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Closing the Quality Gap: A Critical Analysis of Quality Improvement Strategies

Volume 5—Asthma Care

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The information in this report is intended to help clinicians, employers, policymakers, and others make informed decisions about the provision of health care services. This report is intended as a reference and not as a substitute for clinical judgment.

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Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-Based Practice Centers (EPCs), sponsors the development of evidence reports and technology assessments to assist public- and private-sector organizations in their efforts to improve the quality of health care in the United States. The reports and assessments provide organizations with comprehensive, science-based information on common, costly medical conditions and new health care technologies. The EPCs systematically review the relevant scientific literature on topics assigned to them by AHRQ and conduct additional analyses when appropriate prior to developing their reports and assessments.

To bring the broadest range of experts into the development of evidence reports and health technology assessments, AHRQ encourages the EPCs to form partnerships and enter into collaborations with other medical and research organizations. The EPCs work with these partner organizations to ensure that the evidence reports and technology assessments they produce will become building blocks for health care quality improvement projects throughout the Nation. The reports undergo peer review prior to their release.

AHRQ expects that the EPC evidence reports and technology assessments will inform individual health plans, providers, and purchasers as well as the health care system as a whole by providing important information to help improve health care quality.

We welcome comments on this evidence report. They may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 540 Gaither Road, Rockville, MD 20850, or by e-mail to **epc@ahrq.gov.**

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* Appendixes cited in this report are provided electronically at http://www.ahrq.gov/clinic/tp/asthmagaptp.htm

Structured Abstract

Objectives: Despite the availability of evidence-based guidelines for the management of pediatric and adult asthma, there remains a significant gap between accepted best practices for asthma care and actual care delivered to asthma patients. The purpose of this systematic review was to evaluate the evidence that quality improvement (QI) strategies can improve the processes and outcomes of outpatient care for children and adults with asthma.

Data Sources: We searched four literature sources: the Cochrane Effective Practice and Organisation of Care (EPOC) Group database (1/1966 to 4/2006), MEDLINE® (1/1966 to 4/2006), the Cochrane Consumers and Communication Group database (1/1966 to 5/2006), and bibliographies of retrieved articles.

Review Methods: We sought English language studies of interventions that included one or more QI strategies (e.g., patient education, provider education, audit and feedback) for the outpatient management of children or adults with asthma. Included studies were required to be either randomized controlled trials, controlled before-after trials, or interrupted time series trials. The four primary types of outcomes of interest were measures of *clinical status* (e.g., asthma symptoms, spirometric measures); measures of *functional status* (e.g., days lost from work or school); measures of *health services utilization* (e.g., hospital admissions); and measures of *adherence to guidelines* (e.g., number of patients given prescriptions for inhaled corticosteroids).

Results: We identified 3843 potentially relevant articles, of which 200 articles describing 171 studies met our inclusion criteria. These studies exhibited substantial variation in terms of the types of strategies evaluated. However, using broad, pragmatic categories for quality improvement strategies, 100 included at least some component of patient education, 94 studies included some component of self-monitoring or self-management, 27 included some component of organizational change, and 19 included provider education, among others. The studies also evaluated heterogeneous patient populations, but these could be broadly categorized into those that targeted children or adolescents with asthma or their families (79 studies) and outpatient populations with asthma comprised typically of adults (92 studies). Among all studies of pediatric asthma evaluating self-monitoring, self-management, or patient education interventions, those directed at parents or caregivers, as opposed to at the children themselves and not their parents, were more likely to be associated with a statistically significant improvement in clinical outcomes (e.g., improvements in asthma symptoms or spirometric measures (p=0.02)). Self-monitoring, self-management, or patient education interventions for general populations or adults with asthma were associated with improvements in percent predicted FEV_1 (weighted mean difference: 2.92 percent predicted FEV_1; 95% CI 0.92, 4.92; p=0.004) and mean peak flow (weighted mean difference: 27.95 L/min; 95% CI 10.75, 45.15; (p=0.01). QI interventions that are based explicitly on a theoretical framework, provide multiple educational sessions, have longer durations, and use combinations of instructional modalities (e.g., small group teaching with role-playing and handouts) are more likely to result in improvements for patients than interventions lacking these characteristics. When taken as a

group, the improvements reported in the included studies were often statistically significant but possibly only of borderline clinical significance.

Conclusions: A wide variety of types of QI interventions have been found to improve the outcomes and processes of care for children and adults with asthma. Young children with asthma benefit most from QI strategies that also include their caregivers or parents. General populations with asthma can have clinically significant improvements in spirometric measures after participating in self-monitoring, self-management, or patient education interventions—especially interventions that are based on theoretical frameworks, are of relatively long durations, and utilize combinations of educational modalities.

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Appendices and Evidence Tables for this report are provided electronically at http://www.ahrq.gov/downloads/pub/evidence/pdf/qualgap5/asthmagap.pdf.

Executive Summary

Overview

Asthma is one of the most common chronic medical conditions in the U.S. It affects 16 million adults and 6.1 million children and results in two million visits to emergency departments, 70,000 hospitalizations, and 5,000 deaths annually. The burden of asthma disproportionately affects persons of lower socioeconomic status. Because asthma can neither be prevented nor cured, current management objectives are to monitor symptoms and objective measures of lung function, to encourage the use of medications that control and prevent symptoms with the fewest adverse effects possible, to control the triggers of asthma symptoms to which a patient is sensitive (such as house dust mites, tobacco smoke, animal dander, and pollens), and to facilitate an asthma care partnership between patients and providers. Effective asthma management has been demonstrated to reduce symptoms, hospitalizations, and urgent care visits.

Despite the availability of evidence-based guidelines for the management of pediatric and adult asthma, there remains a significant gap between accepted best practices for asthma care and actual care delivered to asthma patients. The objective of this systematic review was to evaluate the evidence that quality improvement (QI) strategies can improve the processes and outcomes of outpatient care for children and adults with asthma, and to identify the most effective strategies.

Key Questions

The two research questions addressed in this study were:

Research Question 1: What is the evidence that QI strategies improve the processes and outcomes of outpatient care for pediatric and adult populations with asthma? Specifically, which QI strategies are effective for improving processes and outcomes of asthma care for specific patient populations (e.g., adults, children, low socio-economic status (SES), racial groups, urban/rural)? Also, does the setting of the QI intervention (e.g., home, school, clinic) determine its effectiveness for improving processes and outcomes of asthma care?

Research Question 2: Are QI interventions for asthma care that incorporate multiple strategies more effective than those that employ a single strategy?

Methodology

We sought English language evaluations of quality improvement strategies designed to improve the outpatient management of children and adults with asthma. We defined QI strategies as interventions aimed at reducing the quality gap (the difference between health care processes or outcomes observed in practice and evidence-based practices potentially obtainable

on the basis of current professional knowledge). We included articles describing interventions with one or more of nine types of QI strategies: patient education, the promotion of self-monitoring or self-management, provider education, organizational change, audit and feedback, provider reminders, patient reminders, facilitated relay of clinical data to providers, and financial or legislative incentives.

Study Design. Because most health care is delivered in settings where continuous QI efforts and other temporal changes are occurring, evaluations of QI strategies that are not randomized or controlled may be subject to confounding from other QI programs ongoing in the facility or region. Thus, included trials were required to have one of three types of study designs: randomized controlled trials, controlled before-after trials which included contemporaneous observation periods for control and intervention groups, or interrupted time series trials that reported data at three or more time points both before and after intervention to facilitate time trend analysis.

Outcomes. Included studies had to report at least one of the four following types of primary outcomes: measures of *clinical status* (e.g., symptoms or symptom-free days, spirometric measures, number of asthma attacks); measures of *functional status* (e.g., days lost from work or school); measures of *health services utilization* (e.g., hospital admissions, ED visits); or measures of *adherence to guidelines* (e.g., number of patients given prescriptions for inhaled corticosteroids).

Literature Sources. We searched four literature sources: MEDLINE® (1966 to April 2006) the Cochrane Effective Practice and Organisation of Care (EPOC) Group databases (1966 to April 2006), the Cochrane Consumers and Communication Group database (1966 to May 2006), and bibliographies of retrieved articles.

Data Abstraction. Two independent investigators reviewed the title and abstract of each article found in our search to determine if the article met inclusion criteria. All disagreements were resolved by repeated review and discussion. Articles requiring full text review were abstracted by a single investigator and then verified by a second abstracter. From each of the included studies we abstracted data about the study design, study participants, detailed descriptions of the QI intervention, and the reported outcomes.

Statistical Analysis. We performed univariate analyses to describe the patient and intervention characteristics of the included studies. For each type of intervention evaluated in a particular population (e.g., patient education strategies for children) for which 15 or more studies presented data on the same specific outcome (e.g., percent predicted FEV_1), we calculated summary standardized and weighted mean differences between intervention and control groups at the end of the trial using a random effects model. We performed least squares regression (weighted by the sample size) to identify associations between the intervention characteristics and improvements in these outcomes. For example, for the studies of patient education interventions, we evaluated the association of the frequency of educational sessions, the type of educator (e.g., nurse, pharmacist), and the setting of the educational program with changes in FEV_1. We

performed formal assessments of heterogeneity for our summary weighted mean differences. We sought evidence of publication bias by visual inspection of funnel plots.

Findings

Our searches yielded 3,843 potential relevant articles, of which 200 articles describing 171 studies met eligibility criteria.

Assessment for Heterogeneity. The included articles were highly heterogeneous:

Study design: 134 were randomized controlled trials, 32 were controlled before-after trials, and 5 were quasi-randomized controlled trials. Out of the total, 35 studies compared two or more interventions without a control group that did not also receive a QI intervention.

QI strategies evaluated: 94 studies described interventions that included a component of self-monitoring or self-management, 100 included a component of patient education, 18 included provider education, 27 included organizational change, five included audit and feedback, and four included provider reminders, five included facilitated relay of clinical data to providers, and two included financial incentives. The interventions took place between 1976 and 2004 and ranged in length from 4 weeks to 5 years (median: 12 months).

Target populations: 79 studies targeted children (six of which exclusively enrolled adolescents) and 92 studies targeted general asthma populations that included primarily adults.

Given the heterogeneity of the included studies, we synthesized data separately for each group of studies that evaluated the same type of QI strategy in the same population.

Assessment for Publication Bias. Overall, we found no statistically significant association between the likelihood of positive outcome with either sample size ($p=0.6$) or study design ($p=0.4$). Visual inspection of the funnel plots of the association of sample size and the likelihood of finding a statistically significant positive outcome also did not suggest substantial publication bias for most interventions and outcomes.

Self-Monitoring, Self-Management, or Patient Education. For the purposes of this report, we classified interventions as being principally "self-monitoring or self-management" if the goal of the intervention was to improve the ability of people with asthma or their caregivers to take actions that can reduce the impact of asthma on their lives. In contrast, we classified interventions as being principally patient education if the purpose was to increase asthma knowledge or improve inhaler technique without emphasizing patient decision making or changing behavior. We recognize that these are somewhat artificial distinctions and that many interventions included components of both.

We found 69 studies evaluating self-monitoring, self-management, or educational strategies for children with asthma or their caregivers.

- Of the self-monitoring, self-management, or patient education interventions for children with asthma or their caregivers, 43/69 (62%) specifically described an underlying conceptual framework or theoretical background as the basis for the intervention. Typically, these interventions relied less on lecture-based or pamphlet-based teaching methods and more on combination educational modalities that including role-playing, videos, and games to reinforce patient learning. In univariate analyses, these studies tended to be more likely to report statistically significant improvements in emergency department visits (36 studies reported both frequency of emergency department visits and described a theoretical framework for the intervention design; p=0.01).

- Twenty-one studies included educational interventions directed at parents or caregivers—13/21 (62%) of which found statistically significant improvements in processes and outcomes of care for children with asthma. We found that among all studies of pediatric asthma evaluating self-monitoring, self-management, or patient education interventions, those directed at parents or caregivers were the most likely to be associated with a statistically significant improvement in clinical outcomes such as improvements in asthma symptoms or spirometric measures (p=0.02). The educational interventions directed at young children that did not include parental involvement did not consistently find statistically significant improvements in the processes or outcomes of care for the asthmatic patients.

- None of the six patient education interventions that exclusively targeted adolescents resulted in statistically significant improvements in medication use, asthma symptoms control, or health services utilization. This included studies that relied on peer teachers or intensive educational programs from physicians or nurse educators.

- Twenty-seven self-monitoring, self-management, or patient education studies reported the mean (or median) days lost from school. The weighted mean difference in days absent between intervention and control groups was -0.11 days/month (95% CI: -0.17, -0.05; p=0.0004); however, the studies included in this analysis were highly statistically heterogeneous. The longer the intervention duration, the greater the observed reduction in asthma-related school absenteeism (p<0.0001).

- The use of video games or Web-based programs as educational or self-monitoring or self-management tools for children with asthma (eight studies) was not associated consistently with statistically significant improvements in outcomes or processes of care for children with asthma.

We identified 78 studies of self-monitoring, self-management, or patient education interventions for general populations or adults with asthma.

- Of these, 17 reported change in percent predicted FEV_1 from which we were able to calculate individual study and a summary standardized mean difference (between intervention and control subjects at the end of the study). These studies were statistically homogeneous and produced a weighted mean difference of 2.92 percent predicted FEV_1

(95% CI: 0.92, 4.92) favoring the intervention groups (p=0.004). The more recent the year of publication, the greater the likelihood of finding improvements in percent predicted FEV_1 (p=0.004).

- Sixteen studies reported mean peak flow at the end of the study period. The weighted mean difference from these 16 (statistically heterogeneous) was 27.95 L/min (95% CI: 10.75, 45.15) favoring the intervention groups (p=0.01).

- The use of combinations of educational techniques including individualized interactions, group interactions, role-playing, and distribution of printed materials was associated with greater improvements in outcomes than the use of single educational techniques.

- The longest interventions were more likely to report a statistically significant reduction in emergency department visits (p=0.02).

- We did not find that the frequency of patient interactions with the provider of the educational intervention was a key factor in producing improvements for patients.

Provider Education. We found seven articles reporting interventions designed to provide training for clinicians caring for children with asthma (typically these programs reviewed asthma diagnosis and management guidelines)—all of which found statistically significant reductions in patients' use of medications (several also reported reductions in asthma symptoms and emergency department visits). We found eleven additional articles reporting on interventions with some component of provider education for adult patients with asthma—55% of these reported that providers receiving the education improved adherence to asthma management guidelines (most often, providing written asthma management plans and increasing the rate of prescription of inhaled corticosteroids). However, only 27% reported improvements in health services utilization and only 9% reported improvements in clinical outcomes. The heterogeneity among the provider education interventions limited our ability to determine which components led to the greatest benefit for patients with asthma.

Organizational Change. We found 13 studies of organizational change strategies designed specifically to benefit children with asthma.

- These studies were relatively heterogeneous and not as likely as other types of QI interventions included in this review to report improvements in outcomes for patients: three (23%) reported improvements in clinical outcomes, three (23%) reported improvements in health services utilization, and three (23%) reported improvements in functional status. The other four studies (31%) reported no improvements for patients with asthma.

- Two of the included studies evaluated the use of directly observed therapy for children with asthma (usually by a school nurse). Both studies found that far more children in the intervention groups received their inhaled corticosteroids than those who received their medications at home.

We found 14 studies of organizational change strategies for general populations or adults with asthma.

- In contrast to the organizational change interventions for children with asthma, these 14 studies reported considerably more improvements in outcomes for patients. The organizational change interventions for general populations or adults were more likely to augment providers' roles (e.g., adding a teaching role to pharmacists already providing routine pharmacy care for patients) or augment the types of providers encountered while receiving "usual care" (e.g., by adding multidisciplinary teams to routine clinical practice). This is in contrast to the addition of specialty care clinics where patients receive care that is distinctly separate from their routine health care encounters (these specialty clinics were more common for children).

- 11 of the 12 organizational change interventions that combined self-monitoring, self-management or patient education with organizational changes (such as adding pharmacists to multidisciplinary teams) resulted in improvements in the processes and outcomes of care for adults with asthma.

Other QI Interventions. We found five studies describing **audit and feedback interventions**, four articles describing **provider reminders**, five interventions that utilized the **facilitated relay of clinical data** for the improvement of care for children with asthma, and two articles that included **financial incentives** to improve care for patients with asthma. The small number of studies of these types of QI interventions limited our ability to evaluate their effectiveness for improving asthma care, but are described individually in this report.

Costs. Twenty-three studies reported cost data associated with QI interventions for children (13 studies) and for general populations or adults with asthma (ten studies).

- Nine studies described the costs associated with intervention implementation: two of these found that there was no statistically significant difference between intervention and control program direct costs. The other seven studies uniformly found that intervention program costs were higher than control program costs.

- Among the interventions for children with asthma, seven reported asthma-related healthcare cost data, five of which reported reduced costs among the intervention groups relative to control groups. Among the interventions for general populations or adults with asthma, four presented asthma-related healthcare costs, two of which found cost savings among the intervention groups.

Quality of Life. Forty-five of the included studies reported QOL data.

- They utilized a variety of both generic measures such as the SF-36 and disease-specific measures such as the Asthma Quality of Life Questionnaire and the St. George's Respiratory Questionnaire, among others.

- Thirteen of 31 (42%) of the interventions aimed at general populations or adult patients resulted in statistically significant improvement in QOL compared to controls, whereas only nine of 12 (25%) of the interventions aimed at children produced a similar result. The other studies reported no difference between control and intervention groups in terms of QOL. Overall, the pediatric QI interventions reported little effect on parent or caregiver quality of life.

- We found that improvements in QOL and clinical status ($p=0.02$) were correlated, as were improvements in QOL and functional status ($p=0.04$).

Tobacco Smoke Exposure. Twelve studies reported either post-intervention tobacco exposure rates or reported whether there was a difference at the end of the intervention between intervention and control subjects.

- The reported rate of tobacco exposure among children with asthma of lower socioeconomic groups was higher than that of higher socioeconomic groups.

- None of the included interventions resulted in statistically significant reductions in tobacco use among patients with asthma or their family members (however, only some of these interventions were designed specifically to reduce tobacco smoke exposure).

- Preliminary evidence suggests that patients with asthma not exposed to tobacco smoke may benefit to a somewhat greater extent from QI interventions than those exposed to smoke.

Summary Answers to the Key Questions

Research Question 1: What is the evidence that QI strategies improve the processes and outcomes of outpatient care for pediatric and adult populations with asthma?

- The QI interventions with the richest evidence base are those that employ self-monitoring, self-management, or patient education strategies. Specifically, for young children—even those from lower socioeconomic groups—educational strategies targeting their caregivers or parents can contribute to statistically significant reductions in asthma symptoms. For general populations or adults with asthma, numerous educational strategies were associated with improvements for patients—however, those that include a component of organizational change (e.g., adding a pharmacist to the team caring for the patient) were consistently found to improve patient outcomes.

- Interventions that are based on a theoretical framework, use multiple educational sessions, have longer durations, and use combinations of instructional modalities (e.g., small group teaching with role-playing and handouts) are more likely to result in improvements for patients than interventions lacking these characteristics.

- Provider education strategies directed at clinicians caring for children with asthma have resulted in improvements in medication use and adherence to practice guidelines.

- We found no evidence that the types of QI strategies reviewed in this report are consistently associated with improvements in the processes or outcomes of care for adolescents. Nor did we find that the QI interventions resulted in statistically significant reductions in tobacco smoke exposure, although this was not the primary objective of the included studies.

- The use of school personnel to administer directly observed therapy has been shown to increase the rate of inhaled corticosteroid use and reductions in health services utilization among school children with asthma, particularly in those who are not exposed to second hand smoke.

- We did not find that a particular setting (or combination of settings) of the QI intervention consistently predicted its effectiveness. We did not have sufficient evidence to assess the differential benefit of asthma QI strategies in urban vs. rural groups or among groups of differing socioeconomic status.

Research Question 2: Are QI interventions for asthma care that incorporate multiple strategies more effective than those that employ a single strategy?

The majority of the included articles evaluated a single QI strategy. However, 75 studies evaluated QI interventions with two or more QI strategies (e.g., interventions that combined both patient education and organizational change), 21 studies evaluated QI interventions with more than two QI strategies. We found that the greater the number of QI strategies, the more likely a study was to report improvements in clinical status ($p=0.009$).

Discussion

Our review had several key findings.

- Most of the QI interventions in this evidence report were designed to achieve a change in behavior. Thus, we reasoned that interventions specifically designed to comport with the principles of effective behavior change would be more likely to produce improved outcomes for patients. Even among the included studies that "described" a theoretical foundation for the design of their intervention (44% overall), many provided very scant information about the rationale for the specific design characteristics of the intervention. For the QI interventions for which we found large numbers of articles (namely, self-monitoring, self-management, or patient education), we found that those studies that described a theoretical framework were more likely to report statistically significant improvements in some outcomes. Given the robust literature on intervention characteristics associated with durable behavior change, future QI interventions for

improving asthma care should strive to incorporate those characteristics with a history of effectiveness in similar situations.

- Children, particularly the very young, are unlikely to have either adequate asthma knowledge or the capacity to take disease modifying actions without considerable assistance from their caregivers. We found that the interventions directed at children that did not also include parental involvement were less effective, suggesting that parallel educational activities, focusing on parents as well as their children, may be needed.

- The use of school personnel to administer directly-observed therapy increased the rate of inhaled corticosteroid use and decrease health services utilization among school children with asthma, particularly those who are not exposed to second-hand smoke.

- For general populations or adults with asthma, educational interventions, particularly those that used combinations of educational modalities and that provided multiple educational sessions over longer durations, were associated with statistically significant improvements in spirometry and days lost from work. However, the clinical significance of these improvements is modest.

- We found that the greater the number of QI strategies, the more likely a study was to report improvements in clinical outcomes. In particular, we found that patient and provider education interventions that also included an element of organizational change (for example, by adding pharmacists to the clinical team or by instituting an information system that facilitates reporting of clinical information between patients and providers) were often associated with improvements in outcomes for patients.

- We found high rates of tobacco exposure among both adults and children with asthma—particularly in lower socioeconomic groups. While the rates of smoke exposure did not change as a result of the QI interventions, some subgroup analyses suggested that improvement resulting from the QI strategy were more likely to occur in the groups not exposed to tobacco smoke. Given the association between smoke exposure and socioeconomic status, it is not clear whether the smoke exposure or other factors associated with patient demographics contributed to this trend.

Future Research

- None of the six studies of educational interventions that specifically targeted adolescents with asthma, even those that relied on peer teachers or intensive educational programs from physicians or nurse educators, resulted in statistically significant durable improvements in medication use, asthma symptoms control, or health services utilization. However, positive effects were seen in studies that included (but did not specifically target) adolescents. Clearly, identification of interventions that result in effective behavior change for this vulnerable population requires further investigation.

- Many types of QI interventions have not been adequately studied (e.g., audit and feedback, provider reminders, facilitated relay). Since some of the studies showed promising results, interventions of these types should be studied in rigorously designed clinical trials.

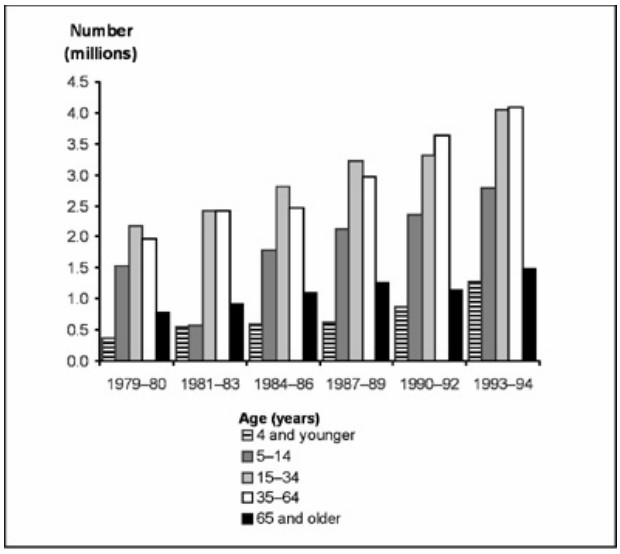
- Relatively few of the included studies reported on the costs associated with their interventions. Thus, the extent to which expenditures change with QI interventions for asthma has not been well documented. A critical gap in this literature that prevents an understanding of the cost-effectiveness of QI programs is that there is not a common effectiveness variable such as symptom-free days gained or episode-free days gained. Also, since many studies only include the costs and benefits accrued during the first year after an intervention, it is difficult to estimate the long-term cost-effectiveness of these programs. Given the enormity of the costs associated with asthma care, these are critically important areas for future research.

TECHNICAL REVIEW

Chapter 1. Introduction

Asthma[*1, 2] is one of the most common chronic medical conditions in the U.S. It affects 16 million adults and 6.1 million children and results in two million visits to emergency departments, 70,000 hospitalizations, and 5,000 deaths annually.[3] Children aged 5 to 17 years have the highest prevalence of asthma among all age groups in the U.S. (Figure 1). Among children with chronic medical conditions, asthma is the most common reason for hospitalization and school absence.[4] The burden of asthma disproportionately affects patients of lower socioeconomic status: they are more likely to be limited by asthma symptoms, to use an emergency department as their usual source of care, and to be hospitalized for asthma care.[3, 5-7] Asthma has serious economic consequences: in 1994, slightly more than half of the estimated $10.7 billion in asthma-related costs were for direct costs, while the rest were indirect costs, including those associated with caregiver costs, travel and waiting time, and premature death.[6] The Pew Environmental Health Commission estimated that totals costs associated with asthma care could increase to $18 billion by 2020.[7]

Figure 1. U.S. asthma prevalence



Source: CDC, NCHS. Surveillance for Asthma—United States, 1960–1995. *Morbidity and Mortality Weekly Report* 47(SS-1);1-28, 1998.

In an effort to reduce the burden of asthma on patients, their families, and the U.S. healthcare system, the National Asthma Education and Prevention Program of the National Heart, Lung, and Blood Institute (NHLBI) has published comprehensive guidelines for diagnosis and management of asthma.[8, 9] Because asthma can neither be prevented nor cured, current management objectives are to monitor symptoms and objective measures of lung function, to encourage the use of medications that control and prevent symptoms with the fewest adverse effects possible, to control the triggers of asthma symptoms to which a patient is sensitive (such as house dust mite, tobacco smoke, animal dander, and pollens), and to educate the patient and provider for a partnership in asthma care.[6, 10-12] Specifically, the reduction of airway inflammation and asthma symptom control is based largely on the use of inhaled corticosteroids,

[*] *Historical note:* References to asthma symptoms have been found in the *Nei Ching*, a Chinese medicine text written between 2500 and 1000 BC and in the *Ebers Papyrus*, an Egyptian medical reference from around 1550 BC. The word asthma is derived from the Greek verb *aazein*, meaning to exhale with open mouth, to pant, to take a "sharp breath." The word first appears in Homer's *Iliad* and Hippocrates first used the word to describe the medical condition. Hippocrates wrote that asthma symptoms were more likely to occur in tailors, anglers, and metalworkers. Six centuries later, Galen was the first to describe it clinically and noted that it was caused by partial or complete bronchial obstruction. Moses Maimonides, a prominent medieval philosopher and physician, wrote a treatise on asthma diagnosis, prevention, and treatment. In the 17th century, Bernardino Ramazzini recognized an association between asthma and organic dust. The use of bronchodilators started in 1901, but it was not until the 1960s that the inflammatory component of asthma was recognized and anti-inflammatories were added to treatment regimens.

inhaled long-acting β-agonists, and leukotriene pathway inhibitors. Breakthrough asthma symptoms are treated with inhaled bronchodilators, which relax bronchial smooth muscle.[9] In general, inhaled corticosteroids, leukotriene receptor antagonists, cromolyn, sustained release theophylline, and long acting inhaled β-agonists combined with inhaled corticosteroids are used to prevent daily symptoms and recurring exacerbations. Short-acting inhaled β-agonists, and, if necessary, oral corticosteroids are used as needed to treat symptoms and exacerbations when they occur. Effective asthma management has been demonstrated to reduce symptoms, hospitalizations, and urgent care visits.[6, 7]

The Quality Gap

Despite the availability of evidence-based guidelines for the management of pediatric and adult asthma, there remains a significant gap between accepted best practices for asthma care and actual care delivered to asthma patients in the U.S.[7, 8] For example, although the National Committee for Quality Assurance has found that more patients with asthma are prescribed appropriate asthma mediations in recent years (71% in 2003 versus 63% in 2000),[13] many patients with asthma and their caregivers do not use preventive medications or know how to prevent and treat asthma attacks.[7] Diette and colleagues evaluated the rate of adherence of asthma care with the National Asthma Education and Prevention Program Guidelines for 318 pediatric patients.[14] They found that 55% of patients used long-term controller medications daily, 49% had written instructions for handling asthma attacks, 44% had instructions for adjustment of medication before exposures, 56% had undergone allergy testing, and 54% had undergone pulmonary function testing.[14] Other research has shown similarly poor guideline adherence among adults with asthma.[15, 16] Even simple preventive measures are often neglected for asthma patients: patients with asthma are at high risk of developing complications after influenza-related illness, yet only one-third of adults and one-fifth of adults younger than 50 years with asthma receive the flu vaccine annually.[17]

A RAND report, "*Improving Childhood Asthma Outcomes in the United States: A Blueprint for Policy Action*" describes three primary barriers to effective management of asthma: the complexity of asthma care (i.e., it requires an understanding of the variety of symptoms, triggers, and use of multiple medications by clinicians, patients, and caregivers); the costliness of asthma care (e.g., patients may not have health insurance or other means to pay for preventive services and medications; schools may lack the resources to provide comprehensive asthma prevention and treatment services); and the lack of comprehensive strategies to improve asthma prevention in health care settings and the community.[7]

Given the prevalence of asthma, its considerable economic effects, the demonstrated gaps between high-quality care and demonstrated practice, and the disproportionate effect of poor care on lower socioeconomic populations, the Institute of Medicine (IOM) has designated quality improvement in asthma care as a priority area.[18] Specifically, the IOM report notes that persons with mild/moderate persistent asthma often do not receive appropriate treatment.[18] The objective of this Report is to evaluate the evidence that quality improvement (QI) strategies can improve the processes and outcomes of outpatient care for children and adults with asthma.

Key Research Questions

The specific research questions addressed in this review are:

Research Question 1: What is the evidence that QI strategies improve the processes and outcomes of outpatient care for pediatric and adult populations with asthma? Specifically, which QI strategies are effective for improving processes and outcomes of asthma care for specific patient populations (e.g., adults, children, low SES, racial groups, urban/rural)? Also, does the setting of the QI intervention (e.g., home, school, clinic) determine its effectiveness for improving processes and outcomes of asthma care?

Research Question 2: Are QI interventions for asthma care that incorporate multiple strategies more effective than those that employ a single strategy?

Chapter 2. Methods

We sought articles describing evaluations of quality improvement strategies designed to improve the care of patients with asthma. In the sections that follow, we describe the types of QI strategies and study designs that we considered eligible for inclusion in this review.

Types of Quality Improvement Strategies

We defined QI strategies as interventions aimed at reducing the quality gap (the difference between health care processes or outcomes observed in practice and those potentially obtainable on the basis of current professional knowledge) for a group of patients representative of those encountered in routine practice.[19] By modifying several well-established classification systems,[20-23] we developed a taxonomy of nine QI strategies,[19] including patient education, provider education, organizational change, audit and feedback, provider reminders, patient reminders, facilitated relay of clinical data to providers, financial or legislative incentives, and the promotion of self-monitoring or self-management. Table 1 presents the QI strategy definitions used for this report. We direct interested readers to a complete description of the taxonomy of QI strategies and the methods used to develop it.[19]

Table 1. Definitions of the nine quality improvement strategies used in the Closing the Quality Gap series

Strategy	Definition
Provider reminders	Information tied to a specific clinical encounter, provided verbally, in writing, or by computer, that is intended to prompt the clinician to recall information, or to consider performing a specific process of care (e.g., to make medication adjustments or order appropriate screening tests).[19]
Facilitated relay of clinical data to providers	Clinical information collected directly from patients is relayed to the provider in situations where the data are not generally collected during a patient visit, or when collected using a means other than the existing local medical record system (e.g., transmission of a patient's home glucose level).[19]
Audit and feedback	Any summary of a health care provider's clinical performance or an institution's clinical performance that is reported, either publicly or confidentially, to or about the clinician or institution (e.g., the percentage of a provider's patients who have achieved or have not achieved some clinical target).[19]
Provider education	Any intervention that includes one of the following sub-strategies: educational workshops, meetings (e.g., traditional Continuing Medical Education (CME)), and lectures; educational outreach visits (the use of a trained person who meets with providers in their practice settings to disseminate information intended to change the provider's practice); or the distribution of educational materials (published or printed recommendations for clinical care, including clinical practice guidelines, audio-visual materials and electronic publications).[19]

Table 1. Definitions of the nine quality improvement strategies used in the Closing the Quality Gap series (continued)

Strategy	Definition
Patient education	Patient education—for individuals or members of a patient group or community, presented either in person or via the distribution of printed or audio-visual educational materials.[19]
Promotion of self-monitoring or self-management	The distribution of materials (e.g., devices for peak flow self-monitoring) or access to resources that enhances patients' ability to manage their condition, the communication of clinical test data back to the patient, or follow up phone calls from the provider to the patient with recommended adjustments to care.[19]
Patient reminders	Any effort directed toward patients that encourages them to keep appointments or adhere to other aspects of self-care.[19]
Organizational change	Changes in the structure or delivery of care designed to improve the efficiency or breadth and depth of clinical care. These include the use of disease management or case management tactics (coordination of assessment, treatment, and arrangement for referrals by a person or multidisciplinary team in collaboration with or supplementary to the primary care provider); other personnel or team changes; the use of telemedicine (communication and case discussion between distant health care professionals); Total Quality Management (TQM) or Continuous Quality Improvement (CQI) approaches (quality problem cycles of measurement, intervention design, implementation, and re-measurement); and changes to medical records systems or hospital information systems.[19]
Financial, regulatory, or legislative incentives	Interventions with positive or negative financial incentives directed at providers (e.g., "pay for performance" where pay is linked to adherence to some process of care or achievement of some target patient outcome). This strategy also included positive or negative financial incentives directed at patients, system-wide changes in reimbursement (e.g., capitation, prospective payment, or a shift from fee-for-service to salary pay structure), changes to provider licensure requirements, or changes to institutional accreditation requirements.[19]

Inclusion and Exclusion Criteria

We sought English language studies of interventions that included one or more of these nine QI strategies for the outpatient management of children and adults with asthma. We adopted the NHLBI definition of asthma.[8†] Included articles had to evaluate QI interventions in the outpatient setting. We defined outpatient programs broadly (e.g., including school-based programs, self-monitoring or self-management programs, and clinician-based interventions).

Because most health care is delivered in settings where continuous QI efforts are occurring, evaluations of QI strategies that are not randomized or controlled may be subject to confounding from other QI programs ongoing in the facility or region. Thus, included trials had to have one of three types of study designs: randomized controlled trials (RCTs) (including quasi-RCTs which typically allocated patients according to non-random means such as "every other patient"

[†]NHLBI Definition: "Asthma is a chronic inflammatory disorder of the airways in which many cells and cellular elements play a role, in particular, mast cells, eosinophils, T lymphocytes, neutrophils, and epithelial cells. In susceptible individuals, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, and cough, particularly at night and in the early morning. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment. The inflammation also causes an associated increase in the existing bronchial hyperresponsiveness to a variety of stimuli."

was assigned to the intervention or control group), controlled before-after trials, or interrupted time series trials. Given the seasonal nature of asthma in many patients, we required that controlled before-after trials included contemporaneous observation periods for control and intervention groups. We required that articles reporting interrupted time series trials provided data at three or more time points both before and after intervention to facilitate time trend analysis.

Included studies had to report at least one of the four following primary outcomes: measures of *clinical status* (monitoring of medications, symptoms or symptom-free days, peak flow or spirometric measures, number of asthma attacks); measures of *functional status* (days lost from work or school, 6-minute walk times, school grades); measures of *health services utilization* (hospital admissions, ED visits, unscheduled MD visits); or measures of *adherence to guidelines* (e.g., number of patients given prescriptions for inhaled corticosteroids).

Search Strategy

We searched four literature sources: MEDLINE® (1966 to April 2006), the Cochrane Effective Practice and Organisation of Care (EPOC) Group databases (1966 to April 2006), the Cochrane Consumers and Communication Group database (1966 to May 2006), and bibliographies of retrieved articles.

The EPOC databases contain the results of extensive periodic searches of MEDLINE® (from 1966-present), CINAHL® (1982-present), and EMBASE® (1980-present), and hand searches of journals and article bibliographies.[24] These EPOC searches are aimed at identifying studies that attempt to "improve professional practice and the delivery of effective health care services," regardless of clinical topic. The EPOC strategy for identification of studies meeting this definition has a sensitivity of 92.4%.[24] The articles identified by initial EPOC searches are triaged into different registries depending on EPOC's inclusion/exclusion criteria. The main EPOC registry primarily includes studies of provider and system-targeted interventions. To maximize our yield of articles, an EPOC research librarian searched the main registry, other EPOC registries, as well as the larger database of initially identified articles.

Because the EPOC databases are restricted to studies targeting provider and system-based interventions, we also performed separate searches of the Cochrane Consumers and Communication Group database and MEDLINE® to identify articles involving patient education or self-monitoring or self-management. The Cochrane Consumers and Communication Group database includes studies that focus on "consumers' interactions with health care professionals, services and researchers."[25] Our detailed search strategies are presented in Appendix A*.

Data Abstraction and Evaluation

Two independent investigators reviewed the title and abstract of each article found in our search to determine if the article met inclusion criteria (Appendix B*). All disagreements were resolved by repeated review and discussion. Articles requiring full text review were abstracted by a single investigator and then all abstracted data were verified by a second abstracter.

* Appendixes cited in this report are provided electronically at http://www.ahrq.gov/clinic/tp/asthmagaptp.htm

Throughout the abstraction process, the investigators engaged in an active dialog about specific articles and reviewed questions regarding data abstraction to maintain a consensus approach among abstractors.

From each of the included studies we abstracted data about the study design, participants, detailed descriptions of the QI intervention, and the reported outcomes. In addition to the primary outcomes, we also abstracted data about the following secondary outcomes: cost of the QI strategy implementation; patient or provider satisfaction; quality of life (QOL) outcomes (for either patients with asthma or their caregivers); and reduction in environmental allergens (e.g., tobacco, pets/dander, cockroach antigen). The complete full-text abstraction form is provided in Appendix B[*].

Multiple articles describing the same population were included only once in our analyses.

Statistical Analysis

Univariate Analyses

We used exploratory univariate analyses to identify the patient, intervention, and study design characteristics associated with the four primary outcomes of interest (clinical status, functional status, health services utilization, and adherence to guidelines). Because we make multiple comparisons, we recommend rejecting the null hypothesis for p values$\leq$0.0125 ($0.05 \div 4 = 0.0125$)—we provide p values and 95% confidence intervals when possible.

We sought evidence of publication bias by evaluating the association between the sample size of a study and the likelihood of that study reporting statistically significant outcomes by visual inspection of funnel plots and calculation of unweighted correlation coefficients between sample size and the likelihood of reporting statistically significant outcomes.

For each type of intervention evaluated in a particular population (e.g., patient education strategies for children) for which 15 or more studies presented data on the same specific outcome (e.g., school absenteeism), we calculated both weighted mean differences and standardized mean differences between intervention and control groups at the end of the trial using a random effects model. We only performed this calculation for outcomes of 15 or more because the purpose of these analyses was to evaluate the predictors of these outcomes and needed to have at least 15 observations to have the statistical power to find such an effect. We performed these calculations using RevMan software version 4.2.8.[26] To be included in a weighted mean difference or standardized mean difference calculation, studies must report an estimate of variance—if the included studies did not report an estimate of variance, we used a mean variance from the other studies reporting that outcome.

The weighted mean difference has the same units as the outcome of interest; thus, it is relatively easy to interpret. However, the standardized mean difference, which is unitless and therefore somewhat less readily interpretable, is less subject to bias. We present both effect sizes in the text. However, we used the more stable standardized mean difference as the dependent variable in our regression analyses seeking the association between study and intervention design

[*] Appendixes cited in this report are provided electronically at http://www.ahrq.gov/clinic/tp/asthmagaptp.htm

characteristics and changes in the outcomes of interest (see below, in the section on multivariate analyses, for additional details on those analyses).

To minimize heterogeneity, we only synthesized those studies describing similar interventions in similar populations. We performed formal assessments of heterogeneity for our summary weighted mean differences and present the Chi^2 statistic for heterogeneity. Additionally, we calculated the I^2 statistic measuring the extent of inconsistency among the studies' results—which is interpreted as the approximate proportion of total variation in study estimates that is due to heterogeneity rather than sampling error.[26] I^2 statistics in excess of 50% are considered heterogeneous.

Multivariate Analyses

For those types of intervention for which we found 15 or more studies reporting on the same outcome, we performed multivariate analyses to evaluate the association between study design characteristics (e.g., duration of the study, whether the study specified the use of an underlying theoretical or conceptual framework) and intervention characteristics (e.g., the setting of the intervention, whether there were multiple QI strategies utilized) and the four primary outcomes of interest (i.e., clinical status, functional status, health services utilization, and adherence to guidelines). For these analyses, we used the standardized mean difference in the outcome of interest as the dependent variable in a weighted least squares regression (weighted by the study sample size).

For those types of interventions for which no specific outcomes were reported by 15 or more studies, we performed logistic regression to evaluate the association between study design and intervention characteristics and the reporting of statistically significant improvements in each of the four primary outcomes of interest.

Peer Review Process

A draft of this Evidence Report was sent to a panel of 15 experts in quality improvement, patient education, and asthma (Appendix D*). Their comments were incorporated into the final Report.

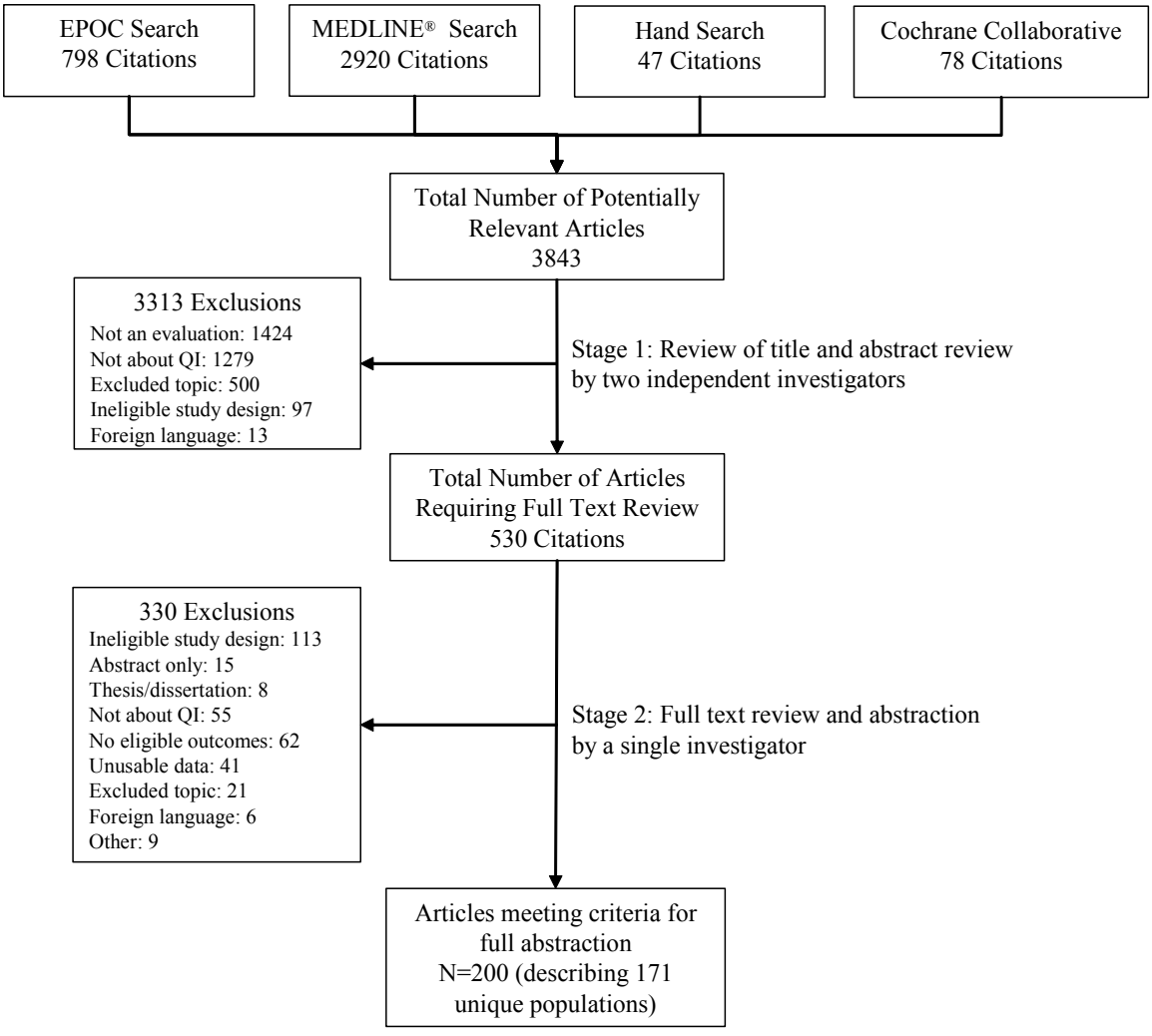
* Appendixes cited in this report are provided electronically at http://www.ahrq.gov/clinic/tp/asthmagaptp.htm

Chapter 3. Results

Results of Literature Search and Article Review Process

Figure 2 presents the results of our search strategy and article review process. Our searches yielded 3843 potentially relevant articles of which 530 articles merited full-text review. A total of 200 articles reporting on 171 unique populations met our inclusion criteria. Appendix C* provides the citations of articles excluded after the full text review, along with the reason for exclusion.

Figure 2. Search results



* Appendixes cited in this report are provided electronically at http://www.ahrq.gov/clinic/tp/asthmagaptp.htm

Summary of Included Studies

General Characteristics of Included Studies

The 171 included studies were highly heterogeneous with respect to study design, the types of QI strategies evaluated, the populations of interest, and types of outcomes reported. In this section, we describe these characteristics (Table 2).

Table 2. Design attributes of the included studies

Design Attribute	Number of studies reporting this attribute/Total number eligible to have this attribute
All studies (n=171)	
If the unit of analysis differed from the unit of treatment allocation (i.e., the trial was "clustered" by provider or clinic) the authors acknowledged this issue or made appropriate adjustments	14/30
Reported obtaining informed consent	107/171
Described basing the intervention design on a theoretic or empiric foundation	76/171
Controlled Before-After Trials (n=32)	
It was specifically reported that measurements in the control group were performed at the same time in the intervention group	30/32
The criteria used for selecting control sites were explained	31/32
The control site was comparable to the experimental site in terms of patient and provider characteristics	30/32

Study Design. Of the included articles, 134 (78%) were RCTs, five (3%) were quasi-RCTs and 32 (19%) were controlled before-after trials. Of these, 35 (21%) studies compared two or more interventions without a control group that did not also receive a QI intervention. (Studies of this design all evaluated either self-monitoring, self-management, or patient education interventions.)

RCTs were much less likely to report statistically significant improvements in the processes and outcomes of care for patients with asthma than were studies of other designs (Table 3).

Table 3. Association of study design and patient outcomes

Study Design	Number of Studies	Reported improvements in clinical status	Reported improvements in guideline adherence	Reported improvements in functional status	Reported improvements in health services utilization
Controlled before-after trial	32	15 (47%)	16 (50%)	2 (6%)	8(25%)
RCT	134	44 (33%)	32 (24%)	19 (14%)	23 (17%)
Quasi-RCT	5	4 (80%)	1 (20%)	1 (20%)	4 (80%)
p value*	-	0.04	0.012	0.4	0.002

*Chi squared test of study design × improvement in each type of outcome. We note that not all of the studies were designed to evaluate all types of outcomes.

Sample Size. The median sample size was 109 (Interquartile range: 54, 205). Many of the included studies were small: 78 (46%) had total sample sizes of 100 subjects or less (Table 4).

We did not find an association between sample size and the likelihood that a study reported statistically significant outcomes (Table 4).

When interpreting the results of the included studies, it is important to consider that few presented power calculations and those that did were often underpowered to find small effects. This may be particularly relevant for interventions directed at patients with mild asthma where the outcomes of interest are relatively rare events such as annual hospitalizations. Additionally, many of the included studies evaluated numerous outcomes and did not make adjustments for multiple comparisons. Because nearly all of the included studies used the sample size that completed the intervention or follow up period in their calculations of effect size (i.e., did not perform intention-to-treat analysis), in the evidence tables, we report the number of subjects in the intervention and control groups at the end of the trial. For those few studies that did perform an intention-to-treat analysis, we present the sample size at the time of randomization or treatment allocation.

Table 4. Association of sample size and patient outcomes

Sample Size	Number of Studies[§]	Reported improvements in clinical status	Reported improvements in guideline adherence	Reported improvements in functional status	Reported improvements in health services utilization
Up to 100 subjects	78	28 (36%)	24 (31%)	7 (9%)	16 (21%)
More than 100 subject	86	34 (40%)	23 (27%)	15 (17%)	17 (20%)
Odds Ratio[*] (95% CI)	-	0.8 (0.4, 1.5)	0.8 (0.4, 1.6)	2.1 (0.82,5.6)	1.0 (0.4,2.1)

[*] Mantel-Haenszel Odds Ratio between the smaller and larger studies; [§]7 studies did not report sample size. We note that not all of the studies were designed to evaluate all types of outcomes.

Intervention Characteristics. Articles often did not report detailed information about the interventions. For example, for educational interventions, we were interested in key aspects of the interventions such as the teaching modalities used, number of sessions subjects received, number of students in the "small groups," the specific content of the curriculum, the training of the instructor, etc. However, the included articles often presented at most a few sentences describing the intervention. In the evidence tables in the sections that follow, we present the abstracted information on each included study and for those studies with detailed intervention descriptions, we noted this.

From each of the included articles, we abstracted whether the investigators cited previous literature or a theoretical framework to describe the evidence base for their proposed intervention. The included articles often provided scant information about whether the design of the QI intervention had a theoretical basis (e.g., the mechanism by which the chosen intervention might influence individual behavior or organizational culture and structure). In other words, numerous studies provided little or no answer to the question of why a particular QI strategy was selected to address a given problem. Only 76 (44%) of the included studies in our report specifically described a theoretical framework for their intervention. When we consider all of the included studies (combining across all types of QI strategies), we did not find that the studies reporting a theoretical framework were more likely to find improvements in outcomes for patients with asthma (Table 5).

Table 5. Association of specifying a theoretical framework and patient outcomes

Theoretical Framework Specified	Number of Studies	Reported improvements in clinical status	Reported improvements in guideline adherence	Reported improvements in functional status	Reported improvements in health services utilization
Yes	62	26 (42%)	25 (40%)	14 (22%)	20 (32%)
No	87	37 (43%)	24 (28%)	8 (9%)	15 (17%)
Odds Ratio* (95% CI)		0.8 (0.4, 1.5)	1.5 (0.75, 2.8)	2.5 (0.97,6.2)	1.9 (0.90,4.0)

* Mantel-Haenszel Odds Ratio. We note that not all of the studies were designed to evaluate all types of outcomes.

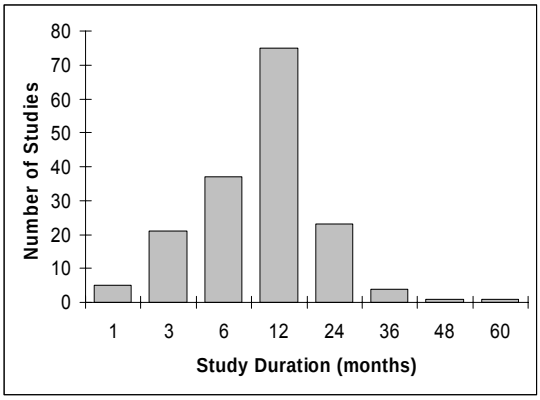
Subject Characteristics. Studies varied with respect to their target populations of interest. For example, 79 studies targeted children exclusively, whereas 92 studies targeted general asthma populations that included primarily adults. Throughout this report, we present the interventions designed specifically for children separately from those that were for general, primarily adult, populations. Six of the 79 studies exclusively enrolled adolescents—they differed in terms of their definitions of adolescents (e.g., 12 to 16 years old). In 20 studies, providers (i.e., physicians, nurses, or pharmacists) were the target of the intervention (typically, provider education or provider reminder interventions). The other interventions were primarily directed at patients with asthma or their caregivers.

We were interested in abstracting data for subjects' baseline asthma severity (as measured by number of medications, number of annual physician and emergency department visits, and spirometric values); however, these data were reported sufficiently infrequently and in highly heterogeneous manner. To the extent possible, we present asthma severity information on each of the included articles in the evidence tables.

The included articles studied asthma patients from around the world: 73 were from the U.S., 27 from the U.K., 11 from Australia, 11 from Canada, eight from the Netherlands, five from Sweden, 23 from elsewhere in Europe, four from South America, and three from India, among others. In the evidence tables, we describe the location where the intervention took place.

QI Intervention Characteristics. The interventions occurred between 1976 and 2004 and ranged in length from 4 weeks to 5 years (median: 12 months) (Figure 3). For those studies that reported data at multiple post-intervention intervals, we abstracted data from the longest period of follow up.

Figure 3. Intervention duration



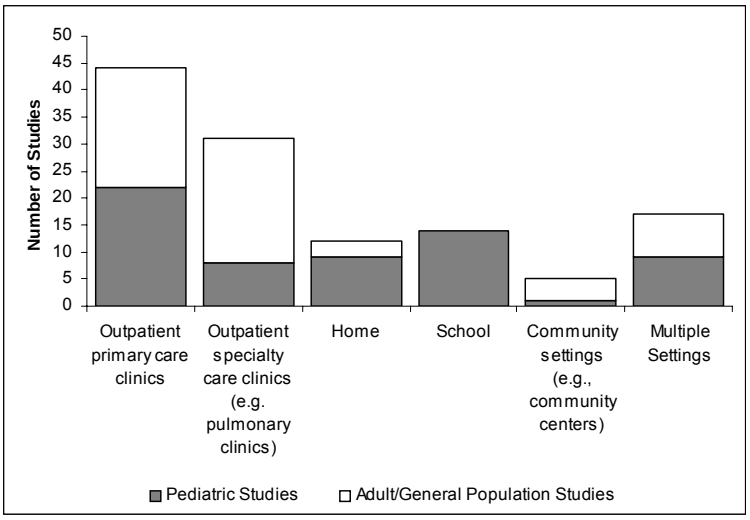
Intervention duration. We found that studies with longer interventions were more likely to report improvements in health services utilization (p=0.011) (Table 6). This may be because visits to the emergency department or urgent care or hospitalizations are relatively rare events (especially among patients with less severe asthma) and reductions in these events accrue only over longer follow up periods. We did not find that longer interventions were associated with improvements in clinical status or other outcomes of interest. This may be in part due to some initial effects of the intervention waning with longer follow up periods.

Table 6. Association of study duration and patient outcomes

Duration (months)	Number of Studies*	Reported improvements in clinical status	Reported improvements in guideline adherence	Reported improvements in functional status	Reported improvements in health services utilization
0-5	33	12 (36%)	12 (36%)	3 (9%)	3 (9%)
6-10	43	16 (37%)	11 (26%)	6 (14%)	5 (12%)
12-60	92	35 (38%)	26 (28%)	13 (14%)	27 (29%)§

*Note: 3 studies did not report their duration of follow up. §Chi squared test, p=0.011. We note that not all of the studies were designed to evaluate all types of outcomes.

Figure 4. Intervention Settings



Intervention settings. The interventions took place in various settings including outpatient clinics, home, and school (Figure 4). Most of the interventions in schools and patients' homes were directed at children with asthma or their parents or caregivers.

Types of QI strategies. Table 7 presents the distribution of type of QI strategies implemented in the included articles. Most of the included articles described self-monitoring, self-management, or patient education interventions. None of the included articles described patient reminder systems.

Table 7. Distribution of included studies by type of QI strategy

QI Strategy	Pediatric Studies*	General Population or Adult Studies	Total
Self-monitoring or self-management	35	59	94
Patient or caregiver education	54	46	100
Provider education	7	11	18
Organizational change	13	14	27
Audit and feedback	0	5	5
Provider reminders	1	3	4
Patient reminders	0	0	0
Facilitated relay of clinical data to providers	3	2	5
Financial, regulatory, or legislative incentives	1	1	2

*Note: The pediatric studies described here included only children. The general population or adult studies typically included adults only; however, some of these were of general populations of patients with asthma that included both children and adults.

Combinations of QI strategies. Most of the included articles evaluated a single QI strategy. However, 75 studies evaluated QI interventions with two or more QI strategies (e.g.,

interventions that combined both patient education and organizational change) (Table 8). We found 21 studies of interventions of more than two QI strategies. Among those interventions with more than one QI strategy, the most common was the combination of self-monitoring, self-management, and patient education. We note that these are overlapping educational classifications and can be considered a single, broad-based educational strategy. For those interventions including other strategies, organizational change was the next mostly likely to be included (e.g., self-monitoring, self-management, or patient education with organizational change). We found that the greater the number of QI strategies, the more likely a study was to report improvements in clinical status (p=0.009) (but not the other primary outcomes of interest) (Table 8).

Table 8. Association of combinations of QI strategies and patient outcomes

Number of QI Strategies in the Intervention	Number of Studies	Reported improvements in clinical status	Reported improvements in guideline adherence	Reported improvements in functional status	Reported improvements in health services utilization
1	96	28 (29%)	27 (28%)	12 (13%)	19 (20%)
2	54	22 (41%)	18 (33%)	6 (11%)	11 (20%)
3	17	9 (53%)	4 (24%)	3 (18%)	4 (24%)
4	4	4 (100%)	-	1 (25%)	1 (25%)
p value*	-	0.009	0.5	0.8	0.9

*Chi squared test of number of QI strategies × improvement in each type of outcome. We note that not all of the studies were designed to evaluate all types of outcomes.

Outcomes Evaluated. We abstracted data on four primary outcomes (measures of *clinical status*, measures of *functional status*, measures of *health services utilization*, and measures of *adherence to guidelines)* and three secondary outcomes (health-related quality of life, exposure to environmental triggers such as tobacco smoke, and costs). Table 9 presents the distribution of the types of outcomes commonly reported in the included studies.

Table 9. Number of studies reporting each outcome

Outcomes	Pediatric Studies	Adult Studies
Clinical status measures	54	75
Asthma symptoms	33	44
Symptom-free days	16	10
Amount of medication used or prescribed	23	45
Number of asthma attacks	15	9
Pulmonary function: peak flow, FEV_1, or other spirometric measures	21	42
Functional status measures	39	36
Activity restriction	12	13
Days lost from school/work	33	26
Health services utilization	53	51
ED or urgent care visits	43	35
Hospitalizations	28	39
Office visits	23	14

Table 9. Number of studies reporting each outcome (continued)

Outcomes	Pediatric Studies	Adult Studies
Guideline adherence	44	47
Adherence with peak flow monitoring	14	15
Use of self-monitoring or self-management or action plans	14	16
Inhaler technique	9	16
Appropriate use of asthma medications	12	21
Cost	10	13
Quality of Life	14	31
Tobacco Exposure Reduction	6	6

Assessment for Publication Bias. We sought evidence for potential sources of publication bias. We found no statistically significant association between sample size and the study reporting a positive outcome (p=0.55). This finding was corroborated by visual inspection of the plots of the association of sample size and the likelihood of finding a statistically significant positive outcome (we present these funnel plots in the sections describing those outcomes).

Given the heterogeneity of the included studies, we synthesized data separately from each group of studies that evaluated the same type of QI strategy in the same population. In the sections that follow, we first present the evidence on the effectiveness of each type of QI strategy for children and adults with asthma from those studies that compared an intervention group receiving the QI strategy compared to a control group receiving usual care. We then present the results from those studies that compared more than one intervention group without including a control group that did not receive some QI intervention. Finally, we present the results synthesizing the outcomes across intervention types.

Results by QI Intervention

Self-Monitoring, Self-Management, or Patient Education Interventions

Inadequate asthma knowledge is an important factor in poor asthma management.[27] Asthma patients play a key role in their own care by identifying and reducing exposures to factors that may worsen their asthma and by adjusting medications to prevent asthma exacerbations. The International Consensus Report on the Diagnosis and Treatment of Asthma describes asthma management as having six parts, the first of which is "to educate patients to develop a partnership in asthma management."[28] The purpose of patient education is defined as "a continual process designed to provide the asthma patient and the patient's family with suitable information and training, so that the patient can keep well and adjust treatment according to a medication plan developed with the clinician."[28] Clearly, considerable overlap exists between patient education and self-monitoring or self-management interventions.

For the purposes of this report, we classified interventions as being principally self-monitoring or self-management if the goal of the intervention was to improve the ability of people with asthma or their caregivers to take action to reduce the impact of the disease on their

lives, often through better monitoring of their symptoms and physiologic metrics. In contrast, we classified interventions as being principally patient education if the purpose was to increase asthma knowledge or improve inhaler technique without emphasizing patient decision making or changing behavior. We recognize that these are somewhat artificial distinctions and that many of the interventions include components of both. Accordingly, we present the evidence from self-monitoring, self-management, or patient education interventions in this single section.

We first briefly describe the results of systematic reviews of self-monitoring or self-management interventions. We then present the general characteristics of the self-monitoring, self-management, and patient education interventions encountered in the primary literature. Next, we present the results of the individual self-monitoring, self-management, and patient education intervention studies separately. However, for those studies that include both types of interventions together, we include them in both the self-monitoring, self-management, and patient education presentations. Finally we present the results of our synthesis of these studies—evaluating the components of the self-monitoring, self-management, or patient education interventions most associated with improvement in outcomes for patients with asthma. We first present the evidence from the interventions directed at children with asthma and their caregivers and then present the evidence from the interventions directed at general populations with asthma.

Systematic Reviews of Asthma Self-Monitoring, Self-Management, or Patient Education

There have been numerous systematic reviews of asthma self-monitoring, self-management or patient education—many of which have been methodologically rigorous.[10, 29-45] We direct interested readers to these reviews for detailed descriptions of their results. In general, the results of these systematic reviews highlight the heterogeneity of these literatures, including disparities in the relevant information reported about the interventions and the content and educational approaches evaluated. A common finding was that interventions directed at improving patient knowledge, typically through non-interactive formats (e.g., lecture, video, print) do not necessarily improve health outcomes. In contrast, interventions that focus on improving self-monitoring or self-management skills through behavior change techniques, often result in reductions in health services utilization and asthma symptoms and improve functional status. The authors of the systematic reviews described the common methodological weaknesses in the evidence base: small sample sizes, lack of long-term follow up, and use of interventions without strong theoretical or empirical foundations.

The research question addressed by many of these reviews was whether written action plans improve the outcomes of care for patients with asthma.[10, 29, 30, 34, 35, 40] For example, the 2001 AHRQ funded Evidence Report entitled, "Management of Chronic Asthma"[10] (which was used to inform the recommendations of the 2002 NHLBI asthma guideline) evaluated whether written asthma action plans improve asthma outcomes and, specifically, whether peak flow monitor-based plans are superior to symptom-based plans. They synthesized the evidence from 36 controlled trials of the efficacy of written asthma action plans to improve outcomes for pediatric and adult populations with asthma. The authors found that most study designs were confounded by multiple asthma management interventions—only nine studies with a total of 1501 patients evaluated self-management programs in isolation.[10] Of the five trials comparing a peak flow-based action plan to no action plan, only one found a statistically significant result—a reduction in emergency department visits for the peak flow-based action plan group. None of these five

trials reported any other statistically significant difference in any other measure of clinical status or health services utilization. The authors note that most studies were underpowered to find statistically significant results.[10] They concluded that there was insufficient evidence to demonstrate an association between the use of written asthma action plans and improved asthma outcomes.[10] Moreover, they found that there was insufficient evidence to support the hypothesis that peak flow monitoring-based plans were superior to symptom-based plans.[10]

The 2004 Cochrane review by Toelle and Ram was designed to assess whether the provision of a written individualized management plan increased adherence with self-monitoring or self-management behaviors.[30] Toelle and Ram concluded that there was insufficient evidence to recommend for or against the use of written management plans for asthma. Toelle and Ram commented that the failure to demonstrate any difference in health outcomes between written individualized plan groups and control groups may be because the provision of a written plan does not lead to any change in behavior or that enrollment in a study may lead to similar improvements in both control and intervention groups.[30]

Additionally, although not systematic reviews, the Working Group Reports from the 1998 World Asthma Meeting are notable for providing succinct descriptions of key trials of a variety of self-management and patient education interventions and discussions of important gaps in the literature.[46, 47] In particular, the article by Partridge and colleagues details the list of self-management skills (including self-monitoring) that are widely accepted as required for effective self care and reviews a number of interventions and international efforts to improve patient-provider communication, provider education, and policy-level interventions for asthma care.[47]

In summary, prior systematic reviews found that non-interactive educational interventions were not effective, and that there was insufficient evidence to determine the value of written self-management plans.

To avoid duplicating the work done in prior reviews, we did not evaluate the comparative effectiveness of symptom-based versus peak flow-based self-monitoring or self-management interventions. Instead, our aim was to evaluate specific intervention characteristic (e.g., setting, teaching strategy, intensity of the intervention) and population characteristics (e.g., adolescents, country of residence) associated with improvements in outcomes of care for children and adults with asthma.

General Characteristics of Self-Monitoring, Self-Management, or Patient Education Interventions for Children With Asthma

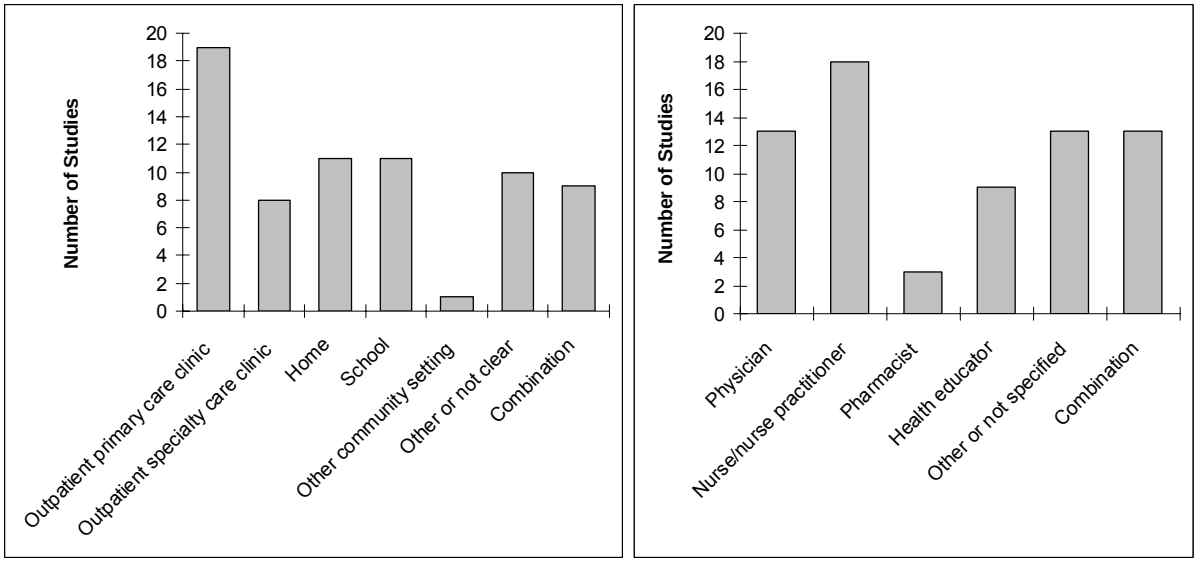
Study Design Characteristics. Among the included articles, 69 had some component of self-monitoring, self-management, or education for children with asthma or their caregivers. The median duration of the follow up period was 12 months (S.D., 5.8 months). The median sample size of these interventions was 90 subjects (Interquartile range: 43, 181). Fifty-nine were RCTs, three were quasi-RCTs, and ten were controlled before-after trials. In univariate analysis, the longest studies were more likely to have the largest number of subjects (p=0.005). Eleven were primarily self-monitoring or self-management, 36 were primarily patient or caregiver education, and 13 included both.

Intervention Characteristics. The included interventions were highly heterogeneous in terms of educational materials provided, setting, frequency and duration of contact with asthma patients and their caregivers, among other key characteristics.

Forty-three (62%) specifically described an underlying conceptual framework or theoretical background as the basis for the intervention. We direct interested readers elsewhere for discussions of the theoretic foundations of asthma educational and self-monitoring or self-management interventions which include theories of empowerment, social ecology, self-regulation, and self-efficacy.[48-50] In univariate analyses, these studies tended to be more likely to report statistically significant improvements in emergency department visits (36 studies reported both emergency department visits and described a conceptual framework; p=0.014) but not the other outcomes of interest.

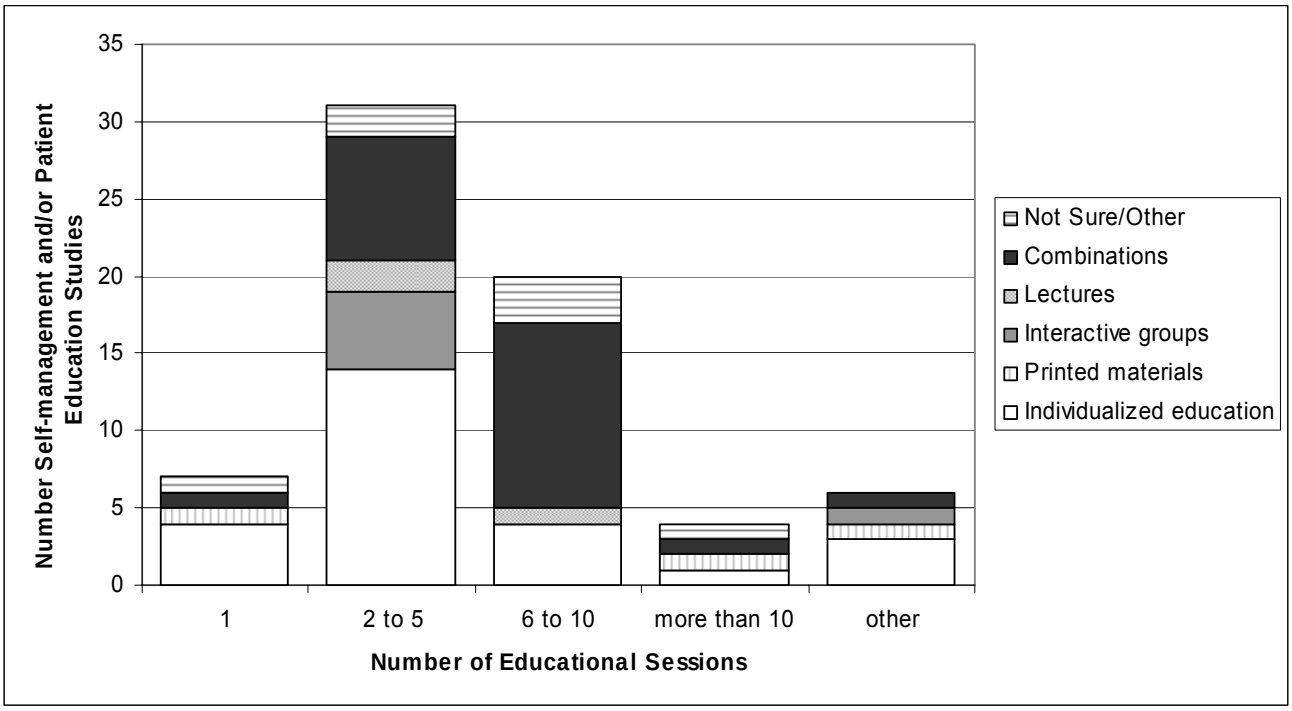
Nineteen of the self-monitoring, self-management, or patient education interventions were performed in outpatient primary care and most were taught by either physicians or nurses/nurse practitioners (Figure 5).

Figure 5. Intervention characteristics: setting and educator type



Thirty-two (46%) of the self-monitoring, self-management, or patient education interventions provided 2 to 5 educational sessions to the children or their caregivers. Twenty-six interventions principally provided individualized instruction, six principally used interactive group teaching sessions, and 23 used combinations of teaching modalities (Figure 6).

Figure 6. Number of educational sessions provided by educational strategy



Eight studies used video games or Web-based programs as educational or self-monitoring or self-management tools for children with asthma.[51-58] For example, "Bronkie's Asthma Adventure" (Click Health, Inc, Mountain View, CA) is a Nintendo®-based game that has been designed to teach children self-monitoring or self-management strategies and provide feedback (in English or Spanish language) on their performance.[58] Similarly, the "Asthma Control" video game features a superhero named "Spacer" whom the player has to lead through six game levels, accumulating points by avoiding both indoor and outdoor triggers/allergens and using controller medications.[54] The use of video games or Web-based teaching modalities was not associated consistently with statistically significant improvements in outcomes or processes of care for children with asthma.

Outcomes Reported. The 69 self-monitoring, self-management, or patient education studies reported on a variety of outcomes. The most frequently reported outcomes were asthma symptoms, days lost from school or work, urgent care or emergency department visits, and hospitalizations due to asthma. Relatively few studies reported on guideline adherence including adherence to self-monitoring or self-management plans. Table 10 presents a summary of the number of studies reporting each of the primary outcomes of interest. Thirty-one studies reported on asthma symptoms; however, these were measured in highly heterogeneous ways (e.g., self reported symptoms from children's diaries, physicians' ratings of asthma symptoms, multiple different asthma symptom questionnaires). Thirty studies reported on days lost from school or work due to asthma. Some authors adjusted days lost from school on the basis of expected seasonal variation in absenteeism, but most reported school days lost in the intervention group compared to the control group.

Table 10. Outcomes reported by the pediatric self-monitoring, self-management, or patient education studies

Outcomes	Number of studies reporting no difference between intervention and control subjects (%)	Number of studies reporting improvement among intervention compared with control subjects* (%)	Number of studies reporting this outcome
Clinical status measures§	21 (44)	27 (56)	48
Asthma symptoms	13 (42)	18 (58)	31
Symptom-free days	8 (57)	6 (43)	14
Amount of medication used or prescribed	12 (67)	6 (33)	18
Number of asthma attacks	9 (69)	4 (31)	13
Pulmonary function from peak flow, FEV_1, or other spirometric measures	13 (65)	7 (35)	20
Functional status measures	21 (62)	13 (38)	34
Activity restriction	5 (50)	5 (50)	10
Days lost from school/work	21 (70)	9 (30)	30
Health services utilization	27 (63)	16 (37)	43
ED or urgent care visits	23 (64)	13 (36)	36
Hospitalizations	19 (83)	4 (17)	23
Office visits	14 (78)	4 (22)	18
Guideline adherence	12 (44)	15 (56)	27
Adherence with PF monitoring	3 (100)	0 (0)	3
Use of self-monitoring or self-management or action plans	7 (64)	4 (36)	11
Inhaler technique	3 (43)	4 (57)	7
Appropriate use of asthma medications	4 (40)	6 (60)	10

*__Note:__ In this table, we present data from all studies of pediatric self-monitoring, self-management, or patient education. These include those in which the intervention subjects were compared to control subjects who typically received "usual care" and the studies which compared two or more groups without a control arm that did not also receive a QI strategy.
§For each of the categories of outcomes highlighted in bold (e.g., clinical status measures, functional status measures), we recorded whether the study reported one or more statistically significant changes between the intervention and control group at the end of the study period in any of the individual metrics associated with that outcome category.

Self-Monitoring or Self-Management Interventions for Children With Asthma

Background. The International Consensus Report on Asthma suggests that peak flows of 80 to 100% of the individual's best are satisfactory and necessitate only routine treatment.[28] Peak flows of 50 to 80% of personal best peak flow should stimulate a treatment change (e.g., increasing bronchodilators or anti-inflammatory medications).[28] Peak flows below 50% of personal best should lead the patient to use their urgent medications (e.g., start oral steroids) and seek medical attention.[28] Most of the self-monitoring or self-management interventions for children with asthma utilize a written, often color-coded plan in which instructions and medications are labeled (green) for routine care, (yellow) for caution/early treatment, and (red) for urgent treatment. The purpose of this section is to present the characteristics of the individual self-monitoring or self-management interventions.

Results. We found 35 interventions designed principally for the improvement of self-monitoring or self-management of asthma symptoms by children with asthma and their caregivers (24 of these studies are presented in Table 11). Nine of the pediatric self-monitoring or self-management studies compared two self-monitoring or self-management interventions without including a control group that did not also receive a self-monitoring or self-management intervention.[55, 56, 59-65] Studies with this design are described in detail in a subsequent section of the report (Table 21).

The studies of pediatric self-monitoring or self-management interventions are notable among all the types of studies synthesized for this report, in two ways. First, many of these studies reported statistically significant improvements in subjects receiving the intervention—specifically, 29 (83%) of the pediatric self-monitoring or self-management studies reported at least one statistically significant outcome for the recipients of the self-monitoring or self-management intervention compared with the control group. We explore the intervention factors associated with improvements in outcomes and processes of care for children with asthma at the end of this section (Table 13 through Table 16).

Second, among the included studies, the reports of self-monitoring or self-management interventions were most likely to have described their efforts to design interventions that were well-grounded in theoretical frameworks such as social learning theory, cognitive development, and behavior change. Twenty-two (63%) of the included pediatric self-monitoring or self-management studies described such a theoretical rationale for either the content of the program or the selection of teaching methods employed.[52-54, 61, 64, 66-81] Typically, these interventions relied less on lecture-based or pamphlet-based teaching methods and utilized multiple educational modalities including role-playing, videotapes, and games to reinforce patient learning.

The 35 interventions were heterogeneous with respect to the specific content and delivery methods of the self-monitoring or self-management program. However, two programs, Open Airways and "Superstuff" are worthy of specific mention because they were the subject of multiple evaluations. Five studies evaluated a school-based self-monitoring or self-management program utilizing multiple educational components called Open Airways.[68-70, 72, 82] This program consists of six 40-60 minute group sessions for inner-city third to fifth graders to increase their ability to care for their asthma on a daily basis. It includes information about asthma pathophysiology, recognizing and responding to asthma symptoms, using asthma medications and deciding about when to seek care, staying active, identifying and controlling asthma triggers, and managing asthma-related school problems. Interactive teaching methods used in Open Airways include group discussions, storytelling, games, and role-playing. Each of these studies found important clinical improvements in asthma outcomes for the participants of this self-monitoring or self-management program (Table 11). The study by Ronchetti and colleagues of children receiving asthma care in 12 Italian centers compared the outcomes of three groups: subjects receiving Open Airways, subjects receiving another self-monitoring or self-management program called Living with Asthma, and control subjects receiving usual care.[72] The content of the Living with Asthma program is similar to Open Airways and it also uses a group format; however, it makes more extensive use of written diaries for developing asthma management skills and does not rely as heavily as Open Airways on encouraging group members to share problems and develop solutions together. One year after enrollment, patients in the Open Airways but not the Living With Asthma groups had fewer emergency treatments for asthma than controls ($p<0.03$).[72]

Three studies reported evaluations of self-monitoring or self-management programs that utilized the "Superstuff" pediatric self-monitoring or self-management kits produced by the American Lung Association (or materials developed from "Superstuff").[66, 83, 84] "Superstuff" kits include a Parent's Magazine containing 29 articles on asthma pathophysiology, triggers, relaxation techniques, and personal control and decision making. The Children's Kit includes riddles about asthma facts, the "Breathe Easy" board game, puzzles and dolls with self-care messages, a comic strip about relaxation exercises, a mystery house for games about discovering allergens, a phone book with advice about when to call the doctor and to record emergency numbers, and assorted asthma-related door signs, posters, stickers, records, and paper cut-outs. In the study by Rakos and colleagues, 20 children with moderate to severe asthma received the "Superstuff" kit in the mail with instructions on its self-administration while 23 children received usual care.[83] One year after receiving the intervention, parental reports suggested a statistically significant decrease in "interruptions due to asthma" ($p<0.04$) but there was no difference in school absenteeism between groups. The study by Whitman and colleagues[84] provided the "Superstuff" kit in addition to eight teaching sessions to 19 children and found that three months after the intervention, there was no difference in number of asthma episodes or days without asthma between recipients and controls (N=19); however, participant's knowledge ($p=0.02$) and asthma skills ($p<0.01$) improved compared to controls. Also, the intervention evaluated by Pérez and colleagues for Venezuelan children with asthma was based on a self-monitoring or self-management packaged adapted from Superstuff and Living with Asthma—they found that intervention subjects reported fewer asthma crises and their physicians reported less severe asthma than among control subjects (Table 11).[66]

Of the other studies, numerous reported statistically significantly greater improvements in outcomes for the intervention group over the control group. However, often these statistically significant findings (e.g., improvement in percent predicted FEV_1 of less than five percent) are of only modest clinical significance.

Conclusions. The 35 self-monitoring or self-management interventions, although heterogeneous in terms of content delivered and method of instruction, tended to be associated with statistically significant improvements in outcomes for children with asthma. Additionally, they tended to be grounded in established theoretical or behavioral frameworks. The interventions with well-established theoretic foundations typically utilized multiple educational modalities including role-playing, videos, and games to reinforce patient learning. Overall, many of the reported improvements were of only modest clinical significance.

Table 11. Summary of self-monitoring or self-management interventions directed at children with asthma

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Agrawal et al.[85]	To evaluate the effects of adding a individualized written asthma home-management plan to standard asthma care.	60 children aged 5-12 years with moderate persistent asthma in India.	RCT	32 children completed the self-management program that included an individualized home-management plan (trained to perform PF measurement, use a PF and symptom diary, and given specific instructions for home medication management based on symptoms and PF measurement). 28 children completed the usual care arm. All subjects were followed weekly for 4 weeks then monthly for 3 additional months (7 visits).	4 months after the intervention, children in the intervention group had fewer acute asthma events (p=0.02), fewer days missed from school (p=0.015), fewer nocturnal awakenings (p=0.001), and fewer symptoms (p=0.0006).[85]
Bartholomew et al.[53]	To evaluate whether a computer-based asthma self-management tool would increase process and clinical outcomes of care for inner-city children with moderate to several asthma in Houston.	133 children aged 6-17 with asthma.	RCT	70 children used the *Watch, Discover, Think, and Act* multimedia CD-ROM program for variable amounts of time after their scheduled office visits. The program presents an "adventure game" in which the player makes choices to manage the game character's asthma (the game's character is matched with the subject on gender and ethnicity). Within the game, children can learn new skills, identify symptoms, reduce environmental triggers, and take preventative actions. 63 children received usual care with telephone reminders before their scheduled office visits.	7.9 months after enrollment in the intervention, there were no differences between groups in the number of ED visits, hospitalizations, or symptoms.[53]
Burkhart et al.[71]	To determine the effects of interventions that combine education and behavioral techniques in managing asthma at home.	42 English-speaking children aged 7-11 years with persistent asthma in Kentucky; N_{int}=21; N_{con}=21.	RCT	Patients received asthma education and instructions on how to use an electronic PF meter twice daily and record data in an asthma diary. Patients received three 1-hour individual sessions with a nurse, a contingency management intervention, which consisted of a contingency contract, reinforcement, tailoring, and reminders. The contract outlined requested behaviors (PF monitoring, diary self-reporting) and associated rewards. (We describe the rewards used in the section on financial incentives.) A nurse educator also contacted patients weekly to reinforce teachings. The control group received the teaching sessions but no contingency contract and no follow up calls from nurses.	At 5 weeks, they found no difference in adherence with PF monitoring between the intervention and the usual-care (control group) children.[71]

Table 11. Summary of self-monitoring or self-management interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Cicutto et al.[77]	To evaluate whether an interactive childhood asthma education program improved asthma-related morbidity among elementary school children in Toronto, Canada.	256 children with asthma in grades 2 to 5 (aged 6-11 years) and their parents. N_{int}=132, N_{con}=124.	RCT	The "Roaring Adventures of Puff (RAP)" consists of 6 sessions of 50-60minutes held once a week for 6 consecutive weeks. Sessions cover use of PF meters, diary monitoring, trigger identification and control, use of inhalers and medications, symptom recognition and action plan use, and managing asthma exacerbations. Parents are invited to the last session in which children showcase their learning and new skills. The strategies utilized included games, puppetry, and model building to teach about trigger identification, medication use, symptom recognition, sharing information with teachers and parents.	12 months after the intervention, RAP attendees had 32% fewer urgent health visits ($p<0.01$), less asthma-related school absenteeism ($p<0.05$), and less activity limitation due to asthma ($p<0.01$) than control children.[77]
Dahl et al.[86]	To evaluate the effects of a behavioral treatment program when superimposed on medical treatment.	19 children in Sweden with severe asthma using continual β-agonist therapy. N_{con}=10, N_{int}=9.	RCT	All patients underwent a 4-week baseline period during which a behavioral analysis was made for each child and daily asthma charts were kept. Patients in the intervention group underwent a 4-week intervention period, during which they received four 1-hour individualized behavior therapy treatment sessions in their home or school focusing on discrimination training of asthma signals, self-management techniques for breathlessness, counter-conditioning any learned fear response, contingency management of asthma-related behavior, and compliance training. The control group received usual care.	All data were presented as comparisons of change from baseline. After 4 weeks of follow up, patients in the intervention group had a significantly larger reduction in "as needed" spray doses of β-agonist and a significantly larger reduction in days of school absenteeism compared to patients in the control group. There was no difference between the groups in PF values.[86]
Evans et al.[68]	To evaluate whether a school-based self-management program would increase children's asthma management skills and other process and clinical outcomes for low income 3rd-5th graders in public schools in New York.	204 low income 3rd-5th graders in public schools in New York, aged 8 to 11 with asthma.	CBA	93 children attended the Open Airways program's six 1-hour small group sessions (over a 3 week period) in which children learned basic information about asthma, recognizing and responding to symptoms, using medications and when to seek help, keeping physically active, identifying and controlling triggers, and handling problems related to school. 87 control children received no additional self-management training.	1 year after the program, experimental children reduced the annual frequency ($p=0.024$) and duration ($p=0.007$) of asthma episodes, and annual days with symptoms ($p=0.004$), and they increased their self-management index score compared to controls ($p=0.05$). There were no differences between the groups in terms of school attendance and number of episodes requiring a physician visit. [68]

Table 11. Summary of self-monitoring or self-management interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Fireman et al.[81]	To determine whether a nurse teaching self-management skills to children and their caregivers would improve their disease outcomes.	26 children aged 2-14 with asthma in Pittsburgh	Sequentially assigned (not randomly) controlled trial	13 children and their caregivers received 4 individualized sessions with a trained nurse on the use of symptom and medication diaries, two 2-hour group sessions for discussion of asthma management, and phone follow up every 3 months by the nurse. 13 children received usual care.	13 months after enrollment, the intervention group had fewer asthma attacks (1.5 vs. 6 per child) ($p<0.01$) and less school absenteeism (0.5 vs. 4.6 days per child) ($p<0.05$). The authors reported fewer hospitalizations and ED visits for the intervention group but no statistical test for the difference between the groups. There was no difference in wheezing days per month.[81]
Homer et al.[54]	To assess the effectiveness of multimedia educational software program about asthma for inner-city children.	Children aged 3 to 12 with asthma living in inner-city Boston. $N_{int}=57$; $N_{con}=49$.	RCT	"Asthma Control" is an interactive educational computer game designed to teach children about asthma and its management. The object of the game is to help the main character, Spacer, a superhero with asthma complete all 6 game levels (3 home and 3 outdoor levels). The player uses his or her knowledge of asthma to help Spacer eliminate common indoor allergens and to avoid outdoor allergens. If Spacer's condition worsens, the program producing coughing and wheezing sounds and he may not be about to jump or run. If the player does not eliminate allergens or use preventive medications, Spacer's mother blocks his/her exit from home. Study patients were asked to return to the study site 3 times to use the educational computer program.	During the one year study period, there were no differences between intervention and control children in terms of ED visits, acute office visits, asthma severity, exposure to environmental triggers, use of PF meters, or asthma management behaviors. Note: 40% of children enrolled in the study had exposure to a least one smoker at home.[54]
LaRoche et al.[78]	To evaluate a multifamily asthma group self management program designed to be culturally relevant and encouraged group cohesiveness among the attending families.	24 African American and Hispanic families living in Boston with children aged 7-13 with asthma.	RCT	The 24 experimental families were randomized to receive three 1-hour sessions that emphasized collaborative asthma management among patients, parents, and physicians and provided training on asthma symptoms and skills for self management. Half of the experimental families received encouragement to work as a group to share experiences and learn from each other. The 11 control families received no intervention.	During the year after the intervention, the experimental children from families that shared group experiences had fewer ED visits (0.7 ± 0.9) than either the experimental children with standard self-management teaching (1.2 ± 1.7) or controls (1.4 ± 2.4) ($p=0.04$). There were no differences in self-management scores. The intervention program costs were approximately $2,295 (per 11 patients) and the savings from reduced ED visits was $4,675 (per 11 patients).[78]

Table 11. Summary of self-monitoring or self-management interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Maslennikova et al.[82]	To assess the effects of a adapting a U.S. self-management educational intervention on asthma outcomes for children in Moscow.	122 children with asthma and their families living in Moscow. N_{int}=60; N_{con}=62.	RCT	The authors adapted "Open Airways" (developed for low literacy children aged 4-7 years) and "Air Power" (developed for average literacy children aged 8-14 years) for similar populations in Moscow. Intervention subjects also received asthma care from clinicians who had been trained "according to the U.S. guidelines for the diagnosis and management of asthma and use of modern asthma medications." Intervention subjects participated in 4 weekly 1hr sessions. Control subjects received usual care from clinicians who received no additional training.	1 year after the intervention, the % of children in the education group who were on inhaled anti-inflammatory medications increased by 46% compared to only 8% for the control group ($p<0.05$). Intervention children's PF measures also improved more than for control children ($p<0.05$). There was no difference in terms of the change in the percent of children using theophylline or β-agonists or days missed from school.
McGhan et al.[76]	To determine whether the asthma education program "Roaring Adventures of Puff (RAP)," improved asthma management behaviors and health status in elementary school children in Edmonton, Canada.	136 children with asthma aged 7-12 years. N_{int}=65; N_{con}=71.	RCT	Parent and teacher asthma awareness events were held within the school setting. The intervention provided recommendations for school asthma guidelines and six educational group sessions for children with asthma described above.[77]	9 months post-intervention, experimental children had "more appropriate use of preventive medication" ($p<0.001$), improvement in asthma-related limitations in play, ($p<0.001$) but there were no differences between groups in medication use, possession of an action plan, ED visits, unscheduled doctor visits, asthma symptoms, or days lost from school. 26% of the children had regular smoking in the home.[76]
McNabb et al.[80]	To evaluate whether children with asthma who had not been compliant with standard medical management would benefit from self-management education that could be tailored to their educational and behavioral needs.	14 children aged 9 to 13 with asthma in northern California.	RCT	Experimental subjects (N=7) received a 30 minute diagnostic interview followed by four 45-minute individually tailored weekly sessions with a nurse educator on asthma self-management. Control subjects (N=7) received usual care.	In the 12 months after the intervention, the experimental group averaged 1.9 emergency treatments compared to 7.4 for the control group (no p value provided). There were no differences in non-emergency visits or drug use between groups. They estimated a program related $507 per child savings on the basis of the reduced emergency visits.[80]

Table 11. Summary of self-monitoring or self-management interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Morgan et al.,[73] Evans et al.,[74], and Sullivan et al.[75]	To evaluate whether a home-based intervention for inner-city children designed to teach caregivers to reduce environmental asthma triggers specific to that child would result in improvements in asthma-related outcomes. (The National Cooperative Inner-City Asthma Study.)	1,023 families of children aged 5 to 11 with asthma from 8 major U.S. cities. N_{int}=515, N_{con}=518.	RCT	During the 12 month intervention, 2 research assistants visited each home 5 to 7 times. Each visit was followed by a phone call to address any barriers to implement the plan. Caregivers were taught about the role of allergens in asthma, mattress covers were installed, families were given a vacuum cleaner with HEPA filter and a HEPA air purifier was set up in the child's bedroom. Professional pest control was provided.	Two years after enrollment, intervention children had more symptom free days (565.1 vs. 538.5), fewer asthma symptoms ($p<0.001$), days lost from school ($p<0.009$), and allergen levels.[73] There were no differences in spirometry or PF measurements or unscheduled visits to the ED, clinic or hospital between the two groups.[73-75] The cost of the intervention was $337 per child for 2 years resulting in an estimate incremental cost-effectiveness ration of $9.20 per symptom-free day gained (95% CI: -$12.56 to $55.29 per symptom free day gained).[75]
Pérez et al.[66]	To evaluate the effectiveness of a self-management program based on social learning models and self management programs with demonstrated effectiveness on asthma morbidity.	29 children with asthma aged 6-14 years in Venezuela.	RCT	17 children and their parents were randomized to receive asthma education. Parents received two 90 minute sessions on asthma pathophysiology, treatment and psychological factors associated with the disease. Children received six 60-minute self-management training sessions that included modeling, positive reinforcement, group dynamics, behavioral practice, role-playing, and feedback.	6 months after the intervention, children reported fewer asthma crises, and their physicians reported less severe asthma than control patients ($p<0.05$). [66]
Persaud et al.[87]	To evaluate the effects of a school-nurse based self management program for school children in Texas.	36 children aged 8 - 12 years with moderate to severe asthma.	RCT	All children had a visit with a primary care provider at the time of enrollment during which time they were all given written guidelines for medication use, asthma control and prevention, PF meters, and asthma diaries. Intervention children (N=18) also received 8 individualized, weekly, 20 minute sessions with a school nurse to review asthma symptoms and medication and PF meter use. Control children (N=18) visited the school nurse sporadically, on their own initiation.	20 weeks after enrollment, the percentage of children visiting the ED for asthma was higher in the control group (50%) than in the intervention group (22%, $p<0.05$); however, there were no differences in number of ED visits per child or days lost from school between groups.[87]

Table 11. Summary of self-monitoring or self-management interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Rakos et al.[83]	To evaluate the effectiveness of a self-administered self-management program for pediatric asthma.	43 children aged 7-12 years with moderate to severe asthma in Cleveland.	RCT	20 children and their caregivers received a "Superstuff" kit in the mail. This program, developed by the American Lung Association, includes a Parent's Magazine containing 29 articles on asthma pathophysiology, triggers, relaxation techniques, and personal control and decision making. The Children's Kit includes riddles about asthma facts, "breathe easy" board game, puzzles and dolls with self-care messages, comic strip about relaxation exercises, mystery house to discover allergens, phone book to advise when to call the doctor and record emergency numbers, and asthma-related door signs, posters, stickers, records, and paper cut-outs. 23 children received usual care.	12 months after receiving the intervention, parental reports suggest a significant decrease in "interruptions due to asthma" ($p<0.04$). No difference in school absenteeism between groups. The cost of the kits was $7.[83]
Ronchetti et al.[72]	To compare the Open Airways program to Living With Asthma program among Italian children with asthma.	209 children with asthma from 12 centers across Italy.	CBA	58 children received either the original version of Open Airways or a 4 session abbreviated version, 56 children received either the original version of Living with Asthma or a 4 session abbreviated version (see text for intervention description). 95 children received usual care.	One year after participation, patients in the Open Airways but not the Living With Asthma groups has fewer emergency treatments for asthma than controls ($p<0.03$).[72]

Table 11. Summary of self-monitoring or self-management interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Runge et al[52]	To evaluate whether an internet-based education program as an add-on to a standard patient education program improved health outcomes and reduced costs of children with asthma in Germany.	178 children with asthma aged 8-16.	CBA	48 children in the control group received no education until after the trial. 86 children received the self-management program of five 2hr sessions in which they used role-playing and small group sessions to teach inhaler use, trigger avoidance, medication management, PF monitoring, and decision making. 44 children received this self-management program plus self-selected to also use the interactive internet adventure game incorporating virtual asthma-related situations in need of management and also provides access to online chats with asthma experts, an online PF protocol that can be maintained by the patient, and chat rooms for other users and healthcare providers.	6 months after enrollment, the self-management plus internet (SMI) education group had a mean of 0 emergency visits compared to 0.2 for the control group (CG) and 0.3 for the self-management (SM) alone group ($p=0.03$). The SM group had significantly ($p<0.05$) fewer physician visits (-44%) and emergency treatments (-67%) than CG. PF improved in all groups, no difference among groups. Significant improvements were seen in 3 of 8 QOL domains in both intervention groups but not in the CG. It cost 585€ to deliver the SMI intervention which reduced asthma costs by 461€. Adjusting for benefits in the CG, 0.79€ were saved for every 1€ spent on the SMI intervention during the 1st year. (1 year follow up data available for the two intervention groups but not the CG.)[52]
Tieffenberg et al.[67]	To evaluate a chronic disease self management program based on behavioral change and learning theory directed at increasing autonomy on the part of children.	188 children with moderate to severe asthma aged 6 to 15 in Argentina.	RCT	65 children were randomized to receive 5 weekly 2-hour meetings with a reinforcement meeting 2-6 months later. The curriculum included identifying early warning signs and symptoms of an attack, identifying triggers, understanding therapies, and decision making skills through games, drawings, stories, videos, and role-playing. 52 children received usual care.	12 months after the intervention, experimental subjects had fewer regular visits for asthma ($p=0.048$), asthma crises ($p=0.36$), and less school absenteeism ($p=0.006$ for fall/winter and $p=0.029$ for spring semesters) but no difference in emergency visits compared to controls.[67]

Table 11. Summary of self-monitoring or self-management interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Toelle et al.[88]	To evaluate whether a community-based asthma management program could reduce asthma symptoms and lung function among school children in Sydney, Australia.	132 school children aged 8 to 11 with asthma and all the adults who influence their care including parents, doctors, pharmacists, community nurses and school teachers.	CBA	Children in the intervention group and their parents (N_{int}=72) were invited to attend 2 education session each 2 hours, 1 week apart with a curriculum on asthma triggers, medication use, inhalation technique, use of written self-management plan. These children's physicians and pharmacists were invited to attend evening workshops during which asthma management guidelines were reviewed. Community nurses and school teachers in the intervention community received an in-service education session at their workplace. All families, children, physicians, and pharmacists who did not attend the intervention sessions were mailed the materials. 60 children received usual care.	147 teachers and community nurses, 53 families (74%), 15 pharmacists (21%), and 11 physicians (20%) attended intervention sessions. 6 months after the intervention, both FEV_1 and dose-response ratios improved in the intervention group but not the control group ($p<0.001$). The number of children with wheeze and symptoms that limit activity did not change but night cough decreased significantly in the intervention group ($p<0.001$). There was no significant difference in physician or ED visits or days absent from school.[88]
Vazquez and Buceta[79, 89]	To evaluate the effects of adding relaxation training to asthma self-management education to improve the care of children with asthma in Spain.	27 children with "light or moderate" asthma aged 8 to 13 years.	CBA	9 children in the control group received usual care; 9 children received six 1-hr weekly sessions with their parents on asthma pathophysiology, use of medication, identification of triggers, and breathing exercises; and 9 children received the self-management instruction plus additional training on relaxation techniques at the end of each self-management session.	At 12 months after the intervention, both intervention groups had better scores on the adherence with self-management behaviors scale used by this study compared to the control group but there were no differences among groups in terms of attack frequency or duration, PF, emergency medical consultations or school absenteeism. [79, 89]
Velsor-Friedrich et al.[69]	To examine the effects of a school-based intervention program on self care abilities, practices and health outcomes of children with asthma.	102 African American 8-13 year old children with asthma recruited from 8 inner-city public schools in Chicago.	QRCT*	The Open Airways educational program utilized an interactive teaching approach applying group discussions, stories, games and role-playing to promote children's active involvement in the learning process. In six 45-minute sessions offered once a week, small groups of children learned new asthma management skills. N_{int}=40, N_{con}=62.	5 months after completion of the program, the treatment group had significantly more improvement in PF measurements (7.5% vs. 2.9% improvement, $p=0.046$), reduction in number of days with symptoms ($p=0.047$), and number of urgent medical visits ($p=0.01$). No differences in terms of reported medication use or school absences.[69]

Table 11. Summary of self-monitoring or self-management interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Webber et al.[70]	To evaluated whether the Open Airways program would reduce asthma morbidity and health services utilization among inner-city children with asthma in the Bronx.	599 3rd to 5th graders in the Bronx with asthma.	CBA	599 children in schools with school-based health centers were scheduled to attend the Open Airways program (as described in the two prior studies). They were compared with students in schools with school-based health centers that did not offer the Open Airways program (N not specified) and children in control schools without school-based health centers (N not specified).	Approximately 15 months after enrollment, there were declines in office visits for children attending schools with school-based health centers (with and without the Open Airways program) but not for control school children (for whom there was a (9% increase in office visits) (p=0.01). ED use and hospitalizations declined for all children (no difference among groups). [70]
Whitman et al.[84]	To evaluate the effects of a self-management curriculum on asthma knowledge, skills, and "asthma experiences."	38 children aged 6 to 14 in Utah.	RCT	19 children received eight 90-minute classes for children and caregivers given twice a week for a month included education on breathing control skills, body relaxations skills, bronchial hygiene silks, and physical conditioning. Additionally, intervention subjects received the "Superstuff" kit described in Rakos.[83] 19 children received no training.	Three months after the intervention, there was no difference in number of asthma episodes or days without asthma between groups. Participants' knowledge (p=0.02) and asthma skills (p<0.01) improved compared to controls.[84]

Note: Eight studies compared two self-management interventions without including a control group that did not also receive a self-management intervention.[55, 56, 59-64] Studies of this design are described in detail in a subsequent section of the report (Table 21). *QRCT=quasi-randomized controlled trials. ED=emergency department. PF=peak flow. QOL=quality of life. CBA=controlled before-after trial.

Patient Education Interventions for Children With Asthma

Background. In general, pediatric patient education strategies for asthma are based on imparting knowledge about asthma pathophysiology to patients and their parents or caregivers and encouraging the appropriate use of peak flow meters and inhaled medications.

Results. We found 54 evaluations of interventions designed primarily to educate children or parents or caregivers of children with asthma (Table 12). The included studies were highly heterogeneous with respect to the target of the intervention (e.g., patients versus their parents or caregivers), the setting of the intervention (e.g., home, school, clinic), and the information being provided (e.g., asthma pathophysiology, allergen reduction). Thirty-seven (69%) studies demonstrated at least one statistically significant improvement in clinical outcomes, functional status, health services utilization, or guideline adherence. The studies reporting decreases in health services utilization tended to have described a theoretical basis for their intervention (p=0.048). Half of the pediatric patient education interventions (N=27) were based on a conceptual or theoretical framework (compared to 63% of the self-monitoring or self-management interventions).

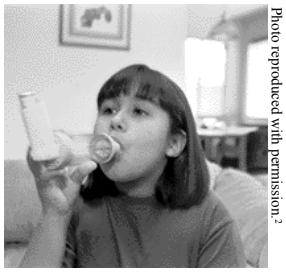


Photo reproduced with permission.[2]

In this section (Table 12), we describe the included studies in groups according to these key characteristics. (Note: The number of studies described in Table 12 is greater than 54 because there is overlap between the school-based interventions and other types of interventions so those studies are presented more than once). At the end of this section, we present the results of our synthesis of the association between intervention characteristics and likelihood of finding statistically significant improvements in the outcomes of interest for patient education or self-monitoring or self-management interventions.[‡]

Parent or caregiver education programs. Whereas most school-age children are typically considered to be sufficiently mature to benefit from asthma education offered outside the context of their families, preschool children learn new skills best within the context of their families, and parents are the primary target of the education of the youngest children with asthma (less than seven years).[90] Among the included articles, we found 21 that included educational interventions directed at parents or caregivers (Table 12a)—13 (62%) of which found statistically significant improvements in processes and outcomes of care for children with asthma. In particular, this type of study was likely to report improvements in clinical outcomes (13 studies found improvements in asthma symptoms and other clinical outcomes among the 15 studies reporting these types of outcomes). Four studies compared two or more parent or caregiver education programs with each other but did not include a control group that did not also receive an educational intervention—these are described in Table 21.[60, 62, 64, 65]

Notable for its size and methodological rigor, the National Cooperative Inner-City Asthma Study (NCICAS) evaluated the effectiveness of a multifaceted, home-based intervention for

[‡]Many of the included patient education interventions evaluated changes in asthma knowledge among intervention and control participants. Asthma knowledge was not one of our key outcomes of interest; however, we abstracted information about this outcome and present it, where available, in Table . Often the asthma knowledge in both groups increased, occasionally, it increased to a greater extent in the intervention arm.

1,033 inner city children aged 5 to 11 years with asthma from seven U.S. cities living in census tracts in which at least 20% of households had income levels below the federal poverty level.[73-75] The NCICAS evaluated an educational intervention designed to teach caregivers about asthma management and to reduce those environmental asthma triggers to which their children had positive skin tests.[73] Intervention families were given training on asthma triggers, environmental controls, and asthma physiology by social workers and were given tools to reduce environmental allergens such as vacuum cleaners, pillow covers, and air filters. Two years after enrollment, intervention children had more symptom free days (565.1 versus 538.5 days), fewer asthma symptoms ($p<0.001$), days lost from school (0.54 versus 0.71 days per two weeks, $p<0.009$), and lower allergen levels.[73] There were no differences in hospitalization rates, physician visits, or emergency department between intervention and control groups.[74, 75] The cost of the intervention was $337 per child for 2 years resulting in an estimated incremental cost-effectiveness ratio of $9.20 per symptom-free day gained (95% CI: -$12.56 to $55.29 per symptom free day gained).[75] We cannot assess the extent to which it was the educational component or the reduction in environmental allergens that resulted in improvements for intervention subjects.

The study by Toelle and colleagues[88] differed from the others in this section in that it was an educational program directed broadly at children with asthma and *all* the adults who influence their care including parents, physicians, teachers, pharmacists, community nurses, and school teachers. Six months after the intervention, pulmonary function (FEV_1(L) was 2.13 at six months vs. 1.78 at baseline) improved in the intervention group but not the control group ($p<0.001$). The number of children with wheeze and symptoms that limited their activity did not change but night cough decreased a statistically significant amount in the intervention group (37.3% at six months vs. 68.3% at baseline; $p<0.001$). There was no statistically significant difference in physician or emergency department visits or days absent from school.

School-based education programs. Sixteen of the studies of pediatric QI studies delivered some portion of their intervention in schools—13 of these were patient education programs (Table 12b). Eleven school-based programs (69%) reported statistically significant improvements in processes and outcomes of care for children with asthma. Although these interventions all occurred in schools, they were highly heterogeneous in terms of the curriculum delivered, training of the person(s) delivering the curriculum, intensity of the program, and target audience. Two studies used the same 6 session educational program called "The Roaring Adventures of Puff." McGhan and colleagues[91] studied the effects of this program in 7 to 12 year old children in Edmonton and Cicutto and colleagues evaluated this program in 6 to 11 year olds in Toronto.[77] In both studies, this program—which is based on asthma practice guidelines, social cognitive theory, and self-regulation theory and utilizes numerous teaching modalities including puppetry, games, role playing, model building, discussions, and asthma diary recordings—found reductions in asthma-related limitations in activity (McGhan et al. reported that in the intervention group, 41.5% of children at baseline vs. 29.2% children post-intervention were limited in their kinds of play; Cicutto et al. reported 6.2 versus 9.1 days of limited activity in the intervention compared to the control group).[77, 91]

Adolescent education programs. During adolescence, developmental behavioral changes can have adverse effects on asthma management if medication adherence declines or medical

supervision becomes less consistent.[92] We found six studies of educational interventions that exclusively targeting adolescents with asthma (Table 12c). None of these six adolescent-targeted interventions, even those that relied on peer teachers or intensive educational programs from physicians or nurse educators, resulted in statistically significant durable improvements in inhaled bronchodilator use, asthma symptoms control, or health services utilization. We note that five of these were relatively short with interventions lasting eight months or less.

We found 24 studies of self-monitoring, self-management, or patient education of general pediatric populations with asthma that included adolescents. Of these, 18 (75%) reported at least one positive outcome. Similarly, adolescents were included in 26 of the interventions directed at general populations with asthma—18 (70%) of these reported at least one positive outcome. Among these 50 studies that included adolescents as part of their study population but were not exclusively targeting adolescents, 14 (28%) reported statistically significant improvements in asthma symptoms or disease severity compared to controls and 12 (24%) reported significantly fewer emergency department/urgent care visits compared to controls. Because none of these studies reported outcomes by age strata, the extent to which these improvements were found among adolescents is unclear.

Outpatient education programs. We found 15 additional studies of educational interventions designed for children with asthma that were coordinated from the outpatient setting, sometimes including home visits and calls (Table 12d). Several of the included studies that directed the educational intervention at children but did not include parental involvement (particularly for young children) did not find statistically significant improvements in the processes or outcomes of care for the asthmatic patients. Several authors noted that even among families with older children, parents did not always respond to the suggestions raised by their children after participation in the educational intervention.[54] Sometimes this was because parents could not afford or were unable to remove environmental factors such as wall-to-wall carpeting in their public housing residences.[54] Others who were capable of removing some allergens or irritants sometimes denied that a particular environmental exposure, such as their smoking, was harmful to the child. These observations strongly suggest that parallel educational activities focusing on parents as well as their children may be needed.

Conclusions. Patient education interventions can be effective for improving the processes and outcomes of care for children with asthma. In particular, school-based programs and those directed at parents or caregivers of young children with asthma (even among lower socio-economic groups) tend to be associated with the greatest improvements in asthma outcomes. However, the effect sizes were often only of borderline clinical significance. Additionally, the few QI strategies that exclusively targeted adolescents have not resulted in much success—emphasizing the need for additional study of this key asthma population.

Table 12a. Summary of patient education interventions directed at the parents or caregivers of children with asthma

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Brook et al.[93]	To compare the parents' knowledge about asthma after an educational seminar and to compare rates of hospitalization of children with asthma whose parents had participated in the seminar with those of children in the control group.	Parents of 54 children with asthma treated in the pediatric respiratory service of Wolfson Hospital in Tel Hashomer, Israel. N_{int}=26, N_{con}=28.	RCT	Intervention parents were invited to participate in an educational project, which included 1-hour weekly meetings over a four-month period where they received lectures and explanations about various aspects of asthma. Lectures were given by pediatric respiratory therapists, allergists, psychiatrists, social workers, and physiotherapists. Additionally, parents received written information about the chronic disease.	During 12 months after the intervention, intervention children had fewer hospitalizations (a decline from 3.6 to 1.3 hospitalizations per year per child than control children (3.6 to 3.1, $p<0.05$).[93]
Brown et al.[90§]	To evaluate whether home-based asthma education of low-income parents and their pre-school children with asthma would be feasible and result in reductions in asthma morbidity, caregiver QOL, and asthma management behaviors.	95 low income children with asthma between 1 and 6.99 years of age in the metropolitan areas of Atlanta, GA and Palo Alto, CA. N_{int}=49, N_{con}=46.	RCT	The Wee Wheezers at Home program (was an adaptation of the Wee Wheezers program[94]) included eight 90-minute sessions at weekly intervals in families' homes. Families also received printed materials and homework at each session and videotapes at some sessions.	At 12 months after the intervention, the education group experiences fewer asthma symptoms, more symptom-free days, and better caregiver QOL among those children aged 1-3 but not those children aged 4-6. There was no difference between treatment and control groups for caregiver asthma management behavior or acute care utilization.[90]
Butz et al.[95]	To evaluate the effectiveness of a parent and child asthma education program for rural families in Maryland.	201 children aged 6-12 years with asthma. N_{int}=112, N_{con}=89.	RCT	The intervention parents received a 1hr education session on asthma management, use of asthma action plan, and early warning signs; a quarterly newsletter, and a resources guide to asthma management that included locations for allergy testing and information about tobacco cessation. The intervention children received two 2-hr interactive sessions on asthma symptoms, use of PF meters and inhalers; a PF meter; a spacer; and a copy of the "My Asthma Coloring Book." Control group received usual care.	10 months after enrollment, the intervention group parents reported less shortness of breath ($p=0.007$) and nighttime wheezing ($p=0.02$). There were no differences in the number of parents with an asthma action plan, number of ED visits, hospitalizations, or office visits or caregiver or child QOL.[95]

Table 12a. Summary of patient education interventions directed at the parents or caregivers of children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Clark et al.[96, 97]	To determine whether health education would increase the ability of parents and children to manage asthma and reduce the use of health services.	290 families of 310 children aged 4-17 years with asthma recruited from clinics serving low income families in New York City.	RCT	207 control group children received regular care. 103 experimental group children received regular care plus six 1-hour small group sessions offered monthly on managing asthma attacks, taking medication, communicating with physicians, improving school performance, maintaining a healthy home environment, and establishing guidelines for the child's physical activities. 5 sessions were taught separately for parents and children, 1 was jointly attended.	1 year after the intervention, there was no statistically significant difference in hospitalizations or ED use between groups. However, among those children with one or more pre-intervention hospitalizations, there were significant reductions in ED visits in the experimental group compared to the control ($p=0.04$). Intervention parents and their children had greater adherence to self-management plans than control children ($p<0.05$). The cost of delivering the program exceeded the healthcare savings realized (for every $1 spent, $0.62 were saved). However, the program saved $11.22 for ever $1 spent for children with 1 or more pre-intervention hospitalizations.[96, 97]
Eggleston et al.[98]	To conduct and evaluate a home-based environmental intervention for inner city children in Baltimore (based on the findings of the National Cooperative Inner-City Asthma Study).	100 children with asthma aged 6-12 years with asthma. $N_{int}=50$, $N_{con}=50$.	RCT	Intervention families received comprehensive home-based evaluations of environmental triggers and were given air filters, pillow covers, and cockroach extermination as needed. Additionally, they received 3 home visits and a telephone follow up to review allergen reduction principals.	1 year after the intervention, the intervention children had fewer daytime asthma symptoms ($p=0.02$) but there were no difference in nighttime symptoms, exercise-related symptoms, exercise-limiting symptoms, acute visits for asthma, FEV_1, or QOL scores. 69% of home contained at least one smoker. After the intervention, 2 parents stopped smoking (did not report group assignment of these parents).[98]
Horner[99]	To evaluate the effects of a school-based education program for children combined with a home-based program for their parents on children with asthma.	44 families of children with asthma aged 8-12 years in the U.S. participated (not clear how many in the intervention group and the control group).	RCT	Children in the intervention group participated in nine 15-minute sessions covering asthma physiology and symptoms, asthma triggers, management decisions using stories, games, posters, and PF meters. Parents received a booklet on asthma pathophysiology, triggers, medication management, use of inhalers and PF meters.	12 months after the intervention, there was no difference in school absenteeism home management by parents or self management by children between intervention and control groups.[99]

Table 12a. Summary of patient education interventions directed at the parents or caregivers of children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Hung et al.[100]	To determine the effects of nursing instruction on the mother's knowledge of asthma medications, inhaler use technique, and her child's health status.	82 children aged 5 to 12 years old with asthma attending the pediatric allergy clinic of a medical center in Taipei. N_{int}=41, N_{con}=41.	QRCT*	The intervention group received a one time individual asthma educational session by a nurse specialist during which they were taught about the objectives of medical treatment, side effects, inhaler use, and the assessment of symptom severity.	Two months after the education, intervention mothers were significantly more likely to have improvements in inhaler technique ($p<0.05$) and their children were less likely to report respiratory symptoms ($p<0.05$).[100]
LaRoche et al.[78]	To evaluate the efficacy of a multifamily asthma group self management program designed to be culturally relevant and encouraged group cohesiveness among the attending families.	24 African American and Hispanic families living in Boston with children aged 7-13 with asthma.	RCT	The 24 experimental families were randomized to receive three 1-hour sessions that emphasized collaborative asthma management among patients, parents, and physicians and provided training on asthma symptoms and skills for self management. Half of the experimental families received encouragement to work as a group to share experiences and learn from each other. The 11 control families received no intervention.	During the year after the intervention, the experimental children from families that shared group experiences had the fewer ED visits (0.7 ± 0.9) than either the experimental children with standard self-management teaching (1.2 ± 1.7) or controls (1.4 ± 2.4) ($p=0.04$). There were no differences in self-management scores. The intervention program cost approximately $2,295 per 11 patients and the savings from reduced ED visits was $4,675 per 11 patients.[78]
Liu and Feekery[27]	To evaluate whether attendance at an asthma education clinic would enhance parents' understanding of asthma, lead to reductions in their children's asthma severity and to evaluate whether the effectiveness of the intervention is related to its delivery.	158 families of attending the Asthma Education Clinic and Royal Children's Hospital in Melbourne, Australia. The control group was recruited from a nearby hospital without an education clinic.	RCT	3 different types of educational sessions with a pediatrician were studied: an individual session with a prior needs assessment; an individual session without prior needs assessment; and a small group session (with 4 or 5 families).	12 months after the intervention, there was a reduction in asthma severity and morbidity scores among the children of parents in the individualized groups.[27]

Table 12a. Summary of patient education interventions directed at the parents or caregivers of children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Maslen-nikova et al.[82]	To assess the effects of a adapting a U.S. self-management educational intervention on asthma outcomes for children in Moscow.	122 children with asthma and their families living in Moscow. N_{int}=60; N_{con}=62	RCT	The authors adapted "Open Airways" (developed for low literacy children aged 4-7 years) and "Air Power" (developed for average literacy children aged 8-14 years) for similar populations in Moscow. Intervention subjects also received asthma care from clinicians who had been trained "according to the U.S. guidelines for the diagnosis and management of asthma and use of modern asthma medications." Intervention subjects participated in 4 weekly 1hr sessions. Control subjects received usual care from clinicians who received no additional training.	1 year after the intervention, the % of children in the education group who were on inhaled anti-inflammatory medications increased by 46% compared to only 8% for the control group ($p<0.05$). Intervention children's PF measures also improved more than for control children ($p<0.05$). There was no difference in terms of the change in the percentage of children using theophylline or β-agonists or days missed from school.
Mesters et al.[101, 102]	To evaluate the effects of a caregiver education program for young children in the Netherlands.	63 general practitioners (GPs) were randomized to provide an educational manual to the caregivers of children aged 0 to 4 with asthma. N_{int}=31, N_{con}=32.	RCT	GPs were given a notebook containing 16 modules of information on topics related to asthma pathophysiology, medication use, symptom recognition, and trigger identification and reduction. GPs distributed some or all of the modules to the caregivers of patients with asthma. Caregivers differed in terms of the number of modules received and the number of follow up visits with the provider.	At 12 months after the intervention, the treatment group of patients had fewer emergency and non-emergency visits with the GP than control patients ($p=0.01$ for both). No difference in hospital admissions between the groups.[101, 102]
Morgan et al.,[73] Evans et al.,[74], and Sullivan et al.[75]	To evaluate whether a home-based intervention for inner-city children designed to teach caregivers to reduce environmental asthma triggers specific to that child (as determined through skin testing) would result in improvements in asthma-related outcomes. (The National Cooperative Inner-City Asthma Study.)	1023 families of children aged 5 to 11 with asthma in 8 major U.S. cities N_{int}=515, N_{con}=518.	RCT	During the 12 month intervention, 2 research assistants visited each home 5 to 7 times. Each visit was followed by a phone call to address any barriers to implement the plan. Caregivers were taught about the role of allergens in asthma, mattress covers were installed, families were given a vacuum cleaner with HEPA filter and a HEPA air purifier was set up in the child's bedroom. Professional pest control was provided.	Two years after enrollment, intervention children had more symptom free days (565.1 vs. 538.5), fewer asthma symptoms ($p<0.001$), days lost from school ($p<0.009$), and allergen levels.[73] There was no difference in spirometry or PF measurements or unscheduled visits to the ED, clinic or hospital between the two groups.[73-75] The cost of the intervention was $337 per child for 2 years resulting in an estimate incremental cost-effectiveness ration of $9.20 per symptom-free day gained (95% CI: -$12.56 to $55.29 per symptom free day gained).[75]

Table 12a. Summary of patient education interventions directed at the parents or caregivers of children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Pérez et al.[66]	To evaluate the effectiveness of a self-management program based on social learning models and self management programs with demonstrated effectiveness on asthma morbidity.	29 children with asthma aged 6-14 years in Venezuela.	RCT	17 children and their parents were randomized to receive asthma education. Parents received two 90 minute sessions on asthma pathophysiology, treatment and psychological factors associated with the disease. Children received six 60-minute self-management training sessions that included modeling, positive reinforcement, group dynamics, behavioral practice, role-playing, and feedback.	6 months after the intervention, children reported fewer asthma crises, and their physicians reported less severe asthma than control patients ($p<0.05$). [66]
Stevens et al. [103]	To examine the effects of providing an asthma education and written self-management plan to the parents of pre-school children on asthma morbidity.	177 children aged 18 months to 5 years at the time of admission to the hospital or attendance at the ED for asthma in the U.K. $N_{int}=87$, $N_{con}=90$.	RCT	The parents and children in the intervention group received a general education booklet about asthma, a written guided self-management plan, and two 2-hour educational sessions given on a one-to-one basis by a specialist nurse in the outpatient clinic. The education sessions focused on personalization of the self-management plan, parental techniques for administering medication, and asthma triggers and symptoms. Children in the control group received usual care.	After 12 months, there was no significant difference between the groups in hospital admissions, ED visits, number of prescriptions for asthma medications, symptoms scores, or parental/caregiver QOL.[103]
Tieffen-berg et al.[67]	To evaluate a chronic disease self management program based on behavioral change and learning theory directed at increasing autonomy on the part of children.	188 children with moderate to severe asthma aged 6 to 15 in Argentina.	RCT	65 families were randomized to receive 5 weekly 2-hour meetings with a reinforcement meeting 2-6 months later. The curriculum included identifying early warning signs and symptoms of an attack, identifying triggers, understanding therapies, and decision making skills through games, drawings, stories, videos, and role-playing. 52 children received usual care.	12 months after the intervention, experimental subjects had fewer regular visits for asthma ($p=0.048$), asthma crises ($p=0.36$), and less school absenteeism ($p=0.006$ for fall/winter and $p=0.029$ for spring semesters) but no difference in emergency visits compared to controls.[67]

Table 12a. Summary of patient education interventions directed at the parents or caregivers of children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Toelle et al.[88]	To evaluate whether a community-based asthma management program could reduce asthma symptoms and lung function among school children in Sydney, Australia.	132 school children aged 8 to 11 with asthma and all the adults who influence their care including parents, doctors, pharmacists, community nurses and school teachers. N_{int}=72; N_{con}=60.	CBA	Parents and children in the intervention group were invited to attend two 2-hr educational session, 1 week apart on asthma triggers, medication use, inhalation technique, and use of written self-management plan. These children's physicians and pharmacists were invited to attend evening workshops which reviewed asthma management guidelines. Community nurses and school teachers in the intervention community received an in-service education session. All families, children, physicians, and pharmacists who did not attend the intervention sessions were mailed the materials.	147 teachers and community nurses, 53 families (74%), 15 pharmacists (21%), and 11 physicians (20%) attended intervention sessions. 6 months after the intervention, both FEV_1 and dose-response ratios improved in the intervention group but not the control group ($p<0.001$). The number of children with wheeze and symptoms that limit activity did not change but night cough decreased significantly in the intervention group ($p<0.001$). There was no significant difference in physician or ED visits or days absent from school.[88]
Wilson et al.[94§]	Overall goals are that parents gain the knowledge, skills and motivation to prevent asthma symptoms; appropriately manage symptoms when they occur; utilize medical, educational and interpersonal resources appropriately for asthma care; communicate effectively with all adults responsible for the child's care; and promote the psychosocial well-being of the family unit.	64 families of children between 6 months and 6.5 years old with asthma in the U.S. completed the trial. N_{int}=33; N_{con}=31.	RCT	The Wee Wheezers intervention involved 4 small group sessions (2 hours each) at one-week intervals conducted by experienced asthma nurses. Parents of children 0-3 years and 4-6 years met in separate groups. For the 4-6 years group, the initial 45 minutes involved direct instruction to the children, which included videos and lectures, asthma action plans, inhaler use, and information recognition of early signs and triggers. Parents develop a written Asthma Action Plan for use of routine medications and at-home management of acute exacerbations.	Treatment children had significantly less increase in asthma morbidity than control children at the end of the intervention (at 3 months). The mean number of symptom-free days in the treatment group increased (8.5 to 10.2 in prior 2 weeks) but decreased in the control group (11.9 to 9.3) ($p<0.01$). Intervention children were more likely to adhere to their treatment regimen than control children ($p<0.01$). 16% of all enrolled children had at least 1 smoker in the home and there was no evidence that anyone stopped smoking in either group.[94]

Note: N_{int}=number of patients in the intervention group at the end of the study. N_{con}=number of patients in the control group at the end of the study. [*]QRCT=quasi-randomized controlled trials. [§]We direct interested readers to the detailed description of the Wee Wheezers program in the article by Wilson et al.[94] and the Wee Wheezers at Home program in the Brown et al.[90] ED=emergency department; PF=peak flow; QOL=quality of life. CBA=controlled before-after trial.

Table 12b. Summary of school-based patient education interventions directed at children with asthma

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Christiansen et al.[104]	To evaluate the effects of a school-based program for Hispanic children with asthma.	42 children in the 4th grade (aged 9 to 12 years) in Southeast San Diego with asthma. N_{int}=27; N_{con}=15.	CBA	Intervention children attended five 20-min sessions at school led by a school nurse practitioner on asthma information, identification of symptoms, reduction of asthma triggers, use of inhalers and PF meters and the development of an action plan.	After 6 months, the asthma symptoms scores were lower in the intervention group than in the control group (p=0.019). There were no differences in PF, school absenteeism, ED visits, or hospitalizations.[104]
Cicutto et al.[77]	To evaluate whether an interactive childhood asthma education program "Roaring Adventures of Puff (RAP)," improved asthma-related morbidity among elementary school children in Toronto, Canada.	256 children with asthma in grades 2 to 5 (aged 6 to 11) and their parents. N_{int}=132; N_{con}=124.	RCT	RAP consists of 6 sessions of 50-60minutes held once a week for 6 consecutive weeks. Sessions cover use of PF meters, diary monitoring, trigger identification and control, use of inhalers and medications, symptom recognition and action plan use, and managing asthma exacerbations. Parents are invited to the last session in which children showcase their learning and new skills. The strategies utilized included games, puppetry, and model building to teach about trigger identification, medication use, symptom recognition, sharing information with teachers and parents.	12 months after the intervention, RAP attendees had 32% fewer urgent health visits (p<0.01), less asthma-related school absenteeism (p<0.05), and less activity limitation due to asthma (p<0.01) than control children.[77]
Evans et al.[68]	To evaluate whether a school-based self-management program would increase children's asthma management skills and other process and clinical outcomes for low income 3rd-5th graders in public schools in New York.	204 children aged 8 to 11 with asthma.	CBA	93 children attended the Open Airways program which consisted of six 1-hour small group sessions (over a 3 week period) in which children learned basic information about asthma, recognizing and responding to symptoms, using medications and when to seek help, keeping physically active, identifying and controlling triggers, and handling problems related to school. 87 control children received no additional self-management training.	1 year after the program, experimental children reduced the annual frequency (p=0.024) and duration (p=0.007) of asthma episodes, and annual days with symptoms (p=0.004), and they increased their self-management index score compared to controls (p=0.05). There was no difference between the groups in terms of school attendance or number of episodes requiring a physician visit.[68]

Table 12b. Summary of school-based patient education interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Henry et al.[105]	To evaluate whether a 3 lesson package about asthma delivered by school teachers to improve symptoms and QOL for children with asthma.	Year 8 students (aged 13-14 years) in 17 intervention and 15 control schools in New South Wales Australia. N_{int}=299; N_{con}=234.	RCT	Each intervention school was invited to send 1 teacher to a 1-day training seminar to learn to provide a 3 lesson asthma education package designed to be taught within the health/physical education curriculum.	6 months after the intervention, there was no significant difference in asthma symptoms. Compared with control students, intervention students has small but significant improvements in total QOL (p=0.003).[105]
Hill et al.[106]	To determine whether an intervention program based on existing school and community resources can reduce school absences and improve participation in sport in children with unrecognized, under-treated asthma.	Children aged 5-10 years in Newcastle with relatively poorly controlled asthma. N_{int}=149; N_{con}=147.	RCT	Parents of the children with asthma were sent letters asking them to take their children for assessment by a general practitioner. The GPs reviewed treatment guidelines and use of PF meters. School nurses were given teaching materials on asthma and asked to hold teaching sessions to review with teachers how to review students' inhaler techniques.	Over the next academic year (~9mos), there was no difference in school absences, participation in school activities, or use of asthma medications.[106]
Horner [99]	To evaluate the effects of a school-based education program for children combined with a home-based program for their parents on children with asthma.	44 families of children with asthma aged 8-12 years in the U.S. participated (not clear how many in the intervention group and the control group).	RCT	Children in the intervention group participated in nine 15-minute session covering asthma physiology and symptoms, asthma triggers, management decisions using stories, games, posters, and PF meters. Parents received a booklet on asthma pathophysiology, triggers, medication management, use of inhalers and PF meters.	12 months after the intervention, there was no difference in school absenteeism home management by parents or self management by children between intervention and control groups.[99]

Table 12b. Summary of school-based patient education interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Lwebuga-Mukasa and Dunn-Georgiou[107]	To evaluate the feasibility and effectiveness of a school asthma program in reducing asthma exacerbations among school children.	Children with asthma aged 4-13 attending 5 elementary school in Buffalo, NY.	CBA	Intervention schools implemented a policy requiring that children with diagnosed asthma who have needed daily medications for the condition in the past 12 months, have a health care provider written asthma care plan available at school for home room teachers and the school asthma health team to access. The children, and their parents or guardians and school personnel received a 2-hour educational session on early signs of an asthma attack, medications, how to monitor a response, and when to seek for additional help. They also were educated on recognizing and removing asthma triggers.	There was a greater reduction in rescue treatments in intervention schools (79.6%) compared to control schools (28.6%) in the Spring of 1998 compared to the Fall of 1996.[107]
McGhan et al.[76]	To determine whether the asthma education program "Roaring Adventures of Puff (RAP)," improved asthma management behaviors and health status in elementary school children in Edmonton, Canada.	136 children with asthma aged 7-12 years. N_{int}=65; N_{con}=71.	RCT	Parent and teacher asthma awareness events were held within the school setting. The intervention provided recommendations for school asthma guidelines and six educational group sessions for children with asthma described above. [77]	9 months post-intervention, experimental children had "more appropriate use of preventive medication" ($p<0.001$), improvement in asthma-related limitations in play, ($p<0.001$) but there were no differences between groups for use of reliever medications, proportions of children on inhaled steroids or bronchodilators, having an action plan, ED visits, unscheduled doctor visits, asthma symptoms, or days lost from school. 26% of the children had regular smoking in the home.[76]
Persaud et al.[87]	To evaluate the effects of a school-nurse based self management program for school children in Texas.	36 children aged 8 to 12 with moderate to severe asthma.	RCT	All children had a visit with a primary care provider at the time of enrollment during which time they were all given written guidelines for medication use, asthma control and prevention, PF meters, and asthma diaries. Intervention children (N=18) also received 8 individualized, weekly, 20 minute sessions with a school nurse to review asthma symptoms and medication and PF meter use. Control children (N=18) visited the school nurse sporadically, on their own initiation.	20 weeks after enrollment, the percentage of children visiting the ED for asthma was higher in the control group (50%) than in the intervention group (22%, $p<0.05$); however, there were no differences in number of ED visits per child or days lost from school between groups.[87]

Table 12b. Summary of school-based patient education interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Salisbury et al.[108]	To compare a nurse-led clinic in schools with general practice care for adolescents with asthma.	382 adolescents with asthma attending secondary schools in Bristol, North Somerset, and South Gloucestershire, U.K.	RCT	Adolescents were randomized to receive either usual care with a pediatrician or to attend a nurse-run asthma clinic. The care in these school-based clinics was "similar to that offered at a nurse-led asthma clinic in general practice, but the discussion was specifically targeted at the needs and interests of adolescents."[108]	At 6 months, intervention adolescents had better inhaler technique, were more like to have a PF meter, and self management plans. There was no significant difference between groups in terms of asthma symptoms, days lost from school, use of inhaled steroids, health services utilization, or health related QOL. The costs of six months asthma care for the interventions were higher than for the control patients.[108]
Shah et al.[92]	To determine if a peer-based, in-school asthma education program can improve HRQL, pulmonary function, and asthma attacks in adolescents with asthma in New South Wales, Australia.	272 students with asthma aged 12-16 years (grades 7 and 10). N_{int}=113; N_{con}=138.	RCT	3-step approach: Step 1: student volunteers were trained as asthma peer leaders during a 6 hour workshop on educating their peers about asthma and its management using games, videos, worksheets, and discussions. Step 2: teams of 3-4 asthma peer leaders conducted three 45-minute health lessons for students in their schools. Leaders used teaching tools to guide students to critically analyze the barriers to asthma management. Step 3: students developed and presented key messages learned in the lessons to their peers. Presentations given by students included short acts, dramas, and songs. All students with asthma were issued a record card to be completed by their doctor.	The results for this study were not reported for all intervention students compared to all control student but were reported for intervention and control students in the 7th grade and the 10th grade. At 8 months, the intervention group had a significant decrease in days absent from school among the 10th graders but not the 7th graders (8 vs. 5days) but not the control group (5.5 vs. 4 days, $p<0.05$). There was no change in pulmonary function or asthma symptoms.[92]
Velsor-Friedrich et al.[69]	To examine the effects of a school-based intervention program on self care abilities, practices and health outcomes of children with asthma.	102 African American 8-13 year old children with asthma recruited from 8 inner-city public elementary schools in Chicago. N_{int}=40, N_{con}=62.	QRCT*	The "Open Airways" educational program utilized an interactive teaching approach applying group discussions, stories, games and role-playing to promote children's active involvement in the learning process. In six 45-minute sessions offered once a week, small groups of children learned new asthma management skills.	5 months after completion of the program, the treatment group had significantly more improvement in PF measurements (7.5% vs. 2.9% improvement, p=0.046), reduction in number of days with symptoms (p=0.047), and number of urgent medical visits (p=0.01). No differences in terms of reported medication use or school absences.[69]

Table 12b. Summary of school-based patient education interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Webber et al.[70]	To evaluated whether the Open Airways program would reduce asthma morbidity and health services utilization among inner-city children with asthma in the Bronx.	599 3rd to 5th graders in the Bronx with asthma.	CBA	599 children in schools with school-based health centers were scheduled to attend the Open Airways program (as described in the two prior studies). They were compared with students in schools with school-based health centers that did not offer the Open Airways program (N not specified) and children in control schools without school-based health centers (N not specified).	Approximately 15 months after enrollment, there were declines in office visits for children attending schools with school-based health centers (with and without the Open Airways program) but not for control school children (for whom there was a (9% increase in office visits) (p=0.01). ED use and hospitalizations declined for all children (no difference among groups).[70]

Note: N_{int}=number of patients in the intervention group at the end of the study. N_{con}=number of patients in the control group at the end of the study.
*QRCT=quasi-randomized controlled trials; ED=emergency department; PF=peak flow; QOL=quality of life. CBA=controlled before-after trial.

Table 12c. Summary of patient education interventions directed at adolescents with asthma

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Bynum et al.[51]	To assess the effectiveness of pharmacists using interactive compressed video (telepharmacy) for teaching MDI technique to rural, adolescents with asthma.	36 adolescents in grades 7-12 with asthma from junior high and high schools in rural Arkansas. N_{con}=21, N_{int}=15.	RCT	All patients had two 15-minute individual sessions with a pharmacist. During the 1st session, intervention subjects demonstrated their MDI technique and were then counseled by a pharmacist via verbal instructions and demonstrations on any needed corrections to their MDI technique. MDI technique was immediately reassessed and measured again 2-4 weeks later (follow up). The control subjects demonstrated MDI technique, were then given written instructions for MDI technique on a package insert with a placebo inhaler, and their MDI technique was assessed again immediately and 2-4 weeks later (follow up). The sessions took place at local health clinics equipped with interactive compressed video technology.	At the 2-4 week follow up, there was no significant difference between the intervention and the control group in MDI technique. However, the intervention group did have statistically significantly more improvement in MDI technique from baseline than the control group ($p<0.001$).[51]
Cowie et al.[109]	To determine the effects of an age-specific asthma program on the rate of hospitalizations and QOL.	62 asthma patients aged 15-20 years old in Calgary. N_{int}=29; N_{con}=33.	RCT	Patients were invited to attend the Young Adult Asthma Program (YAAP) and were asked to follow up 1 year after. The program included 2-5 sessions that involved an initial questionnaire, an assessment of inhaler technique, spirometry, and asthma education delivered by a physician, or health educator.	At six months after the enrollment, there were no differences between groups in terms of disease control, hospitalizations, use of inhaled corticosteroids, symptoms, or days lost from work or school. 53% of the subjects smoked or lived with a smoker. There was no reduction in smoking after the intervention.[109]
Henry et al.[105]	To evaluate whether a 3 lesson package about asthma delivered by school teachers to improve symptoms and QOL for children with asthma in New South Wales Australia.	Year 8 students (aged 13-14 years) in 17 intervention and 15 control schools. N_{int}=299; N_{con}=234 had asthma.	RCT	Each intervention school was invited to send 1 teacher to a 1-day training seminar to learn to provide a 3 lesson asthma education package designed to be taught within the health/physical education curriculum.	6 months after the intervention, there was no significant difference in asthma symptoms or limitations in activity due to symptoms. Compared with control students, intervention students has small but significant improvements in total QOL ($p=0.003$).[105]

Table 12c. Summary of patient education interventions directed at adolescents with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Salisbury et al.[108]	To compare a nurse-led clinic in schools with general practice care for adolescents with asthma.	382 adolescents with asthma attending secondary schools in Bristol, North Somerset, and South Gloucestershire, U.K.	RCT	Adolescents were randomized to receive either usual care with a pediatrician or to attend a nurse-run asthma clinic. The care in these school-based clinics was "similar to that offered at a nurse-led asthma clinic in general practice, but the discussion was specifically targeted at the needs and interests of adolescents."[108]	At 6 months, intervention adolescents had better inhaler technique, were more like to have a PF meter, and self management plans. There was no significant difference between groups in terms of asthma symptoms, days lost from school, use of inhaled steroids, health services utilization, or health related QOL. The costs of six months asthma care for the intervention adolescents were higher than for the control patients.[108]
Shah et al.[92]	To determine if a peer-based, in-school asthma education program can improve HRQL, pulmonary function, and asthma attacks in adolescents with asthma in New South Wales, Australia.	272 students with asthma aged 12-16 years (grades 7 and 10). N_{int}=113; N_{con}=138.	RCT	Step 1: student volunteers were trained as asthma peer leaders during a 6-hr workshop on educating their peers about asthma and its management using games, videos, worksheets, and discussions. Step 2: teams of 3-4 asthma peer leaders conducted three 45-min health lessons for students in their schools. Leaders used teaching tools to guide students to critically analyze the barriers to asthma management. Step 3: students developed and presented key messages learned in the lessons to their peers. Presentations given by students included short acts, dramas, and songs. Students with asthma were issued a "record card" to be completed by their doctor.	The results for this study were reported only for intervention and control students in the 7th and 10th grades. At 8 months, the intervention group had a significant decrease in days absent from school among the 10th graders but not the 7th graders (8 vs. 5days) but not the control group (5.5 vs. 4 days, $p<0.05$). There was no change in pulmonary function or asthma symptoms.[92]
van Es et al.[110]	To determine if a theory-based educational intervention can improve medication adherence in adolescents with asthma in the Netherlands.	67 adolescents with asthma aged 11-18 years old and attending secondary school. N_{int}=33; N_{con}=34.	RCT	A treating physician and a trained asthma nurse provided intensive educational intervention, which involved 4 monthly physician visits, 4 individual visits with asthma nurse, and 3 group sessions. Patients were instructed on medication use, self management, coping skills, communication.	At 24 months after the intervention, the education group reported somewhat higher self-reported adherence (score of 7.7 vs. 6.7 on a 10 point scale in which 1=never take prophylactic medications to 10=always take prophylactic medications) p=0.05.[110]

Note: N_{int}=number of patients in the intervention group at the end of the study. N_{con}=number of patients in the control group at the end of the study. ED=emergency department; PF=peak flow; QOL=quality of life

Table 12d. Summary of outpatient patient education interventions directed at children with asthma

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Alexander et al.[111]	To evaluate whether clinical nurse specialist involvement would influence ED utilization by poorly controlled, noncompliant children with asthma.	21 children (<14 years old) with no regular physician who had had one or more ED visits in Tennessee within the past year. N_{int}=11; N_{con}=10.	RCT	Patients were cared for by a CNS (Clinical Nurse Specialist) that assumed responsibility for assessment, counseling, and follow up. Education was provided in 2-5 classes or sessions.	At 1 year, there was a significant greater reduction in ED visits (2.6 to 0.6 visits per patient per year) among the study group than the control group (2.5 to 2.4) ($p<0.05$).[111]
Bonner et al.[112]	To determine the effects of a theory-based educational intervention on asthma knowledge, adherence, symptoms, and prescription of anti-inflammatory medication in urban Latino and African American families with pediatric asthma.	119 asthma patients treated in the general pediatric clinic or pulmonary clinic of an urban university hospital in New York. Mean age 9.5years (range: 4.2 to 19.1yrs); N_{int}=56; N_{con}=63.	RCT	A trained, bilingual family coordinator delivered intensive, individualized educational intervention, which consisted of 3 asthma workshops that stressed management of chronic disease, coached families about ways to improve communication with doctors, accompanied families to clinic visits to facilitate communication, monitored diaries, and stressed avoidance of triggers. The intervention also included allergy testing to help with avoidance of triggers, and home inspection for potential triggers.	At 3 months, the intervention group had an increased in prescriptions of controller medications , adherence to pharmacotherapy, prophylactic use of bronchodilators, and decreases in symptom persistence and activity restriction ($p<0.05$ for all comparisons). [112]
Burkhart et al.[71]	To determine the effects of interventions that combine education and behavioral techniques in managing asthma at home.	42 English-speaking children aged 7-11 years with persistent asthma in Kentucky; N_{int}=21; N_{con}=21.	RCT	Patients received asthma education and instructions on how to use an electronic PF meter twice daily and record data in an asthma diary. Patients received three 1-hour individual sessions with a nurse, a contingency management intervention, which consisted of a contingency contract, reinforcement, tailoring, and reminders. The contract outlined requested behaviors (PF monitoring, diary self-reporting) and associated rewards. (We describe the rewards used in the section on financial incentives.) A nurse educator also contacted patients weekly to reinforce teachings. The control group received the teaching sessions but no contingency contract and no follow up calls from nurses.	At 5 weeks, they found no difference in adherence with PF monitoring between the intervention and the usual-care (control group) children.[71]

Table 12d. Summary of outpatient patient education interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Deaves[113]	To determine the effectiveness of a health educator in improving outcomes of care for children with asthma in Staffordshire.	63 children with asthma aged 3-16 years in one of 2 general practices. N_{int}=32; N_{con}=31.	QRCT	In a one-time class, children were taught to use PF meter and to keep diary records of asthma events. Parents were given an explanation of the mechanisms of asthma and action of treatment prescribed and given a package of written information	At two years, there were no differences between intervention and control groups in terms of physician-assessments of asthma severity, number of asthma attacks, or days lost from school. However, intervention children had fewer nighttime symptoms and less activity restrictions ($p<0.001$).[113]
Glasgow et al.[114]	Train providers to use and then evaluate the feasibility and effectiveness of a general practice-based, proactive system of asthma care in children with moderate to severe asthma.	Australian children (101 intervention and 73 control) with moderate to severe asthma and a general practitioner and their physicians (12 control and 12 intervention physicians) were enrolled.	RCT	The physicians received 1-to-1 education by one of the study authors on a "3+ Visit Plan" (1st visit: introduce concept of a contract for asthma care; 2nd visit: assess patient's status; 3rd visit: review patient's PF record, complete asthma action plan, and identify triggers; 4th visit: assess progress and answer questions.	12 months after the intervention, intervention children had increased use of written asthma action plans and pressurized metered dose inhalers with a spacer, decreased rates of speech-limiting wheezing, and were less likely to use reliever medications more than 4 days of the week. There was no difference in symptom-free days or ED visits.[114]
González-Martin et al.[115]	To measure the effects of a pharmaceutical care program in children with asthma.	21 children with stable and moderate asthma in Chile. N_{int}=11; N_{con}=10.	RCT	Children were assigned to either a pharmacist-led asthma program or to usual care by their pediatricians. The intervention pharmacists provided both written and verbal instructions to children and parents, information about asthma triggers, treatment alternatives, inhaler techniques, medication side effects, and what to do in the event of an acute attack.	9 weeks after enrollment, there were no differences in spirometry or any domains of health-related QOL.[115]

Table 12d. Summary of outpatient patient education interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Homer et al.[54]	To assess the effectiveness of multimedia educational software program about asthma for inner-city children.	Children aged 3 to 12 with asthma living in inner-city Boston. N_{int}=57; N_{con}=49.	RCT	"Asthma Control" is an interactive educational computer program designed to teach children about asthma and its management. The object of the game is to help the main character, Spacer, a superhero with asthma complete all 6 game levels (3 home and 3 outdoor levels). The player uses his/her knowledge of asthma to help Spacer eliminated common indoor allergens (e.g., cats, smoke) and to avoid outdoor allergens. If Spacer's condition worsens, the program producing coughing and wheezing sounds and may not be about to jump or run. If the player does not eliminate allergens or use preventive medications, Spacer's mother blocks his/her exit from home. Study patients were asked to return to the study site 3 times to use the asthma control educational computer program.	During the one year study period, there were no differences between intervention and control children in terms of ED visits, acute office visits, asthma severity, exposure to environmental triggers, use of PF meters, or asthma management behaviors. Note: 40% of children enrolled in the study had exposure to a least one smoker at home.[54]
Hughes et al.[116]	To determine if education clinic visits and home visits (a comprehensive and ambulatory program) for pediatric asthma management can improve asthma outcomes.	89 children with asthma aged 6-16 years living in Halifax county, Canada. N_{int}=44; N_{con}=45.	RCT	Patients were seen by a pediatric "respiratologist" throughout study period at 3-month intervals. Families were provided a special card to be shown if they were to come to hospital ED. At each clinic visit, a physician outlined the asthma management program, which included the topics of avoidance of triggers, exercise, and medication use. Proper aerosol technique and home management of acute exacerbations were reviewed. Each family was given an education pamphlet. During home visits, potential environmental triggers were identified and discussed. If school problems related to asthma were identified, the nurse coordinator contacted the teacher for discussion.	The intervention group demonstrated improvements in asthma severity scores (p=.02), inhaler technique (p=0.008) and had fewer office visits to primary care physicians than control patients. There were no difference in symptoms (including nighttime symptoms), days missed from school for asthma, ED visits, or hospitalizations at 2 years after the intervention. 59.6% of intervention families and 57.4% of control families had at least one smoker in the home. There were reductions in smokers in both groups, no difference between groups.[116]

Table 12d. Summary of outpatient patient education interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Kamps et al.[117, 118]	To establish whether there are differences between outpatient management of childhood asthma by pediatricians or by asthma nurses.	74 children aged 2-16 with chronic persistent asthma in the Netherlands.	RCT	Children were randomly assigned to receive 1 year of asthma care by either a pediatrician or a specialist asthma nurse. The asthma nurse provided detailed education about the mechanisms of disease, use of medications, management of acute symptoms, and proper inhaler techniques.	At 1 year, there was no difference between children receiving asthma care from a pediatrician than from a nurse specialist in terms of symptom-free days, airway hyperresponsiveness, functional health status, disease-specific QOL.[117] There was also no difference between the groups in terms of daily dose of inhaled or oral steroids, courses of antibiotics, unscheduled outpatient visits, ED visits, hospitalizations, or overall healthcare costs.[118]
Kelly et al.[119]	To examine the effects of a comprehensive education and outreach program designed to decrease ED utilization and hospitalization for Medicaid-insured children with asthma.	78 children with asthma aged 2-16 years enrolled in Medicaid and receiving their care in Norfolk, Virginia.	RCT	Intervention children (and their caretakers) were enrolled in an education and treatment program in a pediatric allergy clinic. They received 1-on-1 education by a physician and asthma outreach nurse on topics including recognition of triggers, environmental control, early warning signs and symptoms, medication usage and side effects, proper usage of inhalers and PF meters. The nurse contacted intervention families monthly to review the patient's health status, symptoms, medications, refill prescriptions, and assist with scheduling and transportation to clinic follow up.	At the end of the study year, intervention children were less likely to have an ED visit and more likely to receive an annual influenza vaccine (95% vs. 23%; $p<0.001$). 47% of the intervention group and 50% of the control group reported $\geq$1 smoker in the home. Subgroup analysis suggested a trend toward greater effectiveness of the intervention to decrease hospitalizations among children residing in smoke-free households.[119]
LeBaron et al.[120]	To assess the effects of an educational program on patient compliance with cromolyn.	31 children aged 6-17 years with mild to moderate asthma not receiving corticosteroids from three private allergy practices in San Antonio, TX. N_{con}=16, N_{int}=15.	RCT	After baseline assessments, patients in the education group received 4 monthly sessions during which patients and their parent(s) received individual instruction from a registered nurse on how and when to use cromolyn. Patients in the control group also had 4 monthly follow up visits during which they were allowed to remain for a longer time in the study office than their allergy visits would have typically lasted during which time they could describe to the investigators any problems their asthma.	After 3 months, there was no significant difference between the groups in frequency or severity of attacks or physician assessment of asthma control in the patients. Comparisons were not made between the intervention and control group for cromolyn sodium compliance because of the high levels of compliance in the experiment and control group at baseline.[120]

Table 12d. Summary of outpatient patient education interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Perrin et al.[121]	To determine the effects of a controlled trial of a combined education and stress management program on the psychological status and daily activities of children.	56 children aged 6-14 with asthma in the U.S. N_{int}=29; N_{con}=27.	RCT	The intervention consisted of sessions including both an education portion and a stress management exercise. 1st session: physician provided education on basic lung function and anatomy and mechanisms of breathing and breathing control. 2nd session: reviewed effects of asthma on other bodily functions and patients' feelings. 3rd session: patients learned methods of prevention and treatment. 4th session: review of previous sessions and discussion of exercise, long-term outcomes, growing up with asthma.	No difference in terms of days of school missed or other functional measures at 4 weeks.[121]
Runge et al[52]	To evaluate whether an internet-based education program as an add-on to a standard patient education program improved health outcomes and reduced costs of children with asthma in Germany.	178 children with asthma aged 8-16.	CBA	48 children in the control group received no education until after the trial. 86 children received the self-management program of five 2hr sessions in which they used role-playing and small group sessions to teach inhaler use, trigger avoidance, medication management, PF monitoring, and decision making. 44 children received this self-management plus self-selected to also use the interactive internet adventure game incorporating virtual asthma-related situations in need of management and also access to online chats with asthma experts, an online PF protocol that can be maintained by the patient, and chat rooms for other users and healthcare providers.	6 months after enrollment, the self-management plus internet (SMI) education group had a mean of 0 emergency visits compared to 0.2 for the control group (CG) and 0.3 for the self-management (SM) alone group ($p<0.03$). The SM group had significantly ($p<0.05$) fewer physician visits (-44%) and emergency treatments (-67%) than CG. PF improved in all groups, no difference among groups. Significant improvements were seen in 3 of 8 QOL domains in both intervention groups but not in the CG. It cost 585€ to deliver the SMI intervention which reduced asthma costs by 461€. Adjusting for benefits in the CG, 0.79€ were saved for every 1€ spent on the SMI intervention during the 1st year. 1 yr follow up data available for the intervention groups but not CG.)[52]

Table 12d. Summary of outpatient patient education interventions directed at children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Shames et al.[58]	To determine if a multi-factorial (behavioral, educational and medical) intervention that includes the use of an asthma education video game intended to promote asthma self-management can reduce morbidity among high-risk, school-aged children.	59 children 5 to 12 years old of low socioeconomic status (receiving or eligible for Medi-Cal) in the San Francisco and San Jose areas. N_{int}=59; N_{con}=60.	RCT	Case managers delivered a 3-session curriculum on asthma self-management, helped coordinate appointments, and made follow up phone calls. The intervention included a super Nintendo asthma video game designed to teach self-management strategies and provide feedback on their performance (in Spanish or English) and an 18-hour per day toll-free hotline staffed by pediatric nurses who had access to each participant's individualized asthma management plan. Patients visited a board certified pediatric allergist-immunologist. Acute and chronic asthma management plans were provided to the families, case managers, and primary care provider.	At 52 weeks, there was no significant difference between the intervention and control groups for symptom-free days, use of a rescue bronchodilator, number of asthma urgent care visits, PF, or FEV_1. There were some improvements in health related QOL in the intervention group.[58]
Shields et al.[122]	To evaluate whether an educational program for children with asthma could decrease ED use.	Patients 18 years or younger who had at least 1 ED visit or hospitalization in Chicago for asthma during the prior 4 years. N_{int}=101; N_{con}=104.	RCT	A nurse provided education within classes and phone calls and covered 23 instructional objectives with 4 content areas: prevention of attacks, medication management, intervention during asthma attacks, and utilization of health care resources.	At 1 year, there was no reduction in ED use, hospitalizations, or office visits between the groups.[122]
Smith et al.[123]	To evaluate an educational intervention to improve medication compliance in Australia.	Patients were invited to participate in the study if they had been prescribed continuous medication, spoke English, and were intending to return to the clinic. N_{int}=93; N_{con}=103.	RCT	Within an outpatient specialty care setting, a physician provided patients with a one time educational session that included written drug information and behavioral strategies.	The intervention group reported better compliance with medicine regimens than controls (78% vs. 54.5%, p<0.001).[123]
Weingarten et al.[124]	To evaluate the effects of multi-disciplinary non-pharmaceutical management of childhood asthma.	21 children with asthma receiving medical care in a general practice in Israel.	RCT	Children were examined by a family physician and a physiotherapist and received information about asthma and its treatment. They also received 12 one-hour group sessions with a physiotherapist who discussed chest expansion exercises for improved lung capacity and clearance of secretions. Mothers had 10 two-hour group meetings with social workers to develop coping mechanisms for acute attacks.	At the end of 10 weeks, PF increased in the intervention group but not in the control group.[124]

Note: *QRCT=quasi-randomized controlled trials. N_{int}=number of patients in the intervention group at the end of the study. N_{con}=number of patients in the control group at the end of the study. ED=emergency department; PF=peak flow; QOL=quality of life. CBA=controlled before-after trial.

Synthesis of Evidence From Self-Monitoring, Self-Management, or Patient Education Interventions for Children With Asthma

In this section we present the results of our evaluation of the association of study design characteristics (e.g., whether the authors specified a theoretical/conceptual framework, year of study, sample size, country), intervention characteristics (e.g., whether parents or caregivers were a target of the intervention, the number of educational sessions provided to students, the setting in which the intervention took place), and improvements in the outcomes of interest for the self-monitoring, self-management, or patient education interventions. We present our analyses according to each of the primary outcome types.

Clinical Outcomes. The 48 studies of pediatric or caregiver education interventions that evaluated clinical outcomes were highly heterogeneous with respect to their reporting of asthma symptoms, spirometric measures, and asthma attacks. (For example, asthma symptoms were reported varyingly as percentage of days with wheeze, amount of daytime wheezing, self-reported severity, and change in physician reported asthma symptoms, among others.) Similarly, we were interested in the effect of these interventions on the amount of rescue medications used in contrast to routine inhaled corticosteroids; however, the heterogeneity of reporting of these outcomes limited our ability to combine them quantitatively. Thus, we evaluated the study design and intervention characteristics associated with the finding of one or more statistically significant clinical outcomes using logistic regression (Table 13). We found that among all studies of pediatric asthma evaluating self-monitoring, self-management, or patient education interventions, those directed at parents or caregivers were most likely to be associated with a statistically significant improvement in clinical outcomes (p=0.02). However, there is insufficient evidence to assess the effect of other key intervention factors such as the intensity of the intervention (i.e., number of times the educator met with the child, parents, or caregivers), the type of provider of the education (e.g., nurse, physician), setting of the educational intervention (e.g., home, school), or the type of educational materials on clinical outcomes.

Table 13. Association of pediatric self-monitoring, self-management, or patient education intervention characteristics and significant clinical outcomes

Predictor variables	Regression Coefficients (SE)	P value
Intervention duration in months (continuous variable)	0.03 (0.08)	0.7
Interventions that targeted parents or caregivers vs. children	-2.70 (1.16)	0.02
Studies that specified a theoretical/conceptual framework vs. those that did not	-0.06 (0.76)	0.9
Year of publication (continuous variable)	-0.05 (0.06)	0.4
Number of educational meetings with the subjects (continuous variable)	-0.28 (0.62)	0.7
Model Constant	99.68 (114.42)	0.4

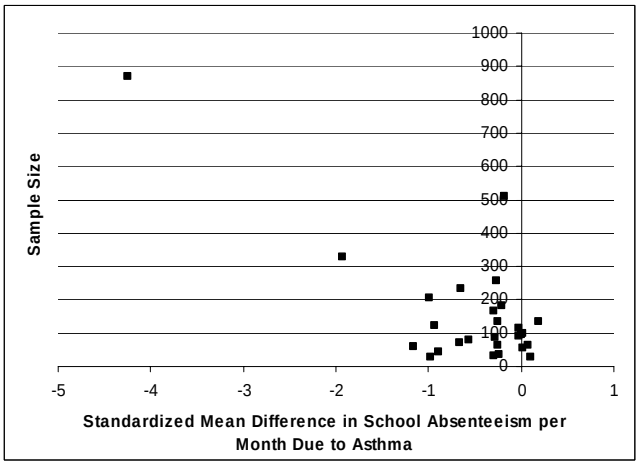
Model details: Method: Logistic regression. Dependent variable: Any statistically significant clinical outcome. R^2=0.3. The predictor variables that were entered as continuous variables are so noted in the table. The 38 studies of self-monitoring, self-management, or patient education interventions reporting data for each of the variables in this regression were included in this analysis. This analysis was not weighted by sample size.

Functional Status Outcomes. Twenty-seven studies reported the mean (or median) days lost from school in a manner that could be use in a summary analysis (as opposed to providing a

statement indicating that there was no difference between treatment and control groups for school absenteeism or a ratio of days in attendance to days absent). For those studies that did not specifically report the timeframe over which the school absenteeism was recorded (e.g., days absent per month versus per school year); we assumed that the reported days of missed school were for the entire study duration. When interpreting these data, we note that not all authors specifically identified these data as mean days lost from school and some likely represent other parameters such as total days lost from school for the whole cohort.

Figure 8 (next page) presents the individual study and summary standardized mean difference (between intervention and control groups) for school absenteeism per month due to asthma. The weighted mean reduction in days absent was 0.11 days/month (95% CI: 0.05, 0.17; p=0.0004). This corresponds to a standardized mean reduction in days absent of 0.53 (95% CI: 0.06, 0.99; p=0.03). However, the studies included in this analysis were highly statistically heterogeneous (Figure 8). Additionally, visual inspection of the funnel plot of these data (Figure 7) suggests that there may be publication bias affecting this result because most of the published studies demonstrated less school absenteeism in the intervention group. Thus, given this heterogeneity and possibility of publication bias, we cautiously conclude that among the self-monitoring, self-management, or patient education studies reporting mean school absenteeism, there may be an overall effect toward reducing asthma-related school absenteeism. Moreover, the magnitude of the effect is relatively small.

Figure 7. Funnel plot: school absenteeism due to asthma



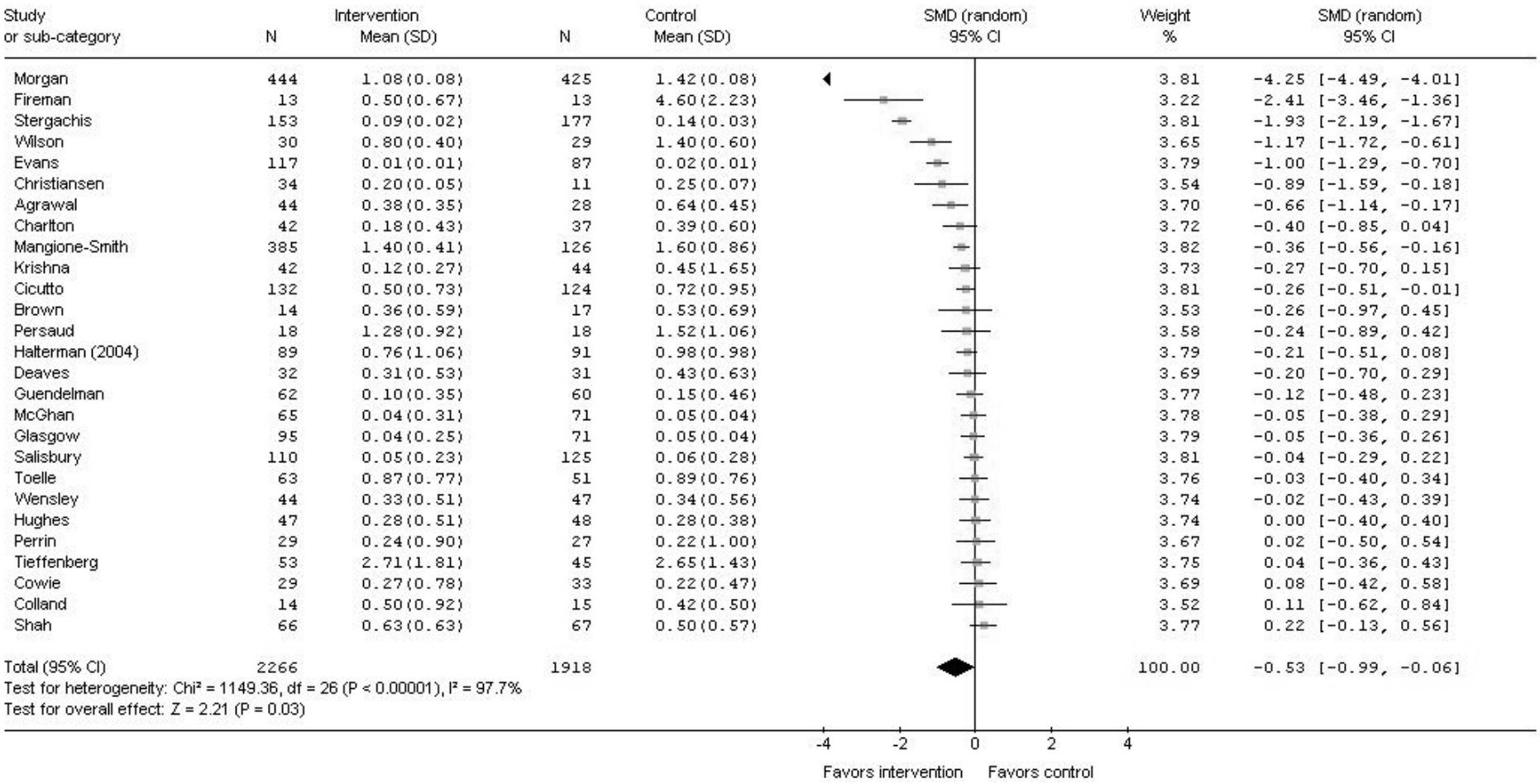
We sought study design and intervention characteristics associated with the greatest reductions in school absenteeism. For this analysis, we used the standardized mean difference in school absenteeism as the dependent variable in a weighted least squares regression. We found that the longer the study duration, the greater the expected reduction in asthma-related school absenteeism (p<0.0001) (Table 14).

Table 14. Association of pediatric self-monitoring, self-management, or patient education intervention characteristics and reductions in school absenteeism

Predictor Variables	Regression Coefficients (SE)	P value
Model Constant	20.974 (95.357)	.829
Intervention duration in months (continuous variable)	-0.159 (0.035)	<0.0001
Year of publication (continuous variable)	-0.01(0.048)	0.8
Studies that specified a theoretical/conceptual framework vs. those that did not	-1.073 (0.596)	0.09
Number of educational meetings with the students (continuous variable)	0.450 (0.387)	0.3

Model details: Weighted least squares regression (weighted by the sample size). Dependent variable: standardized mean difference effect size for school absenteeism. R^2=0.68. 22 studies were included in this analysis (because they reported data for each of the variables included in this regression).

Figure 8. Self-monitoring, self-management, or patient education studies reporting mean number of school days missed due to asthma per month



Notes: The effect sizes presented here are the random effects standardized mean difference (SMD). For those studies that reported the total number of school days missed for asthma per group, we divided the total number of school days missed by the number of subjects in each group to approximate the mean number of days missed per student. For the 13 studies that did not report a measure of variance, we extrapolated a variance from the studies reporting both mean days absent and a variance about this mean weighted by the sample size. We divided the mean number of school days missed by the duration of the study to calculate the mean number of school days missed per month.

Health Services Utilization Outcomes. Among the studies reporting measures of health services utilization, 17 studies reported the mean number of asthma-related emergency department or urgent care visits and 24 studies reported mean number of hospital days in a manner that could be use in summary analyses. For those studies that did not specifically report the timeframe over which the emergency department/urgent care visits or hospitalizations were recorded; we assumed that they were for the entire study duration. For some studies, the authors did not specify whether the reported number of emergency room visits was the total for their cohort or the mean visits per group. Because we calculated standardized mean differences (as opposed to weighted mean differences which are not normalized by the variance in the reported outcome), we included both of these types of data in our analyses. Some studies only reported the percentage of patients in each group who had at least one visit to an urgent care or hospital. We did not include these data in our standardized mean difference calculations. Physician office visits were reported too heterogeneously to be combined (e.g., emergency visits to physician office for asthma, regular physician visits for asthma, total outpatient physician visits).

Asthma-related emergency department or urgent care visits. Figure 11 presents the individual study and summary standardized mean difference (between intervention and control groups) for mean asthma-related emergency department/urgent care visits per month. The weighted mean reduction was 0.01 visits per month (95% CI: 0.00, 0.02; p=0.17). The standardized mean difference was -0.12 (95% CI: -0.29, 0.05; p=0.16). Additionally, the studies included in this analysis were highly heterogeneous—which can readily be seen from the wide range of reported mean visits across the studies (Figure 11-see below). Visual inspection of the funnel plot of these data (Figure 9) does not suggest significant publication bias (there are studies demonstrating a range of effect size). We conclude that among the self-monitoring, self-management, or patient education studies reporting mean emergency visits due to asthma, we did not find a statistically significant overall effect toward reducing asthma-related visits.

We sought study design and intervention characteristics associated with the greatest reductions in asthma-related emergency department/urgent care visits. For this analysis, we used the standardized mean difference in visits per month as the dependent variable in a weighted least squares regression. Our analysis was limited by the small number of studies reporting this outcome. We did not find any statistically significant predictors of reductions in emergency department/urgent care visits (Table 15).

Figure 9. Funnel plot: asthma-related ED/urgent care visits

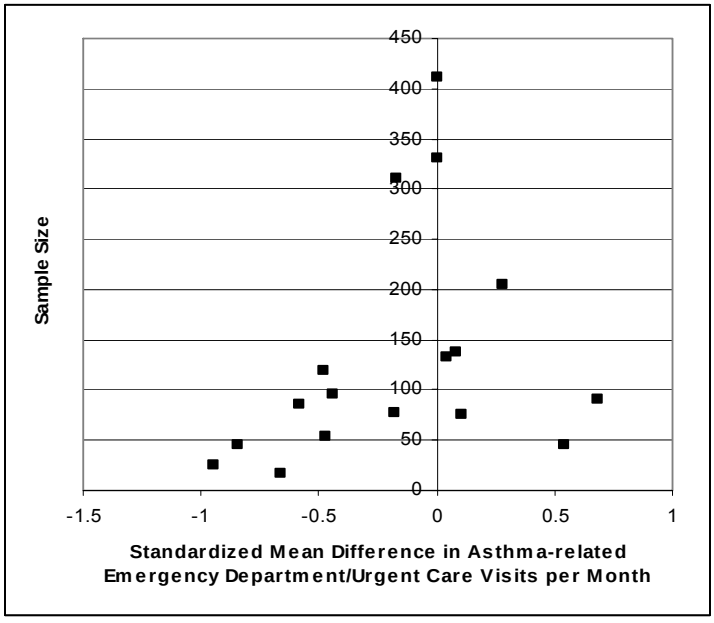


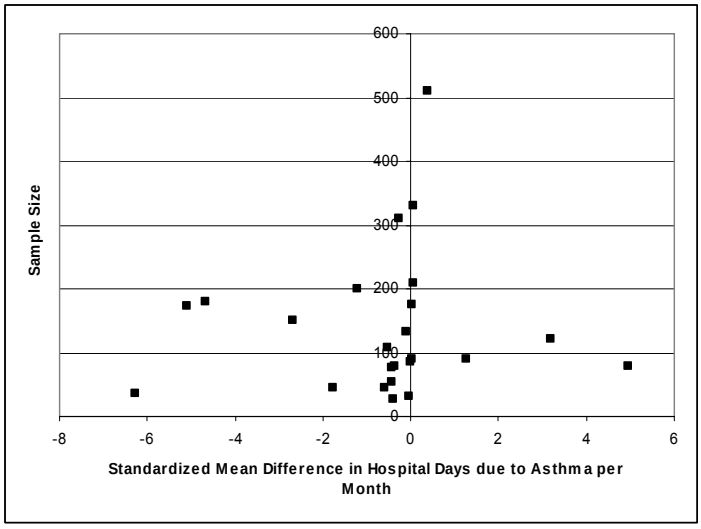
Table 15. Association of pediatric self-monitoring, self-management, or patient education intervention characteristics and reductions in asthma-related emergency department/urgent care visits

Predictor Variables	Regression Coefficients (SE)	P value
Model Constant	-1.52 (2.13)	0.1
Intervention duration in months (continuous variable)	0.03 (0.01)	0.07
Number of educational meetings with the students (continuous variable)	0.46 (0.21)	0.08
Setting in which the intervention took place (categorical variable)	0.07 (0.13)	0.6

Model details: Weighted least squares regression (weighted by the sample size). Dependent variable: standardized mean difference effect size for emergency department/urgent care visits per month. R^2=0.80. 9 studies were included in this analysis (because they reported data for each of the variables included in this regression.

Asthma-related hospitalizations. Figure 12 (see below) presents the individual study and summary standardized mean difference (between intervention and control groups) for mean hospital days per month due to asthma. The weighted mean difference was a reduction of 0.09 hospital days per month (95% CI: -0.26, +0.08; p=0.3). The standardized mean difference was -0.09 (95% CI: -0.26, 0.08; p=0.3). Additionally, the studies included in this analysis were highly heterogeneous—which can readily be seen from the wide range of reported mean hospital days across the studies (Figure 12-see below). Visual inspection of the funnel plot of these data (Figure 10) also suggests that there may be publication bias affecting this result (most studies report greater reduction in mean hospital days in the intervention group). We conclude that among the self-monitoring, self-management, or patient education studies reporting mean hospital days due to asthma, there is no overall effect toward reducing asthma-related hospitalizations.

Figure 10. Funnel plot: hospitalizations due to asthma



We sought study design and intervention characteristics associated with the greatest reductions in asthma-related hospitalizations. For this analysis, we used the standardized mean difference in hospitalizations as the dependent variable in a weighted least squares regression. We found that the greater the number of educational sessions provided, the greater the expected reduction in asthma-related hospitalizations (p=0.01) (Table 16). However, in none of our exploratory analyses was the intensity of the intervention, the type of provider of the education, the setting of the educational intervention, the type of educational materials used, or the number of QI strategies used in the intervention associated with reductions in school absenteeism (not all data shown).

Table 16. Association of pediatric self-monitoring, self-management, or patient education intervention characteristics and reductions in asthma-related hospitalizations

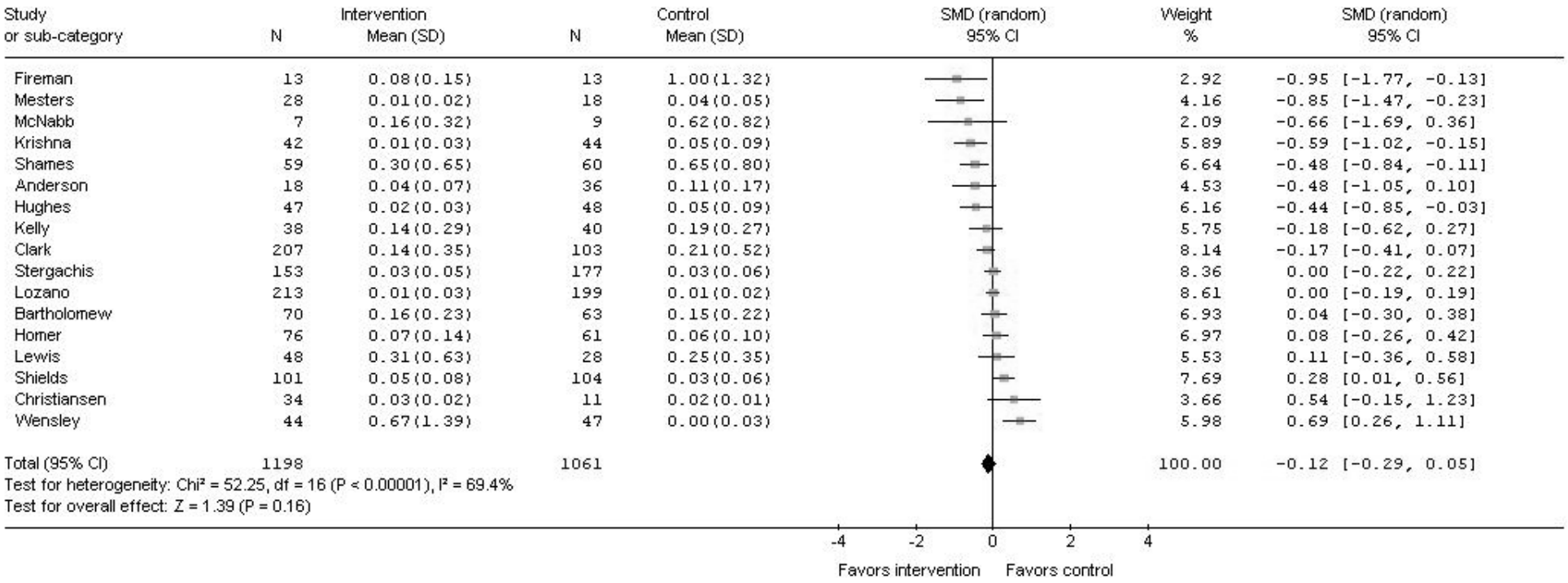
Predictor Variables	Regression Coefficients (SE)	P value
Model Constant	4.0 (2.13)	0.1
Intervention duration in months (continuous variable)	0.0004 (0.08)	0.9
Country of intervention (categorical variable)	0.67 (0.47)	0.2
Studies that specified a theoretical/conceptual framework vs. those that did not	0.79 (1.10)	0.5
Number of educational meetings with the students (continuous variable)	-2.05 (0.63)	0.01
Setting in which the intervention took place (categorical variable)	-0.31 (0.26)	0.3

Model details: Weighted least squares regression (weighted by the sample size). Dependent variable: standardized mean difference effect size for monthly hospital days. R^2=0.64. 13 studies were included in this analysis (because they reported data for each of the variables included in this regression

Guideline Adherence Outcomes. The 27 studies reporting guideline adherence outcomes were highly heterogeneous. We performed logistic regression, using any statistically significant guideline adherence outcome as the dependent variable and study/intervention characteristics as the independent variables. In none of our analyses was the study design, the use of a theoretical/conceptual framework, the duration of the intervention, the frequency of interactions with the patient, the type of provider of the education (e.g., nurse, physician), setting of the educational intervention (e.g., home, school), the type of educational materials used associated with improved outcomes (data not shown).

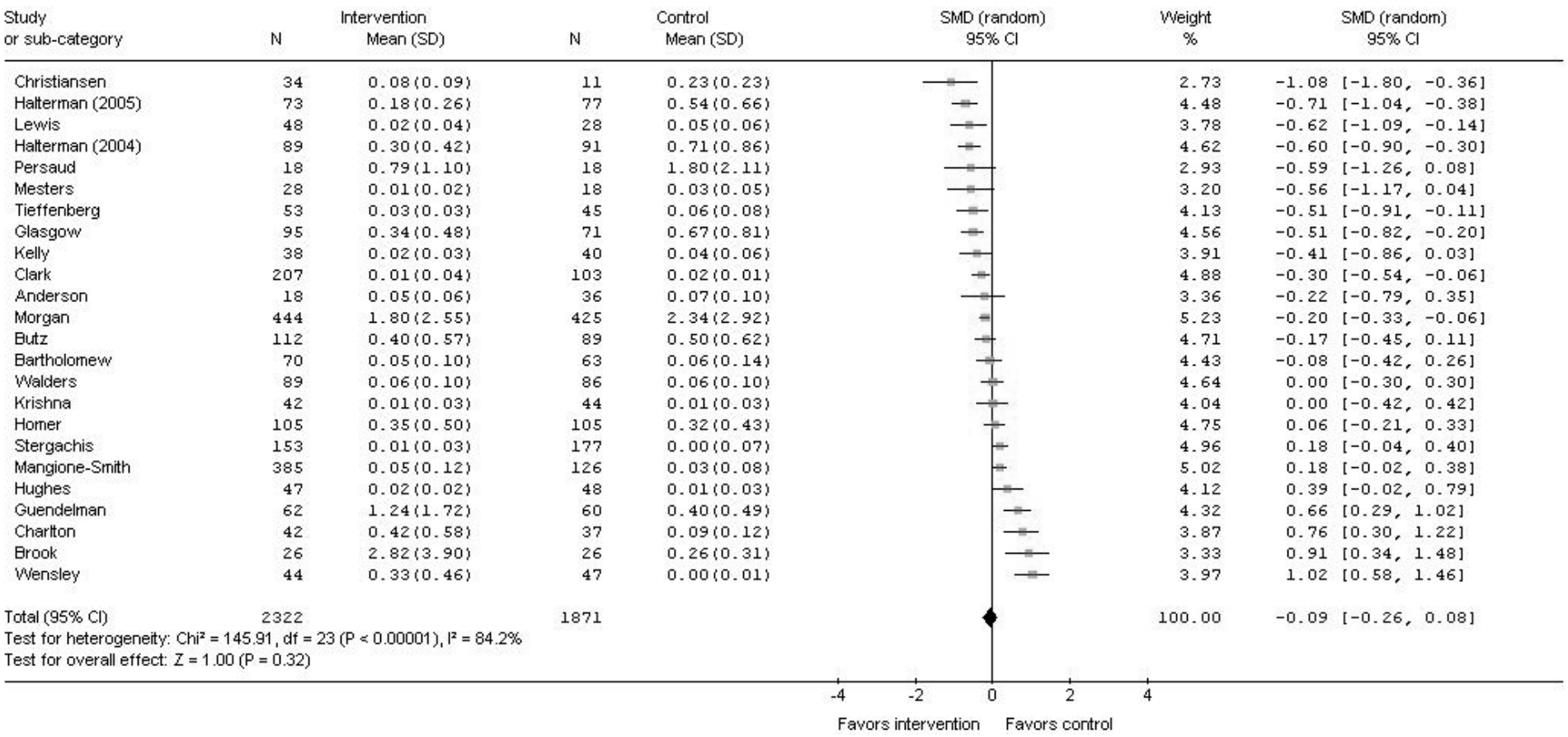
Conclusions. We conclude that self-monitoring, self-management, or patient education interventions may result in improvements in clinical outcomes for children with asthma—particularly interventions that include a component directed at parents or caregivers. Additionally, longer intervention duration and greater numbers of educational sessions may be associated with improvements in functional status. We note that our regression analyses were limited by the small number of studies consistently reporting similar outcomes and the significant heterogeneity among the studies (which likely reflects, in part, the heterogeneity in study populations including key characteristics such as asthma severity and socio-economic status). This relatively low statistical power limited our ability to corroborate some of the univariate associations described in the preceding sections.

Figure 11. Self-monitoring, self-management, or patient education studies reporting mean number of emergency department/urgent care visits due to asthma per month



Notes: The effect sizes presented here are the random effects standardized mean difference (SMD). For the 11 studies that did not report a measure of variance, we extrapolated a variance from the studies reporting both mean days absent and a variance about this mean weighted by the sample size. We divided the mean number of emergency department/urgent care visits by the duration of the study to calculate the mean number of visits per month.

Figure 12. Self-monitoring, self-management, or patient education studies reporting mean number of hospital days due to asthma per month



Notes: The effect sizes presented here are the random effects standardized mean difference (SMD). For those studies that reported the total number of hospital days for asthma per group, we divided the total number of hospital days by the number of subjects in each group to approximate the mean number of hospital days missed per subject. For the 19 studies that did not report a measure of variance, we extrapolated a variance from the studies reporting both mean days absent and a variance about this mean weighted by the sample size. We divided the mean number of hospital days by the duration of the study to calculate the mean number of hospital days per month.

General Characteristics of Self-Monitoring, Self-Management, or Patient Education Interventions for General Populations or Adults With Asthma

Background. As for the interventions designed specifically for children, self-monitoring or self-management interventions for general populations with asthma (typically for adults but occasionally mixed populations) generally include written instructions on how to alter medications based on information about disease status as measured either by symptoms or peak flow. It has been demonstrated that patients with asthma, regardless of age, often do not use their inhalers properly—even the reputedly easy-to-use dry powder inhalers have correct usage rates that vary widely (5 to 78%).[125] Because poor inhaler technique can result in decreased delivery of medication to the lungs, increased asthma symptoms, higher costs, and increased side effects,[125] many patient education interventions are designed to improve inhaler technique and medication adherence, and to decrease asthma symptoms and prevent asthma related co-morbidities.

Photo reproduced with permission.[2]

Study Design Characteristics. We identified 78 studies of self-monitoring, self-management, or patient education interventions for adults—59 of these included a self-monitoring or self-management intervention and 19 focused more on patient education (Table 18). Twenty-four studies compared two or more intervention groups without a control that did not also receive a QI intervention (presented in Table 21). Most of the patient education interventions for adults included at least some minimal component of providing adults with the information that they need to make decisions about their own asthma care. Thus, the self-monitoring, self-management, or patient education interventions for adults were overlapping educational interventions. Therefore, we present them together, grouping them to the extent possible according to common characteristics.

The median duration of the follow up period was 11 months (S.D., 9.2 months). The median sample size of these interventions was 100 subjects (Interquartile range: 51, 187). Sixty-three were RCTs, two were quasi-RCTs, and 13 were controlled before-after trials. In univariate analysis, the longest studies were more likely to report a statistically significant improvement in emergency department visits (p=0.02) but not the other outcomes.

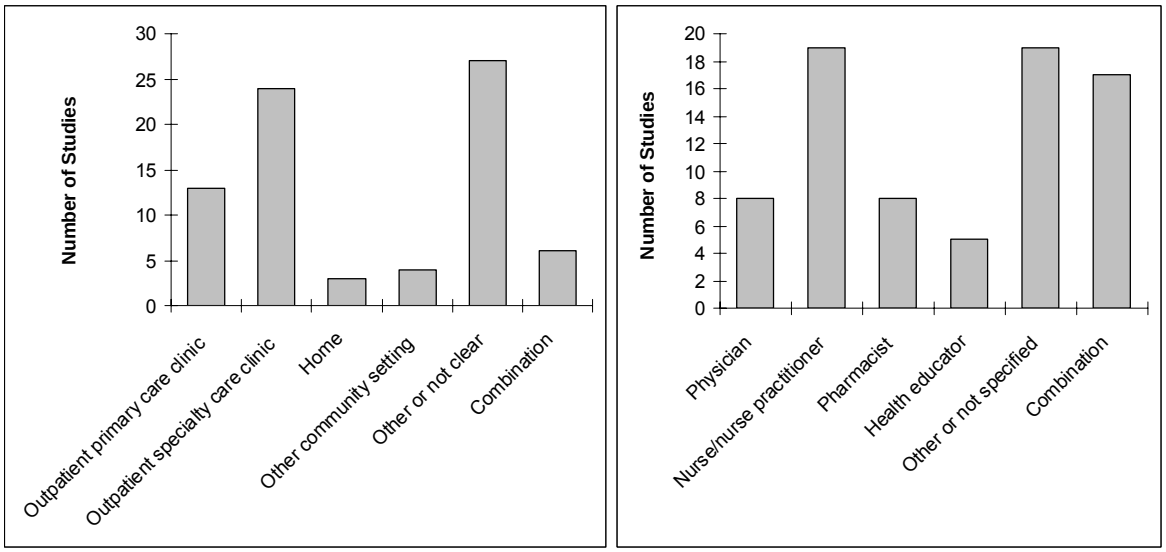
Intervention Characteristics. These educational interventions were highly heterogeneous with respect to the content of the education, the provider of the education, the setting in which the education was provided, and the intensity of the education. Some interventions included multimedia tools, others used one-on-one formal teaching sessions, and several include instructional booklets.

Of the self-monitoring, self-management, or patient education studies, 24 (31%) specifically described an underlying conceptual framework or theoretical background as the basis for the intervention—a considerably lower proportion than for pediatric interventions of this type (62%). The controlled before-after studies were somewhat more likely to report a conceptual or theoretical foundation (38%) than RCTs (27%) (p=0.01).

Compared to the pediatric educational interventions, the educational interventions for general populations or adults were less like to be based in primary care clinics (28% versus 17%) and

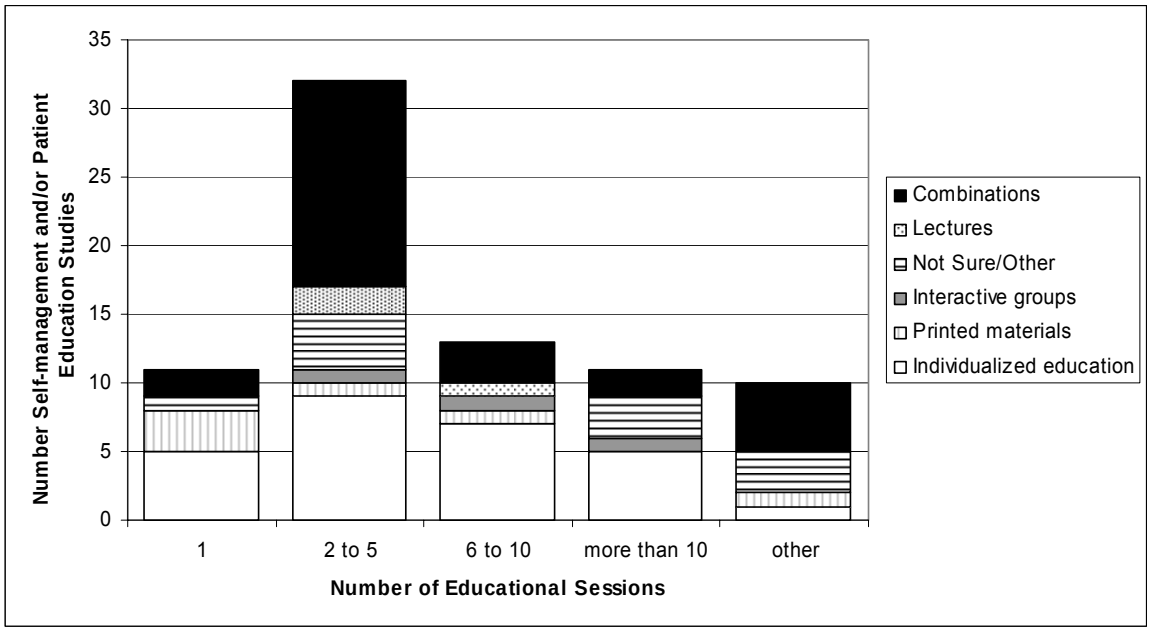
more likely to be based in outpatient specialty clinics (e.g., allergy or pulmonary clinics) (12% versus 30%) (Figure 5 and Figure 13). Most interventions for general populations or adults were taught by nurses/nurse practitioners or physicians (Figure 13).

Figure 13. Intervention characteristics: setting and educator type



Thirty-three (42%) of the self-monitoring, self-management, or patient education interventions provided two to five educational sessions. Twenty-seven interventions principally provided individualized instruction, three principally used interactive group teaching sessions, and 27 used combinations of teaching modalities (Figure 14). Five interventions included a computer/web-based component—the use of these technologies was not associated with statistically significant improvements in outcomes or processes of care for general populations or adults with asthma.

Figure 14. Number of educational sessions provided by educational strategy



Outcomes Reported. The 78 self-monitoring, self-management, or patient education studies' most frequently reported outcomes were asthma symptoms, urgent care or emergency department visits and hospitalizations due to asthma, and amount of asthma medications used (Table 17). The 42 studies that reported on asthma symptoms were highly heterogeneous—some presented self reported symptoms from patient diaries whereas others evaluated physicians' ratings of asthma symptoms. Similarly, the studies reporting on medication use sometime reported frequency of inhaled β-agonist use per patient whereas others reported the number of prescriptions for oral corticosteroids for the intervention group over the study interval.

Table 17. Outcomes reported by the adult self-monitoring, self-management, or patient education studies

Outcomes	Number of studies reporting no difference between intervention and control subjects (%)	Number of studies reporting improvement among intervention compared with control subjects (%)*	Number of studies reporting this outcome
Clinical status measures§	34 (52)	31 (48)	65
Asthma symptoms	23 (55)	19 (45)	42
Symptom-free days	6 (67)	3 (33)	9
Amount of medication used or prescribed	21 (60)	14 (40)	35
Number of asthma attacks	6 (86)	1 (14)	7
Pulmonary function from peak flow, FEV_1, or other spirometric measures	30 (73)	11 (27)	41
Functional status measures	26 (76)	7 (21)	34¶
Activity restriction	10 (77)	3 (23)	13
Days lost from school/work	19 (79)	4 (16)	24¶
Health services utilization	32 (71)	13 (29)	45
ED/urgent care visits	21 (68)	10 (32)	31
Hospitalizations	30 (83)	6 (17)	36
Office visits	13 (93)	1 (7)	14
Guideline adherence	14 (35)	26 (65)	40
Adherence with PF monitoring	7 (70)	3 (30)	10
Use of self-management or action plans	8 (62)	5 (38)	13
Inhaler technique	6 (43)	8 (57)	14
Appropriate use of asthma medications	9 (47)	10 (53)	19

Note: ED=emergency department; PF=peak flow. In this table we present data from all studies of pediatric self-monitoring or self management or patient education, including the studies which compared two or more groups without a control arm that did not also receive a QI strategy.

§ For each of the categories of outcomes highlighted in bold (e.g., clinical status measures, functional status measures), we recorded whether the study reported one or more statistically significant changes between the intervention and control group at the end of the study period in any of the individual metrics associated with that outcome category.

¶ One study reported worsened functional status (specifically increased rates of days lost from work/school) for the intervention group compared to the control group.

Interventions Led Principally by Nurses and Pharmacists. 21 interventions relied primarily on nurses to deliver the self-monitoring or self-management program (Table 18a). (Note: many other studies used a combination of physicians, nurses, and other health providers to work in concert to provide various elements of the educational materials—the interventions described in this section were led exclusively or primarily by nurses.) Six of these compared two or more intervention groups without a control that did not also receive a QI intervention (presented in Table 21).[126-132] Several of the nurse-led interventions lacked key characteristics that would seem predictive of being able to produce and detect statistically significant improvements for patients: only five reported basing their educational intervention on a theoretical or conceptual framework[131-136] and seven had sample sizes of 65 subjects or less.

Notable among the interventions in this category for its rigorous design, sample size, duration, intensity of educational program provided, duration, and reporting is the study by Wilson et al.[136] This RCT with four arms enrolled 235 patients aged 18-50 with moderate to severe asthma from five Northern California Kaiser Medical Centers. Patients enrolled in the small group education program (N=83) met weekly with a nurse-educator for four 90-minute education sessions for instruction in asthma and asthma management. The intervention was designed based on cognitive learning theory and utilized both verbal and printed instruction materials. Patients enrolled in the individual education program (N=81) met weekly with the nurse-educator for three to five 45-minute meetings where the educator chose among 18 instructional modules (covering the same content included in the small-group program) to develop a program tailored to the needs of the individual. Intervention patients kept symptom-medication diaries. The standard control group (N=71) was given no formal education. An information control group (N=75) was given a workbook containing the same basic information given to the intervention groups. At 12 months, patients in both the group and individualized educational programs were significantly more likely than controls to improve in multiple outcomes ($p<0.05$ for all comparisons) including asthma symptoms (55% and 50%, respectively compared to 25% in control group), symptom free days (49% and 51%, respectively compared to 26% in the control group), and bedroom control practices (62% and 53%, respectively compared to 32% in the control group). (See Table 18a for more details on this study.)

Table 18b presents the six education interventions led principally by pharmacists. All of these studies reported finding statistically significant improvements in processes or outcomes of care for general populations or adults with asthma. As a group, these interventions had relatively more frequent interactions with patients than other educational interventions—for example, the brief (3 month) study by Barbanel and colleagues provided patients with an initial individualized session followed by weekly calls from a pharmacist to review medications for the next three months.[137] Similarly, the large study (N=413) by Herborg and colleagues required monthly sessions for patients and their pharmacists for a year. Because of the small number of studies of this category, we did not have sufficient power to assess whether the frequency of patient interactions was consistently associated with the positive outcomes reported among the educational interventions led by pharmacists.

Other General Population or Adult Self-Monitoring, Self-Management, or Patient Education Interventions. The 33 studies in Table 18c evaluated a broad range of interventions. Among these, the factor most consistently associated with improvements in outcomes for patients was the use of combinations of educational techniques and materials including individualized interactions, group interactions, role-playing, and printed materials among others. Twenty-three of the 27 (85%) self-monitoring, self-management, or patient education interventions for adults that utilized combinations of educational modalities found statistically significant improvements in processes and outcomes of care for patients. In contrast, the interventions that utilized principally a single educational modality were less likely to report statistically significant outcomes: 70% (19/27) of the interventions that exclusively used individualized education, 66% (2/3) of interventions that exclusively used lectures, 33% (2/6) of interventions that exclusively used printed materials, and 33% (1/3) of interventions that exclusively used interactive groups found improvements for patients.

We did not find that the frequency of patient interactions with the provider of the educational intervention was a key factor in producing improvements for patients. Some interventions provided no direct interaction between healthcare providers but still found statistically significant improvements in patient outcomes (e.g., the study by Legorreta (one of the largest in this systematic review) involved 999 patients who received self-monitoring or self-management and educational materials including written materials, peak flow meters, and a video directly from their HMO, and were found to have improvement in daily use of steroid inhalers and PF meters[138]). In contrast, other interventions provided intense interactions with patients but failed to produce or detect improvements for patients (e.g., the 10 patient study by Grover and colleagues in which patients received 15 individualized educational sessions[139]).

Similarly, no particular intervention setting was consistently associated with improvements in outcomes. In contrast, three of the self-monitoring, self-management, or patient education studies were home-based and none found improvements in outcomes for patients.[140-142]

Three of the included studies[133, 143, 144] based their self-management intervention on the Wheezers Anonymous program. Developed by Winder and colleagues,[143, 144] Wheezers Anonymous was based on two effective self-monitoring or self-management programs for children (Living with Asthma[145] and the Family Asthma Program[146]) and was designed to provide comprehensive asthma education and self-monitoring or self-management skills with minimal leader training for use in clinical settings (Table 18c). It uses a combination of teaching modalities including lectures, videotaped segments, and discussion sections.[143] The relatively small study by Kotses and colleagues, found improvements in peak flow measures among recipients of Wheezers Anonymous compared to control subjects.[144] However, the other studies did not report consistent improvement in clinical, functional, or health services utilization measures among recipients of Wheezers Anonymous compared to control subjects.[133, 143]

Conclusions. Self-monitoring, self-management, or patient education interventions can be effective for improving the processes and outcomes of care for adults with asthma. In particular, interventions that utilize combinations of educational modalities and those that rely on pharmacists to lead the educational effort have been associated with statistically significant improvements for patients.

Table 18a. Summary of nurse-led self-monitoring, self-management, or patient education interventions directed at adults with asthma

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Berg et al.[133]	To evaluate the effects of a nurse-administered asthma self-management program for patients treated in a rural setting.	55 patients with asthma prescribed inhaled medications over the age of 18 living in a rural area in the U.S. N_{con}=24, N_{int}=31.	RCT	The experimental group received 6 weekly, 2-hour, nurse led asthma self-management education sessions based on Wheezers Anonymous and kept an asthma diary. The education program was held in the community and included information about self-management behaviors and skills, asthma medications, asthma triggers, and prevention of asthma attacks. The intervention group also recorded medication taking and symptom information daily. The control group received usual care.	After 7 weeks, there were no significant differences between the intervention and control groups for average totally daily symptoms, percentage of symptom-free days, and morning or evening PF. However, the intervention group was more adherent to medication regimens than the control group (p=0.043).[133]
Bolton et al.[147]	To determine whether a self-management training program decreases ED visits and reduces costs for patients with asthma.	224 adult patients with asthma aged 18-70 years who visited one of the ED departments of two hospitals (one urban, one suburban) in the U.S. N_{con}=118, N_{int}=106.	RCT	The intervention consisted of three one-hour small-class interactive educational sessions on asthma that stressed compliance with medical regimens and self-care. The sessions were conducted by a specially trained RN and held at one of two hospital sites. Patients in the control group received no intervention.	After 12 months, the intervention group had significantly fewer ED visits (p=0.0005) and days of limited activity (p=0.04) than the control group. There were no significant differences between the groups in hospitalizations or physician visits. ED costs were significantly less (p<0.02) for the intervention. However, physician, hospitalization and total costs did not significantly differ between groups.[147]
Cambach et al.[148]	To determine the differences in efficacy between a pulmonary rehabilitation program within local physiotherapy practices, that include drug treatment and a control condition of drug treatment only.	Adult patients with asthma aged 18-75 years old in the Netherlands. $N_{int-pre}$=22, mean age: 40 yrs.; $N_{con-pre}$=21, mean age: 53 yrs.	RCT	Within an outpatient specialty care setting, a nurse conducted more than 10 interactive group sessions that comprised techniques of breathing retraining and evacuation of mucus, exercise training (both for lower and upper extremities), patient education, relaxation techniques and recreational activities.	6 months after the intervention, subjects had greater exercise tolerance and 6 minute walk times (p<0.05). There was no significant difference in QOL between the groups.[148]

Table 18a. Summary of nurse-led self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Cowan et al.[134]	To determine the effects of a regional asthma education center run principally by nurses on reducing asthma related morbidity and improving the quality of prescribing.	Asthma patients aged 5-45 years living in 2 regions of Quebec referred by their physicians. N_{int}=8,835; N_{con}=19,200.	CBA	Patients were referred to the asthma teaching program for 2 sessions in which they received teaching from a nurse on disease mechanisms, triggers and inhaler techniques. Printed or audiovisual materials were also distributed to participants.	No difference between groups in ED visits or medication use.[134]
Delaronde et al.[149]	To identify and educate members of a regional managed care organization in the U.S. who were not using asthma medications as recommended by the NHLBI by means of a nurse-administered 6-month telephonic case management intervention.	134 patients with asthma aged 13-65 years who were not using asthma medications as recommended by the NHLBI. N_{con}=67, N_{int}=67.	RCT	After an initial patient telephone assessment, a nurse provided monthly telephonic self-management education sessions for six months emphasizing knowledge of the disease process, having an action plan, and knowledge of national guidelines. Compliance with medication use, adherence to the physician-directed asthma management plan, PF monitoring, and trigger minimization and avoidance were assessed during these calls. Patients were also given individualized packets of educational materials. Control patients completed the Mini Asthma Quality of Life questionnaire at baseline and 12 months and were followed for the length of the study.	Six months after the intervention, no significant differences were found between the intervention and control groups in ED visits, hospitalizations, or QOL. When fully adjusted for age and pre-intervention asthma medication index, a significant improvement in dispensed medications (p=0.04) for the intervention group when compared to the control group was noted.[149]
Donaghy et al.[150] and Mulloy et al.[151]	To assess the effectiveness of a structured asthma nurse specialist education intervention.	46 patients with asthma aged 13-50 years in Ireland. N_{int}=18, mean age: 26.2 yrs., N_{con}=28, mean age: 30.7 yrs.	RCT	Within an outpatient specialty care setting, a nurse specialist interviewed patients on asthma technique, reviewed a distributed asthma booklet, and conducted an individual 1-hour asthma action program. Control subjects received usual care.	At one month after the intervention, the intervention group had somewhat better inhaler use (on 2 of 3 measures of inhaler use) than controls. There as no difference in FEV_1 or PF.[150, 151]

Table 18a. Summary of nurse-led self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Garrett et al.[152, 153]	To determine the efficacy of establishing a community asthma education center.	747 patients aged 2-55 years who had received asthma care in the ED in South Auckland.	CBA	2 nurse specialists and a group of respiratory physicians established a community education center run by a nurse and 3 community health workers. The purpose of the education program provided was to educate patients in basic pathophysiology, define and teach trigger avoidance, medications use, inhaler technique and self-management skills (emphasis on PF recordings and symptom diaries), and teach how best to access medical care in response to worsening symptoms.	At nine months, the intervention group was more likely to have preventive medications, PF meters and better PF meter technique, more self-management plans, better knowledge of appropriate action to take when confronted with worsening asthma, less nocturnal awakening, and better self-reported asthma control than the control group. There was no difference between intervention and study patients in medication compliance, hospital admissions, days lost from school or work, ED visits, QOL, or smoking rates (33% for control group and 34% for the intervention group).[152]
Hayward[154]	To assess whether asthma self-management and education improves patient recognition of asthma episodes resulting in improved self-treatment.	42 ages 6-74 at a single practice in the U.K. N_{con}=19, N_{int}=23.	RCT	Patients in the intervention group attended a clinic run by asthma nurse or were telephoned monthly by the nurse for one year. Patients were taught danger signs of worsening asthma and how to react appropriately by increasing medication or seeking medical help. Self-management was based on PF monitoring, and inhaler technique was addressed. The control group received no training or information from the nurse.	After 12 months, the intervention group showed a significant improvement in the number of patients with successful self management (divided by number of asthma exacerbations; $p<0.05$) as compared to the control group. There were no significant differences between the control and intervention group in the number of episodes, symptom scores, or number of days absent from school or work.[154]
Heard et al.[155]	To test whether asthma clinics (intervention) were more effective in reducing morbidity from asthma than standard medical treatment (control).	195 asthma patients between the aged 5-64 years in Australia.	RCT	Each participating practice operated one 3-hour asthma clinic (run by trained nurses) once a week, which were. Clinic sessions involved education in asthma management strategies, written asthma management plans, spirometry and PF instruction, and an asthma diary card. Sessions ended with a consultation with the general practitioner. Patients were asked to attend 3 sessions within the 6 month study interval.	At the end of the study, patients in the intervention group were more likely to own a PF meter and to be smokers than those in the control group. Intervention patients were less likely to wake at least weekly at night due to asthma than control patients. There were no differences in reported time lost from work or school, having an action plan, use of medications, or health services utilization between intervention and control patients. Baseline smoking rates of 9% in the control group and 12% in the intervention group did not change.[155]

Table 18a. Summary of nurse-led self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Janson et al.[156]	To assess the effects of individual self-management education on adherence to medication, airway inflammation, and clinical outcomes.	65 adults (age 18-55) with mild to moderate persistent asthma from clinics in the San Francisco Bay area. N_{con}=32, N_{int}=33.	RCT	All patients participated in a 1-week run-in to collect baseline data. Then patients were randomized. The intervention group received a 30- min individual education from an advanced practice nurse from the asthma education components provided by the National Institutes of Health guidelines. Additionally, inhaler and PF technique were assessed and corrected, and patients were given self-management plans based on PF zones. Follow up visits occurred with the study coordinator biweekly after the education session to reinforce the information covered. All patients kept asthma diaries. The control group had the same number of study visits of the same duration; however, these visits focused on collecting diaries and collecting data.	After 7 weeks, there was significantly higher adherence to inhaled corticosteroids (p=0.01), improved inhaler technique (p=0.01), and numbers of patients making positive environmental control changes (p=0.03) in the intervention group compared to the control. However, there were no between-group differences in symptom severity, the use of β-agonists, FEV1, morning PF, QOL, the use of inhaled steroids regularly at prescribed dose, or monitoring PF regularly.[156]
Levy et al.[157]	To determine whether patient education by hospital based specialist asthma nurses using guided self-management plans could improve patient recognition and self-treatment of asthma.	Patients with asthma over age 18 years in London. N_{int}=103, mean age: 43 yrs., SE: 2. N_{con}=108, mean age: 40 yrs., SE: 2.	RCT	Patients were educated on recognition and self-treatment on asthma, assessed on PF meter use and inhaler technique, and provided a validated, guided self-management credit card plan. Educational intervention was provided in one 1-hour session, followed by two 30-minute sessions with a nurse specialist (either in person or on the phone).	The intervention group reported increased use of inhaled steroids during asthma attacks and had fewer visits to their physicians than control patients. No difference in asthma symptoms, days lost from work, or QOL between groups.[157]

Table 18a. Summary of nurse-led self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Pilotto et al.[158]	To assess the ability of nurse-run asthma clinics based in general practice compared with usual medical care to produce at least a moderate improvement in the QOL in adults with asthma.	153 patients with asthma over the age of 18 from general practices in Australia. N_{con}=82 , N_{int}=71.	RCT	Two respiratory nurses conducted asthma clinics where baseline data was collected, a review of and instruction about inhaler technique was provided, and a packet of information was distributed to each patient. Follow up visits were scheduled at 2 weeks, 3, 6, and 9 months to review inhaler technique and answer questions. Control patients received usual care by their general practitioner.	After 9 months, no significant differences between the intervention and control groups in QOL scores, FEV_1, ED visits, clinic visits or hospitalizations. However, significantly less people in the intervention group compared to the control missed one or more days of work (p=0.004).[158]
Schott-Baer and Christensen[135]	To determine the effects of an asthma patient education program utilizing self-monitoring on patient self-care behaviors.	36 patients with asthma aged 24-74 years from two Midwest ambulatory care clinics. N_{con}=19, N_{int}=17.	RCT	The intervention consisted of a 3-hour instruction program covering the disease process, daily self-monitoring, self-management techniques and daily log completion (diary). A series of 3 phone calls was made between the time of the intervention and the end of the study to reinforce use of the diary. Patients in the control group received standard care, including information and asthma, prescribed medications and instructions on how to record PF measurements.	After 6 weeks, no significant differences were found between the intervention and control groups in ED or clinic visits and no significant difference in recorded PF measurements.[135]
Smith et al.[141]	To determine the effectiveness, in terms of symptom control and QOL, of a psycho-educational program compared to routine care.	84 patients with severe asthma considered to be poorly adherent to their management program in the U.K. N_{con}=42, N_{int}=42.	RCT	Intervention subjects received a 6 month psycho-educational program of home visits and telephone calls from a supervised respiratory nurse specialist. For two months, this included four bi-weekly educational visits, supplemented by brief bi-weekly telephone calls between visits. For four months thereafter, this included monthly telephone calls. Control patients received usual care.	Six months after the intervention, there were no significant differences between the control and intervention groups in symptom control, physical functioning, adherence with PF monitoring, amount of medication used or QOL. When adjusted for major baseline score differences, at 12 months, asthma-specific QOL a significant improvement (p=0.03).[141]

Table 18a. Summary of nurse-led self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Wilson et al.[136]	To evaluate cognitive, behavioral, and clinical effects for individual and group asthma education programs.	235 patients ages 18-50 with moderate to severe asthma from five Northern California Kaiser Medical Centers. N_{con}=71, $N_{con\text{-}info}$=75, $N_{group\text{-}ed}$=83, $N_{ind\text{-}ed}$=81.	RCT	There were four arms to this study. Patients enrolled in the small group education program met weekly with a nurse-educator for four 90-minute education sessions for instruction in asthma and asthma management. The intervention was designed on cognitive learning theory and utilized both verbal and printed instruction materials. Patients enrolled in the individual education program met weekly with the nurse-educator for three to five 45-minute meetings where the educator chose among 18 instructional modules (covering the same content included in the small-group program) to develop a program tailored to the needs of the individual. Intervention patients kept symptom-medication diaries. The standard control group was given no formal education. An information control group was given a workbook containing the same basic information given to the intervention groups.	At 12 months, patients in the group education program showed significant improvements in symptoms (vs. controls), symptom free days (vs. usual control), physician assessment (vs. usual control or individualized group education), physical activity (vs. usual control), bedroom environmental control practices (vs. controls) and MDI technique (vs. controls) ($p<0.05$ for all comparisons). The individualized group education had significant improvements in symptoms (vs. controls), symptom free days (vs. usual control), bedroom environmental control practices (vs. controls) and MDI technique (vs. controls) ($p<0.05$ for all comparisons). The information control (workbook) group showed significant improvement in symptom free days (vs. usual control) and physician assessment (vs. usual control or individualized group education) ($p<0.05$ for all comparisons). No significant difference in FEV1 values, hospitalizations, medication usage, smoking status or allergen reduction was noted between groups. Ad hoc pair wise testing revealed a significant reduction in acute asthma visits ($p<0.05$) for the group education (vs. all other conditions).[136]

Note: ED=emergency department; PF=peak flow; QOL=quality of life; CBA=controlled before-after trial.

Table 18b. Summary of adult self-monitoring, self-management, or patient education interventions provided by pharmacists

Reference	Study Purpose	Target Population	Study Design	Type of Intervention	Results
Barbanel et al.[137]	To evaluate whether a community pharmacist with basic asthma training could improve asthma control by providing self-management advice.	23 adults aged 18-65 years with asthma living in inner city East London. N_{int}=12, N_{con}=11.	RCT	Intervention patients received a 45-60 minute individual session from the pharmacist on asthma pathophysiology, recognition and avoidance of triggers, inhaler technique, self-management skills including symptom and PF monitoring, actions in response to worsening symptoms, accessing emergency care, and smoking cessation, if relevant. They received written self-management plans and weekly phone calls for the next 3 months to review plans and answer questions.	3 months after the intervention, the symptom score increased in the control group and decreased in the intervention group ($p<0.001$).[137]
Cordina et al.[159]	To examine the effects of a community pharmacy-based education and monitoring program for patients with asthma on a range of patient-specific asthma management outcomes.	152 patients over the age of 14 who received their asthma prescriptions at private pharmacies in Malta.	CBA	A comprehensive asthma education and monitoring program was instituted in private pharmacies in Malta for 12 months. The intervention pharmacists reviewed patients asthma symptoms, PF records, medication use, and when necessary suggested changes in treatment to the patient's physician.	There was no significant difference between treatment and control groups in terms of PF measurement, self-reported inhaler use, days lost from work or school, or health related QOL. There were fewer self-reported hospitalizations for asthma among intervention patients (0/86) than among control patients (8/66) ($p<0.002$) but no other differences in health services utilization. The intervention patients were less likely to report nighttime wheezing and more likely to improve their inhaler technique than control patients.[159]
Herborg et al.[160]	To evaluate the effects of the "Danish Therapeutic Outcomes Monitoring" program of increased pharmaceutical care on various outcome and process measures of asthma care.	413 patients aged of 16-60 years old with moderate-to-severe asthma in Denmark cared for in 16 intervention and 15 control pharmacies. N_{int}=209, mean age: 38.8 yrs. N_{con}=204, mean age: 42.4 yrs.	CBA	The program consists of 7 steps for establishing a patient-pharmacist-physician relationship, collecting patient data, identifying and analyzing drug therapy problems, outlining therapeutic goals, choosing individual intervention and monitoring plan, implementing monitoring and follow up, and documenting and reporting to physician and patient. The intervention required monthly sessions with pharmacists over 1 year.	12 months after the intervention, the intervention group had fewer "sick days," fewer physician visits ($p<0.012$), and improved asthma symptoms, inhaler technique ($p<0.001$), health-related QOL ($p<0.05$), and knowledge of asthma medications ($p<0.031$). There was no difference in PFs.[160]

Table 18b. Summary of adult self-monitoring, self-management, or patient education interventions provided by pharmacists (continued)

Reference	Study Purpose	Target Population	Study Design	Type of Intervention	Results
Kelso et al.[161, 162]	To determine if a comprehensive long-term management program, emphasizing inhaled corticosteroids and patient education would improve outcomes in African-American adults with asthma.	39 African-Americans aged ≥18 years with moderate to severe asthma with recent ED visits or hospitalizations for asthma in Memphis. A control group comparable for all demographic variables was identified via chart review at local hospitals. N_{con}=18, N_{int}=21.	CBA	The intervention subjects received 1-hour individual asthma education session from a pharmacist emphasizing environmental control and PF meter and inhaler use. Patients were also given the NIH National Asthma Education Program booklet, individualized inhaled corticosteroid prescriptions, albuterol to use "as needed," and an emergency supply of prednisone. Patients were given PF meters and taught how to use their medications in relation to their PF. The intervention utilized the strategies of role-playing and the distribution of printed or audiovisual materials. Free access to an asthma clinic was provided and an appointment was scheduled within 1 week of their ED visit.	At two years, the intervention group showed a significantly greater reduction in both ED visits ($p<0.05$) and ($p<0.05$) hospitalization compared to the control group.[161]
Knoell et al.[163]	To compare an education program provided by a pharmacist with treatment by a pulmonologist to pulmonologist treatment alone.	100 asthma patients in Ohio $N_{int\text{-}pre}$=45, Age: 8.9% <25 yrs.; 82.2% 25-65 yrs.; 8.9% >/=65. $N_{con\text{-}pre}$=55, Age: 14.5% <25 yrs.; 74.6% 25-65 yrs.;10.9% >/=65.	CBA	Pharmacist developed and implemented individualized education/self-management programs. Within an outpatient specialty care setting, a pharmacist spent 30-60minutes with a patient during the first visit, and had at least one more meeting with the patient over the course of 45-day study. Pharmacist also conferred and coordinated care with a pulmonologist.	The intervention group was more likely to have recorded a recent PF than control subjects. No differences in days missed from work, hospitalization, QOL, drug costs, or physician visits.[163]
Schulz et al.[164]	To determine if a pharmacy-based patient education intervention can improve measures of lung function, HRQOL and self-management in asthma patients.	164 asthma patients in Hamburg. N_{int}=101 (34.6% M), mean age: 46.3 yrs., SD: 11.4. N_{con}=63 (57.4% M), mean age: 45.9 yrs., SD: 12.5.	CBA	Pharmacists and patients met at 6-week intervals for a total of 9 meetings in 12 months. The study pharmacists were trained to detect and teach patients about inhaler technique, adverse drug reactions, adherence, drug interactions, and the need for additional therapy.	At 12 months post- intervention, there was no difference in FEV_1 or physician rated asthma severity, although patient-rated asthma symptoms were improved in experimental subjects compared to controls. The intervention group had significantly higher overall QOL scores ($p=0.02$), but there was no difference between the groups in SF-36 mental summary score. 23% of the total population were current smokers and an additional 25% were ex-smokers. No change in smoking rates.[164]

Note: ED=emergency department; PF=peak flow; QOL=quality of life; CBA=controlled before-after trial.

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Allen et al.[165]	To assess the effects on morbidity and medication compliance of a self-management asthma education program for adults.	113 patients aged 18-65 years with moderate to severe asthma in Australia. N_{con}=57, N_{int}=56.	RCT	Intervention consisted of four 2.5-hour weekly self-management small group education sessions led by asthma educators supplemented by audiovisual, lectures, and written materials. The program focused on improving patient self-management through understanding of asthma physiology, identification and control of triggers, recognition of symptoms and symptom severity, medications, lifestyle and psychosocial factors, inhaler and PF meter use. Patients in the control group kept daily diary records for four weeks corresponding to the period of the education program for the intervention group.	After 12 months, significantly more patients were found to be compliant with their medication (p=0.02) in the intervention group when compared to the control group. No significant differences were found between the two groups in number of days of activity restriction, percentage of days or nights with asthma symptoms, percentage reporting PFR <70% expected, or FEV_1/FVC.[165]
Bailey et al.[166]; Windsor et al.[167]	To investigate the effects of an asthma intervention program on poor self-management practices.	225 patients over the age of 18 with mild to severe asthma recruited from the UAB Pulmonary Medicine Clinic. N_{con}=101, N_{int}=124.	RCT	The "UAB Asthma Self-management Program" consisted of a skill-oriented self-help workbook, an individualized counseling session with a self-help educator that lasted approximately 1 hour and focused on the use of the self-care workbook, proper use of medications, self-monitoring and self-evaluation techniques, early detection of attacks including the use of a PF meter, and attack management. Patients also participated in a small group support group and were followed-up via telephone every 2-4 weeks. Patients in the control group received usual care that included a standard set of asthma pamphlets.	After 12 months, there were no significant differences in outcomes between the intervention and control groups. However, when data were fully adjusted to account for baseline scores, there were improvements in inhaler use, symptoms, and ED visits, hospitalizations[166], and medication adherence.[167] At baseline, 11.5% of the asthma patients smoked. No report of change in tobacco use.[167] The intervention program cost $32.03 per patient versus the control program, which cost $3.61 per patient.[167]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Bailey et al.[168]	To develop and evaluate the effectiveness of less-resource-intensive self-management programs that may be more appropriate for non-academic healthcare settings.	232 patients with moderate to severe asthma from a single pulmonary clinic in Alabama. N_{con}=78, N_{ASMP}=78, $N_{core\text{-}element}$=76.	RCT	The "UAB Asthma Self-management Program," patients were given the same program as described above. Patients also received two follow up calls to discuss any problems and letters encouraging follow up were mailed at 1, 2, and 4 weeks post counseling session. The "UAB Core-Elements Program" group was given a revised, shortened workbook which was reviewed during a brief 15-20 minute one-on-one counseling session. Patients in this group were also trained in the use of inhalers and PF meters. A follow up telephone counseling session was conducted one week later to review the patient's medication regimen and inhaler and PF meter skills. Patients were sent a follow up letter two weeks later. The usual-care group received standard treatment from their physician and were given a standardized set of pamphlets.	After 24 months, there were no significant differences in either intervention group when compared to the control group in medication or inhaler adherence, asthma symptoms, functional impairment or the need for health-care services including ED visits or hospitalizations.[168]
Catov et al.[142]	To evaluate the effects of a home-based teaching on reducing asthma admissions and ED visits.	381 Medicaid-insured patients in Pennsylvania aged 2-56 years with one or more hospitalizations or three or more ED visits with a primary diagnosis of asthma N_{con}=290, N_{int}=91.	CBA	Patients in the intervention group received at least 3 home visits over 2 months by a respiratory therapist who assessed the home environment for asthma triggers, conducted intensive education about asthma and self-management, including the use of a PF meter, and worked with the patient's physician to complete an asthma action plan. Patients who were eligible for home visits, but who declined or were unable to be located served as the control group.	Two study designs were used: "one-group pre/post-test design" and "untreated control group design with pre/post test." The following results are for the more intensive "untreated control group design with pre/post test" design: after 12 months, no significant differences were found between the intervention and control group in ED visits or hospitalizations.[142]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Couturaud et al.[169]	To assess the effects of an educational program in patients with asthma following treatment readjustment.	54 adult patients with moderate to severe asthma seen at the outpatient clinic of two university hospitals in France. N_{con}=28, N_{int}=26.	RCT	All patients underwent an initial two-week run-in period and treatment readjustment if necessary. All patients were taught how to measure PF, and after the run-in all patients received asthma diary cards. Additionally, patients in the intervention group received 5 individual self-management educational sessions after each scheduled visit to the general practitioner (at 1,3, 6, 9, and 12 months) which included information on asthma, asthma triggers, asthma medications and the proper use of inhaler devices, and detection of asthma flare-ups and self-management strategy. The intervention provided to the control group was not described.	After 12 months, there was no significant difference between the groups in percentages of symptom-free days and days off work, unscheduled visits, FEV_1 (% predicted), QOL, medication compliance, or use of self-management action plans. However, there was a patients in the education group reported a significantly higher percentage of days of oral steroid intake compared to the control group(p=0.01).[169]
de Oliveira et al.[170]	To assess the effectiveness of population-based asthma management intervention especially tailored for deprived low-income populations of poor social and cultural backgrounds in Brazil.	43 asthma patients. N_{int}=22, mean age: 41 yrs. N_{con}=21, mean age: 38 yrs.	RCT	Study subjects received monthly instruction over a 6-month period. The education was given by a physician and consisted of inhaler use training, information about environmental control and triggers and early recognition of warning signs of asthma. Instructional tools included posters, discussion sessions or video presentation, reading materials and diary cards.	After the 6 month intervention, intervention patients had fewer ED visits (p=0.03), fewer asthma symptoms (p=0.04), better QOL (p=0.0005), and improved inhaler technique. However, there was no difference in hospital admissions or PF between groups.[170]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Feifer et al. [171]	To determine whether a population-based asthma disease management program, using broad-based educational interventions can have favorable effects on physician and patient adherence to guidelines-based care.	70,900 patients with asthma patients aged 5-45 years using a specific prescription benefit plan in the U.S. 35,450 patients were in each group.	CBA	During the 12-months following enrollment, intervention patients and their physicians received educational materials. Patients in the intervention group received five workbooks and two newsletters. Educational materials emphasized guideline-based elements of asthma pharmacotherapy, self-management techniques, and trigger avoidance. Additionally, patients received refill reminders, prospective compliance reminders, and pollen count alerts by mail. Physicians received asthma management flow sheets to facilitate the tracking and review of patients' therapy. Patients in the control group received no educational materials, nor did their health-care providers.	All outcomes were measured as the change between baseline and 12 months after enrollment. The percentage of patients using controller therapy decreased less in the intervention group ($p<0.0001$), controller prescription refill rate increased in the intervention group ($p<0.0001$), and reliever prescription refills were reduced in the intervention group ($p<0.001$) compared to the control group.[171]
Gallefoss et al.[172-175]	To evaluate the effects of patient education on patients with mild to moderate asthma and COPD patients.	71 patients aged 18-70 years with mild to moderate asthma from a single clinic in Norway. $N_{con}=39$, $N_{int}=32$.	RCT[§]	Patients attended two group sessions for asthma patients in an outpatient specialty care clinic (one led by a physician in which self care, basic physiology, and prevention of attacks was described and one led by a pharmacist who reviewed asthma drugs) and one or two individual sessions with nurses and physiotherapists in which individualized care plans were developed. Patient received a 19-page booklet with on asthma, compliance, medication, self-care, and self-management plans.	At 1 year, intervention patients had fewer asthma symptoms ($p<0.05$), better health related QOL ($p<0.001$), improved FEV_1 ($p<0.05$)[172] , and higher steroid inhaler compliance ($p=0.04$)[173] compared to control patients ($p<0.05$). More patients in the intervention group reported they had symptom free days ($p=0.001$) and nights ($p=0.001$) and that asthma had no effect on daily life ($p=0.02$).[174] There was no significant difference found between the groups in dispensing of β-agonists, courses of oral steroids,[173] activity limitation,[172] hospitalizations, or absenteeism from work.[175] There was no significant difference found between the groups in direct costs, indirect costs, and total costs associated with the program.[174]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Ghosh et al.[176]	To assess the effects of asthma self management training on the health status and resource use of patients with chronic asthma.	176 patients aged 10-45 with chronic asthma who attended the asthma and allergy clinic in the Department of Respiratory Medicine at the Medical College in Trivandrum, India. N_{con}=136, N_{int}=140.	RCT	The intervention consisted of four 2-hour group sessions of asthma self-management education and training during the first month following baseline assessment. Patients in the intervention group were taught to adjust treatment based on severity, which was assessed by PF monitoring and early symptoms. They also kept daily diary recordings of outcome variables including PF values, symptom assessments, and hospitalizations or ED visits. Audiovisual aides supplemented the 2-hour education sessions. The control group received usual care for asthma management including medication.	At 12 months, the intervention group had significantly higher PF values (p<.001) and fewer productive days lost (p=0.003), less hospitalizations (p=0.043), and fewer ED visits (p=0.002). There was a significantly less indirect (p=0.003) and total costs (p=0.036) associated with the intervention group, but no significant difference in direct costs found between the two groups.[176]
Grover et al.[139]	To determine the efficacy of cognitive behavior therapy as an adjunct to standard pharmacotherapy in bronchial asthma.	10 asthma patients 18-50 years old in Bangalore. N_{int}=5; N_{con}=5.	RCT	The intervention consisted of 15 individual sessions which covered asthma physiology, muscle relaxation, cognitive restructuring and coping skills and behavioral counseling to significant others. A health educator delivered education within an outpatient specialty care setting.	At the end of the intervention there was no difference in asthma symptoms between the two groups.[139]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Hilton et al.[177]	To test the hypothesis that an improvement in knowledge of asthma and its treatments leads to a reduction in morbidity.	274 patients with asthma aged 5-70 years cared for by 33 general practitioners in London. N_{con}=100, $N_{ltd\text{-}int}$=88, $N_{max\text{-}int}$=86.	RCT	One group received a maximum education program, one group a limited education program, and the third was a control group. Both intervention groups received a booklet about asthma and a treatment card. The booklet contained information on basic mechanisms of asthma, trigger factors, types of treatment, modes of action and side-effects of anti-asthmatic drugs, and self management. The treatment card contained information on how the patient's drugs acted and whether they were for symptom relief or preventative. Subjects in the maximum intervention group also received a 10-15 minute interview with his/her doctors which covered the same topics as the booklet, a 35-minute audiocassette which expanded on information in the booklet, and follow up appointments every 3 months with the family doctor for a year.	After 12 months, there were no significant differences among the groups in self-management of attacks, drug compliance, inhaler technique, activity limitation, number of days absent from school/work, hospitalization, ED visits, wheezing, frequency of attacks, frequency or severity of nights disturbed by wheezing, incidence of severe attacks, or the proportion of patients who had their drug regimens changed. There was no difference in number of days absent from school or work; however, the mean number of times absent from school or work was significantly lower in the control group than in the intervention groups ($p<0.05$).[177]
Hoskins et al.[178]	To determine whether self-management plans reduce morbidity from asthma.	General practitioners in the U.K. were randomized to either provide their asthma patients with self-management plans or to provide usual care. N_{con}=151, N_{int}=139.	RCT	General practitioners in the intervention group were "invited to issue self-management plans personally to those patients known to have suffered an asthma attack in the past 3 months. The control group were simply asked to identify patients" with asthma.[178] No additional information was provided about the intervention.	The unit of randomization and analysis differed and no adjustments were made for this difference. Six months after the intervention there were no differences in hospital admissions, ED visits, or office visits for asthma among patients of intervention and control physicians.[178]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Jenkinson et al.[179]	To compare the effects of a patient education program presented in either booklet or audio cassette tape form.	177 patients aged 3 to 49 years with asthma from 8 general practices in the U.K. N_{con}=41, N_{book}=46, N_{tape}=46, $N_{book+tape}$=44.	RCT	Patients were randomized to receive education via booklet, audiocassette tape, both booklet and audiocassette tape, or a control group. The booklet was 27 pages: 9 pages described the asthma pathophysiology and prevention measures; 12 pages explained the types and uses of drugs, "how to get the best from them," and coping with asthma problems; and 6 pages covered what to do when things go wrong in 18 possible scenarios. The audiocassette tape was 34 minutes, half on asthma pathophysiology and the actions of drugs and half presented a conversation between a doctor answering questions from a patient with asthma dealing with a series of asthma related problems.	After 12 months, there were no differences among the groups in inhaler technique, quantities of drugs prescribed, medication use, rates of consultations for asthma, or "perceived disability." [179]
Johnson et al.[180]	To evaluate the effectiveness of a comprehensive asthma disease management program.	Patients with asthma covered by Anthem Blue Cross and Blue Shield insurance in the U.S. N_{int}=196, N_{con}=196.	CBA	The intervention lasted 12 months. Intervention subjects received teaching that emphasized self-management behaviors such as avoidance of triggers, correct medication use, recognizing symptoms, seeking medical advice, smoking cessation, and adherence to treatment plans. The program is supported by computer generated communications to providers and case managers regarding whether the patient has an action plan, received flu vaccination, has a rescue inhaler, and use of daily controller medications.	12 months after the intervention, the intervention group had fewer ED visits (118 vs. 305, p<0.0001) and hospitalizations (39 vs. 114, p<0.0001). There were no differences in use of asthma medications or preventative vaccinations. [180]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Kotses et al. [144]	To compare the effectiveness of personalized asthma self-management recommendations with that of a group self-management program.	34 adults with mild to severe asthma in the Toledo, OH area. N_{con}=12, $N_{int\text{-}group}$=11, $N_{int\text{-}ind}$=11.	RCT	This study evaluated 3 groups: individualized self-management, group self-management, and a control. The individualized self-management education program consisted of identification of each patient's asthma triggers in a 60-minute session which included the use of PF values as an early warning sign for asthma onset, methods for avoiding precipitants, and instructions for reducing asthma exacerbations (including, as warranted, progressive relaxation techniques). The group self-management education program was based on Wheezers Anonymous (WA) and included two 2.5-hour sessions with video and audio materials and discussions facilitated by a group leader. WA also included the use of PF monitoring. All patients in the intervention groups kept daily asthma diaries. The control group received usual care.	As compared to the control group, patients in both intervention groups had significantly more improvement in morning PF values ($p<0.05$) as measured against baseline. There were no significant differences among the groups in evening PF values, asthma attacks, activity limitations, or frequency of visits to the ED.[144]
Lahdensuo et al.[181, 182]	To compare the efficacy of an asthma self-management program with traditional treatment.	115 patients aged 18yrs and older with mild to moderate asthma from 3 outpatient clinics in Finland N_{con}=59, N_{int}=56.	RCT	Patients in the intervention group received a 2.5-hr personal self-management education session covering asthma, asthma medications, and the principles of self-management by specially trained nurses with 3 follow up visits at 4 month intervals. They also received physiotherapeutic counseling, including proper breathing and relaxation techniques by physiotherapists, were given guided self-management plans based on PF monitoring, and kept daily asthma diaries. Control patients received usual care.	After 12 months, there were significant differences between the intervention and control groups in the number of courses of antibiotics taken ($p=0.008$), courses of prednisolone ($p=0.01$), days off work ($p=0.03$). No significant differences between the groups were found for unscheduled office visits, hospitalizations, and spirometric values. QOL scores did show trends toward significance when fully adjusted for baseline scores.[181] The total direct costs were 649 Finnish Marks less in the control group than in the experimental group ($p=0.05$)[182] (At the time of publication: 8.84 Finnish Marks=1£).

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Legorreta et al.[138]	To evaluate the effectiveness of a population-based asthma management program in an HMO setting.	999 patients aged 5-65 years with moderate to severe asthma from a large HMO in California. N_{con}=385, N_{int}=614.	CBA	Patients in the intervention group received educational material (Asthma Control Kit) directly from the HMO designed to educate asthmatic patients in proper or self-management skills. The kit included a PF meter, an Asthma Review Guide, a personal diary, a spacer device, and an educational video. Patients in the control group did not receive any materials but completed baseline and follow up assessments. Due to low participation, results from a second intervention (a nurse-led small-group education program) was not included.	After 6 months, patients in the intervention group had significantly greater improvement with daily use of a steroid inhaler (p=0.003) and daily use of a PF meter (p=0.038). No significant differences were found between the groups in absenteeism due to asthma, ED visits or hospitalizations for asthma.[138]
Marabini et al.[183]	To evaluate the effectiveness of a patient education program by a physician in reducing morbidity and improving QOL.	77 asthma patients aged $\geq$ 18 years in Perugia, Italy. N_{int}=37, mean age: 53.1 yrs., SD: 6.8. N_{con}=40, mean age: 49.3 yrs., SD: 16.8.	RCT	Patients participated in an educational program based on "Teach Your patients About Asthma: A Clinician Guide" (NHLBI publication). The three 2-hour sessions conducted by a physician, covered basic information on asthma medications, use of inhalers and PF meters, identification of asthma-warning signs, avoidance of triggers, and development of action/emergency plans. Handouts covering key points were also distributed. Patients were also involved with decision-making and taught how to deal with symptoms early.	3 months after the intervention, no differences in FEV_1, PF, days lost from work or school, symptom-free days, rescue salbutamol use, or medication expenses. 10% of patients were current smokers and 30% were ex-smokers. No reported change in tobacco rates. However, the intervention group had significantly higher overall QOL compared to the control group ($p<0.05$).[183]
Magar et al.[184]	To evaluate the effectiveness of a self-management program for adults with asthma.	Adults (18-60yrs) with asthma in France. Patients enrolled: N_{con}=89, N_{int}=104.	RCT	Intervention subjects received an individualized 30-60 minute interview to assess their educational needs and to discuss diary and PF meter use. Then they received two 2.5 hr interactive group sessions separated by 15 days that reviewed asthma signs, symptoms, pathophysiology, medication use, avoiding triggers, and self-monitoring using symptoms and PF results. Control subjects were asked to keep a symptom diary and received usual care.	At 12 months, the intervention group had greater reductions in symptom-free days per month, nighttime wakening, oral corticosteroids, and greater improvement in QOL scores[184] (p values difficult to interpret from the data provided). There was no significant difference in the rate of tobacco use (7% stopped smoking in the intervention group compared to 2% in the control, p=0.18).[184]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Mayo et al.[185]	To determine the effect of an outpatient program designed to reduce readmissions for asthma exacerbations among adults with asthma.	104 adult patients with asthma who had been hospitalized at a single hospital in New York. Patients had all had at least 2 hospitalizations in the previous 12 months or 5 ED visits in the previous 24 months. N_{con}=57, N_{int}=47.	RCT	Intervention subjects had 2 initial 1-hour visits with a physician or nurse practitioner for discussion of asthma pathophysiology and treatment emphasizing self-management strategies tailored to each patient. During subsequent visits ($\geq$30minutes long with frequency determined by the patient preference and asthma severity), medical regimens were tailored to each patient's asthma pattern to encourage compliance. Patients were taught to use spacers and PF meters and to vary their own treatment according to symptoms, using a PF meter to identify attacks requiring prednisone. The control group received usual care.	After 8 months, mean hospital admissions and hospital days were significantly lower in the intervention group compared to the control group ($p<0.004$ and $p<0.02$, respectively).[185]
Moldofsky et al.[186]	To determine whether a videotape program about asthma would be successful in transferring information about asthma.	79 adult patients with asthma were recruited from the Gage Research Institute in Toronto. N_{int}=149, mean age: 24.0 yrs., N_{con}=160, mean age: 24.8 yrs.	RCT	The intervention group watched an educational videotape entitled "Living With your Asthma" consisting of a dialogue between a physician and a well-known professional hockey player who has had asthma all his life. The 55-minute program described the normal structure and function of the lungs, the physiological abnormalities in asthma, the management of asthma by self-care and drug therapy, and the approach to problems commonly encountered by persons with asthma.	No difference in frequency of visits to their physicians, FEV_1, or hospitalizations.[186]
Onyirimba et al.[187]	To determine the effectiveness of clinician-to-patient feedback of inhaled steroid use compared with standard asthma care.	19 adults from low socioeconomic groups with moderate to severe asthma in Hartford, CT. N_{int}=9, mean age: 45 yrs., N_{con}=10, mean age: 53 yrs., SD:14.	RCT	Clinicians reviewed data from an instrument that electronically recorded inhaler use. This information was then discussed with the patient at a 4 weekly follow up visits, and suggestions were made about where to keep the inhaler based on when the non-adherence occurred.	During the 10-week study period, the intervention group had improved medication adherence rates than the control group ($p<0.0001$). No change in FEV_1 or QOL between groups.[187]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Perneger et al.[188]	To assess the effectiveness of a newly established education program designed to improve patients' health and functional status.	115 adults with asthma at a single hospital in Geneva, Switzerland. N_{con}=57, N_{int}=58.	RCT	The interactive education program consisted of three 75-minute group education sessions scheduled one week apart and delivered by two respiratory physicians and a physiotherapist. Educational materials were also distributed. The primary purpose of the education methods was the design of individual self-management programs. Patients in the control group underwent a baseline evaluation, received "minimal asthma information," and were scheduled for a 6-month follow up.	After 6 months, comparisons were made between the intervention and control groups for 40 outcome variables. Of these, only four variables varied significantly between the intervention and control groups. When adjusted for baseline data, an improvement was seen in inhaler technique in the intervention group compared to control (p=0.048). There were no significant differences between the groups in amount of medication used, work days missed, limitations on physical activity, ED visits, hospitalizations, PF values, or overall QOL. 20% of subjects were smokers and there was no significant decline in tobacco use at the end of the intervention. There was no correction made for multiple comparisons.[188]
Put et al.[189]	To determine if an individualized education and cognitive-behavioral intervention would improve asthma-related behavior.	25 asthma patients aged 18-65 years in Belgium. N_{int}=13, mean age: 43 yrs., SD: 10. N_{con}=12, mean age: 48 yrs., SD: 12.	RCT	Patients received a workbook with information, exercises, and homework assignments. During six 1-hour individual program sessions, different strategies were employed: psycho-education; behavioral techniques; self-observation/self-monitoring; stimulus control (change of behavior antecedents); response control (learns to select the appropriate behavior to avoid or minimize the influence of stimuli by considering behaviors short term vs. long term consequences); cognitive techniques. In addition, whenever problem areas, such as disease-specific anxiety, were identified, certain parts of the training program were elaborated.	3 months after the intervention, there were no difference between groups in terms of PF during the day or night. However, QOL scores were significantly different between the intervention and control groups. The AQLQ scores were higher and the Negative Emotivity Scale were lower (p<0.001 and p<0.01, respectively).[189]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Rasmussen et al.[190]	To assess the outcomes associated with an Internet-based asthma management tool.	253 adults with asthma aged 18-45 years living in Denmark. $N_{cont-GP}$=80, $N_{cont-sp}$=88, N_{int}=85	RCT	There were three groups: an internet management group, a group receiving treatment from an asthma specialist, and a group receiving care from a general practitioner (GP). The Internet-based management tool was comprised of an electronic asthma diary, an action plan for patients, and a decision support system for physicians. Patients were given PF meters, and the Internet tool's action plan comprised a 3-color warning system with a written treatment plan. Patients were encouraged to fill out the diary daily and follow instructions given by the computer or physician. Physicians used the decision support system to follow up with patients on therapeutic changes.	After 6 months, the Internet group had significantly fewer asthma symptoms (p=0.002 compared to specialists; p<0.001 compared to GPs), higher QOL (p=0.03 compared to specialists, p=0.04 compared to GPs), and better FEV_1 (p=0.002 compared to specialists, p<0.001 compared to GPs). The Internet group had significantly more acute, unscheduled visits compared to the two control groups (p=0.05). No significant differences among the groups were found in ED visits, hospitalizations, or medication compliance.[190]
Ringsberg et al.[191]	To measure the effects of a multi-disciplinary asthma school in Sweden.	38 adult asthma patients who had been treated in the hospital where the asthma school was located. N_{int}=20, mean age: 49 yrs. N_{con}=18, mean age: 45 yrs.	RCT	The intervention group was divided into 4 small sub-groups that were educated in an asthma school 4 times in the Spring, 2 times in September 1986, and 1 time in January 1987. Classes met once a week and emphasized information on elementary anatomy and physiology, how to prevent asthma attacks by avoiding triggers, drugs, and self-treatment techniques.	The decrease in number of days hospitalized was greater for the intervention group (83% vs. 74%, p=0.0001). No difference found in FEV_1, leisure time activities, social interactions, or physical activities.[191]
Schaffer and Tian[192]	To compare the effects of a theoretically focused audiotape or a standard educational booklet or both on adherence to asthma preventive medication.	23 adult patients with asthma aged 18 to 65 years in the U.S.; N_{int}=10; N_{con}=13.	RCT	Patients received a 30-minute audiotape incorporating 5 topics critical to asthma self-management. Audiotapes included asthma-related lyrics set to popular tunes to enhance memory. Patients also received a 12-page booklet that covers the same topics as the audiotape but presents the content directly rather than as part of a larger narrative.	6 months after the intervention, significant differences between groups were found in pharmacy adherence (p<0.05). There was no significant difference in QOL between the groups.[192]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Snyder et al.[143]	To test the effectiveness of the Wheezers Anonymous program in teaching self-management skills to adults with asthma.	75 adults (mean age 27yrs) with asthma from the Toledo, OH metropolitan area. (No report of the number of subjects allocated to treatment and control groups.)	RCT	The intervention group attended 2 two-hour group education sessions (8-12 patients) with 15- to 25-minute didactic videotaped presentations interspersed with 10- to 15- minute discussions led by a respiratory therapist who acted as a moderator for group discussion and for practice of the presented information and techniques. The sessions contained information on asthma self-management. In addition to answering questionnaires, patients kept an asthma diary and had their pulmonary function tested at 1, 2, and 3 months following intervention. The waiting list control group received usual care.	After 3 months, there was no significant group difference between the intervention and control in frequency of asthma attacks.[143]
Sundberg et al.[193]	To assess the effectiveness of a computerized limited asthma education program designed to suit young people.	147 patients with asthma aged 18-25 years who were referred to a special asthma outpatient clinic for young adults in Sweden. N_{con}=49, N_{int}=48.	RCT	Intervention consisted of an interactive 30-minute computer program that provided basic information on asthma, asthma medication use, inhaler and PF meter use, and information about asthma triggers and allergens. At the end of the program, an asthma-trained nurse led a structured discussion with each patient about his/her results. The control group received normal care, and all patients were followed up with the clinic team at 6 and 12 months.	After 12 months, no significant differences were found between the intervention and control groups in hospital admissions, ED visits, prevalence of respiratory symptoms, or QOL. However, a significant increase in FEV_1 was observed in the intervention group compared to the control group (p=0.01).[193]
Verver et al.[125]	To evaluate whether inhaler technique and respiratory symptoms of patients with asthma can be improved after instruction by a practice assistant.	6 physicians assistants were trained in the appropriate use of powder inhalers and provided patient education to 48 Dutch asthma patients aged 15-85 years.	RCT	Patients received two training sessions (2 weeks apart) on the correct technique for use of dry powder inhalers (and the correct order in which to use multiple inhalers).	At baseline only 6% of all patients used the dry powder inhalers correctly. Most mistakes were made with the “breathe out” before inhaling and with the “hold your breath for 5 seconds” after inhaling instructions. There was no correlation between the number of inhaler errors and symptoms. The patients in the instruction group significantly reduced the number of inhaler use errors (p=0.01). There was no difference in reported asthma symptoms between the two groups.[125]

Table 18c. Summary of other self-monitoring, self-management, or patient education interventions directed at adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Weng[194]	To evaluate the effects of a government sponsored QI intervention with patient and provider education and case management services for patients with asthma.	1,067 patients with asthma enrolled in the program sponsored by the Taiwanese government. 4,340 patients with asthma who did not enroll in the program served as matched controls.	CBA	Providers received a 6-hour asthma curriculum that included conducting pulmonary function testing, use of medications and PF monitoring, environmental controls, and asthma pathophysiology. They were given copies of asthma clinical practice guidelines. Patients received individualized, personally tailored asthma education on recognizing triggers and symptoms, medication use, PF use, and self-monitoring self-management of exacerbations. Case managers (nurses or physician assistants) provided communication between patients, primary care physicians and specialists, and scheduled quarterly follow up.	1 year after enrollment, the intervention group had longer hospital stays (by 40%, p=0.045) but no difference from control patients in the number of ED visits or number of hospitalizations. However, among patients newly diagnosed with asthma during the study interval, there was a decrease in ED visits (by 61%) in the intervention group compared to the controls.[194]
Yilmaz and Akkaya[195]	To evaluate long-term efficacy of a patient education program in an asthma outpatient clinic in Istanbul.	52 patients with asthma aged >16. N_{int}=25, mean age: 330.6 yrs. N_{con}=27, mean age: 28.9 yrs.	RCT	The educational program took place over a 12-month period and consisted of 6-10 sessions. Patients were provided education through video cassettes, special brochures, and seminars. Physicians checked patients' inhalation device and reviewed proper usage technique. A telephone help-line was available to the participants.	3 years after the intervention, no difference in FEV1, asthma symptoms, ED visits, hospitalizations, or medication use. QOL scores were significantly higher in the intervention group compared to the control group (p=0.009).[195]
Zeiger et al.[196]	To determine whether facilitated care provided by asthma specialists favorably affect asthma outcomes.	309 asthma patients aged 6 to 59 with a recent ED visit or hospitalization for asthma years who were San Diego Kaiser Health Plan members. N_{int}=149, N_{con}=160.	QRCT*	An expedited allergy-clinic evaluation was offered. Allergists provided detailed evaluation including history, physical examination, spirometry, inhalant skin tests, and a comprehensive treatment program, including instruction in relevant environmental control measures, asthma education, and individualized medication recommendations. No subject received immunotherapy during study.	6 months after their index visit/hospitalization, the intervention group had improvement in asthma symptoms (p<0.00001), were more likely to use inhaled corticosteroids or inhaled cromolyn, and had fewer readmissions (p=0.017). There was no difference in absenteeism or spirometry.[196]

*QRCT=quasi-randomized controlled trials. ED=emergency department; PF=peak flow; QOL=quality of life; CBA=controlled before-after trial; NHLBI=National Heart, Lung, and Blood Institute. §The design of the study by Gallefoss et al.[172] was as follows: Two groups of patients, those with asthma and those with COPD were randomly assigned to an intervention group who received an educational program and a control group who received usual care by their General Practitioners. The patients with asthma and COPD were educated separately. We present only the data for the asthma patients.

Synthesis of Evidence From Self-Monitoring, Self-Management, or Patient Education Interventions for General Populations or Adults With Asthma

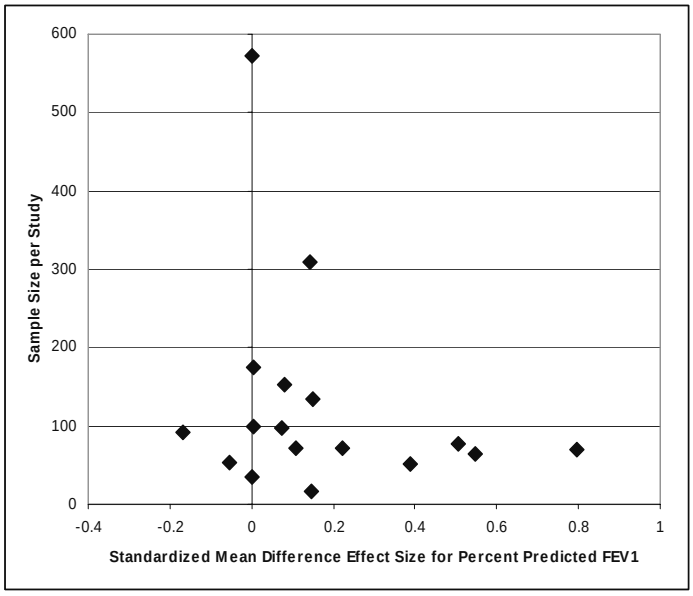
In this section we present the results of our evaluation of the association of study design characteristics (e.g., whether the authors specified a theoretical/conceptual framework, year of study, sample size, country), intervention characteristics (e.g., the number of educational sessions provided to students, the setting in which the intervention took place), and improvements in the outcomes of interest for the self-monitoring, self-management, or patient education interventions. We present our analyses according to each of the primary outcome types.

Clinical Outcomes. Sufficient numbers of studies presented results for percent predicted FEV_1 and peak flow that these data could be synthesized quantitatively.

Percent predicted FEV_1. Among the self-monitoring, self-management, or patient education interventions for general populations or adults with asthma, 17 reported change in percent predicted FEV_1 from which we were able to calculate individual study and a summary standardized mean difference (between intervention and control subjects at the end of the study) (Figure 17-see below). These studies were statistically homogeneous and produced a weighted mean difference of 2.92 percent change in FEV_1 (95% CI: 0.92, 4.92; p=0.004). This corresponds to a summary mean difference of 0.13 (95% CI of 0.03, 0.23) favoring the intervention groups (p=0.01). The funnel plot from these 17 studies (Figure 15) does not suggest substantial publication bias. Of all the quantitative analyses in this report, the data included in this calculation are the most robust given the relatively large number of studies reporting the same outcome in the same way. However, the statistically significant effect reflects a clinical improvement of only borderline significance.

We sought study design and intervention characteristics associated with the greatest improvements in percent predicted FEV_1. For this analysis, we used the standardized mean difference as the dependent variable in a weighted least squares regression. We found that the more recent the year of publication, the greater the likelihood of finding improvements in percent predicted FEV_1 (p=0.004) (Table 19). We denoted the studies with interventions performed since 2000 in Figure 17 with an asterisk. We cannot determine the critical characteristics that distinguish these more recent studies and that might be associated with the improved spirometric measures.

Figure 15. Funnel plot: FEV_1 percent predicted



In none of our analyses was the study design, the use of a theoretical/conceptual framework, the duration of the intervention, the frequency of interactions with the patient, the type of provider of the education (e.g., nurse, physician), setting of the educational intervention (e.g., home, school), the type of educational materials used associated with improved outcomes (data not shown).

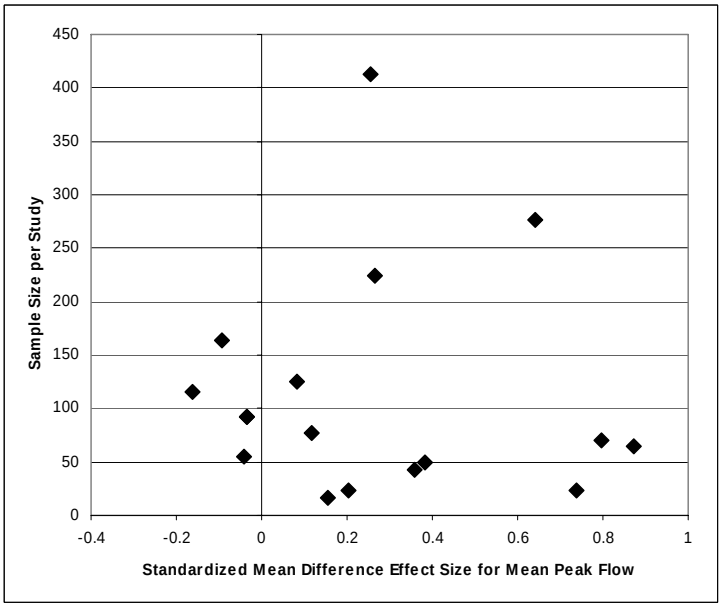
Table 19. Association of study/intervention characteristics and improvements in FEV_1 percent predicted

Predictor Variables	Regression Coefficients (SE)	P value
Model Constant	-23.6 (6.7)	0.004
Intervention duration in months (continuous variable)	-0.0002 (0.001)	0.8
Year of publication (continuous variable)	0.01 (0.003)	0.004
Studies that specified a theoretical/conceptual framework vs. those that did not	-0.004 (0.04)	0.9
Study design (categorical variable)	0.450 (0.387)	0.7

Model details: Weighted least squares regression (weighted by the sample size). Dependent variable: standardized mean difference effect size for percent predicted FEV_1. R^2=0.56. 16 studies were included in this analysis (because they reported data for each of the variables included in this regression).

Peak flow measurements. Among the self-monitoring, self-management, or patient education interventions for general populations or adults, 16 studies reported mean peak flow at the end of the study period. Typically, they reported mean peak flow for the intervention and control groups and did not specify time of day. If they did present mean morning and mean evening measurements, we used mean morning values in our summary analysis because these were the most frequently reported. The weighted mean difference in peak flow from these 16 (statistically heterogeneous) was 27.95 L/min (95% CI: 10.75, 45.15; p=0.01). The standardized mean difference of 0.26 (95% CI of 0.10, 0.42) favored the intervention groups (p=0.001) (Figure 18- see below). As with the FEV_1 results, this represents a change of only modest clinical relevance. The funnel plot (Figure 16) for this analysis does not suggest substantial publication bias.

Figure 16. Funnel plot: mean peak flow



We sought study design and intervention characteristics associated with the greatest improvements in mean peak flow. For this analysis, we used the standardized mean difference as the dependent variable in a weighted least squares regression. We did not find a combination of the intervention or design characteristics that explained a statistically significant proportion of the variation in mean peak flow (R^2=0.29) (Table 20).

Table 20. Association of study/intervention characteristics and improvements in mean peak flow

Predictor Variables	Regression Coefficients (SE)	P value
Model Constant	69.6 (49.1)	0.2
Intervention duration in months (continuous variable)	-0.008 (0.02)	0.7
Year of publication (continuous variable)	-0.35 (0.025)	0.2
Number of educational meetings with the subjects (continuous variable)	-0.05 (0.13)	.7
Studies that specified a theoretical/conceptual framework vs. those that did not	-0.13 (0.2)	0.6
Study design (categorical variable)	0.17 (0.2)	0.9

Model details: Weighted least squares regression (weighted by the sample size). Dependent variable: standardized mean difference effect size for mean peak flow. R^2=0.29. 13 studies were included in this analysis (because they reported data for each of the variables included in this regression).

Functional Status Outcomes. Nine studies reported mean days lost from work or school. For those studies that did not specifically report the timeframe over which the school absenteeism was recorded (e.g., days absent per month versus per school year); we assumed that the reported days of missed school were for the entire study duration. When interpreting these data, we note that not all authors specifically identified these data as mean days lost from school and some likely represent other parameters such as total days lost from school for the whole cohort. We calculated the standardized mean difference between intervention and control groups in terms of the mean number of days lost from work or school (Figure 19). The nine studies were statistically heterogeneous (I^2=73%) and they did not find any statistically significant difference in days lost from work or school between intervention and control subjects (weighted mean difference of -0.19 days absent per month; 95% CI: -0.40, 0.02; p=0.08; standardized mean difference of -0.21; 95% CI: -0.44, 0.02; p=0.08).

We performed logistic regression, using any statistically significant functional status outcome as the dependent variable and study/intervention characteristics as the independent variables. In none of our analyses was the study design, year of intervention, the use of a theoretical/conceptual framework, the duration of the intervention, the frequency of interactions with the patient, the type of provider of the education (e.g., nurse, physician), setting of the educational intervention (e.g., home, school), or the type of educational materials used associated with improved outcomes in any of our analyses (data not shown).

Health Services Utilization Outcomes. Twenty-one studies reported urgent care/emergency department visit data in such a way that they could be combined quantitatively (Figure 20). These studies were highly heterogeneous (I^2=98.9%). They did not find a statistically significant difference in urgent care/emergency department visits between intervention and control subjects (weighted mean difference -0.23 visits per month; 95% CI: -0.64, 0.18; p=0.26; standardized mean difference -0.48; 95% CI: -1.11, 0.14; p=0.13).

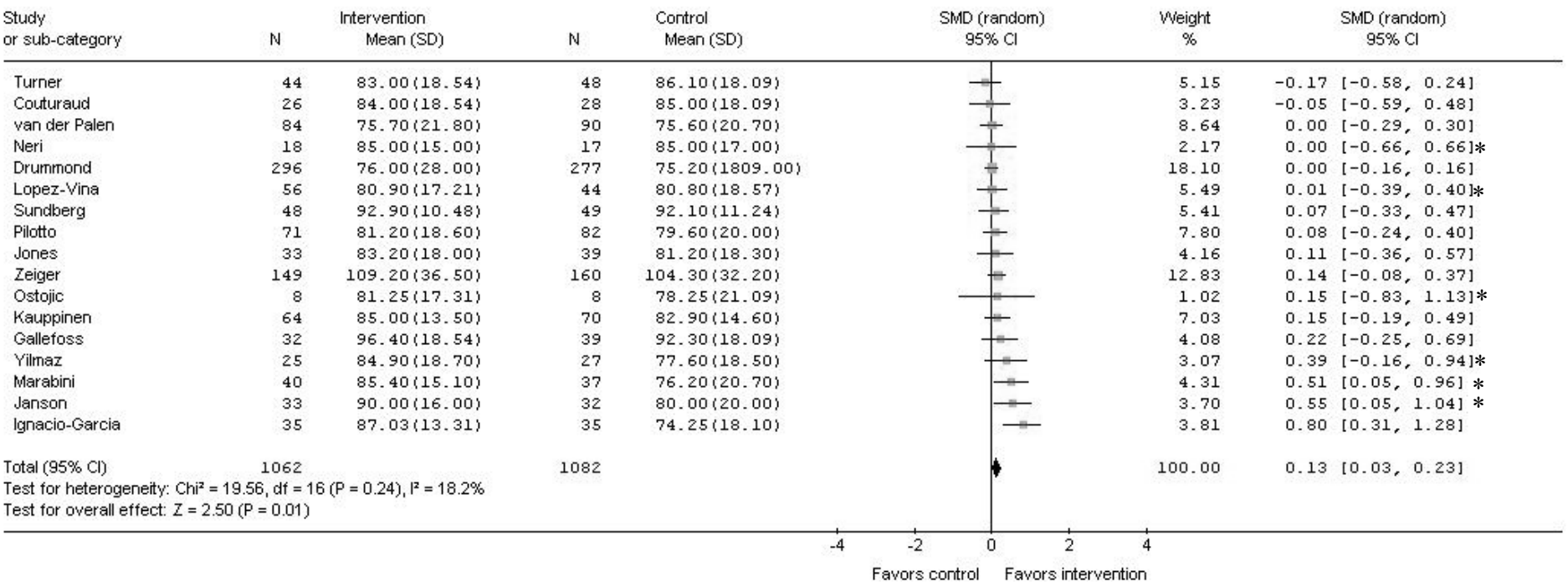
Similarly, 24 studies reported hospitalization rates (Figure 21); however, these were also highly heterogeneous (I^2=99.4%) and they did not find a statistically significant difference in hospitalizations between intervention and control subjects (weighted mean difference -0.34 hospital days per month; 95% CI: -0.99, 0.31; p=0.3; standardized mean difference -0.58; 95% CI of -1.53, 0.37; p=0.23).

We performed logistic regression, using any statistically significant health services utilization outcome as the dependent variable and study/intervention characteristics as the independent variables. We did not find study design, intervention, or patient characteristics that were associated with improved outcomes in any of our analyses (data not shown).

Guideline Adherence Outcomes. The 40 studies reporting on guideline adherence measures were heterogeneous in terms of the specific outcomes evaluated. We performed logistic regression, using any statistically significant guideline adherence outcome as the dependent variable and study/intervention characteristics as the independent variables. We did not find study design, intervention, or patient characteristics that were associated with improved outcomes in any of our analyses (data not shown).

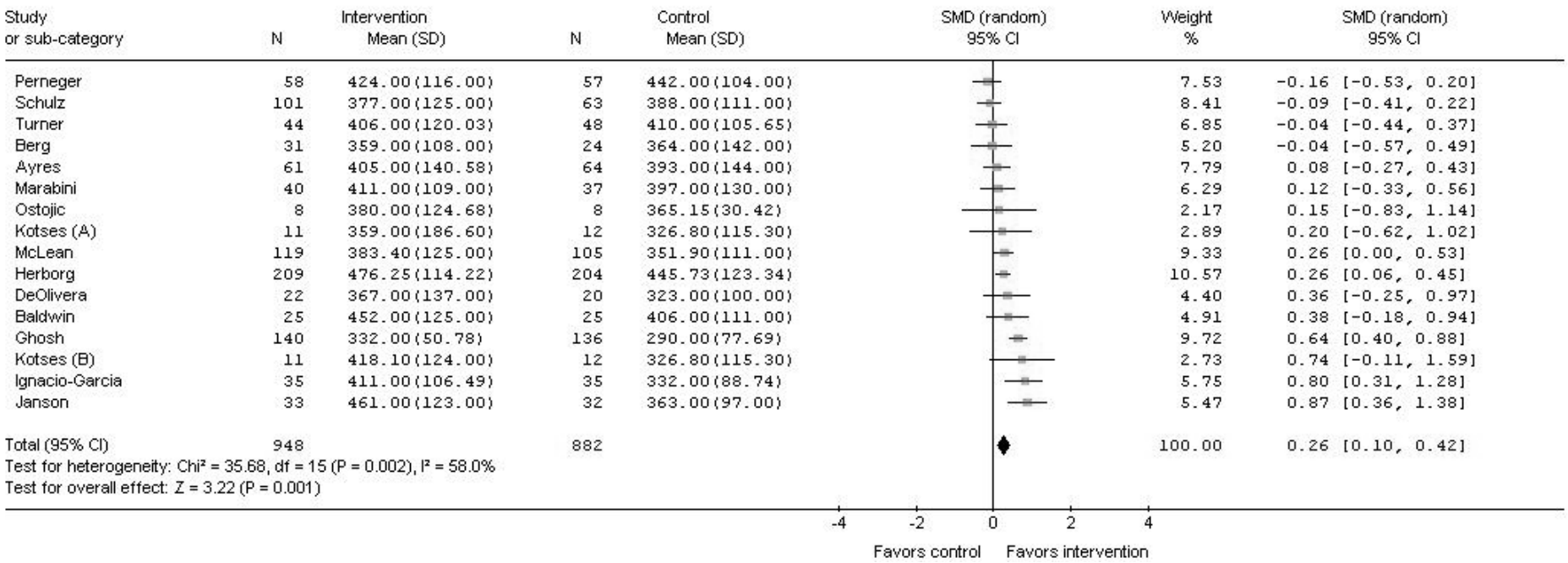
Conclusions. Self-monitoring, self-management, or patient education interventions for general populations or adults with asthma can result in improvements in FEV_1 and peak flow. However, these improvements are of borderline clinical importance. Our analyses suggest that more recent studies may result in greater improvements in these spirometric measures. Whether year of the intervention reflects other key covariates that could affect spirometric outcomes, is likely.

Figure 17. Self-monitoring, self-management, or patient education studies reporting percent of predicted FEV_1



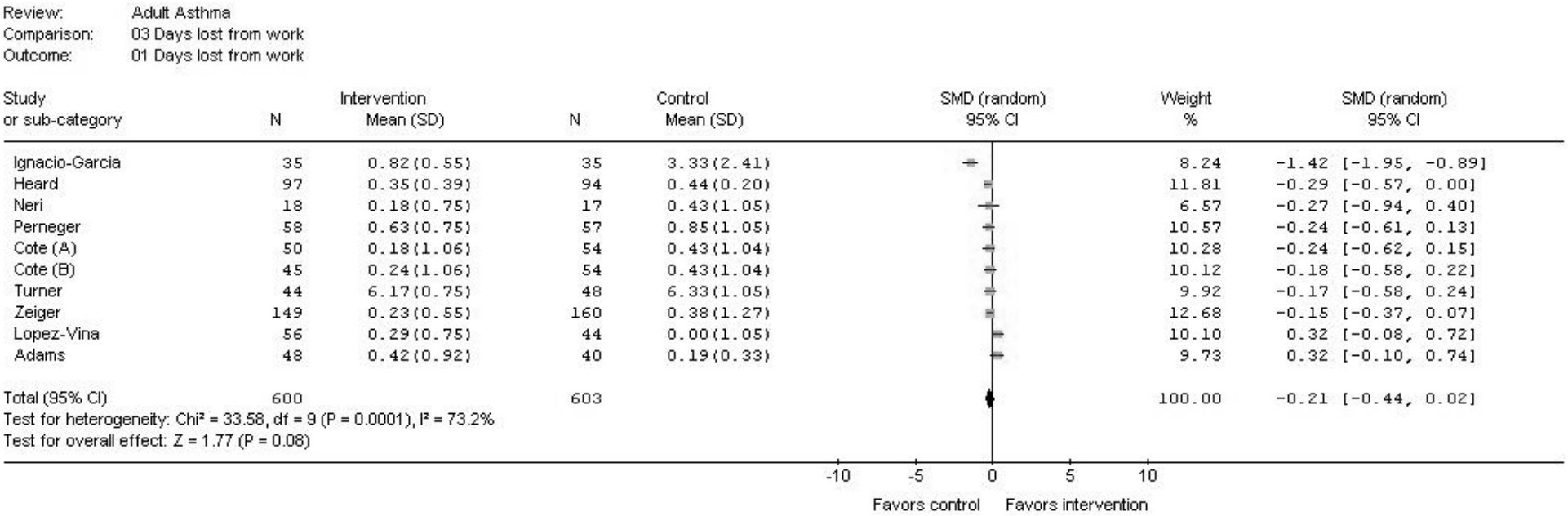
Note: The effect sizes presented here are the random effects standardized mean difference (SMD).

Figure 18. Self-monitoring, self-management, or patient education studies reporting mean peak flow



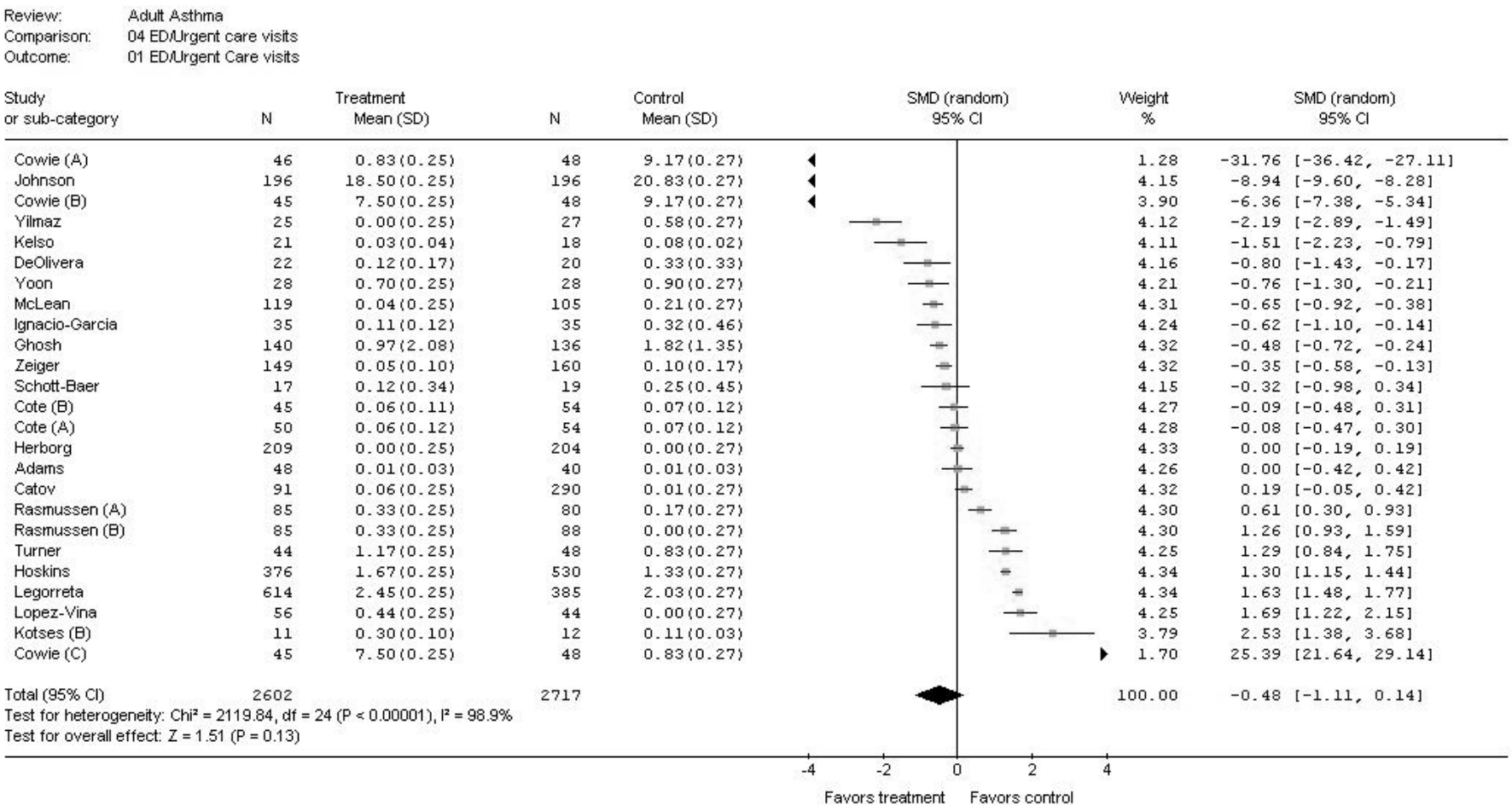
Note: The effect sizes presented here are the random effects standardized mean difference (SMD).

Figure 19. Self-monitoring, self-management, or patient education studies reporting mean days lost from work or school



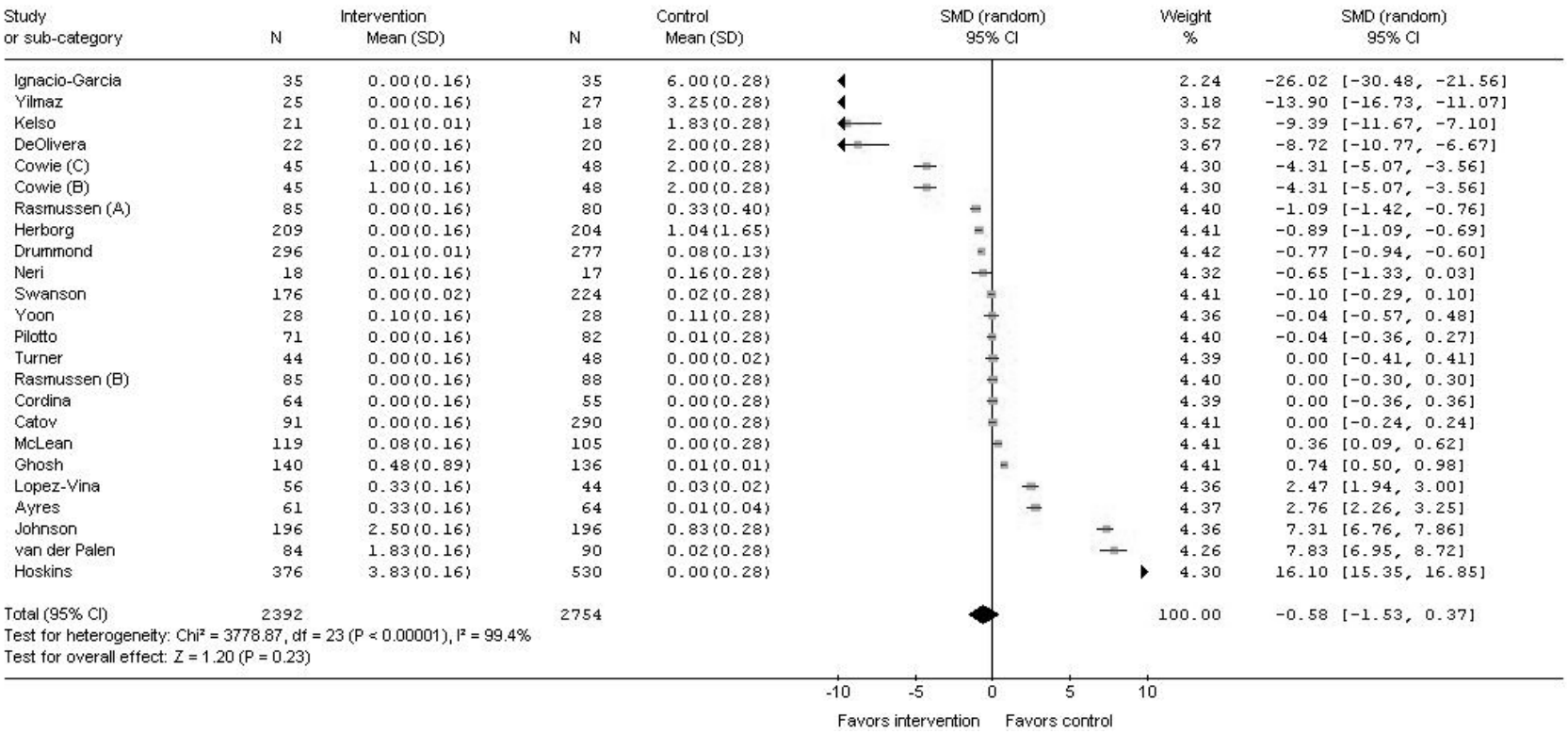
Note: The effect sizes presented here are the random effects standardized mean difference (SMD).

Figure 20. Self-monitoring, self-management, or patient education studies reporting urgent care/emergency department visits



Note: The effect sizes presented here are the random effects standardized mean difference (SMD).

Figure 21. Self-monitoring, self-management, or patient education studies reporting hospitalizations



Note: The effect sizes presented here are the random effects standardized mean difference (SMD).

Self-Monitoring, Self-Management, or Patient Education Trials Comparing Two Intervention Groups Without a Control Group

Background. Several of the included studies compared two or more intervention groups without including a control group that did not also receive a QI intervention. For example, if a study provided a 10-session asthma patient education program to the experimental group and a two-session asthma education program to the "control group," we considered this to be a trial comparing two intervention groups (sometime called a study with an "active control group"). In this section, we present the results of these studies.

Results. We found 35 trials that compared two or more intervention groups without a control group that did not also receive a QI intervention (Table 21). They all included self-monitoring, self-management, or patient education interventions. Typically, these comparative studies were designed such that one group received a less intense version of what the second group received. Perhaps not surprisingly, these studies generally found improvements in both groups over baseline. Thirteen of these 35 (37%) also found differences between the two groups.

Pediatric interventions. Eleven studies focused exclusively on children and all of these were either self-monitoring, self-management, or patient education interventions and two also included organizational change components.[57, 64] Five studies found statistically significant differences between interventions groups.[55, 56, 62, 64, 197] Notable among these was the study of a patient education intervention called A.C.T. (Asthma Care Training) for Kids, an intensive educational program for children with severe asthma whose content is based on programs with demonstrated effectiveness, that was compared to a less intense lecture and discussion program.[62] The article by Lewis et al. describes the conceptual rationale for the A.C.T. program and its contents in more detail than most of the included articles in this review.[62] Briefly, the program emphasizes that children can control their disease rather than being controlled by it. Using the analogy of driving safely, medications and other asthma prevention and treatment techniques are color-coded: green for daily medications used to "keep going and prevent symptoms," yellow for "caution" to be used when mild symptoms develop, and red to "stop" the disease when severe symptoms occur.[62] Participants are taught about underlying asthma pathophysiology and symptomatology, reducing asthma triggers, relaxation skills and breathing techniques, medication use, and decision making skills. They found that the A.C.T. recipients had statistically significantly fewer emergency department visits (2.3 versus 3.7, $p<0.001$) compared with traditional patient education recipients and that, although there were no differences in terms of number of hospitalizations, the A.C.T. recipients tended to have shorter hospital stays (0.67 versus 1.54 days/child/yr, $p<0.001$).[62] The costs of the program were estimated at $125 per A.C.T. recipient and $37.50 per traditional patient education recipient. Given the lower emergency department and hospital costs in the A.C.T. group, the authors estimated a net incremental savings of $180 per child per year for the sponsoring institution.[62]

We did not find that increasing either the frequency or the duration of contact between patients and health educators was consistently associated with improvement in outcomes. Specifically, five of nine studies compared two (or more) interventions of differing interventional frequency or duration and found no statistically significant improvements in any

outcomes. There were no other distinguishing characteristics of the interventions that were associated with improved outcomes.

General population or adult interventions. We found 24 studies that compared two or more QI interventions without a control group that did not also receive a QI intervention for general/adult populations. Interestingly, only two of these were U.S.-based interventions.[198, 199] Eight of sixteen studies reported significantly greater improvements in the intensive treatment arm.[127, 128, 200-207] For example, the study by McLean et al.[205] compared a lower intensity pharmacist-provided asthma education/management program to a more intense pharmacist-provided asthma education program that emphasized asthma action plans, the use of peak flow meters, and other self-monitoring or self-management techniques. This study found that the intensive education group experienced significantly greater improvement than the less intense intervention: 11% improvement in peak flows ($p=0.0002$), 50% overall decrease in asthma symptoms ($p<0.01$ for most symptoms evaluated), improvement in QOL (<0.05), and decrease in medical visits (but not emergency department visits or hospital visits) between groups.[205] The various interventions presented in these studies were heterogeneous with respect to material presented, type of educator, and frequency of interaction with the patients—thus, no particular intervention characteristics were associated with the most successful programs.

Conclusions. Among the trials comparing multiple QI interventions without a control group that did not also receive a QI intervention, we found that, in general, all intervention groups tended to improve from baseline, but only 37% of studies of this type reported statistically significant differences between groups in the outcomes evaluated. The heterogeneity of studies of this type limits conclusions about commonalities of interventions associated with clinically meaningful improvements.

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Pediatric Interventions					
Butz et al.[61]	To evaluate the effects of a home-based self management intervention that emphasized symptom recognition and nebulizer use for inner city children with asthma.	210 children aged 2 to 8 years living in inner city Baltimore with asthma.	RCT	**Group A.** 105 children received 3 home visits to help establish primary care for the children and teach basics of asthma management including PF meter use. **Group B.** 105 children received 6 home visits to teach symptom identification, and the appropriate treatment of these with a home nebulizer. This intervention was based on several previously recognized successful educational programs.	6 months after enrollment, both groups improved in terms of self-management skills (e.g., parents giving asthma medications when children have asthma symptoms). There were not significant differences between the groups in terms of adherence with self-management skills.[61]
Chan[57]	To develop and evaluate an Internet-based store-and-forward video monitoring system for children with asthma.	10 children aged 6 to 17 years with asthma in Hawaii.	RCT	All patients received a home computer system, video camera, microphone, and cable access to the internet. They used the camera and computer to demonstrate inhaler technique, record PF measurements and send in twice weekly symptoms diaries. Case managers (pharmacists) reviewed these data twice a week and sent back feedback via email. **Group A.** 5 patients received asthma education online. **Group B.** 5 patients received asthma education in the office. These patients used written (rather than electronic) symptom diaries.	There were no differences between the groups at the end of 180 days for any of the outcomes evaluated (e.g., amount of corticosteroids or β-agonists used, PF measurements, symptom control, QOL, or patient satisfaction). Inhaler technique improved for both groups ($p<0.05$) whereas compliance with PF meter use and symptom diary use declined over the study period for both groups. Asthma knowledge was good before the study and did not change significantly for either group after the study.[57]
Charlton et al.[64]	To assess a nurse run asthma clinic in a department of pediatrics.	79 children aged 3-16 who either required an admission or outpatient visit for asthma in Australia.	RCT	**Group A.** 42 children received a 45 minute standardized interview from an asthma nurse with explanations of mechanisms of disease, a self-management plan, PF meter and diary card. Every 3 months they received a notice to have their asthma reviewed by either the asthma nurse or their general practitioner. **Group B.** 37 children received a 15 minute standardized interview, a diary card and a PF meter but no reminders for follow up.	12 months after enrollment, Group A patients were less like to report restricted activity ($p<0.05$) but there were no differences in day or nighttime wheezing or nasal symptoms. There were no differences in several spirometric measures but Group A patients spent less time with lung function less than 30% of personal best ($p<0.05$). There were no differences in medication use between groups, days lost from school, or number of office visits.[64]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Colland et al.[60]	To evaluate the feasibility of teaching patients and their caregivers to recognize prodromal signs and the adherence to a treatment plan that includes doubling inhaled corticosteroids if prodromal signs occur.	29 children with moderate asthma in the Netherlands.	RCT	**Group A** (N=15). Both groups of children received individual information from a pediatrician on asthma symptoms, prevention measures, medication and exacerbations during 2 one-hour sessions. Patients' kept PF, medication, and symptom diaries. They were seen every 2 months for one year. **Group B.** 14 children received additional information about individual prodromal signs identified by both the patient and caregiver; they were advised to double the daily dose of inhaled corticosteroid for 1 week when these signs occurred.	There were no differences between the groups in terms of number of asthma exacerbations, reported asthma-related disabilities, or child absence from school or parental absence from work at 1-year post intervention. FEV_1 levels increased in both groups but no difference between the groups. Even in Group B, the recognition of prodromal symptoms was poor.[60]
Greineder et al.[197]	To evaluate the economic effects of an asthma outreach program that included an allergy nurse, allergy nurse practitioner, and allergist.	57 children (aged 1-15 yrs) with asthma in Boston.	RCT	**Group A.** 28 patients had a single visit "typically lasting several hours" with an allergy nurse who provided individual asthma education on asthma, triggers, medications, inhaler and PF meter use, environmental control and a written asthma action plan. **Group B.** 29 patients received the same education as in Group A and then continue to have "regular" follow up by the nurse—mostly over the phone but with in person visits "as needed."	At the end of the 2 year study period, both groups experienced reductions in ED visits, hospitalizations, and health care costs. Group B patients improved significantly more compared to Group A patients: 57% greater reduction in ED visits ($p=0.0002$), 75% fewer hospitalizations ($p<0.05$), and 71% fewer out-of-plan costs ($p<0.001$).[197]
Guendel-man et al.[55]	To compare the effectiveness of an interactive device for children to report asthma symptoms with an asthma symptom diary.	Inner-city children aged 8 to 16 years in Oakland with persistent asthma.	RCT	All children received a standardized teaching session by a nurse during which they received a PF meter and educated on its use, and the appropriate use of asthma medications. **Group A.** 66 children were randomized to receive the Health Buddy device which they used to answer questions from a nurse about their asthma symptoms and send to the answers to a remote, secure server. **Group B**. 68 children recorded their symptoms in an asthma diary.	12 weeks after enrollment, both groups reported a decrease in asthma symptoms and a decrease in PF readings in the yellow or red zone. Group A children were less likely to report activity-limiting symptoms ($p=0.03$) than diary-based patients. There were no differences between groups in terms of school absenteeism, ED visits, or hospitalizations.[55]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Krishna et al.[56]	To evaluate whether the addition of a multimedia asthma education program to a standard education program improves outcomes for children with asthma.	246 children aged <18 with asthma in Missouri and their caregivers.	RCT	**Group A.** 121 children received 1.5 hours of asthma education over 3 visits by a nurse using instructional sheets from the "Caring for Kids With Asthma" series—each of which describes specific aspects of care for asthma such as medication use. Then at each subsequent visit they received 15 minutes of additional individualized training on use of devices and medication and a detailed written self management plan. **Group B.** 107 children received this printed and verbal teaching and also used the 1h 20min Interactive Multimedia Program for Asthma Control and Tracking (IMPACT) for additional reinforcement of asthma skills and knowledge by taking the subject through 4 clinical vignettes.	12 months after enrollment, both groups improved their asthma knowledge over baseline but was significantly greater among Group B ($p<0.01$). Both groups had improvements in asthma symptoms, medication use, sleep disturbance, urgent visits to physicians and the ED over baseline ($p<0.05$). However, Group B had significantly greater decreases in days with asthma symptoms (81 vs. 51/year) ($p<0.01$) and number of annual ED visits (1.93 vs. 0.62) ($p<0.01$) than the control group. There were no differences in between groups in terms of activity limitation, nights of sleep disturbance, urgent visits to the physician, hospitalizations or school absenteeism.[56]
Lewis et al.[62]	To compare the ACT (Asthma Care Training) program with conventional patient education.	Children with severe asthma aged 7-12 yrs in Los Angeles.	RCT	**Group A.** 28 patients received three 1.5 hour sessions consisting of a lecture with discussion in groups of 12-25 people with demonstrations of relaxation and breathing exercises designed to give the child more responsibility for his/her care. **Group B.** 48 patients received the ACT program: five 1-hour session at weekly intervals (some taught by school teachers, others by a physician). Children and parents are taught the same content but in separate sessions. A detailed description of this curriculum is presented in [62].	ACT recipients (group B) had significantly fewer ED visits (2.3 vs. 3.7) compared to Group A patients. There were no differences in terms of number of hospitalizations; however, the ACT group tended to have shorter hospital stays (0.67 vs. 1.54 days/child/yr). Parents in both groups rated their child's health as significantly better one year after the program and "trouble with asthma" ratings decreased significantly in Group B. The costs of the program were estimated at $125/ACT recipient and $37.50 per Group A recipient. Given the lower hospital costs in the ACT group, the authors estimate a $180 annual cost savings per child for the sponsoring institution.[62]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Walders et al.[59]	To assess the effects of an interdisciplinary intervention on asthma symptoms and health care utilization.	175 children aged 4-12 years with asthma in Cleveland.	RCT	**Group A.** 86 children were evaluated by a pediatric pulmonologist who developed a written asthma treatment plan for each child who also received a spacer, PF meter, and prescription for a 1-month supply of medications. **Group B.** 89 children received everything that Group A received and also received a 1hr educational session with a nurse or social worker on asthma pathophysiology, triggers, and treatment; an additional individualized problem-solving visit with a psychologist; and access to a nurse telephone hotline.	12 months after enrollment, there was no difference between groups in terms of number of symptom days or symptom scores, hospitalizations, or QOL (both groups improved over baseline).[59]
Wensley and Silverman[63]	To evaluate the incremental effectiveness of adding routine PF monitoring to symptom-based guided self-management.	90 children aged 7-14yrs with physician diagnosed asthma in the U.K.	RCT	**Group A.** 44 children and their caregivers were given training in spirometry and symptom recording in a 30-90 min session. A color-coded plan was provided with instructions for medication adjustment on the basis of both symptoms and PF measurements. Written symptom diary completed daily. Children were visited every 4 weeks for 3 months to update the self management plan. **Group B.** 46 children and their caregivers received a symptom diary and self-management plan based on symptoms but no PF meters or instructions on their use.	Compliance with written diary data deteriorated over time in both groups from 90% at month 1 to 79% at month 3. There was no difference between groups in daily symptom scores, number of symptom-free days, any lung function parameter (including PF), child or caregiver QOL, hospital or general practitioner visits, emergency prescriptions, or days lost from school.[63]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Yoos et al.[65]	To evaluate the incremental benefit of PF meter use as an adjunction to symptom recognition and self-management of asthma.	168 patients aged 6-19 years with asthma from 11 primary care settings in the U.S. and their families. At enrollment, $N_{Group\ A}$=56, $N_{Group\ B}$=55, $N_{Group\ C}$=57; however, at 1-year, 32 patients did not complete the final post-exit interview. It is not clear which groups these patients belonged to.	RCT	Patients in all groups received asthma education during a home visit from a nurse regarding asthma pathophysiology, symptom recognition, triggers, medications, and treatment goals and were given written materials with personal action plan for symptom management to reinforce this information. **Group A.** 56 patents received training in subjective asthma symptom recognition. **Group B.** 55 patients received subjective asthma symptom recognition and PF meter training with instructions to use PF meter at the time of increased symptoms. **Group C.** 57 patients received subjective asthma symptom recognition training and PF meter training with instructions to do both routine twice daily PF monitoring and at the time of increases in asthma symptoms. Each group had a practice period of 2 weeks, after which they were followed up. All patients kept asthma diaries.	All outcomes were assessed between groups in terms of change from baseline to final measurement. After 3 months, there were no significant differences among the groups in change in spirometry (FEV_1% predicted). There was also no significant difference between Groups A and C or Groups B and C in change in symptom-days; however, there was a more significant improvement in Group B compared to Group A in symptom-days (p=0.01). At 12 months, there were no significant differences among the groups in change in asthma severity, hospitalizations, ED visits, and acute illness visits. However, the average reduction in health care charges due to reduced healthcare utilization was $82 per child for Group A children, $162 per child for Group B children, and $61 per child for Group C children.[65]
General Population or Adult Interventions					
Adams et al.[140]	To compare symptom vs. PF monitoring for detecting asthma flares.	134 adults with moderate to severe asthma who are not poor perceivers of broncho-constriction in Australia.	RCT	**Group A.** 61 patients were given a written, self-management action plan based on symptom monitoring. **Group B.** 73 patients were given a written, self-management action plan based on PF monitoring. All patients were called monthly for monitoring and reinforcement of the use of the action plans.	There were no differences in ED visits, hospitalizations, or days lost from work or school between the groups at 1 year post-intervention. (Compared with the year prior to the intervention, both groups had significant decreased in all three of these outcomes). There were no differences between groups in FEV_1. 85% of the symptom and 86% of the PF groups were reported to have appropriate use of action plans.[140]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Ayres and Campbell [208]	To assess the efficacy of an asthma self-management plan based on PF measurements compared to a standard dose regimen.	125 adults in the U.K. with asthma over the age of 17 with nocturnal symptoms. N_{con}=64, N_{int}=61.	RCT	**Group A.** 64 patients in the "doctor-managed regimen" group made 4 visits to the clinic at 6-week intervals as well, and they had their medication adjusted by the investigator based on their diary card data. **Group B.** 61 patients in the "self-management regimen" received a written personalized self-management plan based on PF monitoring at initial assessment and continued to make 4 visits to the clinic at 6-week intervals to have lung function and asthma severity measured. Patients also completed diary cards twice a day and PF charts.	After 6 months, no significant differences were found between the intervention and control group in sleep disturbance, activity scores, lung function, hospitalizations, or medication usage.[208]
Baldwin et al.[209]	To compare the effectiveness of verbal vs. written instructions for asthma self-management.	50 adults with asthma in the U.K.	RCT	All patients were instructed in the use of PF meters, asked to record daily PF measurements, given hand-outs on asthma. Patients returned to the asthma clinic for 3 visits, 3 months apart. **Group A.** 25 patients received verbal instructions on asthma management. **Group B.** 25 patients received written instructions on asthma management.	Significant differences between the groups at randomization complicates the interpretation of the results (Group A had more severe asthma than Group B). However, both groups showed significant improvements in multiple parameters over the course of the study.[209]
Bheekie et al.[200]	To compare the use of patient-performed PF and symptom monitoring as asthma self-management in a program run by community pharmacists.	61 patients $\geq$6 years old with asthma from 5 community pharmacies in South Africa. $N_{Group\ A}$=21, $N_{Group\ B}$=40.	RCT	**Group A.** 21 patients were taught how to score their symptoms and received personalized self-management plans based on symptom monitoring. **Group B.** 40 patients were taught how to monitor their PF and received personalized self-management plans based on PF readings, which these patients were instructed to monitor twice-daily before the use of bronchodilators. All patients kept diary cards to monitor their asthma.	After 2 months, Group B subjects were significantly more likely than Group A subjects to use their self-management action plans appropriately ($p<0.006$) and to use medication as indicated in their self-management plan ($p<0.05$). However, there was no difference between the groups in rates of seeking medical consultation when considered appropriate by the self-management plan.[200]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Charlton et al.[126]	To compare a PF self management plan for asthma with a symptoms only plan.	115 patients in a U.K. general practice nurse run clinic (46 children and 69 adults) with asthma randomized to PF (N=51) verses symptom only (N=64) group.	RCT	All patients met individually with a nurse for an initial 45 minute interview with a 15 minute session 1 week later for spirometry and a check of inhaler technique. All patients had follow up visits at least every 8 weeks where topics such as smoking, holidays, provoking factors, and emergency treatments were discussed. **Group A.** 64 patients were given self-management plans based on symptoms. **Group B.** 51 patients were given self-management plans based on PF readings. One week later, there was a 15 minute follow up. Patients were followed-up thereafter every eight weeks.	After 12 months, there were no observed significant differences between the PF and symptom only group with regards to symptoms, medication usage or the need to consult a physician for asthma. When stratified by adult verses children, again no significant difference between interventions was observed.[126]
Côté et al.[201-203]	To compare the effectiveness of asthma education with an action plan based on symptom monitoring with an action plan based on PF monitoring.	149 adults with moderate to severe asthma in Québec.	RCT	**Group A.** 54 patients received only instructions from their "respirologist" regarding medication use, asthma triggers, and use of asthma symptom diary. **Group B.** 45 patients received the Group A intervention plus 1 hour individual counseling with a "specialized educator." They were asked to record their asthma symptom score daily and adjust medications according to a symptom-based action plan. **Group C.** 50 patients received the Group A intervention plus 1 hour individual counseling with a "specialized educator." They were asked to measure their PFs twice daily and adjust medications according to a PF-based action plan.	At 12 months, when comparing the action plan patients (Group B and Group C) with "control" patients (Group A), action plan patients' asthma symptoms scores decreased (p=0.006) and the number of days per month without daily asthma symptoms increased (p=0.03).[201] QOL scores improved for all groups but were significantly more improved among action plan patients than controls.[201, 202] Action plan patients were significantly more likely to take measures to reduce household dust mites than the control group (p<0.001), but no more likely to reduce exposure to domestic animals.[201] The use of an action plan and PF values were significantly higher in Group C compared to Group B (p=0.01 and p=0.03, respectively).[202] No significant differences were found among groups in compliance with treatment,[201, 202] hospitalizations, ED visits, courses of oral prednisone or days lost from work or school.[203] All groups had significant improvements in airway responsiveness after the study.[201]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Cowie et al.[127]	To evaluate the effects of a symptom-based versus a PF-based action plan in preventing acute exacerbations in subjects with poorly controlled asthma.	139 adult and adolescent patients who had attended an ED or clinic in Calgary for urgent treatment of asthma in the previous 12 months.	RCT	Patients in all groups received a 30 to 60 minute baseline interview, spirometry assessment, and an individual education session provided by a nurse covering asthma, asthma triggers, medication, and inhalation devices. Inhaler technique was checked and corrected if necessary. **Group A.** 48 patients received no further intervention (no action plan group). **Group B.** 45 patients were given written four-step action plans detailing different response actions based on symptom-monitoring. **Group C.** 46 patients were given written four-step action plans based on PF readings. Patients in Groups A and B also received prescriptions for prednisone for use in the third step of the self-management plan.	After six months, there were significantly fewer ED visits in Group C compared to Groups A and B (p=0.002). There were no significant differences among the groups in terms of hospitalizations, β-agonist utilization, self-rating of asthma severity, night waking with asthma, daily dose of inhaled corticosteroid, or number of courses of prednisone taken.[127]
Drummond et al.,[210] [211] Osman et al.,[212] and Buckingham et al.[213]	To evaluate a personalized computer supported education program for asthma patients (Group 1A/B). To evaluate the use of a PF meter based self-management intervention.	801 adults with asthma in Scotland.	RCT with 3x3x3 design	**Group 1A.** 349 patients received "conventional oral education at outpatient visits." **Group 1B.** 363 patients took part in an enhanced education program (4 personalized booklets, sent by mail). **Group 2A.** 251 patients received no self-management advice. Group 2B. 254 received a PF meter, shown how to use it, and individually tailored self-management guidelines to follow when they identified changes in PF.	12 months after the intervention, there were no difference between groups in any clinical outcomes including days of restricted activity, sleep disturbance, prescription of bronchodilators or inhaled steroids, use of oral steroids, or number of general practitioner consultations for asthma.[210-212] Total cost of integrated care for asthma was estimated to be £40.11/patient/annum compared to £62.12/patient/annum for conventional care.[213]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Ignacio-Garcia and Gonzales-Santos[204]	To determine the usefulness of an objective measure of lung function in association with an educational program and a medication self-management plan in reducing morbidity in adult patients with asthma.	70 patients with asthma ages 14-65 from an outpatient asthma clinic in Spain. N_{con}=35, N_{int}=35.	RCT	During an initial assessment, all patients were given individualized therapeutic schedules and taught proper inhaler technique and how to use a PF meter they were given. **Group A.** 35 patients used symptoms only and spirometric data for following physicians' treatment plans. **Group B.** 35 patients monitored themselves using PF readings, which were the basis for their therapeutic plan. This was coupled with educational intervention—a 30-min session regarding the role of asthma medication and symptom management. All patients were followed up at 3, 5, and 6 months where their inhaler technique, compliance with PF measurement, and diary cards were checked and spirometry was performed.	After 6 months, significant improvements in the intervention group compared to the control group were found in days lost from work ($p<0.008$), acute asthma exacerbations ($p<0.05$), ED visits ($p<0.05$), physician consultations ($p<0.001$), and nocturnal wakening ($p<0.001$). Significant improvements were also found in mean PF ($p<0.002$), FVC_1 ($p<0.004$) and the use of inhaled fenterol and prednisone in asthma exacerbation ($p<0.008$). An observed decrease in the number of hospital admissions for asthma with the intervention did not reach statistical significance.[204]
Janson-Bjerklie and Shnell[198]	To identify self-care strategies used to control asthma symptoms and to determine the effect of PF information on selection of self-care strategies.	28 adult patients with asthma in the U.S. N_A=15, N_B=13.	RCT	All patients participated in an interview during which they gave information about their asthma history, frequency of symptoms, and strategies to control their asthma. All patients were then instructed on how to use and Asthma Care Log to record information about their symptom episodes. **Group B.** 13 patients were told to also record PF 3 times at the beginning and end of each episode, and told high numbers meant good flow and open airways.	After 3 months, there was no difference between the groups in symptom scores or in compliance with medication. However, patients in the intervention group used bronchodilators significantly less than patients in the control group ($p<0.05$).[198]
Jones et al.[214]	To compare asthma self-management program using home-based PF measurement with a program of planned clinic visits for asthma management.	90 practices with patients aged 15-40 years with asthma requiring daily inhaled corticosteroids in the U.K. were invited to participate.	RCT	All patients had 5 visits over 6 months and were taught to use symptom diaries. **Group A.** 33 patients assigned to the self management group received a PF meter, instructed in its use, and given written instructions for how to change their medication regimen in response to PF measurements. **Group B.** 39 patients assigned to the planned visit group had their medications changed by providers in clinic on the basis of their symptom diaries.	No difference between the groups in FEV_1, FVC, or PF; days lows from work or school, outpatient visits, hospitalizations, nighttime awakening, or QOL at 6 months after the intervention. Compared to baseline, Group A reported significant decreases in asthma interference with daily life and improved QOL. Group B had significant improvements in PF rates, FEV and FCV between visits 1 and 2, but the differences between visits 1 and 5 were not significant.[214]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Kauppinen et al.[215-217]	To evaluate the effects of an intensive self-management education program on adults with asthma.	134 newly diagnosed adults with asthma in Finland.	RCT	**Group A.** 70 patients received training in use of inhaled medications and PF meters (which they were issued), they received verbal information and were shown a video (two visits). **Group B.** 64 patients also received every three months for a year additional training with "repetition of self-management instructions, principles of asthma treatment and use of drugs." Additionally, they received two 2-hr educational visits at 6 and 9 months by a nurse and physiotherapist on "social affairs" and "rehabilitation."	There was no significant difference between the groups at 5 years for lung function, bronchial hyper-responsiveness, days lost from work, QOL, or total costs attributed to asthma care.[217]
Kemple and Rogers[218]	To evaluate postal prompts to increase patients' understanding and use of self-management plans.	545 patients with asthma over age 16 in the U.K. N_{GroupA}=197, N_{GroupB}=187, N_{GroupC}=161.	RCT	**Group A.** 197 patients were mailed an invitation to have a medical review of their asthma symptoms, treatments, and asthma action plans. **Group B.** 187 patients were mailed a similar invitation for medical review with a blank asthma self-management plan. **Group C.** 161 received the invitation for the medical review with a partially-completed personalized action plan to be completed at the time of the review with their health care practitioner.	Overall, there was a low response rate: 38% of Group A, 45% of Group B, and 51% of Group C patients attended the medical review. 12 months after the intervention, there were no significant differences among the in symptom scores, ED visits, or hospitalizations.[218]
López-Viña and del Castillo-Arévalo[128]	To compare self-management education program alone to one that includes PF monitoring.	100 adults with asthma in Spain.	RCT	**Group A.** 44 patients received personalized self-management plan with nurse provided education on asthma management and medication information. **Group B.** 56 patients received this same education and they also received and color-coded self management and diary cards to record symptoms, medications, and PFs. For all patients, follow up visits were scheduled at 15 and 30 days after enrollment and every 3 months thereafter until 1 year after enrollment.	At 12 months, Group B subjects were more adherent to their treatment plans (83% vs. 52%, p=0.05) and had higher mean FVC (99 vs. 94, p 0.03) than Group A subjects. However, there were no differences between groups in days with symptoms, reported asthma exacerbations, school/work absenteeism, visits to the ED or hospital admissions, correct use of inhalers, or FEV_1 although many of these parameters improved from baseline in both groups.[128]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Malo et al.[219]	To compare symptom vs. PF monitoring for detecting asthma flares.	60 adults with moderate to severe asthma in Canada.	RCT with Cross-over of arms	**Group A.** Recorded PFs twice a day for six months first then recorded symptoms twice a day for six months. 40 subjects finished the first six month, 20 finished both. **Group B.** Recorded symptoms twice a day for six months first then recorded PFs twice a day for six months. 40 subjects finished the first six month, 20 finished both.	19 (61%) of the total 31 asthma exacerbations were reported while patients were using symptom diaries and 12 (39%) were reported while patients were using PF meters.[219]
McLean et al.[205]	To evaluate the effects of two levels of asthma care by pharmacists on clinical, economic, and QOL outcomes.	20 pharmacists caring for patients with poorly controlled asthma in British Columbia.	Quasi-RCT	**Group A.** Patients were taught inhaler technique, completed monthly asthma diaries of PFs, symptoms, medication use, ED visits, and days off from work/school. Patients encouraged to come once a month for new diaries or at least quarterly. **Group B.** Patients received everything that Group A received plus intensive asthma education and instruction on the use of PF meters and spacer devices. They received private 1hr counseling sessions every 2-3wks for at least 3 wks, then every 3 months for at least 9 months.	Both groups experienced significant improvements over baseline. The intensive education group reported significantly greater improvement than the other patients at 1 year: 11% improvement in PFs ($p=0.0002$), 50% overall decrease in asthma symptoms ($p<0.01$ for most symptoms evaluated), higher QOL ($p<0.05$) and decrease in medical visits (but not ED visits or hospital visits).[205]
Neri et al.[220, 221]	To evaluate the effects of patient education on pulmonary function and inhaler technique among adults with asthma.	35 adults with asthma in Italy.	RCT	**Group A.** 17 patients received a medical exam every two months for 1 year. **Group B.** 18 patients also received six 1-hour lessons "based on the content of an educational booklet on asthma."	At 1 year, there was no difference between the groups in terms of number of asthma attacks, number of work days lost, or hospital admissions.[221] There were no differences between the two groups at 1 or 3 years for FEV_1, asthma knowledge, or number of correct steps during inhaler use evaluation.[220] The program cost per patient was $713 for Group B and $670 for Group A.[221] Compared to baseline, there were significant improvements in FEV, knowledge and inhaler technique in both groups.[220]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Ostojic et al.[206]	To assess the feasibility and reliability of GSM SMS as a tool of asthma monitoring and to ascertain its effects on control of asthma.	16 patients with moderate persistent asthma from a single clinic in Croatia N_{con}=8, N_{int}=8.	RCT	All patients had a 1-hour asthma self-management education session with a specialist at the clinic and were given a self-management plan and a PF monitor. Patients noted PF measurements, medication use and symptoms in a diary. **Group A.** 8 patients were seen in the office at the end of the study to review their asthma diaries. **Group B.** 8 patients sent their PF results daily to physicians via a short-message service (SMS) that used Asthma Center 0.90 Software to compute maximal, minimal, and mean PF, PF variability, and compliance. They then received weekly instructions by SMS from an asthma specialist on therapy adjustments and recommended follow up.	After 4 months, no significant differences between the intervention and the control groups were found in mean PF, $FEV_{1,}$ compliance with PF measurement, daily use of inhaled steroids or β-agonists, wheezing, or limitation of activity. However, when compared to the control group, the intervention group had significantly less coughing ($p<0.05$) and night symptoms ($p<0.05$). The additional cost of SMS per patient, per week was 1.67€ ($1.3 per 1 Euro).[206]
Schonlau et al.[199]	To examine whether a collaborative to improve asthma care influenced processes and outcomes of care for adults with asthma.	6 healthcare organizations from across the U.S. and Puerto Rico sent teams of 3-4 participants for collaborative learning.	CBA	The intervention group (6 sites, 123 patients) sent 3-4 person teams to 3 2-day learning sessions to promote changes in asthma care based on best practices and continuous quality improvement (the curriculum was not described in detail). 2 of 3 control sites (62 patients) had active quality improvement programs for asthma (also not described in any detail).	At 12 months after the intervention, patients in the intervention group were more likely than controls to attend educations sessions ($p=0.03$). However, there were no differences between groups in terms of having a written asthma action plan, goal setting, PF monitoring, use of controller medications, QOL, or asthma knowledge.[199]
Thapar[222]	To compare individual vs. group asthma education sessions.	69 adults with asthma in Wales.	RCT	**Group A.** 34 patients received 20 minute individualized asthma education by a physician with a 5-10 minute follow up session at 3-4months. **Group B.** 34 patients received a 35 minute group asthma education program by the same physician (4-6 patients per group) with a 10-15 minute follow up session at 3-4 months.	At 4-5 months after the initial educational session, there was no difference in asthma knowledge or self-rated "wheeziness scores" between groups. Knowledge increased significantly in both groups compared to baseline.[222]
Thomas et al.[129]	To compare patient education by an asthma nurse with breathing retraining by a physiotherapist.	33 adults with asthma in the U.K.	RCT	**Group A.** 16 adults were given a 60 minute group education session by an asthma nurse on asthma. **Group B.** 17 adults were trained by a physiotherapist in a small group session for 45 minutes followed by 15 minute individual sessions 1 and 2 weeks later (total time 75 minutes) in proper breathing techniques.	There was no difference in asthma medication use between the two groups at 6 months after the intervention. There was a slight improvement in one domain of QOL in the breathing retraining group compared to the nurse educator group ($p<0.05$).[129]

Table 21. Trials comparing two or more intervention groups without a control group that did not also receive an intervention (continued)

Reference	Study Purpose	Target population	Study Design	Type of interventions	Results
Turner et al.[130]	To compare the effectiveness of action plans using either PF monitoring or symptoms to guide self-management.	92 patients with moderate to severe asthma using inhaled corticosteroids from a primary care clinic in Vancouver $N_{Group\ A}$=48, $N_{Group\ B}$=44.	RCT	All patients were given individualized asthma education by a registered nurse, and self-management plans were reviewed in detail. The initial visit consisted of thirty minutes of asthma education and discussion, and follow up visits were scheduled monthly for six months. Patients also kept daily diary cards. **Group A.** 48 patients' self-management plans were based on symptoms **Group B.** 44 patients' self-management plans were based on PF. Therefore, patients with self-management plans based on PF were also instructed in the use of a PF meter.	After 6 months, no significant differences were found between the groups in FEV_1, PF, QOL, symptom scores, the use of β-agonists or inhaled steroids, number of days missed for work/school, ED visits, or hospitalization rates.[130]
Van der Palen et al.[131] and Klein et al.[132]	To assess whether including an action plan in a self-management education program improves asthma outcomes.	245 adults with stable moderate-severe asthma in the Netherlands.	RCT	**Group A.** 122 patients received self-management training and education by an asthma nurse in three 90-min small group sessions. Content included asthma pathophysiology, medication use and side-effects, asthma triggers, symptom identification, PF meter and inhaler technique. **Group B.** 123 patients also received instructions on how to use an action plan to treat exacerbations.	At 1 year, there were no differences between the groups in adherence to medication or the use of action plans.[131] At 2 years, there were no differences between groups in any outcomes including PF, frequency of exacerbations, symptom-free days or nights, outpatient visits, or hospitalizations.[132] Both groups improved in their inhaler technique (p=0.041), knowledge,[131] and QOL.[132]
Yoon et al.[207]	To evaluate the effectiveness of a brief (3hour) patient education program to decrease readmission rates.	76 Australian adults recently discharged after an admission for a severe asthma exacerbation.	RCT	All patients received a PF meter and were shown how to use it and record values from it. **Group B.** 28 intervention subjects also received a single 3hr educational session that emphasized improved inhaler and PF monitor use and self adjustment of the dosage of phrophylactic meds according to a PFs and a treatment plan. Included interactive lecture, videotape, individual training, and a practice session.	10 months after the intervention 1 of 28 intervention patients and 7 of 28 "control" patients were readmitted for asthma (p<0.001). 3 intervention and 7 control patients had ED visits for asthma (p<0.01). No difference in missed work or school between groups, use of inhaled steroids, or reported symptoms.[207]

Note: ED=emergency department; PF=peak flow; QOL=quality of life; CBA=controlled before-after trial.

Provider Education Interventions

Background. The purpose of provider education programs is to inform providers about asthma treatment guidelines and to develop their skills in educating patients and their caregivers about asthma self-monitoring or self-management (whether for providers caring for children or for adults with asthma).[223] Health care providers include nurses, nurse practitioners, physicians, physical therapists, and pharmacists, among others.

Results. Eighteen of the included studies reported on the efficacy of provider education to improve the outcomes and processes of care for patients with asthma.

Interventions targeting providers of children with asthma. We found seven articles reporting interventions designed to provide training for clinicians caring for children with asthma (Table 22).[114, 223, 224] The Pediatric Asthma Care PORT (Patient Outcomes Research Team), conducted a RCT designed to assess the effectiveness of three strategies (physician-peer leaders, peer leaders in combination with asthma nurse visits, and usual care) to implement guidelines for childhood asthma (funded by AHRQ), which is noteworthy for several reasons: It is an effectiveness study intended to evaluate the effects of implementing QI interventions in real-world primary care practices (rather than an efficacy trial in a controlled trial environment), it included 42 primary care practices in four health care organizations around the country (Boston, Seattle, and Chicago), it is one of the largest included trials (with 638 patients), and it had a relatively long intervention and follow up period (two years). At the end of the two year follow up period, compared with the usual-care arm (N=199), patients randomized to the physician-peer leader arm (N=226) had annual increase of 6.5 symptom-free days, whereas those randomized to the physician-peer leader and nurse visit arm (N=213) had an annual increase of 13.3 symptom-free days over usual care patients.[225, 226] The average number of physician visits during the two year trial was higher in the physician-peer leader and nurse visit arm as was regular use of inhaled controller medications (not found for physician-peer leader only patients).[226, 227] Total treatment and intervention costs per year per patient were $1292 for PACI, $504 for physician-peer leaders, and $385 for usual care. The incremental cost-effectiveness compared to usual care was$18/symptom-free day for that physician-peer leader arm and $69/symptom-free day for the physician-peer leader with nurse visit arm.[225]

The study by Homer and colleagues[228] is notable for its methodological rigor. For this study, a physician, nurse, and front office staff person from 22 practices in Boston and Detroit were invited to three 1-day educational sessions on quality improvement strategies for asthma based on the Chronic Care Model and concepts from QI theory including the Model for Improvement (a specific approach to QI that emphasized small, incremental tests of change).[228] Additional support was provided through biweekly conference calls, an active e-mail list, and performance feedback based on review of monthly team reports. The study specifically describes the authors' research hypotheses, study outcome measures, power calculations, and detailed information about the baseline characteristics of the study population. Further, they performed an intention to treat analysis and evaluated the effect of the intervention by comparing the change from baseline for the intervention group with the change from baseline in the control group (21 additional practices) adjusting for the effects of state, practice size, age, and gender. They found

no intervention effect; however, the study serves as model for rigorous analysis and reporting of provider education interventions.

With the study just described by Homer and colleagues as the one exception,[228] all of the other studies found statistically significant improvements in use of medications (most often increases in the use of inhaled controller medications) (Table 22). Several also found improvements in asthma symptoms and reductions in emergency department use. All of the studies gave providers some information about current asthma treatment guidelines, about appropriate follow up for patients with asthma, and some training to encourage providers to teach patients (and their caregivers) about asthma self-monitoring or self-management (particularly through the use of asthma action plans). The interventions differed in terms of their intensity and scope of training. For example, the study by Evans and colleagues evaluated an intervention designed to train all the staff (including physicians, nurses, and clerical staff) at selected pediatric clinics serving low-income minority children in New York City.[224] All staff were included in the training because the developers of the intervention wanted to ensure that everyone in the clinic understood the program and how they could contribute to it. All staff received five three-hour educational sessions over a five month period and then two additional three-hour sessions at the end of the one-year follow up period to give staff opportunities to discuss specific patients and reinforce communications skills. Intervention physicians also spent three hours observing a Columbia faculty physician treating children with asthma in a tertiary care setting. They found that, two years after the intervention, the intervention clinics had enrolled more new asthma patients (40/100 vs. 16/100, $p<0.01$), a greater percentage of asthma patients returning for treatment (42% vs. 12%, $p<0.001$), a greater annual frequency of scheduled visits per patient (1.85 vs. 0.88, $p<0.001$), and a greater proportion of patients on inhaled β-agonists and corticosteroids than control clinics.[224] In contrast, the physicians in the educational intervention described by Glasgow and colleagues received a single one-on-one session training them in the use of a multi-visit asthma treatment plan.[§114] At 12 months after this intervention, Glasgow also showed statistically significant effects: the intervention children had increased use of written asthma action plans (44% versus 34%) and pressurized metered dose inhalers with a spacer (62% versus 38%), decreased rates of speech-limiting wheezing (5% versus 18%), and were less likely to use reliever medications more than 4 days of the week (9% versus 30%). There was no difference in symptom-free days or ED visits.[114]

Interventions targeting providers of general population or adults with asthma. We found 11 studies reporting on interventions with some component of provider education for general populations or adult patients with asthma (Table 23). One of these compared two intervention groups without a control that did not also receive a QI intervention (Table 21).[199]

Four studies evaluated interventions that combined provider education with a component of provider feedback (Table 26).[229-232] Two of these four combination interventions were associated with improvements in provider prescribing practice. For example, the study by Cordina and colleagues of an intervention in which Maltese pharmacists were trained to provide patient education and monitoring of asthma symptoms found improvements in inhaler technique, nighttime wheezing, and patient-reported hospitalizations for asthma (there are additional details

[§]The article by Glasgow and colleagues provides a detailed description of what actions the physician should take at each of the recommended clinic visits.

about this study in the section on organizational change interventions, Table 25).[159] In contrast, a Swedish study of pharmacists/clinical pharmacologists visiting groups of primary care providers to teach them about asthma treatments and to encourage self management found no statistically significant change in prescribing practices.[231]

As a group, 55% of these 11 provider education interventions reported that providers receiving the education improved adherence to asthma management guidelines (most often, providing written asthma management plans and increased prescription of inhaled corticosteroids). They were less likely to report improvements in health services utilization (27%) or improvements in clinical outcomes (9%).

Conclusions. Most provider education interventions include components of training in current asthma therapies, follow up, and self-monitoring or self-management and most reported improvements in the prescription of inhaled controller medications. Given the heterogeneity in the studies and relatively small number of studies, we cannot evaluate the specific provider education intervention characteristics likely to be associated with improvements in clinical outcomes for patients. Moreover, given the wide variation in the types of interventions included, we cannot specify which educational components led to the greatest benefit.

Table 22. Summary of provider education interventions for the improvement of asthma in children

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Clark et al.[233, 234] and Brown et. al[223]	To evaluate the long-term effects of an interactive seminar for physicians based on principles of self-regulation on patient care and outcomes.	67 general pediatricians (N_{int}=34, N_{con}=33) and their patients with asthma aged 1-12 years (N_{int}=202, N_{con}=167) from Ann Arbor, MI and New York, NY.	RCT	Intervention physicians received 2 interactive, multimedia, small group, 2.5-hour seminars that focused on optimal clinical practice based on NAEPP expert panel guidelines and patient teaching and communication. They included brief lectures from a local asthma expert and video showing effective clinician teaching and communication behaviors, case studies of clinical problems, a protocol for self assessment, and a review of messages to communicate and materials to distribute to patients/families. Control group physicians received no intervention.	2 years after the intervention**,** intervention physicians were more likely than controls to provide written instructions on how to adjust the dose or timing of medications when a child's symptoms changed (p=0.02) and provide specific guidelines for patients to use in order to change therapy when clinical conditions changed (p=0.02). There were no significant differences between the groups in the proportion of patients to whom physicians prescribed anti-inflammatory medication or number of ED visits for the previous 12 months. However, patients of intervention physicians had significantly fewer hospitalizations (p=0.03) for the previous 12 than those seen by control physicians. Data were adjusted for baseline values.[233]
Evans et al.[224]	To evaluate the effects of provider training based on National Asthma Education and Prevention Program on all staff at selected pediatric clinics serving low-income minority children in New York City. The authors hypothesized that the intervention clinics would have increased numbers of children diagnosed with asthma and receiving continuing care and increased use of new pharmacologic and educational treatment methods.	11 clinics in the study group (with 80 staff) served 3,118 patients and 11 clinics in the control group (with 54 staff) served 2,487 patients. 36% were Medicaid recipients.	RCT	Staff received five 3-hour educational sessions over a 5 month period. All staff (including clerical staff) participated in each session to ensure that everyone in the clinic understood the program and how they could contribute to it. 2 additional 3-hour sessions were held at the end of the 1year follow up period to give staff opportunities to discuss specific patients and reinforce communications skills. The second component of the intervention was a tutorial session with which the intervention physicians each spent 3 hours observing a Columbia faculty physician treating children with asthma. Outcomes were assessed over a 2 year period.	2 years after the intervention, the intervention clinics had a greater rate of new asthma patients (40/100 vs. 16/100, p<0.01), greater percentage of asthma patients returning for treatment (42% vs. 12%, p<0.001), greater annual frequency of scheduled visits per patient (1.85 vs. 0.88, p<0.001), greater proportions of patients on inhaled β-agonists and corticosteroids.[224]

Table 22. Summary of provider education interventions for the improvement of asthma in children (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Finkelstein et al.,[227, 235] Sullivan et al.,[225] and Lozano et al.[226]	The Pediatric Asthma Care Patient Outcomes Research Team (I and II) compared 2 asthma care strategies in children with mild to moderate asthma with usual care in the primary care setting.	42 primary care clinics in 4 health care organizations in Chicago, Seattle, and Boston that cared for 638 children aged 3-17 years with mild to moderate persistent asthma.	RCT	A peer leader-based physician behavior change intervention (PLE) and a practice-based redesign intervention (PACI) were compared with usual care. The PLE strategy involved training a pediatrician (in 2 workshops and through monthly contact from an educational coordinator and ongoing learning network for peer leaders) at each of the practices sites as an asthma expert and champion. The peer leader functioned as a change agent within the practice and provided support, education, and feedback to other members of the practice. The PACI strategy involved 4-5 scheduled asthma care visits with an asthma care nurse who provided standardized assessments, care planning, coordination with primary care physicians, and self-management tools for the patients and their families. Between visits, the asthma nurse provided phone follow up. The PACI arm included all the components of the PLE arm.	At 2 years, compared with the usual-care arm (N=199), patients randomized to the PLE arm (N=226) had annual increase of 6.5 symptom-free days (SFD), whereas those randomized to the PACI arm (N=213) had an annual increase of 13.3 SFD over usual care patients.[225, 226] The average number of physician visits during the 2 yr trial was 4.7 in the PACI, 3.2 in the usual-care arm, and 3.1 in the PLE arm (p=0.002) for difference between PACI and the other two arms.[225] No difference among arms in terms of the number of hospital days and ED visits. PACI patients were more likely to have regular controller use compared with usual care subjects (RR 0.05; 95% CI 1.0-1.09), no similar effect was found for PLE patients.[226, 227] Total treatment and intervention costs per year per patient were $1292 for PACI, $504 for PLE, and $385 for usual care. The incremental cost-effectiveness compared to usual care was$18/SFD for PLE and $69/SFD for PACI.[225]
Glasgow et al.[114]	Train providers to use and then evaluate the feasibility and effectiveness of a general practice-based, proactive system of asthma care in children with moderate to severe asthma.	Australian children (101 intervention and 73 control) with moderate to severe asthma and a general practitioner and their physicians (12 control and 12 intervention physicians) were enrolled.	RCT	The physicians received 1-to-1 education by one of the study authors on a "3+ Visit Plan" (1st visit: introduce concept of a contract for asthma care; 2nd visit: assess patient's status; 3rd visit: review patient's PF record, complete asthma action plan, and identify triggers; 4th visit: assess progress and answer questions.	12 months after the intervention, the intervention children had increased use of written asthma action plans and pressurized metered dose inhalers with a spacer, decreased rates of speech-limiting wheezing, and were less likely to use reliever medications more than 4 days of the week. There was no difference in symptom-free days or ED visits.[114]

Table 22. Summary of provider education interventions for the improvement of asthma in children (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Homer et al.[228]	To implement a multi-disciplinary provider education program in a large number of practices and evaluate its effects on asthma outcomes for children.	43 practices in Boston and Detroit with 13,878 pediatric patients (aged 2-17) with asthma.	RCT	Intervention practices (N=22) sent a 3-member multidisciplinary team (physician, nurse, and front office staff person) to three 1-day learning sessions on quality improvement strategies for asthma. Additional support was provided through biweekly conference calls, an active e-mail list, and performance feedback based on review of monthly team reports. Control practices (N=21) received no intervention during the experimental year.	After controlling for state, practice size, child age, sex, and within-practice clustering, there was no effect of the intervention on children receiving a written asthma plan, medication use, asthma attacks, activity limitation, hospitalizations or asthma ED visits.[228]
Maslen-nikova et al.[82]	To assess the effects of a adapting a U.S. self-management educational intervention on asthma outcomes for children in Moscow.	122 children with asthma and their families living in Moscow. N_{int}=60; N_{con}=62.	RCT	The authors adapted "Open Airways" (developed for low literacy children aged 4-7 years) and "Air Power" (developed for average literacy children aged 8-14 years) for similar populations in Moscow. Intervention subjects also received asthma care from clinicians who had been trained "according to the U.S. guidelines for the diagnosis and management of asthma and use of modern asthma medications." Intervention subjects participated in 4 weekly 1hr sessions. Control subjects received usual care.	1 year after the intervention, the % of children in the education group who were on inhaled anti-inflammatory medications increased by 46% compared to only 8% for the control group ($p<0.05$). Intervention children's PF measures also improved more than for control children ($p<0.05$). There was no difference in terms of the change in % of children using theophylline or β-agonists or days missed from school.
Toelle et al.[88]	To evaluate whether a community-based asthma management program could reduce asthma symptoms and lung function among school children in Sydney, Australia.	132 school children aged 8 to 11 with asthma and all the adults who influence their care including parents, doctors, pharmacists, community nurses and school teachers. N_{int}=72; N_{con}=60.	CBA	Intervention group participant were invited to attend 2 education sessions each 2 hours, 1 week apart on asthma triggers, medication use, inhalation technique, use of written self-management plan. These children's physicians and pharmacists were invited to attend work-shops on asthma management guidelines. Intervention community nurses and teachers received workplace in-service education sessions. All families, children, physicians, and pharmacists who did not attend the intervention sessions were mailed the materials.	147 teachers and community nurses, 53 families (74%), 15 pharmacists (21%), and 11 physicians (20%) attended educational sessions. 6 mos after the intervention, both FEV_1 and dose-response ratios fell in the intervention group but no the control group ($p<0.001$). Night cough decreased significantly in the intervention group ($p<0.001$). There was no significant difference in # of children with wheeze or symptoms that limit activity, physician or ED visits, or days absent from school.[88]

Note: ED=emergency department; PF=peak flow; NAEPP=National Asthma Education and Prevention Program; CBA=controlled before-after trial.

Table 23. Summary of provider education interventions for the improvement of asthma in general populations or adults

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Cordina et al.[159]	To examine the effects of a community pharmacy-based education and monitoring program for patients with asthma on a range of patient-specific asthma management outcomes.	152 patients over the age of 14 who received their asthma prescriptions at private pharmacies in Malta.	CBA	A comprehensive asthma education and monitoring program was instituted in private pharmacies in Malta for 12 months. The intervention pharmacists reviewed patients asthma symptoms, PF records, medication use, and when necessary suggested changes in treatment to the patient's physician.	There was no significant difference between treatment and control groups in terms of PF measurement, self-reported inhaler use, days lost from work or school, or health related QOL. There were fewer self-reported hospitalizations for asthma among intervention patients (0/86) than among control patients (8/66) ($p<0.002$) but no other differences in health services utilization. The intervention patients were less likely to report nighttime wheezing and more likely to improve their inhaler technique than control patients. [159]
Daniels et al.[236]	To assess the effectiveness of an intervention designed to increase compliance with national asthma care guidelines in primary care safety net health centers serving high-disparity patient populations	16 federally-funded community health centers in eight southeastern states in the U.S. $N_{con}=9$, $N_{int}=7$.	RCT	The intervention consisted of three components: resources (asthma kits including PF meter, MDI spacer device, educational materials) which clinicians were encouraged to give to patients, training of all health center staff in asthma care guidelines which emphasized the need for patients to have Management, action, and prevention plans, and tools or templates for practice-level systems change (asthma flow sheets and standing orders). Control group sites received copies of the national asthma guidelines and one asthma resource kit with information on how they could obtain more at a discounted price.	There were no significant differences between the intervention and control sites in the number of patients who had been instructed how to use and MDI or a PF meter, counseled regarding environmental triggers, been given a written action plan, counseled on maintenance and rescue plans, or prescribed steroids or anti-inflammatory inhalers. There was a significant increase in the intervention group compared to the control in the number of patients who had their PF measured and recorded in clinic ($p=0.006$) and documenting interval symptom history ($p=0.008$).[236]

Table 23. Summary of provider education interventions for the improvement of asthma in general populations or adults (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Feifer et al.[171]	To determine whether a population-based asthma disease management program, using broad-based educational interventions can have favorable effects on physician and patient adherence to guidelines-based care.	70,900 patients with asthma patients aged 5-45 years using a specific prescription benefit plan in the U.S. 35,450 patients were in each group.	CBA	During the 12-months following enrollment, intervention patients and their physicians received educational materials. Patients in the intervention group received five workbooks and two newsletters. Educational materials emphasized guideline-based elements of asthma pharmacotherapy, self-management techniques, and trigger avoidance. Additionally, patients received refill reminders, prospective compliance reminders, and pollen count alerts by mail. Physicians received asthma management flow sheets to facilitate the tracking and review of patients' therapy. Patients in the control group received no educational materials, nor did their health-care providers.	All outcomes were measured as the change between baseline and 12 months after enrollment. The percentage of patients using controller therapy decreased less in the intervention group ($p<0.0001$), controller prescription refill rate increased in the intervention group ($p<0.0001$), and reliever prescription refills were reduced in the intervention group ($p<0.001$) compared to the control group.[171]
Gorton et al.[237]	To evaluate the effect of three different methods of disseminating asthma guidelines on physicians' behavior and attitudes toward education strategies	76 primary care physicians in four Area Health Education Centers (AHECs) at the University of Arkansas for Medical Sciences. A total of 375 patient records were reviewed. $N_{con}=17$, $N_A=11$, $N_B=17$, $N_C=18$.	CBA	The study had 1 control group and 3 intervention groups. All intervention groups received the executive summary of the asthma guidelines produced by the National Institutes of Health (NIH). Physicians in Group A also received a 10-page summary of the guidelines, 2 telephone calls from "academic detailing" peer physicians, and were invited to attend a half-day continuing medical education (CME) conference. Physicians in Group B completed 4 computer-based modules, a computer conference with a moderator to discuss the guidelines. Physicians in Group C received a videocassette created for cable medical television, 4 facsimile messages in the hospital mailbox (weekly, for 4 weeks), and 4 posters were displayed in prominent locations in the hospital (monthly, for 4 months). Group C was also invited to the CME conference and received an audiocassette of the conference. Physicians in the control group received educational materials after the completion of the project.	After 4 months, both Group B and Group C physicians increased the appropriate use of oral β-agonists significantly more than control physicians ($p=0.03$ for both comparisons). Group C physicians increased the ordering of home PF monitoring more than control physicians ($p=0.01$). Groups A and B physicians increased PF monitoring at the office more than control physicians ($p<0.05$ and $p<0.01$, respectively). There were no differences among the groups in terms of improving the use of spirometry or symptom diaries, which remained low. There was also no significant difference in the use of any other asthma medication among the groups.[237]

Table 23. Summary of provider education interventions for the improvement of asthma in general populations or adults (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Lagerløv et al.[230]	To evaluate the effects of a newly developed form of group education for improving the quality of prescribing in primary health care.	190 GPs responsible for the care of asthma patients in Norway.	CBA	Like the control group, the intervention group participated in 2 group meetings—during one they discussed asthma diagnosis, and the key information for making treatment decisions. At the second meeting international and national guidelines for treating asthma were presented. The group then agreed on common quality criteria for what they found to be acceptable and unacceptable prescribing practices. Feedback on their prescription behaviors was given relative to the agreed upon quality criteria.	There was no difference in the number of patients treated by intervention providers with "acceptable medications" (p=0.18).[230]
Lundborg et al.[231]	To develop, implement, and evaluate a new educational model, with messages based on available national guidelines aimed at improving prescribing in primary care.	204 GPs responsible for the care of asthma patients in Sweden.	CBA	GPs were asked to attend 2 group sessions. During the 1st session, individual feedback on written simulated cases was given and discussed. During the 2nd session, feedback on individual prescribing was presented and discussed. GPs were expected to: start/increase inhaled corticosteroids when bronchodilator use is too high; treat asthma exacerbations with anti-inflammatory treatment and not routinely with antibiotics; and 3) not start long-acting β_2-agonists when the patient is on a sub-optimal level of inhaled corticosteroids.	Both the intervention and control groups had increases in the prescription of inhaled corticosteroids.[231]
Rossiter et al.[232]	To determine the potential of a disease management program in terms of improving the health of low-income Medicaid patients while achieving cost savings in providing treatment.	Virginia Medicaid population with moderate to severe asthma (a designation based on assessment of claims) who received care in a primary-care case management program (fee-for-service and HMO-based practices were excluded).	See note[§]	Providers in primary-case-management programs with asthma patients were identified, and those who volunteered received an education workshop to improve communication skills and to inform them about current asthma treatment recommendations. Additionally, most participants also received intermittent feedback regarding who among their patients might benefit from further asthma education and treatment.	The intervention group had improved prescribing practices for β-agonists, but not for inhaled corticosteroids. The program had a significant effect on emergency visits, but only in the short-term post-intervention. This benefit was greater among those Medicaid claimants whose providers received feedback in addition to the educational workshop. The projected direct cost savings of the program is $3-4 for every incremental dollar spent. [232]

Table 23. Summary of provider education interventions for the improvement of asthma in general populations or adults (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Tomson et al.[238]	To assess the effects of a provider education program on prescribing practices and physician and patient knowledge of asthma.	General practitioners practicing in primary care clinics of Stockholm County (Sweden) (of whom 44 practicing in a similar region were assigned to the intervention group and 19 in a different region were assigned to the control group).	CBA*	A clinical pharmacologist and pharmacist visited the intervention practices and met with physicians in groups to discuss the treatment of asthma and to provide written information encouraging the use of inhaled glucocorticoids for prophylaxis, the use of PF meters, and testing to distinguish patients with COPD and asthma.	Significantly more providers in the intervention group reported recommending the use of PF meters and advised their patients in its use. There was no significant difference in prescribing practices.[238]
Veninga et al.[229]	To evaluate the effects of a newly developed form of group education for improving the quality of prescribing in primary health care.	181 general practitioners (GPs) responsible for the care of asthma patients in the Netherlands.	CBA	Intervention providers received group education on asthma prescribing and performed a self-learning audit program for peer groups. During 2 meetings, groups met with a moderator with individual feedback material for all members of the groups; anonymity was not maintained by mutual agreement; use of case vignettes which the GPs had received by mail prior to the meetings; individualized feedback on prescribing provided at second meeting.	Increased use of inhaled corticosteroids was found in the intervention group.[229]
Weng[194]	To evaluate the effects of a government sponsored QI intervention with patient and provider education and case management services for patients with asthma.	1067 patients with asthma enrolled in the program sponsored by the Taiwanese government. 4,340 patients with asthma who did not enroll in the program served as matched controls.	CBA	Providers received a 6-hour asthma curriculum that included conducting pulmonary function testing, use of medications and PF monitoring, environmental controls, and asthma pathophysiology. They were given copies of asthma clinical practice guidelines. Patients received individualized, personally tailored asthma education on recognizing triggers and symptoms, medication use, PF use, and self-management of exacerbations. Case managers (nurses or physician assistants) provided communication between patients, primary care physicians and specialists, and scheduled quarterly follow up.	1 year after enrollment, the intervention group had longer hospital stays (by 40%, p=0.045) but no difference from control patients in the number of ED visits or number of hospitalizations. However, among patients newly diagnosed with asthma during the study interval, there was a decrease in ED visits (by 61%) in the intervention group compared to the controls.[194]

*CBA=controlled before-after trials §The intervention group for this study was selected from providers in specified geographic areas. Medicaid claims were compared between the intervention area and non-intervention areas. Comparisons were made over time (ITS-like, with only two "before" measures but with explanation that analysis of a longer pre-intervention period yielded little change in variables) and between groups. **Note:** ED=emergency department; PF=peak flow; QOL=quality of life.

Organizational Change Interventions

Organizational Change Interventions for Children With Asthma

Background. The studies of organizational change interventions designed to improve the processes and outcomes of care for children with asthma fall broadly into two categories: those that augment the care provided in general pediatrics clinics and those that provide an increased level of care in schools. Whereas the interventions described in the section on patient education (Table 12b) were asthma education programs in schools that often just taught children about the disease and its management, the school-based interventions described in this section all added increased levels of asthma care provided in the school setting. Asthma in children affects schools in several ways: Ongoing disease management typically happens while children are in school and life-threatening acute asthma symptoms can occur at school. Asthma is a leading cause of illness-related school absenteeism and this absenteeism often necessitates "make up" school work for these children and their teachers. Thus, schools are a natural site for asthma-based education and management programs.

Results. We found 13 studies of organizational change strategies designed specifically for children with asthma (Table 24).[108, 115, 117, 119, 124, 239-241] Two of these studies compared two or more intervention groups without a control that did not also receive a QI intervention and are presented with studies of that design (Table 21). As a group of interventions, these were relatively heterogeneous and not as likely as other types of QI interventions to report improvements in outcomes for patients: three studies reported improvements in clinical outcomes, three studies reported improvements in health services utilization, and three studies reported improvements in functional status. They were more likely to report improvements in terms of the number of asthma patients receiving inhaled controller medications.

Asthma specialty clinics/care. Nine studies compared usual asthma care to asthma care augmented by providers with special training (i.e., nurses,[108, 117, 118, 225-227, 235] pharmacists,[115, 241] psychologists and physiotherapists).[124]

The Pediatric Asthma Care PORT (Patient Outcomes Research Team), a RCT designed to assess the effectiveness of three strategies (physician-peer leaders (PLE), peer leaders in combination with asthma nurse visits (PACI), and usual care) to implement guidelines for childhood asthma found that, at the end of the two year follow up period, compared with the usual-care arm (N=199), patients randomized to the PLE arm (N=226) had annual increase of 6.5 symptom-free days (SFD), whereas those randomized to the PACI arm (N=213) had an annual increase of 13.3 SFD over usual care patients.[225, 226] The average number of physician visits during the two year trial was higher in the PACI arm as was regular use of inhaled controller medications (not found for PLE patients).[226, 227] Total treatment and intervention costs per year per patient were $1,292 for PACI, $504 for PLE, and $385 for usual care. The incremental cost-effectiveness compared to usual care was$18/SFD for PLE and $69/SFD for PACI.[225]

The RCT by Kelly and colleagues of low income children in Virginia who were randomized to receive comprehensive education and management by a physician allergist with monthly phone follow up by an outreach nurse found that children in the intervention group were less likely to visit an emergency department or require hospitalization than control children (95%

versus 23%; p<0.001).[119] The rate of smoking was high in both the intervention and control households (47% and 50%, respectively). Subgroup analysis suggested a trend toward greater effectiveness of the intervention to decrease hospitalizations among children residing in smoke-free households.[119]

School-based directly-observed therapy programs. Two of the included studies evaluated the use of directly observed therapy for children with asthma. Long-term asthma control therapies work best when taken on a consistent basis, but compliance with this treatment is a known problem—schools provide an opportunity for directly-observed therapy among pediatric patients. Anderson and colleagues compared outcomes among asthma patients attending the Kunsberg school in Denver (designed specifically for children with chronic health conditions) to outcomes among a matched group of children with asthma attending regular schools.[239] The Kunsberg school had a nurse administrator, two nurses, a social worker, and teachers familiar with methods for managing children with chronic medical conditions who provided a range of patient and parent asthma educational interventions, case management including communication with primary care providers, and daily directly observed medical therapy. At the Kunsberg school, nurses reported that 89% of children with asthma received their inhaled corticosteroids on a daily monitored basis.[239] Compared with controls, children enrolled in the Kunsberg school had fewer hospitalizations, ED visits, and follow up visits for their asthma.[239] A survey of school nurse and parents indicated that improved medication compliance resulted from directly-observed therapy and an overall increased structure of care resulted in better outcomes.[239] Given the resources available to children in this type of school, it may be difficult to generalize their results to other school settings.

Another study, a RCT by Halterman and colleagues specifically evaluated the role of directly-observed therapy.[240] Their study population of children aged 3 to 7 years with asthma from urban and primarily minority and low-income demographic groups received their daily dose of inhaled corticosteroids from the school nurse. The control group continued to receive their inhalers at home. Overall, children in the intervention group had a reported 84% compliance rate with inhaled corticosteroids versus 63% among the control group. Children in the intervention group missed significantly fewer days of school and had more symptom-free days than did children in the control group. In a post-hoc analysis, it was found that all statistically significant improvements that were observed in the study were found in those patients not exposed to second-hand smoke. (Overall, 44% of children with asthma enrolled in the study lived in a home with at least one smoker.)

Conclusions. From the few studies of this type, we conclude that augmenting usual asthma care with additional specialty asthma clinics staffed by asthma-trained nurses and pharmacists can be effective. Directly-observed therapy may increase the rate of inhaled corticosteroid use and improve clinical outcomes among school children with asthma, particularly those who are not exposed to second hand smoke.

Table 24. Organizational change interventions for children with asthma

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Anderson et al.[239]	To assess the health-related benefits of a daily program of a school-based disease management program.	18 asthma patients attending the Kunsberg school in Denver (mostly of low socioeconomic groups) were compared to 36 control children with asthma from the Denver area attending different schools.	CBA*	The Kunsberg school has a nurse administrator, two nurses, a social worker, and teachers familiar with methods for managing children with chronic medical conditions who provide a range of patient and parent asthma educational interventions, case management including communication with primary care providers, and daily directly observed medical therapy.	At the Kundsberg school, nurses reported that 89% of children with asthma received their controller inhaled corticosteroids on a daily monitored basis. Compared with controls, children enrolled in the Kundsberg school had fewer hospitalizations (p=0.05), ED visits (p=0.04), and follow up visits for their asthma (p=0.01). Hospital and clinic costs for asthma care decreased by 80% in the Kunsberg children compared to a 19% decrease in control children ($8,122/year vs. $1,588/year). A survey of school nurses and parents indicated that improved medication compliance resulted from directly observed therapy and an overall increased structure of care resulted in better outcomes.[239]
Bynum et al.[51]	To assess the effectiveness of pharmacists using interactive compressed video (telepharmacy) for teaching metered dose inhaler (MDI) technique to rural, adolescents with asthma.	36 adolescents in grades 7-12 with asthma from junior high and high schools in rural Arkansas. N_{con}=21, N_{int}=15.	RCT	All patients had two 15-minute individual sessions with a pharmacist. During the 1st session, intervention subjects demonstrated their MDI technique to the pharmacist who provided via verbal instructions and demonstrations on improved MDI technique. The control subjects demonstrated MDI technique, were then given written instructions for MDI technique from a package insert for their placebo inhaler. The sessions took place at local health clinics equipped with interactive compressed video technology.	At the 4 week follow up, there was no significant difference between the intervention and the control group in MDI technique. However, there was more significant improvement in the intervention group compared to the control group (p<0.001) in MDI technique from baseline.[51]

Table 24. Organizational change interventions for children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Finkelstein et al.,[227, 235] Sullivan et al.,[225] and Lozano et al.[226]	The Pediatric Asthma Care Patient Outcomes Research Team (I and II) compared 2 asthma care strategies in children with mild to moderate asthma with usual care in the primary care setting.	42 primary care clinics in 4 health care organizations in Chicago, Seattle, and Boston that cared for 638 children aged 3-17 years with mild to moderate persistent asthma.	RCT	A peer leader-based physician behavior change intervention (PLE) and a practice-based redesign intervention (PACI) were compared with usual care. The PLE strategy involved training a pediatrician (in 2 workshops and through monthly contact from an educational coordinator and ongoing learning network for peer leaders) at each of the practices sites as an asthma expert and champion. The peer leader functioned as a change agent within the practice and provided support, education, and feedback to other members of the practice. The PACI strategy involved 4-5 scheduled asthma care visits with an asthma care nurse who provided standardized assessments, care planning, coordination with primary care physicians, and self-management tools for the patients and their families. Between visits, the asthma nurse provided phone follow up. The PACI arm included all the components of the PLE arm.	At 2 years, compared with the usual-care arm (N=199), patients randomized to the PLE arm (N=226) had annual increase of 6.5 symptom-free days (SFD), whereas those randomized to the PACI arm (N=213) had an annual increase of 13.3 SFD over usual care patients.[225, 226] The average number of physician visits during the 2 yr trial was 4.7 in the PACI, 3.2 in the usual-care arm, and 3.1 in the PLE arm (p=0.002) for difference between PACI and the other two arms.[225] No difference among arms in terms of the number of hospital days and ED visits. PACI patients were more likely to have regular controller use compared with usual care subjects (RR 0.05; 95% CI 1.0-1.09), no similar effect was found for PLE patients.[226, 227] Total treatment and intervention costs per year per patient were $1,292 for PACI, $504 for PLE, and $385 for usual care. The incremental cost-effectiveness compared to usual care was$18/SFD for PLE and $69/SFD for PACI.[225]
González-Martin et al.[115]	To measure the effects of a pharmaceutical care program in children with asthma.	13 children with stable and moderate asthma in Chile.	RCT	Children were assigned to either a pharmacist-led asthma program or to usual care by their pediatricians. The intervention pharmacists provided both written and verbal instructions to children and parents, information about asthma triggers, treatment alternatives, inhaler techniques, medication side effects, and what to do in the event of an acute attack.	9 weeks after enrollment, there were no differences in spirometry or any domains of health-related QOL.[115]

Table 24. Organizational change interventions for children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Halterman et al [240]	To determine whether a systematic, school-based asthma screening, coupled with primary care provider notification of asthma severity, would prompt providers to take preventative medication action.	180 children aged 3 to 7 years with mild persistent or more severe asthma and who were from urban and primarily minority and low-income demographic groups in Rochester, New York.	RCT	The intervention cohort received their daily dose of inhaled corticosteroids from the school nurse. The control group continued, as usual, to receive their inhaled corticosteroids at home. Children were followed for a mean of 2.9 years (range 1-6).	Children in the intervention group had a reported 84% compliance rate with inhaled corticosteroids vs. 63% among the control group. Children in the intervention group missed significantly fewer days of school (6.8 vs. 8.8 days, p=0.47) and experienced more symptom-free days during the early winter months (p=0.02) than did children in the control group. No other statistically significant differences in symptom measures or health care utilization measures were found. Children in both groups had improved health status over time. In addition, parents of children receiving directly observed therapy at school reported an improvement in their QOL significantly greater than that among parents of control-group children. In a post-hoc analysis, it was found that all significant improvements were found in those patients not exposed to second-hand smoke. [240]
Kamps et al.[117, 118]	To establish whether there are differences between outpatient management of childhood asthma by pediatricians or by asthma nurses.	74 children aged 2-16 with chronic persistent asthma in the Netherlands.	RCT	Children were randomly assigned to receive 1 year of asthma care by either a pediatrician or a specialist asthma nurse. The asthma nurse provided detailed education about the mechanisms of disease, use of medications, management of acute symptoms, and proper inhaler techniques.	At 1 year, there was no difference between children receiving asthma care from a pediatrician than from a nurse specialist in terms of symptom-free days, airway hyperresponsiveness, functional health status, disease-specific QOL.[117] There were also no differences between the groups in terms of inhaled or oral corticosteroids, courses of antibiotics, unscheduled outpatient visits, ED visits, hospitalizations, or overall healthcare costs.[118]

Table 24. Organizational change interventions for children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Kelly et al.[119]	To examine the effects of a comprehensive education and outreach program designed to decrease emergency department utilization and hospitalization for Medicaid-insured children with asthma.	78 children with asthma aged 2-16 years enrolled in Medicaid and receiving their care in Norfolk, Virginia.	RCT	Intervention children (and their caretakers) were enrolled in an education and treatment program in a pediatric allergy clinic. They received 1-on-1 education by a physician and asthma outreach nurse on topics including recognition of triggers, environmental control, early warning signs and symptoms, medication usage and side effects, proper usage of inhalers and PF meters. The nurse contacted intervention families on a monthly basis to review the patient's health status, symptoms, medications, refill prescriptions, and assist with scheduling and transportation to clinic follow up.	At the end of the study year, children in the intervention group were less likely to have an ED visit and more likely to receive an annual influenza vaccine (95% vs. 23%; p<0.001). 47% of the intervention group and 50% of the control group reported at least one smoker in the home. Subgroup analysis suggested a trend toward greater effectiveness of the intervention to decrease hospitalizations among children residing in smoke-free households.[119]
Mangione-Smith et al.[242]	To examine whether a collaborative to improve pediatric asthma care positively influenced processes and outcomes of care.	Children aged 2-17 receiving care in 13 primary care clinics (9 experimental and 3 control) across the participating in a collaborative to improve the care of children with asthma.	CBA	Each participating clinic sent a team of 3 to 5 health care providers for three 2-day sessions to learn "proven strategies for improving care and refine plans for incorporating such strategies within their organizations."	385 children received care in intervention clinics and 126 children received care in control clinics. Chart review 16 months after the intervention revealed that intervention children were more likely to have PF measurements recorded (p<0001), have written action plan (p<0.0001), have routine asthma follow up at least every 6 months (p=0.004), receive asthma self-management education (p<000.1), receive instruction on inhaler use (p=0.002), and have higher QOL scores (p=0.03). There were no differences between groups in terms of long-term use of controller medications, acute care service use, school absenteeism, or parental missed work days.[242]

Table 24. Organizational change interventions for children with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Salisbury et al.[108]	To compare a nurse-led clinic in schools with general practice care for adolescents with asthma.	382 adolescents with asthma attending secondary schools in Bristol, North Somerset, and South Gloucestershire, U.K.	RCT	Adolescents were randomized to receive either usual care with a pediatrician or to attend a nurse-run asthma clinic. The care in these school-based clinics was "similar to that offered at a nurse-led asthma clinic in general practice, but the discussion was specifically targeted at the needs and interests of adolescents." [108]	At 6 months, intervention adolescents had better inhaler technique, were more like to have a PF meter, and self management plans. There was no significant difference between groups in terms of asthma symptoms, days lost from school, use of inhaled steroids, health services utilization, or health related QOL. The costs of six months asthma care for the intervention adolescents were higher than for the control patients.[108]
Stergachis et al.[241]	To assess the effects of a pharmaceutical care program on changes in disease control, functional status, and health services utilization for pediatric and adolescent patients.	330 children aged 6-17 years with moderate to severe asthma (N_{int}=153; N_{con}=177) in Seattle.	RCT	Pharmacists received an 8-hour training session on management assessment, drug delivery technique and general principles of pediatric asthma care. Specific topics included instructions on how to establish relationship with patients, collect data, assess drug related problems, and implement and plan follow up.	At 12 months, there was no difference between groups in PF, FEV_1, asthma severity, inhaler technique, days lost from school, use of inhaled corticosteroids, or health services utilization. [241]
Weingarten et al.[124]	To evaluate the effects of multi-disciplinary non-pharmaceutical management of childhood asthma.	21 children with asthma receiving medical care in a general practice in Israel.	RCT	Children were examined by a family physician and a physiotherapist and received information about asthma and its treatment, they also received 12 one-hour group sessions with a physiotherapist who discussed chest expansion exercises for improved lung capacity and clearance of secretions. Mothers had 10 two-hour group meetings with social workers to develop coping mechanisms for acute attacks.	At the end of 10 weeks, PF increased in the intervention group but not in the control group.[124]

Note: *CBA=controlled before-after trials; ED=emergency department; PF=peak flow; QOL=quality of life

Organizational Change Interventions for Adults With Asthma

Background. Most of the QI strategies that involve organizational change are designed to create new opportunities for patients to receive comprehensive education and monitoring of symptoms—often by creating asthma specialty clinics in the general practice setting or by creating asthma-specific clinics in other settings (e.g., pharmacies, specialists' offices). For example, recognizing that most patients receive their asthma care in primary care settings, the development of asthma clinics within the general practices of the United Kingdom has been encouraged (a 1993 national survey found that 77% of general practices in the U.K. ran asthma clinics).[243]

Results. We found 14 studies of organizational change strategies for general populations of adults with asthma (Table 25). Three of these studies compared two or more intervention groups without a control that did not also receive a QI intervention and are presented with studies of that design (Table 21).

In contrast to the organizational change interventions for children with asthma, the studies of organization change interventions for general populations or adults with asthma reported considerably more improvements in clinical outcomes. We cannot clearly identify the distinguishing characteristics between the organizational change interventions for pediatric versus adult populations; however, the organizational change studies in this section were more likely to augment providers' roles (e.g., adding a teaching role to pharmacists already providing routine pharmacy care for patients) or augment the types of providers encountered while receiving "usual care" (e.g., by adding multidisciplinary teams to routine clinical practice). This is in contrast to the addition of specialty care clinics where patients receive care that is distinctly separate from their routine health care encounters (these specialty clinics were more common for children).

For example, none of the three articles that described nurse-run asthma clinics within general care practices found statistically significant improvements in processes or outcomes of care for asthma patients.[155, 158, 244] However, several of the other organizational change interventions did result in improvements in the processes and outcomes of care for patients with asthma. For example, the ambitious intervention described by Cordina and colleagues provided training for pharmacists in Malta to assume a greater role in patient education, monitoring of asthma status (including monthly review of patients' medication use, peak flow records, and symptoms), and to recommend treatment changes to patients' physicians (as needed).[159] This represented "a major change in conventional practice for Maltese pharmacists" and resulted in a lower rate of self-reported hospitalizations (no patients in the intervention group versus eight patients in the control group) and nighttime wheezing (20% versus 36%).

Two interventions associated with improvements in clinical outcomes for patients utilized computer tools to facilitate asthma management.[180, 190] One such intervention, described by Johnson and colleagues,[180] was a comprehensive asthma disease management program in which subjects received asthma education and providers and case managers received computer generated communications regarding whether the patient had an action plan, received influenza vaccinations, had rescue inhalers, and reported on patients' use of daily controller medications. This study reported that 12 months after the intervention, the intervention group (196 patients) had fewer emergency department visits (118 versus 305, $p<0.0001$) and hospitalizations (39

versus 114, $p<0.0001$) than the control group (196 subjects) albeit no differences in use of asthma medications or preventative vaccinations.[180]

Three of the studies of organizational change interventions reported smoking rates for participants—in general, these rates were relatively high and recalcitrant to change. For example, in the 1994 study of the implementation of the Scottish health board's asthma education and treatment protocol in general practices, 20-25% of asthma patients studied reported smoking at baseline and there was no statistically significant reduction in smoking as a result of the program.[243] Similarly, the intervention reported by Garrett and colleagues of patients (principally from lower socioeconomic groups) receiving care in a South Auckland asthma community education center found even higher baseline smoking rates (33%-34%), which did not change after nine months enrollment in the education center.[152, 153]

Conclusions. Interventions that augment the "routine care" being provided to patients both in their physicians' offices and in pharmacies were associated with improved outcomes for patients. For example, technologies that enhance communication of patient information to providers can result in statistically significant improvements in outcomes of care for patients.

Table 25. Organizational change interventions for adults with asthma

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Barbanel et al.[137]	To evaluate whether a community pharmacist with basic asthma training could improve asthma control by providing self-management advice.	23 adults aged 18-65 years with asthma living in inner city East London. N_{int}=12, N_{con}=11.	RCT	Intervention patients received a 45-60 minute individual session from the pharmacist on asthma pathophysiology, recognition and avoidance of triggers, inhaler technique, self-management skills including symptom and PF monitoring, actions in response to worsening symptoms, accessing emergency care, and smoking cessation, if relevant. They received written self-management plans and weekly phone calls for the next 3 months to review plans and answer questions.	3 months after the intervention, the symptom score increased in the control group and decreased in the intervention group ($p<0.001$).[137]
Cordina et al.[159]	To examine the effects of a community pharmacy-based education and monitoring program for patients with asthma on a range of patient-specific asthma management outcomes.	152 patients over the age of 14 who received their asthma prescriptions at private pharmacies in Malta.	CBA*	A comprehensive asthma education and monitoring program was instituted in private pharmacies in Malta for 12 months. The intervention pharmacists reviewed patients asthma symptoms, PF records, medication use, and when necessary suggested changes in treatment to the patient's physician.	There was no significant difference between treatment and control groups in terms of PF measurement, self-reported inhaler use, days lost from work or school, or health related QOL. There were fewer self-reported hospitalizations for asthma among intervention patients (0/86) than among control patients (8/66) ($p<0.002$) but no other differences in health services utilization. The intervention patients were less likely to report nighttime wheezing and more likely to improve their inhaler technique than control patients.[159]

Table 25. Organizational change interventions for adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Garrett et al.[152, 153]	To determine the efficacy of establishing a community asthma education center.	747 patients aged 2-55 years who had received asthma care in the ED in South Auckland.	CBA	2 nurse specialists and a group of respiratory physicians established a community education center run by a nurse and 3 community health workers. The purpose of the education program provided was to educate patients in basic pathophysiology, define and teach trigger avoidance, medications use, inhaler technique and self-management skills (emphasis on PF recordings and symptom diaries), and teach how best to access medical care in response to worsening symptoms.	At nine months, the intervention group were more likely to have preventive medications, PF meters and better PF meter technique, more self-management plans, better knowledge of appropriate action to take when confronted with worsening asthma, less nocturnal awakening, and better self-reported asthma control than the control group. There was no difference between intervention and study patients in medication compliance, hospital admissions, days lost from school or work, ED visits, QOL, or smoking rates (33% for control group and 34% for the intervention group).[152]
Heard et al.[155]	To test whether asthma clinics (intervention) were more effective in reducing morbidity from asthma than standard medical treatment (control).	195 asthma patients aged 5-64 years in Australia.	RCT	Each participating practice operated one 3-hour asthma clinic (run by trained nurses) once a week, which were. Clinic sessions involved education in asthma management strategies, written asthma management plans, spirometry and PF instruction, and an asthma diary card. Sessions ended with a consultation with the general practitioner. Patients were asked to attend 3 sessions within the 6 month study interval.	At the end of the study, patients in the intervention group were more likely to own a PF meter and to be smokers than those in the control group. Intervention patients were less likely to wake at least weekly at night due to asthma than control patients. There were no differences in reported time lost from work or school, having an action plan, use of medications, or health services utilization between intervention and control patients. Baseline smoking rates of 9% in the control group and 12% in the intervention group did not change.[155]
Johnson et al.[180]	To evaluate the effectiveness of a comprehensive asthma disease management program.	Patients with asthma covered by Anthem Blue Cross and Blue Shield insurance in the U.S. N_{int}=196, N_{con}=196.	CBA	The intervention lasted 12 months. Intervention subjects received teaching that emphasized self-management behaviors such as avoidance of triggers, correct medication use, recognizing symptoms, seeking medical advice, smoking cessation, and adherence to treatment plans. The program is supported by computer generated communications to providers and case managers regarding whether the patient has an action plan, received flu vaccination, has a rescue inhaler, and use of daily controller medications.	12 months after the intervention, the intervention group had fewer ED visits (118 vs. 305, $p<0.0001$) and hospitalizations (39 vs. 114, $p<0.0001$). There were no differences in use of asthma medications or preventative vaccinations. [180]

Table 25. Organizational change interventions for adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Jones and Mullee[244]	To compare the outcome of asthma care in two similar practices when on practice provided proactive, nurse-run care for asthma and the other continued with a traditional (reactive) approach to the disease.	141 asthma patients aged 5-65 years receiving care in two general practices in the Southampton area of the U.K.	CBA	The intervention practice established a nurse-led asthma clinic in which specialist nurses identified patients with asthma, developed a therapeutic plan for these patients, and developed a "call" system to contact patients with asthma for assessment and follow up.	There were no significant difference between the intervention and control patients in terms of PF, symptoms, health services utilization, or medication use.[244]
Pilotto et al.[158]	To assess the ability of nurse-run asthma clinics based in general practice compared with usual medical care to produce at least a moderate improvement in the QOL in adults with asthma.	153 patients with asthma over the age of 18 from general practices in Australia. N_{con}=82 , N_{int}=71.	RCT	Two respiratory nurses conducted asthma clinics where baseline data was collected, a review of and instruction about inhaler technique was provided, and a packet of information was distributed to each patient. Follow up visits were scheduled at 2 weeks, 3, 6, and 9 months to review inhaler technique and answer questions. Control patients received usual care by their general practitioner.	After 9 months, no significant differences between the intervention and control groups in QOL scores, FEV_1, ED visits, clinic visits or hospitalizations. However, significantly less people in the intervention group compared to the control missed one or more days of work (p=0.004).[158]
Rasmussen et al. [190]	To assess the outcomes associated with an Internet-based asthma management tool.	253 adults with asthma aged 18-45 years living in Denmark. $N_{cont\text{-}GP}$=80, $N_{cont\text{-}sp}$=88, N_{int}=85.	RCT	There were three groups: an internet management group, a group receiving treatment from an asthma specialist, and a group receiving care from a general practitioner (GP). The Internet-based management tool was comprised of an electronic asthma diary, an action plan for patients, and a decision support system for physicians. Patients were given PF meters, and the Internet tool's action plan comprised a 3-color warning system with a written treatment plan. Patients were encouraged to fill out the diary daily and follow instructions given by the computer or physician. Physicians used the decision support system to follow up with patients on therapeutic changes.	After 6 months, the Internet group had significantly fewer asthma symptoms (p=0.002 compared to specialists; p<0.001 compared to GPs), higher QOL (p=0.03 compared to specialists, p=0.04 compared to GPs), and better FEV_1 (p=0.002 compared to specialists, p<0.001 compared to GPs). The Internet group had significantly more acute, unscheduled visits compared to the two control groups (p=0.05). No significant differences among the groups were found in ED visits, hospitalizations, or medication compliance.[190]

Table 25. Organizational change interventions for adults with asthma (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Swanson et al.[243]	To evaluate the effects of a health board program on asthma care in general practice in terms of patients' service and use of self-management.	400 patients aged 2-50 years with asthma receiving care in registered general practices in the U.K. between 1992 and 1994.	CBA	The Scottish health board developed an asthma program which included protocols for asthma treatment, assessment and follow up record cards for use in asthma clinics, and PF diaries.	Chart reviews of patients receiving care in practices adhering to the health board program compared to those of patients receiving care in other general practices. There was no significant difference between patients in terms of the number of general practitioner visits or hospitalizations, days lost from work or school, nighttime awakening from asthma, smoking rates (20% for intervention group and 25% for the control group); however, patients in the intervention group were more likely to make asthma clinic visits than control group patients ($p<0.001$) and more likely to have PF diaries and asthma self-management plans.[243]
Verver et al.[125]	To evaluate whether inhaler technique and respiratory symptoms of patients with asthma can be improved after instruction by a practice assistant.	6 physicians assistants were trained in the appropriate use of powder inhalers and provided patient education to 48 Dutch asthma patients aged 15-85 years.	RCT	Patients received two training sessions (2 weeks apart) on the correct technique for use of dry powder inhalers (and the correct order in which to use multiple inhalers).	At baseline only 6% of all patients used the dry powder inhalers correctly. Most mistakes were made with the "breathe out" before inhaling and with the "hold your breath for 5 seconds" after inhaling instructions. There was no correlation between the number of inhaler errors and symptoms. The patients in the instruction group significantly reduced the number of inhaler use errors ($p=0.01$). There was no difference in reported asthma symptoms between the two groups.[125]
Weng[194]	To evaluate the effects of a government sponsored QI intervention with patient and provider education and case management services for patients with asthma.	1,067 patients with asthma enrolled in the program sponsored by the Taiwanese government. 4,340 patients with asthma who did not enroll in the program served as matched controls.	CBA	Providers received a 6-hour asthma curriculum that included conducting pulmonary function testing, use of medications and PF monitoring, environmental controls, and asthma pathophysiology. They were given copies of asthma clinical practice guidelines. Patients received individualized, personally tailored asthma education on recognizing triggers and symptoms, medication use, PF use, and self-management of exacerbations. Case managers (nurses or physician assistants) provided communication between patients, primary care physicians and specialists, and scheduled quarterly follow up.	1 year after enrollment, the intervention group had longer hospital stays (by 40%, $p=0.045$) but no difference from control patients in the number ED visits or number of hospitalizations. However, among patients newly diagnosed with asthma during the study interval, there was a decrease in ED visits (by 61%) in the intervention group compared to the controls.[194]

Note: *CBA=controlled before-after trials; ED=emergency department; PF=peak flow; QOL=quality of life.

Audit and Feedback Interventions

Background. Updated guidelines for asthma treatment are made widely available, but their implementation may nonetheless be delayed. Audit and feedback interventions are generally designed to help providers improve their patient care by adopting current practice recommendations.

Results. We found five studies describing audit and feedback interventions (Table 26).[229-232] All of these studies evaluated interventions that were combinations of provider education with a component of provider feedback and all reported at least some minimal improvements in outcomes for patients. Three of these articles were from European countries instituting the same intervention—group educational sessions for providers during which providers first reviewed theoretical cases of patients with asthma and then discussed clinical decision-making for asthma care as well as their own individual prescribing practices.[229-231] During these group sessions, providers were confronted with feedback about their actual treatment choices. These interventions were designed based on the premise that behavioral change requires both buy-in on the part of providers and a psychological change. Two of the interventions with this group session design found statistically significant improvements in prescribing practice.

Conclusions. We found no studies that evaluated audit and feedback strategies for clinicians in isolation. Two of the four interventions that combined audit and feedback with provider education were associated with improvements in provider prescribing practice. These types of interventions may be promising but there is currently scant evidence about their efficacy.

Table 26. Audit and feedback interventions

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Johnson et al.[180]	To evaluate the effectiveness of a comprehensive asthma disease management program.	Patients with asthma covered by Anthem Blue Cross and Blue Shield insurance in the U.S. N_{int}=196, N_{con}=196.	CBA*	The intervention lasted 12 months. Intervention subjects received teaching that emphasized self-management behaviors such as avoidance of triggers, correct medication use, recognizing symptoms, seeking medical advice, smoking cessation, and adherence to treatment plans. The program is supported by computer generated communications to providers and case managers regarding whether the patient has an action plan, received flu vaccination, has a rescue inhaler, and use of daily controller medications.	12 months after the intervention, the intervention group had fewer ED visits (118 vs. 305, p<0.0001) and hospitalizations (39 vs. 114, p<0.0001). There were no differences in use of asthma medications or preventative vaccinations. [180]
Lagerløv et al.[230]	To evaluate the effects of a newly developed form of group education for improving the quality of prescribing in primary health care.	190 GPs responsible for the care of asthma patients in Norway.	CBA	Like the control group, the intervention group participated in 2 group meetings—during one they discussed asthma diagnosis, and the key information for making treatment decisions. At the second meeting international and national guidelines for treating asthma were presented. The group then agreed on common quality criteria for what they found to be acceptable and unacceptable prescribing practices. Feedback on their prescription behaviors was given relative to the agreed upon quality criteria.	There was an increase in the number of patients treated by intervention providers in terms of acceptable medications (p=0.18).[230]
Lundborg et al.[231]	To develop, implement, and evaluate a new educational model, with messages based on available national guidelines aimed at improving prescribing in primary care.	204 GPs responsible for the care of asthma patients in Sweden.	CBA	GPs were asked to attend 2 group sessions. During the 1st session, individual feedback on written simulated cases was given and discussed. During the 2nd session, feedback on individual prescribing was presented and discussed. GPs were expected to: start/increase inhaled corticosteroids when bronchodilator use is too high; treat asthma exacerbations with anti-inflammatory treatment and not routinely with antibiotics; and 3) not start long-acting β_2-agonists when the patient is on a sub-optimal level of inhaled corticosteroids.	Both the intervention and control groups had increases in the prescription of inhaled corticosteroids.[231]

Table 26. Audit and feedback interventions (continued)

Reference	Study Purpose	Target population	Study Design	Type of intervention	Results
Rossiter et al.[232]	To determine the potential of a disease management program in terms of improving the health of low-income Medicaid patients while achieving cost savings in providing treatment.	Virginia Medicaid population with moderate to severe asthma (a designation based on assessment of claims) who received care in a primary-care case management program (fee-for-service and HMO-based practices were excluded).	See note	Providers in primary-case-management programs with asthma patients were identified, and those who volunteered received an education workshop to improve communication skills and to inform them about current asthma treatment recommendations. Additionally, most participants also received intermittent feedback regarding who among their patients might benefit from further asthma education and treatment.	The intervention group had improved prescribing practices for β-agonists, but not for inhaled corticosteroids. The program had a significant effect on emergency visits, but only in the short-term post-intervention. This benefit was greater among those Medicaid claimants who's providers received feedback in addition to the educational workshop. The projected direct cost savings of the program is $3-4 for every incremental dollar spent. [232]
Veninga et al.[229]	To evaluate the effects of a newly developed form of group education for improving the quality of prescribing in primary care.	181 general practitioners (GPs) responsible for the care of asthma patients in the Netherlands.	CBA	Intervention providers received group education on asthma prescribing and performed a self-learning audit program for peer groups. During 2 meetings, groups met with a moderator with individual feedback material for all members of the groups; anonymity was not maintained by mutual agreement; use of case vignettes which the GPs had received by mail prior to the meetings; individualized feedback on prescribing provided at second meeting.	Increased use of inhaled corticosteroids was found in the intervention group.[229]

Note: The intervention group for this study was selected from providers in specified geographic areas. Medicaid claims were compared between the intervention area and non-intervention areas. Comparisons were made over time (ITS-like, with only two "before" measures but with explanation that analysis of a longer pre-intervention period yielded little change in variables) and between groups. **Note:** *CBA=controlled before-after trials; ED=emergency department; PF=peak flow.

Facilitated Relay of Clinical Data

Background. Most studies of facilitated relay of clinical data to providers involve inserting letters or reports of patient information collected from the patients, their medical records, or insurance records into the charts of patients for providers to review.

Results. Our search identified five interventions that utilized the facilitated relay of clinical data for the improvement of care for patients with asthma: three that targeted providers for children and two for providers for adults. Two studies compared two or more intervention groups without a control that did not also receive a QI intervention (Table 21).[57, 206]

In one intervention, facilitators reviewed the charts of children with asthma being cared for in general practice in Scotland.[245, 246] Children in the intervention group (n=1585) had their charts reviewed by a facilitator who placed a project sticker on the outside of the chart and, inside, created a separate section devoted to asthma care including a protocol for managing acute asthma attacks and a letter to their providers suggesting that they review the patient and asthma treatment guidelines. Control group children (n=1563) received usual care. One year after the intervention, the intervention group was more likely to have appointments for asthma care (568 versus 242 appointments), new diagnoses of asthma (249 versus 104 patients, and receive prescriptions for inhaled cromoglycate (128 versus 78 patients). Hospitalizations and hospital care costs decreased in the intervention group and rose in the control group (25 versus 28 admissions; total costs 20,727£ versus 19,650£).[245] Outpatient primary care costs rose in the intervention group and fell in the control group (total costs 37,243£ versus 27,990).[245] However, at four years after the intervention, the processes and outcomes of care were similar in intervention and control groups. The overall reduction in costs seen in the intervention group was equivalent to the cost of the facilitator.[246]

In the study by Halterman and colleagues,[247] parents of children aged 3 to 7 years entering school completed a screening form that inquired about chronic diseases including asthma. Parents of children with asthma identified through this screening were interviewed about asthma symptoms, emergency visits, and asthma hospitalizations. Children were then randomized to either the control group (N=77) which received usual care or the provider notification group (N=74) for whom the information obtained from the parental interview was sent via fax to the primary care providers with a copy of the 2002 NHLBI asthma management guidelines. Three to six months after the intervention, there was no difference in terms of new medications prescribed, changes in medication doses, discussion about environmental controls, referral to asthma or allergy specialists, or requests for asthma follow up appointments between the groups.[247]

In the study by Coleman and colleagues, drug utilization information collected from 135 adult Connecticut Medicaid patients using high doses of inhaled β_2-agonists was compared to 510 adult patients using normal doses of inhaled β_2-agonists.[248] Letters were sent to providers and pharmacies of the high dose group explaining the rationale for the drug utilization review and the specific problem identified for the specific patient (e.g., high dose inhaled β_2-agonists use or under-utilization of long-term control agents).[248] Seven months after the letters were sent, there were no statistically significant differences between control and intervention groups in terms of use of inhaled medications or health services utilization.

Conclusions. Two of the five studies of facilitated relay of clinical information reported improvements in clinical outcomes. There are too few studies of facilitated relay of clinical information for asthma to determine the overall effectiveness of these interventions for improving the processes and outcomes of care for asthma.

Provider Reminder Interventions

Background. Treatment guidelines for asthma have been widely available, yet not widely implemented. Provider reminder systems for asthma care are designed to use information from clinical practice guidelines applied to patient-specific information to provide reminders to providers at the point of care.

Results. We found four articles describing provider reminders.[114, 249-251] They described highly heterogeneous interventions (e.g., paper-based versus computer-based, some readily adopted by providers versus others that providers found more cumbersome to include in routine clinical practice).

The study by White and colleagues, which evaluated a paper-based reminder implemented over two years in 23 general practices in England, found no improvement in patient reported symptoms, use of health services, or prescribing.[**251] Similarly, the evaluation of an implementation of a computerized clinical decision support system for the management of asthma in 62 general practices in England by Eccles and colleagues found that the system had no statistically significant effect on health services utilization, prescribing practices, or patient-reported asthma outcomes 12 months after implementation.[††249]

In contrast, the evaluation of a computerized clinical decision support system for asthma care in 17 general practices in England by McCowan and colleagues found that although fewer patients in the intervention group sought primary care for their asthma at six months after implementation (22% versus 34%; OR 0.59 [95% CI 0.37-0.95]), there was no statistically significant change in the use of peak flow meters, self management plans, self-reported symptoms, prescribing of maintenance medications, or hospitalizations.[250] Interestingly, McCowan and colleagues found a lower rate of asthma exacerbations in the intervention group than in the control group (8% versus 17%; OR 0.43 [95% CI 0.21-0.85]) but no difference in use of oral steroids to manage these attacks.[250] (For details of the study by Glasgow and colleagues[114] which implemented a provider education intervention that reminded providers to schedule a follow up appointment for patients—see the provider education section).

Conclusions. The results of the studies of provider reminders to improve the care of patients with asthma are mixed. The small number of studies of reminder interventions limits our ability to determine their overall effectiveness for improving the processes and outcomes of care for asthma.

[**] White and colleagues provide copies of both their data collection forms and reminder notices in this article.

[††] The decision support system used in this study was based on currently available software to support prescribing decisions for acute conditions. More information about this software is available in Purves IN. PRODIGY: Implementing clinical guidance using computers. *Br J Gen Pract* 1998;48:1552-3.

Financial Incentives

Background. The annual health care costs attributed to asthma exceed $6 billion. If the provision of financial incentives could statistically significantly reduce costly emergency department visits or asthma hospitalizations, they could be highly cost-effective.

Results. Financial incentives are typically intended to be used to change the behavior of providers. We found no interventions that utilized financial incentives directed at providers. However, we found two interventions that included financial incentives to change patient behavior. The first intervention, described by Burkhart and colleagues (Table 11), encouraged children with asthma to contract with their parents and caregivers to perform daily asthma self-monitoring or self-management behaviors.[71] For each completed self-monitoring or self-management task, parents gave their children a sticker-star.[71] When five stars had been awarded, children received a pre-negotiated award including special activities (43%), a toy or game (24%), pizza or other fast food (19%), or a monetary reward (14%).[71] They found no difference in adherence with peak flow monitoring between the intervention and the usual-care (control group) children.[71]

The second intervention, described by Baren and colleagues, recruited patients aged 16 to 46 years who had recently visited the University of Pennsylvania emergency department for asthma exacerbation. The patients in the intervention group (N=95) were provided a free 5-day course of oral prednisone, two taxi-cab vouchers for transportation to and from their primary care provider (PCP), and a telephone reminder to make an appointment with their PCP. The patients in the control group (N=83) received a short course of oral steroid therapy and were given instructions and prescriptions at the discretion of the treating physician. The main outcome measure was whether patients successfully followed up with a PCP after their emergency department visit. Patients in the intervention group were more likely (46.3%) than patients in the control group (28.9%) to follow up with their PCP ([RR]1.6; 95% CI 1.1, 2.4).[252]

Conclusions. There is insufficient evidence to assess the effectiveness of QI interventions utilizing financial incentives.

Secondary Outcomes

For a study to be included in this review, it had to report one or more of the primary outcomes of interest. From the included articles, we also abstracted data about three secondary outcomes of interest: cost, quality of life, and reduction in asthma triggers/allergens such as exposure to tobacco smoke (Appendix B*). In the evidence tables presented throughout this report, we also present data from the included studies on these secondary outcomes. In this section, we summarize the results of the effects of QI interventions on these secondary outcomes. When interpreting these results, we note that our literature search was not designed to find all articles presenting results for these secondary outcomes. Thus, we are likely to be missing

* Appendixes cited in this report are provided electronically at http://www.ahrq.gov/clinic/tp/asthmagaptp.htm

articles describing the effects of QI interventions for asthma that were targeted at specifically improving these outcomes.

Costs

Background. In 1990, the direct medical costs attributed to asthma care in the U.S. were $3.6 million.[253] This included physician visits and medications; however, the greatest proportion (nearly $3 million) was attributed to emergency department visits and hospitalizations.[253] Since only a small proportion of patients with asthma require emergency department and hospital care, it has been estimated that 5% of patients with asthma account for more than 70% of the costs.[254] (We direct interested readers elsewhere for reviews of the cost-effectiveness of programs directed at this "high cost" group of patients.[255, 256]) In general, given the large number of patients with asthma in the U.S., even minimally effective programs can be quite cost-effective (e.g., cost-effectiveness analyses of interventions in children with mild to moderate asthma have estimated that treatment with inhaled corticosteroids costs approximately $11/symptom-free day gained[257] and that a community-based education program for inner-city children costs $9/ symptom-free day gained[75]). In this section, we summarize the cost data provided by the included articles.

Results. Twenty-three studies reported cost data: 13 were QI interventions for children and ten were QI interventions for general populations or adults with asthma. Table 27 presents three types of cost data reported in the included articles: costs associated with the implementation of the interventions, asthma-related healthcare costs for study subjects, and other types of costs.

Intervention costs. Nine studies described the costs associated with intervention implementation. Two of these found that there was no statistically significant difference between intervention and control program direct costs.[172-176] The other seven studies uniformly found that intervention program costs were higher than control program costs.

Asthma-related healthcare costs. Among the interventions for children with asthma, seven reported asthma-related healthcare cost data, five of which reported reduced costs among the intervention groups (Table 27). Among the interventions for general populations or adults with asthma, four presented asthma-related healthcare costs. Two of these reported cost savings among the intervention groups. The study by Bolton and colleagues of a patient education intervention found that, after 12 months, emergency department costs were statistically significantly less for the intervention group than for the control ($p<0.02$); however, physician and hospitalization costs did not statistically significantly differ between groups.[147] The study by Rossiter and colleagues of a diseases management program for Virginia Medicaid recipients found that the projected direct cost savings of their audit and feedback/provider educational program was $3 to $4 for every incremental dollar spent on the intervention.[232] Additionally, they estimated that the projected Medicaid savings of the program was $839 per physician trained.[232] The other two studies found no difference in asthma-related healthcare costs between intervention and control subjects.

Other costs. Twelve studies reported other types of cost data, including indirect costs associated with the intervention and analyses of incremental cost-effectiveness. These studies were heterogeneous with respect to cost accounting methods utilized and cost data reported.

Conclusions. In general, we conclude that the implementation of QI interventions for asthma cost more than usual care. The extent to which savings may be reaped from these interventions has not been consistently documented. A critical gap in this literature that prevents an understanding of the cost-effectiveness of QI programs is that there is not a common effectiveness variable such as symptom-free days gained or episode-free days gained. Also, since many studies only include the costs and benefits accrued during the first year after an intervention, it is difficult to estimate the long-term cost-effectiveness of these programs.

Table 27. Summary of studies presenting cost data

Reference	Table	Intervention Cost Data	Asthma-related Healthcare Cost Data	Other
Interventions for children with asthma				
Anderson et al.[239]	Table 24	No data.	Hospital and clinic costs for asthma care decreased by 80% in the Kunsberg school (intervention) children compared to a 19% decrease in control children ($8,122/year vs. $1,588/year). [239]	No data.
Clark et al.[96, 97]	Table 12a	No data.	No data.	The cost of delivering the program exceeded the healthcare savings realized (for every $1 spent, $0.62 were saved). However, the program saved $11.22 for every $1 spent for children with 1 or more pre-intervention hospitalizations.[96, 97]
Finkelstein et al.,[227, 235] Sullivan et al.,[225] and Lozano et al.[226]	Table 22 Table 24	No data.	No data.	Total treatment and intervention costs per year per patient were $1,292 for intensive intervention, $504 for less intensive intervention, and $385 for usual care. The incremental cost-effectiveness compared to usual care was$18/symptom-free day gained for less intensive and $69/symptom-free day gained for more intensive interventions.[225]
Greineder et al.[197]	Table 21	No data.	At the end of the 2 year study period, both groups experienced reductions health care costs. The more intensive treatment group improved significantly more than the less intensive treatment group with 71% fewer out-of-plan costs ($p<0.001$).[197]	No data.
Kamps et al.[117, 118]	Table 12d Table 24	No data.	At 1 year, there was no difference between the groups in terms of overall healthcare costs.[118]	No data.
LaRoche et al.[78]	Table 11 Table 12a	The intervention program cost approximately $2,295 (for 11 patients).[78]	The savings from reduced ED visits was $4,675 (for 11 patients).[78]	No data.
Lewis et al.[62]	Table 21	The costs of the program were estimated at $125/intervention recipient and $37.50 per control recipient.[62]	No data.	Given the lower hospital costs in the intervention group, the authors estimate a $180 annual cost savings per child for the sponsoring institution.[62]

Table 27. Summary of studies presenting cost data (continued)

Reference	Table	Intervention Cost Data	Asthma-related Healthcare Cost Data	Other
McCowan et al.[245, 246]	See text describing Facilitated Relay Intervent-ions	No data.	1 year after the intervention, hospital care costs decreased in the intervention group and rose in the control group.[245] Outpatient primary care costs rose in the intervention group and fell in the control group.[245]	The reduction in costs seen in the intervention group was equivalent to the cost of the facilitator.[246]
McNabb et al.[80]	Table 11	No data.	No data.	At 12 months, they estimated a program related $507 per child savings on the basis of the reduced ED visits. [80]
Morgan et al.,[73] Evans et al.,[74], and Sullivan et al.[75]	Table 11 Table 12a	The cost of the intervention was $337 per child for 2 years.[75]	No data.	The program resulted in an estimate incremental cost-effectiveness ratio of $9.20 per symptom-free day gained (95% CI: -$12.56 to $55.29 per symptom free day gained).[75]
Runge et al[52]	Table 11 Table 12d	It cost 585€ to deliver the intervention.[52]	The intervention reduced asthma costs by 461€.[52]	Adjusting for benefits in the control group, 0.79€ were saved for every 1€ spent on the intervention during the 1st year.[52]
Salisbury et al.[108]	Table 12b Table 12c Table 24	No data.	No data.	At 6 months, the costs of six months of asthma care for the intervention adolescents were higher than for the control patients.[108]
Yoos et al.[65]	Table 21	No data.	The average reduction in health care charges due to reduced healthcare utilization was $82 per child for control children, $162 per child for children asked to monitor their PF when symptoms increased, and $61 per child for the daily PF monitoring children.[65]	No data.
Interventions for general populations or adults with asthma				
Bailey et al.[166]; Windsor et al.[167]	Table 18c	The intervention program cost $32.03 per patient versus the control program, which cost $3.61 per patient.[167]	No data.	No data.
Bolton et al.[147]	Table 18a	No data.	After 12 months, ED costs were significantly less ($p<0.02$) for the intervention. However, physician and hospitalization costs did not significantly differ between groups.[147]	Total costs did not significantly differ between groups.[147]

Table 27. Summary of studies presenting cost data (continued)

Reference	Table	Intervention Cost Data	Asthma-related Healthcare Cost Data	Other
Drummond et al.,[210 211] Osman et al.,[212] and Buckingham et al.[213]	Table 21	No data.	No data.	Total cost of integrated care for asthma was estimated to be £40.11/patient/year compared to £62.12/patient/year for conventional care.[213]
Gallefoss et al.[172-175]	Table 18c	At 1 year, there was no significant difference found between the groups in direct costs associated with the program.[174]	No data.	At 1 year, there was no significant difference found between the groups in indirect costs and total costs associated with the program.[174]
Ghosh et al.[176]	Table 18c	At 12 months, there was no significant difference in direct costs found between the two groups. [176]	No data.	At 12 months, there were significantly less indirect (p=0.003) and total costs (p=0.036) associated with the intervention group.[176]
Kauppinen et al. [215-217]	Table 21	No data.	There was no significant difference between the groups at 5 years for total costs attributed to asthma care.[217]	No data.
Knoell et al.[163]	Table 18b	No data.	No differences in drug costs.[163]	No data.
Lahdensuo et al.[181, 182]	Table 18c	The total direct costs were 649 Finnish Marks less in the control group than in the experimental group (p=0.05).[182] (At the time of publication: 8.84 Finnish Marks=1£.)	No data.	No data.
Ostojic et al.[206]	Table 21	The additional cost of the intervention per patient, per week was 1.67€ ($1.3 per 1 Euro).[206]	No data.	No data.
Rossiter et al.[232]	Table 23 Table 26	No data.	The projected direct cost savings of the program is $3-4 for every incremental dollar spent. The projected Medicaid savings of the program was $839 per physician trained.[232]	No data.

Quality of Life

Background. Poorly controlled asthma can result in symptoms that limit a person's ability to participate in the routine activities of daily life. Thus, health-related quality of life (QOL) is an important metric for evaluating the effects of an asthma QI intervention. A retrospective analysis of 8994 patients from 27 RCTs of trials of various interventions for patients with persistent asthma that reported FEV_1, Asthma Quality of Life Questionnaire (AQLQ) scores, and self-reported symptoms found that percent predicted FEV_1 and symptom-free days were weakly correlated with AQLQ scores.[258] Further, they found that changes in percent predicted FEV_1 correlated weakly with changes in SFD but was more strongly correlated with changes in overall AQLQ scores (r=0.26 and 0.38, respectively; p<0.001).[258] This study suggests that directly measuring changes in QOL may evaluate important aspects of patient's asthma experiences not fully accounted for by objective measures such as lung function.[258]

Results. Forty-five of the included studies reported QOL data. They utilized a variety of generic measures such as the SF-36 and disease-specific measures such as the Asthma Quality of Life Questionnaire and the St. George's Respiratory Questionnaire, among others.

Thirteen of 31 (42%) of the interventions aimed at general populations or adult patients and only three of 12 (25%) of interventions aimed at children resulted statistically significant improvement in QOL compared to controls. Overall, the pediatric QI interventions reported little effect on parent or caregiver quality of life.

As has been previously reported,[258] we found an association between improvements in clinical status and improvements in QOL: Of the 27 studies that found no statistically significant difference between intervention and control groups, only seven reported any statistically significant clinical outcomes. However, of the 18 studies that reported a statistically significant improvement in quality of life, 15 reported at least one statistically significant clinical outcome. We calculated an unweighted correlation between studies reporting statistically significant improvements in QOL and clinical measures (r=0.4, p=0.019) and functional status measures (r=0.4, p=0.037). We found no associations between QOL and other study design, intervention design, or patient characteristics.

Improving QOL for children with asthma. Fourteen studies of QI interventions for children with asthma reported QOL results—this includes the 12 described above plus two that were directed at caregivers of children with asthma (Table 28). Of these, only four found significantly better quality of life among the intervention group compared to the control group. Of the nine studies that found no statistically significant difference in any outcome, six were self-monitoring, self-management, or patient education interventions whose principal educational modality was individualized, or "one-on-one", educational sessions.

Three of the four studies that reported parental/caregiver QOL outcomes showed no statistically significant difference between the groups.[63, 95, 103] The study by Brown and colleagues of home-based asthma education program for low-income parents of children in pre-school found a statistically significant difference between the parents or caregivers of children aged 1 to 3 years, but no statistically significant difference for parents or caregivers of children aged 4 to 6 years.[90] All of the studies that reported parent or caregiver QOL outcomes were parent or caregiver education or self-monitoring or self-management interventions.

Improving the QOL for general populations or adults with asthma. Thirty-one studies of QI strategies for general populations or adults with asthma reported QOL results (Table 29). Of these, 18 found no statistically significant difference in quality of life at follow up between the intervention and control groups. However, 13 studies did show statistically significantly higher quality of life outcomes in the intervention group compared to the control group at follow up. We found no intervention characteristics that were clearly associated with statistically significant improvements in patient quality of life. However, of the eight nurse-led interventions that reported quality of life outcomes, none reported statistically significant differences between the intervention and control groups.

Conclusions. QI strategies can improve QOL for patients with asthma. This benefit is correlated with improvements clinical outcomes and functional status. Among the included studies, QOL was less likely to change for children or their parents or caregivers. The relatively small numbers of studies reporting QOL measures limits our ability to identify specific interventional characteristics most associated with improvements in QOL.

Table 28. Summary of interventions assessing QOL for children with asthma and caregivers

Reference	Evidence Tables	Duration of Follow up	Caregiver QOL assessed	Type of intervention	QOL Result
Brown et al.[90]	Table 12a	12 months after intervention	√	Home-based asthma education of low-income parents of children in pre-school.	Education group experiences better caregiver QOL among those children aged 1-3 but not those children aged 4-6.[90]
Butz et al.[95]	Table 12a	10 months after enrollment	√	Parent and child asthma education.	No differences in caregiver or child QOL.[95]
Chan[57]	Table 21	6 months		Child asthma education online vs. outpatient education.	There were no differences between the groups at the end of for QOL.[57]
Eggleston et al.[98]	Table 12a	12 months after intervention		Home-based parent or caregiver asthma education of parents in the inner-city.	There were no difference in QOL scores.[98]
González-Martin et al.[115]	Table 12d Table 24	2 months after enrollment		Organizational change and patient education provided by pharmacists.	There were no differences in any domains of health-related QOL.[115]
Henry et al.[105]	Table 12b Table 12c	6 months after intervention		School-based patient education program for adolescents.	Compared with control students, intervention students had small but significant improvements in total QOL (p=0.003).[105]
Kamps et al.[117, 118]	Table 12d Table 24	12 months		Organizational change and patient education intervention comparing care by a pediatrician or specialist asthma nurse.	There was no difference between children receiving asthma care from a pediatrician than from a nurse specialist in terms of disease-specific QOL.[117]

Table 28. Summary of interventions assessing QOL for children with asthma and caregivers (continued)

Reference	Evidence Tables	Duration of Follow up	Caregiver QOL assessed	Type of intervention	QOL Result
Mangione-Smith et al.[242]	Table 24	16 months after the intervention		Organizational change strategy in which intervention clinics participated in a collaborative.	Intervention children were more likely to have higher QOL scores (p=0.03).[242]
Runge et al.[52]	Table 11 Table 12d	6 months after enrollment		Self-monitoring, self-management, and patient education program. One arm evaluated the use of an internet-based education program.	Significant improvements were seen in 3 of 8 QOL domains in both intervention groups but not in the CG.[52]
Salisbury et al.[108]	Table 12b Table 12c Table 24	6 months		School-based, nurse led education and asthma care clinics for adolescents.	There was no significant difference between groups in terms of health related QOL. [108]
Shames et al.[58]	Table 12d	12 months		Patient education program including the use of a video game.	There were some improvements in health related QOL in the intervention group.[58]
Stevens et al. [103]	Table 12a	12 months	√	Parent or caregiver education for parents of children in pre-school.	There was no significant difference between the groups in parental/caregiver QOL.[103]
Walders et al.[59]	Table 21	12 months after enrollment		Pediatric self-monitoring, self-management, and education program.	There was no difference between groups in terms of QOL (both groups improved over baseline).[59]
Wensley and Silverman[63]	Table 21	3 months	√	PF-based vs. symptom-based self-management programs.	There was no difference between groups in child or caregiver QOL.[63]

Table 29. Summary of Interventions assessing QOL for general populations or adults with asthma

Reference	Reference Table	Duration of Follow up	Type of Intervention	Results
Cambach et al.[148]	Table 18a	6 months after intervention	Patient education, self-monitoring, or self-management training by a nurse.	No difference in QOL between the groups.[148]
Cordina et al.[159]	Table 18b Table 23 Table 25	12 months	Patient education, self-monitoring or self management training by pharmacists who received specialized education.	No difference in QOL between the groups. [159]
Côté et al.[201-203]	Table 21	12 months	Patient education, self-monitoring, or self-management training based on either symptoms or PF.	QOL scores improved for all groups but were significantly more improved among action plan patients than controls.[201, 202]
Couturaud et al.[169]	Table 18c	12 months	Patient education, self-management training.	No difference in QOL between the groups.[169]
de Oliveira et al.[170]	Table 18c	6 months	Patient education, self-management training by a physician.	The intervention group had significantly higher QOL scores (p=0.0005).[170]
Delaronde et al.[149]	Table 18a	6 months after intervention	Patient education, self-management by a nurse.	No difference were in QOL between the groups.[149]
Gallefoss et al.[172-175]	Table 18c	12 months	Patient education, self-management training by a physician, pharmacist, nurse, and physiotherapist.	Intervention patients had better health related QOL (p<0.001) compared with control patients. (p<0.05).[172]
Garrett et al.[152, 153]	Table 18a Table 25	9 months	A community health center was created where a patient education, self-management training program run by a nurse and community health workers.	QOL was measured as “improvement of ability to do things [patients] liked.” No difference in QOL between the groups.[152]
Herborg et al.[160]	Table 18b	12 months after intervention	Patient education, self-management training by a pharmacist.	Intervention patients had more significantly improved health-related QOL than control patients (p<0.05).[160]
Janson et al.[156]	Table 18a	2 months	Patient education, self-management training by a nurse.	No difference between the groups in QOL.[156]
Jones et al.[214]	Table 21	6 months after intervention	Patient education, self-management training or a doctor-managed regimen.	No difference between the groups in QOL.[214]
Kauppinen et al. [215-217]	Table 21	60 months	Patient education or self-management training of varying intensity.	No difference between the groups in QOL.[217]
Knoell et al.[163]	Table 18b	1.5 months	Patient education, self-management training by a pharmacist.	No difference between the groups in QOL.[163]

Table 29. Summary of Interventions assessing QOL for general populations or adults with asthma (continued)

Reference	Reference Table	Duration of Follow up	Type of Intervention	Results
Lahdensuo et al.[181, 182]	Table 18c	12 months	Patient education, self-management training and physiotherapeutic counseling.	QOL scores did show trends toward significance when fully adjusted for baseline scores.[181]
Levy et al.[157]	Table 18a	6 months	Patient education, self-management training by a nurse.	No difference between the groups in QOL.[157]
Magar et al.[184]	Table 18c	12 months	Patient education, self-management training.	The intervention group had higher QOL scores compared to the control group.[184]
Marabini et al.[183]	Table 18c	3 months after intervention	Patient education, self-management training by a physician.	The intervention group had significantly higher overall QOL compared to the control group ($p<0.05$).[183]
McLean et al.[205]	Table 21	12 months	Patient education, self-management training.	QOL scores were significantly higher overall for the intervention group compared to control ($p<0.05$).[205]
Onyirimba et al.[187]	Table 18c	2.5 months	Patient education, self-management training.	No difference between the groups in QOL. [187]
Perneger et al.[188]	Table 18c	6 months	Patient education, self-management training by two respiratory physicians and a physiotherapist.	No difference between the groups in overall QOL.[188]
Pilotto et al.[158]	Table 18a Table 25	9 months	Nurses created asthma clinic and provided patient education, self-management training.	No difference between the groups in QOL.[158]
Put et al.[189]	Table 18c	3 months after intervention	Patient education, self-management training.	QOL scores were significantly different between the intervention and control groups. The AQLQ scores were higher and Negative Emotionality Scale (NEM) were lower ($p<0.0001$ and $p<0.01$, respectively).[189]
Rasmussen et al.[190]	Table 18c Table 25	6 months	Patient education or self-management training through an Internet-based decision support system that physicians also used to follow up with patients vs. care by a specialist or general practitioner.	The Internet group had significantly higher QOL ($p=0.03$ compared to specialists, $p=0.04$ compared to GPs).[190]
Schaffer and Tian[192]	Table 18c	6 months after intervention	Patient education, self-management training.	No difference between the groups in QOL.[192]
Schonlau et al.[199]	Table 21	12 months after intervention	Provider education to promote changes in asthma care.	No difference between the groups in QOL.[199]

Table 29. Summary of Interventions assessing QOL for general populations or adults with asthma (continued)

Reference	Reference Table	Duration of Follow up	Type of Intervention	Results
Schulz[164]	Table 18b	12 months after intervention	Patient education, self-management training by a pharmacist.	Patients in the intervention group had significantly higher overall QOL scores (p=0.02); however, there was no significant difference between the groups in SF-36 mental summary score.[164]
Smith et al.[141]	Table 18a	6 months after intervention	Home-based patient education, self-management training provided by a nurse.	No difference between the groups in QOL. When adjusted for major baseline score differences, there was an improvement in asthma-specific QOL (p=0.03).[141]
Sundberg et al.[193]	Table 18c	12 months	Patient education, self-management training by a nurse with the aid of a computer program.	No difference between the groups in QOL.[193]
Thomas et al.[129]	Table 21	6 months after intervention	Patient education, self-management training by nurses compared to breathing retraining by physiotherapists.	There was a slight improvement in one domain of QOL in the breathing retraining group compared to the nurse educator group (p<0.05).[129]
Turner et al.[130]	Table 21	6 months	Both groups received patient education by a nurse. Groups then received self-management plans based on either symptoms or PF.	No difference between the groups in QOL.[130]
Yilmaz and Akkaya[195]	Table 18c	36 months	Patient education, self-management training.	QOL scores were significantly higher in the intervention group compared to the control group (p=0.009).[195]

Reductions in Environmental Allergen Exposure

Background. Identifying and reducing exposure to environmental allergens that can exacerbate asthma symptoms is a critical component of asthma prevention. There is a large literature of interventions specifically targeting allergen exposure which we did not review; however, among the included studies, we abstracted information regarding whether the intervention resulted in reductions in environmental allergens.

Results. Five studies reported the effects of their interventions on environmental allergens.[73-75,98] All were self-monitoring, self-management, or patient education interventions and two targeted children with asthma. These studies as a group are notable for their relatively large sample sizes (range: 65-937; median 129).

The large National Cooperative Inner-City Asthma Study[73-75] was a RCT of 1,023 families of children with asthma in eight major U.S. cities to evaluate whether a home-based intervention for inner-city children designed to teach caregivers to reduce environmental asthma triggers specific to that child (as determined through skin testing) would result in improvements in asthma-related outcomes. During the 12 month intervention, research assistants visited each home five to seven

times. Each visit was followed by a phone call to address any barriers to implementing the plan. Caregivers were taught about the role of allergens in asthma, mattress covers were installed, families were given a vacuum cleaner with HEPA filter, and a HEPA air purifier was set up in the child's bedroom. Professional pest control was provided. Two years after enrollment, intervention children had more symptom free days (565.1 vs 538.5 days), fewer asthma symptoms ($p<0.001$), days lost from school (0.54 versus 0.71 days per two weeks, $p<0.009$), and lower allergen levels than control children.[73] There was no difference in spirometry or peak flow measurements or unscheduled visits to the emergency department, clinic or hospital between the two groups.[73-75] The cost of the intervention was $337 per child for 2 years resulting in an estimate incremental cost-effectiveness ration of $9.20 per symptom-free day gained (95% CI: -$12.56 to $55.29 per symptom free day gained).[75]

The study by Eggleston and colleagues was a RCT of home-based environmental intervention for 100 children with asthma living in inner city Baltimore based on the National Cooperative Inner-City Asthma Study.[98] As part of the intervention, families received comprehensive home-based evaluations of environmental triggers and were given air filters, pillow covers, and cockroach extermination as needed. Additionally, they received three home visits and a telephone follow up to review allergen reduction principals. One year later, the intervention children had fewer daytime asthma symptoms ($p=0.02$) but there were no difference in nighttime symptoms, exercise-related symptoms, exercise-limiting symptoms, acute visits for asthma, FEV_1, or QOL scores.[98]

The other three self-monitoring or self-management patient education interventions all reported environmental allergen reductions in the intervention groups.[136, 156, 201-203]

Conclusions. QI improvement strategies can reduce environmental allergens. In particular, home-based environmental control interventions can be effective and may be cost-effective. Patient education and self-monitoring or self-management programs can effectively motivate persons with asthma to reduce environmental allergens.

Tobacco Smoke Exposure

Background. Exposure to tobacco smoke is a well-recognized trigger for asthma.[259-264] In most developed countries the prevalence of active smoking in adults with asthma is about 25%.[265] Between 25% and 43% of all children in the U.S. are regularly exposed to tobacco smoke.[266, 267] As exposure to environmental tobacco smoke increases, acute exacerbations of asthma increase, pulmonary function decreases, and therapeutic responses to corticosteroids become impaired.[268] The mechanism of corticosteroid resistance in smokers with asthma is currently unexplained but could be due to alterations in airway inflammatory cell phenotypes, changes in glucocorticoid receptor alpha-to-beta ratio, and reduced histone deacetylase activity.[265, 269] Cigarette smoking also increases the clearance of drugs such as theophylline by induction of metabolizing enzymes. A complete review of effective interventions for the reduction of tobacco smoke exposure is outside the scope of our review. However, several of the included studies described changes in tobacco exposure among patients with asthma. In this section we summarize their results.

Photo publicly available at www.who.int/tobacco

Results. Twelve studies reported either post-intervention tobacco exposure rates or reported whether there was a difference at the end of the intervention between intervention and control subjects (Table 30). When interpreting these results, we note that reducing tobacco exposure may not have been a primary aim of these studies and small sample sizes may have limited their ability to detect relatively rare events (such as identifying one or two people who stopped smoking).

Not surprisingly, we found that rates of tobacco exposure seemed to be negatively correlated with socioeconomic status. For example, the study by Eggleston and colleagues of inner city children in Baltimore, 73% of whom lived below the 2000 federal poverty level, reported that up to 69% of children with asthma were exposed to tobacco smoke.[98]

None of the QI interventions resulted in a statistically significant reduction in tobacco use (although only a few were specifically designed to reduce tobacco use). None of the studies was specifically designed to evaluate the differences in processes or outcomes of care between those exposed to smoke and those who were not exposed to smoke; however, several noted that improvements were more likely to be found among those who were not exposed.

Conclusions. We note that this section does not provide a comprehensive assessment of interventions to reduce tobacco exposure among patients with asthma—it is intended simply to summarize the results of tobacco exposure as reported in the included studies of QI interventions for asthma and we emphasize that most of the included interventions were not designed to specifically assess or reduce tobacco exposure. The reported rate of tobacco exposure among children of lower socioeconomic groups was higher than that of higher socioeconomic groups. None of the included interventions resulted in a reduction in tobacco smoke exposure among patients with asthma or their family members.

Table 30. Rate of reported tobacco use among patients with asthma and their family members

Reference	Target Population	Demographics	Baseline Smoking*	Results of Intervention
Cowie et al.[109]	Adolescents with severe asthma in Calgary	None reported	53%	No change in smoking rates after the study.[109]
Eggleston et al.[98]	Inner city children with asthma aged 6-12 years with asthma in Baltimore.	73% of families lived below the 2000 federal poverty level	69%	After the intervention, 2 parents stopped smoking (did not report group assignment of these parents).[98]
Halterman et al.[240]	Children with asthma 3-7 years from urban, primarily minority low-income demographic groups in Rochester, NY	32% Hispanic; 59% Black; 53% parents were not high school graduates; 62% received public assistance; 15% private insurance	44%	Children in the intervention group missed significantly fewer days of school and experienced more symptom-free days during the early winter months than did children in the control group. In a post-hoc analysis, it was found that all significant improvements were found in those patients not exposed to second-hand smoke.[240]
Heard et al.[155]	Asthma patients aged 5-64 years receiving care in general practices in Australia	None reported.	11%	Intervention patients were more likely to own PF meters and to smoke but less likely to wake at night due to asthma than control group patients. Baseline smoking rates did not change.[155]
Hughes et al.[116]	Children with asthma aged 6-16 years living in Halifax county, Canada	None reported	57-60%	60% of intervention families and 57% of control families had at least one smoker in the home at the start of the intervention. During the home visit, the role of cigarette smoke as an asthma trigger was addressed, parents were discouraged from smoking in the home, and participation in smoking cessation programs was encouraged. At the end of the intervention, 52% of intervention families and 51% of control families still had at least one smoker (no difference between groups).[116]
Kelly et al.[119]	Children with asthma 2 to 16 years old enrolled in Medicaid in Norfolk, Virginia	94% Black 100% Medicaid recipients	49%	Subgroup analysis suggested trend toward greater effectiveness of the intervention program to decrease hospitalization among children in smoke-free households compared to those households with smokers. A similar trend was noted among children living in households with continuous telephone service compared to those whose telephone service had been disconnected.[119]
Magar et al.[184]	Adults (18-60yrs) with asthma in France. N_{con}=89, N_{int}=104.	None reported.	Not reported.	There was no significant difference in the rate of tobacco use—7% stopped smoking in the intervention group compared to 2% in the control, p=0.18.[184]
Perneger et al.[188]	115 adults with asthma in Geneva, Switzerland	Swiss nationality 55%; University education 18%	21%	No change in smoking rates at the end of the intervention.[188]
Schulz et al.[164]	164 asthma patients in Hamburg. N_{int}=101; N_{con}=63	37% unemployed	23%	No change in smoking rates.[164]

Table 30. Rate of reported tobacco use among patients with asthma and their family members (continued)

Reference	Target Population	Demographics	Baseline Smoking*	Results of Intervention
Swanson et al.[243]	Asthma patients aged 2-50 years in Scotland	None reported.	23%	There was no significant difference between groups in smoking rates.[243]
Wilson et al.[136]	235 patients ages 18-50 with moderate to severe asthma from five Northern California Kaiser Medical Centers.	None reported.	10%	No significant difference in smoking status between groups.[136]
Wilson et al.[94]	Families of children 6 months to 7 years old with asthma in the U.S.	89%White/Caucasian 52% of mothers were college graduates	16%	None of the family members stopped smoking. Intervention children did have improvements in symptom-free days.[94]

*This represents the pre-intervention rate in the study population of at least one smoker at home.

Summary Answers to the Key Questions

Research Question 1: ***What is the evidence that QI strategies improve the processes and outcomes of outpatient care for pediatric and adult populations with asthma? Specifically, which QI strategies are effective for improving processes and outcomes of asthma care for specific patient populations (e.g., adults, children, low SES, racial groups, urban/rural)?***

A wide variety of types of QI interventions have been found to improve the outcomes and processes of care for children and adults with asthma. The QI interventions with the richest evidence base are those that employ self-monitoring, self-management, or patient education strategies. Specifically, for young children—even those from lower socioeconomic groups—educational strategies targeting their caregivers/parents can contribute to statistically significant reductions in asthma symptoms. For general populations or adults with asthma, educational strategies that include a component of organizational change (e.g., adding a pharmacist to the team caring for the patient) have be shown to improve outcomes. Interventions that are based on a theoretical framework, use multiple educational sessions, have longer durations, and use combinations of instructional modalities (e.g., small group teaching with role-playing and handouts) are more likely to result in improvements for patients than interventions lacking these characteristics.

Additionally, the use of school personnel to administer directly-observed therapy may increase the rate of inhaled corticosteroid use among school children with asthma, particularly those who are not exposed to second-hand smoke. Provider education strategies directed at clinicians caring for children with asthma have resulted in improvements in medication use and adherence to practice guidelines. There is insufficient evidence to assess the effectiveness of audit and feedback strategies, provider reminders, facilitated relay of clinical data, and financial incentives.

Also, does the setting of the QI intervention (e.g., home, school, clinic) determine its effectiveness for improving processes and outcomes of asthma care?

We did not find that a particular setting (or combination of settings) of the QI intervention consistently predicted its effectiveness.

Research Question 2: ***Are QI interventions for asthma care that incorporate multiple strategies more effective than those that employ a single strategy?***

The majority of the included articles evaluated a single QI strategy. However, 75 studies evaluated QI interventions with two or more QI strategies and 21 studies evaluated intervention with more than two QI strategies. Among those interventions with more than one QI strategy, the most common combination was self-monitoring or self-management and patient education. We found that the greater the number of QI strategies, the more likely a study was to report improvements in clinical status ($p=0.009$). We note that clinical outcomes were the most frequently reported and that we may have lacked sufficient evidence to find an effect for the other outcomes of interest.

Chapter 4. Discussion

This systematic review of 171 QI interventions for asthma care had several key findings. First, we note that most of the QI interventions in this the evidence report were designed to achieve a change in behavior—on the part of patients with asthma, or their parents or caregivers, or their healthcare providers. Our results confirmed what has been demonstrated in the literature of fields such as psychology and organizational theory: Some behaviors (such as adopting a practice of measuring one's peak flow when asthma symptoms start to flare up) are easier to change than others (such as stopping smoking). Given that an objective of the QI interventions was to change behavior, we reasoned that interventions specifically designed on the principles of effective behavior change would be more likely to produce improved outcomes for patients. For example, evaluations of behavior change interventions have demonstrated that a key component of successful interventions is understanding the barriers to providing high quality care. The included studies rarely described even basic information about underlying reasons for gaps in care that their interventions were trying to address. Even among the included studies that described a theoretical foundation for the design of their intervention (44% overall), many provided very scant information about the rationale for the specific design characteristics of the intervention. For the QI interventions for which we found large numbers of articles (namely, self-monitoring, self-management, or patient education), we did find that those studies that described a theoretical framework were more likely to report statistically significant improvements in some outcomes. Given the robust literature on intervention characteristics associated with durable behavior change, future QI interventions for asthma care should strive to incorporate those characteristics with a history of effectiveness in similar situations.

Second, children, particularly the very young, are unlikely to have either adequate asthma knowledge or the capacity to take disease modifying actions without considerable assistance from their caregivers. Not surprisingly, we found that the interventions directed at children that did not also include parental involvement were less effective, suggesting that parallel educational activities, focusing on parents as well as their children, may be needed. Also, the use of school personnel to administer directly-observed therapy may increase the rate of inhaled corticosteroid use and decrease health services utilization among school children with asthma, particularly those who are not exposed to second-hand smoke. These findings are congruent with the theoretical framework set out by several authors on behavior change for asthma. Namely, that the successful management of asthma requires both knowledge about the disease, its prevention, and treatment and also the capacity to take action to modify exposure to triggers and change medication use in response to changes in disease status.

Third, we were interested in evaluating whether interventions that combined multiple QI strategies would be more likely to benefit patients with asthma than those that utilized a single strategy. We found that the greater the number of QI strategies, the more likely a study was to report improvements in clinical outcomes. In particular, we found that patient and provider education interventions that also included an element of organizational change (for example, by adding pharmacists to the clinical team or by instituting an information system that facilitates reporting of clinical information between patients and providers) were often associated with improvements in outcomes for patients.

Finally, we set out to identify and catalog a broad array of studies that might inform the design and implementation of future asthma QI interventions. By assembling the information on these studies, we are able to generate hypotheses about the comparative advantage of different QI strategies for improving asthma care. The QI strategies with the greatest body of evidence of effectiveness include the self-monitoring, self-management, or patient education interventions. Other strategies worked well in specific circumstances. There is not sufficient evidence to determine definitively which strategy or strategies work best for a given situation. However, the strength of our approach is that we describe the range of QI interventions that have been evaluated under numerous clinical circumstances so that others may review the evidence relevant to their particular constraints.

Limitations

This review has several limitations. First, the included articles were highly heterogeneous with respect to the rigor of the QI strategies implemented, the quality of their study designs, and the details provided about each. We had hoped to be able to identify specific intervention characteristics associated with the greatest improvements for patients with asthma. However, we were limited by the lack of detailed information about the interventions or baseline data for the outcomes of interest. Absence of specific information about the intervention's design limits reproducibility and understanding of the extent to which interventions may be relevant for use in other populations or other settings.

Second, we were limited in our ability to detect benefits for those QI strategies for which there have only been a small number of published studies that met our inclusion criteria. Similarly, because too few studies reported the same specific outcomes (e.g., improvement in FEV_1 or hospitalizations within a given time frame), we used a composite outcome for some of our analysis (namely, any statistically significant result reported for one or more of the four outcomes of interest: clinical status, functional status, health services utilization, or guideline adherence). The use of this composite outcome limited our ability to delineate which QI strategies were more likely to be associated with improvements in each of the four outcomes of interest.

Third, for some of the outcomes reported by the included articles, it is difficult to evaluate their clinical relevance. For example, some studies reported that the intervention group was found to have improvements in inhaler technique relative to the control group; however, we could not evaluate the clinical relevance of this finding—was the incremental improvement in technique of sufficient magnitude that patients would likely have fewer symptoms or require fewer hospitalizations?

Finally, for studies that reported outcomes at multiple time points during and after the intervention, we only abstracted information about the longest period of follow up. Therefore, we may have missed initial improvements in outcomes if they were not durable over time.

Future Research

Our results suggest that QI interventions that specifically target adolescents require additional evaluations. None of the six studies of educational interventions that exclusively

enrolled adolescents with asthma resulted in statistically significant durable improvements in medication use, asthma symptoms control, or health services utilization. However, some of the other interventions that included adolescents in their populations did find improvement—the extent to which they resulted in improvements specifically for adolescents is unknown. Clearly, identification of interventions that result in effective behavior change for this vulnerable population requires further investigation.

Additionally, some authors found that improvements from QI interventions were more likely to occur among patients who were not exposed to tobacco smoke. A potentially confounding factor is that tobacco use was more common in lower socioeconomic groups. These findings suggest the need for additional research to evaluate whether the differential response to QI interventions is related to smoke exposure, socioeconomic status, or other factors.

For some QI strategies, we found a statistically significant association between the year that the intervention was performed and improvements in patient outcomes. However, we did not identify why more recent interventions might produce incrementally better outcomes for subjects relative to controls. This is an area for further investigation.

A number of QI interventions have not been adequately studied (e.g., audit and feedback, provider reminders, facilitated relay). Interventions of these types should be studied in rigorously designed clinical trials.

Relatively few of the included studies reported on the costs associated with their interventions. Thus, the extent to which savings may be obtained from QI interventions for asthma has not been well documented. A critical gap in this literature that prevents an understanding of the cost-effectiveness of QI programs is that there is not a common effectiveness variable such as symptom-free days gained or episode-free days gained. Also, since many studies only include the costs and benefits accrued during the first year after an intervention, it is difficult to estimate the long-term cost-effectiveness of these programs. Given the enormity of the costs associated with asthma care, these are critically important areas for future research.

Conclusions

A wide variety of types of QI interventions have been found to improve the outcomes and processes of care for children and adults with asthma. The QI interventions with the richest evidence base are those that employ self-monitoring, self-management, or patient education strategies. Young children with asthma benefit most from QI strategies that also include their caregivers/parents. In general, interventions that are based on a theoretical framework, use multiple educational sessions, have longer durations, and use combinations of instructional modalities are more likely to result in improvements for patients than interventions lacking these characteristics.

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List of Acronyms/Abbreviations

Acronyms/Abbreviations	Definition
AHRQ	Agency for Healthcare Research and Quality
CBA	Controlled Before-After Trial
CME	Continuing Medical Education
COPD	Chronic obstructive pulmonary disease
CQI	Continuous Quality Improvement
ED	Emergency Department
EPC	Evidence-based Practice Center
EPOC	Cochrane Effective Practice and Organisation of Care
FEV_1	Forced Expiratory Volume in 1 second
HEPA filter	High efficiency particulate air filter
IOM	Institute of Medicine
NHLBI	National Heart, Lung, and Blood Institute
PF	Peak Flow
QI	Quality Improvement
QOL	Quality of Life
QRCT	Quasi-Randomized Controlled Trial
RCT	Randomized Controlled Trial
TQM	Total Quality Management

APPENDIXES

to

"Closing the Quality Gap: A Critical Analysis of Quality Improvement Strategies, Volume 5—Asthma Care"

Prepared by the Stanford University-UCSF Evidence-based Practice Center
(Contract #290-02-0017)

Appendix A: Search Strategies by Database

EPOC Database Search (for QI interventions directed at organizational change and at providers)

#1 Targets the clinical condition of asthma
All fields:
Asthma* OR Anti-asthmatic or Bronchial Hyperreactivity OR Respiratory Hypersensitivity or Reactive airway*

#2 Targets community-based programs/school-based programs
All fields:
"School health services" or "Adolescent Health Services" or "Child Care" or "school health" or "community health services" or "home care"

Title/abstract field:
School OR Community OR Home

#3 Targets self-monitoring or self-management, patient education, and care by others
MeSH terms:
Patient education OR Self care OR Consumer Participation OR Patient Participation OR Peak expiratory flow rate OR Consumer Participation OR Patient care planning OR Health promotion

Title/abstract terms:
Self-monitoring or self-management OR self management OR Patient education OR Self care OR Self-care
Parent* care OR Proxy care OR Peak flow OR Action plan OR Symptom diary OR Monitor OR

Publication type term:
Patient education handout

Cochrane Consumer Group Registry Search (for QI strategies directed at patients and non-providers)

#1: Targets the clinical condition of asthma
MeSH terms:
Asthma OR Anti-asthmatic agents OR Asthma/Drug Therapy OR Bronchial Hyperreactivity OR Respiratory Hypersensitivity

Title/abstract terms:
Asthma* OR Reactive airway*

#2: Targets self-monitoring or self-management, patient education, and care by others
MeSH terms:
Patient education OR Self care OR Consumer Participation OR Patient Participation OR Peak expiratory flow rate OR Consumer Participation OR Patient care planning OR Health promotion OR

Title/abstract terms:
Self-monitoring or self-management OR self management OR Patient education OR Self care OR Self-care
Parent* care OR Proxy care OR Peak flow OR Action plan OR Symptom diary OR Monitor

#3: Search terms for specific codes used in the registry

(asthma* or anti-asthmatic or "bronchial hyperactivity" or "respiratory hypersensitivity" or "reactive airway*") and (Ca-m or Ca-t or N6* or N8g or "patient education" or "consumer participation" or "patient participation" or "patient care planning" or "health promotion" or self-monitoring or self-management or "self management" or self-care or "self care" or "peak expiratory flow rate")

Medline Search Strategy for EPC Asthma Project

#1 Targets the clinical condition of asthma (yield 95,494)
Asthma [mh] OR Anti-asthmatic agents [mh] OR Asthma/Drug Therapy [mh] OR Bronchial Hyperreactivity [mh] OR Respiratory Hypersensitivity [mh] OR Asthma* [ti] OR Reactive airway* [ti] OR Wheez* [ti]

#2 Targets the location of the intervention (yield 223,075)
School Health Services [mh] OR Adolescent Health Services [mh] OR Child Care [mh] OR Home Care Services [mh] OR School [ti] OR Community [ti] OR Home [ti] OR Work[ti]

#3 Targets self-monitoring or self-management studies (yield 119,216)
Patient education [mh] OR Self care [mh] Consumer Participation [mh] OR patient compliance [mh] OR Patient Participation [mh] OR Peak expiratory flow rate [mh] OR Patient care planning [mh] OR Health Promotion [mh] OR Self medication [mh] OR Caregivers [mh] OR Self-monitoring or self-management [ti] OR self management [ti] OR Patient education [ti] OR Self care [ti] OR Self-care [ti] OR Parental care [ti] OR Peak flow [ti] OR Action plan [ti] OR Symptom diary [ti] OR Monitor [ti] OR Care give* [ti] OR Caregive* [ti] OR Self-medication [ti] OR self medication [ti] OR empowerment[ti] OR patient education handout [Publication Type]

#4 Combine Searches #1 AND (#2 OR #3) (yield 6,125)

#5 Systematic review search string (yield 48,084)
(meta-analysis [pt] OR meta-analysis [tw] OR metanalysis [tw]) OR ((review [pt] OR guideline [pt] OR consensus [ti] OR guideline* [ti] OR literature [ti] OR overview [ti] OR review [ti] OR

Decision Support Techniques [mh]) AND ((Cochrane [tw] OR Medline [tw] OR CINAHL [tw] OR (National [tw] AND Library [tw])) OR (handsearch* [tw] OR search* [tw] OR searching [tw]) AND (hand [tw] OR manual [tw] OR electronic [tw] OR bibliographi* [tw] OR database* OR (Cochrane [tw] OR Medline [tw] OR CINAHL [tw] OR (National [tw] AND Library [tw])))) OR ((synthesis [ti] OR overview [ti] OR review [ti] OR survey [ti]) AND (systematic [ti] OR critical [ti] OR methodologic [ti] OR quantitative [ti] OR qualitative [ti] OR literature [ti] OR evidence [ti] OR evidence-based [ti]))) BUTNOT (case reports [pt] OR case* [ti] OR report [ti] OR editorial [pt] OR comment [pt] OR letter [pt])

#6 Original research search string (yield 2,506,960)
Randomised [ti] OR Randomized [ti] OR Controlled [ti] OR intervention [ti] OR evaluation [ti] OR impact [ti] OR effectiveness [ti] OR Evaluation [ti] OR Studies [ti] OR study [ti] Comparative [ti] OR Feasibility [ti] OR Program [ti] OR Design [ti] OR Clinical Trial [pt] OR Randomized Controlled Trial [pt] OR Epidemiologic Studies [mh] OR Evaluation Studies [mh] OR Comparative Study [mh] OR Feasibility Studies [mh] OR Intervention Studies [mh] OR Program Evaluation [mh] OR Epidemiologic Research Design [mh]

#7 Commentaries and news reports search string (yield 1,890,529)
(editorial [pt] OR comment [pt] OR letter [pt] OR news [pt] OR newspaper article [pt] OR case reports[pt])

#8 Combine searches: #5 OR # 6 (yield 2,537,556)

#9 Combine searches: #4 AND #8 (yield 3,112)

#10 Combine searches: #9 BUTNOT #7 (yield 3,003)

#11 Limit to English language, Human (yield 2788)

Appendix B: Data Abstraction Forms

Level One (Screening Title and Abstract) Form

1. Does the article report or evaluate the results of an intervention (whether performed by the investigators or not)?
   - o Yes
   - o No ***{exclusion}***
   - o Can't Tell ***{retrieve article and rescreen}***

2. Does the article involve quality improvement or a QI strategy?
   - o Yes - involves quality improvement or a QI strategy
   - o Yes - systematic review of evaluations of a QI strategy
   - o No ***{exclusion}***
   - o Can't Tell ***{retrieve article and rescreen}***

******Only answer questions 3-4 if questions 1-2 were answered "yes"******

3. Should this article proceed to full text review for this topic?
   - o Yes - evaluates a QI strategy for asthma ***{promotion to full text)***
   - o No – ineligible topic (focused on inpatient care) ***{exclusion}***
   - o No - not an evaluation or not QI ***{exclusion}***
   - o Can't tell - need article ***{retrieve article and rescreen}***

4. What type of study design was used?
   - o RCT or quasi-RCT ***{promotion to full text}***
   - o CBA* or ITS ** ***{promotion to full text}***
   - o Cohort study; before-after or time series not meeting CBA* or ITS** definitions ***{exclusion}***
   - o Observational (e.g., cross-section, case-control) ***{exclusion}***
   - o Systematic review or meta-analysis ***{exclusion}***
   - o Economic or decision analysis, modeling ***{exclusion}***
   - o Non-research (commentary, review, news) ***{exclusion}***
   - o Qualitative research (e.g., focus groups) ***{exclusion}***
   - o Guideline or consensus statement ***{exclusion}***
   - o Can't tell (need article) ***{retrieve article and rescreen}***

* Controlled Before After (CBA) requires contemporaneous observation periods for control and intervention groups AND judgment that control represents a comparable group or setting.

** Interrupted time series (ITS) requires statement of well-defined time period for intervention implementation AND data measurement for at least three time points before and after intervention.

Note: *At this stage of triage,* ***err on the side of inclusion*** *if there is a reasonable chance the study is an RCT, CBA, or ITS. Similarly, if there is a reasonable chance article is a systematic review, designate it as such so article can be pulled.*

Level Two (Full Text) Abstraction Form

1. Does this article merit full text abstraction?

- O Yes
- O No - not QI or not an evaluation of a QI strategy
- O No - ineligible study design (i.e., not RCT, CBA or ITS)
- O No - excluded topic (focused only on inpatient care)
- O No - no eligible outcomes*
- O No - data not reported in a usable way
- O No - foreign language
- O No - other (explain)
- O No - Self management articles

Eligible outcomes are: Measures of clinical status (monitoring of medications, symptoms or symptom-free days, peak flow or spirometric measures, number of asthma attacks); Measures of functional status (days lost from work or school, 6-minute walk times, school grades); Health services utilization (hospital admissions, ED visits, unscheduled MD visits); Use of self monitoring tools (written care plan or self-monitoring or self-management plan); and Adherence to guidelines
**Secondary outcomes (should only be abstracted if clinical outcomes are present): Cost; Patient or Provider Satisfaction; QOL outcomes (of either patients or caregivers); and Reduction in Environmental Allergens (e.g., Tobacco, pets/dander, cockroach antigen)

2. Does this article present data overlapping with another article?

- O Exclude this article as a duplication publication (identify included citation being duplicated)
- O Include this article but obtain listed citation to help with abstraction (e.g. separate methods paper, identify required citation)
- O No or N/A

3. Does abstraction of this study require information from methods or results reported in other citations?

- O Yes (specify)
- O No

4. What category of study question is addressed by the article?

- O Can QI strategies increase the prescribing of inhaled corticosteroids for patients with asthma?
- O Can QI strategies improve the processes of care for asthma?
- O Can QI strategies improve clinical outcomes for patients with asthma?
- O Can QI strategies reduce health services utilization for patients with asthma?
- O Other (explain)
- O None of the above

5. Does the article report data for more than one comparison (i.e., should it be abstracted as more than one study)?

- O Yes (specify which comparison is being abstracted here and which others will be abstracted elsewhere)
- O No

6. Does this article provide references that might lead to additional included studies?

- O Yes (please type in the citation numbers here)
- O No

Study Design Information

7. Describe the purpose of this study (specify the objective of the intervention).

8. What was the study design?

- O Randomized trial (state method of randomization if described)
- O Quasi-randomized trial (state basis for treatment allocation, e.g. alternating patients, calendar date, even or odd identification numbers)

- O Controlled before-after study*
- O Interrupted time series**

*Controlled Before-After (CBA) requires contemporaneous observation periods for control and intervention groups AND judgment that control represents a comparable group or setting.
**Interrupted Time Series (ITS) requires statement of well-defined time period for intervention implementation AND measurement of data at three or more time points both before and after intervention

9. What was the unit of randomization or treatment allocation?
- O Patient
- O Parent or caregiver
- O Teacher
- O Episode of care
- O Clinic day
- O Provider
- O Clinic or practice
- O Firm (describe)
- O Institution
- O Community
- O Other (specify)
- O Not applicable - ITS study (skip to question 24)

10. For the unit of treatment allocation, state sample size in each group (If sample size differs for outcomes, detail differences in "Sample size differs by outcome" text box)
- O Control group - PRE
- O Control group - POST
- O Intervention group - PRE
- O Intervention group - POST
- O Sample size differs by outcome
- O Not stated or not clear (explain)

11. If unit of analysis differed from unit of treatment allocation (e.g. providers randomized but patient outcomes analyzed), state sample size in each group. Use text box for "Sample size differs by outcome"- give details.
- O Control group - PRE
- O Control group - POST
- O Intervention group - PRE
- O Intervention group - POST
- O Sample size differs by outcome (specify)
- O Not stated or not clear
- O Not applicable (unit of analysis same as unit of treatment allocation above)

12. If unit of analysis differed from unit of treatment allocation, did authors acknowledge this issue or make appropriate adjustments?
- O Yes (describe)
- O No
- O Not applicable (unit of analysis did not differ from unit of treatment allocation)

13. Was there adequate concealment of treatment allocation?
- O Yes (unit of allocation was institution, team or professional and randomization process explicitly described, OR unit of allocation was patient or episode of care and some form of centralized randomization scheme or sealed envelopes used)
- O Not clear (only partially meets above criteria) or not stated - specify which
- O No inadequate concealment (enrollment of patients in alternation or through use of even/odd identifying numbers OR unit of allocation was patient or episode of care and reported use of any allocation process that is entirely transparent before assignment (e.g., open list of random numbers) OR allocation was altered by investigators, professionals or patients)

14. Was informed consent obtained? (Check all that apply)

- O Obtained from patients
- O Obtained from parents or caregivers
- O Obtained from providers
- O Obtained from other study participants (specify)
- O Not obtained or not stated (specify)

15. Was IRB approval obtained by investigators?

- O Yes
- O No or not stated

Design Criteria for Randomized and Quasi-Randomized Trials

(If study is a CBA, skip to question 21; if ITS, skip to question 24)

16. Did the study have a cross over design? (Patients randomized to a sequence of interventions such as treatment A followed by treatment B in one group and treatment B followed by treatment A in the other group).

- O Yes (describe)
- O No
- O Not sure (clarify with other reviewers before proceeding)

17. Were patients blind to intervention/treatment allocation?

- O Yes
- O No
- O Not sure (explain)
- O Not applicable (patients not actively involved in study - e.g. provider-focused intervention with patient level data obtained retrospectively from charts)

18. Were caregivers blind to intervention/treatment allocation?

- O Yes
- O No
- O Not sure (explain)
- O Not applicable (caregivers not actively involved in study)

19. Were providers blind to intervention/treatment allocation?

- O Yes
- O No
- O Not sure (explain)
- O Not applicable (explain)

20. Were outcomes assessors blinded to intervention/treatment allocation?

- O Yes
- O No
- O Not sure (explain)
- O Not applicable (explain)

(Now skip to question 27)

Design Criteria for CBA Trials

21. Were measurements in the control group performed at the same time as the intervention group?

- O Yes
- O No
- O Unclear

22. Were the criteria used for selecting the control site explained?
- O Yes (describe)
- O No

23. Was the control site comparable (in both patients and providers)?
- O Yes
- O No (explain why not)
- O Unclear (describe)

(Now skip to question 27.)

Design Criteria for ITS Trials

24. Was the intervention performed independent of other quality improvement efforts or other changes?
- O Yes
- O No
- O Unclear

25. Was the intervention unlikely to affect data collection?
- O Yes
- O No
- O Unclear

26. Was the data analyzed using a formal test for trend (time series ANOVA or regression)?
- O Yes
- O No
- O Unclear

27. (For all studies) Do any methodological aspects of the study design not captured above seriously undermine appropriateness of inclusion of this study?
- O Yes (explain)
- O No (use text box to document any noteworthy methodological features)

Study Setting and Participants

28. Briefly describe the inclusion and exclusion criteria for the CONTROL group.

29. Briefly describe the inclusion and exclusion criteria for the INTERVENTION group.

(We are particularly interested in measures of the baseline asthma severity of the control and intervention groups. If the authors provide baseline number of asthma medications, numbers of ED or physician visits, or other markers of asthma severity, please record these in the pre-intervention portions of the results section)

30. Where did the study take place?
- O US (specify)
- O Non-US (specify)

31. When did the study take place?
- O If supplied, give exact dates of study period (beginning to end of intervention period)
- O Not reported

32. Who or what was the target of the intervention? (check all that apply)
- O Patients
- O Teachers

- O Parents or other caregivers
- O Pharmacists
- O Providers (i.e., individual clinicians, school nurses)
- O Entire population of a geographic area
- O Other (describe)

33. Describe the demographics of the CONTROL population.
Age (describe)
Gender (describe)
Race/ethnicity (describe)
Educational status (describe)
Socioeconomic status (describe)
Urban/Rural information (describe)
Baseline asthma severity or control (describe)

34. Describe the demographics of the INTERVENTION population.
Age (describe)
Gender (describe)
Race/ethnicity (describe)
Educational status (describe)
Socioeconomic status (describe)
Urban/Rural information (describe)
Baseline asthma severity or control (describe)

35. If the study evaluated CAREGIVERS, please describe the demographics of the CAREGIVER population.
Age (describe)
Gender (describe)
Race/ethnicity (describe)
Educational status (describe)
Socioeconomic status (describe)
Urban/rural information (describe)

36. Does the intervention specifically target pediatric asthmatics?
- O Yes, pediatric intervention
- O No

37. In what setting was the intervention delivered? (check all that apply—for example, for an educational program delivered by a nurse educator in a pulmonologist's office that increases home use of self-monitoring or self-management tools, check both Outpatient specialty care clinic and Home)
- O Outpatient primary care clinic
- O Outpatient specialty care clinic (specify type of specialist (e.g. pulmonologist, allergist)
- O Urgent care or walk-in clinic
- O Emergency department
- O Academic healthcare setting
- O VA healthcare setting
- O Home
- O School
- O Work-place
- O Other community setting (e.g., church, community center) (describe)
- O Other or not clear (describe)
- O Not stated

Quality Improvement Attributes of Intervention

38. Did the investigators identify a specific quality gap (a difference between optimal and actual care) in the study population?
- O Yes (describe)
- O No

39. Did the investigators cite previous literature (or a theoretical framework) to describe the evidence base for their proposed intervention?

O Yes (describe)
O No

40. Describe the intervention provided to the CONTROL population?

O No intervention or usual care (describe)
O Some form of low intensity intervention (describe)
O No true control - just two or more different types of intervention (discuss with other reviewers; study may need to be excluded)

41. Describe the intervention provided to the EXPERIMENTAL population?

42. Did the study intervention involve PATIENT, PARENT OR CAREGIVER, OR PROVIDER EDUCATION?

O Yes
O No patient, caregiver, or provider education (skip to question 48)

43. What was the content of the educational material?

O Correct use of metered dose inhalers, nebulizers, and peak flow meters
O Use of asthma diary or other self-monitoring device
O General information about asthma pathophysiology and treatment
O Information about reduction in tobacco use
O Information about reduction in other environmental allergen
O Other (describe)

44. Who was responsible for delivery of the educational content? (check all that apply)

O Physician educating patients/parents or caregivers/teachers
O Physicians educating physician colleagues
O Expert opinion leader (describe how selected)
O Nurse or nurse practitioner
O Pharmacist
O Pharmaceutical sales representative
O Other ancillary health provider (describe)
O Health educator
O Parent or caregiver
O School Teacher
O Peers
O No specific delivery person (e.g. entirely mailed, computer-based, or passively distributed content)
O Other (describe)

45. Which of the following educational strategies was used?

O One-on-one session, in person or via telephone
O Role-playing or practicing of particular behaviors
O Interactive group sessions (e.g. classes, workshops)
O Traditional didactic group teach via meetings or lectures (e.g. traditional CME)
O Distribution of printed or audiovisual materials (e.g. pamphlets or poster in waiting room, published or printed recommendations for clinical care such as clinical practice guidelines, audio-visual materials and electronic publications)
O Community-wide mass media efforts (e.g. television advertisements or billboards)
O Interactive computer-based learning
O Educational outreach visits (e.g. “academic detailing”—a trained person who met with providers in their practice setting to give information with the intent of changing the provider's practice)
O Provision of clinical data to patient or caregiver (e.g. test results)
O Consensus-building sessions (e.g. for development of guideline)
O Not sure or other (describe)

46. How intense was the educational intervention?

O 1-time class, session with an educator, or provision of educational materials
O 2-5 classes or sessions
O 6-10 classes or session
O More than 10 sessions
O Other or unclear (describe)

47. Did the QI strategy involve patient education?

O Yes
O No patient education

48. Was the intervention designed to promote PATIENT SELF-MONITORING OR SELF-MANAGEMENT? If yes, please indicate the objectives of the intervention: (check all that apply)

O Get information about asthma
O Become motivated to avoid future asthma exacerbations
O Identify asthma triggers and behaviors that may lead to asthma exacerbations
O Encourage the use of self monitoring of symptoms (e.g., through asthma diary)
O Encourage the use of self monitoring of disease status (e.g., through peak flows)
O Identify attitudes that reduce chances of successful implementation of new behavior
O Attempt to implement new, asthma self-monitoring or self-management plan
O Evaluate the efficacy of those attempts
O Identify barriers and facilitating features present in his/her life
O Develop the skills s/he needs to overcome those barriers
O Practice those skills and see them modeled by peers
O Implement newly acquired information and skills
O Maintain asthma self-monitoring or self-management behaviors
O Others (describe)

49. Provide additional detail about the PATIENT-SELF MANAGEMENT strategy provided to the CONTROL group not captured in Question 48.

50. Provide additional detail about the PATIENT-SELF MANAGEMENT strategy provided to the INTERVENTION group not captured in Question 48.

51. Did the QI strategy involve PARENT or CAREGIVER education?

O Yes
O No parent or caregiver education

52. Was the intervention designed to promote PARENT OR CAREGIVER SELF MANAGEMENT? If yes, please indicate the objectives of the intervention: (check all that apply)

O Get information about asthma
O Become motivated to avoid future asthma exacerbations
O Identify asthma triggers and behaviors that may lead to asthma exacerbations
O Encourage the use of self monitoring of symptoms (e.g., through asthma diary)
O Encourage the use of self monitoring of disease status (e.g., through peak flows)
O Identify attitudes that reduce chances of successful implementation of new behavior
O Attempt to implement new, asthma self-monitoring or self-management plan
O Evaluate the efficacy of those attempts
O Identify barriers and facilitating features present in his/her life
O Develop the skills s/he needs to overcome those barriers
O Practice those skills and see them modeled by peers
O Implement newly acquired information and skills
O Maintain asthma self-monitoring or self-management behaviors
O Others (describe)

53. Provide additional detail about the PARENT OR CAREGIVER-MANAGEMENT strategy provided to the CONTROL not captured in Question 52.

54. Provide additional detail about the PARENT OR CAREGIVER-MANAGEMENT strategy provided to the INTERVENTION group not captured in Question 52.

55. Did the QI strategy involve PROVIDER EDUCATION?

O Yes
O No

56. Did the QI strategy involve a PROVIDER REMINDER system*?

O Chart based decision support or reminder system*
O Computer based reminder* or decision support*
O Not sure
O No or N/A

* Patient or provider encounter specific information, provided verbally, on paper or on a computer screen, which is intended to prompt provider to recall information at the time of the patient encounter (e.g., reminder to include inhaled corticosteroids in a patient's medical regimen)

57. Did the QI strategy involve provider AUDIT AND FEEDBACK*? (check all that apply)

O Feedback to individual provider (state if confidential)
O Feedback about clinic or practice performance only
O Public reporting of performance data (state if individual data or data for a group or institution)
O Benchmarking**
O Not sure or other
O No or N/A

*Any summary of clinical performance of health care over a specified period of time.
**Benchmarking refers to the provision of performance data from institutions or providers regarded as "leaders in the field." These data provide targets for other providers and institutions to emulate.

58. Did the QI strategy involve ORGANIZATIONAL CHANGE?

O Adding new members to team (e.g. adding a clinical pharmacist to clinic, or creation of a call center for patients) or creating multidisciplinary teams
O Revision of professional roles among health professionals (e.g. nurse practitioner or pharmacist given prescribing authority)
O Increased staffing without changes in roles (e.g., adding more nurses)
O TQM/CQI - cycles of measurement of quality problems, design of interventions, implementation and re-measurement
O Changes in medical records systems -- e.g. changing from paper to computerized records, patient tracking systems
O Communication and case discussion between distant health professionals (e.g., telemedicine)
O Not sure or other
O No or N/A

59. If the intervention involved changes to medical record systems, what type of change was instituted?

O Change from paper to computerized records
O Implementation of computerized provider order entry (CPOE)
O New patient tracking system
O Other (describe)
O Not applicable - No change to medical record system

60. Did the intervention involve FINANCIAL INCENTIVES DIRECTED AT PROVIDERS?

O Financial incentives for achievement of performance goals
O Change in reimbursement system (i.e., capitation)
O Other (describe)
O No component of provider-directed financial incentives

61. Did the intervention involve REGULATORY CHANGES DIRECTED AT PROVIDERS?

- O Restriction of formulary to cover only certain asthma medications
- O Authorization from another physician required to prescribe asthma medications
- O Authorization from health plan required to prescribe asthma medications
- O Restriction of access to pharmaceutical sales representatives
- O Other (describe)
- O No component of provider-directed regulatory changes

62. Did the intervention involve FINANCIAL OR REGULATORY INCENTIVES DIRECTED AT PATIENTS?

- O Additional charge (co-payment) for specific asthma medications
- O Additional charge (co-payment) for visits or phone calls
- O Change in health insurance premiums
- O Other (describe)
- O No component of patient-directed financial or regulatory incentives

63. Did the intervention involve FINANCIAL OR REGULATORY INCENTIVES DIRECTED AT A PRACTICE OR HEALTH SYSTEM?

- O Yes (describe)
- O No component of health-system-directed financial or regulatory incentives

64. Did a clinical information system play a role in design or implementation of intervention?

- O Identification or group allocation of eligible patients or providers
- O Reminders generated by existing clinical information system
- O Decision support at point of care (e.g., for provider order entry)
- O Facilitated communication between providers (e.g., generated emails between members of care team)
- O Audit data gathered from clinical information system to design QI strategy (e.g., audit and feedback, TQM, provider education, financial incentives)
- O Other
- O No role for a clinical information system

65. Use textbox to state any important study features of the QI intervention or concerns not captured above.

66. For unit of treatment allocation (e.g., clinics, providers, patients), were results reported for at least 80% of participants?

- O Yes (state %)
- O No (state %)
- O Not stated or not clear

67. If unit of analysis differed from unit of treatment allocation (e.g., providers randomized, but patient level outcomes analyzed), were results reported for at least 80% of participants?

- O Yes (state %)
- O No (state %)
- O Not stated or not clear
- O Not applicable (unit of analysis same as unit of treatment allocation)

68. What was the length of the study follow up period? (describe)

69. Were the reported outcomes measured at multiple time points?

- O Yes (describe)
- O No

(If outcomes were reported at multiple time points, please use the data for the latest time, provided that this time is still part of the intervention period. For e.g. if a study reports follow up at 3, 6, 9 and 12 months, use the 12 month data. However, if they report follow up at 3 and 6 months, and then state they completed the study and then did a follow up assessment 2 years after study completion, report data from the 6 month period. Make a notation in the comments section that there is also data available from a two year follow up.)

PRIMARY OUTCOMES

Measures of Clinical Status

70. Which of the following measures of clinical status were reported?

- O Frequency of rescue bronchodilators used
- O Use of inhaled corticosteroid
- O Inhaled corticosteroid prescriptions
- O Bronchodilators prescriptions
- O Asthma symptoms
- O Asthma attacks
- O Symptom-free days
- O Peak flows
- O Spirometric data
- O Other measure of clinical status (specify)
- O No measurement of clinical status

Please provide the data for the following outcomes. If the study reports different units of measurement (e.g. median instead of mean or S.E. instead of SD), please indicate that when recording the data.

If the study does not report the data in the format provided by the table, but instead reports data as a change in the post intervention period, please record the change data in the comments column. Report any other concerns about the outcome in the comments column.

	Measure Reported and Units	**N pre**	**Mean Pre**	**SD pre**	**N post**	**Mean Post**	**SD post**	**Significant difference between groups**	**No Significant difference**	**Comments**
71. Frequency of rescue bronchodilators used CONTROLS										
72. Frequency of rescue bronchodilators used INTERVENTN										
73. Use of inhaled corticosteroids CONTROLS										
74. Use of inhaled corticosteroids INTERVENTN										
75. Inhaled corticosteroids prescriptions CONTROLS										
76. Inhaled corticosteroids prescriptions INTERVENTN										
77. Bronchodilators prescriptions CONTROLS										
78. Bronchodilators prescriptions INTERVENTN										

79. Asthma symptoms CONTROLS										
80. Asthma symptoms INTERVENTN										
81. Asthma attacks CONTROLS										
82. Asthma attacks INTERVENTN										
83. Symptom-free days CONTROLS										
84. Symptom-free days INTERVENTN										
85. Peak flows CONTROLS										
86. Peak flows INTERVENTN										
87. Spirometric data CONTROLS										
88. Spirometric data INTERVENTN										
89. Other measure of clinical status 1 (specify) CONTROLS										
91. Other measure of clinical status 1 (specify) INTERVENTN										
92. Other measure of clinical status 2 (specify) CONTROLS										
93. Other measure of clinical status 2 (specify) INTERVENTN										
94. Other measure of clinical status 3 (specify) CONTROLS										
95. Other measure of clinical status 3 (specify) INTERVENTN										

Measures of Guideline Adherence

95. Which of the following measures of guideline adherence were reported?

- O Adherence to a guideline for asthma prescribing
- O Adherence to clinician recommendation by patient
- O Other measure of guideline adherence (specify)

Measures of Asthma Functional Status Outcomes

	Measure Reported and Units	N pre	Mean Pre	SD pre	N post	Mean Post	SD post	Significant difference between groups as reported by author	No Significant difference between groups as reported by author	Comments
96. Adherence to a guideline for asthma prescribing CONTROLS										
97. Adherence to a guideline for asthma prescribing INTERVENTN										
98. Adherence to clinician recommendation by patient CONTROLS										
99. Adherence to clinician recommendation by patient INTERVENTN										
100. Other measure of guideline adherence CONTROLS										
101. Other measure of guideline adherence INTERVENTN										

102. Which of the following measures of asthma functional status outcomes were reported?

- O Days lost from school/work for patients
- O Days lost from school/work for parents or caregivers
- O 6-minute walk times
- O School grades
- O Other measure of asthma functional status (specify)
- O No measurement of asthma functional status

	Measure Reported and Units	N pre	Mean Pre	SD pre	N post	Mean Post	SD post	Significant difference between groups as reported by author	NO Significant difference between groups as reported by author	Comments
103. Days lost from school/work for patients CONTROLS										
103. Days lost from school/work for patients CONTROLS										
104. Days lost from school/work for patients INTERVENTN										

105. Days lost from school/work for parents or caregivers CONTROLS										
106. Days lost from school/work for parents or caregivers INTERVENTN										
107. 6-minute walk times CONTROLS										
108. 6-minute walk times INTERVENTN										
109. School grades CONTROLS										
110. School grades INTERVENTN										
111. Other measure of asthma functional status 1 (specify) CONTROLS										
112. Other measure of asthma functional status 1 (specify) INTERVENTN										
113. Other measure of asthma functional status 2 (specify) CONTROLS										
114. Other measure of asthma functional status 2 (specify) INTERVENTN										

Measures of Self-monitoring or self-management

115. Which of the following measures of asthma self-monitoring or self-management were reported?

- O Rate of adherence to a care plan or self-monitoring or self-management plan
- O Self-efficacy
- O Other measure of self-monitoring or self-management (specify)

	Measure Reported and Units	**N pre**	**Mean Pre**	**SD pre**	**N post**	**Mean Post**	**SD post**	**Significant difference between groups as reported by author**	**No Significant difference between groups as reported by author**	**Comments**
116. Rate of adherence to care plan or self-monitoring or self-management plan CONTROLS										
117. Rate of adherence to care plan or self-monitoring or self-management plan INTERVENTN										

118. Self-efficacy CONTROLS										
119. Self-efficacy INTERVENTN										
120. Other measure of asthma self-monitoring or self-management 1(specify) CONTROLS										
121. Other measure of asthma self-monitoring or self-management 1 (specify) INTERVENTN										
122. Other measure of asthma self-monitoring or self-management 2 (specify) CONTROLS										
123. Other measure of asthma self-monitoring or self-management 2 (specify) INTERVENTN										

Measures of Health Services Utilization

124. Which of the following measures of health services utilization were reported?

- O Unscheduled visits with a health care provider
- O Unscheduled visits to an emergency department or urgent care clinic
- O Hospitalizations
- O Other measure of health services utilization (specify)
- O No measure of health services utilization

	Measure Reported and Units	**N pre**	**Mean Pre**	**SD pre**	**N post**	**Mean Post**	**SD post**	**Significant difference between groups as reported by author**	**No Significant difference between groups as reported by author**	**Comments**
125. Unscheduled visits with a health care provider CONTROLS										
126. Unscheduled visits with a health care provider INTERVENTN										
127. Unscheduled vests to an emergency department or urgent care clinic CONTROLS										

128. Unscheduled vests to an emergency department or urgent care clinic INTERVENTN										
129. Hospitalizations CONTROLS										
130. Hospitalizations INTERVENTN										
131. Other measure of health services utilization (specify) CONTROLS										
132. Other measure of health services utilization (specify) INTERVENTN										

SECONDARY OUTCOMES

DO NOT ABSTRACT THESE OUTCOMES UNLESS AT LEAST ONE PRIMARY OUTCOME HAS BEEN REPORTED.

PLEASE BE SPECIFIC WHEN REPORTING THE TYPE OF OUTCOME AND UNIT OF MEASUREMENT. ONLY ABSTRACT DATA ON WHETHER OR NOT THE AUTHORS REPORTED SIGNIFICANT DIFFERENCES BETWEEN THE CONTROL AND INTERVENTION GROUPS.

133. Which of the following secondary outcomes were reported?

- O Costs
- O Quality of Life
- O Provider Satisfaction
- O Patient Satisfaction with care
- O Parent or Caregiver satisfaction with care
- O Reduction in Exposure to Environmental Allergens
- O No secondary outcomes reported

Specific Outcome Reported	Unit of Measurement	Significant difference between groups as reported by author	No Significant difference between groups as reported by author	Comments
134. Total costs of asthma medications to a practice, hospital or health care system				
135. Cost of health services utilization				
136. Other measure of cost 1 (specify)				
137. Other measure of cost 2 (specify)				
138. Quality of Life 1 (specify)				
139. Quality of Life 2 (specify)				
140. Quality of Life 3 (specify)				
141. Quality of Life 4 (specify)				
142. Quality of Life 5 (specify)				
143. Provider satisfaction				
144. Patient satisfaction with care				
145. Parent or caregiver satisfaction with care				

146. Reduction in environmental allergen 1 (specify)				
147. Reduction in environmental allergen 2 (specify)				
148. Reduction in environmental allergen 3 (specify)				
149. Reduction in environmental allergen 4 (specify)				
150. Reduction in environmental allergen 5 (specify)				

151. Use textbox to state any important results or study concerns not captured above (e.g., reduction in environmental allergens, quality of life, etc.)

Appendix C: List of Excluded Studies

Citation	Reason for Exclusion
Abdulwadud O, Abramson M, Forbes A, James A, Walters E. Evaluation of a randomised controlled trial of adult asthma education in a hospital setting. Thorax. 1999;54(6):493-500.	No eligible outcomes
Abisheganaden J, Ng SB, Lam KN, Lim TK. Peak expiratory flow rate guided protocol did not improve outcome in emergency room asthma. Singapore Med J. Nov 1998;39(11):479-484.	Ineligible study design
Agertoft L, Pedersen S. Importance of training for correct Turbuhaler use in preschool children. Acta Paediatr. Aug 1998;87(8):842-847.	Reported data not usable
Akerman MJ, et al. A successful effort to improve asthma care outcome in an inner-city emergency department. J Asthma. May 1999;36(3):295.	Excluded topic
Akkaya E, Yilmaz A, Ece F, Bayramguler B, Baran A, Akakca A. Effects of patient education to the life quality in asthma patients: 3 years experience [abstract]. Eur Respir J Suppl. 1997;10 Suppl 25:194S.	Abstract
Alexander J, Divin-Cosgrove C, Faner ML, O'Connell M. Increasing the knowledge base of asthmatics and their families through asthma clubs along the southwest border. J Am Acad Nurse Pract. Jul 2000;12(7):260-266.	Ineligible study design
Amirav I, Goren A, Kravitz RM, Pawlowski NA. Physician-targeted program on inhaled therapy for childhood asthma. J Allergy Clin Immunol. Apr 1995;95(4):818-823.	No eligible outcomes
Anthonisen NR, Connett JE, Kiley JP, et al. Effects of smoking intervention and the use of an inhaled anticholinergic bronchodilator on the rate of decline of FEV1. The Lung Health Study. JAMA. Nov 16 1994;272(19):1497-1505.	Excluded topic
Arbes SJ, Sever M, Archer J, et al. Abatement of cockroach allergen (Bla g 1) in low-income, urban housing: A randomized controlled trial.[comment]. J Allergy Clin Immunol. 2003;112(2):339-345.	No eligible outcomes
Aronson N, Lefevre F, Piper M, et al. Management of chronic asthma. Evid Rep Technol Assess (Summ). Sep 2001(44):1-10.	Other
Asthma program targets patient and physician compliance; wins first DM excellence award. Healthc Demand Dis Manag. Dec 1998;4(12):181-184; suppl 181-184.	Ineligible study design
Bailey WC, Richards JM, Jr., Manzella BA, Windsor RA, Brooks CM, Soong SJ. Promoting self-monitoring or self-management in adults with asthma: an overview of the UAB program. Health Educ Q. Fall 1987;14(3):345-355.	Reported data not usable
Baltins M, Holsta A, Silins V, Krams A. Strategy for patient education in asthma [abstract]. Eur Respir J Suppl. 1995;8 Suppl 19:114.	Abstract
Barrett JC. Effects of nursing intervention on teacher inclusion anxiety. The University of Alabama at Birmingham ** D. 1996(172 p).	Thesis/Dissertation
Barta PJ, Brodsky KL. Approaches to asthma care. Medicaid health plans pilot programs to combat a complex health issue. Healthplan. Mar-Apr 2002;43(2):42-45.	Ineligible study design
Becker A, Watson W, Ferguson A, Dimich-Ward H, Chan-Yeung M. The Canadian asthma primary prevention study: outcomes at 2 years of age. J Allergy Clin Immunol. Apr 2004;113(4):650.	Excluded topic
Berwick DM, Yox SB. Change leads to improvement: pediatric asthma and breast cancer care. HMO Practice. Jun 1995;9(2):75.	Ineligible study design
Blackstien-Hirsch P, Anderson G, Cicutto L, McIvor A, Norton P. Implementing continuing education strategies for family physicians to enhance asthma patients' quality of life. J Asthma. May 2000;37(3):247.	Ineligible study design

Citation	Reason for Exclusion
Blixen C, Hammel J, Murphy D, Ault V. Feasibility of a nurse-run asthma education program for urban African- Americans: a pilot study. J Asthma. 2001;38(1):23-32.	Excluded topic
Blumenthal MN, Cushing RT, Fashingbauer TJ. A community program for the management of bronchial asthma. Ann Allergy. Jul 1972;30(7):391-398.	Ineligible study design
Bobb C, Ritz T. Do asthma patients in general practice profit from a structured allergy evaluation and skin testing? A pilot study. Respir Med. Nov 2003;97(11):1180-1187.	Not an evaluation of a QI intervention
Borrelli B, McQuaid E, Becker B, et al. Motivating parents of kids with asthma to quit smoking: the PAQS project. Health Educ Res. 2002;17(5):659-669.	Reported data not usable
Bosnic-Anticevich S, Donnelly A, Saini B. The effect of a peer-led asthma education program on asthma knowledge, confidence and skills [Abstract]. Proceedings of the Thoracic Society of Australia & New Zealand, Annual Scientific Meeting, Adelaide, 4-9 April 2003. 2003.	Abstract
Boulet LP, Boutin H, Cote J, Leblanc P, Laviolette M. Evaluation of an asthma self-monitoring or self-management education program. J Asthma. 1995;32(3):199-206.	Ineligible study design
Brambilla R. Eformoterol in elderly patients: a follow-up. Br J Clin Pract Suppl. Sep 1995;81:6-7.	Not an evaluation of a QI intervention
Bramson R. Self-monitoring or self-management of asthma. J Fam Pract. Jul 1996;43(1):21-22.	Ineligible study design
Brandt HD, Muntingh GL. Decreasing asthma morbidity. S Afr Med J. Dec 1994;84(12):842-844.	No eligible outcomes
Brazil K. The influence of health education on family adaption to childhood asthma [Dissertation]. University of Toronto. 1992.	Thesis/Dissertation
Brewin AM, Hughes JA. Effect of patient education on asthma management. Br J Nurs. Jan 28-Feb 8 1995;4(2):81-82, 99-101.	Excluded topic
Bright P, Burge PS. Occupational lung disease. 8. The diagnosis of occupational asthma from serial measurements of lung function at and away from work. Thorax. Aug 1996;51(8):857-863.	Ineligible study design
Bundy DG, Berkoff MC, Ito KE, Rosenthal MS, Weinberger M. Interpreting subgroup analyses: is a school-based asthma treatment program's effect modified by secondhand smoke exposure? comment. Arch Pediatr Adolesc Med. May 2004;158(5):469.	Ineligible study design
Bunjaroonsilp N, Bunnag A, Jungsomjatepaisal W, Pongsaranunthakul Y, Maksuwan D. Effectiveness of the nurse-run asthma self-monitoring or self-management program for sick children of the university hospitals in Bangkok. Thai J Nurs. 2002;6(3):128.	Other
Burkhart PV, Dunbar-Jacob JM, Rohay JM. Accuracy of children's self-reported adherence to treatment. J Nurs Scholarsh. 2001;33(1):27-32.	No eligible outcomes
Cabana MD, Le TT. Challenges in asthma patient education. J Allergy Clin Immunol. Jun 2005;115(6):1225-1227.	Not an evaluation of a QI intervention
Callahan K, Eggleston P, Rand C, Kanchanaraksa S, Swartz L, Wood R. Knowledge and practice of dust mite control by specialty care. Ann Allergy Asthma Immunol. 2003;90(3):302-307.	No eligible outcomes
Campbell TM, Stamm PL, Johnson JR. Improving drug use in a capitated program for the poor. Am J Health Syst Pharm. Nov 1 1997;54(21):2449-2450.	Ineligible study design
Capen CL, Sherman JM. Fatal asthma in children: a nurse managed model for prevention. J Pediatr Nurs. Dec 1998;13(6):367-375.	Ineligible study design
Castro M, Zimmermann NA, Crocker S, Bradley J, Leven C, Schechtman KB. Asthma intervention program prevents readmissions in high healthcare users. Am J Respir Crit Care Med. Nov 1 2003;168(9):1095-1099.	Excluded topic
Catrambone CD. Effect of a case management intervention on symptoms of asthma in high risk children. Rush university, college of nursing ** 2000 d. 2000(141 p).	Thesis/Dissertation

Citation	Reason for Exclusion
Chandler MH, Clifton GD, Louis BA, Coons SJ, Foster TS, Phillips BA. Home monitoring of theophylline levels: a novel therapeutic approach. Pharmacotherapy. 1990;10(4):294-300.	Excluded topic
Chan-Yeung M, Manfreda J, Dimich-Ward H, Ferguson A, Watson W, Becker A. A randomized controlled study on the effectiveness of a multifaceted intervention program in the primary prevention of asthma in high-risk infants. Arch Pediatr Adolesc Med. Jul 2000;154(7):657-663.	No eligible outcomes
Charlton I, Charlton G, Broomfield J, Mullee MA. Audit of the effect of a nurse run asthma clinic on workload and patient morbidity in a general practice. Br J Gen Pract. Jun 1991;41(347):227-231.	Ineligible study design
Charlton I. Self-monitoring or self-management plans for asthma control. Nurs Times. May 15-21 1991;87(20):52.	other
Chiang LC, Huang JL, Yeh KW, Lu CM. Effects of a self-monitoring or self-management asthma educational program in Taiwan based on PRECEDE-PROCEED model for parents with asthmatic children. J Asthma. Apr 2004;41(2):205-215.	Reported data not usable
Chouaid C, Bal JP, Fuhrman C, Housset B, Caudron J. Standardized protocol improves asthma management in emergency department. J Asthma. Feb 2004;41(1):19.	Ineligible study design
Chowienczyk PJ, Parkin DH, Lawson CP, Cochrane GM. Do asthmatic patients correctly record home spirometry measurements? BMJ. Dec 17 1994;309(6969):1618.	Not an evaluation of a QI intervention
Clancy K. Avoid irritants to reduce breathlessness. Prof Nurse. Feb 2005;20(6):29.	Not an evaluation of a QI intervention
Clark NM, Brown R, Joseph CL, Anderson EW, Liu M, Valerio MA. Effects of a comprehensive school-based asthma program on symptoms, parent management, grades, and absenteeism. Chest. May 2004;125(5):1674-1679.	Reported data not usable
Clark NM, Evans D, Mellins RB. Patient use of peak flow monitoring. Am Rev Respir Dis. Mar 1992;145(3):722-725.	Ineligible study design
Clark NM. Asthma self-monitoring or self-management education. Research and implications for clinical practice. Chest. May 1989;95(5):1110-1113.	Ineligible study design
Cloosterman SG, Schermer TR, Bijl-Hofland ID, et al. Effects of house dust mite avoidance measures on Der p 1 concentrations and clinical condition of mild adult house dust mite-allergic asthmatic patients, using no inhaled steroids. Clin Exp Allergy. Oct 1999;29(10):1336-1346.	Not an evaluation of a QI intervention
Coleman R, Gill G, Wilkinson D. Noncommunicable disease management in resource-poor settings: a primary care model from rural South Africa. Bull World Health Organ. 1998;76(6):633-640.	Ineligible study design
Colland VT. Learning to cope with asthma: a behavioural self-monitoring or self-management program for children. Patient Educ Couns. Dec 31 1993;22(3):141-152.	No eligible outcomes
Comino EJ, Mitchell CA, Bauman A, et al. Asthma management in eastern Australia, 1990 and 1993. Med J Aust. Apr 1 1996;164(7):403-406.	Ineligible study design
Coover L, Vega C, Persky V, et al. A collaborative model to enhance the functioning of the school child with asthma. Chest. Oct 1999;116(4 Suppl 1):193S-195S.	Ineligible study design
Costante C. Asthma: promoting best practice in the school setting. Nasnewsletter. Mar 2000;15(2):12.	Not an evaluation of a QI intervention
Couriel J, Littleton V, Milnes L, Barow S. Patient education for children attending an accident and emergency (a & e) department with acute asthma - a randomised controlled study. European Respiratory Society; 1999 Oct 9-13; Madrid, Spain. 1999:P1756.	Other
Crain EF, Walter M, O'Connor GT, et al. Home and allergic characteristics of children with asthma in seven U.S. urban communities and design of an environmental intervention: the Inner-City Asthma Study. Environ Health Perspect. Sep 2002;110(9):939-945.	Ineligible study design

Citation	Reason for Exclusion
Creer TL, Backial M, Burns KL, et al. Living with Asthma. I. Genesis and development of a self-monitoring or self-management program for childhood asthma. J Asthma. 1988;25(6):335-362.	No eligible outcomes
Creer TL, Caplin DA, Holroyd KA. A self-monitoring or self-management program for adult asthma: part IV, Analysis of context and patient behaviors. J Asthma. Jul-Aug 2005;42(6):455-462.	Reported data not usable
Crockett A, Leonard A. Local asthma guidelines can help reduce hospital admissions. Asthma J. 2001;6(1):31.	Ineligible study design
Darr MS, Self TH, Ryan MR, Vanderbush RE, Boswell RL. Content and retention evaluation of an audiovisual patient-education program on bronchodilators. Am J Hosp Pharm. May 1981;38(5):672-675.	No eligible outcomes
de Blay F, Fourgaut G, Hedelin G, et al. Medical Indoor Environment Counselor (MIEC): role in compliance with advice on mite allergen avoidance and on mite allergen exposure. Allergy. Jan 2003;58(1):27-33.	No eligible outcomes
De Blay F, Fourgaut G, Lieutier-Colas F, et al. Mite allergen reduction: Role of an indoor technician in patients compliance and allergen exposure. J Allergy Clin Immunol. 2001;107(2):S218.	Abstract
de Oliveira MA, Bruno VF, Ballini LS, BritoJardim JR, Fernandes AL. Evaluation of an educational program for asthma control in adults. J Asthma. 1997;34(5):395-403.	Ineligible study design
Demiralay R. Comparison of the effects of three forms of individualized education on asthma knowledge in asthmatic patients. Turk J Med Sci. 2002;32(1):57-64.	No eligible outcomes
Design and implementation of a patient education center for the Childhood Asthma Management Program. Childhood Asthma Management Program Research Group. Ann Allergy Asthma Immunol. Dec 1998;81(6):571-581.	Not an evaluation of a QI intervention
Deter H, Allert G. Group therapy for asthma patients: a concept for the psychosomatic treatment of patients in a medical clinic--a controlled study. Psychotherapy & Psychosomatics. 1983;40(1-4):95-105.	Not an evaluation of a QI intervention
Diaz Vazquez C, Riano Galan I, Cobo Ruisanchez A, Orejas Rodriguez-Arango G, Sandoval Gutierrez L, Florido Mancheno I. Reduction in the number of hospitalizations for asthma. Quality assurance program for the management of asthma crises in a district hospital. Spanish. An Esp Pediatr. Nov 1998;49(5):456.	Foreign language article language
Dickinson J, Hutton S, Atkin A, Jones K. Reducing asthma morbidity in the community: the effect of a targeted nurse-run asthma clinic in an English general practice. Respir Med. Nov 1997;91(10):634-640.	Reported data not usable
Dickinson J, Hutton S, Atkin A. Implementing the British Thoracic Society's guidelines: the effect of a nurse-run asthma clinic on prescribed treatment in an English general practice. Respir Med. Feb 1998;92(2):264-267.	Ineligible study design
Dinelli DL, Higgins JC. Case management of asthma for family practice patients: a pilot study. Mil Med. Mar 2002;167(3):231-234.	Ineligible study design
Doherty SR, Jones PD. Use of an 'evidence-based implementation' strategy to implement evidence-based care of asthma into rural district hospital emergency departments. Rural Remote Health. Jan-Mar 2006;6:529.	Excluded topic
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Maiman LA, Green LW, Gibson G, MacKenzie EJ. Education for self-treatment by adult asthmatics. JAMA. May 4 1979;241(18):1919-1922.	No eligible outcomes
Marabini A, Brugnami G, Currad iF, et al. Short-term effectiveness of an asthma patient education program [abstract]. Am J Respir Crit Care Med. 1998;157(3 Suppl):A737.	Abstract
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Marks MK, Hynson JL, Karabatsos G. Asthma: communication between hospital and general practitioners. J Paediatr Child Health. Jun 1999;35(3):251.	No eligible outcomes
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Matthews B, Dickinson A, Cram F. Establishment and evaluation of a preschool asthma programme: a pilot study. Nurs Prax N Z. Nov 1998;13(3):25-34.	Ineligible study design

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McEwen M, Johnson P, Neatherlin J, Millard MW, Lawrence G. School-based management of chronic asthma among inner-city African-American schoolchildren in Dallas, Texas. J Sch Health. May 1998;68(5):196-201.	Ineligible study design
McMullen AH, Yoos HL, Kitzman H. Peak flow meters in childhood asthma: parent report of use and perceived usefulness. J Pediatr Health Care. Mar-Apr 2002;16(2):67-72.	No eligible outcomes
Meinert R, Frischer T, Kuehr J. The "healthy passive smoker": relationship between bronchial hyper-reactivity in school children and maternal smoking. J Epidemiol Community Health. Jun 1994;48(3):325-326.	Not an evaluation of a QI intervention
Meng A, McConnell S. Asthma education: special applications for the school-age child. Nurs Clin North Am. Dec 2003;38(4):653-664.	No eligible outcomes
Meng A. A school-based asthma clinic: a partnership model for managing childhood asthma. Nurse Pract Forum. Mar 2000;11(1):38-47.	Ineligible study design
Millard MW, Johnson PT, McEwen M, et al. A randomized controlled trial using the school for anti-inflammatory therapy in asthma. J Asthma. 2003;40(7):769-776.	Reported data not usable
Mitchell EA, Ferguson V, Norwood M. Asthma education by community child health nurses. Arch Dis Child. Dec 1986;61(12):1184-1189.	No eligible outcomes
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Murray MD, Loos B, Tu W, Eckert GJ, Zhou XH, Tierney WM. Work patterns of ambulatory care pharmacists with access to electronic guideline-based treatment suggestions. Am J Health Syst Pharm. 1999;56(3):225.	No eligible outcomes
Nair SJ, Daigle KL, DeCuir P, Lapin CD, Schramm CM. The influence of pulmonary function testing on the management of asthma in children. J Pediatr. Dec 2005;147(6):797-801.	Not an evaluation of a QI intervention
Narhi U, Airaksinen M, Tanskanen P, Erlund H. Therapeutic outcomes monitoring by community pharmacists for improving clinical outcomes in asthma. J Clin Pharm Ther. Jun 2000;25(3):177-183.	Ineligible study design
National Asthma Education and Prevention Program. Resolution on asthma management at school. School Nurse News. Nov 2002;19(5):16-17.	Not an evaluation of a QI intervention
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Niksic D, Saracevic E, Cemerlic-Kulic A, Kurspahic-Mujcic A, Bajraktarevic S, Niksic H. Evaluation of efficiency practical issues in the management of childhood asthma. Bosn J Basic Med Sci. Nov 2005;5(4):40-45.	Ineligible study design
Oprehek J, Gayard P, Grimaud C, Charpin J. Patient error in use of bronchidilator metered aerosols. Br Med J. Jan 10 1976;1(6001):76.	Not an evaluation of a QI intervention
Osman LM, Calder C, Godden DJ, et al. A randomised trial of self-monitoring or self-management planning for adult patients admitted to hospital with acute asthma. Thorax. Oct 2002;57(10):869-874.	Excluded topic
Parcel GS, Nader PR, Tiernan K. A health education program for children with asthma. J Dev Behav Pediatr. Sep 1980;1(3):128-132.	No eligible outcomes
Parcel GS, Nader PR. Evaluation of a pilot school health education program for asthmatic children. J Sch Health. Oct 1977;47(8):453-456.	Ineligible study design
Partridge MR, Fabbri LM, Chung KF. Delivering effective asthma care--how do we implement asthma guidelines? Eur Respir J. Feb 2000;15(2):235.	Not an evaluation of a QI intervention
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Patterson EE, Brennan MP, Linskey KM, Webb DC, Shields MD, Patterson CC. A cluster randomised intervention trial of asthma clubs to improve quality of life in primary school children: the School Care and Asthma Management Project (SCAMP). Archives of Disease in Childhood. Aug 2005;90(8):786-791.	Ineligible study design
Pauley TR, Magee MJ, Cury JD. Pharmacist-managed, physician-directed asthma management program reduces emergency department visits. Ann Pharmacother. Jan 1995;29(1):5-9.	Ineligible study design
Peak flow-based compared to symptom-based written action plans. J Allergy Clin Immunol. Nov 2002;110(5 Suppl):S192-196.	Not an evaluation of a QI intervention
Pearce MJ, Begg EJ. Encouraging consensus cost effective drug therapy: five years experience with a hospital drug utilisation review programme. N Z Med J. Mar 281997;110(1040):92.	Excluded topic

Citation	Reason for Exclusion
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Persky V, Coover L, Hernandez E, et al. Chicago community-based asthma intervention trial: feasibility of delivering peer education in an inner-city population. Chest. Oct 1999;116(4 Suppl 1):216S-223S.	Reported data not usable
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Pinnock H, Bawden R, Proctor S, et al. Accessibility, acceptability, and effectiveness in primary care of routine telephone review of asthma: pragmatic, randomised controlled trial. BMJ. Mar 1 2003;326(7387):477.	No eligible outcomes
Pituch M, Bruggeman J. Lungs unlimited: a self-care program for asthmatic children and their families. Child Today. Jul-Aug 1982;11(4):6-10.	Ineligible study design
Poirier S, LeLorier J, Page V, Lacour A. The effect of a $2 co-payment on prescription refill rates of Quebec elderly and its relationship to socio-economic status. Can Pharm J. 1998;131(1):30.	Not an evaluation of a QI intervention
Poulsen SS, Petersen BN. Letter: Letter to the editor. Scand J Respir Dis. 1976;57(2):97-98.	Not an evaluation of a QI intervention
Premaratne UN, Sterne JA, Marks GB, Webb JR, Azima H, Burney PG. Clustered randomised trial of an intervention to improve the management of asthma: Greenwich asthma study. BMJ. May 8 1999;318(7193):1251.	Reported data not usable
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Rachelefsky GS, Lewis CE, de la Sota A, Lewis MA. ACT (asthma care training) for kids. A childhood asthma self-monitoring or self-management program. Chest. Jan 1985;87(1 Suppl):98S-100S.	Ineligible study design
Rance K, Trent C. Broccoli and pixie stix. Profile of a pediatric asthma program. Adv Nurse Pract. Mar 2004;12(3):47-48.	Ineligible study design
Rance KS, Trent CA. Profile of a primary care practice asthma program: improved patient outcomes in a high-risk population. J Pediatr Health Care. Jan-Feb 2005;19(1):25-32.	Ineligible study design
Ratima MM, Fox C, Fox B, et al. Long-term benefits for Maori of an asthma self-monitoring or self-management program in a Maori community which takes a partnership approach. Aust N Z J Public Health. Dec 1999;23(6):601-605.	Ineligible study design
Reddel HK, Toelle BG, Marks GB, Ware SI, Jenkins CR, Woolcock AJ. Analysis of adherence to peak flow monitoring when recording of data is electronic. BMJ. Jan 19 2002;324(7330):146-147.	Not an evaluation of a QI intervention
Redline S, Gruchalla RS, Wolf RL, et al. Development and validation of school-based asthma and allergy screening questionnaires in a 4-city study. School Nurse News. Nov 2004;21(5):12-14.	Not an evaluation of a QI intervention
Richards W, Church JA, Roberts MJ, Newman LJ, Garon MR. A self-help program for childhood asthma in a residential treatment center. Clin Pediatr (Phila). Jul 1981;20(7):453-457.	Ineligible study design
Richardson CR. Homemade spacers useful in asthma treatment. J Fam Pract. Dec 1999;48(12):997.	Not an evaluation of a QI intervention
Ringsberg KC, Timpka T. Clinical health education for patients with asthma-like symptoms but negative asthma tests. Allergy. 2001;56(11):1049-1054.	Excluded topic

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Robichaud P, Laberge A, Allen MF, et al. Evaluation of a program aimed at increasing referrals for asthma education of patients consulting at the emergency department for acute asthma. Chest. Nov 2004;126(5):1495-1501.	No eligible outcomes
Roemer W, Hoek G, Brunekreef B. Pollution effects on asthmatic children in Europe, the PEACE study. Clin Exp Allergy. Aug 2000;30(8):1067-1075.	Not an evaluation of a QI intervention
Rohl BJ, Meyer LC, Lung CL. An individualized, comprehensive asthma care treatment program. Med Interface. Mar 1994;7(3):121-123, 134.	Ineligible study design
Roque F, Walker L, Herrod P, Pyzik T, Clapp W. The Lawndale Christian Health Center Asthma Education Program. Chest. Oct 1999;116(4 Suppl 1):201S-202S.	Ineligible study design
Ross DJ. Ten years of the SWORD project. Surveillance of Work-related and Occupational Respiratory Disease. Clin Exp Allergy. Jun 1999;29(6):750-753.	Not an evaluation of a QI intervention
Ross S, Togger D, Desjardins D. Asthma disease management program cuts readmissions. Hosp Case Manag. Oct 1998;6(10):197-200.	Ineligible study design
RTs, doctors team up to lead successful asthma program. Healthc Demand Dis Manag. Jun 1999;5(6):81-85.	Ineligible study design
Rundall TG, Shortell SM, Wang MC, et al. As good as it gets? Chronic care management in nine leading US physician organisations. BMJ. Oct 26 2002;325(7370):958-961.	Excluded topic
Rupp MT, McCallian DJ, Sheth KK. Developing and marketing a community pharmacy-based asthma management program. J Am Pharm Assoc (Wash). Nov-Dec 1997;NS37(6):694-699.	Ineligible study design
Saini B, Krass I, Armour C. Development, implementation, and evaluation of a community pharmacy-based asthma care model. Ann Pharmacother. Nov 2004;38(11):1954-1960.	Reported data not usable
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Schneider MR, Melton BH, Reisch JS. Effects of a progressive exercise program on absenteeism among school children with asthma. J Sch Health. Feb 1980;50(2):92-95.	Not an evaluation of a QI intervention
Schonberger HJ, Dompeling E, Knottnerus JA, et al. The PREVASC study: the clinical effect of a multifaceted educational intervention to prevent childhood asthma. Eur Respir J. Apr 2005;25(4):660-670.	Excluded topic
Schonberger HJ, Maas T, Dompeling E, Knottnerus JA, van Weel C, van Schayck CP. Compliance of asthmatic families with a primary prevention programme of asthma and effectiveness of measures to reduce inhalant allergens--a randomized trial. Clin Exp Allergy. Jul 2004;34(7):1024-1031.	No eligible outcomes

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Schulte A, Musolf J, Meurer JR, Cohn JH, Kelly KJ. Pediatric asthma case management: a review of evidence and an experimental study design. J Pediatr Nurs. Aug 2004;19(4):304-310.	Ineligible study design
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Shah S, Gibson PG, Wachinger S. Recognition and crisis management of asthma in schools. J Paediatr Child Health. Aug 1994;30(4):312-315.	Ineligible study design
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Shelledy D, McCormick S, LeGrand T, Cardenas J, Peters J. The effect of a pediatric asthma management program provided by respiratory therapists on patient outcomes and cost. Heart & Lung. 2005;34(6):423-428.	Ineligible study design
Sly PD. Peak expiratory flow monitoring in pediatric asthma: is there a role? J Asthma. 1996;33(5):277-287.	Not an evaluation of a QI intervention
Sly RM. Evaluation of a sound-slide program for patient education. Ann Allergy. Feb 1975;34(2):94-97.	No eligible outcomes
Smeele IJ, Van Schayck CP, Grol R, et al. Implementing national guidelines on asthma/COPD in general practice; the effects of continuous monitoring and feedback at patient level dissertation. 1998.	Thesis/Dissertation
Smeele IJM, Grol R, Van Schayck CP, Van den Bosch W, Van den Hoogen HJM, Muris JWM. Can small group education and peer review improve care for patients with asthma/chronic obstructive pulmonary disease? Qual Health Care. Jun 1999;8(2):92.	Reported data not usable
Smeele IJM, Grol R, Van Schayck CP, Van den Bosch W, Van den Hoogen HJM, Muris JWM. Improving care for patients with asthma/COPD. A randomized experimental study on the effects of an intensive small group education and peer review programme on care provision and patient outcomes dissertation. 1998.	Thesis/Dissertation
Smith BJ, McElroy HJ, Ruffin RE, et al. The effectiveness of coordinated care for people with chronic respiratory disease. comment. Med J Aust. 2002;177(9):481.	Excluded topic
Sommaruga M, Spanevello A, Migliori GB, Neri M, Callegari S, Majani G. The effects of a cognitive behavioural intervention in asthmatic patients. Monaldi Arch Chest Dis. Oct 1995;50(5):398-402.	Not an evaluation of a QI intervention
Sondergaard J, Andersen M, Vach K, Kragstrup J, Maclure M, Gram LF. Detailed postal feedback about prescribing to asthma patients combined with a guideline statement showed no impact: a randomised controlled trial. Eur J Clin Pharmacol. May 2002;58(2):127.	Reported data not usable
Sorrells VD, Chung W, Schlumpberger JM. The impact of a summer asthma camp experience on asthma education and morbidity in children. J Fam Pract. Nov 1995;41(5):465-468.	Ineligible study design
Spector SL. Is your asthmatic patient really complying? Ann Allergy. Oct 1985;55(4):552-556.	Not an evaluation of a QI intervention
Sperber K, Ibrahim H, Hoffman B, Eisenmesser B, Hsu H, Corn B. Effectiveness of a specialized asthma clinic in reducing asthma morbidity in an inner-city minority population. J Asthma. 1995;32(5):335.	Ineligible study design
Steinwachs DM, Wu AW, Skinner EA. How will outcomes management work? Health Aff (Millwood). Fall 1994;13(4):153-162.	No eligible outcomes

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Swartz LJ, Callahan KA, Butz AM, et al. Methods and issues in conducting a community-based environmental randomized trial. Environ Res. Jun 2004;95(2):156-165.	Reported data not usable
Tai S, Nazareth I, Donegan C, Haines A. Evaluation of general practice computer templates: Lessons from a pilot randomised controlled trial. Methods Inf Med. Sep 1999;38(3):177.	No eligible outcomes
Talabere L. The effects of an asthma education program on selected health behaviors of school-age children who have recently experienced an acute asthma episode. The Ohio State University ** Ph.D. (260 p). 1990.	Thesis/Dissertation
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Tanyeli G, Demir R, Ozylimaz S, Kiyan E, Gurses N. Effects of a comprehensive rehabilitation program and patient education on posture and breathing patterns in asthmatics. Eur Respir J. 2001;18(Suppl 33):299s.	Abstract
Teo S, Hanson R, Van Asperen P, et al. Improving asthma documentation in a paediatric emergency department. J Paediatr Child Health. Apr 1995;31(2):130.	Ineligible study design
Thoonen BP, Schermer TR, Jansen M, et al. Asthma education tailored to individual patient needs can optimise partnerships in asthma self-monitoring or self-management. Pat Educ Couns. Aug 2002;47(4):355.	No eligible outcomes
Thoonen BP, Schermer TR, Van Den Boom G, et al. Self-monitoring or self-management of asthma in general practice, asthma control and quality of life: a randomised controlled trial. Thorax. Jan 2003;58(1):30-36.	Reported data not usable
Tilly KF, Garvey NJ, Gold M, Powell E, Proudlock ML. Outcomes management and asthma education in a community hospital: ongoing monitoring of health status. Qual Manag Health Care. Spring 1996;4(3):67-78.	Ineligible study design
Tinkelman D, Wilson S. Asthma disease management: regression to the mean or better? Am J Manag Care. Dec 2004;10(12):948-954.	No eligible outcomes
Tschopp JM, Frey JG, Janssens JP, et al. Asthma outpatient education by multiple implementation strategy. Outcome of a programme using a personal notebook. Respiratory Medicine. Mar 2005;99(3):355-362.	Ineligible study design
Tschopp JM, Frey JG, Pernet R, et al. Bronchial asthma and self-monitoring or self-management education: implementation of Guidelines by an interdisciplinary programme in health network. Swiss Med Wkly. Feb 23 2002;132(7-8):92-97.	Ineligible study design
Tsoukleris MG, Michocki RJ. Geriatrics for the clinician. Inhalation therapy and the elderly: what every physician should consider. Md Med J. Dec 1995;44(12):1049-1052.	Not an evaluation of a QI intervention
Vafiadou M, Ranuro R. Managing asthma: a pediatric program that works. Caring. Nov 1999;18(11):16-21.	Ineligible study design
Van Asperen P, Jandera E, De Neef J, Hill P, Law N. Education in childhood asthma: a preliminary study of need and efficacy. Aust Paediatr J. Feb 1986;22(1):49-52.	No eligible outcomes
van Walraven C, Forster A. Effect of follow-up physician visits on emergency readmissions. comment. Am J Med. Sep 2002;113(4):347.	Ineligible study design
Velsor-Friedrich B, Srof B. Asthma self-monitoring or self-management programs for children. Part II: Empiric evaluation of programs and recommendations. J Child Fam Nurs. May-Jun 2000;3(3):173-190; quiz 191, 190.	Ineligible study design

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Veninga CC, Lagerlov P, Wahlstrom R, et al. Evaluating an educational intervention to improve the treatment of asthma in four European countries. Drug Education Project Group. Am J Respir Crit Care Med. Oct 1999;160(4):1254.	Reported data not usable
Veninga N. Improving prescribing in general practice dissertation. Thesis. 2000.	Thesis/Dissertation
Verstappen WH, van der Weijden T, Sijbrandij J, et al. Effect of a practice-based strategy on test ordering performance of primary care physicians: a randomized trial. JAMA. May 14 2003;289(18):2407.	No eligible outcomes
Vilar ME, Reddy BM, Silverman BA, et al. Superior clinical outcomes of inner city asthma patients treated in an allergy clinic. Ann Allergy Asthma Immunol. Mar 2000;84(3):299-303.	No eligible outcomes
Wakefield M, Banham D, McCaul K, et al. Effect of feedback regarding urinary cotinine and brief tailored advice on home smoking restrictions among low-income parents of children with asthma: a controlled trial. Prev Med. Jan 2002;34(1):58-65.	No eligible outcomes
Warburton CJ, Niven RM, Pickering CA, Fletcher AM, Hepworth J, Francis HC. Domiciliary air filtration units, symptoms and lung function in atopic asthmatics. Respir Med. Nov 1994;88(10):771-776.	Not an evaluation of a QI intervention
Ward A, Willey C, Andrade S. Patient education provided to asthmatic children: a historical cohort study of the implementation of NIH recommendations. J Asthma. Apr 2001;38(2):141-147.	Ineligible study design
Watson E, Young L. Re-engineering care delivery to improve the health outcome of asthmatics in Campbelltown, New South Wales. Medinfo. 1995;8(Pt 1):545.	No eligible outcomes
Webber MP, Carpiniello KE, Oruwariye T, Lo Y, Burton WB, Appel DK. Burden of asthma in inner-city elementary schoolchildren: do school-based health centers make a difference? Arch Pediatr Adolesc Med. Feb 2003;157(2):125-129.	Not an evaluation of a QI intervention
Weinberger M, Murray MD, Marrero DG, et al. Effectiveness of pharmacist care for patients with reactive airways disease: a randomized controlled trial. JAMA. Oct 2 2002;288(13):1594-1602.	Excluded topic
White M, Michaud G, Pachev G, Lirenman D, Kolenc A, FitzGerald JM. Randomized trial of problem-based versus didactic seminars for disseminating evidence-based guidelines on asthma management to primary care physicians. J Contin Educ Health Prof. 2004;24(4):237-243.	No eligible outcomes
White PT, Pharoah CA, Anderson HR, Freeling P. Randomized controlled trial of small group education on the outcome of chronic asthma in general practice see comments. J R Coll Gen Pract. May 1989;39(322):182.	Not an evaluation of a QI intervention
Wiegers TA, Kerkstra A. COPD home visit with children. Comparison of the quality of various models . Dutch. Verpleegkunde. Aug 1993;8(2):80.	Foreign language article language
With little to go on but much to gain, small IPA starts asthma DM program. Healthc Demand Dis Manag. Jun 1998;4(6):94-95.	Not an evaluation of a QI intervention
Witt K, Knudsen E, Ditlevsen S, Hollnagel H. Academic detailing has no effect on prescribing of asthma medication in Danish general practice: a 3-year randomized controlled trial with 12-monthly follow-ups. Family Practice. 2004;21(3):248.	Reported data not usable
Worth H, Dhein Y, Woehl A, Schacher C, Volmer T. Economic benefits of an outpatient education programme (AFAS) for adult asthmatics. Eur Respir J. 2001;18(Suppl 33):188s.	Abstract
Worth H. Patient education in asthmatic adults. Lung. 1990;168 Suppl:463-468.	Ineligible study design
Wraight JM, Cowan JO, Flannery EM, Town GI, Taylor DR. Adherence to asthma self-monitoring or self-management plans with inhaled corticosteroid and oral prednisone: A descriptive analysis. Respirology. Jun 2002;7(2):133-139.	Ineligible study design
Written action plans compared to medical management alone. J Allergy Clin Immunol. Nov 2002;110(5 Suppl):S183-191.	Ineligible study design

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Yang M, Chiang C, Yao G, Wang K. Effect of medical education on quality of life in adult asthma patients. J Formos Med Assoc. 2003;102(11):768-774.	No eligible outcomes
Yawn BP, Algatt-Bergstrom PJ, Yawn RA, et al. An in-school CD-ROM asthma education program. J Sch Health. Apr 2000;70(4):153-159.	No eligible outcomes
Yawn BP, Wollan P, Scanlon PD, Kurland M. Outcome results of a school-based screening program for undertreated asthma. Ann Allergy Asthma Immunol. May 2003;90(5):508-515.	Not an evaluation of a QI intervention
Yoon R, McKenzie D, Bauman A. Randomised controlled trial evaluation of an asthma education program. Hosp Pharm. 1989;19(1):51.	Abstract
Yoon R, McKenzie DK, Miles DA, Bauman A. Characteristics of attenders and non-attenders at an asthma education programme. Thorax. Dec 1991;46(12):886-890.	No eligible outcomes
Yoos HL, McMullen A, Bezek S, et al. An asthma management program for urban minority children. J Pediatr Health Care. Mar-Apr 1997;11(2):66-74.	Ineligible study design
Young NL, Foster AM, Parkin PC, et al. Assessing the efficacy of a school-based asthma education program for children: a pilot study. Can J Public Health. Jan-Feb 2001;92(1):30-34.	No eligible outcomes
Zieve FJ, Ciesco E. Computer-focused modification of physician prescribing behavior. Proc Annu Symp Comput Appl Med Care. 1992:617.	Excluded topic
Zimbro KMS. Explanatory power of the behavior model of utilization for pediatric asthma health care in an urban managed care setting. Old Dominion University. Ph.D. 2000(267 p).	Thesis/Dissertation

Appendix D: Technical Expert Panel and Peer Reviewers

Technical Expert Panel

Martin Eccles, M.D., Centre for Health Services Research, University of Newcastle upon Tyne, EPOC
Russell Glasgow, Ph.D., Kaiser Permanente, Colorado
Jeremy Grimshaw, M.B.Ch.B., Ph.D., University of Ottawa, Cochrane Collaboration Effective Practice and Organisation of Care Group (EPOC)
Charles Homer, M.D., M.P.H., National Institute for Children's Health Care Quality
Harmon Jordan, Sc.D., previously with New England Medical Center Evidence-based Practice Center, currently at Abt Associates
Val Lawrence, M.D., M.Sc., The University of Texas Health Science Center at San Antonio and South Texas Veterans Health Care System
Andrew Oxman, M.D., M.Sc., Department of Health Services Research, Norwegian Directorate for Health and Social Welfare, EPOC
Sandra Wilson, Ph.D., Department of Health Services Research, Palo Alto Medical Foundation
James Zazzali, Ph.D., RAND

Peer Reviewers

David Atkins, M.D., M.P.H., Chief Medical Officer, Agency for Healthcare Research and Quality, Center for Outcomes and Evidence
William Bailey, M.D., The Kirklin Clinic
Homer Boushey, M.D., Past President ATS, Professor, Department of Medicine, Division of Pulmonary and Critical Care Medicine, University of California San Francisco
Noreen Clark, Ph.D., Professor and Dean, University of Michigan School of Public Health
Peter Cvietusa, M.D., Kaiser Permanente
Rob Fulwood, Ph.D., M.S.P.H., Senior Manager Public Health Program Development, NHLBI/OPEC
Kevin Weiss, M.D., M.P.H., F.A.C.P., Midwest Center for Health Services and Policy Research, Hines VA Hospital, The Center for Health Care Studies, Northwestern University Feinberg School of Medicine, Chicago
Barbara Yawn, M.D., M.Sc., American Academy of Family Physicians