

In Home Environmental Assessments: A Key Component of a Comprehensive Asthma Management Initiative

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ABSTRACT

Asthma is one of the most common chronic diseases of childhood, and carries a high public health burden. Asthma is more prevalent and more severe in children from minority groups and those of lower socioeconomic status (Akinbami, 2009). Direct and indirect health care costs of asthma in the US total more than \$18 billion per year (AAAAI, 2009). Although it is not a curable illness, it can be effectively managed with comprehensive care that includes medical management, education, and environmental modifications. In 2007, national asthma management guidelines were modified to include environmental trigger identification and remediation as a critical component of asthma care. This is based on a growing body of evidence that suggests that reduction of indoor environmental triggers in the home environment of children with asthma may lead to a decrease in asthma-related morbidity and in asthma-related health care costs.

A home visit is an optimal setting to provide patient education and to identify and mitigate the effects of environmental triggers in the home. In the last several years, a number of research studies and programs have attempted home-based interventions that provide a combination of tailored home environmental assessments, patient education, and supplies to reduce indoor allergens. Using these experiences as a starting point, Community Care of Wake and Johnston Counties is in the process of developing and implementing an asthma initiative that focuses on indoor environmental trigger reduction through home assessments and case management. This paper will focus on the planning and development of a program and evaluation plan for a multi-faceted in home environmental intervention for Wake County children with asthma.

EPIDEMIOLOGY OF ASTHMA

Asthma is a chronic inflammatory disease of the lungs that is characterized by episodes of coughing, wheezing and breathing difficulties. It is one of the most common chronic illnesses of childhood, and is a major cause of school absenteeism, emergency room visits and hospitalizations in children. Approximately 20 million people in the United States have asthma (American Lung Association), and 9 million children under the age of 18 have been diagnosed with asthma (AAAAI, 2009). More than 4 million children have had an asthma attack in the previous year (AAAAI, 2009). The prevalence and severity of asthma increased 75% from 1980-1994 (AAAAI, 2009), and have maintained a plateau at historically high levels since 1997 (Akinbami, 2009). This plateau has continued despite advances in the recognition and treatment of the disease (Akinbami, 2009).

In the United States in 2004, there were 1.8 million ER visits for asthma, and almost 497,000 hospitalizations for asthma exacerbations (American Lung Association, 2009). Approximately 44% of all hospitalizations for asthma are for children (AAAAI, 2009). Young children carry a particularly high disease burden, as the highest rates of asthma hospitalizations and asthma-related health care use are among children 0-4 years of age (Akinbami, 2009). Each year, there are approximately 5,000 deaths from asthma in the US (ALA, 2009).

Asthma prevalence and morbidity are substantially higher in children from minority and medically underserved communities. Nationally, black children are 1.6 times more likely to have asthma than white children (Akinbami, 2009). Socioeconomic and racial disparities in adverse outcomes are more pronounced than the differences in prevalence. In the US, black children had an ED visit rate 4.1 times higher, a hospitalization rate 3 times higher and a death rate 7.6 times higher than the rates for white children (Akinbami, 2009). For Hispanic children, prevalence rates are equivalent to those of white children, but ED visits rates are 2 times higher (Akinbami, 2009).

At a statewide level, asthma in North Carolina children is a significant public health issue, with higher prevalence percentages than the national average. In 2005, 17.5% of children in the state (approximately 311,000) were reported to have asthma, compared to 13.1% nationally (NC Asthma Report). Almost 25% of children with current asthma in North Carolina visited the hospital emergency department or urgent care clinic in the last 12 months, and African American children were more than twice as likely as white children to go to the emergency department for their asthma. In North Carolina, children with asthma are 37 times more likely to miss school than children without asthma (NC Asthma Report).

Asthma carries a significant cost burden at local, state and national levels. According to the Asthma and Allergy Foundation, the total annual cost of asthma in the US is estimated at \$18.3 billion, including \$10.1 billion in direct costs, and \$8.2 billion in indirect costs (Asthma and Allergy Foundation, 2009). Direct costs include costs for health care services and medications, while indirect costs account for other effects such as lost productivity due to missed days of work or of school. In North Carolina in 2003, total estimated asthma costs exceeded \$631 million, and total charges for hospitalizations in NC for asthma exceeded \$88 million dollars (North Carolina Asthma Program Report).

LITERATURE REVIEW ON ASTHMA AND INDOOR ENVIRONMENTAL ISSUES

Asthma has a multi-factorial etiology with both genetic predispositions and environmental influences. There is an increasing recognition of the role indoor environmental triggers play in asthma pathophysiology, both in the onset of asthma in genetically predisposed individuals, as well as in asthma flares in people with the disease (IOM, 2000). Environmental factors that can contribute to asthma include both allergens and irritants. Children with asthma frequently have positive allergy test findings to cockroaches, dust mites, pets, pollens or molds, and may have

airway hyperreactivity to chemical irritants (IOM, 2000). Some of the most common and well-studied indoor triggers that are linked to asthma are listed in the following table:

Table 1: INDOOR ENVIRONMENTAL TRIGGERS IMPORTANT IN ASTHMA DISEASE

Allergens	Where Found/examples	Strategies To Reduce Exposures
Dust mites	Mattresses, bedding, stuffed toys, upholstered furniture, curtains, carpeting	Encase mattresses and pillows in dust-mite proof covers. Wash bedding in hot water. Remove carpets from bedroom. Keep stuffed animals out of child's bed.
Cockroaches – body parts, secretions and droppings	Areas with food and water – e.g. Kitchen, bathroom, basement	Keep food out of bedroom. Keep food and garbage in closed containers. Use poison baits, boric acid or gels.
Animals (pests and household pets)	Throughout entire house	Keep pets out of the home, or at least out of the bedroom. Pest control services for mice/rodents.
Mold	Areas with excess moisture – e.g. kitchens, bathrooms, basements	Fix leaks. Don't use humidifier. Clean moldy surfaces.

Irritants	Where Found/Examples	How To Reduce Exposures
Secondhand smoke	Home and car. Lingers on clothing, upholstery	Advise family members on tools for smoking cessation. Encourage no smoking in the house, car, or around patient with asthma.
Nitrogen dioxide	Associated with gas cooking appliances, fireplaces, woodstoves, and unvented kerosene heater	Ensure adequate ventilation in home. Decrease use of fireplaces, woodstoves, etc.
Chemicals and fragrances	Household cleaners, candles, air fresheners, perfumes, etc.	Eliminate use of these products in the home.

In 2000, the Institute of Medicine (IOM) released a comprehensive review titled “Clearing the Air: Asthma and Indoor Exposures” (IOM, 2000), an evidence-based review of scientific studies on how indoor pollutants contribute to asthma-- its onset, prevalence, and severity. The IOM classified the associations as either causal (evidence in this category is strong enough to conclude that an allergen or irritant *causes* symptoms to develop in predisposed individuals or to worsen in those with known asthma) or associated (evidence in this category is sufficient to conclude there is an *association*, but there is insufficient evidence to conclude causality). According to the IOM, there is sufficient evidence to conclude the following associations:

Table 2: EVIDENCE-BASED INFORMATION ON LINK BETWEEN ASTHMA AND ENVIRONMENTAL TRIGGERS

<i>Causal relationship- trigger exposure can cause asthma onset</i>	<i>Causal relationship – trigger exposure can cause asthma exacerbation</i>	<i>Association – trigger is associated with asthma onset</i>	<i>Association – trigger is associated with asthma exacerbation</i>
Dust mites	Dust mites Environmental tobacco smoke (ETS) - in preschool age children Cats Cockroaches	ETS - in young children	Dogs Fungi/molds Nitrogen oxide

These types of findings, along with the fact that children spend the majority of their time indoors (Sharma, 2007), make the indoor environment an important public health area in asthma prevention and management. Because of the strength of the evidence that environmental factors exacerbate asthma symptoms, national guidelines for asthma care were revised in 2007 to include a

new focus on the control of environmental triggers (NHLBI, 2007). The widely respected 2007 National Asthma Education and Prevention Program (NAEPP) guidelines list these as the four major components of effective asthma management:

1. Routine monitoring of asthma symptoms and of lung function
2. *Control of environmental factors and other triggers that contribute to asthma symptoms and disease severity*
3. Pharmacological therapy, including the use of controller medications
4. Patient education to help create a partnership between patients and their health care providers.

The NAEPP expert panel concluded that the available evidence has strengthened the recommendations that reducing exposure to indoor allergens can improve asthma control by reducing inflammation, symptoms, and need for medication. Steps towards this goal include evaluating the potential role of allergens and irritants by identifying individual exposures, and using allergy testing to assess allergen sensitivity. Based on this tailored information, patients with asthma can be advised on reducing exposures to allergens and irritants to which they are sensitive (NHLBI, 2007).

Though the scientific evidence on the link between environmental exposures and asthma symptoms is extensive, in the past, research on the effectiveness of interventions in reducing environmental exposures and asthma symptoms has been more limited. Fortunately, in the last five to ten years, there has been an increasing awareness of the potential benefits of environmental assessments of indoor environments and remediation of triggers, particularly when interventions are combined with patient education. As the new NAEPP summary report and guidelines describe, effective allergen avoidance requires a multifaceted and comprehensive approach, that the home

setting may be a particularly useful point of care, and that single interventions are usually not effective (NHLBI, 2007).

When conducting a literature review on the effectiveness of environmental interventions, it is useful to consider the differences in the nature of this type of evidence as compared to other types of more scientifically rigorous research. Individual studies, if viewed in isolation, frequently have limitations on study design, scope or methods, due to the “real world” settings in which they are conducted. Public health officials and policy makers may need to rely on the weight of the evidence, in which conclusions are drawn on the basis of a collection of studies.

One interesting study of home intervention to control allergens had a study design with three groups, with the intervention group receiving a home visit, impermeable mattress and pillow covers, and correct education on washing bedding in hot water (Carter et al, 2001). The placebo control families received a home visit, ineffective dust-mite permeable mattress covers, and incorrect education on washing bedding in cold water; while the no-visit control group received no home visits or supplies. Both the placebo and intervention groups had reduced acute care visits when compared to the no-visit group. However the placebo and intervention groups did not differ significantly from each other, suggesting that the home visit itself resulted in improved asthma control.

Other early studies focused on single allergen reduction. For example, measures to avoid exposure to dust mites, such as bedding encasements, reduced the levels of exposure to dust mite allergen, but did not necessarily improve asthma outcomes (Gotzche et al, 2008). Exposure to cockroach allergens may worsen asthma symptoms among urban children who are allergen-sensitized, but reducing allergen levels in inner-city homes has been shown to be difficult, and with minimal clinical benefit (Gergen et al, 1999). One probable reason for the limited effectiveness shown in these single-intervention programs is that children with asthma usually are exposed to

multiple environmental triggers in their indoor environments. By focusing on one allergen without addressing other potential environmental irritants, asthma morbidity may be persistent and health care outcomes unchanged.

Recent research has tried to move past the limitations of intervention strategies that focus on decreasing exposure to a single allergen, and instead working on a more comprehensive approach to asthma management. There is a small collection of information on multi-faceted environmental interventions, which have used different combinations of asthma management strategies. Various strategies used include - providing education to families about the connection between asthma and the home environment; providing services such as home environmental assessments and pest management; and providing supplies and/or structural interventions (e.g. bedding encasements, vacuum cleaners, air filters, etc).

In 2002, the Journal of Asthma published a study on an individualized intervention to improve asthma management among urban Latino and African-American families (Bonner et al, 2002). The study was a randomized cohort design of 119 families who were randomly assigned to an intervention or control group. The intervention group received a targeted asthma education program and home assessment, where family coordinators provided comprehensive asthma education, accompanied families to medical appointments, conducted a home environmental assessment and suggested strategies for reducing asthma triggers. The study results showed that families experienced some improvement in health outcomes measured (asthma knowledge, self-efficacy for asthma management, asthma symptoms), and a statistically significant improvement in family knowledge of asthma. Some limitations of the study were that family coordinators were nonmedical individuals who required extensive training, the educational component was time-intensive, and the environmental assessment was conducted by noncertified personnel.

In 2004, the results of the Inner City Asthma Study (ICAS) multi-center trial were published (Morgan et al, 2004). In this large study, 937 children were enrolled in a randomized controlled trial of a one year comprehensive in-home environmental intervention that included asthma education and home remediation for indoor allergens. The intervention group received extensive patient-tailored asthma education, a home assessment, multiple follow-up home visits over one year, pest control, and supplies such as allergy covers, vacuum cleaners and air purifiers. Intervention activities were tailored to each family based on allergy-testing of the child and staff observations during the baseline home evaluation. Study outcomes measured included asthma symptoms, medication use, and allergen levels in household. Over the two year follow-up, significant reductions occurred in measured levels of cat, dust mite and cockroach allergens in the bedroom, and these reduced levels were associated with reductions in symptoms, fewer school absences, and a decrease in ED visits in the first follow-up year. This study suggests that education about relevant environmental control in the home, along with provision of tools for allergen reduction, can enable families to reduce allergen levels and asthma morbidity.

A clinical randomized controlled trial of home environmental intervention with inner-city children who had mild persistent asthma demonstrated that tailored environmental treatment and education can reduce levels of airborne allergens in inner-city homes, resulting in a modest effect on asthma morbidity (Eggleston, 2005). In this study, the intervention group received home-based education, pest management, bedding covers, and HEPA-filter air purifiers, while the control group received no interventions until one year after the trial. Although allergen levels were lower in the homes of the intervention group, the effects on symptoms, ED use, and pulmonary function were not significant. This may be partly due to the lack of tailored intervention strategies, and the lower level of intensity of the intervention.

In 2002, the Seattle-King County Healthy Homes project published a study of interventions of varying intensities for 274 children and their families (Krieger et al, 2002). Results of a series of home visits and provision of equipment by community health workers at two different levels of intensity were compared. In the high intensity group, community workers and environmental home specialists conducted initial home assessments, provided individualized action plans, and made up to 6 additional home visits over a one year period to provide education and social support, provision of materials to reduce exposures, assistance with pest management, and advocacy for improved housing conditions. The low intensity group received an initial home assessment with limited education, a home asthma action plan and bedding encasements. Both intervention groups experienced a reduction in asthma symptom days, improved quality of life for caretakers; however, the quality of life and health care utilization improved more significantly in the high intervention group. Urgent care costs were also reduced in the high-intensity group compared to the low intensity group.

More research is needed to increase our understanding of how and which combinations of home-based educational interventions and provision of services and tools for allergen control in high-risk asthma populations can most effectively reduce the burden of allergen exposure and affect asthma morbidity. Studies are also needed to evaluate the cost-effectiveness and feasibility of widespread implementation of all allergen-control interventions delivered in patients' homes.

There is limited information on the cost-effectiveness of environmental intervention programs, although there are some recent reviews that suggest that these programs can be cost-effective. A 2004 review of environmental interventions states the available evidence "suggests that in-home education and environmental interventions can be cost-effective approaches for improving the health status of those with asthma, particularly when targeted at those with more severe asthma" (Brugge et al, 2004, p. 266). Another review included an analysis of the National

Cooperative Inner City Asthma Study which was the predecessor to the Inner City Asthma Study described earlier. This study found that when compared to usual care, the study intervention (of high intensity) greatly improved outcomes for a “relatively modest overall increase in costs”, an average additional cost of approximately \$9.20 per symptom-free day gained (Sullivan et al, 2002).

Application of Information/Next Steps

Many of the programs studied have utilized a combination of asthma education, supplies to mitigate exposure, and services. The level of intensity of the services provided depended on funding, staffing, community partners and other resources. An initial home visit, coupled with a follow-up second visit sometime later, provided the opportunity to reinforce educational points and support family efforts at allergen control. Allergy testing was included by many programs, as it provided another opportunity to tailor education, supplies and allergen remediation techniques to the individual patient.

With regards to outcome evaluation, most studies reviewed patient satisfaction, knowledge and some asthma control measures, such as frequency of symptoms and missed school days. There was somewhat less information available on asthma morbidity measures such as rates of ED visits and hospitalizations and on cost-effectiveness of the program. Some programs had difficulty in recruiting and retaining eligible patients.

The literature review on environmental management of asthma indicates that multifaceted approaches, using a combination of tailored environmental assessments and education to address multiple triggers, work best. An asthma management strategy that includes home visits provides an optimal setting to educate families, review medications, and help families to identify triggers and learn remediation strategies for specific environmental factors in their homes that may be

contributing to their child's asthma symptoms. A home-based environmental intervention plan also allows the asthma management team a better understanding of a family's circumstances, insight into potential barriers that may be contributing to suboptimal asthma control, and the ability to tailor environmental interventions to a family's particular needs.

Community Care of Wake and Johnston Counties Pilot Project

Community Care of North Carolina (CCNC) is an organization that focuses on building community health networks organized and operated by community health and social services providers and organizations. Community Care of Wake and Johnston Counties (CCWJC) is one of the 14 Community Care of North Carolina networks across the state. CCWJC focuses on population management for medically high cost and high risk Medicaid patients by promoting evidence-based best practices while controlling costs. Some of the techniques used for population management include promoting adherence to best practice guidelines for chronic diseases, promoting access to primary care, decreasing non-emergent use of emergency departments, direct case management services to high risk or high cost patients, and support to primary care practices. Since 2003, CCWJC has provided asthma education and case management for Medicaid asthma patients using nurse case managers. Case management services include medication review, home visits, communication with medical providers, telephone follow-ups, facilitation of patient self-management skills and a link to community resources.

In 2006, based on research in the environmental sciences field, Wake County Environmental Services (WCES) began exploring the possibility of conducting home assessments for asthmatic patients. After WCES approached CCWJC and Wake County Human Services (WCHS) as potential collaborators, it was felt that CCWJC provided the best resources for a collaborative effort as the organization had an established population of prospective participants, and had access

to asthma-related claims data. Dovetailing an environmental home assessment to existing case management services provided a means of combining resources, reinforcing educational messages, and providing more comprehensive and integrated asthma management. The initial planning team consisted of the medical director of CCWJC, the CCWJC lead asthma nurse coordinator, and two environmental specialists from WCES. Various consultants from WCHS and community asthma organizations were solicited as needed for their expertise and suggestions. The small size of the planning team facilitated communication through regular meetings and e-mail correspondence, but was large enough to maintain a diversity of experience, community connections, ideas and expertise within the group.

Enthusiasm for the proposed combined intervention increased after the revised NAEPP guidelines were released in 2007, with a new focus on the importance of environmental assessments and intervention. Using available information from previous programs, a pilot program was developed to assess the ease, implementation and outcomes of comprehensive environmental home assessments. From August 2006 through November 2007, a pilot program of environmental surveys was carried out in the homes of twelve children on Medicaid with asthma. These participants were identified as high-risk, high-cost patients based on provider referrals, claims data review by CCWJC staff, and real-time data on hospital and ED utilization. Identified patients were contacted by their case manager to see if they would consent to a home assessment. Environmental services staffing consisted of 2-4 hours per month to conduct these surveys, allowing for approximately one survey/month. The average time spent with each family was 3 hours, and a home assessment checklist from the EPA was used to conduct the comprehensive home survey. The assessment team consisted of the environmental specialist and the nurse case manager.

The home was surveyed for 8 potential asthma triggers including dust/dust mites, mold, roaches, pets, rodents, chemicals, combustion by-products and tobacco exposure; and education and recommendations on trigger reduction were given to the families. The families were also provided with some supplies to assist in allergen control including bedding covers, dust cloths, and HEPA-filter vacuum cleaners. In some cases, if the family consented, the environmental specialist wrote letters to the landlord detailing allergenic conditions that were beyond the ability of the tenant to repair. Phone follow-up was done at 6 weeks, 6 months, and 1 year post-intervention to determine whether changes had been made to the environment. Asthma-related Medicaid claims data for outpatient visits, pharmacy costs, ED visits and hospital admissions were compiled for the two years preceding the home survey intervention, and are still being evaluated for two years post-intervention.

Pilot program claims data results are available for an average of 21 months post-intervention for nine of the twelve patients. The other three of the original twelve patients were lost to follow-up when their Medicaid insurance expired. Preliminary findings showed that before the home survey, there was an average of 3.7 asthma triggers found in the indoor environment of the patient, and the average number of positive changes made by the family toward trigger reduction was 4.4. Other outcome measures based on claims data are described in the following table:

Outcome measure	Pre-intervention		Post-intervention	
	Total	Per patient	Total	Per patient
ED visits	30	3.3	9	1
ED costs	\$27,185.80	\$3020.64	\$4,492.39	\$499
Clinic visits	27	3	19	2.1
Clinic costs	\$2,472.04	\$274.67	\$1,873.05	\$208.12
Hospital Admissions	4	0.4	2	<0.1
Hospital Admissions costs	\$ 9,176.69	\$1,019.63	\$3,260.76	\$362.30
Total costs for asthma	\$ 50,934.15	\$5,659.35	\$22,172.89	\$2,463.65

For the 9 patients in the pilot for whom both pre- and post-intervention data is available, the total costs difference was \$28,761.26, an impressive potential cost -savings.

Some of the particular strengths of the program that became apparent during the pilot included the access to Medicaid claims data through the CCWJC case manager information system (CMIS). This allowed CCWJC to find and recruit eligible patients based on their asthma severity profiles, and facilitated tracking of claims data for outcome measures. The environmental specialist available through Wake County Environmental Services provided particular knowledge and expertise during the home assessment, and was able to write letters to landlords to help with issues in rental situations. Many of the case managers are bilingual, and had already established a working relationship with their clients. Having a case manager present that the family was already acquainted with helped with issues of trust, and provided an opportunity to reinforce other aspects of asthma care.

There were also some limitations that became apparent during the pilot. The combination of the environmental specialist and the case manager conducting the intervention reduced the capacity to schedule and do home assessments, and makes it potentially more difficult to reproduce the intervention in other settings, particularly in more rural areas. Funds for supplies were limited, and there was insufficient organizational capacity to conduct a follow-up home assessment. Although the program did communicate with landlords, staff did not have any legal authority to help patients in unsound rental situations or who feared recourse from their landlord because a home assessment was conducted. Allergy testing was not part of the program intervention, which caused some limitations to the ability to tailor the home visit and recommendations to the patient's specific allergen sensitivities.

The small scope of the pilot program allowed the planning team time to assess organizational capacity and the logistics of the intervention, and to then make process

modifications at an early low value stage. Some of the lessons learned about processes and implementation during the pilot program included the need for stable funding to expand and sustain the program, the need for more user-friendly forms for the home visit and for data input, the need for a more organized report form for providers and families, the need for bilingual and health literacy level appropriate educational handouts, and the need to more clearly define the triggers being assessed. For example, some triggers are more readily changed by the family (e.g. dust, removal of chemical irritants, etc), whereas others require external help for remediation (e.g. structural flaws in housing, roaches in connected dwellings, etc). The combination of the environmental specialist and a case manager doing the home visit works well to provide a multi-faceted intervention that includes education, medication review, and addressing environmental triggers.

Program Plan

Utilizing the promising results of the limited pilot program for home environmental interventions the project management team began a search for funding to hire a part-time environmental specialist position to conduct the home assessments. This funding was critical towards the goal of developing a larger and sustainable program to address environmental trigger remediation in the homes of asthmatic children in Wake County who are insured by Medicaid. Wake County Human Services, which had been part of the earliest discussions, was approached as a potential funder for the position. Based on the strength of the pilot data, the credibility and worth of the proposed intervention, and the potential cost-savings to the county, WCHS agreed to provide the funding stream for the 0.5 FTE environmental specialist position.

The first participants in the environmental assessment program began in September 2008; however, the process of developing a program and evaluation plan has been on-going. The three

major collaborators for the initiative have been Community Care of Wake and Johnston Counties, Wake County Environmental Services and Wake County Human Services. Wake County Human Services provides the funding for the environmental staff position and links to county resources; Wake County Environmental Services provides scientific and programmatic expertise; and CCWJC provides medical expertise, case management, supplies and materials, programmatic oversight and community connections. Other involved stakeholders include the Asthma Alliance of North Carolina, Wake Med Asthma Education Program, the National Institute of Environmental Health Sciences (NIEHS) and the State Department of Health. These other organizations' contributions have included provision of educational materials, sources of referrals, networking and technical expertise.

The project management team has been successful at creating a working environment of shared cultural values, mutual respect and value of the inputs of all team members. Meetings are held monthly, and program planning is ongoing and proactive as to how to best meet the needs of family participants as well as of stakeholders. The process of planning the intervention has been relatively smooth, as there is consensus among the team that the initiative is a credible and worthwhile intervention based on evidence-based best practices. Differences of opinion and negotiations have occurred mainly on the issue of ideal program scope vs. limitations in organizational capacity, and have been managed using input from all team members. Program plan details will be described in the following sections, and are also described in the logic model in the appendix.

Program Goal and Program Design

The goal of the Environmental Home Assessment Program is to reduce childhood asthma-related morbidity of Medicaid patients in Wake County by reducing home environmental triggers, leading to

an improvement in quality of life for children with asthma and to a reduction in asthma-related health care expenditures.

The program design consists of these steps:

- Identification of prospective high-risk high-cost children with asthma in Wake County through monitoring real-time data on hospital and ED visits, Medicaid claims data related to asthma care, or through referrals by the case manager or primary care provider.
- Conduction of a comprehensive home environmental assessment by an environmental specialist and case manager to identify asthma triggers in the indoor environment of participants.
- Education about the identified triggers and strategies to reduce the effect of these triggers.
- Supplies to assist families in remediation strategies.
- Case management services and education on other aspects of asthma management.
- Follow-up phone calls and/or visits by a nurse case manager to reinforce education and trigger reduction strategies, and to support families in their efforts to manage their child's asthma.
- Collection of data on outcomes measures including patient demographics, numbers and types of triggers, ED visits/costs, hospitalizations/costs, visits with primary care providers, pharmacy costs, cost of supplies, etc. Data will be collected for the 1 year prior to intervention, and for 1 year post-intervention (intervention is designated as beginning on the date of the home visit).
- Patient questionnaires pre- and post-intervention on self-confidence, knowledge of triggers, and satisfaction with the program.

Based on experience from the pilot program and from review of other similar programs, measurable process, effect and outcome objectives have been determined that serve as a guide to focus and assess project strategies for implementation and success.

Program Objectives

Process Objectives

1. The program will conduct an average of four environmental assessments per month by an environmental specialist. This number will be modified as warranted by patient need and by organizational capacity.
2. By year one after the home assessment, 75% of program participants will have had two or more follow-up phone calls or visits by their case managers.
3. By two weeks after the home visit, 80% of families will have a copy of their environmental assessment report, which will detail remediation strategies in a culturally appropriate and health literacy appropriate level.
4. By two weeks after the home visit is conducted, findings from 100% of the home assessments will be submitted to the participants' case managers and health care providers.
5. By month one after the home visit, 80% of families will have received appropriate educational materials and supplies to reduce environmental triggers in their home.
6. On an ongoing basis, CCNC staff will collect asthma-related claims data information on 80% of the participants enrolled in the program.
7. By year one, 75% of participating families will complete a pre-intervention questionnaire and post-intervention questionnaires at 6 weeks and 1 year after the home visit.
8. By year one, environmental specialist will conduct one or more training sessions per year for case managers on environmental issues related to asthma.

Effect Objectives – These are short-term outcomes we hope to see in our participants and families.

1. By week six post-intervention, 50% of parents/families will modify two or more environmental factors in their home, based on recommendations made during the home assessment.
2. By year one post-intervention, there will be a reduction in the average number of environmental triggers in the homes of participating families.
3. By year one, 50% of families will express an improvement in their self-confidence in dealing with their child's asthma.

4. By year one, 50% of families will express an improvement in their knowledge of asthma and asthma triggers.
5. By year one, 50% of families will have an asthma action plan accessible in their home.
6. By year one, 50% of participants will show an improvement in their asthma control.

Outcome Objectives – This encompasses the long-term potential outcomes of our program.

1. By year one, there will be a reduction in the number of asthma-related emergency department visits for participants.
2. By year one, there will be an overall reduction in the number of asthma-related hospitalizations for program participants.
3. By year one, there will be a reduction in total costs of asthma-related emergency department visits for participants.
4. By year one, there will be a reduction in the total costs of asthma-related hospitalizations for participants.
5. By year one, families of participants will experience an improvement in their quality of life.
6. By year one, participants will exhibit an improvement in their asthma control.

Evaluation Plan

The evaluation planning and process will be an integrated part of the program, providing important information about program management, service delivery decisions and outcomes. A comprehensive process and impact evaluation is critical to CCWJC for many reasons, including the following:

- To ensure that available resources are being utilized effectively. This is important information for the internal organization as well as for funding agencies.
- To strengthen the individual components of the environmental assessment and case management process for Wake County families with asthma.
- To facilitate the potential for program replication in other locations, particularly at other Community Care of North Carolina networks in other counties. A solid evaluation will allow our program to better understand the key components of this project that can be adapted and implemented in other settings, and will help others build on lessons learned.

- To present information about our program to potential partners and involved stakeholders. This increased program recognition will allow opportunities for networking, recruiting participants, building partnerships, seeking funding,, and continuing stakeholder engagement. For example, there are many county agencies that do home visits for other public health issues (e.g. directly observed therapy by tuberculosis nurses, child service coordinators, maternal outreach workers). Potential partnerships with these other programs will increase the likelihood of identifying and addressing complex health needs of families at multiple levels.
- To allow for opportunities to influence policy development in the field of asthma management.

The process of evaluation planning requires input from all stakeholders, allowing the program to stay aware of the many levels of interest in the project. For our program, input has been obtained from the implementation team, program staff, funders, asthma alliances and organizations in the community, and from participants. The North Carolina State Department of Health will be involved with the program staff in developing formalized protocols and training opportunities for other sites to learn from this initiative. Regular progress reports will be generated, and findings presented to stakeholders as requested.

The evaluation will be conducted as an internal process, with oversight by the program director and the implementation team. The advantages of using an internal evaluator are they will have a valuable familiarity with the history and the daily operations of the project, will understand the needs and perspectives of stakeholders, and will have access to organizational resources (e.g. claims database). Internal evaluation will also allow for more opportunities for informal feedback from program staff and from stakeholders.

Study design and methods

The evaluation will be conducted as a quasi-experimental case series study where the outcomes for a group of participants will be compared for 1 year prior to the home visit and for 1 year after the home assessment. The scientific rigor of the evaluation is somewhat limited due to the lack of a randomized controlled design; however, the collected data will help us determine the effectiveness of our intervention in its “real world” setting. Eligible participants are children with asthma in Wake County who are insured by Medicaid, and have claims data indicating high-risk or high-cost disease (e.g. frequent ED visits for asthma, recent hospitalization, overuse of asthma medication); or who are referred by their primary care provider. Potential limitations in the study design include the lack of stringent eligibility criteria, the variability in the amount of time participants receive case management services prior to the home assessment and the potential for sample attrition and incomplete data as many patients with Medicaid roll on and off of their insurance.

Evaluation methods will include collection of both qualitative and quantitative information. Qualitative data will include observations and informal feedback from program staff and from participants, as well as information from patient questionnaires pre- and post-intervention. These methods provide the advantage of flexibility, and can provide some of the best information on the strengths and weaknesses of the program. The major disadvantage of these types of data is the potential for bias. Process and impact data will also be collected in quantitative methods. In addition to open-ended questions, patient questionnaires will include scored questions about patient confidence and disease knowledge. The program database will compile data on patient demographics, triggers, numbers and costs of clinic visits, numbers and costs of ED visits, numbers and costs of hospitalizations, pharmacy and medical equipment costs, costs of supplies, and indications of rescue medication overuse.

CONCLUSION

There is a growing body of evidence to demonstrate that control of environmental factors is a critical part of asthma management, and that environmental remediation strategies work best when combined with comprehensive asthma management. Considering the large public health burden of asthma in the United States, reduction in environmental triggers carries an enormous potential to reduce asthma morbidity, thereby improving quality of life for people with asthma and reducing health-care expenditures. Indoor environmental allergens are particularly important in childhood asthma control, as children are estimated to spend the vast majority of their time indoors.

A review of scientific literature on environmental interventions reveals that multi-faceted approaches that include a combination of patient education, home assessments, and provision of tools to remediate triggers have worked better than single interventions. Community Care of Wake and Johnston Counties and its collaborative partners are in an ideal position to provide a comprehensive program that includes asthma case management, patient education, and environmental interventions towards asthma control. The additional benefit of empowering families with asthma by providing knowledge, tools and promotion of self-management skills will hopefully result in more sustained health benefits. Developing this type of multifaceted intervention requires careful deliberation on the ideal balance between program scope and organizational and budgetary limitations.

If this initiative continues to prove successful, there is potential for expansion of services, program dissemination to other sites, and for expanding collaboration with other community partners. Having a solid program and evaluation plan will facilitate the ability to replicate the program in other settings, will provide needed information to program funders, and will allow the organization the ability to improve and sustain the program as it matures.

APPENDIX A: LOGIC MODEL FOR ASTHMA ENVIRONMENTAL ASSESSMENT PROGRAM

Resources/Input	Activities	Outputs	Short-Term Outcomes	Long-Term Impact
Personnel:	Training/education of case managers	Completed home assessments	Improved knowledge of families on trigger reduction	Decrease in ED rates for asthma
<ul style="list-style-type: none"> Environmental specialist CCWJC implementation team Nurse case managers 	Home assessments	Completed training sessions for case managers	Improved confidence of families on trigger reduction and on asthma management	Decrease in hospitalization rates for asthma exacerbations
	Education of families on trigger reduction, asthma medication use, and asthma management	Letters to families, case managers and primary care providers re. results of environmental assessment	Decreased use of rescue medications for asthma control	Decreased costs to Medicaid for asthma management
Claims data information to identify potential participants	Letters to landlords	Letters to landlords, if requested by family	Improvement in Asthma Control Test scores for patients	Improvement in quality of life for patients and their families
Supplies and educational material to give to families	Follow-ups by case managers at regular intervals after the home assessment	Improved knowledge on ways to reduce environmental triggers	Reduction in asthma triggers	Reduced burden of asthma in Wake and Johnston County
Funding from Wake County, CCWJC, Wake County Human Services	Questionnaires to participating families	Education and resources for families on trigger reduction	Decrease in incidence of asthma exacerbations	Increase in awareness of the role of environmental triggers in asthma
Health care professionals to refer patients to the program	Network with local asthma coalitions and alliances	Ongoing claims data information	Increased collaboration between CCWJC and providers	Replication of initiative at other Community Care networks in NC

APPENDIX B: EVALUATION PLANNING TABLES

Process objective 1 – The program will conduct an average of four environmental assessments per month by an environmental specialist. This number will be modified as warranted by patient need and by organizational capacity.

Evaluation question	Evaluation method
How many assessments per month are being conducted? Were patients selected based on appropriate eligibility criteria? Is there a need to re-define eligibility criteria?	Review of documents (referrals, claims data), calendar
Is there a need to expand or reduce number of assessments/month?	Review of referrals, claim data, observations of program staff
How many participants decline participation in the program? If so, why? What barriers to scheduling home assessments were noted? What barriers to conducting home assessments were noted?	Observations of case managers, environmental specialist
Is the process of the home assessment generally well-received by families? Are their issues of trust? Are there cultural or language barriers?	Observations of environmental specialist, case managers. Family interviews.

Process objective 2 – By year one after the home assessment, 75% of program participants will have had two or more follow-up phone calls or visits by their case managers.

Evaluation question	Evaluation method
How many follow-up visits or calls are being conducted on each participant?	Database, Case manager data system
What barriers to conducting follow-ups were noted?	Observations of case managers, review of CMIS notes

Process Objective 3 and 4 – By two weeks after the home visit, 80% of families will have a copy of their environmental assessment report, which will detail remediation strategies in a culturally appropriate and health literacy appropriate level. By two weeks after the home visit is conducted, findings from 100% of the home assessments will be submitted to the participants’ case managers and health care providers.

Evaluation question	Evaluation method
How long is it taking the environmental specialist to compile their report?	Interview of environmental specialist
Are there barriers to getting a copy of the report to the family?	Observations of environmental specialist, case managers, families
Are there barriers to getting a copy of the report to the case manager or health provider?	Observations of environmental specialist, case managers
Are reports written in the primary language of the family? Are patient recommendations written in simple, easy to understand language?	Review of environmental survey reports

Process Objective 5 – By month one after the home visit, 80% of families will have received appropriate educational materials and supplies to reduce environmental triggers in their home.

Evaluation question	Evaluation method
What supplies are being distributed to families?	Database, case manager notes
What criteria are being used to determine which supplies are being provided?	Interview of environmental specialist, case managers; review of CMIS data
Do the provided supplies match the recommendations made during the home visit?	Review of database, environmental survey reports
Do the distributed educational materials match the recommendations made during the home visit?	Review of environmental survey reports, interview with case managers
Are the educational materials culturally appropriate, and at an appropriate health literacy level for participants?	Review of handouts, interviews with environmental specialist and case managers

Process Objective 6 - On an ongoing basis, CCWJC staff will collect claims data information on 80% of the participants enrolled in the program.

Evaluation question	Evaluation method
When is claims data information being collected and entered into the database? By whom? Are there methods to facilitate ease of data collection and entry? Are there barriers to assembling needed claims information?	Review of database; observations of data entry person and case managers.

Process Objective 7 - By year one, 75% of participating families will complete a pre-intervention questionnaire and two post-intervention questionnaires.

Evaluation question	Evaluation method
Are questionnaires succinct, easy to understand, and written at an appropriate literacy level?	Review of forms, review of parent responses and unanswered questions, parent interviews.
Are questionnaires being distributed and collected from the families at the time of assessment, 6 weeks post-intervention, and 1 year post-intervention? If not, why? Are families completing the questionnaires? If not, why?	Interviews of case managers Database Staff observations, informal feedback from participants.

Process Objective 8 - By year one, the environmental specialist will conduct one or more training sessions for case managers on environmental modifications and asthma.

Evaluation question	Evaluation method
What training sessions were conducted in the past year?	Review of calendar
What specific topics that program staff/case managers would like to have the environmental	Survey of program staff/case managers

specialist conduct educational and training sessions on?	
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Effect Objectives Evaluation Planning Table

Effect Objective 1 and 2 - By week six post-intervention, 50% of parents/families will modify two or more environmental factors in their home, based on recommendations made during the home assessment. By year one post-intervention, there will be a reduction in the average number of environmental triggers in the homes of participating families.

Evaluation question	Evaluation method
How many environmental triggers did families modify after the home assessment? Were there particular triggers that were more readily modifiable? If so, which triggers? Was there a change in the number of triggers pre- and post-intervention?	Database of case manager follow-ups by phone or home visit at 6 weeks, 6 months and 1 year. Observations of parents, program staff
How often did landlords help modify resources?	Case manager notes
What barriers did families experience to trigger modification?	Post-intervention questionnaires; case manager notes
Have families received appropriate supplies? If so, have they found them helpful toward trigger reduction?	Case manager notes post-intervention questionnaires to family
Have families found the received educational materials useful toward trigger reduction?	Post-intervention questionnaires of family

Effect Objective 3 and 4 - By year one, 50% of families will express an improvement in their self-confidence of dealing with their child's asthma. By year one, 50% of families will express an improvement in their knowledge of asthma and asthma triggers.

Evaluation question	Evaluation method
Has the level of confidence of families changed pre- and post-intervention?	Quantitative data from family questionnaires pre-and post-intervention
Have families experienced an improvement in	Quantitative data from family questionnaires

their knowledge of the relationship of asthma to environmental factors and of asthma in general?	pre- and post-intervention
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Effect Objective 5 and 6 - By year one, 50% of families will have an asthma action plan accessible in their home. By year one, 50% of participants will show an improvement in their asthma control.

Evaluation question	Evaluation method
How do Asthma Control Test scores of patients compare pre-intervention and post-intervention?	Asthma control test scores (administered at home assessment, and 1 year post-intervention)
Is there an improvement in adherence to asthma medication?	Pharmacy claims data on prescriptions for asthma medication.
Is there an asthma action plan in the home?	Case manager notes from follow-ups

Outcome Objectives Planning Table

Outcome Objectives 1, 2, 3 and 4 - By year one, there will be a reduction in the # of asthma-related emergency department visits for participants. By year one, there will be an overall reduction in the number of asthma-related hospitalizations for program participants. By year one, there will be a reduction in total costs of asthma-related emergency department visits for participants. By year one, there will be a reduction in the total costs of asthma-related hospitalizations for participants.

Evaluation question	Evaluation method
Compare the numbers of ED visits, hospitalizations and costs pre- and post-intervention.	Claims data for outcome measures for 1 year pre-intervention and 1 year post-intervention

Outcome Objectives 5 and 6 -By year one, families of participants will experience an improvement in their quality of life. By year one, participants will exhibit an improvement in their asthma control.

Evaluation question	Evaluation method
How do families rate their quality of life pre- and post-intervention?	Family questionnaires pre- and post-intervention
Do participants experience an improvement in asthma control?	Asthma control test scores, pharmacy data on medication adherence, overuse of rescue medications

APPENDIX 3: REFERENCES

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