Peak Asthma Control Tool (PACT): An Asthma Self-Management Mobile Application Program Plan and Evaluation

By

Seyram Fudzie

A Master’s Paper submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Masters of Public Health in the Public Health Leadership Program

Spring 2018

Approved by:

________________________________________
Date

________________________________________
Date
Abstract

Asthma is a chronic respiratory disease that impacts millions of people around the world (Bhuia, Nwaru, Weir, & Sheikh, 2017). Evidence has demonstrated that following guideline recommendations lead to well-controlled asthma symptoms (GINA, 2017). Despite the advances in disease management, asthma continues to be associated with poor disease control and high rates of medication non-adherence (Fuhlbrigge et al., 2009; Jones et al., 2003). A potential solution to this problem is a comprehensive self-management mobile application and program. A literature review was conducted to identify existing mobile health applications that target asthma control and medication adherence in adult patients. Next, the paper proposes an education and management program for adult patients who have uncontrolled asthma through the use of a mobile health application. The paper will discuss the elements of the program, the program’s theoretical basis, the goals and objectives, and the implementation plan. Finally, the paper will outline a program evaluation plan, which will be used to ensure the program is meeting its objectives and to determine the impact of the interventions made throughout the program.

KEYWORDS: Asthma, Control, Therapy, Mobile Application, Medication Adherence, Self-Management, Mobile Health, Telehealth,
Table of Contents

Abstract ................................................................................................................................. 2
List of Tables .......................................................................................................................... 4
List of Figures .......................................................................................................................... 4
List of Abbreviations ............................................................................................................. 5
Introduction ............................................................................................................................ 6
Systematic Review .................................................................................................................. 8
  Introduction ......................................................................................................................... 8
  Methods .............................................................................................................................. 8
  Summary of Programs ........................................................................................................ 9
  Limitations .......................................................................................................................... 13
  Conclusion .......................................................................................................................... 13
Program Plan ........................................................................................................................ 14
  Proposed Asthma Control Program .................................................................................... 14
  Overview ............................................................................................................................ 14
  Program Context ................................................................................................................ 16
  Program Theories ............................................................................................................... 19
  Goals and Objectives ......................................................................................................... 20
  Program Implementation .................................................................................................... 22
Evaluation Plan ..................................................................................................................... 24
  Rationale and Approach to the Evaluation Plan ............................................................... 24
  Evaluation Study Design ................................................................................................... 25
  Evaluation Methods .......................................................................................................... 26
  Evaluation Planning Tables ............................................................................................... 27
Conclusion ............................................................................................................................. 29
References ............................................................................................................................ 30
Appendix ............................................................................................................................... 34
  Proposed Asthma Education Topics .................................................................................. 34
List of Tables

Table 1: Asthma Control and Medication Adherence Self-Management Programs ............. 35
Table 2. HBM constructs within the PACT Program ...................................................... 36
Table 3. PACT Program Eligibility .................................................................................. 37
Table 4. PACT Program Budget ...................................................................................... 37

List of Figures

Figure 1. The Ecological Model of Health Behavior within the PACT Program ............. 36
Figure 2. Program Logic Model ....................................................................................... 38
Figure 3. PACT Mobile App User Interface .................................................................... 39
## List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT</td>
<td>Asthma Control Test</td>
</tr>
<tr>
<td>AANC</td>
<td>Asthma Alliance of North Carolina</td>
</tr>
<tr>
<td>AQLQ</td>
<td>Asthma Quality of Life Questionnaire</td>
</tr>
<tr>
<td>app</td>
<td>(Mobile) Application</td>
</tr>
<tr>
<td>BCBSNC</td>
<td>Blue Cross Blue Shield of North Carolina</td>
</tr>
<tr>
<td>EHR</td>
<td>Electronic Health Record</td>
</tr>
<tr>
<td>GINA</td>
<td>Global Initiative for Asthma</td>
</tr>
<tr>
<td>IG</td>
<td>Intervention Group</td>
</tr>
<tr>
<td>NAEPP</td>
<td>National Asthma Education and Prevention Program</td>
</tr>
<tr>
<td>NCBRFSS</td>
<td>North Carolina Behavioral Risk Factor Surveillance System</td>
</tr>
<tr>
<td>NHIS</td>
<td>National Health Interview Survey</td>
</tr>
<tr>
<td>NHLBI</td>
<td>National Heart, Lung and Blood Institute</td>
</tr>
<tr>
<td>ODPHP</td>
<td>Office of Disease Prevention and Health Promotion</td>
</tr>
<tr>
<td>PACT</td>
<td>Peak Asthma Control Tool</td>
</tr>
<tr>
<td>PPT</td>
<td>Program Planning Team</td>
</tr>
<tr>
<td>RC</td>
<td>Routine Care Group</td>
</tr>
<tr>
<td>RPM</td>
<td>Remote Patient Monitoring</td>
</tr>
<tr>
<td>SABA</td>
<td>Short-Acting Beta-Agonist</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
Introduction

Asthma is a chronic respiratory inflammatory disease that is characterized by recurrent symptoms, episodes of airway obstruction, bronchial hypersensitivity, and inflammation (Martinez & Vercelli, 2013). According to the 2012 National Health Interview Survey (NHIS), over 40 million people in the United States suffer from lifetime asthma (Nunes, Pereira, & Morais-Almeida, 2017). On a global scale, it is estimated that 300 million people worldwide have asthma. In 2010, asthma was ranked as the 14th most important cause of years lived with disability (YLDs) in the world and the number of disability-adjusted life years (DALYs) lost to asthma worldwide is estimated to be 15 million per year (Bhuia et al., 2017; Masoli, Fabian, Holt, & Beasley, 2004). The high DALYs lost to asthma indicates a high burden disease of disease. The World Health Organization (WHO) defines burden of disease as the death and loss of health due to diseases, injuries, and risk factors that is quantified by determining the DALYs lost to the disease. Over the past few decades, the prevalence and incidence of asthma have been on the rise (Nunes et al., 2017). The increasing rates of asthma can be attributed to many causes including changes in genetic background and environmental factors.

Although asthma is associated with a high burden of disease, research has demonstrated significant advances in the management of asthma (Park et al., 2010). Evidence-based guidelines have assisted health-care providers to diagnose and appropriately manage asthma. The most referenced guidelines are the 2007 National Asthma Education and Prevention Program (NAEPP) and the 2017 Global Initiative for Asthma (GINA) guidelines, which provide recommendations on creating asthma action plans, first-line medications and other treatment considerations (NHLBI, 2007). The two primary goals of asthma management are symptom control and risk reduction (GINA, 2017).

Despite the advances in medical treatment and evidence of improved outcomes when treatment recommendations are followed, asthma continues to burden millions of people.
According to a national study conducted by Fuhlbrigge et al., which surveyed 10,139 adults with asthma, 41% of adults had uncontrolled asthma according to Asthma Control Test (ACT) scores (Fuhlbrigge et al., 2009). The rate of poor asthma control (low ACT score) is highly associated with poor medication adherence to asthma therapy. The rates of medication adherence in asthma patients have been as low as 30-40% (Jones et al., 2003). Adherence has been defined as the extent to which a person takes their medication as prescribed (Vrijens, De Geest, Hughes, Demonceau, & Ruppar, 2012). A patient is considered non-adherent to medications when they fail to fill prescriptions, reduce the dose or frequency of administration, or inaccurately use the medication (Briesacher, Gurwitz, & Soumerai, 2007).

In health care, the issue of poor disease control and medication non-adherence has prompted the development of mobile and web-based self-management applications (apps). In 2015, there were over 13,000 health care-related apps in the iTunes and Google Play app stores (Wu, Carpenter, & Himes, 2015). Currently, the majority of mobile health apps are used for fitness, education, and dietary tracking (Sama, Eapen, Weinfurt, Shah, & Schulman, 2014). For example, a text-messaging program increased adherence to medications in patients with Type 2 Diabetes (Raiff, Jarvis, & Dallery, 2016). A potential solution to the problem of medication non-adherence and poor asthma symptom control is a comprehensive self-management program that utilizes a mobile app platform. The mobile app should educate patients about asthma, provide reminder notifications, and improve communication between health care providers and patients.
Systematic Review

Introduction

The purpose of this literature review was to identify existing mobile health apps that target asthma control and medication adherence.

The research questions for this literature review were: 1. What mobile health apps exist that aim to improve asthma control and medication adherence in adult asthma patients? 2. What information can be gathered on the impact of the mobile health apps on asthma control and/or medication adherence?

Methods

A preliminary literature search was conducted to identify key search terms using the PubMed MeSH database. After reviewing the key terms, a second search was performed on January 17, 2018 in PubMed using the terms: ((("Asthma/prevention and control"[Mesh] OR "Asthma/therapy"[Mesh])) AND "Mobile Applications"[Mesh]) AND "Adult"[Mesh]. This search yielded 6 results. A search using the EMBASE database was conducted using the terms: 'asthma'/exp AND ('mobile application'/exp OR 'smartphone'/exp) AND ('asthma control test'/exp OR 'asthma quality of life questionnaire'/exp OR 'patient compliance'/exp). This search generated 28 articles. Article titles and abstracts were reviewed to determine the relevance to research questions.

The literature review included articles that met the following inclusion criteria:

1. Studies that included adults with uncontrolled asthma.
2. Programs that utilized self-management using technology to influence asthma control or medication adherence (i.e., mobile app, web-based resource, smartphone device).
3. Programs that evaluated outcomes by assessing the Asthma Control Test (ACT), Asthma Quality of Life Questionnaire (AQLQ), or medication adherence.
4. Articles that were available in English and were available at no charge through the University of North Carolina at Chapel Hill Libraries via the PubMed-MeSH and Embase databases.

The Exclusion Criteria were:

1. Articles that only discussed the design of the smartphone application.
2. Articles that only discussed a mobile application study protocol.
3. Programs that only included children and/or adolescents.

After reviewing each article title and abstract, only two articles met the inclusion criteria of this literature review (Table 1). A common theme among the remaining 34 articles was that they only described a future study protocol or the features of a mobile health app. These articles were excluded from this analysis because they did not provide information on the outcomes of the interventions. Additionally, 8 articles were excluded because they only assessed how the mobile apps affected children or adolescents in their study. The results of this literature review indicate the need for evidence-based studies that evaluate the impact of mobile health applications on asthma control and medication adherence in adults.

Summary of Programs

*Scripps Asthma Coach*

(Program Description)

Scripps Asthma Coach is a mobile application that was developed with the goal of meeting three target objectives of medication adherence, avoidance of asthma triggers, and self-monitoring of symptoms (Cook, Modena, & Simon, 2016). The developers of the program recognized that other asthma self-management applications already existed. Additionally, the program developers emphasized that having a comprehensive self-management tool could increase the likelihood of having long-lasting improvements in adherence and asthma outcomes.
The key components of the app featured educational materials and videos about asthma triggers, the importance of medication adherence, and inhaler technique (Cook et al., 2016). Additionally, participants could monitor their asthma symptoms, triggers, and medication use by manually entering data into the application. The application was programmed to send alerts to the participants regarding their control status. For example, if a participant reported frequent symptoms and rescue inhaler usage, the application would display the message “Over the last 4 weeks your asthma has not been controlled”.

Program Evaluation

The impacts of Scripps Asthma Coach were assessed using a prospective, single-arm study design. The primary objective of the study was to assess the efficacy of the application on the improvement of asthma control in adult patients with poorly controlled asthma (Cook et al., 2016). Participants were recruited by sending letters to patients who were identified in an electronic medical record which met the inclusion criteria. The inclusion criteria consisted of adult patients, who had at least 2 urgent health care visits over the past year (emergency room visit or unscheduled clinic visit). The first sixty patients who met the inclusion criteria were enrolled and were instructed to download the app from the iOS or Android App store. The primary outcome of the study was measured using the Asthma Control Test (ACT). The ACT scores are distributed into three categories a score >19 signifies adequate control (green zone), score 16 to 19 indicates inadequate control (yellow zone), and a score <16 indicates poor control (red zone). The participants completed the five-question ACT survey during enrollment and one survey per month throughout the study. The secondary outcome was to assess the impact of the application on participants’ spirometry and systemic steroid usage.

As reported by Cook and colleagues, the baseline characteristics of the study participants were: average age was 50.1 years (SD 17), 68% were female, and 83% were White/Non-Hispanic. The average ACT score at study enrollment was 16.6 (SD 4.6) indicating poor asthma control and only 32% of participants had ACT scores in the green zone. The
results at the end of the 4-month study demonstrated that the mobile application had both a statistically and clinically significant impact on participants’ level of asthma control. The final ACT score survey revealed that 78% of participants were in the green zone (p <0.0001) and the mean ACT score increased 3.9 points (p <0.0001). The secondary outcomes assessed the changes in patients’ spirometry and systemic corticosteroid use after participating in the study. Twenty-four patients (40%) used systemic corticosteroids 6 months prior to the study and 17 patients (28%) used systemic corticosteroids 6 months after the study (P=0.065). The decrease in systemic corticosteroid use was not found to be statistically significant at the 0.05 alpha level (Cook et al., 2016).

A limitation of the Scripps Asthma Coach application is that users must manually record their medication usage. Self-reporting may not be the most reliable way to determine medication usage and adherence since users may alter or forget to input their usage (Zeller, Ramseier, Teagtmeyer, & Battegay, 2008). Additionally, the study period was only four months. The short study period limits the ability to determine the long-term impact of the mobile application. An additional limitation of the study is that the racial demographics of study participants do not reflect the current prevalence of asthma in the United States. Eighty-three percent of participants were White/Non-Hispanic. According to the CDC, White/Hispanics accounted for only 7.7% of the all asthma patients in the United States from 2008-2010 (CDC, 2011). This difference in prevalence decreases the external validity of the study results to the general population of asthma patients.

Propeller Health

Program Description

Propeller Health is a comprehensive program that utilizes an FDA-approved Bluetooth sensor and a mobile application that seeks to help providers and patients better control their asthma (Merchant, Inamdar, & Quade, 2016). The novel aspect of Propeller Health’s model is the sensor which records the date, time, and frequency an inhaled medication is used. The
information is transmitted from the sensor to the mobile application where it is upload to a secure server. The data collected over time can help determine what may be causing their asthma symptoms and how often patients are having symptoms that require their rescue inhaler. Additionally, the information can be sent to providers, so they can also monitor the patient’s medication usage and adherence.

**Program Evaluation**

The effects of the Propeller Health mobile application were evaluated in a randomized controlled study conducted in Yolo and Sacramento counties in California (Merchant et al., 2016). The primary objective of the study was to assess the reduction in Short-Acting Beta-Agonist (SABA) and the improvement in ACT scores. A total of 495 patients were randomized into an Intervention Group (IG) or Routine Care Group (RC). Participants in both groups received Bluetooth sensors that attached to their SABA inhalers. However, only the participants in the IG group received feedback from the Propeller Health application and system. All participants completed an initial ACT that served as the baseline measurement of asthma control.

The baseline characteristics of the study participants were comparable between the two groups (Merchant et al., 2016). The average age was 36 years old, 42% of participants were male, and about 45% were White. Merchant and colleagues noted: “The routine care arm had a significantly higher proportion of participants identified as Hispanic (P = .031), but no other significant differences between the arms at baseline were found.” (p. 459) The average ACT score at baseline was the same for participants in the RC group and the IG group (17.7 – yellow zone). The percentage of participants that had an initial ACT scores in the green zone was 43.5% and 46.7%, in the RC and IG groups respectively. At enrollment, the mean daily SABA use per person in the RC group was 0.5 and 0.55 in the IG group. At the end of the 12-month study period, there was a clinically and statistically significant reduction in mean daily SABA use per person in the RC group to 0.19 and to 0.14 in the IG (p < 0.001). In adults that were initially
uncontrolled (yellow or red zone), there was a significantly larger improvement in ACT scores in the IG group compared to the RC group (p <0.01), indicating that the use of the application contributed to the increased asthma control. (Merchant et al., 2016)

A limitation of the Propeller Health study is that the application and Bluetooth sensor only tracked SABA use and did not track maintenance medication use. The absence of the maintenance medication use limits the ability to determine if patient adhered to their daily medications. Another limitation of the study is that the Propeller Health application did not sync data with the health system Electronic Health Record (EHR). This lack of information sharing may have led to the underutilization by health care providers.

Limitations

This literature review has a couple of limitations. First, the literature review excluded articles that only focused on children and adolescents. This exclusion is a limitation considering that the overall prevalence of asthma is higher in children than adults in the United States (CDC, 2011). However, these articles were excluded from the literature review since the proposed program plan will only be implemented in adult patients. Additionally, the literature review only included articles written in the English Language. It is possible that valuable information regarding asthma control and medication adherence was not captured if the article was written in another language.

Conclusion

The literature review has demonstrated that there is a growing number of asthma self-management mobile apps available for patients. However, the review also revealed that there is a lack of mobile apps focused on adult patients with poorly controlled asthma. Additionally, there is a need for evidence-based studies that demonstrate the effectiveness of mobile apps and their ability to improve asthma control and management. This need presents an opportunity to
develop a comprehensive self-management mobile application and program aimed at improving asthma control and medication adherence in patients with asthma.

Program Plan

Proposed Asthma Control Program

After reviewing the current literature surrounding asthma control programs, mobile apps, and medication adherence, I have developed the following program called Peak Asthma Control Tool (PACT). The program plan will provide an overview of the elements of the program, the theories that support the program, and the specific goals and objectives of the program.

Overview

The purpose of this overview is to propose an asthma control program that tackles many of the current issues that are leading to poor asthma control and medication non-adherence. Peak Asthma Control Tool (PACT) is an education and management program that will be for adults who have uncontrolled asthma. The program utilizes a comprehensive smartphone app that seeks to educate users on asthma topics, empower patients to manage their asthma, and engage providers and caretakers. The program will consist of two phases, including a short-term Active Phase and a long-term Maintenance Phase. Throughout the three-month Active Phase, patients will actively use the application features by watching educational videos, reporting symptoms, and communicating with providers. After completing the three-month Active Phase, patients will enter the Maintenance Phase of the program. During the Maintenance Phase, patients will continue to have access to the mobile application and will be able to monitor their symptoms and track their medication usage. In addition to serving the needs of patients with poorly controlled asthma, the PACT program will also benefit health care providers, health systems, and insurance companies. Currently, many health care institutions are seeking ways reduce health care costs and improve disease outcomes (Akinbami et al.,
The PACT program offers a way for health care systems to improve their asthma outcomes and reduce asthma health care utilization.

**Educate**

An important part of asthma self-management is understanding that asthma symptoms can be controlled when medications are used as prescribed (Pollard, Bansback, FitzGerld, & Bryan, 2017). Some patients with poorly controlled asthma will opt out of using their maintenance medications because they do not understand that it will control asthma symptoms or because they cannot afford the medications (Lindsay & Heaney, 2013). Instead, these patients will use their rescue inhalers (SABAs) when they start to wheeze or become short of breath. Patients also need to be educated on the environmental factors that can cause and aggravate their asthma symptoms (GINA, 2017). The PACT mobile app will provide short 1-minute educational videos on topics including what is asthma, medications, inhaler technique, asthma triggers and more. The video series will be constructed using patient-friendly terms and entertaining graphics to engage patients.

**Empower**

Patients who feel empowered and motivated to control their asthma are more likely to adhere to their medications (Borrelli, Riekert, Weinstein, & Rathier, 2007). A key part of the PACT mobile app comes from the attachable Bluetooth sensor to the patient’s maintenance and rescue inhalers. The sensor will alert the application every time a patient uses their maintenance and rescue inhalers. Not only will the sensor help inform the patient of when and how often they miss a scheduled dose, but the mobile app will also track what the air quality was like at the time of SABA use based from the patients’ geolocation. The data provided will enable and motivate patients by keeping them informed of the status of their asthma control.
Engage

Studies have demonstrated that patients are more likely to adhere to their medications if they have support from their families or caregivers (Kelly, McCarthy, & Sahm, 2014). One study demonstrated text-message reminders and incentives improved medication adherence in patients with type 2 diabetes (Raiff et al., 2016). The PACT program will create an opportunity to engage patients, caregivers, and providers to improve asthma control and medication adherence. PACT will encourage patients that adhere to their medications by rewarding them with cash and prizes. The anticipated funding needed to support the prices will come from grants and money received from advertisements for sponsoring pharmacies and pharmaceutical companies. Additionally, authorized caregivers and health care providers will have access to medication usage information through remote patient monitoring. Remote patient monitoring (RPM) is a type of telehealth that utilizes technology to monitor and manage patients outside of the traditional health care settings (Vegesna, Tran, Angelaccio, & Arcona, 2017). Evidence has demonstrated that RPM has improved the quality of life of patients with chronic conditions, such as COPD and Heart Failure (Davis, Bender, Smith, & Broad, 2015). Additionally, previous studies have utilized RPM to track asthma symptom control and exacerbations (Kew & Cates, 2015). The information collected from the app will allow caregivers and providers to communicate with patients if they see that their asthma is poorly controlled or to encourage them to continue to adhere to their medications.

Program Context

Needs Assessment

Information on the prevalence of asthma in North Carolina is collected from the NC Behavioral Risk Factor Surveillance System (NC BRFSS). According to the NC BRFSS, in 2015, 13.4 percent of adults in North Carolina reported ever having been told by a doctor, nurse or other health care provider that they had asthma (Thie, 2017). The survey also demonstrated
that significant disparities exist when it comes to asthma prevalence. Adult females living in NC are twice as likely to have asthma than males. The 2008 NC BRFSS reported that African American adults have a higher rate of asthma-related mortality and hospitalizations compared with White adults (NC BRFSS, 2008). The PACT program will target these vulnerable populations by recruiting them to participate in the program when they are seen in the emergency room, hospitalized or during an outpatient provider appointment.

Asthma is a significant financial burden at the national, state, and local levels. According to the CDC, it is estimated that asthma cost $3,300 per patient each year due to medical costs, missed work and school, and deaths (CDC, 2017). In the past two decades, the medical expenses associated with asthma have increased from $48.6 billion in 2002 to $50.1 billion in 2007 (CDC, 2011). In North Carolina in 2014, there were a total of 9,035 hospitalizations and 58,216 emergency room visits where the primary diagnosis was asthma (Thie, 2017). The average charge per inpatient hospitalization was $15,420 (Thie, 2017).

Political Environment

The current political landscape associated with asthma management is related to environmental policy and health care cost. The rising cost of health care has been on the public agenda for many years. From 2008 – 2016, President Barack Obama made lowering costs and improving the quality of care a top priority during his administration (Obamawhitehouse.gov, n.d.). However, according to the 2018 State of the Union Address, health care as a whole is not among President Trump’s main priorities for the nation (Trump, 2018). Environmental policy and air quality have been a topic of debate since the passage of the Clean Air Act in 1970 (Samet, Burke, & Goldstein, 2017). Despite the advancements in environmental policies, the current White House administration hopes to reduce environmental regulations (Samet et al., 2017). Weakening environmental regulations related to air quality could influence the prevalence of asthma symptom triggers. In summary, the political landscape surrounding environmental policy
and the cost of health care has the potential to influence asthma management for millions of Americans.

Consistency with Local, State, and National Priorities

In 2010, the Office of Disease Prevention and Health Promotion (DPHP) launched Healthy People 2020, which outlined the nation’s public health-related goals and objectives for the next ten years. Healthy People 2020 detailed eight specific objectives related to asthma including reduce asthma-related deaths, reduce hospitalizations for asthma, and reduce emergency department visits for asthma (ODPHP, 2010).

In North Carolina, there are a few key organizations that are committed to improving asthma care in the state including, the North Carolina Asthma Program and the Asthma Alliance of North Carolina (AANC). The North Carolina Asthma Program is a division of the NC DHHS that is responsible for developing the State Asthma Plan and increasing public awareness on the importance of reducing the burden of asthma (NC DHHS, n.d.). The AANC is a partnership of all the local and state organizations that collaborate to address asthma concerns in North Carolina (NC DHHS, n.d.). In 2013, under a cooperative agreement with the CDC, the North Carolina Asthma Program and the Asthma Alliance of North Carolina developed a five-year initiative called the North Carolina Asthma Action Plan 2013 – 2018 (NC DHHS, 2013). The document outlines the four main goals related to reducing asthma-related disparities, improving access to care for asthma patients, and community involvement and awareness.

Financial Resources

The PACT program will require a significant amount of funding to implement and sustain the program. The aspects of the program that will require the most funding are the infrastructure, development of the mobile application, and payment of health care providers and personnel involved in the program. The initial round of funding will come from organizations that provide grants to groups with innovative ideas that have the potential to improve health care.
The Blue Cross Blue Shield of North Carolina (BCBSNC) Foundation is an independent foundation that partners with organizations and provides grants to help support health policies and programs ("BCBSNC Foundation," n.d.). In 2017, the BCBSNC Foundation provided over $10,000 to multiple organizations associated with health care and technology. The UNC Eshelman Institute for Innovation is an organization that provides funding for innovative ideas and solutions to current health care issues (UNCEII, n.d.). The funding needed to sustain the program will come from payment models that include third-party advertisements, insurance companies, and health care systems. During the initial five years of the PACT program, the mobile app will be free to all patients and providers. After the program has successfully demonstrated a positive impact on asthma control and medication adherence, the program can shift from grant-based model to a payment model where health insurance companies and health care systems can purchase the application for their members and patients.

Program Theories

To ensure the success of the interventions made within the PACT program, it is important to consider what program theories will be incorporated into the program. The Ecological Model of Health Behavior and the Health Belief Model (HBM) will serve as the primary health behavior theories supporting this program. The Ecological Model of Health Behavior states that health behavior has multiple levels of influence including intrapersonal, interpersonal, organizational, community and public policy (Glanz, Rimer, Sallis, Owen, & Fisher, n.d.). The PACT program will mainly target the intrapersonal and interpersonal, and organizational levels of influence (Figure 1). The intrapersonal level will be addressed by providing knowledge on various asthma topics and by changing their beliefs on asthma symptom management. The interpersonal level will be incorporated by involving communication between health care providers and the patient.
The Health Belief Model (HBM) is comprised of individual-level theories that address how different factors influence health decisions and behaviors (Rimer & Glanz, 2005). The HBM consists of six main constructs that influence how individuals make decisions about their health. The six constructs include perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cue to action, and self-efficacy. The HBM constructs are all addressed within three pillars of the PACT program (Table 2). The educational features of the program and mobile app aligns with the constructs of perceived severity and perceived benefits. Patients who access the educational material will learn about how adhering to their maintenance medications will improve their asthma symptoms. Perceived susceptibility and cues to action apply to the empowering aspects of the program by providing real-time environmental alerts and medication reminders. Furthermore, the self-efficacy and perceived barriers will be addressed by engaging patients through communication with health care providers and by providing incentives to adhere to their medications.

**Goals and Objectives**

The goal of the PACT program is to reduce the rates of uncontrolled asthma and improve medication adherence in adult patients in Chapel Hill, North Carolina. The objectives and activities are summarized and illustrated in the program logical model in Figure 2.

**Short-Term Objectives (1-3 years)**

1. By month one, the PACT Program Planning Team will have secured a mobile application developer.

**Activities:** The Program Planning Team (PPT) will post jobs online for a mobile app developer with experience in developing the health-related mobile app. The program planning team will work with the developer to design the different features and user interface of the application.
2. By month three, the PPT will have assembled an alliance of physicians, pharmacists, and nurses that will serve as the outpatient follow-up providers and content experts.
   **Activities:** The PPT and will meet with the health care providers to gain their insight on app features, educational content, and program workflow. The PACT Program planning team will begin training emergency room staff and outpatient providers on the patient referral process.

3. By month four, the PACT mobile app will be fully developed.
   **Activities:** The mobile application and Bluetooth sensor will have gone through beta testing to guarantee that the app is functional and user-friendly. The mobile app developer will work with the PPT and epic engineers to ensure that the app will communicate effectively and securely with the UNC electronic health records.

4. By month twelve, 100 patients will be recruited to participate in the PACT program.
   **Activities:** Adult patients with poorly controlled asthma who are seen in the emergency room, hospitalized or during an outpatient provider appointment will be recruited to participate in the program. An initial Asthma Control Test (ACT) and Asthma Quality of Life Questionnaire (AQLQ) will be performed to assess the patients baseline level of asthma control.

5. By the month eighteen, patients will increase their ACT scores by 3 points and their AQLQ by 0.5 points indicating a clinical improvement in patient’s asthma control and quality of life (Apfelbacher, Jones, Hankins, & Smith, 2012; Schatz et al., 2009).
   **Activities:** Improvement in patients’ asthma control and quality of life from the use of educational materials, medication reminders, and communication with providers.

*Long-Term Objectives (3-5 years)*

1. By the end of year three, increase the percentage of patients in the PACT Program that adhere to their asthma medications by 10%.
Activities: Patients medication adherence rate will be assessed prior to beginning the program. The Bluetooth sensor and prescription fill information will be used to determine medication adherence through the program.

2. By the end of year five, decrease the percentage of adults in Chapel Hill, NC that represent to the UNC emergency department or other health care provider for uncontrolled asthma by 10%.

Activities: Patients who participate in the program should complete the educational material and benefit from the medication reminders, health care provider communications, and education material offered through the program. Participation in the program will improve patient’s asthma control and prevent them from having asthma-related symptoms.

Program Implementation

Setting

Patients with uncontrolled asthma are more likely to present to emergency departments for acute exacerbations (Johnson, Chambers, & Dexheimer, 2016). Additionally, patients with one asthma-related emergency department visit are more likely to experience another emergency department visit due to asthma within one year (Johnson et al., 2016). Adult patients who present to the UNC Hospital Emergency Department with uncontrolled asthma will be recruited to participate in the PACT program. The other qualifying factors are listed in Table 3. Prior to discharge from the emergency room or hospital, a medical assistant will schedule a next-day appointment with one of the members of the health care provider alliance. Patients will also be given general information about the program and will be given a login name and code for the mobile app. During the first appointment with the outpatient provider, patients will receive the Bluetooth sensor, information regarding incentives, and information regarding the entire program.
**Income**

The PACT program will require a budget totaling approximately $400,000 over the span of 5-years (Table 4). Much of the funding will come from grants and investors. The main options for funding are the Blue Cross Blue Shield Foundation and the UNC Eshelman Institute for Innovation. To allow for expansion of the program and sustainability, the program will also receive funding in the form of advertisements from asthma medication manufactures and community pharmacies.

**Property**

Most of the PACT program interactions will occur in the UNC Hospital Emergency Department and in outpatient provider clinics. However, the program will require renting a small office for the program manager, planning team, and program evaluator to work. The office space will include one room with four workstations and one room to serve as a small conference room.

**Personnel**

Implementation of the PACT program will involve employment of the program planning team and the mobile app developer. The PACT Program Planning Team will be composed of the program manager, outreach coordinator, and finance coordinator. An external evaluator will also be hired to conduct the program’s evaluation. The responsibilities of the program manager will be to recruit and lead the health care provider alliance, manage the program planning team members, serve as the main contact for the mobile app developer. The program manager is expected to work an average of 0.5 FTE and will receive a yearly stipend of $20,000. The outreach coordinator will be responsible for the patient recruitment and retention efforts which includes training health care providers and Emergency Department staff. The outreach coordinator will also be responsible for distributing and replacing lost Bluetooth sensors. The finance coordinator will serve as the lead grant writer and accountant for the program. The
program evaluator will be responsible for data collection and the program evaluation. The outreach coordinator, finance coordinator, and program evaluator will be part-time employees (0.25 FTE each) and will each receive a stipend of 8,500 per year.

**Evaluation Plan**

**Rationale and Approach to the Evaluation Plan**

It is essential that the PACT program undergo an initial and periodic evaluation to ensure that the program is meeting its objectives and to determine the impact of the interventions made throughout the program. Implementing the PACT program will require a great deal of time and resources. One of the primary reasons why the program will be evaluated is to measure the success of the program in improving asthma control and medication adherence. The organizations that fund the program will also require the PACT program to submit results of the evaluation before renewing grants and financial resources. Lastly, completing a program evaluation will provide the opportunity to publish and disseminate information on the interventions made so that other organizations can replicate or adapt the program.

**Stakeholders**

The PACT program will involve three main categories of stakeholders: the individuals affected by the intervention, the individuals involved with performing the intervention, and the individuals who will utilize the results of the evaluation. The individuals affected by the intervention includes all the patients who will participate in the program. The individuals involved in performing the intervention includes the program planning team, app developer, and members of the alliance of health care providers. Lastly, the individuals who will use the evaluation results include the program planning team, funders, and partners.

**Program Evaluator**

An external program evaluator will mainly lead the PACT program evaluation. The role of the program evaluator will be to implement the evaluation timeline throughout the program.
Additionally, the program evaluator will be responsible for ensuring that the appropriate information needed for the evaluation is collected from various stakeholders before and during the program implementation phase. The program evaluator will also be responsible for consolidating, analyzing and preparing the results of the program evaluation for dissemination.

**Evaluation Study Design**

*Process Evaluation*

A process evaluation will be conducted to assess the implementation phase of the program. The process evaluation will determine if the program activities were delivered as they were intended to (Issel, 2014). The ongoing process evaluation will also identify what improvements are needed to meet the programs goals and objectives successfully.

*Outcome Evaluation*

An outcome evaluation will be conducted to assess the impact of the program. Most of the outcome evaluation will follow a quasi-experimental design. Since the program does not involve randomizing patients into an intervention or control group, an experimental design would not be warranted (Issel, 2014). However, a quasi-experimental approach is appropriate since data will be collected from patients before, during and after the intervention. The outcomes of the intervention will include the level of asthma control, changes in quality of life, and improvements with medication adherence. The outcome evaluation will involve a one-group pretest and posttest design. An evaluation that encompasses a one-group pretest/posttest involves collecting data from the program participants before and any time after they have received the program intervention (Issel, 2014). The one-group pretest/posttest design will be useful in determining the change in an individual level of asthma control and quality of life before and after participating in the PACT program.
Evaluation Methods

The evaluation will involve a mixed-methods approach by utilizing both qualitative and quantitative data collection methods. The process evaluation will utilize focus groups and open and close-ended surveys throughout the ongoing implementation phases of the program. The outcome evaluation will incorporate open and close-ended surveys and individual in-depth interviews.

Focus Groups

Focus groups will be used during the process evaluations. Focus groups are an ideal way to collect qualitative and receive instant feedback from different stakeholders (Issel, 2014). A focus group comprised of health care providers will be formed and will be used to determine if the educational content and mobile app features align with the program goal and objectives. This focus group will occur before patients are recruited to participate in the program. The health care provider focus group will also meet throughout the implementation phase to assess if there are any opportunities to improve the patient communication and provider engagement.

Open and Close-Ended Surveys

Open and close-ended surveys will be utilized throughout the process and outcome evaluations. The close-ended surveys will provide a portion of the quantitative outcome data collected during the evaluation. Throughout the implementation phase of the program, patients will be required to take weekly, close-ended surveys regarding the asthma symptoms. The open-ended surveys will be used to provide qualitative information from the patients and health care providers for the process evaluation. The open-ended surveys will be conducted monthly to assess what educational components and mobile app features of the mobile app are helpful and what features need improvement. Both the open and close-ended surveys will be incorporated into the mobile app. Patients will be prompted to complete the surveys on a weekly and monthly basis, and health care providers will complete the survey monthly.
**Individual In-depth Interviews**

The outcome evaluation will involve conducting individual in-depth interviews. In-depth interviews are a useful way to collect an individual’s personal and reflective thoughts regarding a program intervention (Issel, 2014). A sample of program participants will complete an in-depth interview at the completion of their participation in the program. Since one of the challenges associated with in-depth interviews is the time required to conduct and translate the interviews, only a sample of patients will undergo this evaluation method (NC DHHS, 2016). The interviews will be used to assess how individual’s attitudes toward asthma and asthma control have changed after completing the program. Additionally, in-depth interviews will provide insight into what features of the mobile app and program were the most beneficial to the participants.

**Evaluation Planning Tables**

<table>
<thead>
<tr>
<th>Process Evaluation Planning Table</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evaluation Questions</strong></td>
</tr>
<tr>
<td><strong>What features of the mobile app are most beneficial to program participants?</strong></td>
</tr>
<tr>
<td>Which mobile app features have been your favorite and least favorite?</td>
</tr>
<tr>
<td>Which mobile app features do you use most often and least often?</td>
</tr>
<tr>
<td>Do you wish that there were any additional app features?</td>
</tr>
<tr>
<td>Which mobile app features did you find were the most beneficial for patients?</td>
</tr>
<tr>
<td><strong>Which educational resources were the most beneficial to program participants?</strong></td>
</tr>
<tr>
<td>What did you enjoy about the educational content within the mobile app?</td>
</tr>
<tr>
<td>Which educational topic was your favorite and least favorite?</td>
</tr>
<tr>
<td>What type of educational resource was the most beneficial to you (i.e. video, article, infographic)</td>
</tr>
<tr>
<td>Question</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Were there too many or too little educational topics?</td>
</tr>
<tr>
<td>Are there any educational topics that should be added?</td>
</tr>
</tbody>
</table>

**What communications strategies were the most effective?**

<table>
<thead>
<tr>
<th>Question</th>
<th>Participants</th>
<th>Evaluation Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>What aspects of communicating with providers through the app did you find beneficial?</td>
<td>Program Participants Focus Groups In-depth Interviews</td>
<td></td>
</tr>
<tr>
<td>What aspects of communicating with providers through the app did you find unhelpful?</td>
<td>Program Participants Focus Groups Open-Ended Surveys In-depth Interviews</td>
<td></td>
</tr>
<tr>
<td>Were you able to effectively communicate with patients by using the mobile app?</td>
<td>Health Care Providers Focus Groups</td>
<td></td>
</tr>
</tbody>
</table>

**Outcome Evaluation Planning Table**

<table>
<thead>
<tr>
<th>Evaluation Questions</th>
<th>Participants</th>
<th>Evaluation Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Have individual’s level of asthma control improved since starting and completing the program?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Was there a change in individual’s ACT scores?</td>
<td>Program Participants</td>
<td>Close-Ended surveys</td>
</tr>
<tr>
<td>Was there a change in reported asthma symptoms?</td>
<td>Program Participants</td>
<td>Close-Ended surveys</td>
</tr>
<tr>
<td>Was there a change in number of visits to emergency rooms and urgent care for asthma-related symptoms?</td>
<td>Program Participants</td>
<td>Close-Ended surveys</td>
</tr>
<tr>
<td><strong>Have individual’s overall quality of life improved since starting and completing the program?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Was there a change in individuals AQLQ scores?</td>
<td>Program Participants</td>
<td>Close-Ended surveys</td>
</tr>
<tr>
<td>Was there a change in medication adherence?</td>
<td>Program Participants</td>
<td>Close-Ended surveys</td>
</tr>
<tr>
<td><strong>How have individual perceptions of asthma changed since completing the program?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How do you currently feel about having asthma?</td>
<td>Program Participants</td>
<td>In-depth Interviews</td>
</tr>
<tr>
<td>How important do you think adhering to medications is for maintaining control of your asthma symptoms?</td>
<td>Program Participants</td>
<td>In-depth Interviews</td>
</tr>
</tbody>
</table>
Conclusion

Asthma is a chronic respiratory disease that impacts over 40 million people in the United States (Nunes et al., 2017). Although advances in modern medicine have created treatment options that can alleviate asthma symptoms, over 41% of adults have uncontrolled asthma (Fuhlbrigge et al., 2009). The rate of poor asthma control has been associated with poor adherence to prescribed medications and therapies (Sumino & Cabana, 2013). Mobile applications are becoming an increasingly popular approach to combat medication non-adherence and poor disease control (Wu et al., 2015). A literature review revealed the need for asthma mobile apps that demonstrate clinically relevant outcomes in adult populations.

This paper outlines a comprehensive education and self-management program intended to improve medication adherence and asthma control in patients with uncontrolled asthma. The PACT program and mobile app will be used to educate patients on asthma topics, empower patients to manage their asthma, and engage providers and caretakers. The process and outcome evaluations will be essential to demonstrate that program goals and objectives were accomplished.
References


Lindsay, J. T., & Heaney, L. G. (2013, April 19). Nonadherence in difficult asthma &ndash; facts, myths, and a time to act. https://doi.org/10.2147/PPA.S38208


Sumino, K., & Cabana, M. D. (2013). Medication adherence in asthma patients: *Current Opinion in Pulmonary Medicine, 19*(1), 49–53. https://doi.org/10.1097/MCP.0b013e32835b117a


Appendix

Proposed Asthma Education Topics

The alliance of physicians, pharmacists, and nurses will be involved in the development of the educational content. The following educational topics will serve as a framework for the educational content and videos (CHEST Foundation, 2016).

I. Asthma 101
   a. What is Asthma?
   b. Who gets Asthma?
   c. Why do some people have Asthma?
   d. What causes Asthma?
   e. How is Asthma diagnosed?

II. Asthma Symptoms
III. Asthma Triggers
IV. Asthma Action Plan
V. Asthma Medications
   a. Rescue Inhalers
   b. Maintenance Inhalers
   c. Oral Medications

VI. Adhering to Medications
VII. Inhaler Techniques
   a. HFA Inhalers
   b. Diskus Inhalers
   c. Nebulizers
   d. Spacers
<table>
<thead>
<tr>
<th>Program Name</th>
<th>Population</th>
<th>Design</th>
<th>Evaluation</th>
<th>Outcomes</th>
<th>Strengths and Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scripps Asthma Coach</strong> (Cook et al., 2016)</td>
<td>Total number of participants: 60</td>
<td>Prospective, single-arm</td>
<td>ACT scores after 4 months of app usage. (5 ACT surveys total= initial + 4 monthly surveys)</td>
<td>- Increase in patients with asthma &quot;well controlled&quot; from 32% to 59% at 5 weeks, 69% at 10 weeks and 78% at 16 weeks (P &lt;0.0001)</td>
<td><strong>Strengths</strong> - Comprehensive app features - Demonstrated improvement in asthma control - Used validated source to determine asthma control (ACT)</td>
</tr>
<tr>
<td>Setting: San Diego, CA</td>
<td>Duration: 4 months</td>
<td><strong>App Features</strong></td>
<td>- Alerts - Asthma control - Educational materials - Symptom tracking</td>
<td><strong>Limitations</strong> - Only 4 months assessed - Users have to manually report usage - Racial demographics limits external validity</td>
<td></td>
</tr>
<tr>
<td>Inclusion</td>
<td>- ≥ 18 years old</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- ≥ 2 events of urgent health care utilization over past year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exclusion</td>
<td>- No smartphone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Baseline Characteristics</strong></td>
<td>- Age Range: 17-82 years old</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mean Age: 50 year old</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mean baseline ACT Score - 16.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Propeller Health</strong> (Merchant et al., 2016)</td>
<td>Total number of participants: 495</td>
<td>Randomized control trial</td>
<td>Effect of mobile app and Bluetooth sensor on SABA inhaler use Improvement of ACT scores Primary Endpoint: SABA use</td>
<td>- Clinically and statistically significant reduction in mean daily SABA use, decrease of 0.31 in RC and 0.41 in IG, (P&lt;0.001) - In adults who initially had uncontrolled asthma, there was a significant decrease in SABA use in RC vs IG groups, 0.51 and 0.62 respectively. (P=0.004) - Increase in SABA-free days by 17% in RC and 21% in IG (p&lt;0.001) - Improvement in ACT scores of by +4.6 in RC and +6.2 in IG</td>
<td><strong>Strengths</strong> - Automated medication adherence tracking via Bluetooth sensor - Decrease in SABA usage - Demonstrated improvement in asthma control - Used validated source to determine asthma control (ACT)</td>
</tr>
<tr>
<td>Setting: Yolo and Sacramento Counties, CA</td>
<td>Duration: 12 months</td>
<td><strong>App Features</strong></td>
<td>- Medication adherence - SABA inhaler use - Communication with health care providers - Bluetooth sensor syncing</td>
<td><strong>Limitations</strong> - Hawthorne effect of RC group due to automated tracking - Funding from study may have introduced bias - Racial demographics limits external validity</td>
<td></td>
</tr>
<tr>
<td>Inclusion</td>
<td>- Adults and children (≥ 5 y.o.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Patients with uncontrolled asthma at Woodland HealthCare and Mercy Medical Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exclusion</td>
<td>- Patients with significant comorbidities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Baseline Characteristics</strong></td>
<td>- Mean Age- 36 years old</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Percent under 18y- 30%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mean baseline ACT Score in adults 17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Percent white – 43.7 in RC, 49.6% in IG.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mean daily SABA use per patient was 0.5 in RC, 0.55 in IG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 1. The Ecological Model of Health Behavior within the PACT Program

Table 2. HBM constructs within the PACT Program

<table>
<thead>
<tr>
<th>Program Elements</th>
<th>HBM Constructs</th>
<th>How Constructs Apply to the Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educate</td>
<td>Perceived Severity</td>
<td>Patients will learn about the consequences of non-adhering to maintenance medications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Patients will learn about when to use rescue inhalers, how to avoid asthma triggers</td>
</tr>
<tr>
<td></td>
<td>Perceived Benefits</td>
<td></td>
</tr>
<tr>
<td>Empower</td>
<td>Cues to action</td>
<td>Patients will receive real-time alerts of environmental factors that can influence their asthma symptoms and medication reminders</td>
</tr>
<tr>
<td></td>
<td>Perceived susceptibility</td>
<td></td>
</tr>
<tr>
<td>Engage</td>
<td>Self-efficacy</td>
<td>Patients will be able to communicate with and receive guidance from health care providers</td>
</tr>
<tr>
<td></td>
<td>Perceived Barriers</td>
<td>Patients will receive incentives for adhering to medications</td>
</tr>
</tbody>
</table>
### Table 3. PACT Program Eligibility

<table>
<thead>
<tr>
<th>PACT Program Eligibility Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult (age ≥ 18 years old)</td>
</tr>
<tr>
<td>Uncontrolled asthma (ACT score ≤ 20)</td>
</tr>
<tr>
<td>Smartphone</td>
</tr>
<tr>
<td>Recent asthma-related emergency department or hospitalization or referral by an outpatient provider</td>
</tr>
</tbody>
</table>

### Table 4. PACT Program Budget

<table>
<thead>
<tr>
<th>Spending Category</th>
<th>Item/Position</th>
<th>Yearly Cost</th>
<th>5-Year Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Administrative Office</td>
<td>N/A</td>
<td>$6,000</td>
<td>$6,000</td>
</tr>
<tr>
<td>Supplies</td>
<td>Bluetooth Sensors (#300)</td>
<td>N/A</td>
<td>$30,000</td>
<td>$30,000</td>
</tr>
<tr>
<td></td>
<td>Program Manager</td>
<td>$20,000</td>
<td>$100,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mobile App Developer</td>
<td>N/A</td>
<td>$120,000</td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td>Outreach Coordinator</td>
<td>$8500</td>
<td>$42,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finance Coordinator</td>
<td>$8500</td>
<td>$42,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Program Evaluator</td>
<td>$8500</td>
<td>$42,500</td>
<td></td>
</tr>
<tr>
<td>Advertising</td>
<td>PACT Program Brochure</td>
<td>$250</td>
<td>$750</td>
<td>$750</td>
</tr>
<tr>
<td></td>
<td>Level 1 Prize</td>
<td>$400</td>
<td>$2,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level 2 Prize</td>
<td>$500</td>
<td>$2,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level 3 Prize</td>
<td>$600</td>
<td>$3,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level 4 Prize</td>
<td>$700</td>
<td>$3,500</td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td></td>
<td></td>
<td>$395,750.00</td>
</tr>
</tbody>
</table>
Figure 2. Program Logic Model

**Inputs**
- **People**
  - PACT Program Planning Team
  - Alliance of health care providers
  - Program participants
  - Mobile app developer
- **Partners**
  - Emergency department and local doctors office to help recruit participants
  - Community pharmacies
  - Insurance companies
  - Pharmaceutical companies and manufacturers
- **Financing**
  - Budget of $500,000 spread over 5 years
- **Materials & Resources**
  - Mobile Application
  - Bluetooth sensors
  - Asthma education materials

**Activities**
- **People**
  - Recruit PACT Program Planning Team
  - Form Alliance of health care providers
  - Hire mobile app developer
  - Develop asthma educational materials and videos
  - Test mobile app for functionality and usability
- **Partners**
  - Train ED staff and doctors offices on referral process
  - Work with community pharmacies to create Application Program Interfaces (API)
  - Meet with pharmaceutical companies to get advertisement

**Outputs**
- **People**
  - PACT Program Planning Team
  - 100 adult patients with poorly controlled asthma recruited to participate in the PACT program
  - Alliance of health care providers recruited and trained
- **Partners**
  - Partnerships with community pharmacies created
  - Pharmaceutical companies partnerships created
- **Materials & Resources**
  - Mobile app created
  - Educational materials and videos created

**Outcomes**
- **Short-Term (1-3 years)**
  - Recruit a mobile app developer and the assemble alliance of health care providers
  - Develop mobile app
  - Recruit 100 patients to participate in the PACT program
  - Increase ACT scores by 3 points and the AQLQ scores by 0.5 in the patients with poorly controlled asthma
- **Partners**
  - Partnerships with community pharmacies created
  - Pharmaceutical companies partnerships created
- **Materials & Resources**
  - Mobile app created
  - Educational materials and videos created

**Impact**
- **Asthma Control**
  - Improve asthma symptom control and the quality of life of adults living in Chapel Hill
- **Cost**
  - Reduce the amount of money spent on preventable hospitalizations and ED visits due to poorly controlled asthma

**Long-Term (3-5 years)**
- Increase the percentage of patients that adhere to their asthma medications by 10%
- Decrease the percentage of patients that re-present to the ED for uncontrolled asthma by 10%
Figure 3. PACT Mobile App User Interface