UNIVERSITY OF CALIFORNIA

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Adherence to National Asthma Education and Prevention Program Guidelines in the Medi-Cal Population before and after the Implementation of the Asthma Registry into the Electronic Medical Record at CHOC Children's

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Nursing

by

Joanne Marie Fierro

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ABSTRACT OF THE DISSERTATION

Adherence to National Asthma Education and Prevention Program Guidelines in the Medi-Cal Population before and after the Implementation of the Asthma Registry into the Electronic Medical Record at CHOC Children's

by

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Doctor of Philosophy in Nursing

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The National Asthma Education and Prevention Program (NAEPP) was established in 1991, with the goal to address the growing and significant national health problem of asthma. The NAEPP was last updated in 2007. CHOC Children's (CHOC) in Orange County, California integrated an Asthma Registry into the electronic medical record (EMR) in 2015 to improve provider adherence to the NAEPP guidelines. **Method:** A serial cross-sectional design was used to compare change in provider management of asthma patients before an Asthma Registry with NAEPP guidelines was integrated into the EMR to after integration into the EMR. Four variables (Asthma Control Test [ACT], Asthma Action Plan [AAP], inhaled corticosteroids [ICS] and spacers) were evaluated pre-integration (2014) and compared to post-integration (2018) of the Asthma Registry. Using 2018 data, the outcomes of hospital admission, emergency department (ED) and outpatient visits with the diagnosis of asthma exacerbation were compared between the

Children's Medical Group (CMG) and the non-CMG of CHOC Health Alliance**. Results:** In 2018, patients were more likely to receive an ACT, (OR = 14.95, 95% CI 12.67, 17.65, $p <$ .001), AAP, (OR = 12.70, 95% CI 11.10, 14.54, $p < .001$), ICS (OR =1.85, 95% CI 8.52, 14.54, $p < .001$) and spacer (OR= 1.45, 95% CI 1.31, <2e-16, $p < .001$) compared to those in 2014. In 2018, CMG patients had more asthma exacerbations than non-CMG patients (OR = 1.130, 95% CI 1.049, 1.217, $p = .01$). When the visit location was analyzed, only ED visits had a significant difference: patients in the CMG group were 1.35 times more like than the non-CMG to have an ED visit (95% CI 1.236, 1.476, $p < .001$). The increased asthma exacerbations in the CMG patients may be related to the population. The CMG group was 76.4% Hispanic and the non-CMG group was 66.9% Hispanic ($\chi^2[1] = 39.71$, $p < .001$). Hispanics have been reported to have a higher rate of low health literacy than their white counterparts (Valerio, George, Liu, Osakwe, & Bruzzese, 2018). **Conclusion*:*** The integration of the Asthma Registry into the EMR was shown to be an effective intervention to increase provider adherence to the NAEPP guidelines, but ongoing monitoring and education are needed to promote and maintain the behavioral change.

The dissertation of Joanne Marie Fierro is approved.

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LIST OF ACRONYMS

AAAAI	American Academy of Allergy, Asthma & Immunology
AAP	Asthma Action Plan
ACAFE	Asthma Clinical Assessment Form and Electronic Decision Support
ACE	Asthma Control Evaluation
ACEFE	Asthma Clinical Assessment Form and Electronic decision support
ACET	Asthma Control Evaluation and Treatment
ACT	Asthma Control Test
AHRQ	Agency for Healthcare Research and Quality
C-ACT	Child Asthma Control Tool
CCAT	Community Coalition Action Theory
CDS	Clinical decision support
CHA	CHOC Health Alliance
CHOC	CHOC Children's Hospital of Orange County
CI	Confidence interval
CINAHL	Cumulative Index of Nursing and Allied Health Literature
CMG	Children's Medical Group
CPG	Clinical practice guideline
DO	Doctor of Osteopathic Medicine
DPI	Dry powder inhaler
ED	Emergency Department
EMR	Electronic medical record
EPR	Expert Panel Report
FQHC	Federally Qualified Healthcare Center
GERD	Gastroesophageal reflux disease
GINA	Global Initiative for Asthma
GLMM	General Linear Mixed Model
GWAS	Genome-wide association studies
HCPCS	Healthcare Common Procedure Coding System
HIMSS	Healthcare Information and Management Systems Society
ICATA	Inner-City Anti-IgE Therapy for Asthma
ICD	International Classification of Disease
ICS	Inhaled corticosteroid
IRB	Internal Review Board
IT	Information Technology
LABA	Long acting beta agonist
LLC	Local learning collaborative
MCO	Managed Care Organization
MD	Doctor of Medicine
MDI	Metered dose inhaler
MeSH	Medical Subject Heading

MLP	Mid-Level Provider
NACI	National Asthma Control Initiative
NAEPP	National Asthma Education & Prevention Plan
NAS	National Asthma Survey of Physicians
NDC	National drug code
NHLBI	National Heart Lung and Blood Institute
NP	Nurse Practitioner
OR	Odds ratio
OSA	Obstructive sleep apnea
PA	Physician's Assistant
PACT	Pediatric Asthma Control Tool
PCP	Primary Care Provider
PF	Practice facilitation
PFM	Peak flow meter
PFT	Pulmonary function test
PROSE	Preventative Qmalizumab or Step-up Therapy for Severe Fall Exacerbations
Q&A	Questions & answers
RCT	Randomized control trial
SABA	Short acting beta agonist
SCT	Social Cognitive Theory
SES	Socio economic status
SLT	Social Learning Theory
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
U.S.	United States
UCLA	University of California at Los Angeles
WHO	World Health Organization

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CHAPTER 1

INTRODUCTION

Problem Definition

Asthma, a major public health concern, has no known cure, but with medication and monitoring it can be controlled (U.S. Department of Health and Human Services, 2014). There are two components of asthma, inflammation and bronchospasm in the respiratory system. Symptoms include wheezing, cough, chest tightness,

and shortness of breath which may occur intermittently or daily. Besides the physical symptoms, the individual's life and family are affected.

Comorbidities influence asthma control and treatment, the full degree of influence has not been determined (Boulet & Boulay, 2011). Comorbidities include but are not limited to rhinitis, obstructive sleep apnea (OSA), gastroesophageal reflux disease (GERD), sinusitis, and psychopathologies. Asthma can affect 23 major organ systems (Boulet & Boulay, 2011). It has also been reported by Adams et al. (2006) that asthma patients have a higher prevalence of diabetes, stroke, osteoporosis, heart disease, arthritis and cancer.

The American Asthma Foundation (2017) reports people living in poverty are 50% more likely to develop Asthma than those not living in poverty. Socioeconomic status (SES) and ethnic disparities were studied by Forno and Celedon (2009). They identified the following risk factors for poor asthma outcomes in populations with low SES: exposure to indoor allergens (e.g. cockroaches), higher prevalence of smoking (31%), obesity, poor diet and lack of exercise. With morbid obesity, there is an increase in resistance to the chest wall with breathing which decreases airflow to the lungs. Lack of health insurance or access to care, indoor allergens, and smoking are not the only factors affecting asthma. Forno and Celedon (2009) also report United States

(U.S.) Puerto Ricans, who have easier access to health care, have a higher morbidity than Mexican-Americans. There has been a hereditary component of asthma reported, affecting between 36 and 79 percent of patients with asthma. Asthma specific genes have been identified by genome-wide association studies (GWAS) (Forno & Celedon, 2009). Xu et al. (2018) reported a strong association of childhood asthma in patients with reduced whole-blood DNA methylation at 14 CpG sites. A review of research on the 17q12-21 asthma locus by Stein et al. (2018) shows inconsistencies and recommends additional studies to understand the relationship between genotype and asthma phenotype. These studies are ongoing.

Asthma is a chronic illness, which requires daily medication and monitoring. Asthma affects not only the patient but the entire family. A literature review by Wood, Miller, and Lehman (2015) identified asthma is not only a financial burden, but also has psychosocial implications. Caregivers may feel demoralized. Depression symptoms increase for mothers, and the fathers become more vulnerable to depression. The caregiver's quality of life changes, daily routines are disrupted, and family conflicts are more likely to occur. These stressors within the family interfere with treatment adherence, causing increased exacerbations and emergency department (ED) visits (Wood et al., 2015).

The financial burden of asthma is alarming. Nurmagambetov, Kuwahara, and Garbe (2018) reported the cost of asthma in the U.S. increased from $39.3 billion in 2008 to $57.9 billion in 2013, an increase of $18.6 billion in five years. Annual per-person direct costs increased from $2,698 in 2008 to $3,728 in 2013, an increase of $1,030 per-person. Annual medication cost per-person was $2,196 in 2013, an increase of $652 from 2008. The indirect costs of lost school time and lost work days were calculated for 2008-2013. Lost school days for asthma were 2.3 days per year more than those without asthma, a cost of $1.1 billion per year.

Lost work days in the same time period was 1.8 days with a cost of $1.9 billion per year (Nurmagambetov et al., 2018). Barnett and Nurmagambetov (2011) reported for 2002-2007, the mean total value of lost work days per year was $1.657 billion; lost school days, total was $0.371 billion. During the six-year period of 2008-2013 the value of lives lost (3,168 deaths) due to asthma was $29.0 billion, an average of $4.83 billion per year (Nurmagambetov et al., 2018). This is an increase of $2.46 billion from the six-year period of 2002-2007 of $13.25 billion, an average of $2.37 billion per year (Barnett & Nurmagambetov, 2011). The CDC reports asthma cost of more than $82 billion annually, which is consistent with the findings of Nurmagambetov et al. (2018) (Inserro, 2018).

The Centers for Disease Control and Prevention (2017) report a prevalence of asthma in the population of 7.9%, or 25.2 million Americans are living with asthma. There are 6.2 million children under of 18 years of age with asthma. In 2017, asthma deaths totaled 3,564, a rate of 9.9 deaths per million. Of these, 185 were children less than 18 years of age (rate of 2.5 per million). In 2016, there were 188,968 hospital inpatient stays for asthma (rate 5.9 per 10,000); 80,235 children (less than 18 years of age) with asthma had hospital inpatient stays; this equates to a rate of 10.7 per 10,000 children. ED visits in 2016 for asthma exacerbations were 1.8 million; of these 546,013 were children <18 years, a rate of 74.3 per 10,000 children (Centers for Disease Control and Prevention, 2017).

National Asthma Education and Prevention Program

The National Heart, Lung, and Blood Institute (NHLBI) held a workshop in 1988, "Asthma Education: A National Strategy" (National Heart Lung and Blood Institute, 2016). This was in response to the astounding increase of asthma prevalence. According to the Morbidity and Mortality Weekly Report (1998), the epidemiological report showed an increase in asthma prevalence through the 1980's. In 1980, 6.8 million people (rate = 30.7/1,000) self-reported asthma. This increased to 7.9 million (rate = 34.6/1,000) people in 1981-83, 8.8 million (rate = 37.6/1,000) in 1984-86, and 10.2 (rate = 42.9/1,000) in 1987-89. The death rate of asthma also increased: 1981-83 the deaths from asthma were 3,255 (rate = 13.1/million per year), with an increase in 1984-86 to 3,800 (rate = 14.4/million per year), and 1987-89 to 4,609 (rate = 16.6/million per year). Individuals admitted to the hospital in 1981-1982 for asthma was 451,000 (rate = 20.0/10,000). This increased in 1984-86 to 478,000 (rate = 20.5/10,000) but decreased in 1987-89 to 476,999 (rate = 19.8/10,000) (Morbidity and Mortality Weekly Report, 1998). From 1980 to the early 1990's the rates had increased by 75 percent overall and the death rate due to asthma increased by 56% while the population growth between the two time periods was only three percent. There also was a dramatic increase of asthma among children aged 0-4 years of 45%, and 5-14 years of 13% (Morbidity and Mortality Weekly Report, 1998).

Recommendations of the 1988 workshop "Asthma Education: A National Strategy" and coordinated research on asthma education, benefits and outcomes became the motivation to develop guidelines and define objectives for a national asthma program. In 1989 NHLBI established the National Asthma Education Program committee (National Heart Lung and Blood Institute, 2016). This committee developed and published the first Expert Panel Report: Guidelines for the Diagnosis and Management of Asthma in 1991. This became known as the National Asthma Education and Prevention Program (NAEPP). Additional documents were also produced, including patient education flyers, pamphlets, and handouts. Special guides for providers based on discipline (e.g. family practice, nurses, ED, obstetrics) were also developed (National Heart Lung and Blood Institute, 2016).

In 1997, the second Expert Panel Report (EPR-2) was released (U.S. Department of Health and Human Services, 1997). This was an update to the original guidelines. Recommendations were based on research findings and included medications for controlling asthma and relieving symptoms, allergy testing for some patients, reduction of exposure to tobacco smoke, treatment of infants aggressively, and the benefits of spirometry and peak flow meters (PFM). A focus on children ensued, targeting schools, parents and families with additional educational materials, programs, and school initiatives (National Heart Lung and Blood Institute, 2016).

In 2002, the NAEPP committee published an update to EPR-2. The update was a new approach, where they did not look at all the guidelines, but only a few of the topics that were pressing and required a more in-depth review. Recent data and research were systematically reviewed which resulted in the update and changes to identified areas focusing on medications, monitoring and prevention. The step-wise approach and dosage recommendations were revised to include the changes research demonstrated to be effective (U.S. Department of Health and Human Services, 2002).

The NAEPP EPR-3 was published in 2007 (U.S. Department of Health and Human Services, 2007a). This revision had a few major changes based on new evidence presented from recent research. The best scientific evidence was systematically reviewed by the Expert Panel, along with critique and peer review by 140 experts in asthma. Asthma changes with age. Specific treatment and monitoring to the step-wise approach in three separate age groups (0–4 years of age, 5–11 years of age, and youth ≥12 years of age and adults) was added to the guidelines. The step-wise approach was expanded to six different steps for ease of assessment and implementation in each step. Impairment and risk of severity and control was a new focus.

Emphasis was placed on education, environmental control and comorbid conditions. The ultimate goal of this review was to improve patient outcomes and quality of care by disseminating asthma recommendations to providers in the primary care setting (U.S. Department of Health and Human Services, 2007b).

With the last update in 2007, the coordinating committee for NAEPP EPR-4 has been established, with the first meeting December 14, 2017. They held a second meeting June 2019 which made recommendations for changes to EPR-3. A barrier to implementation of the guidelines was lack of buy-in form organizations. Focus will be on identifying stakeholders. The target audience will be the primary care community. The updating the guidelines will include six topics: intermittent inhaled corticosteroids, long-acting muscarinic antagonist therapy, bronchial thermoplasty, immunotherapy, indoor allergen reduction, and fractional exhaled nitric oxide (National Heart Lung and Blood Institute, 2020).

According to Balas and Boren (2000), to implement new knowledge into clinical practice is slow, taking an average of 17 years. Making scientific evidence-based research more accessible and useful to clinicians is a recommendation of the Institute of Medicine (2001) to the Department of Health and Human Services. The dissemination of information is imperative for implementation of new knowledge. Leadership from public and private sectors, consumer representatives, and health care leaders are involved acceptability by providers and patients. It has now been 29 years since the publication of NAEPP guidelines, with the last update fourteen years ago. Adherence to the guidelines would be expected to increase over time (Institute of Medicine, 2001). Multiple researchers have reported success in improving asthma outcomes after implementation of the NAEPP guidelines (Cloutier, 2016; Grant, Bowen, Neidell, Prinz, &

Redlener, 2010). Despite the implementation of NAEPP guidelines, sequelae of asthma continued to be high as measured by ED visits, hospital admissions, and deaths.

The NAEPP guidelines were first published in 1991. Yet, after more than 25 years of their inception, the prevalence of asthma has increased from 4.3% in 1992 to 8.3% in 2016 (Centers for Disease Control and Prevention, 2016; Morbidity and Mortality Weekly Report, 1998). ED visits, hospital visits, and death rates have decreased since 1992, but continue with high rates of incidence and prevalence; with asthma continuing to be a major public health concern. Poverty and low economic status places a person at increased risk for severe asthma disease. For this reason, this project looked at provider adherence to NAEPP guidelines of the Medi-Cal or Medicaid population.

CHOC Children's Asthma Registry Data

CHOC Children's uses the Cerner electronic medical record (EMR) system. CHOC collaborates with Cerner to improve patient care with the use of the EMR. CHOC maintains a database called Health"e" Intent, which is located on the Amazon Cloud. The data is imported from many different sources including clinical data from the Cerner EMR, claims data, lab data from Quest and LabCorp. CHOC is continuing to expand the data imports into the database. The CHOC Clinic Smart Registry utilizes information from Health"e" Intent. At the implementation of the Asthma Registry into the EMR two measures (asthma control test [ACT] and Asthma Action Plan [AAP]) were chosen to focus provider's adherence. This registry data is embedded into the CHOC ambulatory EMR which gives providers real time feedback on patient measures. Providers can then use the information to assist in decision making based on NAEPP guidelines.

CHOC received the 2016 Healthcare Information and Management Systems Society (HIMSS) Enterprise Davies Award (Cerner, 2018). This prestigious award is given to organizations who have adopted the EMR to improve patient outcomes and information technology while achieving a return on their investment. One of four studies submitted to HIMSS was embedding the asthma care guidelines in the inpatient EMR. They created alerts for the discharge of asthma patients from the inpatient setting for patients who did not have an AAP. The provider could not continue with the discharge until the AAP was initiated. This intervention decreased the average length of stay from 2.14 days in 2010 to 1.72 days in 2016 a 19.6% decrease. Asthma readmissions within 30 days after discharge decreased by 59% per quarter from a mean of 1.7 per quarter (Q3 2010 – Q4 2011) to 0.7 per quarter (Q1 2012 – Q3 2015) (Cerner, 2018). CHOC continued to collaborate with Cerner and integrated the Asthma Registry data into the EMR in 2015. Since the integration, CHOC has seen changes in provider behavior but has not researched or published the data.

EMR training was provided by the Information Technology (IT) Department at CHOC at the initial implementation of the EMR (Go Live) in February and March 2015 for the primary care clinics, and all new providers employed after the initial implementation (J. Jones, personal communication, September 27, 2018). Providers attended two sessions of training (three hours each) to focus on ambulatory electronic documentation and order entry prior to the Go Live. During the two weeks of Go Live, an informatics' support/super user was provided for every two providers (ratio 1:2), which was adjusted if a provider was struggling with the use of the EMR in their practice. New hire providers were given web-based modules to complete prior to attending the two classes (three hours each). New hires were offered an optional working session two to three weeks after their start date for questions and answers (Q&A), and Tips and Tricks. Providers supported each other after the training classes, with the attending provider supporting the residents, during the implementation phase of applying the information to daily practice (J. Jones, personal communication, September 26, 2018).

The Asthma Registry Platform Go-Live was in 2015, with a “soft Go-Live” in late 2016 (J. Jones, personal communication, September 26, 2018). During the Go-Live, informatics’ team members attended division meetings to provide an overview of the registries. The team members rounded with providers to reinforce the importance and use of the registry in evaluating and developing treatment plans for asthma. New hires received a module which provided an overview of the registry. Cerner also provided adoption coaches to assist with training (J. Jones, personal communication, September 26, 2018). In 2019, the providers were given financial incentives to improve their adherence to the two designated asthma measures, ACT and AAP (W. Feaster, personal communication, August 3, 2018).

The data from Health“e” Intent was used in this research to answer the questions:

1. Is there a difference in the use of NAEPP guidelines after the integration of the Asthma Registry into the electronic medical record as compared to before, in the Medi-Cal population at CHOC Children’s? Variables to measure: ACT, AAP, inhaled corticosteroids (ICS) prescription written, and spacer prescription written.

2. Is there a difference in patient outcomes (hospital admission, ED visits, clinic visit with diagnosis of asthma exacerbation) between Children’s Medical Group (CMG) and Non-CMG in CHOC Health Alliance (CHA) after the integration of the Asthma Registry into the EMR?

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CHAPTER 2

LITERATURE REVIEW

A systematic literature review was conducted for the topic of Provider Adherence to the National Asthma Education and Prevention Program (NAEPP) guidelines in the Medi-Cal population utilizing the following databases: PubMed at UCLA, Cumulative Index of Nursing and Allied Health Literature (CINAHL), Cochrane Library and Web of Science. To complete the search, the following key words and terms were used: guidelines, adherence, asthma, use of guidelines, interventions, provider, physician or medical doctor (MD), nurse practitioner (NP), electronic medical record (EMR), and electronic health record (EHR). Multiple research articles were retrieved in the search. The review was accomplished using two different subject searches: provider adherence to NAEPP guidelines, and interventions used to improve provider adherence to NAEPP guidelines.

Provider Adherence to NAEPP Guidelines

The search of provider adherence to NAEPP guidelines generated the following results. PubMed at UCLA yielded 24 documents. Medical Subject Heading (MeSH) were then used which brought 22 articles, three additional articles were retrieved. The use of MeSH in CINAHL yielded 36 articles, all the articles were retrieved in the original CINAHL search which yielded 54 articles. The search in Web of Science bore 16 documents. Web of Science does not have MeSH search available. The search gave 92 research articles in total which were reviewed for content and application.

Articles containing research on adherence to NAEPP guidelines were evaluated utilizing inclusion criteria of physician and NP. This search retrieved only one article with both disciplines. An expanded search was then conducted for individual articles for physician or NP.

This search produced ten additional articles for physicians and one article for NPs. To broaden the search, international articles were included. Criteria for inclusion was expanded to include guidelines from National Heart, Lung, and Blood Institute (NHLBI) NAEPP or Global Initiative for Asthma (GINA) and World Health Organization (WHO) guidelines. GINA and WHO guidelines are based on the NHLBI NAEPP guidelines used in the United States (U.S.). Articles were excluded if they used any other asthma guidelines. Limiting to these guidelines permits the evaluation and synthesis of the same guidelines with international studies. The expanded search resulted in two additional articles from Saudi Arabia and Malaysia, one from each country.

Analysis. The literature review yielded a total of fourteen (14) research articles on adherence to NAEPP guidelines. Many of these articles did not use recent data at the time they were written. Ten of the fourteen articles were published more than five years ago. There were two major updates to the guidelines in 1997 and 2007 making it difficult to directly compare the individual items identified to determine adherence. Data prior to 2007 was used by Janson-Bjerklie (2004) and Navaratnam, Jayawant, Pedersen, and Balkrishnan (2008). Therefore, they used the NAEPP Expert Panel Report 2 (EPR-2) update in 2002. Data from 2003-2006 was used by C.-L. Tsai, A. F. Sullivan, A. A. Ginde, and C. A. Camargo (2010) prior to the 2007 guideline change. Their article was published in 2010, four years after the data collection and three years after the NAEPP Expert Panel Report 3 (EPR-3) was published. Five articles were published within four years after the 2007 NAEPP EPR-2 update: Diette, Skinner, Nguyen, et al. (2001), Diette, Skinner, Markson, et al. (2001), Finkelstein et al. (2000), Legorreta et al. (1998), and Scribano, Lerer, Kennedy, and Cloutier (2001). Flores, Lee, Bauchner, and Kastner (2000) did not identify when their data was collected. Within the past seven years, four articles have been published: Akinbami et al. (2019), O'Laughlen, Rance, Rovnyak, Hollen, and Cabana (2013), Yawn, Rank, Cabana, Wollan, and Juhn (2016), and Aftab, Khan, Syed Sulaiman, Ali, and Khan (2014), an international article.

The checklist from The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) (Von Elm et al., 2014) was used to evaluate the articles. For each of the 22 items of the manuscript, a scale of .25-1 (1 being most rigorous) was used. Fourteen articles were evaluated. Out of these 22 items, the overall rating of the articles was moderately low. The fourteen articles had a mean of .65 (range .35 – .95). There are multiple reasons for the relatively low ratings: survey validity and reliability, response rate, lack of stratification of disease severity, method of study not clearly defined, poor statistical measures, and time lag of data collection and report.

Seven of the fourteen studies used surveys with low response rates reported in all but two of the studies. Diette, Skinner, Markson, et al. (2001) reported a 60% response rate. Abudahish and Bella (2010) reported a 100% response rate; a directive was given by the Director of Health Affairs to the physicians to comply, a bias which was identified in the study. Only one, Legorreta et al. (1998), of the six studies validated their survey. Akinbami et al. (2019) utilized the 2012 National Asthma Survey of Physicians (NAS): National Ambulatory Medical Care Survey (NAMCS) which was approved by National Center for Health Statistics' NAMCS. O'Laughlen et al. (2013) made changes to Cabana, Rand, Becher, and Rubin (2001) survey, but did not validate it prior to use. Aftab et al. (2014) only used face validity in their study. Validity was not addressed by Abudahish and Bella (2010), Diette, Skinner, Markson, et al. (2001) and Diette, Skinner, Nguyen, et al. (2001).

Ten of the fourteen studies were cross sectional studies. C.-L. Tsai et al. (2010) identified their study as a retrospective cohort study, but it also was a cross sectional study. They looked at emergency department (ED) visits in 23 states from the National Emergency Department Safety Study at a single designated time. Scribano et al. (2001) research was a prospective cohort study with a Hawthorne effect as a possible limitation. Diette, Skinner, Markson, et al. (2001) used a retrospective study for the period 2010 through 2014. A retrospective study was also used by Yawn et al. (2016) for the years 2009-2014.

Nurse practitioners (NP) were identified as included and compared in only two of the studies. Comparison of NP adherence with physicians was studied by O'Laughlen et al. (2013). Physician adherence data was used from the Cabana et al. (2001) study. To evaluate NPs, the researchers adapted the Cabana et al. (2001) survey and administered it in 2009 and 2010. The administration of the survey was after the EPR-3 revision in 2007. Therefore, the guidelines for practice were different for both groups due to the eight-year time span between the administration of the survey for the two groups. C.-L. Tsai et al. (2010) attempted to look at the adherence of the NP (n=17) and physician assistants (PA) (n=61) and compare with physicians in the ED. Due to the small numbers of NPs and PAs, the two disciplines were combined as mid-level providers (MLP). Training was identified as a limitation of the study due to many new hires in the MLP group. They did not identify which MLPs were new and this was not controlled for in the study. Identification of the MLP as supervised and unsupervised was identified, but the researchers did not identify which of the MLPs were supervised in their results. Supervision is not required of NPs by licensing, but the facility may have developed protocols that require supervision. Because of the limitation of these studies, a difference in practice cannot be appropriately determined.

NAEPP guidelines recommend individual treatment plans based on disease severity at time of diagnosis and at each follow up visit. One recommendation is the use of inhaled corticosteroids (ICS) with patients classified with persistent asthma on step two. Many of the studies did not identify the patient classification, yet looked at adherence with ICS prescription. Asthma disease severity was a measure in five of the fourteen studies. Two studies identified both ICS treatment with disease severity: Diette, Skinner, Nguyen, et al. (2001) and Legorreta et al. (1998).

Similar limitations were identified among the studies. The potential for self-report bias was found in five studies: Abudahish and Bella (2010), Aftab et al. (2014), Akinbami et al. (2019), Finkelstein et al. (2000), and O'Laughlen et al. (2013). Actual practice from self-report may differ. Managed Care Organization (MCO) data was used by Diette, Skinner, Nguyen, et al. (2001), Diette, Skinner, Markson, et al. (2001), Finkelstein et al. (2000), and Legorreta et al. (1998). MCO is a private insurance. Due to the exclusion of Medicaid/Medi-Cal and the uninsured populations, the studies are not generalizable to these populations.

Logistic regression was the most commonly used statistical measure controlling for confounding variables in the studies. This is an appropriate analysis but many of the independent variables did not allow for a complete analysis of the relationships within the data; no interactions of variables were reported in any of the statistical tests. An example is a study by Janson-Bjerklie (2004) looking at the use of ICS. The severity of disease was not assessed in relation to the use of ICS, therefore it is unknown if providers are adhering to the guideline for use of ICS with specific disease severity classification.

Results. Low adherence of all disciplines was shown by all fourteen research articles. Aftab et al. (2014) found a fair level of patients (75.9%) who received treatment in the ED were in compliance with GINA guidelines. Adherence to the guidelines varied by years of clinical experience. Physicians with less than three years' experience (n =18, 67%) had adequate knowledge of the GINA guidelines (n = 16, 88.8%). The researchers report this may be due to more familiarity with the guidelines due to their recent attendance in school and attending more conferences. The remaining physicians (33%) had 3-5 years of experience. Of the eleven research articles, Aftab et al. (2014) showed the highest rate of adherence to NAEPP guideline.

O'Laughlen et al. (2013) considered greater than 90% as acceptable adherence to guidelines. They measured four components using chi-square (χ^2 measurement was not reported): prescribing an ICS (NPs 79%, MDs 54%, $p = .001$), patient screening/counseling on smoking cessation (NPs 62%, MDs 43%, $p = .001$), parental screening/counseling on smoking cessation (NPs 55%, MDs 53%, p = n.s), and peak flow meter instruction (NPs 21%, MDs 38%, statistical test $p = .001$). NPs were more adherent to NAEPP guidelines than MDs, yet neither discipline was over 90%, thereby, neither NP nor MD were adherent to guidelines. As stated previously there were many limitations in this study including the time span between measurement of the two disciplines in the study and use of different versions of the guidelines. C. L. Tsai, A. F. Sullivan, A. A. Ginde, and C. A. Camargo, Jr. (2010) reported supervised MLP (67%) and MD (64%) adherence rates were similar, but unsupervised MLPs (57%) were lower than both groups. The researchers felt the difference was due to new staff members and lack of training on NAEPP guidelines. The disease severity was not identified, thereby unable to determine if the treatment measured in the study was recommended by the guidelines.

Cross sectional studies were done by two researchers to compare the primary care provider with the specialist (allergist or pulmonologist). Both found adherence by the specialist was greater than the primary provider. Diette, Skinner, Nguyen, et al. (2001) found within specified domains, the specialist performed significantly higher than the PCP: controller meds (94% vs. 72%, $p < .01$), written instructions (69% vs. 46%, $p < .05$), and pulmonary function test

(PFT) (86% vs. 48%, $p < .05$) (Diette, Skinner, Nguyen, et al., 2001). Similar results were shown by Janson-Bjerklie (2004) of specialist adherence greater than PCP to NAEPP guidelines. Chi-square was used to compare the two groups showing statistical significance between the specialist and PCP: spirometry at diagnosis (dx) (73% vs. 27%, $\chi^2 = 93.9$, $p = .0001$), spirometry used to monitor patients (88% vs. 68%, $\chi^2 = 19.9$, $p < 0.0001$), prescription for peak flow monitor (94% vs. 84%, $\chi^2 = 8.5$, $p = 0.014$), and written action plans ($\chi^2 = 26.2$, $p < 0.0001$) (Janson-Bjerklie, 2004).

Physician adherence was evaluated by six additional studies, six were cross sectional. An additional study by Scribano et al. (2001) was a prospective cohort study. Training on new clinical practice guidelines (CPG) was provided for all physicians in the study. After training, physician adherence to NAEPP guidelines was 68%, with a possible Hawthorne effect. With the additional training, the researchers recommended additional training to increase adherence to NAEPP guidelines. Malaysian physicians showed a fair adherence of 74.1% (Aftab et al., 2014). As previously stated, this study had physicians with minimal experience; less than three years (66%); and 3-5 years of experience (33%). There was a statistical significance between the less than three years and 3-5 years of experience groups, ($p = 0.02$).

Managed care organizations (MCO). MCOs were evaluated by Legorreta et al. (1998), Finkelstein et al. (2000), Diette, Skinner, Markson, et al. (2001), and Diette, Skinner, Nguyen, et al. (2001). All four studies concluded providers did not adhere to NAEPP guidelines based on multiple variables, but no overall adherence was reported in any of the studies. Different measures were evaluated by the different researchers. Finkelstein et al. (2000) evaluated the measures of spirometry, specialty referrals and peak flow meter (PFM) comparing adherence of family physicians to pediatricians. They found family physicians were more likely than pediatricians to utilize spirometry for diagnosis (odds ratio [OR] = 5.9, 95% confidence interval [CI] 2.4, 14.6). There was no statistically significant difference between the two groups when referring to a specialist. Legorreta et al. (1998) compared the generalist to the specialist using the different measures of ICS, beta 2 agonist use, and disease management knowledge (results are in the respective sections of this chapter below). Two studies evaluated PFM. Family physicians were less likely than pediatricians to recommend PFM (OR = 0.3) (Finkelstein et al., 2000). Legorreta et al. (1998) found PFMs were recommended more by specialists than generalists (46% vs 19%), $p < .001$. Diette, Skinner, Nguyen, et al. (2001) surveyed patients/families of MCOs with the diagnosis of asthma and their knowledge to evaluate provider adherence. They found statistically significant differences when patients saw a specialist than those seen by PCPs. All three research articles showed a low adherence to NAEPP guidelines in the MCOs. Diette, Skinner, Markson, et al. (2001) utilized the same survey of MCO patients/families, and reported deficiencies in all four domains of care measured.

Asthma Action Plan. NAEPP guidelines recommends all patients receive an Asthma Action Plan (AAP) which includes 2 elements: daily management and how to recognize and handle worsening symptoms (U.S. Department of Health and Human Services, 2007). Of all the research studies, Yawn et al. (2016) was the only study to look at AAPs. They found of 1176 participants only 37 (3.1%) had AAP. When looked at by age, 8.9% of 5-11 years, 2.4% of 12-18 years, and 1.0% of adults 19-65 years of age had AAP. They report this as being the least commonly documented non-medication element in the medical record (Yawn et al., 2016).

Asthma Control Test. EPR-3 recommends the assessment for control of asthma and discusses the use of a validated Asthma Control Test (ACT) to facilitate and standardize the assessment (U.S. Department of Health and Human Services, 2007). Yawn et al. (2016) and

Akinbami et al. (2019) looked at asthma control and ACT as a measurement. Both found low compliance. Akinbami et al. (2019) reported Family/General Medicine providers self-reported Asthma control/ACT: almost always 3.5%/2.4%, often 3.5%/2.5%, and sometimes/never 3.5%/2.5%. Pediatricians self-reported: almost always 4.2%/3.5%, often 4.4%/3.3%, and sometimes/never 5.2%/3.5%. Yawn et al. (2016) reported documentation of asthma control in 15% of all patients and a validated tool was used 7.5% of the time. When stratified by age results showed (documentation of asthma control/use of validated tool): 5-11 years (15.0%/7.5%); 12-18 years (22.1%/11.2%), and adults 19-65 years (11.6%/6.0%). A validated instrument was used in 50% of the assessments (Yawn et al., 2016).

Patient Education. Diette, Skinner, Nguyen, et al. (2001), who evaluated MCOs, found patient knowledge was higher when seen by a specialist, as compared to PCPs. They looked at combined indicators from the survey administered to determine knowledge. Patients were asked about when to use medications. A positive response for use of controller medications for those who saw a PCP was 72.2%; those who saw a specialist was 94.3% ($p < .05$). Survey participants showed less knowledge about appropriate use of ICS if they saw only a PCP (33.3%) compared to those who saw a specialist 57.6% ($p < .05$). PFT performed by a PCP (47.8%) vs. a specialist (86.1%) was also statistically significant, ($p < .05$). Diette, Skinner, Markson, et al. (2001) used two conceptual domains to measure education: patient education for a partnership which included four measures, and control of factors contributing to asthma severity, consisting of two measures. They reported the percentage for each measure within age groups as low, and a significant difference for race and age. Non-whites were less likely than whites to receive education of peak flow meters (58% vs 77%, $p < .05$), and inhalers (65% vs. 78%, $p < .05$). Older children more likely than younger children to receive instruction on inhaler use (82.1% vs.

70.2%, $p < .05$). Legorreta et al. (1998) reported when patient's knowledge on managing a severe asthma attack was rated, 70% of patients reported their knowledge as good. Abudahish and Bella (2010) reported documentation of education in 53.7% of specialty asthma medical records, none was reported in the traditional or paper medical records. Physician knowledge was reported: 82% knew of the guidelines, 73.8% had read the guidelines, and 46.7% were trained on guideline usage.97.8% of the physicians were in agreement of the GINA guidelines, but 90% were not using the most recent GINA guidelines (Abudahish & Bella, 2010). Yawn et al. (2016) measured education of inhaler technique, 7.6% of all ages documented education, with only 1.3% documented observation of technique with the education.

Inhaled Corticosteroids (ICS). NAEPP recommendations include the use of ICS for all severities of persistent asthma in all age groups (HHS, 2007). Seven of the studies reviewed evaluated ICS as an independent variable (Diette, Skinner, Markson, et al., 2001; Diette, Skinner, Nguyen, et al. (2001); Janson-Bjerklie, 2004; Legorreta et al., 1998; Navaratnam et al., 2008; O'Laughlen, Rance, Rovnyak, Hollen, & Cabana, 2013; Yawn et al., 2016).

Janson-Bjerklie (2004) compared PCPs to specialists in ICS use. Patients were grouped based on severity of disease of mild or moderate persistent asthma. ICS was given for mild persistent disease by PCPs (67%), and specialists (80%) of the time, $\chi^2 = 7.84$, $p = .005$. For moderate persistent asthma, ICS was prescribed by PCPs (85%) and specialists (93%), $\chi^2 = 4.30$, $p = .038$. Legorreta et al. (1998) showed ICS use by specialists was 81% and generalist 63%. Logistical regression showed there was increased likelihood of providers prescribing ICS for older populations: age 26-35 years (OR=1.57, $p < .01$, 95% CI [1.23, 2.01]), 36-45 years (OR= 1.81, $p < .01$, 95% CI [1.44, 2.29]), 46-55 years (OR=2.03, $p < .01$, 95% CI [1.61, 2.57]), 56-65 years (OR=2.45, $p < .01$, 95% CI [1.91, 3.15]), African American compared to Hispanic, Asian, and other (OR=0.65, $p < .01$, 95% CI [0.49, 0.86]), and completed some college (OR=1.48, $p < .01$, 95% CI [1.26, 1.73]). Similarly, Diette, Skinner, Nguyen, et al. (2001) compared ICS use by specialists (94%) and PCPs (72%) (χ^2 value not reported, $p < .01$). O'Laughlen et al. (2013) compared NPs prescribing of ICS for patients with daily symptoms (79%) to MDs (54%) and found statistical significance (χ^2 value not reported, $p = .001$). Navaratnam et al. (2008) measured ICS and rescue medication adherence, controlling for physician and patient characteristics. Patients in 2002 were 3.3 times more likely to be prescribed controller medications than patients in 1998, (OR= 3.346, 95% CI 1.94, 5.76, $p < .001$). But, in 2003 this had decreased to 1.9 times more likely to receive controller medications than patients in 1998, (OR = 1.881, 95% CI 1.04, 3.37, $p = .04$). The odds ratio for ICS prescribing was not statistically significant in any of the years after 1998, but established patients were two times more likely than new patients to receive ICS, $p = .04$ (Navaratnam et al., 2008). The difference of ICS prescriptions between age groups was reported as low by Diette, Skinner, Markson, et al. (2001) and Yawn et al. (2016). Diette, Skinner, Markson, et al. (2001) reported 72% of children (0 – 17 years of age) with asthma had a controller (ICS), with only 46.2% reporting daily use. Yawn et al. (2016) reported similar findings of daily maintenance 70.4% for ages 5-17 years.

Spirometry. To accurately diagnosis asthma, spirometry is the gold standard. It is also recommended that spirometry be used at follow-up visits to evaluate current status and compare changes with prior testing (HHS, 2007). The use of spirometry was evaluated in five studies (Akinbami et al., 2019; Diette, Skinner, Markson, et al., 2001; Diette, Skinner, Nguyen, et al., 2001; Finkelstein et al., 2000; Janson-Bjerklie, 2004).

Janson-Bjerklie (2004) used chi-square to compare PCPs' and specialists' use of spirometry in the diagnosis of asthma. Using an interview survey, they found PCPs used spirometry to diagnose 27% of the time and specialists 73% ($\chi^2 = 93.9$, $p = .0001$). Monitoring patients with spirometry, PCP usage was 68% and specialists 88% ($\chi^2 = 19.9$, $p = .0001$). Finkelstein et al. (2000) and Akinbami et al. (2019) used self-report by physicians. Finkelstein et al. (2000) research showed physicians self-reported their use of spirometry as: always using spirometry for dx 20.5%; and some of the time 20.6%. Physicians reported their use of spirometry for routine follow up monitoring: always 8.3%, and some of the time 19.9%. Akinbami et al. (2019) research shows family practice providers report use of spirometry almost always 2.0%, often 2.8%, and sometimes/never 2.8%. Diette, Skinner, Nguyen, et al. (2001) compared PCP use of PFT (can be used in place of spirometry) at 47%, with the specialist at 88% ($p < .001$). There was no differentiation made between diagnosing and monitoring in Diette, Skinner, Nguyen, et al. (2001). Diette, Skinner, Markson, et al. (2001) reported 52.8% of asthma patients 0-17 years of age ever had a pulmonary function test. Low adherence for the use of spirometry for diagnosis and monitoring was found in all four studies (Diette, Skinner, Markson, et al., 2001; Diette, Skinner, Nguyen, et al., 2001; Finkelstein et al., 2000; Janson-Bjerklie, 2004).

Peak flow meter (PFM). NAEPP recommendation for patients above the age of five years is to use PFM for daily monitoring. PFM are used at home to monitor changes in pulmonary status to assess treatment and prevent asthma exacerbations prior to severe symptoms occurring. PFM is not intended to be used for the diagnosis of asthma (HHS, 2007). PFM monitoring was evaluated in four of the studies reviewed (Akinbami et al., 2019; Finkelstein et al., 2000; Janson-Bjerklie, 2004; Legorreta et al., 1998).

Finkelstein et al. (2000) compared family practice physicians and pediatricians in recommending the use of daily PFM monitoring. Pediatricians were 2.4 times more likely than family practice physicians to use daily PFM (95% CI [1.3, 4.3]). Janson-Bjerklie (2004) compared PCPs and specialists in the prescription of PFMs. PFMs were prescribed 84% by PCPs and 94% by specialists showing a significant statistical difference ($\chi^2 = 8.5$, $p = .014$). Akinbami et al. (2019) self-report shows PCP ask about peak flow results: almost always 1.9%, often 3.2%, and sometimes/never 3.4% of the time. Legorreta et al. (1998) reports 26% of asthma patients have PFMs at home, of those patients only 16% are using it daily. It is not clear what the percentage of PFMs were prescribed by PCPs or specialists. Adherence to recommendations for PFM is very low in two of the reviewed studies (Finkelstein et al., 2000; Janson-Bjerklie, 2004), and provider adherence was not able to be ascertained in Finkelstein et al. (2000).

Interventions to Improve Provider Adherence

A separate literature review was conducted to evaluate interventions used to increase provider adherence to NAEPP guidelines. Databases accessed for the search were PubMed at UCLA, CINAHL, Cochrane Library and Web of Science. Key terms included intervention, asthma, provider, adherence, behavior, and guidelines. PubMed at UCLA yielded 527 articles, CINAHL produced an additional six articles, Cochrane Library one additional article, and none from Web of Science. Attempts were made to decrease the number of articles using combinations of the terms but only two to five articles were retrieved in each. Therefore, each of the 564 titles and abstracts were reviewed for relevance to the subject. During this portion of the review 20 articles which contained EHR or EMR interventions were identified for separate evaluation to be discussed in the next section. Of the remaining 544 research articles, 54 articles were identified for more in-depth review.

The Agency for Healthcare Research and Quality (AHRQ) published a comprehensive systematic review of the literature in Comparative Effectiveness Review, Number 95 titled

“Interventions to Modify Health Care Provider Adherence to Asthma Guidelines” (Okelo et al., 2013). The review included 73 studies, of which 38 were conducted in the U.S. Due to this review, articles obtained in this literature review before 2013 were excluded (n=27). Provider behavior unrelated to guidelines use and patient adherence were the subjects of 17 studies from the search which were also excluded. The remaining studies included the Okelo et al. (2013) published review of the AHRQ report, Mold et al. (2014), Cloutier (2016), and Walls, Hughes, Mullan, Chamberlain, and Brown (2017). The interventions of these three articles are discussed in relation to the findings of Okelo et al. (2013) literature review.

The AHRQ review was conducted because of the limited use of NAEPP guidelines by providers (Okelo et al., 2013). The guidelines have shown to be effective towards patient outcomes, yet providers do not use the guidelines. Most interventions have been focused on the patient to improve outcomes. There has been research on provider adherence and reason for not adhering to NAEPP guidelines, but there is no consensus on the most effective way to change provider behavior to adhere to the guidelines. The Okelo et al. (2013, p. 51) literature review asked “In the care of the pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines: 1) impact health care process outcomes? 2) impact clinical outcomes? 3) impact health care process outcomes that then affect clinical outcomes?”

The AHRQ review identified four components: asthma controller medication prescription, AAP, ED visits/admission, and number days missed work or school. There were eight types of interventions: decision support, organizational change, feedback and audit, clinical pharmacy support, education only, quality improvement and pay-for-performance, multicomponent, and information only. Of the 73 studies in the AHRQ review, 68 addressed one of the four components. Few randomized control trials (RCT) were identified to test the interventions, most were pre-post design which reported a beneficial effect. The research focused most on improving health care processes, with less on clinical outcomes. A summary of the strengths of the eight different interventions based upon the four outcomes was presented. They concluded, due to the insufficient evidence (few RCT) they could not comment on the effectiveness of the interventions. The review showed more research is needed on the improvement of clinical outcomes from the interventions, with the inclusion of cost to implement the measures.

Pathway in emergency department. A change concept was used to implement best practice guidelines in a community ED (Walls et al., 2017). Patients in the ED received an asthma score (1-10). The score gives providers standardization and operational definition, which allowed easier communication within the care team. The pathway included two order sets: triage and provider. Nurse initiated therapies (triage) allowed for early administration of steroids. Adjustments were also made within the ED for increased availability of respiratory therapists and movement of the medication dispensing system to the triage area. Education was provided to the care team, including providers. The study showed an increase of steroid use from 60% before the pathway implementation to 76% after (OR = 2.2, 95% CI 1.6, 3.0, $p < .0001$). (Walls et al., 2017).

This intervention of decision support is congruent with Okelo et al. (2013) report of interventions on outcomes; which states prescription of control medications with decision support has a large magnitude of benefit effect. Walls et al. (2017) also reported on the outcome measurement of ED and hospital admissions. The study was done in the ED, the transfer of patients to the inpatient setting had decreased from 14% to 10% after the implementation of the guidelines (OR = 0.63, 95% CI 0.40, 0.99, $p = .046$) (Walls et al., 2017). Okelo et al. (2013) reports the outcome of decreased hospital ED and admission with decision support as a benefit with moderate effect. Walls et al. (2017) did not measure or report AAP or missed school work days; therefore, these two outcomes cannot be compared with Okelo et al. (2013) review.

Practice facilitation and local learning collaborative. The intervention studied by Mold et al. (2014) used practice facilitation (PF) and local learning collaborative (LLC) in a random controlled trial with four arms: 1) PF only, 2) LLC only, 3) PF plus LLC, and 4) control. There were 43 practices in three research networks of primary care practice enrolled. Each practice received handouts including NAEPP guidelines, and a toolkit. A clinician was designated to give education and feedback to providers in all groups. Those in the PF had a facilitator visit their practice every other week for six months. Those in the LLC met for one hour monthly to discuss performance data, strategies and implement changes to refine their plan. There were six outcomes measured in each group. The outcome measure of assessment of asthma severity was improved after the intervention in each of the four groups ($p < .01$), with an overall $p < .001$. The control group had only two of six measurements with significant improvement ($p < .01$). The PF only group had three of six measures with significant improvement ($p < .01$), while the LLC group had four of six measures with significant improvement (two measures at $p < .01$, and two measures $p < .05$). The PF plus LLC had the most improvement with five of six measures significant (three measures $p < .01$, and two measures $p < .05$). The outcome measure for AAP was only significant in the LLC group (p < .05), but still low at 8% after the LLC intervention. The use of asthma controllers improved in all groups but was only significant in the PF plus LLC, and LLC groups (p < .05) (Mold et al., 2014).

Mold et al. (2014) concluded even though practitioners were given tools, they were not given a sequence of steps. Each practice was allowed to identify their goals, design improvement strategies and implement the changes independently. They found PF was significantly better than education alone and practice tools or feedback in two of the six measures (Mold et al., 2014). These findings conflict with Okelo et al. (2013) who reports AAP with feedback have a benefit effect with low magnitude and education alone as small to moderate benefit effect. The prescription of controller medication according to Okelo et al. (2013) had a moderate benefit effect with feedback and no benefit with education, which is demonstrated in the research of Mold et al. (2014). The difference found may be due to the RCT which Okelo et al. (2013) had very few. The RCT of Mold et al. (2014) supports Okelo et al. (2013) statement of the need for additional RCT and their inability to comment on the effectiveness of interventions to change provider adherence in the use of NAEPP guidelines.

Easy breathing program. The Easy Breathing Program was implemented in Connecticut 18 years ago (Cloutier, 2016). The program guides the provider in clinical diagnosis (severity) and treatment with decision support. An easy to understand AAP was developed and used by providers for patients. Cloutier, Wakefield, Carlisle, Bailit, and Hall (2002) had previously published the effects of the Easy Breathing Program in 2002, which was included in the Okelo et al. (2013) review. After implementation of the program 18 years ago, it continues to have adherence to asthma severity specific therapy (96%) and AAP (94%) (Cloutier, 2016). Cloutier (2016) did not report any additional findings but did include the topic of information technology in the EHR/EMR and its implications in the article, which are discussed in the next section.

Interventions of EHR/EMR to Improve Provider Adherence

The comprehensive literature search was conducted using the key intervention, asthma, provider, adherence, behavior, and guidelines. The search identified 20 articles with EHR/EMR as a topic. Of these articles, eleven described the development, use and/or implementation of NAEPP guidelines into practice. None of the eleven were research articles giving results of the implementation and were not included in the literature review. An additional five articles were excluded. The topics of these articles were: attitudes of providers toward the use of NAEPP guidelines in the EMR, patient self-report survey after guideline integration into the EMR, defining terms based on algorithms in the EMR, and evaluating the difference between the provider and the computer decision support system assessment. This left four remaining studies for review.

Of the four remaining articles, two are research studies that implemented NAEPP guidelines into the EMR with differing processes for the providers: Bell et al. (2010) and Kercsmar et al. (2019). A third study by Kwok, Dinh, Dinh, and Chu (2009), implemented the National Asthma Council guidelines in Australia. The study was included due to the low number of studies published implementing NAEPP guidelines into the EMR. A dissertation by Kidd (2016) is included as one of the four studies being presented. Bell et al. (2010), Kercsmar et al. (2019) and Kwok et al. (2009) identified the intervention as a decision support tool to improve provider adherence to NAEPP guidelines. The decision support tool is an intervention identified by Okelo et al. (2013) as a benefit with moderate affect. All four studies used χ^2 to compare the control and intervention groups. Kercsmar et al. (2019) also used Kruskal-Wallis test for continuous variables.

Analysis. The four studies were all conducted after 2007, the publication of NAEPP EPR-3. Publication dates were 2009 (Australia), 2010, 2016, and 2018. The checklist from The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) (Von Elm et al., 2014) was used to evaluate the articles. For each of the 22 items of the manuscript, a scale of .25-1 (1 being most rigorous) was used. The mean for the three articles was 0.69 (.35 – .95).

Bell et al. (2010) described the clinical decision support (CDS) intervention in their study as the Pediatric Asthma Control Tool (PACT) introduced into the EMR. The CDS provided alerts and reminders to the provider to guide their use of the tools. The alerts and reminders were personalized to the individual patient based on information captured in the PACT, diagnosis and medical history. They had one pop-up, which was not disruptive, that gave the provider a brief history of the patient and recommendations the provider can choose. Kercsmar et al. (2019) developed the Asthma Control Evaluation and Treatment (ACET) Program. The CDS tool was used to score patients with persistent uncontrolled asthma age 6 – 20 years. Patients were then assigned appropriate step treatment based on NAEPP guidelines. Follow up measures were also entered at visits with changes in control levels and treatment steps evaluated. Kwok et al. (2009) used a decision support system called Asthma Clinical Assessment Form and Electronic decision support (ACAFE). This tool gave providers alerts and suggestions for management in real time. They did not show or discuss how the alerts were provided. The third study by Kidd (2016), did not state what was included in the EMR or how providers were affected by the implementation of the new template.

Of the four articles reviewed, Bell et al. (2010) had the most rigor of .95. The study had a large sample size of 19,450 children aged 2 – 18 years with 49,059 visits. The researchers designed a cross sectional prospective cluster randomized trial with the clusters stratified as urban and suburban. Initial differences between the two groups were identified which was reflected in the outcomes. The researchers used generalized linear models for cofounding variables and χ^2 for statistical testing between the two groups (Bell et al., 2010).

Kercsmar et al. (2019) research scored .75 for rigor. An RCT was designed and recruited persistent uncontrolled asthma patients (age 6-20 years) in urban census tracts. The study had a moderate sample size of 1443 participants in three trials over 10 years. They did not specify how the control group was determined. There was a Hawthorne effect which was identified as a limitation, as participating providers were specialized and trained for the study and knew they were being monitored during the study. Another limitation identified was the recruitment of participants: the ACET Program was used of which all participants belonged, therefore there was no non-ACET participants for a control group (Kercsmar et al., 2019),

The rigor of Kwok et al. (2009) was good with a score of .7, but had many limitations. The study was in Australia using their National Asthma Council guidelines. They used a small sample size of 100 (50 control, 50 intervention), but does give a power of 90% and alpha of .05. The patient must be enrolled at registration for the EHR intervention to be enacted, therefore, not all patients or providers utilized the Asthma Clinical Assessment Form and Electronic Decision Support (ACAFE). The hospital had also implemented a new registration process at the time the study was started which may have impacted patients being enrolled. The study took place over six months: Aug 2007 to Feb 2008. The researchers used χ^2 or Fischer exact test, Mann Whitney and 2 tailed statistical tests in their results (Kwok et al., 2009).

A dissertation by Kidd (2016) was not a rigorous study at .35. The study implemented an evidence-based asthma EHR template, but did not state what the template did or how the providers used it. The researcher used the Child Asthma Control Tool (C-ACT) designed by a pharmaceutical company which was validated to obtain information from the medical records manually. The study was in one pediatric practice with four MDs and one NP. A small sample size of 50 children aged 5 – 12 years was used, with no power or alpha given. The control (pre-implementation) and intervention (post-implementation) groups were compared using χ^2. There was no report of cofounding influences (Kidd, 2016).

Results. After implementation of a decision support intervention in the EHR/EMR, three of the four studies showed improved provider adherence to NAEPP guidelines: Bell et al. (2010), Kwok et al. (2009), and Kidd (2016). All three studies used AAP and spirometry as an outcome measure. Severity of illness and ICS was measured in two studies. Kercsmar et al. (2019) measured patient outcomes for asthma control (symptoms, rescue medication use, pulmonary function measure, and adherence estimates). None of the studies measured patient outcomes such as hospital admits, ED visits, or missed school/work days. Kwok et al. (2009) did state improving provider adherence to asthma guidelines with the use of information technology can ultimately improve the quality of healthcare delivery. Kidd (2016) stated a limitation of her study was the incompletion of the secondary purpose, the lack of comparison of missed school day, outpatient visits and hospital admissions due to lack of time.

Asthma action plan. Three studies included AAP as an outcome measure. Bell et al. (2010) reported after the implementation of CDS, the suburban group increased from 39% to 53% (14%), which was significant as compared to the control group who decreased by 11% (p = .03). But the intervention and control urban groups had decreased. The urban intervention group decreased 66% to 63% (-3%), with the urban control group decreased 72% to 68% (-4%). This difference was not significant. The researchers felt the difference in results of the suburban and urban groups was due to the urban groups having a higher use of AAP prior to the implementation of CDS. This was one of the statistical differences noted between the groups initially. A statistical difference was found for increased AAP by Kwok et al. (2009) in their study: the study group showed a higher rate (76%) than the control group (16%) (χ^2 measurement was not reported, $p < .01$). Kidd (2016) reported an improvement in AAP after the integration of the template into the EMR from 10% to 74% (χ^2 measurement was not reported, $p = .001$)

Spirometry. Significant improvement was reported in use of spirometry by Bell et al. (2010) in both the suburban and urban groups. The suburban intervention group improved from 8% to 14% compared to the control group which declined from 8% to 1% ($p = .003$). The urban intervention group improved from 15% to 24% compared to the control group's improvement of 16% to 22% ($p = .04$). Kwok et al. (2009) did show a difference between the study (70%) and control (66%) groups, but it was not significant ($p = .18$). The researches did not give a reason for the non-significant finding. Kidd (2016) reported an increase in spirometry from 4% to 32% after the implementation of the template ($p = .001$). Reported in the study was the purchase of a spirometer at the beginning of the study. It is difficult to say if the increase is from the new spirometer purchase or the template implementation.

Inhaled corticosteroids. Bell et al. (2010) reported a significant improvement in ICS prescriptions in the urban intervention group when compared to the control group (p = .006). But there was no significance in the suburban group. The researchers gave the rationale for the lack of significance in the suburban due to improvement in both groups improving (control 48% to 51%, intervention 57% to 74%), whereas in the urban group they were already performing high (control 79% to 80%, intervention 71% to 78%); yet the control group performed higher than the intervention group after the CDS was implemented (Bell et al., 2010). The study by Kidd (2016) shows an improvement in ICS from 58% to 100% (p = .258). The researcher states the non-significance is due to the provider having knowledge prior to the intervention. The rationale does not coincide with the initial result of 58%. Also, the report of 100% use of ICS is questionable as there are exceptions to the use (e.g. severity of disease, adverse reaction).

Severity of disease. Documentation of disease severity is recommended by NAEPP guidelines. The severity is used to determine the management and treatment of asthma. Kidd (2016) and Kwok et al. (2009) both report significant improvement in documenting asthma severity. Kwok et al. (2009) reported an 80% increase in documentation after implementing ACAFE from 18% to 98% (p < .01). A large increase of 38% was also reported by Kidd (2016) after implementation of an asthma template into the EMR. Before implementation, documentation was 60% compared to after implementation of 98% (p = .011) (Kidd, 2016).

Patient outcomes. A goal of the NAEPP guidelines is to improve patient outcomes including symptom control, decreased exacerbations, decreased ED and hospital admissions (U.S. Department of Health and Human Services, 2007). Kercsmar et al. (2019) measured asthma control in three multicenter RCTs from 2004 to 2014. They defined well controlled as when a participant within the prior two weeks had 0-3 days of minimal daytime symptoms, 0 – 1 night symptoms, and FEV_1 greater than or equal to 80% to 85% predicted value. Three trials were evaluated: Asthma Control Evaluation (ACE), Inner-City Anti-IgE Therapy for Asthma (ICATA), and Preventative Qmalizumab or Step-up Therapy for Severe Fall Exacerbations (PROSE). All three trials showed an increase in the well-controlled group: ACE trial increased from 22.7% to 72.8% (p < .001), ICATA trial increased from 27.7% to 62.7% (p < .001); and PROSE trial increased from 13.3% to 51.7% (p < .001) (Kercsmar et al., 2019).

Conclusion

There is little research published on provider adherence to NAEPP guidelines. Of the fourteen articles published, few are rigorous, with only three in the past seven years. As demonstrated, there are limitations and areas where specific analyses were not performed to ascertain adherence to NAEPP guidelines. There is no research specifically with Medi-Cal or Medicaid populations. These patients are at higher risk for increased asthma severity. MCOs were evaluated in three studies, all showed low adherence to NAEPP guidelines. With the most at-risk population not being evaluated, a true gap exists in the literature.

The comprehensive review of interventions to increase provider adherence to NAEPP guidelines by Okelo et al. (2013) included 38 articles from the U.S. The search after 2013 yielded 17 articles on interventions. Only six were research articles with the remaining 11 articles being descriptions of interventions and processes. Of the six published research articles, only four studies were asthma CDS interventions in the EMR. In 2003, CDS was reported to be in its infancy (Bates et al., 2003). Yet, 17 years later, there is little published research on the use of CDS in asthma patient care. Only three research articles have been published for the use of guidelines in the EMR, with only Bell et al. (2010) and Kercsmar et al. (2019), using NAEPP guidelines. This demonstrates a very large gap in the literature.

The literature review shows the overall adherence of providers to the NAEPP guidelines is low (range < 10% to 77%). Adherence to individual measures within the guidelines ranged from 3.1% to 88%. When specialists were compared with PCP, it was found the specialist adhered more to the NAEPP guidelines, but was low. NPs were found to adhere more than MDs to NAEPP guidelines but there were many limitations in the study. With the low adherence being shown in the literature many interventions have been developed to improve adherence with some improvement. One intervention described was implementing a CDS in the EMR, with only four studies (3 published [2 used NAEPP guidelines], 1 dissertation) completed. With only two articles published on intervention in the EMR to improved provider adherence to NAEPP guidelines, more research is needed in this area.

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CHAPTER 3

THEORETICAL FRAMEWORK

The foundation upon which knowledge is constructed is the theoretical framework (C. Grant & Osanloo, 2016). The framework guides the course of the research providing structure and support for the rationale of the research study. This research study utilized two theories, The Community Coalition Action Theory (CCAT) and Bandura's Social Learning Theory (SLT). The following describes the stages and phases of the CCAT, with application of the theory to this research study. The four concepts of SLT are also discussed based upon the application of SLT to this research study. The interaction of the two theories shows how the CCAT assisted in the development of the guidelines, and how SLT influences the provider's learning and integration of the guidelines into practice. Empiricism is presented as the philosophical method to evaluate the research.

Theoretical Framework

In 1989 the National Heart, Lung and Blood Institute (NHLBI) established the National Asthma Education Program. This program engaged different agencies including major medical associations, voluntary health organizations and community programs (National Heart Lung and Blood Institute, 2016). The goal of these groups was to improve the quality of life for asthma patients and decrease morbidity and mortality of the disease. This meets the definition of a community coalition according to Feighery and Rogers who define community coalitions as "a group of individuals representing diverse organization, factions, or constituencies within the community who agree to work together to achieve a common goal" (Feighery and Rogers as cited in Butterfoss and Kegler, 2002, p. 238). For community coalitions to develop and be successful they must progress through phases according to the Community Coalition Action

Theory (CCAT) (Butterfoss & Kegler, 2009). The theory includes interventions as a construct but does not provide guidance for changing individual behavior. There are many concepts to learning and changing behavior according to Bandura's Social Learning Theory (SLT) (Bandura, 2005). These concepts include modeling, triadic reciprocal determinism, self-efficacy and self-regulation (Bandura, 2005). For this reason, the Community Coalition Action Theory and Bandura's Social Learning Theory was used to guide the research.

Community Coalition Action Theory

In the 1990s there were many theories and models which described coalition development, components, interactions and outcomes: Typology of Community Organization and Community Building, Community Organization and Development Model, Framework of Organization Viability, Health Promotion and Community Development Model, Model of Community Health Governance, Framework for Partnerships for Community Development, and Community Coalition Model (Office of Health Policy, 2010). The CCAT built on all these models and was presented in 2002 (Butterfoss & Kegler, 2009). The authors of CCAT reported the difficulty of keeping up with the fast pace of building coalitions. This led to a delay in the development of CCAT theory development (Butterfoss & Kegler, 2002).

Butterfoss and Kegler (2002) developed the CCAT to describe coalitions not only in development, but also maintenance. Much of the prior research of community coalitions was focused on the relationship within the coalition and the reasons members join the alliances. The authors of the theory utilized literature from prior decades, their wisdom and knowledge of the subject, and personal experiences for the development (Butterfoss & Kegler, 2009). There were two significant research efforts that looked at community participation, which was the initial coalition research: the Neighborhood Participation Project and the Block Booster Project in New

York City (Butterfoss & Kegler, 2002). Butterfoss and Kegler (2002) identified assumptions. Their first assumption was based on a constructionist philosophy of communities being able to manage their own problems, where people in the community should make and adjust to control the changes needed. Proposed changes in communities are not effective if the changes are not meaningful or self-developed. Another assumption was that of holistic approaches. Fragmented approaches many times cannot have successful outcomes and requires additional support or ideas. For change to occur, cooperation and participation must come from the community. The learning skills of community members make it possible for good outcomes (Butterfoss & Kegler, 2002).

According to Butterfoss and Kegler (2009), coalitions may form for many reasons. One formation is due to a national threat. They use the example of asthma prevalence which augments community resources of many agencies. One agency which does not have access to many resources may benefit. Within a coalition their resources may expand such as: media coverage, meeting space, personnel, professional experts and networks. Another reason for formation may be the funding source requiring a coalition. An example is the Robert Wood Johnson Allies Against Asthma initiative (Butterfoss & Kegler, 2009). This initiative was provided by the Center for Managing Chronic Disease, University of Michigan. Outcomes of the initiative suggested programs that were community centered, collaborative, clinically connected and responsive to needs were more likely to report positive health outcomes from the impact of the program (University of Michigan, 2008).

The CCAT consists of 14 constructs and 21 propositions (previously 23), within the three phases of formation, maintenance and institutionalization (Figure 3.1) (Table 3.1) (Butterfoss & Kegler, 2009). Not all the relationships between the constructs have been tested. The researchers speculated on the relationships using the propositions to assist in logical ordering of the constructs (Butterfoss & Kegler, 2002). The CCAT has been used to assist in selecting factors for coalitions as opposed to being tested as a theory (Butterfoss & Kegler, 2009). The three phases are not linear; the coalition may loop around and backwards many times until the desired outcome is achieved with the first two propositions used for planning throughout the process (Butterfoss & Kegler, 2009).

The formation stage includes the constructs of a lead agency and coalition membership with propositions 4 through 14 (Table 3.1) (Butterfoss & Kegler, 2009). This stage occurs after a health or social issue is identified (proposition 3). After a lead agency identifies a health or social issue, they bring key organizations together to focus on the problem. Key leaders are identified incorporating community gatekeepers who have an in-depth understanding of the community and groups that can provide support and value to the project whereby structure and processes develop. Recruiting broad constituents and incorporating diverse groups within committed organizations produces a more effective coalition. During this stage communication is critical for decision making and conflict management. These processes ensure a positive environment where the benefits outweigh the costs. Costs may include loss of resources, control and competitive position, conflict of goals and outcomes, and delays in problem solving. Strong leadership and staff with interpersonal skills create a synergistic effect within the coalition to assist in making the collaboration successful (Butterfoss & Kegler, 2009).

The maintenance stage includes the propositions 15 through 19 (Butterfoss & Kegler, 2009). During this phase resources are pooled from the many agencies and external resources to design comprehensive strategies to lead to improved health and social outcomes. This phase includes the planning and implementation. Member engagement ensures that members are committed and satisfied which leads to a more productive working group. Identifying outside resources and pooling resources expedites a comprehensive assessment of the problem which leads to thorough planning for better implementation. Implementation strategies should be directed at multiple levels within the organizations and community to increase the success of the interventions developed (Butterfoss & Kegler, 2009).

The final stage of institutionalization in CCAT includes propositions 19 through 21 (Butterfoss & Kegler, 2009). Successful implementation of the strategies designed by the coalition is required to enter the institutionalization stage. This stage is demonstrated by successful long-term outcomes which were results of the multilevel interventions or strategies. Changes have been made within the community. The organizations adopt the interventions within the community, the resources are mobilized, and interventions are effective at focusing on the identified problem. A successful coalition may have synergistic effects and have processes or strategies applied to different social or health issues within the community (Butterfoss & Kegler, 2009).

Application of theory. The National Asthma Education and Prevention Program (NAEPP) has completed the formation stage and has looped back as reviews are done with updates published (Expert Panel Report [EPR]-2 and EPR-3). In 1989 the NHLBI identified the prevalence of asthma as a public health concern and initiated the NAEPP by bringing many organizations together including three working groups: Cost Effectiveness, Quality of Care, and Financing of Asthma Care (Weiss, 1996). The NHLBI was designated as the lead agency. Initially they performed comprehensive literature reviews to evaluate the current research and practices of asthma (National Heart Lung and Blood Institute, 2016). The program has grown and added committee members since its inception. The two updates, EPR -2 in 1997 and EPR-3 in 2007, had changing committee members (Table 3.2) and coordinating committee members (Table 3.3) with many of the same organizations (U.S. Department of Health and Human Services, 1997, 2007). In December 2008, the National Heart Lung and Blood Institute (2015) established the National Asthma Control Initiative (NACI) due to very little change in patient outcomes after the implementation of NAEPP guidelines. Members of NACI included American Academy of Allergy, Asthma & Immunology (AAAAI), National Institute for Occupational Safety and Health, University of Washington, National environmental Education Foundation, Allergy & Asthma Network Mothers of Asthmatics, National Association of Pediatric Nurse Practitioners, and National Asthma Campaign Foundation (National Heart Lung and Blood Institute, 2015). The changes of members and organizations demonstrates the formation stage and its ongoing loop as it progresses to the maintenance stage.

Currently, the NAEPP is in the maintenance stage where they are implementing strategies and writing updates to NAEPP EPR-4 (12th construct and 18th proposition). In the beginning of this stage the coalition used results of the comprehensive literature review and developed recommendations for asthma care based on evidenced based practices to improve asthma outcomes. To disseminate the information, educational materials for providers and patients were developed including bilingual informational handouts for patients and are available on the NACI website (National Heart Lung and Blood Institute, 2015). Continuing medical education and continuing educations units are a requirement for renewal of the provider’s license (American Association of Nurse Practitioners, 2018; American Nurses Credentialing Center, 2018; Federation of State Medical Boards, 2018). Many conferences for providers include sessions on asthma emphasizing the NAEPP guidelines. A few conference examples are Pri-Med, AAAAI, Annual University of California, Los Angeles Family Medicine Refresher Course, American

Academy of Family Physicians and other agencies within the coalition. As shown in the comprehensive literature review of this paper, interventions have continued to be developed to increase provider adherence to the NAEPP guidelines. These interventions have had minimal impact on provider adherence (Okelo et al., 2013).

NAEPP guidelines are not being implemented and are not affecting outcomes, thus they are not in the final stage of institutionalization. The implementation must be complete to enter the institutionalization stage according to CCAT theory. The guidelines developed are based on evidence that has been shown to improve asthma outcomes (Cloutier, Hall, Wakefield, & Balit, 2005; R. Grant, Bowen, Neidell, Prinz, & Redlener, 2010); but to be effective, the NAEPP guidelines need to be implemented into practice. There is a need to change provider behavior and improve adherence to NAEPP guidelines in order to improve asthma outcomes.

Social Learning Theory

Albert Bandura published his Social Cognitive Theory (SCT) in 1977 (Bandura, 1977a). Bandura (2005) states that when he started his career, he was not content with the theories of behaviorism being used to explain learning. He felt there was more to learning than positive and negative reinforcement. He could not understand how a person learned familial customs, language, occupational and educational competencies, and political and religious practices through rewarding and punishing. In 1941 Miller and Dollard published “Social Learning and Imitation” where the phenomenon of modeling was identified, but the authors did not develop the concept. Bandura “found this conception seriously wanting” (Bandura, 2005, p. 11). He then began his research on observational learning and modeling. Later with the rapid changes in technology, he integrated socio-cognitive theory with social network theory (Bandura, 2005).

Bandura (2005) brings a constructionist influence into his theory. Berger and Luckmann (as cited in Wallace & Wolf, 1999) describes constructionism as a philosophy where through interaction and negotiation, people create their own world. Bandura (2005) felt people created their situations to serve their purpose. A person's beliefs and experiences influence how their life circumstances are organized, created, and managed. Bandura agreed with the theories of Piaget (cognitive development) and Skinner (operant conditioning), but felt individuals did not learn solely from positive and negative reinforcement (McLeod, 2016). Bandura felt learning occurred after seeing exemplified behavior by others (Bandura, 2005).

There are four main concepts in SCT: modeling, triadic reciprocal determinism, self-efficacy and self-regulation. Each of these concepts are relevant in the learning or cognitive process of individuals. Bandura (1986, pp. 47-70) goes against tradition in the concept of modeling. He states a person can learn by seeing others perform a behavior, as opposed to prior theories that state learning is from experience. Bandura describes the process of modeling or imitation as linear, using stages. The first stage is attention where the individual is drawn to the behavior; the more interesting then there is more attraction. Attention may be enhanced when rewards are seen after the behavior. Retention, the next phase, is remembering the behavior. Symbolic transformation may be used where the individual restructures the information to retrieve in the future. Reproduction immediately follows and coincides with retention. As the individual attempts to repeat the behavior, the retention is reinforced. With the reinforcement and repeated behavior, the behavior becomes easier to replicate and becomes part of the person. Motivation is the final stage. Modeled behavior is more likely to be exhibited when is has valued outcomes. The value or reward may be from three sources: direct, vicarious, and self-produced (Bandura, 1986, pp. 47-70).

Modeling is influenced by the concept of triadic reciprocal determinism (Bandura, 1986, pp. 21-22). This incorporates the cognitive or other personal factors, environment, and behavior. Cognitive or other personal factors include the individual's personality, personal experiences, genetics, and demographics. It is here where cognition determines how events are perceived, their effects, and use in the future. A motivating factor is future consequences. Bandura (1986, pp. 168-169) views environmental factors to include not only the physical surroundings, but also culture. The person may create or activate the environment Bandura (1977b, p. 204). The third part of triadic reciprocal determinism is behavior factors. Bandura (1986, pp. 20-29) includes body language which consists of facial expressions, words and actions in behavior factor. Behavior factors also include human nature. Evolution and neurophysiological mechanisms influence an individual's behavior over time (Bandura, 1986, pp. 20-29).

According to (Bandura, 1977b, pp. 194-213) triadic reciprocal determinism is the interaction of all three concepts. Each has a bidirectional relationship with the other (Figure 3.2). Each factor influences and determines the operation of the other. The relationships are dynamic and changes in different situations. At times one factor may have a greater influence over another but may change as the situation changes. Patterns of behavior can be predicted by the influences from the cognitive or personal, behavioral, or environmental factors (Bandura, 1977b, pp. 194-213).

Bandura (1977a) introduces self-efficacy as the individual's feeling of their ability to accomplish the behavior. It also includes outcome expectations where a person's behavior produces certain outcomes. Initiation and persistence of the individual influences the outcome. The person's self-efficacy determines the choices made. As self-efficacy increases, the individual's efforts are increased. Expectations differ in magnitude, generality and strength.

When strong expectations are in place, coping mechanisms persevere even in bad experiences to achieve the expected outcome. Expectations are derived from four sources: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal. Those who have low self-efficacy may undermine their efforts (Bandura, 1986, p. 435).

Bandura (1986, pp. 435-437) identified internal and external factors of self-regulation which is the person's ability to determine their own behavior. Internal factors include self – observation, self-evaluation and reaction (self-reinforcement or self-punishment) of the behavior. External factors are the standards of evaluation and reinforcement by others or the environment. Self-regulation is strengthened when the behavior is mastered. But the opposite can be true: recalling pleasures of negative behavior (e.g. drug addiction or alcoholism) strains self-regulation. A person can disengage from the behavior if their self-evaluation minimizes, disregards or distorts the consequences (Bandura, 1986, pp. 435-437).

Bandura identified assumptions within the concepts of his theory (Bandura, 1986). People learn by observing others is the assumption of his original work with modeling. As people learn through modeling not all behaviors are reproduced. Learning is an internal process which may or may not lead to behavior, which is goal directed. People set goals for themselves and determine which behavior is needed to achieve the goal. Behavior becomes self-regulated by the individual. Reinforcement and punishment have indirect effect on learning. Bandura (1986, p. 1177) identifies the self-enhancing bias, where the individual over estimates their ability. When a person's self-appraisal is optimistically high, it can be a benefit, leading to the outcome desired. Or, it can be detrimental in an over expectation, leading to failure. Under estimation can be a self-limitation of ability to learn where the individual does not set and attain more difficult goals (Bandura, 1986).

Albert Bandura has published over 80 articles, with 18 books on Amazon. His articles demonstrate and test the concepts within SCT. He also utilizes SCT to predict behavior with empirical testing. The primary application for SCT is understanding the individual's learning and behavior to predict behavior. It has been used widely in many disciples to generate and test hypotheses which has led to interventions successfully changing behavior. Google Scholar (2016) showed the use of SCT in humanities, health, mathematics, social sciences, physics, business, and many more disciplines.

Summary of SCT development. Bandura (1977b) gave a basic model of his theory demonstrating the triadic reciprocal causation (Figure 3.2). In 2004, he updated his model (Figure 3.3) to include self-efficacy which was added in 1977 (Bandura, 2004) This model has a linear approach, not showing the bidirectional areas of the original model. Shortridge-Baggett (2004) introduced a model of SCT where she does show the bidirectional flow and added the original concepts into the model (Figure 3.4). She shows the relationships of all the concepts and the complexity of SCT.

Application of theory. The application of SCT with provider adherence to NAEPP guidelines fits well. Provider adherence is a behavior. SCT explains the behavior of providers and areas where interventions can be developed to reinforce or change the behavior. The four main concepts of SCT are discussed related to provider behavior.

The concept of modeling is seen on a daily basis as providers work side-by-side. Providers discuss cases throughout the day. As a provider has difficulty with improving outcomes for an asthma patient, he/she may discuss the case with another provider. The provider utilizing the guidelines assists with the case, gives recommendations, and demonstrates the use of the guidelines. Also, within provider meetings cases are presented. The presentation of asthma cases utilizing NAEPP guidelines are presented, showing positive outcomes and “modeling” for other providers to see and follow.

Providers incorporate the triadic reciprocal determinism when evaluating and making independent treatment plans for the patient. The process also occurs within the provider when utilizing NAEPP guidelines within the electronic medical record (environment). The electronic medical record (EMR) prompts and identifies areas to use guidelines. The behavior of the provider in how he/she implements the guidelines determines adherence. The interaction of all three of these concepts determines the provider’s behavior in adhering to NAEPP guidelines. If a provider does not have an environment that encourages use, for example, no spirometry, the provider could not adhere to diagnosis and follow-up easily. The provider’s lack of knowledge in how to implement the guidelines for a specific classification would lead to an inappropriate treatment plan, including medication administration.

The application of self-efficacy is demonstrated as providers utilize NAEPP guidelines. As they see patient outcomes improve, they utilize the guidelines more. The provider learns how to implement the guidelines on a daily basis within the EMR and making changes in treatment plans as the patient’s condition changes. As the provider sees greater improvement, his/her expectations increase and their behavior for adherence increases. The strong expectations assists when making treatment decisions with difficult cases. Those who have a low self-efficacy or low expectations, may not utilize the guidelines frequently as they have not seen the benefit or have been able to implement the NAEPP guidelines successfully.

Self-regulation is the fourth concept of SCT. The provider evaluates him/herself in adhering to NAEPP guidelines. The provider looks at their practice, develops a plan for him/herself to improve or continue their current regime in asthma management. He/she makes changes to beliefs or processes to improve adherence, thereby improving patient outcomes. External factors include insurance companies. Many insurance companies provide incentives for providers who adhere to guidelines which are measured by patient outcomes. The provider may also disengage with adherence if there is no support from management with NAEPP guideline adherence.

As discussed, CCAT and SCT are comprehensive theories. Integrating SCT of behavior and learning with CCAT in the implementation proposition increases provider adherence after the implementation of asthma guidelines into the EMR. The four concepts of modeling, triadic reciprocal determinism, self-efficacy, and self-regulation in SCT is applied to providers when adhering to NAEPP guidelines. SCT guides the provider behaviors, giving a better understanding to the behavior. As provider behavior is evaluated and adherence is determined SCT provides many areas that can be assessed, and interventions developed to reinforce or improve provider adherence to NAEPP guidelines. Provider adherence to NAEPP guidelines will advance the CCAT from the maintenance stage to the institutionalization phase with improved patient outcomes of Medi-Cal asthma patients.

Philosophy

A quantitative research approach was used to evaluate provider adherence to NAEPP guidelines. The use of empiricism as the philosophical foundation for this research allows for development of a hypothesis for change in provider adherence to NAEPP guidelines after implementation of asthma guidelines into the EMR. An alternate or null-hypothesis was generated and tested. The results of the testing either support the null-hypothesis, thereby rendering the original hypothesis as false; or by rejecting the null-hypothesis giving support to the original hypothesis.

This chapter presented the utilization of two theories, CCAT and SLT, that guided this research study. CCAT was used in the initial stages when NHLBI identified asthma as a public health concern. With the identification of a lead agency and committee development, the theory demonstrates the progression and development of the NAEPP guidelines. Currently, the NAEPP guidelines are in the implementation stage and have not progressed to the final stage of integration. The use of SLT provides a framework to assist in changing provider behavior to implement the guidelines into practice. The four SLT concepts provide different techniques that facilities and providers may use to change their behavior. The concept of triadic reciprocal determinism supports and is specific for the intervention of integrating the Asthma Registry into the EMR to improve provider's adherence to the NAEPP guidelines. To evaluate this research, the philosophy of empiricism was used to support and/or reject the null hypothesis

Table 3.1

Constructs and Related Propositions, Community Coalition Action Theory

Phase	Construct	Proposition
Planning Cycle	Stages of Development	1. Coalitions develop in specific stages and recycle through these stages as new members are rec4ruited, plans are renewed, and/or new issues are added. 2. At each stage, specific factors enhance coalition function and progression to the next stage
	Community Context	3. Coalitions are heavily influenced by contextual factors in the community throughout all stages of development.
Formation	Lead Agency or Convening Group	4. Coalitions form when a lead agency or convening group responds to an opportunity, threat, or mandate. 5. Coalition formation is more likely when the lead agency or convening group provides technical assistance, financial or material support, credibility, and valuable networks/contacts. 6. Coalition formation is likely to be more successful when the lead agency or convening group enlists community gatekeepers to help develop credibility and trust with others in the community.
	Coalition Membership	7. Coalition formation usually begins by recruiting a core group of people who are committed to resolving the health or social issue. 8. More effective coalitions result when the core group expands to include a broad constituency of participants who represent diverse interest groups and organizations.
	Processes	9. Open and frequent communication among staff and members helps make collaborative synergy more likely by engaging members and pooling resources. 10. Shared and formalized decision-making helps make collaborative synergy more likely by engaging members and pooling resources. 11. Conflict management helps make collaborative synergy more likely by engaging members and pooling resources.
	Leadership and Staffing	12. Strong leadership from a team of staff and members improves coalition functioning and make collaborative synergy more likely by engaging members and pooling resources. 13. Paid staff make collaborative synergy more likely by engaging members and pooling resources.

Table 3.1

Constructs and Related Propositions, Community Coalition Action Theory (continued)

Phase	Construct	Proposition
Formation (continued)	Structures	14. Formalized rules, roles, structures, and procedures improve collaborative functioning and make collaborative synergy more likely by engaging members and pooling resources.
Maintenance	Member Engagement	15. Satisfied and committed members will participate more fully in the work of the coalition.
	Pooled Member and External Resources	16. The synergistic pooling of members and external resources prompts comprehensive assessment, planning, and implementation of strategies.
	Assessment and Planning	17. Successful implementation of effective strategies is more likely when comprehensive assessment and planning occur.
	Implementation of Strategies	18. Coalitions re more likely to create change in community policies, practices, and environments when they direct interventions at multiple levels.
Institutional-ization	Community Change Outcomes	19. Coalitions that are able to change community policies, practices, and environments are more likely to increase capacity and improve health/social outcomes.
	Health/Social Outcomes	20. The ultimate indicator of coalition effectiveness is the improvement in health and social outcomes.
	Community Capacity	21. By participating in successful coalitions, community members and organizations develop capacity and build social capital that can be applied to other health and social issues.

Note. Adapted from Butterfoss, F. D., & Kegler, M. C. (2009). The community coalition action theory. In R. J. DiClemente, R. A. Crosby, & M. C. Kegler (Eds.), Emerging theories in health promotion practice and research (Vol. 2, pp. 237-276). San Francisco, CA: Jossey-Bass.

Table 3.2

NAEPP Committee Members

EPR-2	EPR-3
Shirley Murphy, M.D., **Chair** Professor and Chair, Department of Pediatrics, University of New Mexico School of Medicine Albuquerque, New Mexico	William W. Busse, M.D., **Chair** University of Wisconsin Medical School Madison, WI
William W. Busse, M.D., University of Wisconsin Medical School Madison, WI	-
Homer A. Boushey, M.D. University of California at San Francisco San Francisco, CA	Homer A. Boushey, M.D. University of California at San Francisco San Francisco, CA
H. William Kelly, Pharm.D. University of New Mexico Health Science Center Albuquerque, NM	H. William Kelly, Pharm.D. University of New Mexico Health Science Center Albuquerque, NM
Robert F. Lemanske, M.D. University of Wisconsin Hospital and Clinics Madison, WI	Robert F. Lemanske, M.D. University of Wisconsin Hospital and Clinics Madison, WI
Fernando D. Martinez, M.D. University of Arizona Medical Center Tucson, AZ	Fernando D. Martinez, M.D. University of Arizona Medical Center Tucson, AZ
Harold S. Nelson, M.D. National Jewish Medical and Research Center Denver, CO	Harold S. Nelson, M.D. National Jewish Medical and Research Center Denver, CO
Gail Shapiro, M.D. University of Washington Seattle, WA	Gail Shapiro, M.D. University of Washington Seattle, WA
Stuart Stoloff, M.D. University of Nevada School of Medicine Reno, NV	Stuart Stoloff, M.D. University of Nevada School of Medicine Reno, NV
Eugene R. Bleecker, M.D. Professor of Medicine School of Medicine University of Maryland Baltimore, Maryland	Carlos A. Camargo, Jr., M.D., Dr.P.H. Massachusetts General Hospital Boston, Massachusetts
Sonia Buist, M.D. Oregon Health Sciences University Portland, OR	David Evans, Ph.D., A.E.-C, Columbia University New York, New York

Table 3.2

NAEPP Committee Members (continued)

EPR-2	EPR-3
Noreen M. Clark, Ph.D. University of Michigan School of Public Health Ann Arbor, MI	Michael B. Foggs, M.D. Advocate Health Centers Chicago, Illinois
Howard Eigen, M.D. Director, Section of Pulmonology and Intensive Care/ Professor and Associate Chairman for Clinical Affairs, Department of Pediatrics, Riley Hospital for Children Indianapolis, Indiana	Susan L. Janson, D.N.Sc., R.N., A.N.P., F.A.A.N. University of California–San Francisco San Francisco, California
Jean G. Ford, M.D. Chief, Division of Pulmonary Medicine Harlem Hospital Center. Assistant Professor of Medicine and Public Health (Environmental Health Sciences) Columbia University New York, New York	Robert J. Meyer, M.D. U.S. Food and Drug Administration Silver Spring, Maryland
Susan L. Janson, D.N.Sc., R.N., A.N.P., F.A.A.N. University of California–San Francisco San Francisco, California	Thomas A. E. Platts-Mills, M.D., Ph.D. University of Virginia School of Medicine Charlottesville, Virginia
Carolyn C. Lopez, M.D. Chief, Department of Family Practice Cook County Hospital Associate Professor, Department of Family Medicine, Rush Medical College Chicago, Illinois	Michael Schatz, M.D., M.S. Kaiser-Permanente–San Diego San Diego, California
Richard Nowak, M.D., M.B.A. Vice Chairman Department of Emergency Medicine Henry Ford Hospital Detroit, Michigan	Stanley Szefler, M.D. National Jewish Medical and Research Center Denver, CO
Thomas A.E. Platts-Mills, M.D., Ph.D. Director UVA Asthma and Allergy Disease Center. Head, Division of Allergic and Clinical Immunology, University of Virginia School of Medicine Charlottesville, Virginia	Scott T. Weiss, M.D., M.S. Brigham and Women's Hospital Boston, Massachusetts

Table 3.2

NAEPP Committee Members (continued)

EPR-2	EPR-3
Kevin Weiss, M.D., M.P.H. Director, Center for Health Services Research, Rush Primary Care Institute Chicago, Illinois	Barbara P. Yawn, M.D., M.Sc. Olmstead Medical Center Rochester, Minnesota

Note. 1st group same members with different chairs. 2nd group different members. Adapted from U.S. Department of Health and Human Services. (1997). *Expert panel report 2: Guidelines for the diagnosis and management of asthma.* U.S. Department of Health and Human Services. (2007). *Expert panel report 3: Guidelines for the diagnosis and management of asthma.*

Table 3.3

NAEPP Coordinating Committee

EPR-2	EPR-3
National Heart, Lung, and Blood Institute *Claude Lenfant, M.D., **Chair**	NHLBI, Acting Director Barbara Alving, M.D., **Chair**
-	NHLBI, National Institutes of Health (NIH) Elizabeth Nabel, M.D.
Agency for Health Care Policy and Research Denise Dougherty, Ph.D.	Agency for Healthcare Research and Quality Denise Dougherty, Ph.D.
Allergy and Asthma Network/Mothers of Asthmatics, Inc. Nancy J. Sander	Allergy and Asthma Network Mothers of Asthmatics Nancy Sander
American Academy of Pediatrics Gary S. Rachelefsky, M.D.	American Academy of Pediatrics Gary S. Rachelefsky, M.D.
American College of Allergy, Asthma, and Immunology William Storms, M.D.	American College of Allergy, Asthma, and Immunology William Storms, M.D.
American Association for Respiratory Care Thomas J. Kallstrom, R.R.T.	American Association for Respiratory Care Thomas J. Kallstrom, R.R.T., F.A.A.R.C.,AE-C
American College of Chest Physicians John P. Mitchell, M.D., F.A.C.P.	American College of Chest Physicians John Mitchell, M.D., F.A.C.P.
American College of Emergency Physicians Richard M. Nowak, M.D., M.B.A.,F.A.C.E.P.	American College of Emergency Physicians Richard M. Nowak, M.D., M.B.A., F.A.C.E.P.
American Lung Association Noreen M. Clark, Ph.D.	American Lung Association Noreen M. Clark, Ph.D.
American Pharmaceutical Association Dennis M. Williams, Pharm.D.	American Pharmacists Association Dennis M. Williams, Pharm.D.
American Medical Association Paul V. Williams, M.D.	American Medical Association Paul V. Williams, M.D.
American Nurses Association Karen Huss, R.N., D.N.Sc.	American Nurses Association Karen Huss, D.N.Sc., R.N., A.P.R.N.B.C., F.A.A.N., F.A.A.A.A.I.
American Public Health Association Pamela J. Luna, Dr.P.H., M.Ed.	American Public Health Association Pamela J. Luna, Dr.P.H., M.Ed.
U.S. Food and Drug Administration Robert J. Meyer, M.D.	U.S. Food and Drug Administration Robert J. Meyer, M.D.
NHLBI Ad Hoc Committee on Minority Populations Ruth I. Quartey, M.A., R.R.T.	NHLBI Ad Hoc Committee on Minority Populations Ruth I. Quartey, Ph.D.
National Medical Association Michael Lenoir, M.D.	National Medical Association Michael Lenoir, M.D.

Table 3.3

NAEPP Coordinating Committee (continued)

EPR-2	EPR-3
American School Health Association Lani S.M. Wheeler, M.D., F.A.A.P.,F.A.S.H.A.	American School Health Association Lani S. M. Wheeler, M.D., F.A.A.P.,F.A.S.H.A.
Council on State and Territorial Epidemiologists Sarah Lyon-Callo, M.A., M.S.	Council of State and Territorial Epidemiologists Sarah Lyon-Callo, M.A., M.S.
National Black Nurses Association, Inc. Susan B. Clark, R.N., M.N.	National Black Nurses Association, Inc. Susan B. Clark, R.N., M.N.
National Center for Health Statistics, CDC Lara Akinbami, M.D.	National Center for Health Statistics, CDC Lara Akinbami, M.D.
American Academy of Family Physicians Barbara P. Yawn, M.D., M.Sc	American Academy of Family Physicians Kurtis S. Elward, M.D., M.P.H., F.A.A.F.P.
American Academy of Allergy, Asthma, and Immunology Gail Shapiro, M.D.	American Academy of Allergy, Asthma, and Immunology Michael Schatz, M.D., M.S.
American Society of Health System Pharmacists Leslie Hendeles, Pharm.D.	American Society of Health-System Pharmacists Kathryn V. Blake, Pharm.D.
American Thoracic Society Barbara L. Hager, M.P.H., C.H.E.S.	American Thoracic Society Stephen C. Lazarus, M.D.
Asthma and Allergy Foundation of America Mary E. Worstell, M.P.H.	Asthma and Allergy Foundation of America Mo Mayrides
National Association of School Nurses Carol Costante, R.N., M.A.,S.N., F.N.A.S.N.	National Association of School Nurses Donna Mazyck, R.N., M.S., N.C.S.N.
National Center for Chronic Disease Prevention, Centers for Disease Control and Prevention Mary Vernon-Smiley, M.D., M.P.H.	National Center for Chronic Disease Prevention, Centers for Disease Control and Prevention (CDC) Sarah Merkle, M.P.H.
National Institute for Occupational Safety and Health, CDC Gregory R. Wagner, M.D.	National Institute for Occupational Safety and Health, CDC Margaret Filios, S.M., R.N.
National Institute of Allergy and Infectious Diseases Kenneth Adams, Ph.D.	National Institute of Allergy and Infectious Diseases (NIAID), NIH Peter J. Gergen, M.D., M.P.H.
National Center for Environmental Health, CDC Leslie P. Boss, Ph.D., M.P.H.	National Center for Environmental Health, CDC Paul M. Garbe, M.D.

Table 3.3

NAEPP Coordinating Committee (continued)

EPR-2	EPR-3
National Institute of Environmental Health Sciences J. Patrick Mastin, Ph.D.	National Institute of Environmental Health Sciences, NIH Charles A. Wells, Ph.D.
Society for Academic Emergency Medicine Carlos A. Camargo, M.D., Dr.P.H.	Society for Academic Emergency Medicine Rita Cydulka, M.D., M.S.
U.S. Department of Education Estelle Bogdonoff, M.P.H., C.H.E.S.	U.S. Department of Education Dana Carr
U.S. Environmental Protection Agency Mary T. Smith, J.D.	U.S. Environmental Protection Agency Office of Research and Development Hillel S. Koren, Ph.D.
American Academy of Physician Assistants Gabriel R. Ortiz, M.P.A.S., PA-C	American Academy of Physician Assistants Tera Crisalida, P.A.-C., M.P.A.S.
American Association of Occupational Health Nurses Pam Carter, R.N., C.O.H.N.-S.	-
U.S. Department of Housing and Urban Development David E. Jacobs, Ph.D.	-
Association of State and Territorial Directors of Health Promotion and Public Health Education Stephen C. Lazarus, M.D.	-
U.S. Public Health Service Olivia Carter-Pokras, Ph.D	-
-	National Respiratory Training Center Pamela Steele, M.S.N., C.P.N.P., AE-C
-	U.S. Environmental Protection Agency Indoor Environments Division David Rowson, M.S.

Note. *Chair of initial committee in 1989.

1st group same organization and member with different chairs. 2nd group same organization with different members. 3rd group different organizations. Adapted from U.S. Department of Health and Human Services. (1997). *Expert panel report 2: Guidelines for the diagnosis and management of asthma.* U.S. Department of Health and Human Services. (2007). *Expert panel report 3: Guidelines for the diagnosis and management of asthma.*

Figure 3.1. Community Coalition Action Theory Model

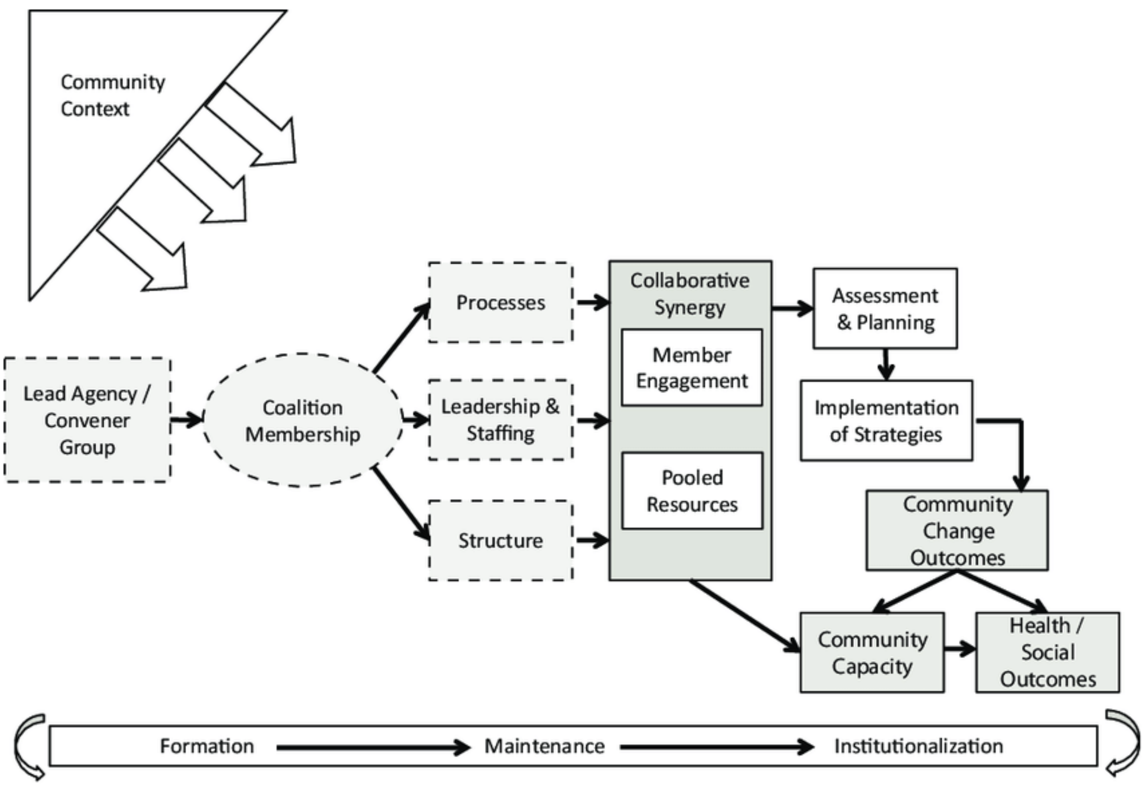

Figure 3.1. Butterfoss & Keglers model of Community Coalition Action Theory Model. Butterfoss, F. D., & Kegler, M. C. (2002). Toward a comprehensive understanding of community coalitions. In R. J. DiClemente, R. A. Crosby, & M. C. Kegler (Eds.), *Emerging theories in health promotion practice and research* (pp. 157-193). San Francisco, CA: Jossey-Bass.

Figure 3.2 Social Cognitive Learning Model

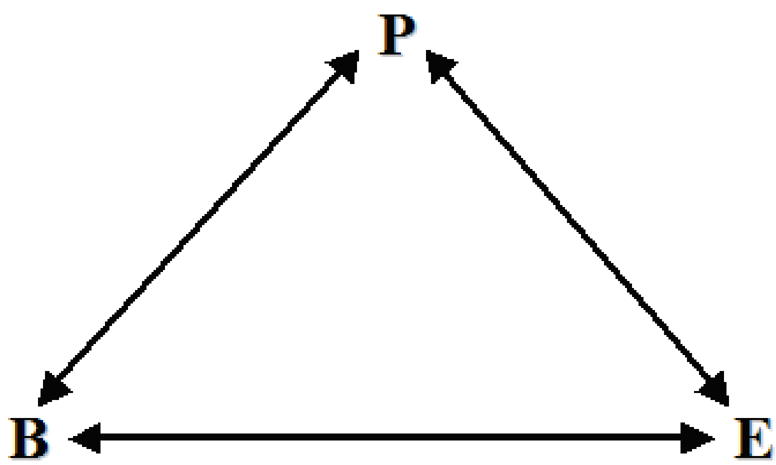

Figure 3.2. Bandura's model of triadic reciprocal causation. P = person; B = behavior; E = environment. Bandura, A. (1977b). *Social learning theory*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Figure 3.3 2004 Update Social Cognitive Learning Model

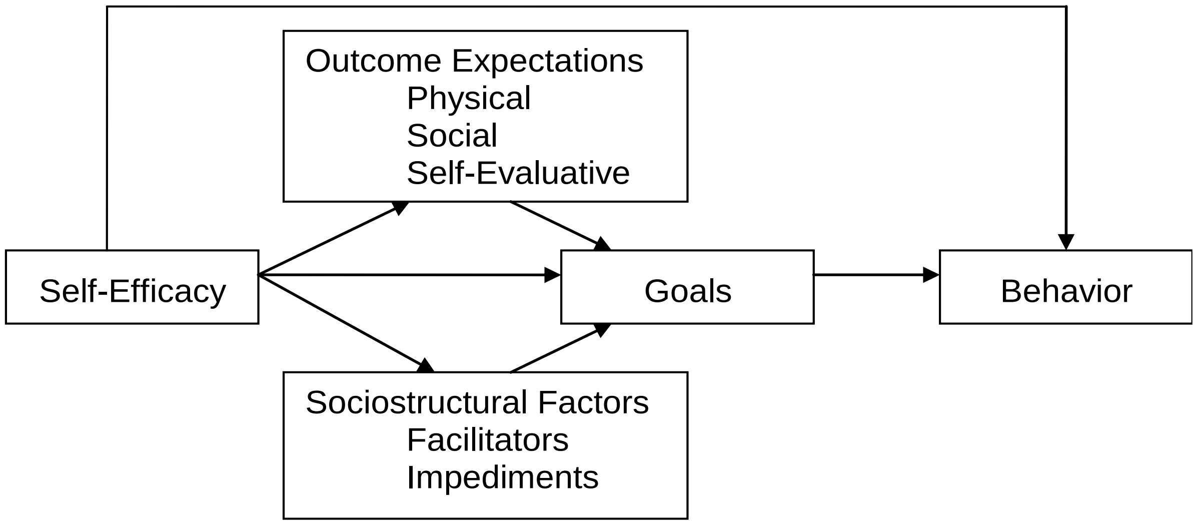

Figure 3.3. Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior*, *31*(2), 143-164.

Figure 3.4 Incorporation of Relationships in the Social Cognitive Learning Model

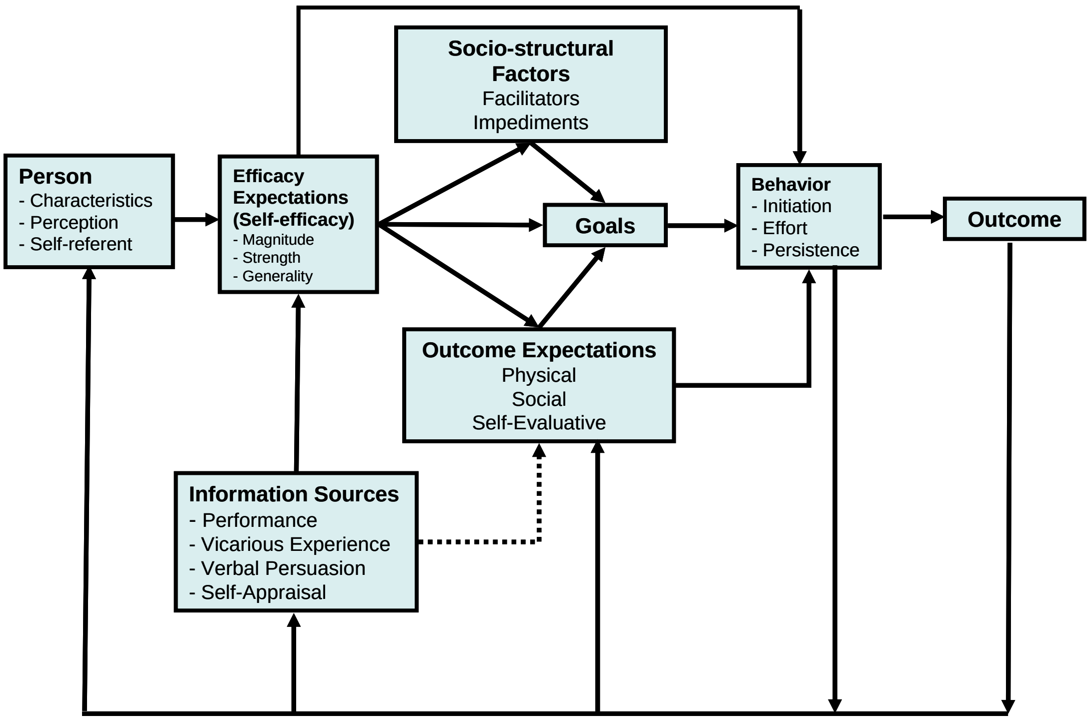

Figure 3.4. Model of social cognitive theory which incorporates the reciprocal relationships showing the complexity of the model. Shortridge-Baggett, L. M. (2004). *Understanding the role of theoretical frameworks in the research process.* Paper presented at the Academic Forum Queensland University of Technology.

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CHAPTER 4

METHODOLOGY

Research Design

This study evaluated provider adherence to the National Asthma Education and Prevention Program (NAEPP) guidelines pre- versus post- integration of an Asthma Registry into the electronic medical record (EMR) at CHOC Children's' (CHOC). The CHOC Clinic Smart Registry in the EMR allows providers to compare their patients in real-time to grouped patient data in the registry as to clinical management actions related to the NAEPP guidelines as well as health outcomes. For this dissertation research, changes in provider management actions were measured pre-post changes to the EMR in the Medi-Cal population of asthma patients (N=6606 in 2014 and N=6945 in 2018), ages birth to 21 years on the following: use of Asthma Control Test (ACT), Asthma Action Plan (AAP), inhaled corticosteroids (ICS), and spacers. The time periods compared were year 2014, prior to incorporation of the Asthma Registry into the medical record, and 2018 after incorporation of the Asthma Registry into the EMR. A serial cross-sectional design was used to compare change in provider management of asthma patients before an Asthma Registry with NAEPP guidelines was integrated into the EMR to after integration into the EMR. The main outcomes of interest were provider adherence to the NAEPP guidelines (as indicated by number of patients appropriately given ACT, AAP, ICS, spacers) and patient health outcomes. The overall goal of the work was to determine if the EMR can be used as a tool to improve provider adherence to the NAEPP guidelines and if this improves health outcomes for the population of Medi-Cal asthma patients.

Human Subjects

Institutional Review Board (IRB) approval was sought from UCLA and CHOC. Upon submission to both IRBs, it was determined that approval was not required from UCLA because the data had been de-identified. Confidentiality was maintained at CHOC.

Setting

CHOC was established in 1964 as a community hospital, which has evolved into a world-class pediatric health care system affiliated with the University of California, Irvine. CHOC serves children under the age of 21 years and is the premier children's hospital in Orange County serving a population of over 3 million people and 724,000 children. The main campus located in Orange, California includes a 334-bed hospital, primary and specialty care clinics, with another 54-bed hospital in Mission Viejo. The medical staff includes more than 700 pediatricians including primary care and 30 pediatric subspecialties (CHOC Children's, 2020).

Database

CHOC maintains a data base called Health"e" Intent which is stored and maintained on the Amazon Cloud. The data is imported from many different sources including clinical data from the Cerner EMR, claims data, lab data from Quest and LabCorp. CHOC is continuing to expand on the data imports into the database. The CHOC Clinic Smart Registry utilizes information from Health"e" Intent. This registry data is then embedded into the CHOC ambulatory EMR to give providers real time feedback on patient measures. The source database used for this dissertation research, and all direct work with the database were done at CHOC adhering to CHOC IRB approved confidentially procedures.

Research Questions

Within the Medi-Cal population at CHOC Children's:

1. Is there a difference in provider adherence to the NAEPP guidelines after the integration of the NAEPP guidelines into the EMR as compared to before? Outcome measures: ACT, AAP, ICS prescription written, and spacer prescription written.

AIM 1. Compare Children's Medical Group (CMG) provider adherence to the NAEPP guidelines before and after implementation of the Asthma Registry data into the EMR looking at four key elements: ACT, AAP, ICS prescription written, and spacer prescription written.

2. Is there a difference in patient outcomes (hospital admission, ED visits, and outpatient clinic visit with diagnosis of asthma exacerbation) between CMG providers and non-CMG providers in CHOC Health Alliance (CHA) after the integration of the NAEPP guidelines into the EMR?

AIM 2. Compare patient outcomes between CMG and non-CMG providers in CHA after the implementation of the Asthma Registry into the EMR. Outcome measurements included: hospital admissions, ED visits, and clinic visits with diagnosis of asthma exacerbation.

Samples

Medi-Cal is the State of California's free or low-cost health insurance which covers low-income adults, families with children, seniors, persons with disabilities, pregnant women, children in foster care and former foster youth up to age 26 (Department of Health Care Services, 2020). CalOptima, is a county wide health plan which administers the Medi-Cal program in the County of Orange with 738,535 members as of December 31, 2019 (CalOptima, 2020). It was established in 1993 and launched the Med-Cal program in 1995 (CalOptima, 2018). CHA is a health network within CalOptima; and serves approximately 150,000 members under the age of

21 years (CHOC Health Alliance, 2018). Within CHA is the CMG with approximately 3,000 members (W. Feaster, personal communication, August 3, 2018). The sample for this research utilized the Healty“e” Intent CHOC Clinic Smart Registry database of patients in CMG, approximately 3,000. The database includes all data fields in the EMR.

Aim 1. Provider adherence was measured across all providers (not by looking at individual providers) by considering the proportion of patients given ACT, AAP, ICS, and spacer prescriptions. A patient is counted only once (even if multiple visits).

For testing Aim 1, a study sample was derived from the total CMG EMR patient population for 2014 and again for 2018 that met the eligibility criteria: less than 21 years of age, diagnosed with asthma alone (no other chronic pulmonary diagnoses), and with Medi-Cal insurance. For example, in 2014 CMG EMR included 78,656 patients of whom 78,380 were less than 21 years of age and 6606 were covered by Medi-Cal and free of other chronic pulmonary diagnosis (8.39% of the total CMG EMR patients). Thus, the study population used for Aim 1 was 6606 for 2014 and 6945 for 2018.

Not all patients diagnosed with asthma require an ICS. For patients of any age with a diagnosis of persistent asthma, NAEPP recommendations include an ICS; for those with intermittent asthma, an ICS is not always recommended (U.S. Department of Health and Human Services, 2007). At CHOC the asthma classification is documented on the AAP, unfortunately, this field was not retrievable for data analysis. Without this field, not all patients with ICS recommendation were included in the study. Providers do not regularly provide an International Classification of Diseases, 10th revision (ICD-10) diagnosis code, which includes the asthma classification, therefore accurate classification of all asthma patients at CHOC was not possible. For this dissertation study, a subset of patients who had an ED visit, hospital admit, or outpatient clinic visit with the diagnosis of asthma exacerbation within the designated year was used to evaluate for the prescription of two ICS prescriptions within the same year.

A separate subset of the initial identified population was used for the evaluation of spacer prescriptions. NAEPP guidelines recommends the use of a spacer for all ages for administration of medication with a metered dose inhaler (MDI) (U.S. Department of Health and Human Services, 2007). A patient was included if there was a prescription written for an MDI. Patients were excluded if all aerosol medications were given by nebulizer or a dry powder inhaler (DPI).

Aim 2. Data was retrieved from the CHOC Health Alliance (CHA) claims data from 2018 to compare the CMG and the non-CMG patients after the integration of the Asthma Registry into the CHOC EMR in order to evaluate patient outcomes. The non-CMG are those patients who have CHA whose primary care provider (PCP) is not a CHOC provider. The sample retrieved for each group included patients less than 21 years of age with a diagnosis of asthma exacerbation. Patients were excluded with a chronic pulmonary diagnosis. Patient outcomes included hospital admission, ED visits, and outpatient visits. The sample size for the CMG was 7,451 and non-CMG 17,699.

Initial sample size calculations were the following. For a model comparing percentages, controlling for four covariates and adjusting for a design effect from clustering (some patients appearing in both years), a sample size of 223 was calculated as allowing detection of medium effects (odds ratio = 2.5) with power = .80 assuming the following: 2-sided alpha = .05, percentage with outcome at 2014 as small as 5%, intraclass correlation (ICC) as large as .10, average cluster size of 1.6, with approximations based on logistic regression and adjusting for design effect. For outcome percentages in 2014 greater than .05 or for smaller ICC, then power would be greater. The average cluster size was estimated very conservatively assuming all patients of eligible ages would have visits in both years; in reality, many patients change health systems, which would lead to a smaller average cluster size and greater power. For simple chi square test comparing proportions within age strata, the sample size of 223 would allow detection of 13%-19% differences between years depending on percentage with outcome (e.g. from 5%-50%, respectively), with 2-tailed alpha=.05 and power=.80.

Data extraction for the study yielded sample sizes well in excess of the initial calculations. For the multivariable models comparing percentages, the resulting sample size was sufficient to detect small effects (OR=1.21) with power = .99. For simple comparisons of percentages within age strata, the smallest stratum provided power=.80 to detect a difference of 8%.

Inclusion and Exclusion

Patient records meeting the inclusion criteria were drawn from the Health“e” Intent CHOC Clinic Smart Registry data base for years 2014 and 2018.

Inclusion criteria. Cerner (2018) established the following inclusion criteria.

- Medi-Cal as payer source.
- Person’s age is < 21 years as of the last day of the current measurement period.
- Patient has one of the following:
    - A diagnosis of Asthma during the current measurement period or prior measurement.
        - Prior to 2015, patients with International Classification of Diseases, Ninth Revision (ICD-9) diagnosis codes 493.2 Asthma (chronic), 493.9 asthma (acute), 493.91 status asthmaticus, and 493.92 acute exacerbation.

- After October 2015, patients with International Classification of Diseases, Tenth Revision (ICD-10) diagnosis codes J45.*.
- Has had a problem of Asthma (not in a resolved status) at any time prior to the end of the current measurement period.

- Patient had an outpatient visit during the current measurement period. Cerner (2018).

To measure ICS, a subset of the above patients with hospital admission or emergency department (ED) visits with the diagnosis of asthma exacerbation during the current measurement period were included. To be considered as meeting this measurement two prescriptions of ICS must have been prescribed or filled within the designated year (2014 or 2018).

To measure spacers, patients meeting the initial criteria who had a prescription for an MDI were included. Patients with dry powder inhalers only or those with nebulized medication only were excluded. A prescription for one spacer during the measurement period was considered as meeting the measurement.

Exclusion criteria. Cerner (2018) established the following exclusion criteria:

- Patient has at least one of the following during the current measurement period or in the two pervious measurement periods:
  - Cystic Fibrosis
  - Has a tracheostomy
  - Chronic respiratory disease arising in the perinatal period (codes of bronchopulmonary dysplasia are under this concept)
  - Bronchiectasis
  - Chronic respiratory failure

- Deceased

- Person is manually excluded

Variables

Information was collected from the Health"e" Intent CHOC Clinic Smart Registry on patient domains. Patient information included demographics and health status. NAEPP guidelines recommends all patients have an ACT and AAP (U.S. Department of Health and Human Services, 2007). Both variables have been identified by CHOC as measures for providers to improve. To meet this guideline a patient must have an ACT and AAP documented at least one time within the calendar year. The sample for 2018 was evaluated for the change of ACT and APP after the integration of the Asthma Registry into the EMR from the 2014 sample.

Patient variables. Patient variables extracted from database (and possibly used just to identify inclusion/exclusion or to construct outcome variables) and variables used in statistical analysis include:

- Identification number (used to identify all visits for an individual patient for construction of outcome variables),
- Insurance/payer (used to identify Medi-Cal for inclusion in the study),
- Age or date of birth (to stratify age groups of 0 – 4 years, 5 – 11 years and ≥ 12 years),
- Race and/or ethnicity (Hispanic, Caucasian, African American, Asian, Native American (American Indian/Alaska Native), Native Hawaiian/Other Pacific Islander, Other/Unknown),
- Language spoken (English, Spanish, Vietnamese, Chinese, Other), and
- Visit dates to primary care clinic, emergency department, and hospital admissions.

Asthma related variables. Asthma related variables include:

- Asthma control test, categorical variable (yes/no). Yes, if given any time during the relevant study year:
    - Date completed.
- Asthma action plan, categorical variable (yes/no). Yes, if given any time during the relevant study year:
    - Date implemented, and
    - Update at clinic visit.
- Inhaled corticosteroid, categorical variable (yes/no). Yes, if given or filled two prescriptions of ICS during the relevant study year:
    - Prescription date in the EMR, and
    - Prescription billed (pharmacy claim data using National Drug Code [NDC]).
- Spacer, categorical variable (yes/no). Yes, if given prescription any time during the relevant study year:
    - Prescription date in EMR, and
    - Spacer billed (clinic and pharm data using Healthcare Common Procedure Coding System [HCPCS] codes S8100, S8101, S8097, or NDC codes).
- ICD-9 diagnosis codes 493.9 asthma (acute), 493.91 status asthmaticus, and 493.92 acute exacerbation.
    - Patient hospital admission and discharge date with ICD-9 diagnosis codes 493.9 asthma (acute), 493.91 status asthmaticus, and 493.92 acute exacerbation; and ICD-10 dx code for exacerbation (J45.21, J45.31, J45.41, J45.51, J45.901).

Hospital admission is a categorical variable (yes/no); yes, the patient had at least one hospital admission in 2018.

- Patient ED visits with ICD-9 diagnosis codes 493.9 asthma (acute), 493.91 status asthmaticus, and 493.92 acute exacerbation; and ICD-10 dx code for exacerbation (J45.21, J45.31, J45.41, J45.51, J45.901). ED visit is a categorical variable (yes/no); yes, the patient had at least one ED visit in 2018.
- Patient outpatient visits with ICD-9 diagnosis codes 493.9 asthma (acute), 493.91 status asthmaticus, and 493.92 acute exacerbation; and ICD-10 dx code for exacerbation (J45.21, J45.31, J45.41, J45.51, J45.901). Outpatient visit is a categorical variable (yes/no); yes, the patient had at least one outpatient visit in 2018.

Intervention

In 2015 CHOC integrated the Healty“e” Intent CHOC Clinic Smart Registry into the Cerner EMR. This integration gave the provider real time information of the patient’s measures with the NAEPP guidelines. There are two measures, which were implemented and are currently evaluated: ACT and AAP. The provider signs into the EMR, then enters the patient chart. The Health“e” Registries section is selected which immediately displays the measures in real time and if they have been met. Asthma order sets have been designed within the EMR. The order sets are based upon classification of the patient’s asthma (age and severity of disease). When the patient’s diagnosis is classified, the disease classification definition is displayed with the NAEPP recommendations to the right. Currently there is no algorithm designed which leads the EMR to give a suggestion or recommendation on the patient disease classification.

Statistical Analysis Plan

The purpose of this study was to determine if the implementation of the Asthma Registry into the EMR makes a difference in provider adherence of NAEPP guidelines within the Medi-Cal population at CHOC. Using CHOC asthma data from Medi-Cal patients with ICD-10 diagnosis code J45.*, we evaluated the following specific AIMs:

Aim 1. Compare CMG provider adherence to the NAEPP guidelines before and after implementation of the Asthma Registry data into the EMR looking at four key elements:

Hypothesis 1a: There is an increase in ACT after implementation of the Asthma Registry into the EMR.

Hypothesis 1b: There is an increase in prescription of AAP after implementation of the Asthma Registry into the EMR.

Hypothesis 1c: There is an increase in prescription of ICS after implementation of the Asthma Registry into the EMR.

Hypothesis 1d: There is an increase in prescription of spacers after implementation of the Asthma Registry into the EMR.

***Statistical analysis*.** A General Linear Mixed Model (GLMM) was used to compare outcomes from 2014 with 2018, controlling for age, gender, race/ethnicity, and language. This approach was selected because it allows for specialization of the model to the binomial distribution of the dependent variable, adjusts for overlap in the study-year samples (some patients have visits in both years), and allows the inclusion of covariates. Maximum likelihood estimation was used. Additional chi-square statistics were calculated to assess change in each outcome variable 2014 to 2018 within each stratum of the age variable (unconditional comparisons, not controlling for covariates). Chi-square statistics were also used to compare the study-year samples in terms of demographic characteristics.

- Dependent variable – ACT, AAP, ICS, spacer.
- Independent variable – CMG use of the guidelines before and after implementation of Asthma Registry into the EMR.
- Potential confounding variables –Patient variables include age, gender, race/ethnicity, and language.
- Assumptions – Normality of distribution is not needed for categorical dependent variables, and the statistical model selected was specialized for this binomial distribution.

Reported results from GLMM include odds ratio, confidence intervals, and *p* value to test the hypotheses of differences between 2014 and 2018. Reported results of unconditional change (2014 to 2018) for each within each age stratum include chi-square, degrees of freedom, sample size and *p* value.

Aim 2. Compare patient outcomes between CMG and non-CMG in CHA after the implementation of the Asthma Registry into the EMR:

Hypothesis 2a: There will be fewer patients with a hospital admission in the CMG group compared to the non-CMG in CHA group.

Hypothesis 2b: There will be fewer ED visits in the CMG group compared to the non-CMG in CHA group.

Hypothesis 2c: There will be fewer clinic visits for asthma exacerbation of the CMG compared to the non-CMG in CHA group.

Statistical analysis. GLMM and Chi-Square. Data from 2018 of CMG and non-CMG patients was used to compare the CMG and non-CMG groups. Patients with multiple same location visits in the designated year were counted as one in each location for the specified year. Patients were counted in each of the three locations if they had a hospital admission, ED visit, and outpatient visit with the diagnosis of asthma exacerbation. When the GLMM was run using any location, the patient was counted only one time if they had had any type of visit in 2018.

- Dependent variable – hospital admission, ED visits, and clinic visits for asthma exacerbation
- Independent variable – CMG and non-CMG in CHA after implementation of Asthma Registry into the EMR (2018)
- Confounding variables - Patient variables include: age or date of birth, race and/or ethnicity, and language spoken.
- Assumptions – Normality of distribution is not needed for categorical variables, and the model selected represents the distribution.

Reported results from GLMM included odds ratio, confidence intervals, and *p* value to test the hypotheses of differences between CMG and non-CMG; and within the stratified variable. Reported results of unconditional difference for the demographic variables included chi-square, degrees of freedom, sample size and *p* value.

Summary

A serial cross-sectional design was used to compare change in provider management of asthma patients before an Asthma Registry with NAEPP guidelines was integrated into the EMR to after integration into the EMR. The main outcomes of interest were adherence to the NAEPP guidelines (as indicated by numbers of relevant patients receiving ACT, AAP or prescribed ICS, spacer) and patient health outcomes. The overall goal of the work was to determine if the EMR can be used as a tool to improve provider adherence to the NAEPP guidelines and if this improves health outcomes for the population of Medi-Cal asthma patients.

The Healty“e” Intent CHOC Clinic Smart Registry database was utilized to obtain the defined variables for both clinical and claims data. Research questions looked at the difference before (2014) and after (2018) the integration of the Asthma Registry into the EMR at CHOC and between the CMG and non-CMG in CHA groups specifically in 2018. Statistical analysis included GLMM, and chi-square.

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CHAPTER 5

RESULTS

Introduction

This study was designed to answer the following research questions, within the Medi-Cal population at CHOC Children's:

1. Is there a difference in provider adherence to the National Asthma Education and Prevention Program (NAEPP) guidelines after the integration of the Asthma Registry into the electronic medical record (EMR) as compared to before? Outcome measures: Asthma Control Test (ACT), Asthma Action Plan (AAP), inhaled corticosteroid (ICS) prescription written, and spacer prescription written.

AIM 1. Compare Children's Medical Group (CMG) provider adherence to the NAEPP guidelines before and after implementation of the Asthma Registry data into the EMR looking at four key elements: ACT, AAP, ICS prescription written, and spacer prescription written.

Hypothesis 1a: There is an increase in ACT after implementation of the Asthma Registry into the EMR.

Hypothesis 1b: There is an increase in prescription of AAP after implementation of the Asthma Registry into the EMR.

Hypothesis 1c: There is an increase in prescription of ICS after implementation of the Asthma Registry into the EMR.

Hypothesis 1d: There is an increase in prescription of spacers after implementation of the Asthma Registry into the EMR.

2. Is there a difference in patient outcomes (hospital admission, emergency department [ED] visits, and outpatient clinic visit with diagnosis of asthma exacerbation) between CMG

providers and non-CMG providers in CHOC Health Alliance (CHA) after the integration of the Asthma Registry into the EMR?

AIM 2. Compare patient outcomes between CMG and non-CMG providers in CHA after the implementation of the Asthma Registry into the EMR. Outcome measurements include: hospital admissions, ED, and clinic visits with diagnosis of asthma exacerbation.

Hypothesis 2a: There will be fewer patients with a hospital admission in the CMG group compared to the non-CMG in CHA group.

Hypothesis 2b: There will be fewer ED visits in the CMG group compared to the non-CMG in CHA group.

Hypothesis 2c: There will be fewer clinic visits for asthma exacerbation in the CMG compared to the non-CMG in CHA group.

Aim 1 Results

Patient Demographics (Comparing 2014 to 2018)

Demographics of the samples for each year (2014 and 2018) were similar except in terms of age grouping (stratified according to NAEPP guidelines) and race/ethnicity (Table 5.1). The age strata had significant differences between 2014 and 2018: the number and percentage of patients in the 0 – 4 year stratum decreased from 2,396 (36.3%) to 1,399 (20.1%) ($\chi^2[1] = 245.80$, $p < .001$), the 5 – 11 year stratum increased from 2,828 (42.8%) to 3,223 (46.4%) ($\chi^2[1] = 6.79$, $p = .009$), and the ≥12 year stratum increased from 1,382 (20.9%) to 2,323 (33.4%) ($\chi^2[1] = 153.37$, $p < .001$). In the 2014 sample 3,745 (56.7%) patients were male, with 3,977 (57.3%) in 2018 ($\chi^2[1] = .12$, $p = .725$). While the CMG patient population is predominantly Hispanic, there was a significant change in the 4 years. The number and percentage of Hispanic patients decreased from 5,099 (77.2%) in 2014 to 5,089 (73.3%) in 2018 ($\chi^2[1] = 3.93$, $p = .047$). The number and percentage of Caucasian patients increased from 740 (11.2%) to 888 (12.3%) in 2018 ($\chi^2[1] = 6.31$, $p = .012$). Even with a decrease in the number of Hispanics, the number and percentage of patients with Spanish as primary language increased from 2,821 (42.7%) to 3,178 (45.8%) ($\chi^2[1] = 4.95$, $p = .026$).

Patient Demographics for ICS Subset

The subset to analyze patients with ICS totaled 2,593 in 2014 and 2,772 in 2018. The demographics were similar in both study-year groups except for age (Table 5.2). The number and percentage of patients in the 0 – 4 year old age stratum decreased from 1,119 (43.2%) to 657 (23.7%) ($\chi^2[1] = 115.12$, $p < .001$); whereas, the 5 – 11 years stratum increased 1,131 (32.6%) to 1,385 (50.0%) ($\chi^2[1] = 7.85$, $p = .005$) and the $\geq$ 12 years stratum increased 343 (13.2%) to 730 (26.3%) ($\chi^2[1] = 96.54$, $p < .001$). There was a similar percentage of males: 2,056 (59.2%) males in 2014 and 2,213 (59.4%) males in 2018.

Patient Demographics for Spacer Subset

Demographics of the spacer subset were similar in 2014 and 2018 except for the age stratums (Table 5.3). The number of patients in the 0 – 4 year stratum decreased from 1,140 (32.8%) to 584 (15.7%) ($\chi^2[1] = 117.98$, $p < .001$), the 5 – 11 year stratum had a non-significant increase from 1,700 (49.0%) to 1,867 (50.1%) ($\chi^2[1] = .333$, $p = .564$), .and the $\geq$ 12 year stratum had a significant increase from 632 (18.2%) to 1272 (34.2%) ($\chi^2[1] = 138.22$, $p < .001$). The number of patients of male gender in 2014 was 2,056 (59.2%) and 2,213 (59.4%) in 2018 ($\chi^2[1] = .008$, $p = .927$).

Comparison of Outcomes 2014 to 2018

Data were available for a total of 13,551 patients (6,606 in 2014, and 5,945 in 2018). Clustering of visits within patients was accounted for in the model; denoting a patient as “yes” met the specified criteria for the outcome measures with one or more visit. Using the GLMM, outcomes each increased significantly between 2014 and 2018 ($p < .001$) (Table 5.4, Appendix A). All four hypotheses posed were supported. For hypothesis 1a, results showed that patients in 2018 had odds 15 times greater than patients in 2014 to receive an ACT (OR = 14.95; 95% CI 12.67, 17.65; p<.001). For hypothesis 1b, results showed that patients in 2018 had odds 13 times greater than patients in 2014 to receive an AAP (OR = 12.70; 95% CI 11.10, 14.54, $p < .001$). For hypothesis 1c, results showed that patients in 2018 had odds 1.9 times greater than patients in 2014 to receive an ICS (OR = 1.85; 95% CI 1.61, 2.13, $p < .001$). For hypothesis 1d, results showed that patients in 2018 had odds 1.5 times greater than patients in 2014 to receive a spacer (OR = 1.45; 95% CI 1.31, 1.60, $p < .001$).

Additional Exploration

Further analysis was done looking at change between years for each age stratum and among age strata within the same year. These analyses did not control for gender, race/ethnicity, or language

Asthma control test (ACT). Administration of ACT across the total of all ages increased from 3.5% in 2014 to 32.9% in 2018 ($\chi^2[1] = 1{,}347.5$, $p < .001$) (Table 5.5). Between 2014 and 2018 ACT administration in each of the three age strata increased, with the greatest improvement in the 5 – 11 year stratum 136 (4.8%) to 1249 (38.8%) ($\chi^2[1] = 640.7$, $p < .001$). In 2014 there was a significant difference in ACT administration between the 0 – 4 year stratum (n = 47, 2.0%) and the other two age strata: 5-11 years (n=136, 4.8%) ($\chi^2[1] = 29.08$, $p < .001$), and $\geq$ 12 years (n=54, 3.9%) ($\chi^2[1] = 12.03$, $p < .001$) (Table 5.6). In 2018, all three strata significantly differed from each other: between the 0 – 4 year stratum (n = 47, 2.0%) and the 5 – 11 year stratum (n = 136, 4.8%) ($\chi^2[1] = 111.37$, $p < .001$), and the $\geq$ 12 years (n = 54, 3.9%) ($\chi^2[1] = 70.91$, $p <$

.001); and the smallest change between the between the 5 – 11 year stratum (136, 4.8%) and the ≥ 12 years (n=54, 3.9%) (χ^2[1] = 5.74, p = .017.

Asthma action plan (AAP). Further analysis showed AAP receipt across the total of all three age strata increased from 371 (5.6%) to 2,770 (39.9%) (χ^2[1] = 1,430.2, $p < .001$) (Table 5.5). The 5 – 11 year stratum had the largest increase from 175 (6.1%) to 1,410 (43.7%) (χ^2[1] = 670.7, $p < .001$). Table 5.6 shows in 2014, when each age stratum was compared to each of the other age strata in the same year, only the 5 – 11 year (n = 175, 6.1%) and ≥12 year (n = 59, 4.3%) strata were significantly different (χ^2[1] = 5.86, p = .015). In 2018, the 5 – 11 year (n = 1,410, 43.7%) stratum was significantly different from the other two strata, which coincides with the 5- 11 year old stratum having the largest increase: 0 – 4 years (n = 511, 36.5%) (χ^2[1] = 8.83, p = .003), and ≥ 12 years (849, 36.5%) (χ^2[1] = 12.32, $p < .001$) (Table 5.6).

Inhaled corticosteroids (ICS). Chi-Square calculations showed a statistically significant difference for the total of all ages from 540 (20.8%) in 2014 to 863 (31.1%) in 2018 (χ^2[1] = 430.34, p = <.001). There was a significant change between the years 2014 and 2018 for the 0 – 4 year stratum (χ^2[1] = 20.75, $p < .001$) and 5 – 11 year stratum (χ^2[1] = 14.66, $p < .001$) (Table 5.5), but no significant change for the ≥ 12 year stratum (χ^2[1] = 2.25, p =.113). When comparing the age strata within the same year, in 2014 only the 0 – 4 year (n = 380, 33.3%) and the 5 – 11 year (n = 703, 41.3%) age strata showed a statistically significant difference (χ^2[1] = 19.09, p = < .001). Whereas in 2018 the 5 – 11 year stratum was significantly different from both the 0 – 4 year (χ^2[1] = 6.28, p = .01) and ≥ 12 year (χ^2[1] = 6.48, p = .01) strata.

Spacers. A significant change was seen between 2014 (1303 [37.5%]) and 2018 (1642 [44.1%]) for the total of all the age groups (χ^2[1] = 13.45, p = <.001). There was a significant change 2014 to 2018 in the 0 – 4 year (χ^2[1] = 13.23, p = < .001) and in the 5 – 11 year (χ^2[1] =

12.73, p = < .001) strata. There was no significant change in the ≥ 12 year stratum (χ^2[1] = .57, p = .451). In 2018, the 0 – 4 year and 5 – 11 year strata had increased by 13.6% and 9.9%, but the ≥ 12 years had decreased by 2.4% from 2014. When comparing the three age strata within 2014: the 0 – 4 year stratum differed significantly from the 5 – 11 year stratum (χ^2[1] = 8.44, p = .004). The ≥ 12 year stratum was not significantly different from the other two age strata: 0 – 4 years (χ^2[1] = .20, p = .66), and 5 – 11 years (χ^2[1] = 3.65, p = .056). Whereas in 2018 the ≥ 12 year stratum was significantly different from the other two strata: 0 – 4 years (χ^2[1] = 16.16, p = <.001), and 5 – 11 years (χ^2[1] = 44.24, p = <.001).

Aim 2 Results

Patient Demographics

The demographics of the CMG and non-CMG patients differed in terms of age, race/ethnicity, and language, but not gender (Table 5.7). Both samples have the same percentage of patients of male gender of 57.0% (χ^2[1] = <.001, p = .992). The samples showed significant differences in terms of 0 – 4 and ≥12 age strata. The non-CMG patients were younger than CMG patients: in the 0 – 4 years stratum, the CMG group was 1,373 (18.4%), and the non-CMG group was 4,409 (24.9%) (χ^2[1] = 79.723, p < .001); in the ≥ 12 year stratum, the CMG group was 2,639 (35.4%), and the non-CMG group was 5,249 (29.7%) (χ^2[1] = 41.54, p < .001). There was no significant difference between the groups for the 5 – 11 year stratum, which is the largest population for both groups: CMG was 3,349 (46.2%) and non-CMG 8,041 (45.4%) (χ^2[1] = .4114, p = .521).

There were significant differences in the race/ethnicity and language characteristics. Hispanic and Caucasian numbers and percentages were significantly higher in the CMG group compared to the non-CMG group. The Hispanic characteristic of the CMG group was 5,694

(76.4%) and the non-CMG group was 11,832 (66.9%) ($\chi^2[1] = 39.71$, $p < .001$); the Caucasian characteristic of the CMG group was 867 (11.6%) and the non-CMG group of 1,448 (8.2%) ($\chi^2[1] = 61.48$, $p < .001$). The Asian and other/unknown groups were significantly higher in the non-CMG group. The Asian characteristic of the CMG group was 160 (2.1%) and the non-CMG group was 883 (5.0%) ($\chi^2[1] = 99.15$, $p < .001$). The other/unknown characteristic of the CMG group was 540 (7.2%) and the CMG group of 3,276 (18.5%) ($\chi^2[1] = 397.20$, $p < .001$).

The significant differences in the language characteristic coincide with the race/ethnicity. Spanish language was significantly higher in the CMG group 4,090 (54.9%) than the non-CMG group 7,074 (40.0%) ($\chi^2[1] = 175.21$, $p < .001$). The non-CMG group was significantly higher in English, Vietnamese and other/unknown. English is significantly less in the CMG group 3,349 (44.9%) than the non-CMG group 9,831 (55.5%) ($\chi^2[1] = 76.98$, $p < .001$). The Vietnamese language is also significantly less in the CMG group 2 (.0003%) than the non-CMG group 273 (1.5%) ($\chi^2[1] = 109.53$, $p < .001$). The other/unknown language characteristic of the CMG group was 8 (.001%) and the CMG group of 505 (2.9%) ($\chi^2[1] = 192.09$, $p < .001$).

Comparison of Outcomes

Using claims data from CHA, data was available for 25,150 patients in the designated sample (7,451 in CMG, and 17,699 in non-CMG). It is unknown how many or if any are duplicate patients in the groups because a patient may change their medical group each month. Clustering of visits within patients was accounted for in the model, a patient denoted as “yes” had one or more hospital admission, ED visit, or outpatient visit within each of the outcome measures.

The total of asthma exacerbations in any location showed the CMG group was 1.1 times more likely than non-CMG group in 2018 to have a health encounter with a diagnosis of asthma exacerbation (OR = 1.130, 95% CI 1049, 1.217, $p < .01$) (Table 5.8, Appendix B). Analyses showed the CMG had a greater percent of patients (with diagnosis of asthma exacerbation) with hospital admissions, ED visits and outpatient visits than the non-CMG group (Table 5.8, Appendix C); however, that difference was significant only for ED visits ($p < .001$), controlling for age, gender, race/ethnicity, and language.

More specifically, patients in the CMG group were 1.4 times more like than the non-CMG to have an ED visit (OR = 1.351, 95% CI 1.236, 1.476, $p < .001$). Whereas, a non-significant result was found for hospital admissions, with patients in the CMG group 1.2 times more likely than the non-CMG to have a hospital admission (OR = 1.190, 95% CI .949, 1.479, $p = .133$). Outpatient visits also resulted in a non-significant difference: patients in the CMG group were 1.1 times more like than the non-CMG to have an outpatient visit with a diagnosis of asthma exacerbation (OR = 1.068, 95% CI .973, 1.172, $p = .133$). Thus, results showed that all hypotheses of Aim 2 were not supported.

Tables

Table 5.1

Aim 1 Patient Demographics

	2014 n (%)	2018 n (%)	p^1
Gender			
Male	3745 (56.7)	3977 (57.3)	.724
Female	2861 (43.3)	2968 (42.7)	.671
Age			
0 – 4 years	2396 (36.3)	1399 (20.1)	<.001***
5 – 11 years	2828 (42.8)	3223 (46.4)	.009**
≥ 12 years	1382 (20.9)	2323 (33.4)	<.001***
Race/ethnicity			
Hispanic	5099 (77.2)	5089 (73.3)	.047*
Caucasian	740 (11.2)	888 (12.3)	.012*
African American	111 (1.7)	144 (2.1)	.098
Asian	136 (2.1)	167 (2.4)	.183
Native American (AI/AN)	4 (<.1)	5 (<.1)	.796
Native Hawaiian/Other Pacific Islander	25 (<.1)	27 (0.4)	.923
Other/Unknown	491 (7.5)	625 (9.0)	.002**
Primary Language			
English	3774 (57.1)	3754 (54.1)	.542
Spanish	2821 (42.7)	3178 (45.8)	.026*
Vietnamese	5 (<.1)	5 (<.1)	.937
Chinese	1 (<.1)	2 (<.1)	.593
Other	5 (<.1)	6 (<.1)	.827

Note. 2014 N = 6606, 2018 N= 6945, AI/AN = American Indian/Alaskan Native.

* p <.05. ** p < .01. *** p < .001.

[1] From chi square comparing 2014 to 2018 for the specific characteristic.

Table 5.2

Aim 1 ICS Subset Patient Demographics

	2014 n (%)		2018 n (%)		p^1
Gender					
Male	1578	(60.6)	1699	(61.3)	.872
Female	1015	(39.1)	1073	(38.7)	.828
Age					
0 – 4 years	1119	(43.2)	657	(23.7)	<.001***
5 – 11 years	1131	(43.6)	1385	(50.0)	.005**
≥ 12 years	343	(13.2)	730	(26.3)	<.001***
Race/ethnicity					
Hispanic	1883	(72.6)	1891	(68.2)	.141
Caucasian	262	(10.1)	322	(11.6)	.111
African American	47	(1.8)	57	(2.1)	.526
Asian	48	(1.9)	62	(2.2)	.329
Native American (AI/AN)	0		0		
Native Hawaiian/Other Pacific Islander	10	(0.4)	11	(0.4)	.948
Other/Unknown	343	(13.2)	429	(15.5)	.042*
Primary Language					
English	1460	(56.3)	1460	(52.7)	.147
Spanish	1129	(43.5)	1309	(47.2)	.097
Vietnamese	2	(.08)	2	(.07)	.947
Chinese	1	(.04)	2	(.07)	.603
Other	1	(.04)	0		

Note. 2014 N = 2593, 2018 = 2772, AI/AN = American Indian/Alaskan Native.

* p <.05. ** p < .01. *** p < .001.

[1] From chi square comparing 2014 to 2018 for the specific characteristic.

Table 5.3

Aim 1 Spacer Subset Patient Demographics

	2014 n (%)	2018 n (%)	p^1
Gender			
Male	2056 (59.2)	2213 (59.4)	.927
Female	1416 (40.7)	1511 (40.6)	.907
Age			
0 – 4 years	1140 (32.8)	584 (15.7)	<.001***
5 – 11 years	1700 (49.0)	1867 (50.1)	.564
≥ 12 years	632 (18.2)	1273 (34.2)	<.001***
Race/ethnicity			
Hispanic	2622 (75.5)	2726 (73.2)	.388
Caucasian	408 (11.8)	477 (12.8)	.228
African American	78 (2.2)	80 (2.1)	.781
Asian	75 (2.1)	89 (2.3)	.524
Native American (AI/AN)	3 (.09)	2 (.05)	.599
Native Hawaiian/Other Pacific Islander	14 (.4)	16 (.4)	.863
Other/Unknown	272 (7.8)	334 (9.0)	.111
Primary Language			
English	1944 (56.0)	2036 (54.7)	.547
Spanish	1520 (43.8)	1679 (45.0)	.489
Vietnamese	3 (.09)	3 (.08)	.932
Chinese	1 (.03)	1 (.03)	.960
Other	4 (.12)	5 (.13)	.819

Note. 2014 N = 3472, 2018 N = 3724, AI/AN = American Indian/Alaskan Native.

* *p* <.05. ***p* < .01. ****p* < .001.

[1] From chi square comparing 2014 to 2018 for the specific characteristic.

Table 5.4

Aim 1—Comparison from 2014 to 2018 for Asthma Control Test, Asthma Action Plan, Inhaled Corticosteroid, and Spacer Prescription—Results from General Linear Mixed Models

	2014 N n (%)	2018 N n (%)	OR	SE	CI Lower	CI Upper	*p*
Asthma Control Test	6606 237 (3.5)	6945 2286 (32.9)	14.95	.085	12.674	17.653	<.001
Asthma Action Plan	6606 371 (5.6)	6945 2770 (39.9)	12.70	.069	11.102	14.537	<.001
Inhaled Corticosteroid	2593 540 (20.8)	2772 863 (31.1)	1.85	.072	1.61	2.13	<.001
Spacer	3472 1303 (37.5)	3724 1642 (44.1)	1.45	.052	1.310	1.603	<.001

Note. SE = standard error; OR = odds ratio; CI – confidence interval.

**p* <.05. ***p* < .01. ****p* < .001 after controlling for age, gender, race/ethnicity and language

Table 5.5

Unconditional differences between 2014 to 2018 within age strata for Asthma Control Test, Asthma Action Plan, Inhaled Corticosteroid, and Spacer Prescription

	2014		2018			
	n [1](%[2])	N[3]	n[1] (%[2])	N[3]	Chi-Square	*p*
Asthma Control Test	237 (3.5)	6606	2286 (32.9)	6945	1347.5	< .001***
0 – 4 years	47 (2.0)	2396	244 (17.4)	1399	248.2	< .001***
5-11 years	136 (4.8)	2828	1249 (38.8)	3223	640.7	< .001***
≥ 12 years	54 (3.9)	1382	793 (34.1)	2323	305.3	< .001***
Asthma Action Plan	371 (5.6)	6606	2770 (39.9)	6945	1430.1	< .001***
0 – 4 years	137 (5.7)	2396	511 (36.5)	1399	398.3	< .001***
5-11 years	175 (6.1)	2828	1410 (43.7)	3223	670.7	< .001***
≥ 12 years	59 (4.3)	1382	849 (36.5)	1212	322.1	< .001***
Inhaled Corticosteroid	540 (20.8)	2593	863 (31.1)	2772	430.3	< .001***
0 – 4 years	180 (16.1)	1119	179 (27.2)	657	20.8	< .001***
5-11 years	286 (25.3)	1131	484 (34.9)	1385	14.7	< .001***
≥ 12 years	74 (21.6)	343	200 (27.4)	730	2.3	.113
Spacer	1303 (37.5)	3472	1642 (44.1)	3724	13.5	< .001***
0 – 4 years	380 (33.3)	1140	274 (46.9)	586	13.2	< .001***
5-11 years	703 (41.3)	1700	956 (51.2)	1867	12.7	< .001***
≥ 12 years	220 (34.8)	632	412 (32.4)	1273	0.6	.451

Note. **p* <.05. ***p* < .01. ****p* < .001.

[1] number (subset of N in same row and year) with specific prescription for all patients and for each age stratum.

[2] % is 100*(n/N) for same row and year.

[3] Number of patients in year with data for outcome variable, overall and by age stratum.

Table 5.6

Results of Aim 1 All Variables Comparison of Age Strata Within the Same Year

	2014				2018			
	5-11 years		> 12 years		5-11 years		> 12 years	
	Chi-Square	*p*	Chi-Square	*p*	Chi-Square	*p*	Chi-Square	*p*
Asthma Control Test								
0 – 4 years	29.08	<.001***	12.03	<.001***	111.37	<.001***	70.91	<.001***
5-11 years			1.60	.205			5.74	.017*
Asthma Action Plan								
0 – 4 years	.45	.501	3.38	.066	8.83	.003**	<.001	.993
5-11 years			5.86	.015*			12.32	<.001***
Inhaled Corticosteroid								
0 – 4 years	19.09	<.001***	3.79	.052	6.28	.012*	.002	.96
5-11 years			1.21	.270			6.48	.01**
Spacer								
0 – 4 years	8.44	.004**	0.20	.659	1.10	.294	16.16	<.001***
5-11 years			3.65	.056			44.24	<.001***

Note. *p <.05. **p < .01. ***p < .001.

Table 5.7

Aim 2 Patient Demographics

	CMG n (%) 7451	Non-CMG n (%) 17699	*p*
Gender			
Male	4250 (57.0)	10093 (57.0)	.992
Female	3201 (43.0)	7606 (43.0)	.990
Age			
0 – 4 years	1373 (18.4)	4409 24.9)	<.001***
5 – 11 years	3439 (46.2)	8041 (45.4)	.521
$\geq$ 12 years	2639 (35.4)	5249 (29.7)	<.001***
Race/ethnicity			
Hispanic	5694 (76.4)	11832 (66.9)	<.001***
Caucasian	867 (11.6)	1448 (8.2)	<.001***
African American	159 (2.1)	203 (1.1)	<.001***
Asian	160 (2.1)	883 (5.0)	<.001***
Native American (AI/AN)	6 (8.0e-4)	13 (7.3e-4)	.852
Native Hawaiian/Other Pacific Islander	25 (0.003)	44 (0.24)	.230
Other/Unknown	540 (7.2)	3276 (18.5)	<.001***
Primary Language			
English	3349 (44.9)	9831 (55.5)	<.001***
Spanish	4090 (54.9)	7074 (40.0)	<.001***
Vietnamese	2 (2.7e-4)	273 (1.5)	<.001***
Chinese	2 (2.7e-4)	16 (9.0e-4)	.085
Other	8 (0.001)	505 (2.9)	<.001***

Note. Children's Medical Group (CMG) N = 7451, Non-CMG N = 17699. AI/AN = American Indian/Alaskan Native.

**p* <.05. ***p* < .01. ****p* < .001.

Table 5.8

Results of Aim 2 Patients with Asthma Exacerbations in 2018 Using General Linear Mixed Model

	CMG n (%)	Non-CMG n (%)	OR	SE	CI Lower	CI Upper	*p*
Hospital Admission	122 (1.6)	265 (1.5)	1.190	.113	.949	1.479	.133
Emergency Department	900 (12.1)	1572 (8.9)	1.351	.045	1.236	1.476	<.001***
Outpatient	748 (10.0)	1722 (9.7)	1.068	.047	.973	1.172	.167
Total all locations	1301 (17.5)	2803 (15.8)	1.130	.038	1.049	1.217	.01**

Note. The total of all locations is not additive (1770). Many patients have visits in each location.

Children's Medical Group (CMG) N = 7451, Non-CMG N = 17699

SE = standard error; OR = odds ratio; CI – conf0idence interval.

**p* <.05. ***p* < .01. ****p* < .001 after controlling for age, gender, race/ethnicity and language.

CHAPTER 6

DISCUSSION AND CONCLUSION

Discussion

Aim 1

Is there a difference in provider adherence to the National Asthma Education and Prevention Program (NAEPP) guidelines after the integration of the Asthma Registry into the electronic medical record (EMR) as compared to before? Outcome measures: Asthma Control Test (ACT), Asthma Action Plan (AAP), inhaled corticosteroid (ICS) prescription written, and spacer prescription written.

Aim 1. Compare Children's Medical Group (CMG) provider adherence to the NAEPP guidelines before and after implementation of the Asthma Registry data into the EMR looking at four key elements: ACT, AAP, ICS prescription written, and spacer prescription written.

Adherence to the NAEPP guidelines in terms of ACT, AAP, ICS, and spacers improved comparing pre-intervention 2014 data to post-intervention 2018 data. The changes were statistically significant for each variable of interest (ACT, AAP, ICS and spacers) after controlling for age, gender, race/ethnicity, and language. Although all changes were statistically significant, ACT (OR = 14.96) and AAP (OR = 12.70) were greater than ICS (OR = 1.85) and spacers (OR = 1.45). This may be attributed to using the ACT and AAP as the initial measures monitored when the Asthma Registry was implemented into the EMR. No additional measures have been added since the integration in 2015.This gives support to measures improving when they are monitored and providers being aware of the monitoring.

Asthma Control Test. From 2014 to 2018 ACT (one per year) had a significant increase across all ages, from 237 (3.5%) to 2286 (32.9%). The increased findings in 2018 are higher than those reported by Yawn, Rank, Cabana, Wollan, and Juhn (2016); a validated tool to evaluate asthma was documented in 7.5% of the medical records. The integration of the Asthma Registry into the EMR could be the reason for the increase. Providers were aware that the ACT was being measured after the Asthma Registry integration and could explain the larger increase over ICS and spacers that were not being measured initially. All individual age strata had a significant increase, with the smallest in the 0 – 4 year stratum. There are ACTs for the different age strata, and these may not be distributed in all clinics. A clinic location variable would be helpful to further analyze this question.

Asthma Action Plan. The total increase for all ages and for each of the three age strata were significant for the AAP documentation (initial or one update per year). Like the ACT, providers were aware of the AAP being measured. The integration of the Asthma Registry into the EMR could be the reason for the increase. AAP findings in 2014 and 2018 are higher than those reported by Yawn et al. (2016), who reported 3.1% of participants had an AAP documented.

ACT and AAP had the greatest increase for the 5 – 11 year age stratum between 2014 and 2018. This increase may be due to the CHOC Breathmobile. The Breathmobile is an asthma clinic van with 2 exam rooms, pulmonary function testing (spirometry and oscillometry), and asthma specialty staff (CHOC Children's, 2020). The Breathmobile visits 22 elementary schools in Orange County providing comprehensive asthma follow-up care. It visits a school every four to six weeks. The visit includes a comprehensive history of the child, including an ACT. With the use of an ACT, an AAP is developed with the team and family. The Breathmobile preschool and school-aged children are included in the 5 – 11 year stratum (CHOC Children's, 2020).

Inhaled corticosteroids. The control of asthma includes use of ICS per NAEPP guidelines (U.S. Department of Health and Human Services, 2007). The largest increase of ICS use was in the 0 – 4 year stratum, 16.1% to 27.2% ($p < .001$). This increase is most likely related to the Asthma Registry in the EMR. Providers have access to see the admission and ED visit more easily, along with recommendation to use ICS in these patients. Compared to the literature, the use of ICS for the CMG patients in 2018 is less than reported by Diette et al. (2001); Janson-Bjerklie (2004); Legorreta et al. (1998); O'Laughlen, Rance, Rovnyak, Hollen, and Cabana (2013); Yawn et al. (2016). In 2018 the 5 – 11 year stratum (34.9%) was significantly different from the other two age strata (0 – 4 years 27.2%, $\geq$ 12 years 27.4%). This result may also be related to the CHOC Breathmobile, which provides comprehensive follow-up care until the child's asthma is under control. The Breathmobile has decreased hospital admissions from 16.0% to 4.6% and ED visits from 40.9% to 17.0% (CHOC Children's, 2020). Los Angeles Breathmobile Program (2016) was the first Breathmobile Program developed in the U.S. Their reports for 2002 – 2006 show ED visits for Orange County and Los Angeles County decreased by 68%, 74% for Chicago, and 56% for Baltimore. For this same period hospitalizations decreased by 83% in Orange County, 87% in Los Angeles, 88% in Chicago and 78% in Baltimore. Also reported was a decrease in missed school days (elementary): 86% in Orange County, 82% in Los Angeles and Chicago, and 59% in Baltimore (LA Breathmobile Program, 2016). Location of the clinic would be useful to include in future research.

Spacers. Spacer use for the age stratum 0 – 4 years was 380 (33.3%) in 2014 and 274 (46.9%) in 2018. Of note, in 2014, 1140 (32.8%) of the 0 – 4 year stratum had an MDI prescribed, this decreased to 584 (15.7%) in 2018 ($p < .0001$), which is a decrease by more than half (52.2%). Children at this age may be receiving more nebulized treatments than MDI (excluded from the study), which is appropriate due to the inability to use an MDI unless a spacer is used. With a low spacer prescription rate, the question is raised as to how the medication is being administered to the children who are receiving the aerosol medication from an MDI. A question was raised if patients are receiving free spacers in clinic, but through discussions with clinic staff and respiratory therapists at CHOC, this service is not provided in primary care. The data retrieval was expanded to include a two-year period, but this did not change the results. Insurance payment is not a factor for this population. All patients in the study have Medi-Cal which covers the cost of a spacer one time per year (Medi-Cal Update, 2018).

Implementation. Implementation of the Asthma Registry into the EMR at CHOC was associated with increased provider adherence to the NAEPP guidelines when ACT, AAP, ICS, and spacers were evaluated. But the adherence continued to be low in the post-intervention 2018 data with ACT at 32.9%, AAP at 39.9%, ICS at 31.1%, and spacers at 44.1%. Improvement was found to be higher in measures that providers knew were being monitored, demonstrated by the ACT and AAP odds ratios being higher than those of ICS and spacer. Although integration of the Asthma Registry into the EMR appears to be a successful intervention to increase provider adherence to the NAEPP guidelines, ongoing monitoring and education are needed to promote and maintain the behavioral change.

Aim 2

The total of asthma exacerbations in any location showed the CMG group was 1.1 times more likely than non-CMG group in 2018 to have a health encounter with a diagnosis of asthma exacerbation (OR = 1.130, 95% CI 1049, 1.217, $p < .01$). When the locations were analyzed individually, all showed CMG was higher than non-CMG with only ED visits being significantly higher. Evaluation of the demographics may give insight to the difference. The CMG group has more children 12 years or older and less young children (0 – 4 years) than the non-CMG group. Nath and Hsia (2015) report in the United Kingdom 2 – 5 year old children have more ED visits than children aged 10 – 17 years. In the United States., the National Center for Health Statistics (2017) reported ED visits for age 0 – 4 years was 7.2%, age 5-14 years 10.5%, and 15-24 years 14.5%. The CMG group has a higher ED rate for the $\geq$ 12 year strata (12.1%) than the non-CMG group (8.9%) (OR = 1.35. 95% CI 1.236, 1.476, $p < .001$), which is similar to the CDC reporting. Hospital admissions and outpatient visits even though higher, did not show a significant difference.

Race/ethnicity may influence the outcomes. The CMG group has a larger Hispanic and Spanish speaking population than the non-CMG group. Hispanics have a higher rate of low health literacy than their white counterparts (Valerio, George, Liu, Osakwe, & Bruzzese, 2018). Seibert et al. (2019) report Hispanic asthma patients had an increase of hospital admits, ED visits, and same day appointments. Hispanic asthma patients were 1.71 more likely to have a hospital admit than white asthma patients (95% CI 1.08, 2.70, p <.05) (Seibert et al., 2019). The larger Hispanic and Spanish speaking population may contribute to the higher outcomes of the CMG group.

The non-CMG group has a significantly higher Vietnamese population. There is no research specific to health literacy in the Vietnamese population for asthma. Nguyen et al. (2015) reports in Orange County, CA, the same location as this research, the prevalence of asthma risk to be higher than commonly appreciated, with many of the patients not previously diagnosed. It is unknown how the difference in the Vietnamese characteristic affects the outcomes of the CMG or non-CMG groups.

Limitations

Study results should be interpreted considering several possible limitations having to do with data (unable to integrate two databases, classification of disease severity, ICD coding, potential confounding variables), analysis, incentives, and generalizability.

Data. ***Integration of two databases.*** Access to both the EMR and claims data was available, but integration of both databases to obtain a more comprehensive analysis was not possible. The EMR was utilized for Aim 1 due to more data fields and the ability to capture the provider's orders. Integrating both databases would allow for additional fields to be used. An example would be if a patient went to an ED in the community and given a spacer, the spacer would be captured in the billing database, but it is not captured in the CHOC EMR.

The use of claims data for pharmacy data is a limitation. The claims/pharmacy data do not reflect the written prescription. The provider may have been adherent and wrote the prescription (annotated in the EMR), but patient did not fill the prescription.

For Aim 2, EMR data was not available for all CHA patients, only for those patients with CMG as provider. Therefore, only data that was billable (in the claims database) could be retrieved.

Classification of disease severity. Providers are increasing the use of AAP which contains a field to document the asthma severity. Unfortunately, this field was not retrievable for analysis. Diagnosis coding changed in 2015 from ICD-9 to ICD-10 allowing for classification within the diagnosis code. Providers are not consistently using the ICD-10 to classify the severity of asthma with asthma patients. The change in the coding system may also contribute to a difference in data collection. Without classification, it was difficult to determine which patients would benefit from ICS. As a surrogate for this study, patients with ED visit or hospital admits for asthma exacerbation where diagnosis of asthma exacerbation in the medical record was used as a subset for analysis: but not all patients requiring an ICS may have been included in the subset.

ICD coding. There was a change from ICD-9 to ICD-10 diagnosis codes in 2015. Thus, different diagnosis coding was used in pre-test and post-test study year data. ICD-10 codes give more detail for the diagnosis as compared to ICD-9. For this reason, the ICD-10 diagnosis code for asthma with all extenders was used to identify patients with asthma. The implementation of the registry data into the EMR was in the early phase in 2015. Outcomes were chosen that did not require classification of disease. Many of the NAEPP recommendations are based on classification and patient age. ICD-10 allows for classification yet, few providers classified asthma patients. For this reason, in order to look at ICS adherence, patients who were admitted or had ED visits were included in the study.

Analysis. Note that while the primary tests of hypotheses controlled for selected patient characteristics (age, gender, race/ethnicity, and language), additional exploration of change within each age stratum for Aim 1 did not include these controls. Future analyses should include a broader range of covariates (including provider characteristics).

Potential confounding variables. Statistical models included control for only a limited set of potential confounding (patient) variables. Provider characteristics may also impact outcomes; however, data on provider characteristic was not available for inclusion in the analysis. Patient confounding variables were limited in definition and scope. EMR data did not provide family or sociodemographic characteristics. Race and ethnicity were combined into one variable in the database, not providing separate details on the two characteristics. Utilization of chi-square to analyze the results of variable differences between years did not control for the patient variables.

Provider demographics. Provider demographics were not analyzed. There may be confounding variables within the provider demographics that could explain differences in the age strata. Location of provider's practice would be helpful; all are Medi-Cal patients but differing clinics may be providing more or different care based on guidelines. Years in practice may influence the provider's understanding and implementation of the guidelines.

Patient demographic data. Demographic data included age, gender, race/ethnicity and language. CHOC has a predominant and high Hispanic population, but the race categories do not purely represent race due to the two variables being combined. It is unknown if a white Hispanic chose white or Hispanic, similarly a black Hispanic could choose black or Hispanic. CHOC also has a clinic in Garden Grove (a Vietnamese community) with Vietnamese providers and staff. Having the provider demographics to identify the location of the patients would assist in further explicating the significant difference in Aim 2. It would also be beneficial to know the stratification of race/ethnicity data within the age strata in Aim 2 but was not available for analysis.

Statistical analysis. There were few small cell sizes in the race/ethnicity and language covariates in the GLMM (Appendix A and B). The impact of specific covariate categories for selected outcomes cannot be interpreted; but this should not affect interpretation of results for comparisons across years. Future analyses could examine in more depth race/ethnic/language differences in order to better serve specific population subgroups.

Financial incentives. In 2018, CHOC started to discuss financial incentives to providers for their performance of two measures (ACT and AAP). Due to this potential change, provider actions may not be due solely to the EMR change.

Generalizability. The generalizability of this study is limited to the pediatric Medi-Cal providers who utilize Cerner as their EMR.

Recommendations

Next steps include additional research to include provider demographics for a more comprehensive analysis in which the additional potential confounding variables could be explored. Availability of these data may also identify which providers are more likely to use the guidelines. These providers can then educate and train additional providers in the organization.

Additional analysis of CMG and non-CMG demographics may answer questions regarding the difference of outcomes between the two groups. Further analysis could include acuity of patients and location of admission in both CMG and non-CMG patients. Additional outcomes such as prescription for short acting beta agonist, ICS, oral steroids, and spacers, as well as length of stay can be used to determine the acuity of patients.

Promoting provider's use of the ICD-10 diagnosis code for classification of asthma and adding this as a measure of provider adherence is recommended. Use of the ACT is required to determine the patient classification of asthma. The use of the ACT may increase if the classification is being monitored. Also, with proper classification, NAEPP guidelines can be utilized appropriately giving a more accurate AAP to improve patient outcomes.

Increased monitoring has been discussed at CHOC with an added benefit of provider incentives in 2018. Monitoring would be evaluated regularly with formal feedback to the provider. It is also recommended that adding additional asthma guideline measures be included to increase adherence to the guidelines. For example, adding ICS and spacers as the next measures will increase provider adherence to the guidelines and improve patient outcomes as shown in the literature.

Conclusion

This research shows that after integration of an Asthma Registry into the EMR at CHOC Children's in the Medi-Cal population, provider adherence to the NAEPP guidelines increased. All four hypotheses posed in Aim 1 were supported. ACT, AAP, ICS and spacers had significant increases from 2014 to 2018. ACT and AAP were being monitored and were higher than ICS and spacers giving strength to monitoring behavior increases adherence to the measurement.

The results of Aim 2 did not support the hypotheses. Patient demographics showed differences between the CMG and non-CMG group which may cause the difference. Acuity of patients may be another reason but requires further research.

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Appendix A

Aim 1 – General Linear Mixed Model Results

ACT

```
Random effects:
 Groups     Name        Variance Std.Dev.
 PATIENT_ID (Intercept) 0.5806   0.762
Number of obs: 13551, groups:  PATIENT_ID, 9088

Fixed effects:
                                            Estimate Std. Error z value Pr(>|z|)
(Intercept)                                 -4.20981    0.12797 -32.898  < 2e-16 ***
sexMale                                      0.11474    0.05529   2.075  0.03796 *
AgeAge05to11                                 1.06938    0.08066  13.257  < 2e-16 ***
AgeAge12AndAbove                             0.83303    0.08537   9.757  < 2e-16 ***
raceWhite                                    0.08963    0.08681   1.033  0.30183
raceAsian                                    0.21808    0.19165   1.138  0.25515
raceBlack or African American                0.22885    0.20221   1.132  0.25776
raceAmerican Indian or Alaska Native         0.44020    0.98783   0.446  0.65587
raceNative Hawaiian or Other Pacific Islander 0.18248   0.45514   0.401  0.68847
racezOtherUnknown                            0.26378    0.09635   2.738  0.00619 **
lang1English                                -0.51481    0.06122  -8.409  < 2e-16 ***
lang2Chinese                                 0.14919    1.58009   0.094  0.92478
lang3Vietnamese                             -1.02016    1.23802  -0.824  0.40993
lang4Other                                   0.52291    0.86092   0.607  0.54360
service_year2018                             2.70525    0.08454  32.001  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

	OR	ciLower	ciUpper
(Intercept)	0.014849241	0.01155524	0.019082249
sexMale	1.121579641	1.0063968	1.249945242
AgeAge05to11	2.913569705	2.487506276	3.412609853
AgeAge12AndAbove	2.300275931	1.945852694	2.719254843
raceWhite	1.093770469	0.922644375	1.29663592
raceAsian	1.243692	0.854242997	1.81069063
raceBlack or African American	1.257148991	0.845789631	1.86857763
raceAmerican Indian or Alaska Native	1.553015658	0.224042751	10.765167
raceNative Hawaiian or Other Pacific Islander	1.200191019	0.491847504	2.928668888
racezOtherUnknown	1.301845237	1.077814117	1.572442774
lang1English	0.597616631	0.530045731	0.673801556
lang2Chinese	1.160890831	0.052458601	25.69011534
lang3Vietnamese	0.360538252	0.03185247	4.080934051
lang4Other	1.686930631	0.312088562	9.118357097
service_year2018	14.95812339	12.67419134	17.6536277

AAP

```
Random effects:
 Groups     Name        Variance Std.Dev.
 PATIENT_ID (Intercept) 0.3216   0.5671  
Number of obs: 13551, groups:  PATIENT_ID, 9088

Fixed effects:
                                              Estimate Std. Error z value Pr(>|z|)    
(Intercept)                                   -3.06282    0.08801 -34.799  < 2e-16 ***
sexMale                                        0.12082    0.04890   2.471 0.013487 *  
AgeAge05to11                                   0.22373    0.06164   3.630 0.000284 ***
AgeAge12AndAbove                              -0.10594    0.06865  -1.543 0.122770    
raceWhite                                      0.17727    0.07538   2.352 0.018691 *  
raceAsian                                      0.16177    0.16637   0.972 0.330879    
raceBlack or African American                  0.10205    0.17698   0.577 0.564181    
raceAmerican Indian or Alaska Native          -0.89734    1.15571  -0.776 0.437489    
raceNative Hawaiian or Other Pacific Islander  0.02503    0.39680   0.063 0.949694    
racezOtherUnknown                              0.25250    0.08552   2.953 0.003150 ** 
lang1English                                  -0.25839    0.05254  -4.918 8.73e-07 ***
lang2Chinese                                   0.16334    1.43956   0.113 0.909659    
lang3Vietnamese                                0.24495    0.84284   0.291 0.771340    
lang4Other                                     1.05226    0.77429   1.359 0.174144    
service_year2018                               2.54190    0.06877  36.961  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

	OR	ciLower	ciUpper
(Intercept)	0.046755676	0.039347459	0.055558689
sexMale	1.128426851	1.025288797	1.24193999
AgeAge05to11	1.250727683	1.10839846	1.411333373
AgeAge12AndAbove	0.899479923	0.786248065	1.029018917
raceWhite	1.193954309	1.029965732	1.384052738
raceAsian	1.175593995	0.848474896	1.628829854
raceBlack or African American	1.107441399	0.782848651	1.566620125
raceAmerican Indian or Alaska Native	0.407652584	0.042320269	3.92673852
raceNative Hawaiian or Other Pacific Islander	1.025350523	0.471099838	2.231679166
racezOtherUnknown	1.287242049	1.088599855	1.522131465
lang1English	0.77229208	0.696726858	0.856052913
lang2Chinese	1.177442341	0.070077802	19.78330405
lang3Vietnamese	1.277556181	0.244878108	6.66515193
lang4Other	2.86412284	0.627939774	13.06367262
service_year2018	12.70378647	11.101824	14.53690768

ICS

```
Random effects:
 Groups     Name        Variance Std.Dev.
 PATIENT_ID (Intercept) 0.9874   0.9937
Number of obs: 5365, groups:  PATIENT_ID, 3505

Fixed effects:
                                           Estimate Std. Error z value Pr(>|z|)
(Intercept)                              -1.752e+00  9.990e-02 -17.540  < 2e-16 ***
sexMale                                   6.683e-03  7.871e-02   0.085  0.93233
AgeAge05to11                              4.832e-01  8.696e-02   5.556 2.76e-08 ***
AgeAge12AndAbove                          6.763e-02  1.129e-01   0.599  0.54931
raceWhite                                 3.961e-01  1.259e-01   3.146  0.00166 **
raceAsian                                -4.163e-01  3.462e-01  -1.203  0.22915
raceBlack or African American             2.084e-01  2.931e-01   0.711  0.47718
raceNative Hawaiian or Other Pacific Islander  2.650e-01  6.350e-01   0.417  0.67647
racezOtherUnknown                         6.550e-01  1.068e-01   6.130 8.77e-10 ***
lang1English                             -6.007e-01  8.390e-02  -7.159 8.13e-13 ***
lang2Chinese                             -1.723e+01  9.295e+03  -0.002  0.99852
lang3Vietnamese                          -6.320e+00  2.764e+01  -0.229  0.81917
lang4Other                               -3.470e+01  6.711e+07   0.000  1.00000
service_year2018                          6.161e-01  7.234e-02   8.517  < 2e-16 ***
```

	OR	ciLower	ciUpper
(Intercept)	0.173397442	0.142563773	0.210899812
sexMale	1.006705848	0.86279185	1.174624755
AgeAge05to11	1.621172466	1.36712788	1.922424524
AgeAge12AndAbove	1.069964676	0.857508252	1.335059349
raceWhite	1.486083921	1.161061249	1.902092091
raceAsian	0.659504441	0.334635704	1.299760015
raceBlack or African American	1.231646614	0.693419114	2.187642873
raceNative Hawaiian or Other Pacific Islander	1.303397813	0.375469477	4.524591118
racezOtherUnknown	1.925166295	1.561419932	2.373650539
lang1English	0.548442467	0.465276326	0.646474198
lang2Chinese	3.30E-08	0	Inf
lang3Vietnamese	0.001800448	5.31E-27	6.10E+20
lang4Other	8.47E-16	0	Inf
service_year2018	1.851769814	1.606971256	2.13385985

Spacers

```
Random effects:
 Groups     Name        Variance Std.Dev.
 PATIENT_ID (Intercept) 0.4129   0.6426
Number of obs: 7196, groups:  PATIENT_ID, 4424

Fixed effects:
                                          Estimate Std. Error z value Pr(>|z|)
(Intercept)                               -0.53622    0.07057  -7.599 2.99e-14 ***
sexMale                                    0.05868    0.05429   1.081   0.2798
AgeAge05to11                               0.30010    0.06465   4.642 3.45e-06 ***
AgeAge12AndAbove                          -0.36653    0.07803  -4.697 2.64e-06 ***
raceWhite                                 -0.19177    0.08600  -2.230   0.0258 *
raceAsian                                 -0.06077    0.18837  -0.323   0.7470
raceBlack or African American             -0.05886    0.18736  -0.314   0.7534
raceAmerican Indian or Alaska Native     -11.38177  192.40705  -0.059   0.9528
raceNative Hawaiian or Other Pacific Islander -0.08058 0.42228 -0.191   0.8487
racezOtherUnknown                         -0.12740    0.09796  -1.301   0.1934
lang1English                              -0.26984    0.05770  -4.677 2.92e-06 ***
lang2Chinese                             -10.75535  217.51867  -0.049   0.9606
lang3Vietnamese                           -1.46150    1.19827  -1.220   0.2226
lang4Other                                -1.05776    0.88662  -1.193   0.2329
service_year2018                           0.37084    0.05158   7.190 6.50e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

	OR	ciLower	ciUpper
(Intercept)	0.58495525	0.509395508	0.671722932
sexMale	1.060437809	0.953389491	1.179505708
AgeAge05to11	1.349995492	1.189336457	1.532356817
AgeAge12AndAbove	0.693137117	0.594837379	0.80768136
raceWhite	0.825499962	0.697454937	0.97705264
raceAsian	0.941037267	0.650522039	1.361293061
raceBlack or African American	0.942834198	0.653060404	1.361185457
raceAmerican Indian or Alaska Native	1.14E-05	1.90E-169	6.83E+158
raceNative Hawaiian or Other Pacific Islander	0.922584782	0.40323669	2.110826471
racezOtherUnknown	0.880379681	0.726581013	1.066733604
lang1English	0.76350158	0.681862359	0.854915445
lang2Chinese	2.13E-05	1.50E-190	3.03E+180
lang3Vietnamese	0.231888727	0.0221466	2.428019705
lang4Other	0.347231209	0.061083472	1.973848372
service_year2018	1.448947377	1.309627408	1.603088396

Appendix B

Aim 2- General Linear Mixed Model for Exacerbation, Any Location

	CMG	Non-CMG
ED, IP, or OP Exacerbation	1301	2803
No Exacerbation	6150	14896

```
Call:
glm(formula = ANY_EXA ~ SEX + Age + RACE_OR_ETHNICITY + LANG +
    IS_CMG, family = binomial, data = d)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.9949  -0.6379  -0.5730  -0.4882   2.5174

Coefficients:
                                                   Estimate Std. Error z value Pr(>|z|)
(Intercept)                                        -1.63635    0.04833 -33.857  < 2e-16 ***
SEXMale                                             0.20067    0.03521   5.699 1.21e-08 ***
AgeAge05to11                                       -0.08720    0.04193  -2.080  0.03755 *
AgeAge12AndAbove                                   -0.49084    0.04870 -10.078  < 2e-16 ***
RACE_OR_ETHNICITYAmerican Indian or Alaska Native  -0.08387    0.63214  -0.133  0.89445
RACE_OR_ETHNICITYAsian                             -0.01543    0.08833  -0.175  0.86134
RACE_OR_ETHNICITYBlack or African American          0.19234    0.13381   1.437  0.15061
RACE_OR_ETHNICITYNative Hawaiian or Other Pacific Islander  0.74975    0.26126   2.870  0.00411 **
RACE_OR_ETHNICITYWhite                             -0.06219    0.06294  -0.988  0.32307
RACE_OR_ETHNICITYzOtherUnknown                     -0.17109    0.05588  -3.062  0.00220 **
LANG1English                                        0.11787    0.03895   3.026  0.00248 **
LANG2Chinese                                       -0.29834    0.75362  -0.396  0.69219
LANG3Vietnamese                                    -0.04446    0.18247  -0.244  0.80749
LANG4Other                                         -0.82742    0.18303  -4.521 6.16e-06 ***
IS_CMG1                                             0.12229    0.03778   3.237  0.00121 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 22379  on 25149  degrees of freedom
Residual deviance: 22117  on 25135  degrees of freedom
AIC: 22147

Number of Fisher Scoring iterations: 5
```

	OR	ciLower	ciUpper
(Intercept)	0.194689158	0.177093198	0.214033452
SEXMale	1.22221543	1.140708037	1.309546797
AgeAge05to11	0.916498066	0.844198335	0.994989767
AgeAge12AndAbove	0.612114362	0.556385917	0.673424652
RACE_OR_ETHNICITYAmerican Indian or Alaska Native	0.919552214	0.266378491	3.174341401
RACE_OR_ETHNICITYAsian	0.984690678	0.828165666	1.170799238
RACE_OR_ETHNICITYBlack or African American	1.212082047	0.932459111	1.575557439
RACE_OR_ETHNICITYNative Hawaiian or Other Pacific Islander	2.116470086	1.268321303	3.531790892
RACE_OR_ETHNICITYWhite	0.939703379	0.830653823	1.063069135
RACE_OR_ETHNICITYzOtherUnknown	0.842749136	0.755319467	0.940298956
LANG1English	1.125097082	1.042403511	1.214350711
LANG2Chinese	0.742045435	0.169411939	3.250251603
LANG3Vietnamese	0.956513368	0.668920079	1.367753568
LANG4Other	0.43717356	0.305395488	0.625813836
IS_CMG1	1.130084972	1.049421766	1.21694831

Appendix C

Aim 2- General Linear Mixed Model for Exacerbation, Location Specific

Hospital admission – Main Effects

```
Call:
glm(formula = HAD_IP_EXA ~ SEX + Age + RACE_OR_ETHNICITY + LANG +
    IS_CMG, family = binomial, data = d)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.4741  -0.2038  -0.1659  -0.1060   3.4535

Coefficients:
                                                      Estimate Std. Error z value Pr(>|z|)
(Intercept)                                           -3.79680    0.13487 -28.151  < 2e-16 ***
SEXMale                                                0.09838    0.10566   0.931  0.35180
AgeAge05to11                                          -0.65169    0.10933  -5.961 2.51e-09 ***
AgeAge12AndAbove                                      -1.81870    0.18187 -10.000  < 2e-16 ***
RACE_OR_ETHNICITYAmerican Indian or Alaska Native    -11.41144  323.76050  -0.035  0.97188
RACE_OR_ETHNICITYAsian                                -0.06385    0.25439  -0.251  0.80181
RACE_OR_ETHNICITYBlack or African American             0.55807    0.31982   1.745  0.08099 .
RACE_OR_ETHNICITYNative Hawaiian or Other Pacific Islander 1.06059 0.52594  2.017  0.04374 *
RACE_OR_ETHNICITYWhite                                 0.14689    0.17319   0.848  0.39635
RACE_OR_ETHNICITYzOtherUnknown                        -0.22139    0.17137  -1.292  0.19640
LANG1English                                           0.33885    0.11908   2.845  0.00443 **
LANG2Chinese                                         -11.06490  337.39652  -0.033  0.97384
LANG3Vietnamese                                       -0.50372    0.73118  -0.689  0.49088
LANG4Other                                            -0.22216    0.47864  -0.464  0.64254
IS_CMG1                                                0.16975    0.11310   1.501  0.13340
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 3998.8  on 25149  degrees of freedom
Residual deviance: 3828.3  on 25135  degrees of freedom
AIC: 3858.3

Number of Fisher Scoring iterations: 14
```

	OR2	ciLower2	ciUpper2
(Intercept)	0.022442433	0.017229161	0.029233157
SEXMale	1.10338006	0.896995021	1.357251186
AgeAge05to11	0.521164893	0.420645075	0.645705517
AgeAge12AndAbove	0.162236882	0.113589791	0.231718059
RACE_OR_ETHNICITYAmerican Indian or Alaska Native	1.11E-05	2.88E-281	4.26E+270
RACE_OR_ETHNICITYAsian	0.938142637	0.569809883	1.544570625
RACE_OR_ETHNICITYBlack or African American	1.747304901	0.933545223	3.270408697
RACE_OR_ETHNICITYNative Hawaiian or Other Pacific Islander	2.888073373	1.030204709	8.096417866
RACE_OR_ETHNICITYWhite	1.158226143	0.824852826	1.626335943
RACE_OR_ETHNICITYzOtherUnknown	0.801404542	0.572769841	1.121304221
LANG1English	1.403327066	1.111206507	1.772242011
LANG2Chinese	1.57E-05	1.00E-292	2.44E+282
LANG3Vietnamese	0.60428137	0.144165634	2.532891956
LANG4Other	0.800787872	0.313401365	2.046134087
IS_CMG1	1.185005085	0.949395333	1.47908569

Emergency Department – Main Effects

```
Call:
glm(formula = HAD_ED_EXA ~ SEX + Age + RACE_OR_ETHNICITY + LANG +
    IS_CMG, family = binomial, data = d)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.7725  -0.4837  -0.4304  -0.3681   2.8827

Coefficients:
                                                    Estimate Std. Error z value Pr(>|z|)
(Intercept)                                         -2.42859    0.06197 -39.187  < 2e-16 ***
SEXMale                                              0.26739    0.04410   6.063 1.33e-09 ***
AgeAge05to11                                         0.05493    0.05333   1.030  0.30295
AgeAge12AndAbove                                    -0.27020    0.06117  -4.417 1.00e-05 ***
RACE_OR_ETHNICITYAmerican Indian or Alaska Native   -0.83707    1.02923  -0.813  0.41605
RACE_OR_ETHNICITYAsian                              -0.50729    0.12851  -3.947 7.90e-05 ***
RACE_OR_ETHNICITYBlack or African American           0.28194    0.15047   1.874  0.06097 .
RACE_OR_ETHNICITYNative Hawaiian or Other Pacific Islander  0.54465    0.31091   1.752  0.07981 .
RACE_OR_ETHNICITYWhite                              -0.16342    0.07712  -2.119  0.03408 *
RACE_OR_ETHNICITYzOtherUnknown                      -0.49959    0.07600  -6.573 4.92e-11 ***
LANG1English                                         0.20444    0.04746   4.308 1.65e-05 ***
LANG2Chinese                                        -0.05932    1.03274  -0.057  0.95419
LANG3Vietnamese                                     -0.72862    0.36708  -1.985  0.04715 *
LANG4Other                                          -0.94090    0.28908  -3.255  0.00113 **
IS_CMG1                                              0.30067    0.04528   6.640 3.14e-11 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 16162  on 25149  degrees of freedom
Residual deviance: 15884  on 25135  degrees of freedom
AIC: 15914

Number of Fisher Scoring iterations: 6
```

	OR	ciLower	ciUpper
(Intercept)	0.088160914	0.07807716	0.099546996
SEXMale	1.306548118	1.198364675	1.424497918
AgeAge05to11	1.056468184	0.951625216	1.172861968
AgeAge12AndAbove	0.763227588	0.676989574	0.860450994
RACE_OR_ETHNICITYAmerican Indian or Alaska Native	0.432979179	0.057595545	3.25495611
RACE_OR_ETHNICITYAsian	0.602127993	0.468058891	0.774599364
RACE_OR_ETHNICITYBlack or African American	1.325697099	0.987106772	1.780428266
RACE_OR_ETHNICITYNative Hawaiian or Other Pacific Islander	1.723999829	0.937318008	3.170935996
RACE_OR_ETHNICITYWhite	0.849231789	0.730101524	0.987800475
RACE_OR_ETHNICITYzOtherUnknown	0.60678056	0.52280382	0.704246284
LANG1English	1.226843434	1.117866941	1.346443621
LANG2Chinese	0.942402281	0.124499873	7.133517785
LANG3Vietnamese	0.482572891	0.235021697	0.990872753
LANG4Other	0.390276582	0.221465526	0.687763071
IS_CMG1	1.35076738	1.236046485	1.47613584

Outpatient Visits – Main Effects

```
Call:
glm(formula = HAD_OUT_EXA ~ SEX + Age + RACE_OR_ETHNICITY + LANG +
    IS_CMG, family = binomial, data = d)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.7644  -0.4908  -0.4555  -0.3714   2.6485

Coefficients:
                                                 Estimate Std. Error z value Pr(>|z|)
(Intercept)                                    -2.0555959  0.0584098 -35.193  < 2e-16 ***
SEXMale                                         0.1133376  0.0435076   2.605 0.009187 **
AgeAge05to11                                   -0.1581811  0.0506327  -3.124 0.001784 **
AgeAge12AndAbove                               -0.6490632  0.0610725 -10.628  < 2e-16 ***
RACE_OR_ETHNICITYAmerican Indian or Alaska Native  0.1404827  0.7513793   0.187 0.851687
RACE_OR_ETHNICITYAsian                          0.2656106  0.1014824   2.617 0.008863 **
RACE_OR_ETHNICITYBlack or African American      0.1060133  0.1744195   0.608 0.543316
RACE_OR_ETHNICITYNative Hawaiian or Other Pacific Islander  0.7961701  0.3030189   2.627 0.008602 **
RACE_OR_ETHNICITYWhite                         -0.0251819  0.0797112  -0.316 0.752067
RACE_OR_ETHNICITYzOtherUnknown                 -0.0318674  0.0681901  -0.467 0.640263
LANG1English                                   -0.0001789  0.0486814  -0.004 0.997068
LANG2Chinese                                   -0.7064206  1.0328865  -0.684 0.494020
LANG3Vietnamese                                 0.2624276  0.1885900   1.392 0.164066
LANG4Other                                     -0.7403265  0.2116605  -3.498 0.000469 ***
IS_CMG1                                         0.0654796  0.0473700   1.382 0.166879
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 16153  on 25149  degrees of freedom
Residual deviance: 15970  on 25135  degrees of freedom
AIC: 16000

Number of Fisher Scoring iterations: 5
```

	OR3	ciLower3	ciUpper3
(Intercept)	0.128016522	0.11416883	0.143543819
SEXMale	1.120009971	1.028461813	1.219707256
AgeAge05to11	0.853695201	0.773044034	0.94276065
AgeAge12AndAbove	0.522535077	0.463586152	0.588979858
RACE_OR_ETHNICITYAmerican Indian or Alaska Native	1.150829124	0.263897726	5.018639952
RACE_OR_ETHNICITYAsian	1.304227066	1.068984048	1.591238187
RACE_OR_ETHNICITYBlack or African American	1.111836662	0.789904909	1.564974148
RACE_OR_ETHNICITYNative Hawaiian or Other Pacific Islander	2.217033604	1.224171036	4.015156264
RACE_OR_ETHNICITYWhite	0.975132512	0.83409087	1.140023768
RACE_OR_ETHNICITYzOtherUnknown	0.968635047	0.84745498	1.107143007
LANG1English	0.999821154	0.908834114	1.099917273
LANG2Chinese	0.493407163	0.065164474	3.735940969
LANG3Vietnamese	1.300082361	0.898344181	1.881477258
LANG4Other	0.476958175	0.315002925	0.722180913
IS_CMG1	1.067670988	0.973007211	1.171544595