.4 million to 14.6 million from 1990 to 1994 (Adams & Benson, 1991, CDC, 1995). Increased hospitalization rates could be due to more frequent admissions of individuals diagnosed with asthma, or repeated readmissions of the same individuals over time (To, Dick, Feldman, & Hernandez, 1996; Mitchell, Bland, & Thompson, 1996). However, some of these admissions might be preventable and may indicate poor asthma management (Heard, Campbell, Ruffin, Smith, Luke, & Roder, 1997).

One possible explanation for increased asthma hospitalization rates is decreased access to appropriate outpatient care, which may result in poor asthma management. Asthma hospitalizations and emergency room visits are sentinel events that provide alerts to improve preventive and outpatient care (Carr, Szapiro, Heisler, & Krasner, 1989). Repeated asthma hospitalizations due to uncontrolled asthma may prompt unexpected visits to the emergency room, which may have been prevented by seeking care from outpatient providers or a regular primary care physician. The estimated annual rate of emergency room visits for asthma in 1995 was 120.7 per 10,000 population for those ages 0-4, and 81.3 per 10,000 population for those ages 5 to 14 (MMWR, April, 1998), while office visit rates from 1993 to 1995 were 50.3 per 1,000 population for those ages 0-4 and 51.5 for those ages 5-14. Children who are diagnosed with more severe forms of asthma and children who have problems accessing primary care who frequently use the emergency room may be more acutely ill when they are finally admitted to the hospital than those who have more

appropriate outpatient management. Lack of appropriate asthma therapy and management can result in sudden death, which can often be avoided (Sly, 1988).

Asthma As An Urban Problem

Uncontrolled asthma, poverty, and decreased access to primary care in urban areas may contribute to the increase in pediatric asthma hospitalization rates (Halfon & Newachek, 1993; Gerstmann, Bosco, & Tomita, 1993; Calmes, Leake, & Carlisle, 1998). Children residing in inner cities have high rates of asthma prevalence, hospitalization, and death compared to other children (MMWR, September, 1996). Inner city children with asthma often use the emergency room for their usual source of care (Dinkevich, Cunningham, & Crain, 1998; Farber, Johnson, & Beckerman, 1998), and may lack access to preventive medications (Crain, Kercsmar, Weiss, Mitchell, & Lyn, 1998).

Other factors that may contribute to the increase of asthma hospitalizations and asthma morbidity in cities are inadequate access to transportation, limited access to medical facilities in urban areas, lack of continuity of care, poor compliance with therapy, polluted environments, cigarette smoke, cockroaches, and dust mites (Homer et al., 1997; Farber, Johnson, & Beckerman, 1998).

Asthma and Quality of Life

Quality of life is an important concern for children with asthma, since many children miss school days, are limited by restricted activity and breathlessness,

and experience disruption in social activities due to asthma attacks. Caregivers and parents also experience difficulties with missed work days and increased daycare costs for children who miss school due to asthma attacks (Smith, Malone, Lawson, Okamoto, Battista, & Saunders, 1997).

Children with chronic illnesses such as asthma may experience more psychological and social problems, as compared to other healthier peers (Pless & Douglas, 1971). Children with chronic disorders often need comprehensive services, including physician visits, and psychological or social support services, but some providers may not have enough resources to coordinate care and services for chronically ill children (Jessop & Stein, 1994).

Purpose and Significance of Study

The purpose of this study is to assess the quality of care for children with asthma, the most common childhood chronic disease, by examining selected factors associated with pediatric asthma readmission. Using Donabedian's theoretical framework on the use of structure, process, and outcomes in quality assessment, this study examined the relationship between selected structure factors, process factors and outcomes of care measured by pediatric asthma readmission and attempted to identify significant predictors of asthma readmission. Structure factors in this study included hospital size, hospital volume of annual admissions, and insurance, while process factors included length of stay, previous admissions for asthma, and use of inhaled steroids during hospitalization. Outcome measures for pediatric asthma readmission were asthma readmission within one year of initial hospitalization, readmission

within 30 days, and multiple readmissions for asthma within one year. These outcomes were not mutually exclusive, so that a child who was readmitted for asthma within 30 days could also have had multiple asthma readmissions within one year.

Examining risk factors for asthma readmission could help providers identify asthmatic children at risk for continued readmissions or early readmission, so that these children are targeted for specific interventions to control asthma. Understanding the risk factors associated with asthma readmission can help develop interventions to improve quality of care and quality of life for children with asthma, prevent unnecessary costly or avoidable hospitalizations and emergency room visits, and help children with asthma access appropriate outpatient care to improve asthma management (MMWR, August, 1997). Identifying factors that influence readmissions for chronic diseases, such as asthma, may help health care providers and policy-makers evaluate interventions and address the special health care needs of children with chronic diseases, improve outcomes of care, and reduce high costs associated with preventable hospital admissions.

The results of this study may aid in understanding how health care quality is affected by specific factors. By analyzing the nature of the relationship between structure factors, process factors, and outcomes, the results of this study can contribute to the body of knowledge on quality assessment and provide a practical application of Donabedian's theory to assess the quality of care of children with asthma.

Overview of Past Studies on Asthma Outcomes

Various factors may affect asthma hospitalizations. Some studies have suggested that patient characteristics or demographic factors, such as young age, African-American race, and gender are associated with increased asthma hospitalizations and readmissions (Volmer, Buist, & Osborne, 1992; Senthilselvan, 1995). Some asthma readmission studies have suggested that process of care or clinical factors, such as preventive treatments, maintenance medications, and history of previous hospitalizations affect asthma outcomes (Mitchell, Bland, & Thompson, 1994; To, Dick, Feldman, & Hernandez, 1996; Lieu, Quesenberrry, Sorel, Mendoza, & Leong, 1998). Past research studies have found that severity of illness classifications, used to determine sicker patients due to individual patient characteristics, may affect outcomes of care (Desharnais, McMahon, Wroblewski, & Hogan, 1990; Iezonni, 1993). Risk-adjustment methods are often used in outcomes studies to account for individual patient characteristics that may affect outcomes of care.

Insurance status may be associated with asthma hospitalizations. One study found that asthmatics with public insurance are more likely to be treated as inpatients than those with commercial insurance, and few Medicaid recipients with asthma were treated at outpatient sites (Apter, Reisine, Kennedy, Cromley, Keener, Zu, & Wallack, 1997). Poor children and African-American children with Medicaid are more likely to be hospitalized for asthma (Halfon & Newacheck, 1993; Ali & Osberg, 1997; Goodman, Stukel, & Chang, 1998). There are very

few studies on asthma outcomes that also look at hospital characteristics, in addition to looking at patient factors and clinical factors (Samuels, Novack, Martin, & Connell, 1998; Meurer, Kuhn, George, Yauck & Layde,1998).

Even though various factors may affect asthma hospitalizations, it is unclear whether the combination of hospital structure factors, process of care or clinical factors, adjusted for patient characteristics, impact asthma outcomes. Lack of literature that combine these various factors in one study shows that there is still a need to determine whether the combination of structure and process factors, controlling for patient characteristics, impact pediatric asthma readmission and quality of care.

Theoretical Framework

Avedis Donabedian's theory (1992) on the relationship between structure, process, and outcomes can be used to assess quality of care (Blaiss, 1997). Health care outcomes can be defined as conditions of individuals or populations which can be attributed to the previous care provided for an illness, and may include changes in knowledge or behavior that affects future health status (Donabedian, 1992). Donabedian's theory suggests that major approaches to quality assessment are based on the elements of structure, process, and outcomes. This theory suggests that there is a functional relationship among the elements of structure, process, and outcomes such that structure characteristics can influence the process of care, and process of care can influence the effect of care on health status (Donabedian, 1980). Donabedian suggests that studies on

quality assessment should consider the use of indicators that would represent each element of structure, process, and outcome.

This study tested Donabedian's theory and assessed quality of care by selecting structure, process, and outcome indicators and applying this theory to determine predictors of asthma readmission for children hospitalized with asthma. This study developed multivariate models that determined which hospital and patient structure factors and process factors were significant predictors of asthma readmission, while adjusting for additional patient variables that may also affect asthma outcomes, such as age, race, gender, and severity of illness.

This study used selected structure and process indicators that could be determined from most hospital information. In this study, hospital structure factors were hospital characteristics, such as hospital bed size (number of licensed beds), hospital volume of admissions, and hospital reimbursement methods represented by the patient's insurance type during the initial hospitalization for asthma. Process of care or clinical variables were patient use of inhaled steroid medications during the initial hospitalization for asthma, length of stay during the initial hospitalization, and patient history of previous hospitalization for asthma in the prior year.

Asthma outcomes, the dependent variable in this study, were measured by pediatric asthma readmissions. Asthma readmission refers to repeated hospitalizations for asthma after the first hospitalization for asthma during the study period. Pediatric asthma readmissions were captured for each child by

using three outcome measures: asthma readmission at least once within one year of initial hospitalization, multiple asthma readmissions within one year of initial hospitalization, and asthma readmission within 30 days of initial hospitalization. The outcome measures for asthma readmission within one year of initial hospitalization and multiple asthma readmissions within one year of initial hospitalization were measured by the patient's total number of admissions for pediatric asthma. Asthma readmission within 30 days of initial hospitalization, which indicates time between admissions for each patient, was measured by calculating the total number of days between patient's initial hospitalization and first readmission for asthma. It was anticipated that using several different outcome measures for pediatric asthma readmission may provide more specific information on the nature of the relationship between structure, process, and outcomes.

Research Questions

To determine what selected factors were related to pediatric asthma readmissions and to develop models to predict pediatric asthma readmissions in order to test Donabedian's theory, the following research questions were examined in this study:

1. Are structure factors, such as insurance, hospital size, and hospital volume of annual admissions, associated with pediatric asthma readmissions?
   A. Is insurance type associated with pediatric asthma readmissions?
   B. Is hospital size associated with pediatric asthma readmissions?

C. Is hospital volume associated with pediatric asthma readmissions?

2. Are process factors, such as length of stay, previous admissions for asthma, and use of inhaled steroids during hospitalization associated with pediatric asthma readmissions?
   A. Is length of stay associated with pediatric asthma readmissions?
   B. Is previous admission for asthma associated with pediatric asthma readmissions?
   C. Is the use of inhaled steroids in hospitalization associated with pediatric asthma readmissions?
3. Do structure factors and process factors interact to impact pediatric asthma readmissions? (Test of Donabedian's Theory on the relationship between structure, process, and outcomes elements)

Hypothesis tests that were generated from these research questions are presented in Chapter 3. The hypotheses were tested using results from the multivariate analysis. The results of the hypothesis tests are presented in Chapter 4.

Scope of Study

This study examined asthma readmissions from a computerized database, which was a secondary dataset of pediatric asthma hospital discharges taken from a sample of children's hospitals in the United States. The study sample

included hospital discharges from calendar year 1996 and were taken from 21 children's hospitals who were members of Child Health Corporation of America (CHCA), a consortium of non-competing children's hospitals. Most CHCA hospitals submit clinical and financial data to CHCA's Pediatric Health Information System (PHIS) database so that member hospitals can share information to compare hospital resource utilization and outcomes of care. Most children's hospitals that submit discharge data to PHIS are located in urban areas and are also academic teaching hospitals. This study investigated readmissions at the patient level, so specific hospital names and locations were not necessary for the analysis.

Even though various factors may affect outcomes of care, variables used in this study were limited to the data elements available in the PHIS database. Only hospitals with complete variables were used in the sample. In order to select children for the study cohort, the study determined which children in the PHIS database had at least one hospital discharge for asthma in calendar year 1996. Since asthma hospitalizations and admissions were determined from the discharge database, the terms for hospitalizations, admissions, and discharges are used interchangeably in this study. Asthma admissions were determined by selecting discharges with principal diagnosis codes for asthma, which were recorded with the International Classification of Diseases, Clinical Modification, 9th Revision (ICD-9-CM) diagnosis codes of 493.01 or 493.91, and used by hospitals to identify children with asthma or with status asthmaticus. The principal diagnosis code was used for determining asthma hospitalizations for

this study, since it is the diagnosis code that explains best why the child was hospitalized and is a required code in hospital discharge abstracts submitted to PHIS. Therefore, secondary diagnoses and admitting diagnoses were not used in selecting asthma discharges in the PHIS database.

In order to select the cohort for the study and evaluate asthma readmissions within one year of initial hospitalization, PHIS discharges for asthma were extracted from the PHIS database for the study period, defined as January 1, 1996 to December 31, 1997. This time frame was used in studying readmissions because the PHIS database had data available from six months prior to that period, and one year after that period, in order to measure the subject's previous hospitalizations and readmissions. The cohort of patients selected for the sample of asthma admissions included children with hospital discharges in the PHIS database who were hospitalized for asthma between January 1, 1996 and December 31, 1996. Readmissions within one year of the initial hospitalization for asthma in the study period were determined for the study cohort from pediatric asthma discharges between January 2, 1996 and December 31, 1997. Previous admissions for asthma, or admissions within the last six months of the prior calendar year, were determined for the study cohort from PHIS asthma discharges between June 1, 1995 and December 31, 1995. Only children ages 0-17 in calendar year 1996 were included in the study. Asthma patients with discharges in the PHIS database who died during the hospitalization and PHIS hospitals or asthma patients who had incomplete information on any of the study variables were not included in the study sample.

Delimitations, Limitations, and Assumptions

There were several assumptions for this study. Since secondary datasets were used, it was assumed that the principal diagnosis code for asthma was coded correctly on the hospital discharge abstract by the medical records department at each PHIS hospital used in this study. Another assumption is that all CHCA data elements that were used to determine pediatric asthma readmissions and factors associated with pediatric asthma readmissions were recorded accurately in the PHIS database. It was also assumed that the masked patient identifier used in linking patient discharges for asthma was accurately recorded in the PHIS database, and that patient demographic information used to account for patient characteristics was reliably and consistently collected. It was assumed that most patients admitted for asthma to a PHIS hospital returned to the same PHIS hospital for subsequent asthma admissions.

This study was limited to children hospitalized for asthma in PHIS children's hospitals, so hospitalizations in other facilities, transfers, or readmissions to adult hospitals or other acute facilities cannot be determined in this study. Because the study sample was limited to selecting children with the principal diagnosis of asthma who had asthma discharges recorded in the PHIS database, this sample may not be representative of all children with asthma.

Some data from PHIS hospitals contained incomplete information for the study variables, so analysis was limited to PHIS hospitals with discharges that had complete and consistent datasets. The PHIS database only contained

inpatient data, so patient information pertaining to resource utilization, treatments or medications that were given for outpatient or ambulatory asthma care was not available for this study. The study was limited to treatment of inhaled steroids given at the PHIS hospital. The time frame of this study produced limitations, since asthma hospitalizations before June 1, 1995 and hospitalizations after one year of initial hospitalization or after December 31, 1997, were not considered in the analysis of this study. Since the study sample is limited to PHIS children's hospital discharges, the generalizability of the results of this study was limited. The study sample only included children admitted for asthma to the PHIS hospitals that fit the study criteria. Children with asthma who were admitted to PHIS hospitals and were readmitted to other hospitals could not be tracked in this study. Children selected for this study cohort were not randomly selected, since all children from the sample of PHIS hospitals who fit the study criteria were included in the cohort. Lack of random selection for the study cohort may have produced a bias in the sample selection.

Other limitations in this study included restrictions imposed by use of a secondary dataset and the study's retrospective cohort design. Secondary datasets of hospital administrative data can be used to determine outcomes such as readmissions (Roos, Wald, Wajda, Bond, & Hartford, 1996; Rosenheck, Fontana, & Stolar, 1999), but limitations exist. The use of a secondary dataset and retrospective cohort study design did not allow for control of the independent structure or process variables in examining asthma outcomes, so that cause and effect relationships could not be determined from the study results. Other

unmeasured factors, which were not available in the PHIS dataset, may also affect asthma outcomes, so the interpretation of study findings is limited. For example, limitations in this study included lack of measures for patient compliance with medications. If patients became compliant with asthma therapies during the study period and were not readmitted because they improved their asthma management within the study period, then the study was limited by regression toward the mean. Regression toward the mean would have eventually lowered the number of readmissions and frequency of readmissions for compliant asthma patients. Also patients who utilized many health care services for asthma, who were not compliant with asthma therapies, could have continued to be readmitted during the study period. Because the study was limited to variables available from the PHIS database, costs, compliance with various treatment plans, use of home medications, outpatient services, outpatient medications, environmental factors, and other social or behavioral factors were not measured in the study. It is possible that the utilization of outpatient care for asthma patients included in this study could have been closely monitored by providers, but outpatient care was not measured in this study.

CHAPTER II: LITERATURE REVIEW

Introduction

Donabedian's theory and approach to quality assessment can be applied to the examination of structure and process factors associated with outcomes, such as pediatric asthma readmissions. The application of this theory will be explained in detail in this chapter. The review of past research that pertains to the study will also be presented. This chapter will present literature on various patient factors, structure and process components as they relate to outcomes of care for asthma readmissions and asthma hospitalizations. An explanation of the study's variables and its control for limitations of previous studies will also be discussed.

Application of Donabedian's Theory

Elements of structure, process, and outcomes are identifiable in health care settings, and are interrelated (Donabedian, 1980). These elements are related in such a way that structure characteristics can influence the process of care, and process of care can influence the effect of care on health status (Donabedian, 1980). Structure, process, and outcome elements can provide measures in the assessment of quality of care. Structure elements are the relatively stable characteristics of providers. Some examples of structure elements are provider characteristics, equipment, human, financial or physical resources, financial reimbursement methods, policies and organization of health

services, and physical and organizational settings used to provide medical care (Donabedian, 1980).

Process factors are activities performed between practitioners and their patients, and are often taken from the medical record or other recorded information. Treatments, therapies, diagnostic tests, care plans and medications for asthma are part of the process of care in Donabedian's model (Donabedian, 1980).

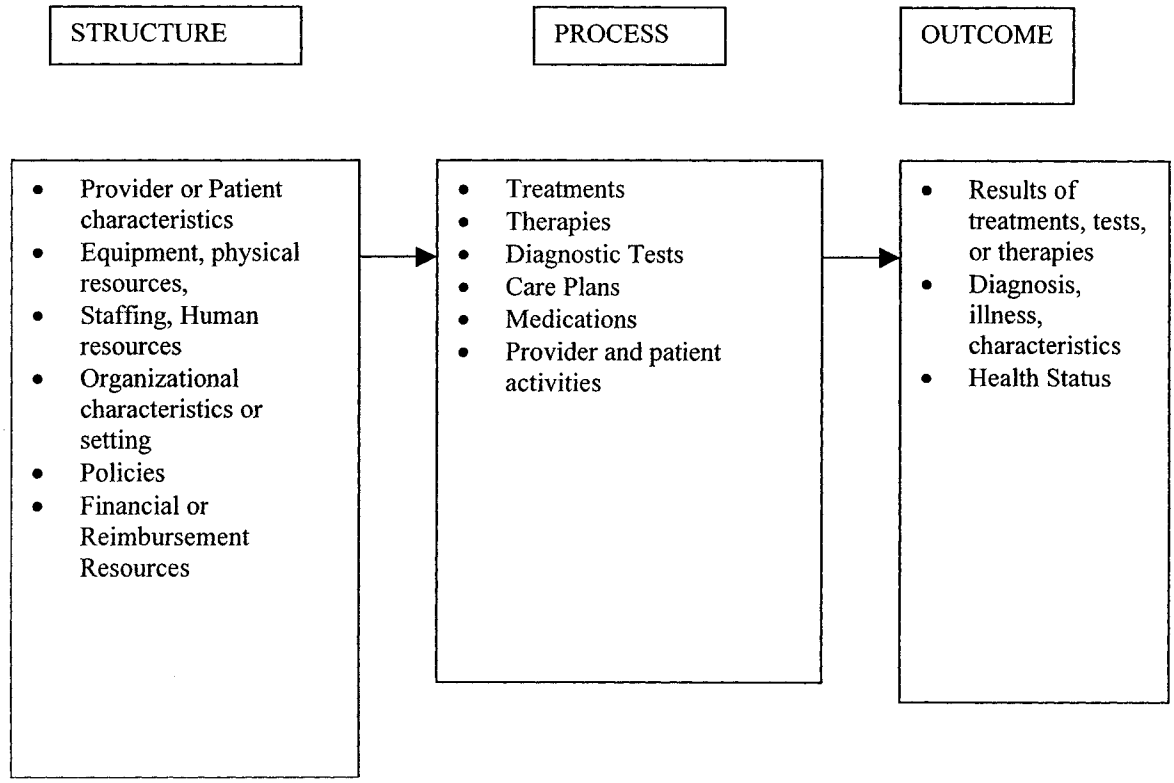
Outcomes are defined as changes in a patient's health status that can be attributed to the health care processes (Donabedian, 1992). Outcomes can be measured by complication rates, readmission rates, mortality rates, patient functional status, health status, or patient satisfaction.

Donabedian suggests that it is important to look at the whole relationship between structure, process, and outcomes when assessing quality of care (Donabedian, 1980, Future of Children, 1998). Donabedian suggests that quality of care studies should combine measures of structure, process, and outcome elements in assessing quality of care, and that intervening patient or provider factors could influence the relationship between structure, process and outcomes.

Donabedian (1992) asserts that it is often difficult to see the relationship between the elements of structure, process, or outcomes in quality assessment, and that it is difficult to identify a causal relationship between these elements. Because the relationship between structure, process, and outcomes may be complex and other unknown confounding factors could affect quality of care,

outcomes data should be interpreted carefully (Donabedian, 1992). Donabedian's theory of the relationship between structure, process, and outcomes, and examples of this relationship are presented in Figure 1.

FIGURE 1 DONABEDIAN'S THEORY
EXAMPLES OF ELEMENTS OF STRUCTURE, PROCESS, AND OUTCOME (Donabedian, 1980)



Elements of structure, process, and outcomes were selected for use in this study and applied to Donabedian's model, in order to determine factors associated with asthma readmission. This study used pediatric asthma readmissions to represent outcomes of care in Donabedian's model. Asthma outcome measures were readmission within one year of initial hospitalization, multiple asthma readmissions within one year, and readmission within 30 days of initial hospitalization. Outcome variables for this study were calculated by determining the total number of patient admissions for asthma and time between readmissions, which was the total number of days between the patient's first hospitalization in the study period and the patient's first readmission within the study period.

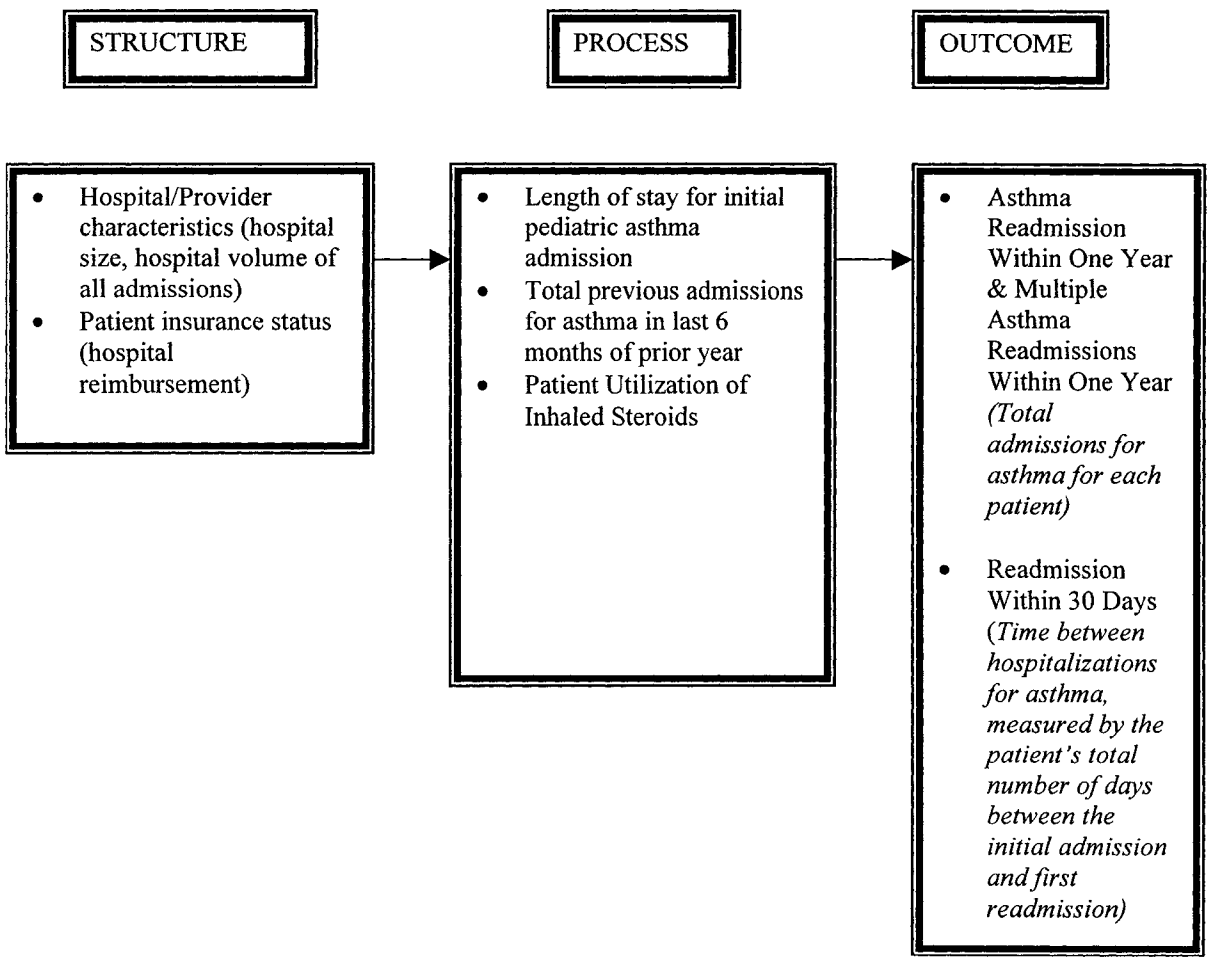
Hospital characteristics were measured by hospital size, which represents the number of licensed beds in the facility, and estimated hospital volume of annual admissions for all diagnoses including asthma. Insurance status, which represents hospital financial reimbursement method, was another structure factor measured in this study.

In addition to structure variables, the study measured process elements to examine pediatric asthma readmissions. Hospital process measures included resource utilization measures, such as total patient charges for the patient's initial hospitalization for pediatric asthma admission, and length of stay for the initial hospitalization for pediatric asthma. Process variables were measured by the use of inhaled steroids during the patient's initial hospitalization in the study period and by the patient's history of previous hospitalizations for asthma.

In determining the relationship between pediatric asthma readmissions and selected structure and process factors, other confounding factors which represent Donabedian's intervening variables that may affect outcomes, such as patient age, race, gender and severity of illness and were supported by the literature review, were measured in the study. These variables could possibly be classified as patient structure factors, since they are stable characteristics of the patient, but they are not included in the application of Donabedian's model and are only used for risk adjustment in this study. The combination of the study's structure, process, outcome, and confounding variable measures were consistent with Donabedian's recommendation to select measures of each element of structure, process, and outcomes in quality and assessment and to account for possible intervening variables. The application of Donabedian's theory to this research study is presented in Figure 2.

FIGURE 2: APPLICATION OF DONABEDIAN'S THEORY ON ELEMENTS OF STRUCTURE, PROCESS, AND OUTCOME (Donabedian, 1980)

Theory as applied to quality assessment for pediatric asthma hospitalizations



Note. As suggested by Donabedian, adjustments to the applied structure, process, and outcomes model were made for possible intervening variables. These variables were patient demographic characteristics (patient structure variables) that were supported in the literature review, such as patient age, patient race, patient gender, and patient severity of illness. Since these variables were only used for risk-adjustment purposes, they were not added to the applied model.

Patient Factors Related to Asthma Hospitalizations

Patient Age and Gender

Several studies have found a relationship between asthma hospitalizations and patient demographic characteristics of age and gender (Vollmer, Buist, & Osborne,1992; Hisnanick, Coddington, & Gergen, 1994; Senthilselvan, 1995; To, Dick, Feldman, & Hernandez, 1996). Most of these studies suggest that young children, or children under the age of 5, have the highest asthma hospitalization rates (Vollmer, Buist, & Osborne, 1992; Hisnanick, Coddington, & Gergen, 1994; Mitchell, Bland, & Thompson, 1994; To, Dick, Feldman, & Hernandez, 1996). Research has found that boys have higher number of asthma hospitalizations (Vollmer, Buist, & Osborne, 1992), but female gender may be associated with increased readmissions (Senthilselvan, 1995). Most of these studies have looked at trends in asthma hospitalizations, instead of factors associated with readmisions (Vollmer, Buist, & Osborne, 1992; Hisnanick, Coddington, & Gergen, 1994; To, Dick, Feldman, & Hernandez, 1996), and did not combine other process measures or characteristics such as insurance status or hospital size.

In their study of pediatric asthma admissions, readmission rates, and time between readmissions in Canada, To, Dick, Feldman, and Hernandez (1996) found that children ages 0 to 4 had significantly higher probabilities for asthma readmission than children between the ages of 5 and 17. The authors looked at hospital discharges from a sample of 28,646 children admitted for asthma in Ontario. The six month probability of asthma readmission for children of ages 0

to 4 were 20%, and 11.7% for children ages 5 to 17. One year probabilities for readmission were 25.9% for those ages 0 to 4 and 17.4 for those of ages 5 to 17 ($p < .001$). Race, hospital variables, and patient treatments were not measured in this study.

Hisnanick, Coddington, and Gergen (1994) studied trends in asthma and asthma-related hospitalizations for 5,889 American Indian and Alaskan Native children cared for by the Indian Health Service. The authors found that children ages 0 to 4 had the most asthma hospitalizations. This study did not compare these children to children of other races and did not look at insurance status, patient treatments, and time between readmissions.

Vollmer, Buist, and Osborne (1992) looked at trends of asthma hospitalizations among 310,000 HMO enrollees and found that boys under the age of five years had the most significant increase in asthma hospitalization rates. Also, rates for boys ages 0 to 14 exceeded the rate for girls in that same age group. The study sample was limited to HMO enrollees and did not measure readmissions, or include other types of insurance categories.

Mitchell, Bland, and Thompson (1994) looked at risk factors for pediatric asthma readmissions in Canada. The sample included 1,034 children admitted for asthma and were followed up to 33 months. The study found that factors associated with readmissions included female gender, more previous hospitalizations, and age under 5 years . The study also measured other clinical variables such as duration of wheeze, respiratory rate, intravenous treatment, use of steroids, theophylline, and antibiotics, beta-agonists, whether there was a

written action plan in the patient's medical record, and follow-up with a general practitioner, pediatrician, or asthma clinic. This study did not measure race, socioeconomic status or time between readmissions.

In examining the effect of readmissions on increased hospital admission rates for Canadian children over the age of 5 with asthma, Senthilselvan (1995) found that female gender was associated with increased readmissions. The sample included children admitted for asthma in 134 hospitals. This study also found that girls ages 10 to 14 had the highest readmission rates for asthma, even though boys between the ages of 10 and 14 had higher hospital admission rates than girls in this age group. This study did not look at children under age 5 and did not measure hospital factors or treatment variables.

Patient Race, Insurance Status or Socioeconomic Status

Previous research suggests that non-white children, such as African-Americans or Asian-Americans, may have more asthma hospitalizations (Lozano, Connell, & Koepsell, 1995; Calmes, Leake, & Carlise, 1998; Goodman, Stukel, & Chang, 1998). These studies did not combine hospital characteristics, with insurance or race to determine risk factors associated with pediatric asthma readmissions. Children in poverty or who have Medicaid insurance may have more asthma hospitalizations (Halfon & Newacheck, 1993; Apter, Reisine, Kennedy, Cromley, Keener, Zu, & Wallack,1997). It is not clear whether race combined with low socioeconomic status or public insurance affects asthma outcomes. More research is needed to determine if hospital characteristics,

patient structure factors of insurance status or socioeconomic status affects pediatric asthma readmissions, while controlling for race.

Calmes, Leake, and Carlise (1998) studied factors associated with adverse asthma outcomes in California and concluded that Asian-Pacific American children were more likely to have adverse outcomes, measured by intubation, cardiopulmonary arrest, or death than white children. The sample included 113,974 pediatric asthma discharges from acute care hospitals in California. The authors suggested that adolescent children and children who had a secondary diagnosis of pneumonia were more likely to have adverse asthma outcomes. Gender and insurance were not associated with adverse asthma outcomes in this study. This study did not measure asthma readmissions or hospital characteristics.

Goodman, Stukel, and Chang (1998) looked at patient characteristics and regional trends in pediatric asthma hospitalization rates and found an increase in asthma hospitalization rates among Black and Hispanic children. The sample included 374,718 children discharged for asthma in hospitals from four states, New York, New Hampshire, Maine, and Vermont. They determined that most of the Black and Hispanic children hospitalized for asthma had Medicaid or self-pay as a payor source. The authors also noted a decrease in asthma discharge rates among white children. The study was limited since it did not measure readmissions and used a regional sample.

Lozano, Connell, and Koepsell (1995) studied asthma inpatient, emergency room, and outpatient utilization of health services for pediatric asthma

for children with Medicaid in the state of Washington. The sample included 576 African-American children and 1,369 White children who received services for asthma. This study concluded that African-American children were 1.7 times more likely than white children to have emergency room visits, and were 1.42 times more likely to be hospitalized for asthma. The researchers also found that African-American children were half as likely to have an office visit for asthma than white children, but they did not measure severity of illness and did not include children with other insurance types or measure readmissions.

Halfon and Newacheck (1993) studied the impact of poverty and asthma utilization of health services, using the 1988 National Health Interview Survey on Child Health. The study found that 4.3% of children under the age of 17 had asthma and that poor children had a higher prevalence of asthma. Poor children had more hospitalizations, fewer office visits and more emergency room visits than non-poor children. The authors did not look at hospital factors or other patient factors, such as age or race, and did not measure asthma readmissions in this study.

Apter, Reisine, Kennedy, Cromley, Keener, Zu, and Wallack (1997) examined demographic factors associated with acute care and outpatient treatment sites for asthmatic children and adults, and concluded that those having public assistance, such as Medicaid, were more likely to be hospitalized. The sample included 1,455 patients with asthma who received services at the University of Connecticut Health Center. Also children with Medicaid were more likely to receive care in acute sites. Young age was a predictor of treatment in

hospitals and emergency rooms, but race and gender were not significant predictors of treatment sites. This study did not look at asthma readmissions or hospital factors.

Patient Severity of Illness

Past research studies have found that individual patient characteristics may affect outcomes of care (Desharnais, McMahon, Wroblewski, & Hogan, 1990; Iezonni, 1993). Risk-adjustment methods are often used in outcomes studies to account for individual patient characteristics that may affect outcomes of care. Adjustment methods can measure patient severity of illness and encompass patient co-morbidities and risk of mortality.

Various measures of severity of illness have been used in past studies of asthma readmissions. Past asthma studies have used clinical severity of illness measures often taken from the patient's medical record, such as the use of intravenous antibiotics, intensive care, or intubation (Mitchell, Bland, & Thompson ,1994; McArthur, Calpin, Parkin, & Feldman, 1996). But more general severity of illness or risk-adjusted measures, such as 3M's All Patient Refined-Diagnosis Related Groups (APR-DRGs), have been developed for hospital discharge databases. The APR-DRG severity of illness classification system encompasses a resource-based method for capturing patient severity of illness. APR-DRG assignment for a patient's discharge is determined by resource utilization, patient demographics and comorbidities. Past research has found that APR-DRGs were acceptable and reliable in predicting individual patient

outcomes, such as mortality (Landon, Iezzoni, Ash, Shwartz, Daley, Hughes & Mackiernan, 1996; Romano & Chan, 2000), but these studies did not focus on pediatric asthma readmissions. More study is needed to determine how controlling severity of illness using resource-based methods such as APR-DRGs affects the relationship between pediatric asthma readmissions and hospital and patient level structure and process variables.

Patient Utilization of Inhaled Steroids

Several studies have supported the relationship between the use of inhaled steroids and decreased asthma readmissions. Most of the studies on asthma readmissions and the use of inhaled steroids do not measure hospital characteristics, or other demographic characteristics, such as patient insurance status and socioeconomic status. More research is needed to determine if increased use of inhaled steroids is associated with asthma readmissions, and how this relationship is affected by the use of other patient and hospital structure or process factors.

McArthur, Calpin, Parkin, and Feldman (1996) examined factors associated with asthma readmissions in a Canadian children's hospital. The sample included 68 children admitted for asthma. The authors found that children who were prescribed prophylactic inhaled steroids at the time of discharge and children who were followed up by a pediatrician or pediatric pulmonologist, rather than a family practitioner, were less likely to be readmitted. Demographic variables such as age, sex, and disease severity, measured by

intubation and intensive care use were not significant predictors of asthma readmissions. This study did not measure socioeconomic status, hospital characteristics, or race.

Minkovitz, Andrews, and Serwint (1999) studied rehospitalization of children with asthma and found that prescriptions of asthma medications and multiple admissions were associated with more rehospitalizations. The study included a sample of 119 children with asthma who received services from an urban primary care clinic. The authors noted that among lower income children, increased asthma readmissions were associated with female gender, prescriptions of albuterol and cromolyn, presence of chronic condition and pulmonary consultations, having prescribed daily asthma medications, and having been intubated or hospitalized in an ICU. The authors suggested that disease severity, measured by intubation or ICU utilization, may be associated with increased readmissions for asthma. The study did not measure hospital characteristics, time between readmissions or use a resource-based method such as APR-DRGs to measure severity of illness.

Lieue, Quesenberry, Sorel, Mendoza, and Leong (1998) evaluated computer-based prediction models to identify HMO children ages 0 to14 who were at risk for future hospitalization and emergency room visits for asthma. The sample included 16,520 children with asthma enrolled in an HMO in California. The study found that prior hospitalizations 6 months before follow-up and having an oral steroid prescription were factors associated with increased risk of future hospitalization for asthma. Having a personal physician identified in the computer

was associated with decreased risk of hospitalization. This study did not measure hospital factors, compare other insurance types, and did not examine time between readmissions.

Previous Patient Hospitalizations for Asthma

History of previous asthma hospitalization could also affect asthma outcomes. Past studies suggest that children with previous hospitalizations for asthma are more likely to be readmitted (Mitchell, Bland, & Thompson, 1994; Lieue, Quesenberry, Sorel, Mendoza, & Leong, 1998; Minkovitz, Andrews, & Serwint, 1999). But these studies did not combine measures of hospital characteristics, severity of illness using APR-DRGs, or race in evaluating asthma outcomes. Further study is needed to determine if previous hospitalization is a predictor of asthma readmission when combined with other structure and process factors.

Hospital Characteristics (Hospital Structure and Process Factors- Hospital Size, Volume and Length of Stay)

Past studies have revealed a relationship between hospital characteristics and outcomes of care (Hughes, Hunt & Luft, 1987; Thomas & Holloway, 1991; Keeler et al., 1992). Past research suggests that large hospitals and teaching hospitals may have lower mortality rates (Keeler et al., 1992) and hospitals with more surgical volume may also have better outcomes (Hughes, Hunt & Luft,

1987), but these studies were mainly focused on adult hospitals. In contrast to having better mortality outcomes, another study found that patients admitted to larger, teaching hospitals have increased risk of readmission (Thomas & Holloway, 1991). Several studies on pediatric asthma which have included average length of stay and average charges along with hospital characteristics, but these studies did not examine asthma readmissions (Samuels, Novack, Martin, & Connell,1998; Meurer, Kuhn, George, Yauck & Layde,1998). More study is needed to combine hospital and patient structure variables with process measures to examine pediatric asthma readmissions.

Keeler et al., (1992) compared hospital characteristics and quality of care, at different types of hospitals, using 297 hospitals in their sample. The sample included 14,0008 adult patients with one of five conditions, such as acute myocardial infarction, pneumonia, stroke, congestive heart failure, and hip fracture. The study found that larger, teaching, and urban hospitals have better mortality rates or quality than small, non-teaching, and rural hospitals. They used data abstracted from medical records to evaluate the effects of prospective payment on quality of care for hospitalized Medicare patients. Hospitals in five states were sampled and patients were randomly sampled from those with five diseases selected for the study. The outcome measure used was mortality within 30 days of admission, adjusted for sickness at admission. In examining the quality of care, this study did not look at readmissions, asthma hospitalizations, other process and treatment variables, and did not include children's hospitals.

Thomas and Holloway (1991) reviewed the relationship between hospital and patient factors and early readmission, or readmission within 31 days or shortly after a previous discharge, using various hospitals and select Diagnostic-Related-Groups (DRGs). The sample included discharges from 18 acute care hospitals. The study found that large hospitals and teaching hospitals had increased risk of readmission and were in need of better discharge planning to prevent early readmissions. Hospital location (urban or rural), occupancy levels, and patient demographic factors such as age, sex and race were not consistent significant predictors of readmission. Severity of illness and case complexity, measured by disease staging indicators and clinical patient management categories, were also risk factors for early readmission for selected DRGs; higher severity was associated with increased risk of early readmission. The study suggested that hospital characteristics and patient clinical factors were risk factors for early readmission, so that better discharge planning, support, and improved medical care may be needed to reduce readmissions. This study used adult hospitals, did not examine treatments used or previous hospitalizations, and did not measure time between readmissions.

Hughes, Hunt, and Luft (1987) have examined the relationship between hospital surgical volume, physician volume and patient outcomes for surgical patients. The sample included 503,662 patient discharge abstracts from 757 hospitals. Higher hospital surgical volume was positively related to better outcomes, measured by lowered mortality rates. The study did not examine asthma readmissions, did not look at frequency of readmission in relation to

hospital volume, did not include children's hospitals, and only included surgical patients.

Samuels, Novack, Martin, and Connell (1998) compared length of stay for asthmatic children hospitalized at either a children's hospital, which was a teaching hospital, or a community hospital and found that length of stay was not significantly different between the two hospitals. The sample included 2,491 children hospitalized for asthma in Washington. But children who used public insurance had significantly longer length of stay than children who did not have public insurance. The authors noted that children from the children's hospital were significantly younger, more often male, used public insurance, and resided in low-income areas. This study did not look at treatment or medication utilization for asthma and did not measure asthma readmissions.

Meurer, Kuhn, George, Yauck and Layde (1998) examined charges for childhood asthma by hospital characteristics and concluded that average length of stay did not differ significantly by hospital type, but.average charges were higher at urban teaching hospitals compared with urban non-teaching hospitals. The sample included 28,545 children admitted for asthma to 735 acute care hospitals. This study did not look at other process characteristics such as treatment and medication utilization for asthma, and did not look at asthma readmissions for each hospital.

This research study attempted to support previous studies and determine the relationship between structure, process and outcomes for children with asthma, by testing Donabedian's theory as applied to quality assessment for

asthma, while accounting for patient demographic characteristics that may affect asthma outcomes. This study improved on the limitations of other studies on asthma readmissions because it combined selected hospital and patient factors that represented each element of structure, process, and outcome, and adjusted for additional possible confounding patient demographic variables that were suggested by the literature review. This study on asthma readmissions combined all elements in Donabedian's model by measuring specific structure factors, such as hospital characteristics of size, volume and insurance type (a measure of hospital reimbursement method), along with process factors, such as length of stay, previous admissions for asthma, and use of inhaled steroids during hospitalization, while controlling for patient demographic variables, such as age, race, gender, and severity of illness..

This research developed several multivariate models to predict asthma readmission, a common quality of care indicator, and applied Donabedian's model of the relationship between structure elements, process elements, outcome elements, and intervening variables in the development of these models. Tables 1 and 2 summarize the review of the literature on specific studies that look at the relationship between structure factors, process factors, and asthma outcomes.

Table 1 Overview of Literature Review on Structure Factors and Asthma Outcomes

Structure Factors and Findings	Study
Hospital Size:	
Larger hospitals- lower mortality	Keeler et al (1992)
Larger hospitals- higher readmission	Thomas & Holloway (1991)
Hospital Volume:	
Higher volume- better outcomes	Hughes, Hunt, & Luft (1987)
Insurance:	
Public assistance- more asthma admissions	Apter, Reisine, Kennedy, Cromley, Keener, Zu, & Wallack (1997)
Public payor- higher length of stay	Samuels, Novack, Martin, & Connell (1998)

Table 2 Overview of Literature Review on Process Factors and Asthma Outcomes

Process Factors and Findings	Study
Previous Admissions:	
More previous admissions- higher risk of asthma readmissions	Mitchell, Bland, & Thompson (1994); Lieu, Quesenberry, Sorel, Mendoza, & Leong (1998); Minkovitz, Andrews, & Serwint (1999)
Inhaled Steroid Use or Asthma Medications:	
Prescription of inhaled steroid at discharge- lower risk of asthma readmission	McArthur, Caplin, Parkin, & Feldman (1996)
Prescriptions of asthma medications at time of discharge- higher risk of asthma rehospitalization	Minkovitz, Andrews, & Serwint (1999)
Oral steroid prescription- higher risk of future hospitalization	Lieu, Quesenberry, Sorel, Mendoza, & Leong (1998);
Length of Stay:	
Asthma Length of Stay -higher for children with Public insurance	Samuels, Novack, Martin, & Connell (1998)
Average Length of Stay -not differ by hospital teaching status	Meurer, Kuhn, Goerge, Yauck, & Layde (1998)

CHAPTER III: METHODOLOGY

Introduction

This study examined the relationship between structure factors, process factors and asthma readmissions, and tested Donabedian's theory on the relationship between structure, process, and outcome variables. The study design, sample, variables, hypotheses, and methods used in the analysis are described in detail in this chapter.

Study Design

The study design was a retrospective cohort study design, an ex post facto or causal-comparative study, which utilized secondary data on children with asthma. This study design was used to find specific structure and process factors associated with pediatric asthma readmission using past data collected from a source organization. This design allows quick data retrieval for large amounts of information, and statistically significant associations and predictors of outcomes can be identified and described using secondary datasets.

Threats to Validity

There are several threats to the internal validity of the causal-comparative study, including lack of control for the independent variables drawn from the secondary datasets (Isaac & Michael, 1995). This study design did not allow for the manipulation of any independent variables so that cause and effect

relationships cannot be determined from this study (Babbie, 1992). Other unmeasured factors or combination of unmeasured factors may influence the dependent variable for asthma readmission, so the interpretation of study results may be limited.

Research Questions and Hypotheses

This study examined the relationship between structure factors, process factors, and pediatric asthma outcomes, measured by asthma readmission within one year of initial hospitalization for asthma, multiple asthma readmissions within one year, and readmission within 30 days of initial hospitalization. In order to determine these relationships, the following hypotheses were generated from the research questions presented previously:

Research Question 1: Are structure factors, such as insurance, hospital size, and hospital volume of annual admissions, associated with pediatric asthma readmissions?

Research Question 1A.: Is insurance type associated with pediatric asthma readmissions?

Hypothesis 1A1.: Children admitted for asthma with public insurance are more likely to be readmitted for asthma within one year than children admitted for asthma with private insurance.

Hypothesis 1A2.: Children admitted for asthma without private insurance or public insurance are more likely to be readmitted for asthma within one year than children admitted for asthma with private insurance.

Hypothesis 1A3.: Children admitted for asthma with public insurance are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with private insurance.

Hypothesis 1A4.: Children admitted for asthma without private insurance or public insurance are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with private insurance.

Hypothesis 1A5.: Children admitted for asthma with public insurance are more likely to be readmitted for asthma within 30 days than children admitted for asthma with private insurance.

Hypothesis 1A6.: Children admitted for asthma without private insurance or public insurance are more likely to be readmitted for asthma within 30 days than children admitted for asthma with private insurance.

Research Question 1B: Is hospital size associated with pediatric asthma readmissions?

Hypothesis 1B1.: Children admitted for asthma to medium-sized hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large-sized hospitals.

Hypothesis 1B2.: Children admitted for asthma to small-sized hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large-sized hospitals.

Hypothesis 1B3.: Children admitted for asthma to medium-sized hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large-sized hospitals.

Hypothesis 1B4.: Children admitted for asthma to small-sized hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large-sized hospitals.

Hypothesis 1B5.: Children admitted for asthma to medium-sized hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large-sized hospitals.

Hypothesis 1B6.: Children admitted for asthma to small-sized hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large-sized hospitals.

Research Question 1C.: Is hospital volume associated with pediatric asthma readmissions?

Hypothesis 1C1.: Children admitted for asthma to medium volume hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large volume hospitals.

Hypothesis 1C2.: Children admitted for asthma to small volume hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large volume hospitals.

Hypothesis 1C3.: Children admitted for asthma to medium volume hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large volume hospitals.

Hypothesis 1C4.: Children admitted for asthma to small volume hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large volume hospitals.

Hypothesis 1C5.: Children admitted for asthma to medium volume hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large volume hospitals.

Hypothesis 1C6.: Children admitted for asthma to small volume hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large volume hospitals.

Research Question 2: Are process factors, such as length of stay, previous admissions for asthma, and use of inhaled steroids during hospitalization associated with pediatric asthma readmissions?

Research Question 2A.: Is length of stay associated with pediatric asthma readmissions?

Hypothesis 2A1.: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma are more likely to be readmitted for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization.

Hypothesis 2A2.: Children admitted for asthma with a length of stay of five or more days during the initial hospitalization for asthma are more likely to be readmitted for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization.

Hypothesis 2A3.: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization.

Hypothesis 2A4.: Children admitted for asthma with a length of stay of five or more days during the initial hospitalization for asthma are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization.

Hypothesis 2A5.: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma are more likely to be readmitted for asthma within 30 days than children

admitted for asthma with a length of stay of one day during the initial hospitalization.

Hypothesis 2A6.: Children admitted for asthma with a length of stay of five or more days during the initial hospitalization for asthma are more likely to be readmitted for asthma within 30 days than children admitted for asthma with a length of stay of one day during the initial hospitalization.

Research Question 2B.: Is previous admission for asthma associated with pediatric asthma readmissions?

Hypothesis 2B1.: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year are more likely to be readmitted for asthma within one year than children admitted for asthma who did not have previous admissions for asthma.

Hypothesis 2B2.: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year are more likely to have multiple readmissions for asthma within one year than children admitted for asthma who did not have previous admissions for asthma.

Hypothesis 2B3.: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year are more likely to be readmitted for asthma within 30 days than

children admitted for asthma who did not have previous admissions for asthma.

Research Question 2C.: Is the use of inhaled steroids in hospitalization associated with pediatric asthma readmissions?

Hypothesis 2C1.: Children admitted for asthma who used inhaled steroids in the initial hospitalization for asthma are less likely to be readmitted for asthma within one year than children who did not use inhaled steroids in the initial hospitalization.

Hypothesis 2C2.: Children admitted for asthma who used inhaled steroids in the initial hospitalization for asthma are less likely to have multiple readmissions for asthma within one year than children who did not use inhaled steroids in the initial hospitalization.

Hypothesis 2C3.: Children admitted for asthma who used inhaled steroids in the initial hospitalization for asthma are less likely to be readmitted for asthma within 30 days than children who did not use inhaled steroids in the initial hospitalization.

Research Question 3.: Do structure factors and process factors interact to impact pediatric asthma readmissions?

Hypothesis 3A.: Structure factors and process factors will interact to impact the odds of a child being readmitted for asthma within one year.

Hypothesis 3B.: Structure factors and process factors will interact to impact the odds of a child having multiple readmissions for asthma within one year.

Hypothesis 3C.: Structure factors and process factors will interact to impact the odds of a child being readmitted for asthma within 30 days.

Study Variables and Definitions

In order to test hypotheses generated by the study's research questions, independent and dependent variables were defined using the elements available in the PHIS dataset and were selected to represent structure, process, and outcome indicators. Independent structure factors were hospital reimbursement method measured by insurance status, hospital size measured by the number of licensed beds, and hospital volume of annual admissions. Independent process factors were length of stay for initial hospitalization for pediatric asthma admissions, patient utilization of inhaled steroids and patient history of previous hospitalizations. Dependent outcome measures are asthma readmission within one year of initial hospitalization, multiple readmissions for asthma within one year, and asthma readmission within 30 days of initial hospitalization.

Variable definitions and detailed descriptions of the type of data, level of data for data analysis, source of data, valid values and other information for each of the independent and dependent variables are explained in more detail.

Definitions of Outcome or Dependent Variables:

Total number of pediatric asthma readmissions (Used to develop outcome measures for: Asthma Readmission Within One Year of Initial Asthma Hospitalization and for Multiple Asthma Readmissions Within One Year of Initial Asthma Hospitalization)

Type: Dependent variable/patient outcome variable/ratio, later grouped into nominal data with 2 categories: 1) readmission at least once for asthma within one year of initial hospitalization for asthma; and 2) Multiple asthma readmissions within one year, which means the child had at least 2 or more asthma readmissions within one year of initial hospitalization.

Definition: This is the total number of asthma hospitalizations for the patient within one year after the discharge date of the patient's initial hospitalization for asthma in the study period.

Source: PHIS database/ calculated for each patient in study

Total number of days between initial hospitalization and the first readmission (Measure for Readmission for Asthma within 30 Days)

Type: Dependent variable/patient outcome variable/ratio, later grouped into nominal data to indicate whether or not the child had a readmission for asthma within 30 days of the initial discharge date of the child's first hospitalization for asthma recorded in the study period.

Definition: This is the number of days between the date of the patient's initial hospitalization recorded for asthma in the study period and the first readmission date recorded for asthma

Source: PHIS database/ calculated for each patient readmitted in study

Definitions of Structure Variables:

Insurance status (Hospital Reimbursement Method)

Type: Independent variable/patient structure variable/nominal

Definition: This variable will indicate whether the child was enrolled or not enrolled in Public Insurance Programs, Private/Commercial Insurance Programs, or not enrolled in a Public or Private insurance program (Not Public or Private) at the time of the initial hospitalization after the beginning of the study period. Valid values are Public Insurance (Medicaid or other government or public sponsored insurance), Private Insurance Plans (commercial insurance), or Not Public or Private (self-pay or other payor categories, which are not Medicaid, not government or public sponsored, or not commercial insurance).

Source:PHIS database/ assigned insurance categories/ assigned for each patient in study

Hospital size

Type: Independent variable/hospital structure variable/nominal

Definition: This is the number of licensed beds for the hospital to which the child was admitted. This variable will categorize the hospitals into groups of large, medium, or small, based on the normal distribution of this variable. The methodology used for selection of hospital groups will be explained in the section describing the hospital sample.

Source: CHCA report of PHIS hospital characteristics

Hospital volume of admissions

Type: Independent variable/hospital structure variable/nominal

Definition: This is the estimated total number of hospital admissions for all diagnoses for all admissions in calendar year 1996, recorded by the PHIS hospital. This variable will categorize hospitals into high volume, medium volume, or small volume, based on the normal distribution of this variable. The methodology used for selection of hospital groups will be explained in the section describing the hospital sample.

Source: CHCA report of PHIS hospital characteristics

Definitions of Process Variables:

Length of stay for initial hospitalization for pediatric asthma

Type: Independent variable/process variable/ratio, later grouped into nominal

Definition: This is the total number of days of the patient's initial hospital stay. This variable will categorize hospitals into one of three categories:

length of stay for initial hospitalization less than one day, length of stay for initial hospitalization between two and four days, length of stay for initial hospitalization of five or more days.

Source: PHIS database/ calculated for each patient in study

Utilization of inhaled steroids

Type: Independent variable/patient process variable/nominal

Definition: This variable will indicate whether or not the patient was treated with inhaled steroids during the first recorded hospitalization of the study period. Valid values are yes (treated with inhaled steroids) or no (not treated with inhaled steroids)

Source: PHIS database/ assigned for each patient admitted for pediatric asthma in calendar year 1996.

Previous hospitalizations

Type: Independent variable/patient process variable/ratio, later grouped into nominal

Definition: This variable will show the number of times the patient was hospitalized for pediatric asthma in the previous year, within the last six months of calendar year 1995 (within 6 months prior to January 1, 1996, the begin date of study period). This variable will be grouped into 2 categories: No previous admissions within the last six months of the prior

year; or at least one previous admission within the last six months of the prior year.

Source: PHIS database/ assigned for each patient admitted for pediatric asthma in calendar year 1996.

Measures for Other Variables

This study included hypothesis tests to determine the relationship between structure and process factors and asthma readmissions, but the literature review presented other confounding variables that may affect outcomes of care, such as age, race, gender and severity of illness. Confounding variables, which are possible intervening variables according to Donabedian's theory, are variables that are not the main independent variables of interest, but are known variables that can affect asthma outcomes. The data available in the PHIS database made it possible to examine outcomes while controlling for the effects of confounding variables. As suggested by Donabedian's theory, variation in outcomes due to possible confounding variables, such as individual patient differences measured by the demographic variables of age, race, gender, and severity of illness, were considered in determining the relationship between structure, process, and outcomes for children admitted for asthma. Therefore, intervening variables, or patient characteristics of age, race, gender, and severity of illness, were statistically controlled or held constant, in developing the adjusted multivariate models to identify significant structure and process predictors of pediatric asthma readmissions and to test hypotheses. Groups developed for possible

confounding factors were categories suggested by the literature review, which included: patient age (nominal data/grouped into age categories of 0-4 years, 5-14, and over 14 years), patient gender (nominal data/ male or female), patient race (nominal data/ African American, White, or Other Race, such as Asian or Hispanic), and patient severity of illness (nominal data/ resource-based severity of illness measure using All Patient Refined Diagnostic Related Group (APR-DRG) classifications for severity of illness for minor, moderate, and major and extreme severity of illness, which was assigned by the source organization. Since very few asthma admissions in the sample had the APR-DRG extreme severity of illness classification, the major and extreme severity categories were combined for purposes of this study.

Population and Sample

Children included in this retrospective cohort study on asthma readmissions were selected from the hospitals that submitted discharges to the CHCA Pediatric Health Information System database in calendar year 1996. There were 26 hospitals that submitted data to PHIS in 1996. The PHIS database was reviewed to determine which hospitals in the population of 26 PHIS hospitals met the criteria for inclusion in this study. In order to be included in this study, the PHIS hospitals had to have submitted complete information for all 1996 discharges for the following data elements: insurance status, principal diagnosis, admission date, discharge date, discharge disposition (for mortality), comorbidites (for determining the APR-DRG severity of illness group), age, race, gender, hospitalization charges, use of inhaled steroids during hospitalization,

masked medical record identifier, hospital size, and hospital volume of annual admissions. Out of the 26 PHIS hospitals, only 21 hospitals (80%) met the study criteria and were used in the sample because five hospitals had incomplete information on one or more of the variables used in this study.

Sample Characteristics of Hospitals Included in the Study

This study used a sample of 21 hospitals to select asthma admissions in 1996 for the study cohort. These hospitals varied in hospital size and hospital volume of annual admissions. In order to compare asthma readmissions for each child admitted for asthma by the hospital volume and hospital size, hospitals were stratified into several categories. Hospital size and volume categories were determined by the distribution of hospital data and on the ranges of volume of annual admissions and number of licensed beds for the 21 hospitals included in the study. These categories were created to assure that there were fairly even distributions of PHIS hospitals in each group, to assure that no hospital size or volume category had less than five hospitals in each hospital group, and to protect the PHIS hospital's identity.

Hospital size, as measured by the number of licensed beds in the hospital, was divided into 3 categories: large-sized (235-283 licensed beds), medium-sized hospitals (192-222 licensed beds), and small-sized hospitals (100-180 licensed beds). There were seven small, eight medium, and six large hospitals, based on the number of licensed beds. The hospital sample by hospital size is presented in Table 3.

Table 3 Hospital Sample by Hospital Size (N=21)

Hospital Size Category	Range of Number of Licensed Beds	Total Number of Hospitals in Sample
Small Size	100-180	7
Medium Size	192-222	8
Large Size	235-283	6

Estimated total number of annual admissions ranged from 4,800 annual admissions to 17,476 annual admissions for the entire sample of hospitals. Hospital volume of annual admissions was divided into 3 categories: low volume of annual admissions (4,800-7,871 estimated annual admissions), medium volume of annual admissions (8,022-9,717 estimated annual admissions), and high volume of annual admissions (10,507-17,476 estimated annual admissions). There were eight low volume, six medium volume, and seven high volume hospitals, based on estimated annual hospital admissions. The hospital sample by hospital volume is presented in Table 4.

Asthma admissions made up a significant portion of total annual admissions for all diagnoses for the hospitals included in this sample. Asthma admissions as a percent of total volume of annual admissions for all diagnoses ranged from 1.2% to 9.7% for high volume hospitals; 2.5% to 6.6% for medium volume hospitals, and 2.2% to 16.9% for low volume hospitals. Low volume hospitals had the highest average percent of asthma admissions (6.9%). Asthma as a percent of total volume of admissions was 5% for high volume hospitals, and average percent of total admissions for asthma in medium volume hospitals was the lowest at 4%.

Table 4 Hospital Sample by Hospital Volume (N=21)

Hospital Volume Category	Total Number of Hospitals in Sample	Range of Estimated Number of Annual Admissions	Range of Asthma Admissions as Percent of Annual Admissions
Low Volume	8	4800-7871	2.2%-16.9%
Medium Volume	6	8022-9717	2.5%-6.6%
High Volume	7	10507-17476	1.2%-9.7%

Results from the bivariate analysis, which used Chi-square tests of association, showed that hospital size and hospital volume were significantly related ($X^2 = 18.41$, df=4, $p<0.01$). This relationship was not surprising since the number of licensed beds at a hospital may depend on the number of patients served annually so that providers can plan accordingly, but this study used both variables since the literature considered them to be structure factors.

Sample Characteristics of Children Admitted for Asthma

Selection criteria used to determine the study cohort was based on age and principal diagnosis upon discharge, since the study used a hospital discharge database. Children selected for the study sample were all children between the ages of 0 and 17, which were the age ranges for children often used in the literature, who were admitted to a PHIS hospital in the hospital sample, who had at least one hospital discharge with a principal diagnosis of asthma, and who were discharged for asthma between January 1, 1996 and December 31, 1996. The first asthma discharge recorded in the database within this time period was considered to be the initial asthma admission in this study. These

discharges included hospitalizations of children whose principal diagnosis was coded using the Hospital International Classification of Diseases, Clinical Modification, 9th Revision (ICD-9-CM) or ICD-9-CM diagnosis codes of 493.01 or 493.91, which were both used to identify children with asthma or with status asthmaticus.

The number of children admitted for asthma in 1996 and percentages (rounded to the nearest whole percent) of children admitted for asthma by structure, process, and demographic characteristics are presented in Table 5, which shows the sample of children admitted for asthma in this study. There were 7,848 children admitted at least once for asthma in calendar year 1996. The sample included 10,045 total asthma hospitalizations between January 1, 1996 and December 31, 1997. The demographics for this sample of asthma admissions were similar to the demographics of the sample of asthma patients used in the study conducted by Calmes, D., Leake, B.D., & Carlisle, D.M. (1998), who studied adverse asthma outcomes in California hospitals. The majority of their sample were school aged children with public insurance.

In the present study, children admitted for asthma with public insurance, such as Medicaid, made up 46% of all asthma admissions in 1996. Only a third of the sample had private commercial insurance. Over 40% of children with asthma were admitted to hospitals with high volume of annual admissions. Also, 36% of children admitted for asthma were admitted to large-sized hospitals.

Most children (58%) admitted for asthma had an initial hospitalization length of stay between two and four days. The majority (87%) of children

admitted for asthma had no previous admissions in the last six months of calendar year 1995, and many children (86%) did not use inhaled steroids during the initial hospitalization.

About half (49%) of the children admitted for asthma in 1996 were in the 5-14 age group, and 44% were under the age of five. African-Americans made up 44% of asthma admissions, while Whites made up 37%. The majority of admissions were males (62%). Over 95% of asthma admissions had minor or moderate severity of illness rating.

Table 5 Sample of Children Admitted for Asthma in 1996 (N=7848)

Sample Characteristics for Children Admitted for Asthma (N=7848)	Total Children Admitted for Asthma	% of Total Children Admitted for Asthma
AGE		
0-4 Years	3468	44%
5 to 14 Years	3879	49%
Over 14 Years	501	6%
RACE		
White	2908	37%
Black	3442	44%
Other	1498	19%
GENDER		
Male	4871	62%
Female	2977	38%
SEVERITY OF ILLNESS		
Minor Severity	5765	73%
Moderate	1722	22%
Major/ Extreme	361	5%
INSURANCE		
Private	2625	33%
Public	3560	45%
Not Public or Private	1663	21%
HOSPITAL SIZE (LICENSED BEDS)		
Large Bed Size	2831	36%
Medium Bed Size	2619	33%
Small Bed Size	2398	31%
HOSPITAL VOLUME (ANNUAL ADMISSIONS)		
High Volume	3362	43%
Medium Volume	1723	22%
Low Volume	2763	35%
LENGTH OF STAY (LOS)		
LOS 1 Day	2428	31%
LOS 2-4 Days	4588	58%
LOS Over 5 Days	832	11%
PREVIOUS ADMISSIONS (6 Months)		
No Previous Admissions	6857	87%
One or More Previous Admissions	991	13%
INHALED STEROID USE		
Did Not Use Inhaled Steroids	6788	86%
Used Inhaled Steroids in Hospitalization	1060	14%

Method of Data Collection

The source of the secondary dataset analyzed in this study was the Child Health Corporation of America (CHCA) Pediatric Health Information System (PHIS) database, a database which contains hospital discharges and other information voluntarily submitted by children's hospitals in the United States. Children's hospitals that submit data to PHIS must comply with CHCA's data submission policies to ensure confidentiality, consistent data collection, format, and definitions, and to provide reliable and accurate data before adding the information to the PHIS on-line database. The source organization's data submission process requires standardization of data collection and a verification and edit process to ensure data quality. PHIS staff members provide system support for this process and for database use. Children's hospitals that submit data to PHIS are notified immediately of any problems that occur and sign forms that verify final approval of the data submission.

Masked discharge identification keys and masked medical record numbers were applied to the dataset by the source organization before the data was released to PHIS database users. All variables needed for this study, such as patient demographics, medications, discharge information, hospital volume of annual admissions, and hospital size, were available from the source organization. The list of discharge data elements extracted from the PHIS discharge database and the purpose of each variable are presented in the Appendix in the form for the External Use of Data Request for use of PHIS data.

Procedure

In order to examine the factors associated with asthma readmission for the study cohort, the researcher obtained a raw dataset from the source organization and analyzed hospital and discharge data to match definitions and categories defined in this study. The sample unit used in the analysis for this study was the child, who had at least one hospital discharge for asthma in calendar year 1996. The PHIS hospital discharge files contained a masked patient identifier, which allowed for the tracing of individual patients with asthma readmissions. Index cases were defined as the first hospital discharge for asthma in 1996 for the child.

To determine if the child had any readmissions for asthma and to determine the number of days until the child's first readmission for asthma, the masked patient identifier was linked to subsequent hospital admissions for asthma recorded during the study period. Matched discharge records resulting from these links and the total number of asthma hospitalizations were recorded for each child. Each child was classified as being readmitted or not readmitted within one year of initial hospitalization. A child was readmitted within one year of initial hospitalization if the number of days between the index hospitalization discharge date and the admission date of the first subsequent asthma discharge was less than 365 days.

For those readmitted at least once, the child was classified as having only one readmission within one year of initial hospitalization or multiple readmissions for asthma, which means the child had two or more readmissions within one year

of initial hospitalization. The readmitted child was also classified as being readmitted within 30 days of initial hospitalization or not being readmitted within 30 days of initial hospitalization. Children who were not readmitted were classified as not having multiple readmissions and were also classified as not being readmitted within 30 days.

Previous admissions for asthma for each child in the study cohort were determined by linking the masked medical record number to previous hospital discharges for asthma between June 1, 1995 and December 31, 1995. The previous admissions variable for asthma was determined by recording the number of hospitalizations the patient had for pediatric asthma within the last six months of the previous year (within the last six months of calendar year 1995). If the child had previous hospital discharge records linked, then the child was classified as having previous asthma admissions. If the child did not have any previous records linked for the last six months of calendar year 1995, then the child was classified as not having previous admissions for asthma. The PHIS database also provided treatment information to indicate whether or not the patient received inhaled steroids during each hospitalization. If the index hospitalization showed that the child received inhaled steroids during the index hospitalization, then the child was classified as using inhaled steroids during the initial hospitalization for asthma.

Several calculations were needed to assign subjects to categories for data analysis. Total patient admissions and readmissions for asthma, total days between the initial hospitalization and the first readmission for pediatric asthma,

and length of stay for initial hospitalization for pediatric asthma were calculated, using the definitions discussed previously. From these calculations, categories for structure, process, and outcome variables were assigned for each child. Outcome categories were assigned for: asthma readmission within one year, multiple readmissions for asthma within one year, asthma readmission within 30 days of initial hospitalization. Using definitions of categories presented previously, structure and process categories for hospital size, hospital volume, length of stay for initial hospitalization, previous admissions, and insurance type were assigned, as well as categories for patient characteristics, such as patient age and race. Gender groups were already indicated in the discharge dataset.

To control for patient differences and comorbidities in analyzing health outcomes and to consider sicker patients admitted for asthma, the PHIS discharge dataset includes severity of illness APR-DRG classifications for each patient discharge record. The patient discharge APR-DRG severity of illness classification is calculated by the source organization and stored in the dataset. APR-DRG classifications, developed by 3M Health Care, are often used in hospital discharge datasets. The APR-DRG methodology has been found to be acceptable and reliable in predicting individual patient outcomes, such as mortality (Landon, Iezzoni, Ash, Shwartz, Daley, Hughes & Mackiernan, 1996; Romano & Chan, 2000),.

APR-DRGs were developed to encompass severity of illness, risk of mortality and resource intensity. The methodology used to determine APR-DRG severity of illness classification for each hospital discharge is based on

information recorded on the discharge abstract. The APR-DRG classification system was developed as an expansion of the Diagnosis-Related Groups (DRG) classifications. This expansion added four subclasses to each DRG, addressing the patient differences in severity of illness and risk of mortality by considering the patient's secondary diagnoses or comorbidities. Severity of illness levels are numbered from 1 to 4 and classified as minor, moderate, major and extreme, and classifications may differ according to whether the APR-DRG is medical or surgical. Determining the severity of illness or risk of mortality subclass of a patient is done in three phases. The first phase determines the level of each secondary diagnosis. Then the patient is assigned to a base subclass for the secondary diagnosis. In phase three, the final subclass is determined by considering the impact of the principal diagnosis, age, non-operating room procedures, and the combinations of secondary diagnosis categories. The APR-DRG assignment was applied to each hospital discharge by the source organization, before the discharge data was released for this study.

Statistics and Data Analysis

In order to analyze the dataset, completeness of data was reviewed for each variable in the study. Frequency of data was analyzed for all nominal level variables, and means, medians, modes, standard deviations, and ranges were calculated for all ratio level independent variables. Normality of the data was determined by examining the distribution of the data. Categories for variables were collapsed into defined groups and established after frequencies were calculated for the dataset. Reference groups for comparison of readmission of children by specific subgroups were based on reference categories found in the literature review.

Bivariate analysis using Chi-square tests for association was performed to determine significant associations between structure variables and asthma readmissions, process variables and asthma readmissions, and demographic variables and asthma readmissions. As part of the study's additional data analysis and post-hoc analysis, Pearson's r statistics were calculated to determine associations between initial asthma hospitalization charges and total asthma admissions and between initial asthma hospitalization charges and the number of days between the initial hospital discharge and first asthma readmission. Hospital charges, which were not measured as a process factor in this study, often reflect resource utilization which was already captured by other process factors in Donabedian's applied model for length of stay and medication use during the hospitalization. Multivariate analysis using logistic regression was performed to develop three separate models identifying significant predictors for

each asthma outcome measure (asthma readmission within one year, multiple asthma readmissions within one year, and readmission within 30 days of initial hospitalization). Unadjusted and adjusted models were developed to compare significant unadjusted and adjusted odds of readmission for each structure and process variable and were used to test Donabedian's theory. Unadjusted odds ratios were calculated for each independent variable to determine significant predictors of asthma readmission without adding covariates to the models. Adjusted odds ratios of readmission, which controlled for the effect of other structure and process variables and other possible confounding variables such as age, race, gender, and severity of illness, were calculated for each independent variable in each multivariate model. The results from the adjusted models were used to test hypotheses for structure and process variables. Additional logistic regression results from the multivariate adjusted models that showed the odds of readmission for each patient demographic variable were also reviewed to compare results for demographic factors to past studies, even though hypothesis tests were not developed for demographic variables.

Study Limitations

Limitations of this study were previously discussed in Chapter One. These limits included lack of control of independent variables, possible effects from unmeasured confounding factors, limited generalizability of findings, non-randomized sample selection, use of principal diagnosis of asthma, use of non

wage-adjusted hospital charges, and limits from using only hospital admissions to PHIS hospitals for the study time period.

Human Subjects Review

The researcher has taken strict measures to protect the anonymity of the hospitals and patients used in this study, regarding patient demographic, medical information and hospital discharge data. No patient contact was needed for this study. The PHIS computerized discharge dataset contained masked patient medical record numbers assigned by CHCA. The dataset used in this study did not include real patient identifiers, such as the patient's name, address information, social security number, true medical record number or account number. Also, each discharge in the PHIS discharge dataset contains a masked hospital identifier, known as the PHIS hospital number, which is assigned by CHCA. Therefore, the researcher did not need to identify or contact any patients used in this study. This dataset was used with permission from the CHCA, the source organization and Children's Hospital of The King's Daughters in Norfolk, Virginia (a CHCA PHIS hospital), where the data was accessed.

As recommended by CHCA, hospital categories were grouped according to the distribution of hospital size and volume of annual admissions for the 21 hospitals included in the study, and groups included at least five hospitals in each category, to protect the identity of individual CHCA hospitals. All discharge information, hospital information, and output from the data analyses were kept confidential. Masked medical record numbers and age groups were used to

protect the identity of children in the study cohort, since all analysis and comparisons were made at the patient level, using categories previously defined in this chapter. This data was secured through hospital network security at Children's Hospital of The King's Daughters in Norfolk and by computer passwords. Written permission to access the hospital network and computerized information from Children's Hospital of The King's Daughters and CHCA was requested and obtained before the study was conducted (see Appendix).

Approval of Study

Limited approval was obtained from CHCA for use of the PHIS data in the study. The PHIS approval committee made several recommendations to the study proposal and will review the results of this study before any publication.

The methodology for this study has been reviewed and approved by the Old Dominion University Human Subjects Committee as of August 1999 and the committee has granted approval to conduct the study. Please see the Appendix for letters from the Human Subjects committee and study recommendations from CHCA.

CHAPTER IV: RESULTS

Introduction

The results of data analysis are presented, including the frequency of asthma readmissions within one year, multiple asthma readmissions within one year, and readmission within 30 days of initial hospitalization for asthma. The frequencies and results of the bivariate analysis will be discussed for each asthma readmission measure. Hypothesis tests for each structure and process factor are presented with results from the multivariate analysis, which determined significant predictors of asthma readmissions.

Frequency of Asthma Readmissions

Out of the sample of 7,848 children admitted for asthma in 1996, 1,495 (19%) were readmitted at least once within one year of initial hospitalization. The majority of children (81%) admitted for asthma were not readmitted for asthma within one year of initial hospitalization. About six percent, or 436 of the children admitted for asthma had multiple readmissions for asthma within one year of initial hospitalization. Frequencies of total asthma admissions are presented in Table 6.

Table 6 Frequency of Asthma Admissions Within One Year (N=7848)

Total Asthma Admissions Within One Year	Frequency	Percent
1	6353	81.0%
2	1059	13.5%
3	299	3.8%
4	66	0.8%
5	41	0.5%
6	19	0.2%
7	9	0.1%
8	1	0.01%
9	1	0.01%
Total	**7848**	**100.0%**

Out of the sample of 7,848 children admitted for asthma, about two percent or 182 children were readmitted for asthma within 30 days of the initial discharge date for asthma. About 17% of children admitted for asthma were readmitted after 30 days of the initial discharge date for asthma. Out of the 1495 children readmitted for asthma, most children (40%) were readmitted between 6 months and 1 year of the initial discharge date for asthma, and only 12% of the children who were readmitted for asthma were readmitted within 30 days of initial discharge for asthma. Frequencies of total days until first readmission for asthma for those readmitted for asthma at least once within one year are presented in Table 7.

Table 7 Total Days Until First Readmission for Asthma (n=1495)

Total Days Until First Readmission	Frequency	Percent of Readmitted Children	Percent of All Asthma Patients
Less than 14 days	75	5%	1%
15-30 days	107	7%	1%
31-60 days	182	12%	2%
61-90 days	173	12%	2%
91-180 days	367	25%	5%
181-365 days	591	40%	8%
Total	**1495**	**100%**	**19%**

Frequency of Asthma Readmission Within One Year and Results of Bivariate Analysis

Frequencies of the number of children readmitted for asthma at least once within one year of initial hospitalization and the percent of children admitted for asthma in that subgroup who were readmitted within one year are shown in Table 8, along with the Chi-square results of the bivariate analysis. Only 16% of those admitted for asthma with private insurance were readmitted within one year, while 21% of those with public insurance were readmitted within one year. About 23% of those admitted to small-sized hospitals were readmitted within one year, while only 16% and 18% were readmitted to medium and large-sized hospitals respectively.

About 26% of children admitted with length of stay over five days were readmitted within one year, while only 15% of those admitted with one day length of stay were readmitted. Forty-three percent of children admitted with one or more previous asthma admissions were readmitted within one year, and 26% of

children admitted for asthma who used inhaled steroids in the initial hospitalization were readmitted.

About 24% of children over the age of 14 who were admitted for asthma were readmitted within one year, while only 19% of children ages 5 to 14 years who were admitted for asthma were readmitted and 18% of those under the age of five were readmitted. Twenty-three percent of African-American children admitted for asthma were readmitted within one year, and 20% of females in the sample were readmitted within one year. Only 18% of children with minor severity of illness admitted for asthma were readmitted within one year, while 23% of children with asthma with major or extreme severity of illness were readmitted within one year.

Chi-square tests for association were performed to determine significant independent associations between pediatric asthma readmission within one year and each structure variable, process variable, and demographic variable. From the bivariate analysis, asthma readmission within one year was significantly associated ($p<0.05$) with all structure variables, or insurance type, hospital bed size, and hospital volume of annual admissions. The bivariate analysis also revealed that asthma readmission within one year was significantly associated ($p<0.05$) with all process variables, or length of stay, previous admissions for asthma, and inhaled steroid use. The results for readmissions on this sample were similar to the study results on asthma rehospitalizations conducted by Minkovitz, Andrews, & Serwint (1999), since more children who used inhaled steroids were readmitted, as were females.

Table 8 Children Readmitted for Asthma Within One Year (n=1495)

	#	%	X^2
STRUCTURE VARIABLES			
INSURANCE			*29.91***
Private	411	16%	
Public	748	21%	
Not Public or Private	336	20%	
HOSPITAL SIZE (LICENSED BEDS)			*38.15***
Large Bed Size	521	18%	
Medium Bed Size	424	16%	
Small Bed Size	550	23%	
HOSPITAL VOLUME (ANNUAL ADMISSIONS)			*71.39***
High Volume	666	20%	
Medium Volume	212	12%	
Low Volume	617	22%	
PROCESS VARIABLES			
LENGTH OF STAY (LOS)			*50.57***
LOS 1 Day	374	15%	
LOS 2-4 Days	902	20%	
LOS Over 5 Days	219	26%	
PREVIOUS ADMISSIONS (6 Months)			*425.01***
No Previous Admissions	1068	16%	
One or More Previous Admissions	427	43%	
INHALED STEROID USE			*33.75***
Did Not Use Inhaled Steroids	1224	18%	
Used Inhaled Steroids in Hospitalization	271	26%	

*p<0.05
**p<0.01
Note. % is percent of children admitted for asthma in the subgroup who were readmitted within one year.

Frequency of Multiple Asthma Readmissions Within One Year and Results of Bivariate Analysis

Frequencies of the number of children who had multiple asthma readmissions within one year of initial hospitalization and the percent of children admitted for asthma in that subgroup who were readmitted multiple times within one year are shown in Table 9, along with the results of the bivariate analysis for each category. About seven percent of the children admitted for asthma with public insurance had multiple readmissions for asthma within one year, while only five percent of those with private insurance had multiple readmissions. Only three percent of children admitted to medium volume hospitals had multiple readmissions for asthma, and six percent of children admitted to high volume and low volume hospitals had multiple asthma readmissions within one year. The percent of children with multiple asthma readmissions within one year did not differ greatly by hospital size.

About nine percent of children admitted for asthma with length of stay over five days had multiple readmissions for asthma, compared to only four percent of children with only one day length of stay. Also 17% of those with previous admissions for asthma had multiple asthma readmissions, while only four percent of those without previous admissions in the last six months of the prior calendar year had multiple asthma readmissions. Eight percent of those who used inhaled steroids during the initial hospitalization had multiple readmissions for asthma, while five percent of those who did not use inhaled steroids had multiple asthma readmissions.

Only five percent of children with asthma under the age of five had multiple asthma readmissions within one year, while nine percent of children with asthma over the age of 14 had multiple readmissions. About seven percent of African-American children with asthma had multiple asthma readmissions, four percent of White children with asthma had multiple asthma readmissions. The percent of children with multiple asthma readmissions within one year did not differ greatly by gender or severity of illness.

Chi-square tests for association were performed to determine significant independent associations between multiple asthma readmissions within one year and each structure variable, process variable, and demographic variable. From the bivariate analysis, having multiple asthma readmissions within one year was significantly associated ($p<0.05$) with all structure variables, or insurance type, hospital bed size, and hospital volume of annual admissions. From the bivariate analysis, having multiple asthma readmissions within one year was significantly associated ($p<0.05$) with all process variables, or length of stay, previous admissions for asthma, and inhaled steroid use.

Table 9 Children With Multiple Asthma Readmissions Within One Year (n=436)

	#	%	X^2
STRUCTURE VARIABLES			
INSURANCE			*13.11***
Private	120	5%	
Public	234	7%	
Not Public or Private	82	5%	
HOSPITAL SIZE (LICENSED BEDS)			*6.33**
Large Bed Size	154	5%	
Medium Bed Size	127	5%	
Small Bed Size	155	6%	
HOSPITAL VOLUME (ANNUAL ADMISSIONS)			*24.69***
High Volume	211	6%	
Medium Volume	54	3%	
Low Volume	171	6%	
PROCESS VARIABLES			
LENGTH OF STAY (LOS)			*37.31***
LOS 1 Day	95	4%	
LOS 2-4 Days	262	6%	
LOS Over 5 Days	79	9%	
PREVIOUS ADMISSIONS (6 Months)			*285.78***
No Previous Admissions	267	4%	
One or More Previous Admissions	169	17%	
INHALED STEROID USE			*17.62***
Did Not Use Inhaled Steroids	348	5%	
Used Inhaled Steroids in Hospitalization	88	8%	

*$p<0.05$
**$p<0.01$
Note. % is percent of children admitted for asthma in the subgroup who were readmitted multiple times within one year.

Frequency of Asthma Readmissions Within 30 Days and Results of Bivariate Analysis

Frequencies of the number of children who were readmitted for asthma within 30 days of initial hospitalization and the percent of children admitted for asthma in that subgroup who were readmitted for asthma within 30 days of initial hospitalization are shown in Table 10, along with the results of the bivariate analysis for each category. Three percent of children admitted for asthma with public insurance were readmitted within 30 days, while only two percent of those admitted with private insurance were readmitted within 30 days. About one percent of children admitted for asthma to medium volume hospitals were readmitted within 30 days, while two percent and three percent were readmitted to high volume and low volume hospitals respectively. The percent of children admitted for asthma who were readmitted within 30 days did not differ greatly by hospital size.

About four percent of the children admitted for asthma with length of stay over five days were readmitted within 30 days of initial hospitalization, while two percent of those with one day length of stay were readmitted within 30 days. Only two percent of the children without previous admissions for asthma were readmitted within 30 days, but six percent of children with previous admissions for asthma were readmitted within 30 days. About three percent of those who used inhaled steroids in the initial hospitalization were readmitted within 30 days, and only two percent of those who did not use inhaled steroids were readmitted within that time frame.

Only two percent of children ages 5 to 14 admitted for asthma and two percent of children under the age of five admitted for asthma were readmitted within 30 days, while four percent of children over the age of 14 with asthma were readmitted within 30 days. About five percent of those children with major or extreme severity of illness were readmitted within 30 days, while only two percent of those with minor severity of illness were readmitted in that time frame. The percent of children with asthma readmitted within 30 days did not differ greatly by race or by gender.

Chi-square tests for association were performed to determine significant relationships between readmission within 30 days of the initial discharge date for asthma and each structure variable, process variable, and demographic variable. From the bivariate analysis, readmission within 30 days was significantly associated ($p<0.05$) with hospital volume of annual admissions, but not significantly associated with hospital size or insurance type. From the bivariate analysis, readmission within 30 days was significantly associated ($p<0.05$) with all process variables, or length of stay, previous admissions for asthma, and inhaled steroid use.

Table 10 Children Readmitted for Asthma Within 30 Days (n=182)

	#	%	X^2
STRUCTURE VARIABLES			
INSURANCE			*3.15*
Private	50	2%	
Public	92	3%	
Not Public or Private	40	2%	
HOSPITAL SIZE (LICENSED BEDS)			*2.88*
Large Bed Size	61	2%	
Medium Bed Size	55	2%	
Small Bed Size	66	3%	
HOSPITAL VOLUME (ANNUAL ADMISSIONS)			*9.31***
High Volume	81	2%	
Medium Volume	24	1%	
Low Volume	77	3%	
PROCESS VARIABLES			
LENGTH OF STAY (LOS)			*14.25***
LOS 1 Day	41	2%	
LOS 2-4 Days	108	2%	
LOS Over 5 Days	33	4%	
PREVIOUS ADMISSIONS (6 Months)			*66.14***
No Previous Admissions	123	2%	
One or More Previous Admissions	59	6%	
INHALED STEROID USE			*6.28**
Did Not Use Inhaled Steroids	146	2%	
Used Inhaled Steroids in Hospitalization	36	3%	

*$p<0.05$
**$p<0.01$
Note. % is percent of children admitted for asthma in the subgroup who were readmitted within 30 days.

Results of Multivariate Analysis

Multivariate analysis using logistic regression was performed to determine significant predictors of asthma readmission. To determine significant structure and process predictors of asthma readmission, adjusted odds ratios were calculated for asthma readmission within one year, multiple readmissions for asthma within one year and readmission within 30 days. Unadjusted models, which only included the independent variable and the asthma outcome variable in the models, were developed to compare unadjusted odds ratios to adjusted odds ratios and to review the impact of covariates on significant odds ratios in the adjusted models. All structure and process variables were entered as covariates, along with possible confounding patient demographic variables, in the adjusted multivariate models. The multivariate models yielded adjusted odds ratios for each structure and process variable and asthma readmission, while controlling for the effects of covariates on the relationship between each independent variable and the asthma outcome.

The multivariate analysis was used to determine if odds of asthma readmission were significantly different between children from various structure and process groups, using reference categories as the standard for comparison of subgroups at risk for asthma readmission. Reference categories used to compare significant odds ratios in the logistic regression analysis were based on subgroups of children often used as reference groups, as presented in the literature review. The results from the logistic regression analysis for the

adjusted models were used to test the hypotheses on the relationship between individual structure factors and asthma readmission outcomes and to test hypotheses on the relationship between individual process factors and asthma readmission outcomes. Both unadjusted and adjusted models were reviewed to test Donabedian's theory. All multivariate and bivariate calculations were completed using SPSS® statistical software.

Multivariate Results for Structure Factors

Insurance type was a significant predictor of asthma readmission within one year of initial hospitalization for asthma. Hospital volume of annual admissions was also a significant predictor of asthma readmission within one year. Hospital size was not a significant predictor of asthma readmission within one year.

Hospital volume of annual admissions was a significant predictor of multiple asthma readmissions within one year. Insurance type and hospital size were not significant predictors of having multiple asthma readmissions within one year.

Hospital volume of annual admissions was a significant predictor of readmission for asthma within 30 days of initial hospitalization. Insurance type and hospital size were not significant predictors of asthma readmission within 30 days. Adjusted odds ratios for structure factors and asthma readmissions are presented in Table 11.

Table 11 Adjusted Odds Ratios for Structure Factors (N=7848)

STRUCTURE VARIABLES	ASTHMA READMISSION WITHIN ONE YEAR Adjusted Odds Ratio 95% Confidence Intervals	MULTIPLE WITHIN ONE YEAR Adjusted Odds Ratio 95% Confidence Intervals	WITHIN 30 DAYS Adjusted Odds Ratio 95% Confidence Intervals
INSURANCE			
Private[a]			
Public	1.27** (1.10-1.47)	1.23 (0.96-1.57)	1.29 (0.89-1.88)
Not Public or Private	1.41** (1.18-1.68)	1.01 (0.74-1.33)	1.29 (0.82-2.04)
HOSPITAL SIZE (LICENSED BEDS)			
Large Bed Size[a]			
Medium Bed Size	0.92 (0.78-1.09)	1.12 (0.85-1.48)	1.11 (0.72-1.72)
Small Bed Size	1.23 (0.87-1.74)	1.30 (0.70-2.44)	1.02 (0.45-2.31)
HOSPITAL VOLUME (ANNUAL ADMISSIONS)			
High Volume[a]			
Medium Volume	0.62** (0.51-0.75)	0.49** (0.35-0.69)	0.55* (0.33-0.91)
Low Volume	1.00 (0.73-1.38)	0.80 (0.45-1.42)	1.14 (0.55-2.39)

[a] Reference group
* $p \leq 0.05$
** $p \leq 0.01$

Results of Hypotheses Tests for Insurance

The logistic regression models developed for asthma readmission within one year, multiple asthma readmissions, and readmission within 30 days for asthma produced significant adjusted odds for insurance and tested hypotheses generated from Research Question 1A: Is insurance type associated with pediatric asthma readmissions?

It was hypothesized in Hypothesis 1A1 that: Children admitted for asthma with public insurance are more likely to be readmitted for asthma within one year than children admitted for asthma with private insurance. The multivariate analysis yielded the following significant adjusted odds ratios for Public insurance: Children admitted with asthma with public insurance were more likely (OR=1.27; 95% CI, 1.10-1.47, p< 0.01) to be readmitted for asthma within one year than children with private insurance. *Therefore, this research supports this hypothesis.*

It was hypothesized in Hypothesis 1A2 that: Children admitted for asthma without private insurance or public insurance are more likely to be readmitted for asthma within one year than children admitted for asthma with private insurance. The multivariate analysis yielded the following significant adjusted odds ratios for the insurance category Not Public or Private: Children admitted with asthma without private insurance or public insurance (Not Public or Private) were more likely (OR=1.41; 95% CI, 1.18-1.68, p< 0.01) to be readmitted for asthma within one year than children with private insurance. *Therefore, this research supports this hypothesis.*

It was hypothesized in Hypothesis 1A3 that: Children admitted for asthma with public insurance are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with private insurance. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for insurance. *Therefore, this research does not support this hypothesis.*

It was hypothesized in Hypothesis 1A4 that: Children admitted for asthma without private insurance or public insurance are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with private insurance. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for insurance. *Therefore, this research does not support this hypothesis.*

It was hypothesized in Hypothesis 1A5 that: Children admitted for asthma with public insurance are more likely to be readmitted for asthma within 30 days than children admitted for asthma with private insurance. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for insurance. *Therefore, this research does not support this hypothesis.*

It was hypothesized in Hypothesis 1A6 that: Children admitted for asthma without private insurance or public insurance are more likely to be readmitted for asthma within 30 days than children admitted for asthma with private insurance. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for insurance. *Therefore, this research does not support this hypothesis.*

Results of Hypotheses Tests for Hospital Size

The logistic regression models developed for asthma readmission within one year, multiple asthma readmissions, and readmission within 30 days for asthma did not produce significant odds for hospital size and tested hypotheses generated from Research Question 1B: Is hospital size associated with pediatric asthma readmissions?

It was hypothesized in Hypothesis 1B1 that: Children admitted for asthma to medium-sized hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large-sized hospitals. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for hospital size. *Therefore, this research does not support this hypothesis.*

It was hypothesized in Hypothesis 1B2 that: Children admitted for asthma to small-sized hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large-sized hospitals. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for hospital size. *Therefore, this research does not support this hypothesis.*

It was hypothesized in Hypothesis 1B3 that: Children admitted for asthma to medium-sized hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large-sized hospitals. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for hospital size. *Therefore, this research does not support this hypothesis.*

It was hypothesized in Hypothesis 1B4 that: Children admitted for asthma to small-sized hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large-sized hospitals. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for hospital size. *This research does not support this hypothesis.*

It was hypothesized in Hypothesis 1B5 that: Children admitted for asthma to medium-sized hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large-sized hospitals. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for hospital size. *Therefore, this research does not support this hypothesis.*

It was hypothesized in Hypothesis 1B6 that: Children admitted for asthma to small-sized hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large-sized hospitals. The multivariate analysis did not yield significant odds ratios in testing this hypothesis for hospital size. *Therefore, this research does not support this hypothesis.*

Results of Hypotheses Tests for Hospital Volume of Annual Admissions

The logistic regression models developed for asthma readmission within one year, multiple asthma readmissions, and readmission within 30 days for asthma produced significant adjusted odds for hospital volume of annual admissions and tested hypotheses generated from Research Question 1C: Is hospital volume associated with pediatric asthma readmissions?

It was hypothesized in Hypothesis 1C1 that: Children admitted for asthma to medium volume hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large volume hospitals. The multivariate analysis yielded the following significant adjusted odds ratios for hospital volume: Children admitted for asthma to medium volume hospitals were less likely (OR=0.62; 95% CI, 0.51-0.75, p< 0.01) to be readmitted for asthma within one year than children admitted for asthma to large volume hospitals. *Therefore, this research supports this hypothesis.*

It was hypothesized in Hypothesis 1C2 that: Children admitted for asthma to small volume hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large volume hospitals. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for hospital volume. *Therefore, this research does not support this hypothesis.*

It was hypothesized in Hypothesis 1C3 that: Children admitted for asthma to medium volume hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large volume hospitals. The multivariate analysis yielded the following significant adjusted odds ratios for hospital volume: Children admitted for asthma to medium volume hospitals are less likely (OR=0.49; 95% CI, 035-0.69, p< 0.01) to have multiple readmissions for asthma within one year than children admitted for asthma to large volume hospitals. *Therefore, this research supports this hypothesis.*

It was hypothesized in Hypothesis 1C4 that: Children admitted for asthma to small volume hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large volume hospitals. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for hospital volume. *This research does not support this hypothesis.*

It was hypothesized in Hypothesis 1C5 that: Children admitted for asthma to medium volume hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large volume hospitals. The multivariate analysis yielded the following significant adjusted odds ratios for hospital volume: Children admitted for asthma to medium volume hospitals are less likely (OR=0.55; 95% CI, 0.33-0.91, $p< 0.05$) to be readmitted for asthma within 30 days than children admitted for asthma to large volume hospitals. *Therefore, this research supports this hypothesis.*

It was hypothesized in Hypothesis 1C6 that: Children admitted for asthma to small volume hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large volume hospitals. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for hospital volume. *Therefore, this research does not support this hypothesis.*

Multivariate Results for Process Factors

Length of Stay was a significant predictor of asthma readmission within one year of initial hospitalization. Having at least one previous admission for asthma within 6 months of the prior calendar year was also a significant predictor

of asthma readmission. The use of inhaled steroids in the initial hospitalization for asthma was a predictor of asthma readmission within one year.

Length of Stay was a significant predictor of having multiple asthma readmissions within one year of initial hospitalization. Having at least one previous admission for asthma within 6 months of the prior calendar year was also a significant predictor of having multiple asthma readmissions within one year. The use of inhaled steroids in the initial hospitalization for asthma was not a significant predictor of multiple asthma readmissions within one year.

Having at least one previous admission for asthma within 6 months of the prior calendar year was also a significant predictor of readmission for asthma within 30 days of the initial hospitalization. Length of stay and the use of inhaled steroids in the initial hospitalization for asthma were not significant predictors of readmission for asthma within 30 days. Adjusted odds ratios for process factors and asthma readmissions are presented in Table 12.

Table 12 Adjusted Odds Ratios for Process Factors (N=7848)

PROCESS VARIABLES	ASTHMA READMISSION		
	WITHIN ONE YEAR Adjusted Odds Ratio 95% Confidence Intervals	MULTIPLE WITHIN 1 YEAR Adjusted Odds Ratio 95% Confidence Intervals	WITHIN 30 DAYS Adjusted Odds Ratio 95% Confidence Intervals
LENGTH OF STAY (LOS)			
LOS 1 Day[a]			
LOS 2-4 Days	1.21** (1.05-1.39)	1.31* (1.02-1.69)	1.21 (0.83-1.76)
LOS Over 5 Days	1.66** (1.34-2.06)	2.10** (1.49-2.97)	1.6 (0.95-2.69)
PREVIOUS ADMISSIONS (6 Months)			
No Previous Admissions[a]			
One or More Previous Admissions	3.67** (3.17-4.24)	4.36** (3.52-5.39)	3.22** (2.32-4.48)
INHALED STEROID USE			
Did Not Use Inhaled Steroids[a]			
Used Inhaled Steroids in Hospitalization	1.32** (1.12-1.56)	1.20 (0.92-1.57)	1.25 (0.84-1.87)

[a] Reference group
* $p \leq 0.05$
** $p \leq 0.01$

Results of Hypotheses Tests for Length of Stay

The logistic regression models developed for asthma readmission within one year, multiple asthma readmissions, and readmission within 30 days for asthma produced significant odds for length of stay and tested hypotheses generated from Research Question 2A: Is length of stay associated with pediatric asthma readmissions?

It was hypothesized in Hypothesis 2A1 that: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma are more likely to be readmitted for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization. The multivariate analysis yielded the following significant adjusted odds ratios for length of stay between two and four days: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma were more likely (OR=1.21; 95% CI, 1.05-1.39, $p<0.01$) to be readmitted for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization. *Therefore, this research supports this hypothesis.*

It was hypothesized in Hypothesis 2A2 that: Children admitted for asthma with a length of stay of five or more days during the initial hospitalization for asthma are more likely to be readmitted for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization. The multivariate analysis yielded the following significant adjusted

odds ratios for length of stay of five or more days: Children admitted for asthma with a length of stay of five or more days during the initial hospitalization for asthma were more likely (OR=1.66; 95% CI, 1.34-2.06, p< 0.01) to be readmitted for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization. *Therefore, this research supports this hypothesis.*

It was hypothesized in Hypothesis 2A3 that: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization. The multivariate analysis yielded the following significant adjusted odds ratios for length of stay between two and four days: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma were more likely (OR=1.31; 95% CI, 1.02-1.69, p< 0.05) to have multiple asthma readmissions within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization. *Therefore, this research supports this hypothesis*

It was hypothesized in Hypothesis 2A4 that: Children admitted for asthma with a length of stay of five or more days during the initial hospitalization for asthma are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization. The multivariate analysis yielded the following significant adjusted odds ratios for length of stay of five or more days: Children admitted for

asthma with a length of stay of five or more days during the initial hospitalization for asthma were more likely (OR=2.10; 95% CI, 1.49-2.97, p< 0.01) to have multiple asthma readmissions within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization. *Therefore, this research supports this hypothesis*

It was hypothesized in Hypothesis 2A5 that: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma are more likely to be readmitted for asthma within 30 days than children admitted for asthma with a length of stay of one day during the initial hospitalization. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for length of stay. *This research does not support this hypothesis.*

It was hypothesized in Hypothesis 2A6 that: Children admitted for asthma with a length of stay of five or more days during the initial hospitalization for asthma are more likely to be readmitted for asthma within 30 days than children admitted for asthma with a length of stay of one day during the initial hospitalization. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for length of stay. *Therefore,this research does not support this hypothesis.*

Results of Hypotheses Tests for Previous Admission for Asthma

The logistic regression models developed for asthma readmission within one year, multiple asthma readmissions, and readmission within 30 days for

asthma produced significant odds for previous admission for asthma and tested hypotheses generated from Research Question 2B: Is previous admission for asthma associated with pediatric asthma readmissions?

It was hypothesized in Hypothesis 2B1 that: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year are more likely to be readmitted for asthma within one year than children admitted for asthma who did not have previous admissions for asthma. The multivariate analysis yielded the following significant adjusted odds ratios for previous asthma admissions: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year were more likely (OR=3.67; 95% CI, 3.17-4.24, $p< 0.01$) to be readmitted for asthma within one year than children admitted for asthma who did not have previous admissions for asthma. *Therefore, this research supports this hypothesis.*

It was hypothesized in Hypothesis 2B2 that: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year are more likely to have multiple readmissions for asthma within one year than children admitted for asthma who did not have previous admissions for asthma. The multivariate analysis yielded the following significant adjusted odds ratios for previous asthma admissions: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year were more likely (OR=4.36; 95% CI, 3.52-5.39, $p< 0.01$) to have multiple asthma readmissions within one year than children

admitted for asthma who did not have previous admissions for asthma. *Therefore, this research supports this hypothesis.*

It was hypothesized in Hypothesis 2B3 that: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year are more likely to be readmitted for asthma within 30 days than children admitted for asthma who did not have previous admissions for asthma. The multivariate analysis yielded the following significant adjusted odds ratios for previous asthma admissions: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year were more likely (OR=3.22; 95% CI, 2.32-4.48, $p< 0.01$) to be readmitted for asthma within 30 days than children admitted for asthma who did not have previous admissions for asthma. *Therefore, this research supports this hypothesis.*

Results of Hypotheses Tests for Inhaled Steroid Use In Hospitalization

The logistic regression models developed for asthma readmission within one year for asthma produced significant odds for previous admission for asthma and tested hypotheses generated from Research Question 2C: Is the use of inhaled steroids in hospitalization associated with pediatric asthma readmissions?

It was hypothesized in Hypothesis 2C1 that: Children admitted for asthma who used inhaled steroids in the initial hospitalization for asthma are less likely to be readmitted for asthma within one year than children who did not use inhaled

steroids in the initial hospitalization. The multivariate analysis yielded the following significant adjusted odds ratios for use of inhaled steroids during hospitalization, but also showed a positive relationship between use of inhaled steroids during the initial hospitalization and readmission for asthma within one year: Children admitted for asthma who used inhaled steroids in the initial hospitalization for asthma were more likely (OR=1.32; 95% CI, 1.12-1.56, p< 0.01) to be readmitted for asthma within one year than children who did not use inhaled steroids in the initial hospitalization. *Therefore, this research did not support this hypothesis, since the adjusted odds ratio was significant and greater than one, and results showed that children admitted for asthma who used inhaled steroids in hospitalization were more likely to be readmitted for asthma within one year of initial hospitalization.*

It was hypothesized in Hypothesis 2C2 that: Children admitted for asthma who used inhaled steroids in the initial hospitalization for asthma are less likely to have multiple readmissions for asthma within one year than children who did not use inhaled steroids in the initial hospitalization. The multivariate analysis did not yield significant adjusted odds ratios in testing this hypothesis for use of inhaled steroids during the initial hospitalization. *Therefore, this research did not support this hypothesis.*

It was hypothesized in Hypothesis 2C3 that: Children admitted for asthma who used inhaled steroids in the initial hospitalization for asthma are less likely to be readmitted for asthma within 30 days than children who did not use inhaled steroids in the initial hospitalization. The multivariate analysis did not yield

significant adjusted odds ratios in testing this hypothesis for use of inhaled steroids during the initial hospitalization. *Therefore, this research did not support this hypothesis.*

Multivariate Models and Analysis Used to Test Donabedian's Theory

In order to test Donabedian's theory to determine the impact of other intervening variables on asthma outcomes, this study compared significant unadjusted and adjusted odds ratios for each multivariate model developed to predict asthma readmission within one year, multiple asthma readmissions, and asthma readmission within 30 days.

Models for Asthma Readmission Within One Year

Significant unadjusted odds were calculated for several structure and process variables, without adjusting for other covariates, such as age, race, gender, severity of illness, and other structure or process variables in the unadjusted models used to determine the relationship between each independent variable and asthma readmission within one year. The unadjusted odds ratios for asthma readmission within one year were significant for: children admitted for asthma with public insurance or children without public or private insurance, children admitted for asthma to small-size hospitals, children admitted to medium-volume and low volume hospitals, children with length of stay of 2-4 days and children with length of stay over 5 days, children who had previous admissions, children who used inhaled steroids, children over the age of 14, African-American children, and children with moderate or major/extreme severity of illness. All of these groups were more likely to have asthma readmission within one year, except for children admitted for asthma to medium volume

hospitals who were less likely to have a readmission within one year of initial hospitalization.

But after entering all covariates in the adjusted model, controlling for the effects of covariates on asthma readmission or holding the other variables constant in the adjusted model, adjusted odds ratios for asthma readmission within one year were significant for: children admitted for asthma with public insurance or children with a Not Public or Private insurance type, children admitted for asthma to medium volume hospitals, children with length of stay of 2-4 days and children with length of stay over 5 days, children who had previous admissions, children who used inhaled steroids, African-American children, and female children admitted for asthma. After adjustments for covariates were made to the adjusted model for asthma readmission within one year, odds ratios were no longer significant for children admitted to small-sized hospitals, low-volume hospitals, children over the age of 14, and children with moderate or major/extreme severity of illness. Odds ratios for female gender became significant with adjustments for covariates. Unadjusted and adjusted odds ratios for this model is presented in Table 13. The adjusted model statistics for asthma readmission within one year were: R^2=0.065, X^2=526.18**, df=17.

Table 13 Structure and Process Predictors of Asthma Readmission Within One Year (N=7848)

Predictors of Asthma Readmission Within One Year	Unadjusted Odds Ratio 95% Confidence Intervals	Adjusted Odds Ratio 95% Confidence Intervals
STRUCTURE VARIABLES		
INSURANCE		
Private[a]		
Public	1.43** (1.25-1.63)	1.27** (1.10-1.47)
Not Public or Private	1.36** (1.16-1.60)	1.41** (1.18-1.68)
HOSPITAL SIZE (LICENSED BEDS)		
Large Bed Size[a]		
Medium Bed Size	0.85* (0.74-0.99)	0.92 (0.78-1.09)
Small Bed Size	1.32** (1.15-1.51)	1.23 (0.87-1.74)
HOSPITAL VOLUME (ANNUAL ADMISSIONS)		
High Volume[a]		
Medium Volume	0.56** (0.48-0.67)	0.62** (0.51-0.75)
Low Volume	1.16* (1.03-1.32)	1.00 (0.73-1.38)
PROCESS VARIABLES		
LENGTH OF STAY (LOS)		
LOS 1 Day[a]		
LOS 2-4 Days	1.35** (1.18-1.53)	1.21** (1.05-1.39)
LOS Over 5 Days	1.9** (1.62-2.37)	1.66** (1.34-2.06)
PREVIOUS ADMISSIONS (6 Months)		
No Previous Admissions[a]		
One or More Previous Admissions	4.10** (3.56-4.73)	3.67** (3.17-4.24)
INHALED STEROID USE		
Did Not Use Inhaled Steroids[a]		
Used Inhaled Steroids in Hospitalization	1.56** (1.34-1.82)	1.32** (1.12-1.56)

[a] Reference group
* $p \leq 0.05$
** $p \leq 0.01$

Models for Multiple Asthma Readmissions Within One Year

Without adjusting for covariates of age, race, gender, severity of illness, and other structure or process variables in the model, the unadjusted odds ratios for multiple asthma readmissions within one year were significant for: children admitted for asthma with public insurance, children admitted to medium-volume hospitals, children with length of stay of 2-4 days and children with length of stay over 5 days, children who had previous admissions, children who used inhaled steroids, children over the age of 14, and African-American. Since significant unadjusted odds ratios were calculated, without accounting for the effects of possible confounding variables, these subgroups were more likely to have multiple asthma readmissions within one year, except for children admitted for asthma to medium volume hospitals who were less likely to have multiple asthma readmissions within one year of initial hospitalization.

But after entering all covariates in the adjusted model, controlling for the effects of covariates or holding the other variables constant in the adjusted model, adjusted odds ratios for multiple asthma readmissions within one year were significant for: children admitted for asthma to medium volume hospitals, children with length of stay of 2-4 days and children with length of stay over 5 days, children who had previous admissions, African-American children, and children over the age of 14 admitted for asthma. After adjustments were made to this model, odds ratios were no longer significant for children admitted for asthma with public insurance and children who used inhaled steroids during the

initial hospitalization. Unadjusted and adjusted odds ratios for this model is presented in Table 14. The adjusted model statistics for multiple asthma readmissions within one year were: R^2=0.035, X^2=276.72**, df=17.

Table 14 Structure and Process Predictors of Multiple Asthma Readmissions Within One Year (N=7848)

Predictors of Multiple Asthma Readmissions Within One Year	Unadjusted Odds Ratio 95% Confidence	Adjusted Odds Ratio 95% Confidence
STRUCTURE VARIABLES		
INSURANCE		
Private[a]		
Public	1.47** (1.17-1.84)	1.23 (0.96-1.57)
Not Public or Private	1.08 (0.81-1.44)	1.01 (0.74-1.33)
HOSPITAL SIZE (LICENSED BEDS)		
Large Bed Size[a]		
Medium Bed Size	0.88 (0.69-1.12)	1.12 (0.85-1.48)
Small Bed Size	1.2 (0.95-1.51)	1.30 (0.70-2.44)
HOSPITAL VOLUME (ANNUAL ADMISSIONS)		
High Volume[a]		
Medium Volume	0.48** (0.36-0.65)	0.49** (0.35-0.69)
Low Volume	0.98 (0.80-1.21)	0.80 (0.45-1.42)
PROCESS VARIABLES		
LENGTH OF STAY (LOS)		
LOS 1 Day[a]		
LOS 2-4 Days	1.49** (1.17-1.89)	1.31* (1.02-1.69)
LOS Over 5 Days	2.58** (1.89-3.51)	2.10** (1.49-2.97)
PREVIOUS ADMISSIONS (6 Months)		
No Previous Admissions[a]		
One or More Previous Admissions	5.07** (4.13-6.23)	4.36** (3.52-5.39)
INHALED STEROID USE		
Did Not Use Inhaled Steroids[a]		
Used Inhaled Steroids in Hospitalization	1.67** (1.31-2.14)	1.20 (0.92-1.57)

[a] Reference group
* $p \leq 0.05$
** $p \leq 0.01$

Models for Asthma Readmission Within 30 Days

Without adjusting for covariates of age, race, gender, severity of illness, and other structure or process variables in the model, the unadjusted odds ratios for asthma readmission within 30 days of initial hospitalization were significant for: children admitted to medium-volume hospitals, children with length of stay over 5 days, children who had previous admissions, children who used inhaled steroids, children over the age of 14, and children with moderate severity of illness or major/extreme severity of illness. In the unadjusted model which did not control for the effects other variables, all of these groups were more likely to be readmitted within 30 days of initial hospitalization; children admitted for asthma to medium volume hospitals were less likely to have been readmitted within 30 days of initial hospitalization.

But after adjusting for all the covariates in the model, the adjusted odds ratios for asthma readmission within 30 days of the initial hospitalization were significant for: children admitted for asthma to medium volume hospitals, children who had previous admissions, and children with major/extreme severity of illness. After adjustments were made to this model, odds ratios were no longer significant for children with length of stay over 5 days, children who used inhaled steroids during the initial hospitalization, children over the age of 14, and children with moderate severity of illness. Unadjusted and adjusted odds ratios for this model is presented in Table 15. The adjusted model statistics for asthma readmission within 30 days were: R^2=0.011, X^2=83.81**, df=17.

Table 15 Structure and Process Predictors of Asthma Readmission Within 30 Days (N=7848)

Predictors of Asthma Readmission Within 30 Days	Unadjusted Odds Ratio 95% Confidence Intervals	Adjusted Odds Ratio 95% Confidence Intervals
STRUCTURE VARIABLES		
INSURANCE		
Private[a]		
Public	1.36 (0.96-1.93)	1.29 (0.89-1.88)
Not Public or Private	1.27 (0.83-1.93)	1.29 (0.82-2.04)
HOSPITAL SIZE (LICENSED BEDS)		
Large Bed Size[a]		
Medium Bed Size	0.97 (0.67-1.41)	1.11 (0.72-1.72)
Small Bed Size	1.28 (0.90-1.82)	1.02 (0.45-2.31)
HOSPITAL VOLUME (ANNUAL ADMISSIONS)		
High Volume[a]		
Medium Volume	0.57* (0.36-0.90)	0.55* (0.33-0.91)
Low Volume	1.16 (0.84-1.59)	1.14 (0.55-2.39)
PROCESS VARIABLES		
LENGTH OF STAY (LOS)		
LOS 1 Day[a]		
LOS 2-4 Days	1.40 (0.95-2.02)	1.21 (0.83-1.76)
LOS Over 5 Days	2.40** (1.51-3.82)	1.6 (0.95-2.69)
PREVIOUS ADMISSIONS (6 Months)		
No Previous Admissions[a]		
One or More Previous Admissions	3.46 (2.52-4.76)	3.22** (2.32-4.48)
INHALED STEROID USE		
Did Not Use Inhaled Steroids[a]		
Used Inhaled Steroids in Hospitalization	1.60* (1.10-2.32)	1.25 (0.84-1.87)

[a] Reference group
* $p \leq 0.05$
** $p \leq 0.01$

In addressing results for Research Question #3: Do structure factors and process factors interact to impact pediatric asthma readmissions?

It was hypothesized in Hypothesis 3A that: Structure factors and process factors will interact to impact the odds of a child being readmitted for asthma within one year.

It was hypothesized in Hypothesis 3B that: Structure factors and process factors will interact to impact the odds of a child having multiple readmissions for asthma within one year.

It was hypothesized in Hypothesis 3C that: Structure factors and process factors will interact to impact the odds of a child being readmitted for asthma within 30 days.

In testing Donabedian's theory, the results of this study showed differences in significant odds ratios for readmission for each independent variable, in comparing the results between the unadjusted and adjusted models. The differences in odds ratios between unadjusted and adjusted models may have resulted from interaction effects between demographic, structure and process variables. *Therefore, this research supports Hypothesis 3A, Hypothesis 3B, and Hypothesis 3C.*

The results of this study support these hypotheses and support Donabedian's theory that there is a relationship between structure, process, and outcomes, since the odds ratios for several variables changed in significance, after adjusting for covariates and other structure and process variables in each of the models for asthma readmission.

Other Multivariate Results (Demographic Variables, Charges and Asthma Readmission)

Even though hypothesis tests were only developed for structure and process factors and asthma readmission, additional post-hoc analysis and results from the bivariate and multivariate analysis were reviewed to compare past studies and determine the effects of possible confounding demographic variables on asthma outcomes for variables. Additional results from the covariates entered in the adjusted logistic regression models provided some information on the relationship between non-structure or non-process variables, such as patient demographic variables of age, race, gender and severity of illness, and asthma readmissions. Bivariate analysis of possible demographic confounding variables, suggested by the literature review, was performed to determine significant independent associations between patient demographic variables and asthma readmissions, before adding these possible confounding variables as covariates in the adjusted multivariate models. Female gender and African-American race were significantly associated ($p<0.05$) with asthma readmission within one year. Age over 14 years and African-American race were significantly associated ($p<0.05$) with having multiple asthma readmissions within one year, but gender and severity of illness were not significantly associated with having multiple asthma readmissions within one year. Severity of illness was significantly associated ($p<0.05$) with asthma readmission within 30 days, but other

demographic factors such as age, race, and gender were not significantly associated with asthma readmission within 30 days.

Since all independent variables and confounding variables were added to the multivariate models to obtain adjusted odds ratios for each of the independent structure and process variables in this study, adjusted odds ratios for confounding variables were also calculated. Several confounding variables or demographic variables used in this study were significant predictors of asthma readmission within one year, multiple asthma readmissions within one year and readmission for asthma within 30 days. The odds ratios for demographic variables, or confounding variables, may help identify children at risk for asthma readmission. African-American race and female gender were significant predictors of asthma readmission within one year. Age and severity of illness were not significant predictors of asthma readmission within one year. Age over 14 years and African-American race were significant predictors of having multiple readmissions within one year of initial hospitalization. Gender and severity of illness were not significant predictors of multiple asthma readmissions within one year. Major/extreme severity of illness was the only demographic predictor of asthma readmission within 30 days of initial hospitalization. Age, race, and gender were not significant predictors of asthma readmission within 30 days.

Since age, race, gender, and severity of illness were only confounding factors in the adjusted models and were not the structure or process variables of interest in this study, no hypothesis tests were conducted for these variables, given the results from the logistic regression analysis. The following results and

significant adjusted odds ratios were calculated for confounding variables from the adjusted models' results of the multivariate analysis:

African-American children admitted for asthma were more likely (OR=1.34; 95% CI, 1.17-1.55, p< 0.01) to be readmitted for asthma within one year than White children admitted for asthma.

Female children admitted for asthma were more likely (OR=1.14; 95% CI, 1.01-1.28, p< 0.05) to be readmitted for asthma within one year than male children admitted for asthma.

Children over the age of 14 admitted for asthma were more likely (OR=1.45; 95% CI, 1.02-2.06, p< 0.05) to have multiple readmission for asthma within one year than children ages 5 to 14 admitted for asthma.

African-American children admitted for asthma were more likely (OR=1.32; 95% CI, 1.02-1.69, p< 0.05) to have multiple readmission for asthma within one year than White children admitted for asthma.

Children with major/extreme severity of illness admitted for asthma were more likely (OR=1.95; 95% CI, 1.10-3.47, p< 0.05) to be readmitted within 30 days of initial hospitalization for asthma than children with minor severity of illness admitted for asthma.

As part of the post-hoc analysis, bivariate tests were also conducted for severity of illness and use of inhaled steroids, since inhaled steroids are often given in the hospital or emergency room based on the severity of the asthma attack. The APR-DRG severity of illness classification was significantly related to the use of inhaled steroids during hospitalization (X^2 = 14.41, df=2, p<0.01).

Bivariate tests for volume of admissions and insurance type also yielded a significant relationship (X^2 = 174.63, df=4, p<0.01). This relationship may need to be considered if children's hospitals with a larger volume of annual admissions serve more patients without commercial insurance.

Hospital charges may be related to process factors such as length of stay, use of inhaled steroids or other asthma medications. Since the patient's total hospital charges for the initial asthma admission was available in the PHIS dataset, a post-hoc analysis was done to determine if there was a significant relationship between initial asthma hospitalization charges and asthma readmission. To test this relationship, descriptive statistics and Pearson's r correlations were calculated. Descriptive statistics for charges and total asthma admissions are presented in Table 16.

Table 16 Descriptive Statistics for Initial Asthma Hospitalization Charges (N=7848)

RESULTS DESCRIPTIVE STATISTICS FOR CHARGES		MEAN	STANDARD DEVIATION	RANGE
All Children	$	5,435	8829.60	0-300658
Readmitted Children	$	6,080	9861.80	0-137268
Not Readmitted	$	5,283	8564.21	0-300658

Total charges for the initial hospitalization for asthma were significantly and positively correlated ($r=0.046$, $p<0.001$) with total admissions for each child admitted for asthma in 1996. Total charges for the initial hospitalization for asthma were also significantly and positively correlated ($r=0.06$, $p<0.05$) with total admissions for each child who was readmitted at least once for asthma. Total charges for the initial asthma hospitalization were significantly and negatively correlated ($r=-0.055$, $p<0.05$) with the total days between initial discharge and first readmission for each child readmitted for asthma. The total charges used in this study were not adjusted for the HCFA wage-price index that considers price variations and locations of the PHIS hospitals.

Summary of Data Analysis

The results of the data analysis showed significant relationships between structure factors, process, factors and asthma outcomes. After adjusting for the effects of other variables, structure factors that were predictors of asthma readmission and significantly associated with asthma readmission within one year were insurance type and hospital volume. Process factors significantly associated with asthma readmission within one year were length of stay, inhaled steroid use in hospitalization, and previous admissions for asthma. Structure and process factors associated with multiple asthma readmissions within one year were hospital volume, length of stay, and previous admissions for asthma. Structure and process factors significantly associated with readmission within 30 days were hospital volume of admissions and previous admissions for asthma.

The study results showed that at least one structure element and one process element were significant predictors of asthma readmission for each model developed to predict asthma outcomes. Hospital volume and previous admission for asthma were consistent and significant predictors of asthma readmission within one year of initial hospitalization, multiple asthma readmissions within one year, and asthma readmission within 30 days of initial hospitalization.

In examining significant predictors in both the unadjusted and adjusted models for asthma readmission, confounding demographic variables, structure and process factors interacted to impact the odds of asthma readmission within one year, multiple asthma readmissions within one year, and asthma readmission within 30 days, supporting Donabedian's theory. Summaries for the hypothesis tests for each research question are presented in Tables 17, 18, and 19.

Table 17 Summary of Hypotheses Tests for Structure Factors

Summary of Results of Hypotheses Tests for Structure Factors and Asthma Readmissions	Results Support
Research Question #1: Are structure factors, such as insurance, hospital size, and hospital volume of annual admissions, associated with pediatric asthma readmissions?	
Research Question 1A: Is insurance type associated with pediatric asthma readmissions?	
Hypothesis 1A1: Children admitted for asthma with public insurance are more likely to be readmitted for asthma within one year than children admitted for asthma with private insurance.	Yes
Hypothesis 1A2: Children admitted for asthma without private insurance or public insurance are more likely to be readmitted for asthma within one year than children admitted for asthma with private insurance.	Yes
Hypothesis 1A3: Children admitted for asthma with public insurance are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with private insurance.	No
Hypothesis 1A4: Children admitted for asthma without private insurance or public insurance are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with private insurance.	No
Hypothesis 1A5: Children admitted for asthma with public insurance are more likely to be readmitted for asthma within 30 days than children admitted for asthma with private insurance.	No
Hypothesis 1A6: Children admitted for asthma without private insurance or public insurance are more likely to be readmitted for asthma within 30 days than children admitted for asthma with private insurance.	No
Research Question 1B: Is hospital size associated with pediatric asthma readmissions?	
Hypothesis 1B1: Children admitted for asthma to medium-sized hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large-sized hospitals.	No
Hypothesis 1B2: Children admitted for asthma to small-sized hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large-sized hospitals.	No
Hypothesis 1B3: Children admitted for asthma to medium-sized hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large-sized hospitals.	No
Hypothesis 1B4: Children admitted for asthma to small-sized hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large-sized hospitals.	No
Hypothesis 1B5: Children admitted for asthma to medium-sized hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large-sized hospitals.	No
Hypothesis 1B6: Children admitted for asthma to small-sized hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large-sized hospitals.	No
Research Question 1C: Is hospital volume associated with pediatric asthma readmissions?	
Hypothesis 1C1: Children admitted for asthma to medium volume hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large volume hospitals.	Yes
Hypothesis 1C2: Children admitted for asthma to small volume hospitals are less likely to be readmitted for asthma within one year than children admitted for asthma to large volume hospitals.	No
Hypothesis 1C3: Children admitted for asthma to medium volume hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large volume hospitals.	Yes
Hypothesis 1C4: Children admitted for asthma to small volume hospitals are less likely to have multiple readmissions for asthma within one year than children admitted for asthma to large volume hospitals.	No
Hypothesis 1C5: Children admitted for asthma to medium volume hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large volume hospitals.	Yes
Hypothesis 1C6: Children admitted for asthma to small volume hospitals are less likely to be readmitted within 30 days than children admitted for asthma to large volume hospitals.	No

Table 18 Summary of Hypotheses Tests for Process Factors

Summary of Results of Hypotheses Tests for Process Factors and Asthma Readmissions	Results Support
Research Question #2: Are process factors, such as length of stay, previous admissions for asthma, and use of inhaled steroids during hospitalization associated with pediatric asthma readmissions?	
Research Question 2A: Is length of stay associated with pediatric asthma readmissions?	
Hypothesis 2A1: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma are more likely to be readmitted for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization.	Yes
Hypothesis 2A2: Children admitted for asthma with a length of stay of five or more days during the initial hospitalization for asthma are more likely to be readmitted for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization.	Yes
Hypothesis 2A3: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization.	Yes
Hypothesis 2A4: Children admitted for asthma with a length of stay of five or more days during the initial hospitalization for asthma are more likely to have multiple readmissions for asthma within one year than children admitted for asthma with a length of stay of one day during the initial hospitalization.	Yes
Hypothesis 2A5: Children admitted for asthma with a length of stay between two and four days during the initial hospitalization for asthma are more likely to be readmitted for asthma within 30 days than children admitted for asthma with a length of stay of one day during the initial hospitalization.	No
Hypothesis 2A6: Children admitted for asthma with a length of stay of five or more days during the initial hospitalization for asthma are more likely to be readmitted for asthma within 30 days than children admitted for asthma with a length of stay of one day during the initial hospitalization.	No
Research Question 2B: Is previous admission for asthma associated with pediatric asthma readmissions?	
Hypothesis 2B1: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year are more likely to be readmitted for asthma within one year than children admitted for asthma who did not have previous admissions for asthma.	Yes
Hypothesis 2B2: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year are more likely to have multiple readmissions for asthma within one year than children admitted for asthma who did not have previous admissions for asthma.	Yes
Hypothesis 2B3: Children admitted for asthma who had at least one previous admission for asthma in the last six months of the prior calendar year are more likely to be readmitted for asthma within 30 days than children admitted for asthma who did not have previous admissions for asthma.	Yes
Research Question 2C: Is the use of inhaled steroids in hospitalization associated with pediatric asthma readmissions?	
Hypothesis 2C1: Children admitted for asthma who used inhaled steroids in the initial hospitalization for asthma are less likely to be readmitted for asthma within one year than children who did not use inhaled steroids in the initial hospitalization.	No
Hypothesis 2C2: Children admitted for asthma who used inhaled steroids in the initial hospitalization for asthma are less likely to have multiple readmissions for asthma within one year than children who did not use inhaled steroids in the initial hospitalization.	No
Hypothesis 2C3: Children admitted for asthma who used inhaled steroids in the initial hospitalization for asthma are less likely to be readmitted for asthma within 30 days than children who did not use inhaled steroids in the initial hospitalization.	No

Table 19 Summary of Hypotheses Tests for Donabedian's Theory

Summary of Results of Hypotheses Tests for Donabedian's Theory and Hospital Charges	Results Support
Research Question #3: Do structure factors and process factors interact to impact pediatric asthma readmissions?	
Hypothesis 3A: Structure factors and process factors will interact to impact the odds of a child being readmitted for asthma within one year.	Yes
Hypothesis 3B: Structure factors and process factors will interact to impact the odds of a child having multiple readmissions for asthma within one year.	Yes
Hypothesis 3C: Structure factors and process factors will interact to impact the odds of a child being readmitted for asthma within 30 days.	Yes

CHAPTER V: CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Summary

The purpose of this research was to examine selected hospital and patient risk factors related to pediatric asthma readmissions, using Donabedian's framework for structure, process, and outcomes. This study used hospital discharges for asthma from 21 children's hospitals, which included 7,848 children admitted at least once for asthma in 1996. The results of this study showed that several structure and process factors were significantly associated with asthma readmissions and were also significant predictors of asthma readmission, measured by readmission for asthma within one year, multiple readmissions for asthma in 1 year, and asthma readmission within 30 days. These results can help policymakers and providers improve the quality of care for children with asthma, by identifying patients at risk for readmission and developing interventions to reduce preventable and costly hospitalizations.

Summary of Predictors of Asthma Readmission Within One Year

After adjusting for confounding factors, structure and process factors significantly associated with increased asthma readmission within one year were the type of payor, such as Medicaid or government sponsored insurance, self pay or other non-commercial insurance, longer length of stay, inhaled steroid use in hospitalization, and previous admissions for asthma. The volume of annual

hospital admissions was associated with asthma readmission within one year. Medium hospital volume of annual admissions was significantly associated with decreased risk of asthma readmission within one year of initial hospitalization. Hospital size was not a significant predictor of asthma readmission within one year.

Summary of Predictors of Multiple Asthma Readmissions Within One Year

Several factors were also significantly related to frequent asthma readmissions. Structure and process factors significantly associated with increased risk of multiple asthma readmissions within one year were longer length of stay and previous admissions for asthma. Medium hospital volume was associated with decreased risk of multiple asthma readmissions within one year. Hospital size, insurance type, use of inhaled steroids were not predictors of multiple asthma readmissions within one year.

Summary of Predictors of Asthma Readmission Within 30 Days

Only one structure factor and one process factor were significantly related to early readmission for asthma, or readmission within 30 days of being discharged from the initial asthma hospitalization. Structure and process factors associated with readmission within 30 days were hospital volume of admissions and previous admissions for asthma. Medium hospital volume was associated with decreased risk of asthma readmission within 30 days, while previous admission was associated with increased risk of asthma readmission within 30

days. Hospital size, insurance type, length of stay, and use of inhaled steroids were not significant predictors of readmission for asthma within 30 days.

Since the odds and significance of odds for asthma readmission changed between unadjusted and adjusted models, structure and process variables interacted to impact odds of asthma readmission, supporting Donabedian's theory that structure, process, and outcomes are related and that intervening variables may affect this relationship. From additional results of the logistic regression analysis, it was also found that several patient demographic factors were also significantly associated with pediatric asthma readmission, even though hypothesis tests only focused on structure and process variables in this study. African-American children admitted for asthma and females were also at risk for asthma readmission within one year. Children over the age of 14 with asthma and African-American children were at risk for multiple asthma readmissions within one year of initial hospitalization. Major and extreme APR-DRG severity of illness was also a predictor of asthma readmission within 30 days.

Support of Findings and Implications of Study

Structure Factors

Several structure factors, such as insurance type and hospital volume of annual admissions, were found to be significantly related to asthma readmissions, which confirm findings from previous research. Hospital size was

the only hospital structure factor that was not significantly associated with any of the asthma outcomes measured in this study.

This research found that children hospitalized for asthma without commercial insurance were more likely to be readmitted for asthma at least once within one year of the initial hospitalization. The results show that lack of commercial insurance, or having Medicaid or government sponsored insurance, self pay or other non-commercial insurance, is only significantly associated with asthma readmission within one year. This finding confirms results from past studies that children without commercial insurance and children with Medicaid insurance, who may have low socioeconomic status are more likely to be hospitalized for asthma (Halfon & Newacheck, 1993; Apter, Reisine, Kennedy, Cromley, Keener, Zu, & Wallack, 1997).

Children admitted for asthma without commercial insurance could be poor children, children of the working poor, or have low socioeconomic status (Weissman, Stern, & Epstein, 1994). Past research has found that African-American race, inner-city conditions, and lack of access to preventive therapies or appropriate outpatient care are risk factors for poor children with asthma (Carr, Zeitel & Weiss, 1992; Finkelstein, Brown, Schneider, Weiss, Quintana, Goldmann, & Homer, 1995; Lozano, Connell, & Koepsell, 1995). Poor children with asthma may lack reliable transportation to outpatient providers, lack financial resources to purchase asthma medications, may be unable to keep follow-up appointments that monitor asthma management, may live in inner cities or environments that contain more pollution, dust and other asthma triggers, or lack

family support to help recognize symptoms to control asthma attacks (Halfon & Newachek, 1993; Dinkevich, Cunningham, & Crain, 1998). Even though many children's hospitals used in this study were located in inner cities which may serve poor areas, the present study was limited in that it did not measure socioeconomic status, access to care, outpatient medication use, ambulatory care, compliance with therapies, social, or environmental factors, which may affect the risk of asthma hospitalization. Insurance type was a predictor of readmission within one year, but it was not a significant predictor of frequent asthma readmission, which was measured by multiple asthma readmissions within one year or readmission within 30 days. This may be due to unmeasured factors in this study, which may affect hospitalization for asthma and prevent successful long-term outpatient asthma management.

Medium hospital volume of annual admissions is a consistent and strong predictor of decreased risk of asthma readmission, multiple readmissions, and readmission within 30 days. Compared to children admitted for asthma to hospitals with a large volume of annual admissions, children admitted to hospitals with a medium volume of annual admissions are less likely to be readmitted. Few studies have looked at volume and asthma readmissions in children's hospitals, but past studies have shown that in some hospitals, higher surgical volume was associated with better mortality outcomes (Shortell & LoGerfo, 1981; Hughes, Hunt & Luft, 1987; Tilford, Simpson, Green, Lensing, & Fiser, 2000). Past research shows that higher surgical volume may lead to better outcomes for mortality, since many surgery conditions can be controlled by the

provider (Luft, Bunker, & Enthoven, 1979). This suggests that more practice and familiarity with cases can help improve staff proficiency, thus improving the chances of better outcomes. It is possible that there is less variation in physician practice for surgical cases, but unlike surgical cases, outcomes and readmissions for medical cases, such as asthma, may be influenced by other factors outside of the provider's control. Unmeasured or intervening variables may affect the relationship between volume and outcomes for medical cases.

Hospitals with different structure characteristics and processes of care may have implemented programs that result in better asthma management for their patient populations. It is possible that the medium volume hospitals have adapted asthma management programs based on the characteristics of the patient population. Many of the children admitted for asthma to medium volume hospitals in this study came from small or medium sized hospitals, but hospital size was not a significant predictor of asthma readmission. Differences in clinical management or discharge planning, which may vary at hospitals (Thomas & Holloway, 1991), may account for increased risk of readmission for large volume hospitals. It is possible that medium volume hospitals in the study sample, despite differences in hospital size, have successfully implemented clinical pathways, guidelines and hospital protocols to treat children with asthma and have educated physicians and staff on these protocols, thus reducing asthma readmissions.

Hospitals with higher volume of annual admissions may have more physicians and staff to manage their large volume of patients. There may be

more difficulty in having a large number of staff consistently follow specific guidelines or protocols (Brickman, Axelrod, Roberson, & Flanagan, 1998), so better standardization and care coordination could be needed in large volume hospitals.

It is also possible that small volume hospitals in this sample may lack the staff or financial resources to implement these interventions to reduce asthma admissions, or the sample size of asthma admissions in this study was too small to yield significant results. The current study did not collect information on whether hospital protocols or guidelines for asthma were used by hospitals in the sample, so future studies on this sample could include these measures. Since managed care interventions such as disease management or case management interventions were not measured in this study, it is unclear whether medium volume hospitals have been affected by these programs. The study sample was limited to children's hospitals, which were mostly academic medical centers, and the study did not measure physician or clinician variables, the number of residents in each hospital or other staffing variables, which could also affect hospital volume and outcomes. Future studies could be conducted to determine why medium volume hospitals have reduced risk of asthma readmission and frequent asthma readmissions or investigate the relationship between hospital volume and other hospital factors that affect asthma outcomes.

Hospital size, a structure variable measured by the number of licensed beds at each hospital, was not a significant predictor of asthma readmission for the outcomes measured in this study. Past research has shown that larger

hospitals have more readmissions (Thomas & Holloway, 1991). Hospital size may be influenced by other hospital characteristics not collected in this research. Other hospital structure or process factors not measured in this study, such as practice style of physicians, community support for ambulatory care, hospital pathways, and hospital bed occupancy levels, may influence hospitalization rates (Homer et al., 1996) or may be explored in future studies on asthma readmission.

Process Factors

The results of this study suggest that process factors, such as length of stay, utilization of inhaled steroids, and previous admissions for asthma, are strong predictors of asthma readmission. In this study, children with a history of previous admissions for asthma are at risk for early readmission for asthma, or readmission within 30 days, readmission within one year of initial hospitalization, and multiple readmissions. These findings are consistent with several past studies that also found previous admissions for asthma to be a risk factor for rehospitalization (Mitchell, Bland, & Thompson, 1996; Lieu, Quesenberrry, Sorel, Mendoza, & Leong, 1998). Previous admissions for asthma may indicate more acute cases of asthma or indicate non-compliance with asthma outpatient therapies.

The results of this study showed that the use of inhaled steroids during hospitalization is associated with asthma readmission within one year of initial hospitalization. In contrast, past studies found that inhaled steroid use was not significantly associated with asthma readmissions (McArthur, Calpin, Parkin, &

Feldman, 1996; Minkovitz, Andrews, & Serwint,1999). The present study measured the administration of inhaled steroids during the hospitalization, but these studies measured inhaled steroid use based on prescriptions for home medications or discharge medications because inhaled steroids are often used as part of a maintenance program or outpatient therapy. Differences in study results may be due to children who received inhaled steroids during the initial hospitalization, but do not regularly use inhaled steroids as part of their prescribed outpatient therapy. Inhaled steroid use has been recommended the National Institute of Health to control frequent asthma attacks and is often administered immediately to children after an asthma attack. Inhaled steroids are often given to children based on the age of the child, diagnosis, and as part of asthma therapy given by providers in both outpatient and inpatient facilities. Lack of consistent use of inhaled steroids and other asthma medications, or non-compliance with outpatient therapies may be related to access to care or socioeconomic status (Crain, Kercsmar, Weiss, Mitchell, & Lyn, 1998), but were not factors measured in the current study. Since inhaled steroid use was not a significant predictor of early readmission, or readmission within 30 days, but was significant for readmission within one year, long-term compliance with medications may affect the risk of asthma readmission.

Children who use inhaled steroids during the hospitalization may be more acutely ill upon admission to the hospital and may also require more acute care or inpatient medications when asthma attacks worsen. Frequency of inhaled steroid use has been found to be higher for children who often use the

emergency room (Stempel, Carlson, & Buchner, 1997). These children may be non-compliant with asthma medications, have poor self-management for asthma, or lack access to primary care providers. Also children diagnosed with mild asthma are less likely to receive inhaled steroid treatments (Crain, Kercsmar, Weiss, Mitchell, & Lyn, 1998), so that children with more severe cases or who have acute asthma attacks may receive more inhaled steroid treatments. Past research has found that minority children are less likely to receive preventive therapies, including anti-inflammatories such as inhaled steroids (Finkelstein, Brown, Schneider, Weiss, Quintana, Goldmann, & Homer, 1995). The present study did not measure inhaled steroid use from outpatient care or measure if inhaled steroids were prescribed to patients upon discharge from the hospital, since the study only measured administration of inhaled steroids during the initial asthma hospitalization.

This study found that length of stay, a process factor, is a significant predictor of asthma readmission. The results show that longer length of stay, or length of stay over one day, during the initial asthma hospitalization is associated with increased risk of asthma readmission within one year and multiple asthma readmissions. In contrast, Minkovitz, Andrews, and Serwint (1999) found that length of stay was not significantly associated with asthma rehospitalizations. Differences in study results may be due to limited sample size, since only 1 hospital was used in their study, while the present study used 21 children's hospitals to evaluate asthma readmissions. It has also been found that length of stay does not significantly impact the probability of readmission in some teaching

hospitals (Cleary, Greenfield, Mulley, Parker, Schroeder, Wexler, & McNeill, 1991). Differences in the results for the current study could be due to the sample characteristics, since only children's hospitals, which often provide more specialized care, were included in the current study. In this sample, longer length of stay may indicate other comorbidities or complications not captured by the APR-DRG severity of illness classification used in this study; these other conditions may contribute to poor asthma outcomes. One study found that patient stays may be more prolonged after complications arise during hospitalizations for conditions such as pneumonia (Silber et al., 1999). It has also been found that longer length of stay is associated with increased mortality (Bradbury, Golec, & Steen, 1994).

Since longer stays were found to be significantly associated with increased risk of asthma readmission in this study, these findings suggest that shorter stays for asthma hospitalizations, often implemented by managed care providers to reduce hospital costs, are not associated with increased risk of asthma readmission. It is possible that interventions that reduce length of stay for patients hospitalized for asthma may include other outpatient programs that help reduce the risk of asthma hospitalization and may have been implemented in various PHIS hospitals, but enrollment in asthma programs or interventions was not measured in this study.

Need for Interventions to Prevent Asthma Readmission

In evaluating the quality of care of children with asthma, this study found that children who lack commercial insurance and who have had a history of high inpatient resource utilization may be at risk for frequent asthma admissions. Children who are at risk for asthma readmission could be targeted for interventions, which providers could develop to help address the special needs of this population.

Patterns of resource utilization may be linked to pediatric asthma readmission, since insurance type, length of stay, hospital charges, previous admissions, and inhaled steroid use were significant predictors of asthma readmission in this study. Because asthma is regarded as an ambulatory-sensitive condition, lack of access to appropriate outpatient care may affect the utilization of health care services (Halfon & Newacheck, 1993; Minkovitz, Andrews, & Serwint, 1999). Children with asthma attacks may have parents who wait until their conditions worsen, seek care in emergency rooms, and often end up being hospitalized (Apter, Reisine, Kennedy, Cromley, Keener, Zu, & Wallack, 1997), instead of using preventive measures or appropriate outpatient care.

Past research has found that young inner-city children with asthma often have poorly controlled asthma (Farber, Johnson, & Beckerman, 1998), which may result in frequent hospitalizations. Since this study used children's hospitals located in inner-cities and urban areas, some of the children with frequent readmissions for asthma may be poor, non-compliant with asthma outpatient therapies, lack transportation or caregiver support, or lack access to outpatient

care to monitor asthma, which may lead to more frequent hospitalizations. This study did not measure proximity to ambulatory or inpatient care, transportation issues for children in the sample, or patterns of utilization of ambulatory care in their cities.

Higher utilization of inpatient resources may indicate more serious problems with asthma management. Children diagnosed with severe asthma who have a history of high hospital resource utilization, such as longer length of stay, more previous admissions, or children with asthma who have used more inpatient medications may be more acutely ill when admitted to the hospital. Children diagnosed with higher severity of asthma are often rehospitalized (Mitchell, Bland, & Thompson, 1996; Minkovitz, Andrews, & Serwint, 1999), and disease severity has been found to be a risk factor for early readmission (Thomas & Holloway, 1991). Children diagnosed with severe cases of asthma, who may need more outpatient therapies, could be identified and targeted for specific interventions and followed-up by providers to ensure compliance with therapies and reduce the risk of readmission for asthma.

Even though the multivariate analysis controlled for severity of illness using the APR-DRG classification from the PHIS discharge data, the results may be limited due to lack of information on inpatient clinical measures of severity which are not captured by the APR-DRG methodology. Since APR-DRGs are primarily based on inpatient resource use during the hospital stay, other complications or comorbidities from the patient's medical record or patient history, and the severity of illness upon admission to the hospital or emergency

room were not measured in the present study. From additional results in the multivariate analysis, the APR-DRG severity of illness rating, which was not a structure or process factor in this study, was a significant patient variable in the multivariate model for readmission within 30 days. In this study, children admitted for asthma in the APR-DRG severity of illness group for major or extreme severity of illness were more likely to be readmitted within 30 days. But this finding may be due to sample characteristics, since the study sample was selected from children's hospitals who often treat very sick children who may have more complications or other comorbidities upon admission. Children with asthma who were classified in the mild or moderate APR-DRG severity groups were not significantly likely to be readmitted within one year, have multiple asthma readmissions, or be readmitted with 30 days of initial hospitalization. More study can be done with other severity of illness measures to determine risk of asthma readmission.

Several interventions, which providers have developed and targeted to children who need to improve asthma management, may help reduce high hospitalization costs and improve the quality of life for children with asthma. Better disease management may be needed to prevent frequent readmissions for children with frequent attacks, children who are diagnosed with a severe condition of asthma, and children who are identified as non-compliant with therapies. Children who have very frequent asthma attacks and their parents may need more education to help monitor asthma and to use home medications properly (Homer et al., 1996; Minkovitz, Andrews, & Serwint ,1999). Better

asthma management programs could include more frequent patient and provider education, reinforcement, and outpatient follow-up visits to primary care doctors or specialists to prevent frequent hospitalizations or emergency room visits.

It has been shown that provider guidelines and primary care physician education, combined with patient education, can improve asthma outcomes (Higgins, Kiser, McClenathan, Tynan, 1998). This study included 61 asthma patients unassigned to a primary care provider and who were frequent users of the emergency department. These patients were assigned a provider trained in national asthma guidelines, in addition to receiving patient education on asthma management. This intervention improved outcomes for this cohort and reduced costs, by reducing emergency room visits and hospitalizations after 22 months of follow-up. Another study used an interactive computer software education program in a hospital-based clinic as a cost-effective method to improve asthma education and asthma management (Homer, Susskind, Alpert, Owusu, Schneider, Rappaport, & Rubin, 2000).

One children's hospital implemented a provider guideline using an assessment driven algorithm to treat children hospitalized with asthma and to reduce length of stay and costs, without increasing morbidity (McDowell, Chatburn, Myers, O'Riorda, & Kercsmar, 1998). Patients in the algorithm group (104 patients) were treated with standard medications administered at a frequency based on the patient's clinical condition, while providers used specific criteria and algorithm cues to decrease or augment therapy. Patients in the control group (97 patients) were given unstructured standard treatment. After

one week of discharge, these patients were interviewed, and results showed that average length of stay was much shorter for those in the algorithm group (2.0 vs. 2.9 days, $p<0.001$); there was no difference in short-term relapse between groups and the intervention saved about $700 in hospital charges per patient admission.

Other programs, such as case management and disease management interventions, often implemented by managed care providers, may provide better education and support for both parents and children with asthma, encourage better outpatient management of asthma, and help reduce hospitalization costs (Wissow, Warshow, Box, & Baker, 1988). The use of case management has also been successful in reducing asthma admissions to one children's hospital and helped provide better asthma outcomes and more standardized care (Evans, LeBailly, Gordon, Sawyer, Christoffel, & Pearce, 1999). This hospital established a pulmonary unit and expanded bed capacity for asthma patients, while case managers provided education and follow-up with patients. This intervention improved quality of care, by reducing length of stay, readmissions, and emergency department use. Another children's hospital reduced emergency room visits and hospitalizations for children with asthma, by using an outreach nurse, maintaining monthly contact with families, and providing asthma education (Kelly, Morrow, Shults, Nakas, Strope, & Adelman, 2000).

Contribution to Body of Knowledge

The findings from this research have determined that Donabedian's theory can be used to assess quality of care for children with chronic diseases such as asthma, by measuring elements of structure, process, and outcomes related to asthma hospitalizations. Since several structure and process factors were significantly related to asthma outcomes in this study, Donabedian's theory can be applied in quality assessment studies to predict asthma readmissions and frequent readmissions, by capturing measures for structure, process, and outcomes elements.

Donabedian's theory that structure, process, and outcomes are interrelated was supported by the findings from this study. The study results showed that for each model of asthma readmission developed in this study to predict asthma readmission within one year, multiple readmission, or readmission within 30 days, both structure and process factors were significantly associated with each measured asthma outcome. When structure and process variables were individually tested in unadjusted models, some structure and process variables were significantly associated with asthma readmissions before adjustments were made for other covariates. All structure and process variables, along with patient demographic variables, were added as covariates to the adjusted models, to determine significant odds ratios for readmission.

After controlling for the effects of all other variables in the adjusted models, hospital volume and previous admissions were consistently and significantly associated with all outcome measures of asthma readmission in this

study. The results showed that patients admitted to medium volume hospitals had decreased risk of asthma readmission, multiple asthma readmissions, and readmission within 30 days, while patients with previous admissions were at increased risk of asthma readmission within one year, multiple asthma readmissions, and readmission within 30 days. In addition, the only significant predictors of early readmission, or readmission within 30 days, were hospital volume of annual admissions and previous admission for asthma.

Based on the results of this study, it is possible that hospital protocols combined with patient history may be very strong predictors of asthma readmission, frequent readmission and early readmission. It is important for providers to examine other provider processes or programs that can reduce the risk of readmission, and identify children who have a history of high inpatient resource utilization. It is important for providers to look at various programs implemented by medium volume hospitals and adapt or develop new interventions to reduce frequent preventable hospitalizations.

Insurance type, another structure factor, or lack of commercial insurance was not a significant predictor of early readmission or multiple asthma readmissions, but insurance type was only a significant predictor of asthma readmission within one year in the adjusted model. It may be that insurance status or possible socioeconomic and environmental factors affect successful long-term asthma management. It is unclear whether lack of commercial insurance, socioeconomic factors, or access to care may have affected this relationship, since outpatient variables and measures for socioeconomic status

were unavailable in this study. It is also possible that large volume hospitals may serve more children who are poor or have low socioeconomic status, than medium or small volume hospitals, but socioeconomic status was not measured in this study. In the adjusted models, hospital volume was the only hospital structure factor significantly associated with asthma readmission, since hospital size was not a significant predictor of asthma readmission for any of the asthma outcomes measured in this study. More research is needed to determine what other hospital and process variables may affect asthma readmission or confound the relationship between structure and process variables and asthma readmission.

Another contribution of this study is that process factors, such as previous admission for asthma and length of stay, were found to be very strong predictors of asthma readmission. Significant odds ratios for process factors and asthma readmission were generally higher than odds ratios for structure factors and readmission. Identifying patterns of resource utilization, such as past history of high length of stay, previous admissions, or past use of inhaled steroids, can help providers improve the quality of care for children who are at risk for asthma readmission.

Additional Findings

This study confirmed past research on several patient variables and asthma hospitalizations, from the results obtained through risk adjustments for patient characteristics in the models developed to predict asthma readmission.

From a post-hoc analysis, or significant results obtained after structure and process factors were analyzed in this study, it was found that children over the age of 14, African-American children, female children, and children with APR-DRG classifications of major or extreme severity of illness were more likely to be readmitted for asthma. Therefore, patient characteristics or demographic variables may affect the relationship between asthma outcomes, structure and process factors.

This study confirms that gender is a significant predictor of asthma readmission within one year of initial hospitalization. Female children are more likely to be hospitalized and readmitted for asthma within one year of initial hospitalization than males. Findings from this study are consistent with findings from past studies on gender and asthma rehospitalizations (Senthilselvan, 1995; Mitchell, Bland, & Thompson, 1996; Minkovitz, Andrews, & Serwint ,1999). Senthilselvan concluded that adolescent females have more readmissions than boys of any age group. Confirming Senthilselvan's study, the present study also found that adolescents over the age of 14 are more likely to have multiple readmissions for asthma than children ages 5 to 14.

The results of this study did not show significant odds ratios for young children, or children ages 0 to 4, as compared to children ages 5 to 14. Past studies determined that children ages 0 to 4 are often hospitalized for asthma (Vollmer, Buist, & Osborne, 1992; Halfon & Newacheck, 1993; Mitchell, Bland, & Thompson, 1996; To, Dick, Feldman, & Hernandez, 1996). Asthma may go unrecognized in very young children, until the condition is severe, and young

children may have difficulty in self-managing or handling daily asthma medications. Differences in the results of this study may be due to the samples used in the study and possible coding issues, since asthma conditions may be classified with other ICD-9 codes for young children.

The findings of this study showed that race is another demographic predictor of frequent asthma admissions. African-American race was significantly associated with asthma readmission within one year and with multiple asthma readmissions within one year. This study determined that African-American children are more likely to be hospitalized or be readmitted for asthma than white children. This finding supports past studies on race and asthma hospitalizations (Lozano, Connell, & Koepsell, 1995; Goodman, Stukel, & Chang, 1998). African-Americans may also have a higher risk of utilizing emergency room services and being hospitalized, compared to Whites (Lozano, Connell, & Koepsell, 1995).

Higher morbidity, socioeconomic status, cultural influences, and social support may be other factors related to race and readmissions for asthma. Parental attitudes toward asthma management may affect compliance with therapies or utilization of services. Their health beliefs, knowledge of asthma, social or physical environment, and concerns over the use and safety of asthma medications may be barriers to asthma care (Mansour, Lanphear, & DeWitt, 2000).

Additional post-hoc analysis results showed that initial hospitalization charges, often used as a proxy for hospital costs, could be related to resource utilization measures, such as length of stay. From the post-hoc results, hospital

charges are positively and significantly correlated with the total number of asthma admissions, and negatively correlated with the number of days between the initial hospitalization discharge and the first readmission for asthma. Children with higher inpatient charges, which often reflect longer length of stay, greater use of inpatient medications, or more severe cases of asthma, may be at risk for asthma readmission. In a study on resource expenditures and outcomes, it was found that longer length of stay was significantly associated with mortality in adult hospitals, but charges were not significantly related to outcomes, such as mortality (Bradbury, Golec, & Steen, 1994). Differences in the findings for this study may be due to the current study sample limitations or lack of charge adjustments for the HCFA wage and price index to account for charge variations in the locations of the PHIS hospitals used in this sample. Future studies may consider the relationship between hospital costs for asthma, wage-adjusted charges and the quality of care for children with asthma.

Policy Implications

The identification of structure and process factors associated with asthma outcomes, such as asthma readmission, can help provide useful information on the quality of care for children with asthma. Providers and policymakers could evaluate quality of care to determine risk factors associated with poor asthma outcomes and develop interventions to address the needs of children at risk for poor outcomes, in order to improve quality and reduce high health care costs for preventable asthma hospitalizations.

Providers and policymakers could monitor the quality of care for children with chronic diseases and the quality of care for specific pediatric populations, since characteristics of childhood diseases may be manifested over time (Szilagyi & Schor, 1998). By identifying and focusing attention on monitoring the quality of care for specific patient populations, providers may be able to assess and recognize access to care issues, determine other demographic, social or environmental factors that may contribute to increased risk of asthma readmission, and develop interventions to improve asthma outcomes.

Because process factors are strongly associated with asthma readmission, identifying children with high inpatient resource utilization, such as children who have had hospitalizations with high length of stay, more previous admissions for asthma, or have used inhaled steroids in the initial hospitalization, can help prevent unnecessary asthma admissions. Identifying and tracking children with asthma who have had high inpatient resource utilization may help providers recognize characteristics of children who have a severe condition of the disease, are non-compliant with therapies, encounter access to care problems, or have other risk factors associated with frequent readmissions. Since inhaled steroid use was associated with increased risk of asthma readmission within one year, it is important for providers to follow-up children over time, monitor compliance with therapies, medication use and effects of medications on children who have had high inpatient utilization.

Other patient risk factors associated with asthma readmission, such as age, race, gender, and insurance status, can be easily identified and tracked by

providers and payors, in order to reduce unnecessary asthma hospitalizations and reduce hospitalization costs. This study found that children with asthma over the age of 14 are at risk for multiple readmissions within one year. Age-specific patient education may benefit children who have difficulty with home medications. More research is needed to evaluate care for adolescents with asthma, who may be faced with hormonal problems, peer pressures, social problems, confidentiality issues, and other barriers in seeking outpatient care (Mangione-Smith & McGlynn, 1998).

Children who are at risk for increased asthma readmission, who are identified through tracking, can be followed up by primary care providers, specialists. These children can be enrolled in asthma management programs, disease management programs, or case management programs, often used by managed care plans to reduce costs and monitor the quality of care for children with chronic diseases (Zimbro, 2000). Since lower length of stay was not associated with increased risk of readmission in this study, it is possible that managed care interventions, which monitor patients with chronic diseases and use preventive care to reduce hospitalizations or length of stay, may help prevent frequent asthma readmissions, without reducing the quality of care. These programs can help children with asthma gain access to appropriate outpatient care or use preventive care, in order to prevent unnecessary hospitalizations or emergency room visits and lower health care costs (Wissow, Warshow, Box, & Baker, 1988).

Other asthma management interventions, such as outreach and peer-based programs that consider cultural and family beliefs and motivate patients or caregivers to monitor asthma, may also prevent unnecessary asthma readmissions. It has been found that race, culture, poor environment and social support from peers or family may affect health risks (Halfon & Newacheck, 1993; Szilagyi & Schor, 1998; Sheppard, 1997). The present study found that children who lack commercial insurance, who may also be poor, and African-American children were at risk for asthma readmission, but it did not measure attitudes, health beliefs, socioeconomic, cultural or social factors. More research may be needed to understand the quality of care and determinants of health for African-Americans and other minorities, such as Latinos, Asians, Native Americans, or other cultures.

Providers can also examine other hospital structure and process factors that affect asthma readmissions. Providers can learn from other hospitals or find benchmark hospitals that have successfully implemented hospital processes, or clinical guidelines for pediatric asthma; they can determine if similar programs can be implemented within their organization and with their patient population. They can compare programs or processes from other health care providers to determine if more health care resources are needed to implement successful programs that prevent unnecessary readmissions, improve quality of care, and lower health care costs. Providers can also educate staff on generally accepted guidelines or specific disease protocols for asthma, involve community resources to reach specific patient populations, and follow-up on patient outcomes to

determine if current provider processes need to be changed to improve health outcomes. They can evaluate other structure and process factors, variations in practices, and outcomes of care to help improve the quality of care of children with chronic diseases.

Study Limitations and Need for Future Research

The use of the PHIS database to determine risk factors for pediatric asthma readmission provided useful information on assessing the quality of care, but it also suggested several limitations to this study. This study was limited to asthma hospitalizations in children's hospitals, since an inpatient database of hospital discharges was used for the sample. Consequently, this study was limited in that it captured inpatient hospitalization information on children admitted to PHIS hospitals and could not account for any emergency room or outpatient care that these children received or determine any other admissions that these children had to other hospitals. The study did not measure any home medications or compliance with any specific treatments for asthma, the impact of managed care factors, or other hospital characteristics that may affect outcomes of care, and only looked at children admitted to urban children's hospitals. The outcomes of care used in this study were limited in that they were not mutually exclusive; this means that children who had early asthma readmissions in this study could have also been the same children who had multiple asthma readmissions. Therefore, this study did not differentiate patient characteristics for mutually exclusive outcomes. The study did not account for other

psychological, environmental or social factors that may have influenced asthma outcomes or hospital admissions, such as family support, physical environment, or motivation. It could not account for any changes in insurance status that the child had between the initial hospitalization and first readmission for asthma.

One limit to the present study is that the methodology used secondary data analysis, which yielded results at the patient level instead of the hospital level, as was requested by PHIS, the data source organization. Patient level analysis may ignore many unmeasured hospital specific factors or processes that may affect readmissions. Since the study did not use the HCFA wage-adjusted price index to account for differences in hospitalization charges for asthma for each PHIS hospital location or use hospital costs, the results from the relationship between hospital charges and asthma readmission are limited.

More research on process measures is needed to evaluate the quality of care for children, so that providers can be held accountable for their process of care. Providers may improve the quality of care for children by looking at controllable factors that may affect outcomes of care for children with chronic diseases (McGlynn & Halfon, 1998). Managed care plans have begun to monitor the use of appropriate medications for asthma, in order to monitor quality of care for patients with asthma, so more research on drugs used to prevent asthma readmissions is needed. More research can be done so that structure, process, and outcome relationships can be assessed at the community level, in order to improve the quality of health care for children at a broader level. Donabedian's

theory can also be tested to evaluate the quality of care of children with other chronic diseases.

More research is needed to determine whether other structure or process variables, such as managed care factors, health care costs, specific medications, physician practice patterns, provider staff to patient ratios, specific interventions such as home care or case management, or social or environmental factors affect asthma outcomes. Future studies that combine various structure and process factors with asthma outcomes can be designed to determine the impact of hospital factors, such as urban or rural location of the hospital, hospital managed care penetration, use of clinical pathways, guidelines, or other hospital processes, on other asthma outcomes for patients admitted to children's hospitals. More studies can be done on specific populations, such as African-Americans with asthma, other race groups, adolescent children, female children, or children under the age of 5, to identify other risk factors associated with asthma readmissions and other asthma outcomes for those sub-groups.

This research concludes that structure, process, and outcome elements are related, and that Donabedian's theory on quality assessment can be used to predict asthma readmissions. It is important that providers identify patient characteristics and risk factors of asthma readmission, monitor the quality of care of children with asthma, and apply successful interventions to target specific populations, especially patients with a history of high resource utilization or who lack commercial insurance. These activities may improve the quality of care for children with chronic diseases and reduce costs for preventable hospitalizations.

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APPENDIX

PHIS EXTERNAL USE OF DATA REQUEST

HUMAN SUBJECTS APPROVAL

Kronenburg, Maria

From: david.bertoch@chca.com[SMTP:david.bertoch@chca.com]
Sent: Friday, January 07, 2000 09:38
To: Maria_Kronenburg@chca.com
Subject: External Use of Data Request - Maria Kroenburg

Microsoft Word 4.doc

----- Forwarded by David Bertoch/CHCA on 01/07/00 08:43 AM -----

David Bertoch
01/05/00 03:59 PM

To: Terry Curtis, Cindy Nuesslein, Lorna Dyk/CHCA@CHCA, James Todd, Annette Bollig, Mark Kirschbaum/CHCA@CHCA
cc: Vince Leonardo/CHCA@CHCA
Subject: External Use of Data Request - Maria Kroenburg

Back in August the External Data Request Review Committee reviewed a request from Maria Kronenburg from Norfolk. She was preparing to do a study for her PhD program. The Review Committee had a series of questions and comments for Maria to respond to.

Maria has agreed to all of the requirements set by the Review Committee and revised her request, which is attached. There is no further action or decision needed by the Review Committee but I did want to provide the revised data request so you would be aware of the changes.

Among the issues/concerns that Maria has addressed:

* Maria did receive approval from the PHIS Sponsor at CHKD, Andrea Hickling.
* She has received approval from the hospital's IRB.
* She has received feedback from her dissertation committee and their feedback paralleled the Review Committee's feedback in many areas.
* Age in years will be used instead of date of birth
* PHIS will be able to review the study prior to final publication
* The results of the study will be presented to hospital administrators and medical directors at CHKD
* She will make the dataset available to other PHIS members, upon request.
* Hospitals will be stratified by bed size and admissions, with no group of less than five hospitals.
* She is willing to present the results at a PHIS meeting if requested.

(See attached file: Kronenburg_datareq2.doc)

If you have any questions or comments please let me know.

David Bertoch
Director of Operations, PHIS

PHIS External Use of Data Request

Date: December 20, 1999 (update to July 20, 1999 initial request and PHIS feedback)

Requestor: *(Name, title, company/hospital)*

Maria Kronenburg, Manager, Physician Decision Support, CHKD, Norfolk, VA
Submitting request as a Ph.D. candidate at Old Dominion University

Objective/Intent: *(brief description and purpose)*

Asthma is the most common chronic illness of childhood and is a frequent cause of hospitalizations. Pediatric asthma hospitalization rates have risen in the past 2 decades, while the frequency of hospitalization for other common pediatric illnesses has declined. Readmissions may account for the increase in asthma hospitalization rates. This study will focus on identifying specific patient and hospital characteristics associated with pediatric asthma readmissions and frequency of readmissions.

Use of PHIS Data: *(purpose for using PHIS)*

1. Principal diagnosis – to determine sample of asthmatics and asthma admissions
2. Length of stay- to calculate average length of stay (*Grouped field, see additional comments)
3. Total charges for hospital admission- to calculate average charge per case (*Grouped field, see additional comments)
4. Severity of illness (APR-DRG and Class Assignment Number for APR-DRG)- to adjust for patient severity of illness
5. Admission date and Discharge date- to determine selection of sample and time between admissions. These dates will also be used to indicate whether or not the patient was admitted at least once for asthma within 6 months prior to the initial admission in the study period. They will be used to determine if previous hospitalization for asthma is a significant predictor of readmissions.
6. Date of birth-to determine age (*Grouped field, see additional comments)
7. Masked medical record number-to determine readmissions for patient
8. Masked hospital number- to determine hospital readmission rates (*Grouped field, see additional comments)
9. Race- to adjust for patient race
10. Gender- to adjust for patient gender
11. Principal payer (insurance status)- to determine if this variable is a significant predictor of readmissions (*Grouped field, see additional comments).
12. Discharge disposition- to determine patients who were transferred or died, so that they will be excluded from the study
13. Pharmacy Drug Name and Route of Administration- to determine whether the patient was treated with inhaled steroids during the initial hospitalization in the study period and to determine if this variable is a significant predictor of readmissions.

Primary Deliverable: *(publication, information-only, presentation/seminar)*

Dissertation

Potential Audiences: *(anyone who see information derived from PHIS data)*

Dissertation Committee Members
Clare Houseman, Ph.D., Dissertation Chair, Old Dominion University, Norfolk, VA
Brenda Nichols, Ph.D., Old Dominion University, Norfolk, VA
Richard Dean Benjamin-Coleman, Ph.D., Old Dominion University, Norfolk, VA

Dr. Lindsay Rettie, Dean, College of Health Sciences, Old Dominion University

Children's Hospital of The King's Daughters Hospital Administrators and Medical Directors

Compensation/Funding: *(any associated revenues, funding, compensation...)*

None

Background/Summary: *(describe approach and method to be used for analysis – may span more than one page in length)*

Insurance status, length of stay, total charges, utilization of inhaled steroids, and the number of previous hospitalizations will be examined to identify predictors of pediatric asthma readmission within 1 year after the initial admission for asthma. Hospital variables, such as hospital size (number of licensed beds) and total annual hospital admissions, will also be examined to determine predictors of pediatric asthma readmission. Descriptive statistics will be calculated for all variables. Chi-square tests will be used to identify significant predictors of pediatric asthma readmission. Logistic regression will also be used to analyze pediatric asthma readmissions.

Request Criterion

☒ Yes ☐ No	Hospital-Specific (used to identify, group or filter individual hospitals) If "Yes", what will be used as the "Hospital Identifier"? (*Grouped field, see additional comments)
☐ Yes ☒ No	Patient-Specific (used to identify, group or filter individual patients) If "Yes", what will be used as the "Patient Identifier"? _____
☐ Yes ☒ No	Physician-Specific (used to identify, group or filter individual physicians) If "Yes", what will be used as the "Physician Identifier"? _____
☐ Yes ☒ No	Subspecialty-Specific (used to identify, group or filter by physician subspecialty such as General Pediatrics, Cardiology, Gastroenterology) If "Yes", what will be used as the "Subspecialty Identifier"? _____
☒ Yes ☐ No	Payer-Specific (used to identify, group or filter individual payers) If "Yes", what will be used as the "Payer Identifier"? (*Grouped field, see additional comments)

Request Abstract

Data Format	☐ Raw Data ☐ Reports ☒ Publication
Population of Interest	Pediatric asthma admissions
Stratification Groups	• Hospital Bed Size (Number of Licensed Beds) (*Grouped field, see additional comments) • Estimated Hospital Annual Admissions/Volume of Admissions (*Grouped field, see additional comments) • Age Groups (*Grouped field, see additional comments) • LOS Groups (*Grouped field, see additional comments) • Charge Groups (*Grouped field, see additional comments) • Payer Groups (*Grouped field, see additional comments)
Measures	• Readmissions • Use of Inhaled Steroids • LOS • Insurance Status • Total charges
Add'l Inclusion/Exclusion Criteria	Only PHIS hospitals and PHIS asthma discharges that meet the study criteria and have complete data (no missing data) in the measured fields will be included in the sample

Additional Information and Comments

As recommended by the PHIS External Use of Data Committee and the ODU Dissertation Committee for this study, categories will be assigned for several PHIS variables and for all Hospital level variables.

Recommendations from the ODU Dissertation Committee:

1. Based on feedback received from the ODU Dissertation Committee for this study, one of three different payer groups (Public, Private, or Other Payer) will be assigned for each asthma discharge. Payer groups for PHIS payer codes are:
   - Public Payer (PHIS Codes: 1=Medicare, 2=Medicaid, 3=Title V, 4=Other Govt.)
   - Private Payer (PHIS Codes: 6=Blue Cross, 7=Other Insurance)
   - Other Payer (PHIS Codes: 5=Workers Comp, 8=Self Pay, 9=Other, 10=No Charge)

2. LOS will be assigned into one of 4 categories:
   - LOS <= 1 day
   - LOS between 2 and 4 days
   - LOS between 5 and 9 days
   - LOS of 10 or more days

3. Severity of Illness will be measured by Class Assignment Number (CAN severity level) and will be controlled for in the analysis of the study.

4. As recommended by the PHIS External Use of Data Committee and the ODU Dissertation Committee, PHIS hospital numbers will not be used and individual hospitals will not be identified in the study. Hospital groups will be determined based on Hospital Size (number of licensed beds) and Hospital Estimated Annual Admissions (Hospital Volume of all admissions).

   - Hospital Bed Size (number of licensed beds) will be categorized into Large Sized Hospital, Medium Sized Hospital, or Small Sized Hospital, based on the normal distribution of the bed size variable.

   - Hospital Estimated Annual Admissions will be categorized into Large Volume Hospital, Medium Volume Hospital, or Small Volume Hospital, based on the normal distribution of the Estimated Annual Admissions variable.

5. Hospital Charges will be classified into quartiles (each hospital will be assigned into one of 4 groups, quartile ranks from lowest to highest hospital charges for asthma).

6. Age categories will be used instead of date of birth, in order to protect patient confidentiality.

Age categories will be assigned as follows:

- 0-4 years of age
- 5-14 years of age
- Over 14 years of age

Other Recommendations and Comments:

- The Old Dominion University Human Subjects Research Review Committee (IRB) has approved the proposed study.
- Andrea Hickling, PHIS Sponsor at Children's Hospital of The King's Daughters in Norfolk, VA has approved the use of PHIS data for this study and has sent a letter to PHIS with her approval.
- The results of this study will be submitted to the PHIS External Use of Data Committee, prior to being published.
- The results of this study will be presented to PHIS members, upon request. The dataset created from this study will be available to other PHIS members, upon completion of the study.
- The results of this study will be presented to hospital administrators and medical directors at Children's Hospital of The King's Daughters, who will determine the usefulness of the study.
- Expected completion date for the analysis of this study is April 1, 2000.

OLD DOMINION UNIVERSITY

School of Nursing
Technology Building, Rm. 361
4608 Hampton Blvd.
Norfolk, Virginia 23529-0500
Phone: (757) 683-4297
FAX: (757) 683-5253
http://www.odu.edu/~nursing/index.htm

August 11, 1999

Maria A. Kronenburg
2264 Bartholomew Crossing
Virginia Beach, Virginia 23456

Dear Ms. Kronenburg:

Your proposal entitled, " **Factors Associated with Asthma Readmissions in Children's Hospitals** ", was reviewed by the Human Subjects Committee and has been approved for one year from the beginning of data collection. Should your project extend beyond this period another review would be needed. At the end of your project a summary report or abstract should be submitted to the committee chair. Martha Walker, a Community Health and Physical Therapy faculty member, will chair this committee during 1999-2000. If we can be of assistance to you please contact the committee. Thank you and best wishes for your success.

Sincerely,

Laurel S. Garzon, DNSc, CPNP
Associate Professor

Autobiographical Statement

Maria Acedo Kronenburg received her Bachelor of Science degree in Mathematics in 1986 from The College of William and Mary in Williamsburg, Virginia. In 1990, she received her Master's degree in Business Administration from Old Dominion University in Norfolk, Virginia.

Maria is currently working as the Manager of Physician Decision Support at Children's Health System in Norfolk, Virginia. She has worked in the areas of computer programming, systems analysis, health care administration, and health care research. She is married and lives in Virginia Beach, Virginia.