*Draft Comparative Effectiveness Review*

**Number XX**

# Interventions to Modify Health Care Provider Adherence to Asthma Guidelines

**Prepared for:**
Agency for Healthcare Research and Quality
U.S. Department of Health and Human Services
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**Contract No. xxx-xx-xxxx**

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**AHRQ Publication No. xx-EHCxxx**
**<Month Year>**

## Statement of Funding and Purpose

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The information in this report is intended to help health care decisionmakers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of health care services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information, i.e., in the context of available resources and circumstances presented by individual patients.

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### Financial Disclosure Statement
None of the investigators has any affiliations or financial involvement that conflicts with the material presented in this report.

**Suggested citation:** <Authors>. Interventions to Modify Adherence to Asthma Guidelines. Evidence Report/Technology Assessment. No. <#>. (Prepared by .) Rockville, MD: Agency for Healthcare Research and Quality. <Month, Year>. http://www.ahrq.gov/clinic/epcix.htm. Accessed: <Date>. <URL>.

# Preface

The Agency for Healthcare Research and Quality (AHRQ) conducts the Effective Health Care Program as part of its mission to organize knowledge and make it available to inform decisions about health care. As part of the Medicare Prescription Drug, Improvement, and Modernization Act of 2003, Congress directed AHRQ to conduct and support research on the comparative outcomes, clinical effectiveness, and appropriateness of pharmaceuticals, devices, and health care services to meet the needs of Medicare, Medicaid, and the Children's Health Insurance Program (CHIP).

AHRQ has an established network of Evidence-based Practice Centers (EPCs) that produce Evidence Reports/Technology Assessments to assist public- and private-sector organizations in their efforts to improve the quality of health care. The EPCs now lend their expertise to the Effective Health Care Program by conducting comparative effectiveness reviews (CERs) of medications, devices, and other relevant interventions, including strategies for how these items and services can best be organized, managed, and delivered.

Systematic reviews are the building blocks underlying evidence-based practice; they focus attention on the strength and limits of evidence from research studies about the effectiveness and safety of a clinical intervention. In the context of developing recommendations for practice, systematic reviews are useful because they define the strengths and limits of the evidence, clarifying whether assertions about the value of the intervention are based on strong evidence from clinical studies. For more information about systematic reviews, see http://www.effectivehealth care.ahrq.gov/reference/purpose.cfm

AHRQ expects that CERs will be helpful to health plans, providers, purchasers, government programs, and the health care system as a whole. In addition, AHRQ is committed to presenting information in different formats so that consumers who make decisions about their own and their family's health can benefit from the evidence.

Transparency and stakeholder input from are essential to the Effective Health Care Program. Please visit the Web site (http://www.effectivehealthcare.ahrq.gov) to see draft research questions and reports or to join an e-mail list to learn about new program products and opportunities for input. Comparative Effectiveness Reviews will be updated regularly.

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

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## Acknowledgments

The authors gratefully acknowledge the continuing support of our AHRQ Task Order Officer, Christine Chang, M.D., M.P.H. We extend our appreciation to our Key Informants and members of our Technical Expert Panel (listed below), all of whom provided thoughtful advice and input during our research process.

The investigators deeply appreciate the considerable support, commitment, and contributions of the EPC team staff at <NAME>. We express our gratitude to the following individuals for their contributions to this project: <NAME, degrees>

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# Structured Abstract

**Objective**: To synthesize the published literature on the effect of interventions designed to improve health care providers' adherence to asthma guidelines on: 1) health care process outcomes (Key Question 1); 2) clinical outcomes (Key Question 2); 3) health care processes that subsequently impact clinical outcomes (Key Question 3).

**Data Sources**: Reports of studies from MEDLINE®, EMBASE®, Cochrane Central Register of Controlled Trials (CENTRAL), Cumulative Index to Nursing and Allied Health Literature (CINAHL®), Educational Resources Information Center (ERIC), PsycInfo, and Research and Development Resource Base in Continuing Medical Education (RDRB/CME), up to January, 2012.

**Review Methods**: Paired investigators independently reviewed each title, abstract, and full-text article to assess eligibility. Only comparative studies were eligible. Investigators abstracted data sequentially and independently graded the evidence.

**Results**: 72 articles were eligible for review. A slight majority of studies were conducted in the U.S. (n=38). We classified studies as assessing eight types of interventions: Decision Support, Organizational Change, Feedback and Audit, Clinical Pharmacy Support, Education Only, Quality Improvement/Pay-for-Performance, Multi-component and Information Only. Half of the studies were randomized trials (n=37), 25 were pre-post, and the remaining 11 were a variety of non-randomized study designs. The studies took place exclusively in primary care settings. The most frequently cited health care process outcome was prescription of asthma controller medication (n=42), followed by provision of an asthma action plan (n=18), prescription of a peak flow meter (n=17), and self-management education (n=12). Common clinical outcomes included emergency department visits (n=29) and hospitalizations (n=26), followed by use of short-acting β2 agonists (n=8), missed school days (n=7), lung function tests (n=6), symptom days (n=6), quality of life (n=5) and urgent doctor visits (n=5).
We identified 4 critical outcomes for which 70 studies provided information. There was moderate evidence for increased prescriptions of asthma controller medications and provision of self-management education/asthma action plans as a result of decision support (2-34%; 14-84%, respectively), feedback/audit (5-50%; 4-46%, respectively) and clinical pharmacy support interventions (6-20%; 40-57%, respectively). There was moderate evidence for education only interventions increasing health care provider prescriptions of asthma controller medicines (3.5 – 50%). We identified an insufficient or low strength of evidence for the other interventions on these health care processes outcomes. Moderate evidence supported the use of decision support interventions to reduce emergency department visits/hospitalizations (5– 60% reductions).The evidence for the remainder of interventions was insufficient or low in strength. There was insufficient/low strength of evidence to evaluate the effect of any intervention on the number of missed days of work or school due to asthma.

**Conclusions**: There is low to moderate evidence to support the use of decision support tools, feedback and audit, and clinical pharmacy support to improve the adherence of health care providers to asthma guidelines, as measured through health care process outcomes, and to

improve clinical outcomes. There is a need to further evaluate health care provider-targeted interventions with a focus on standardized measures of outcomes and more rigorous study designs.

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# Executive Summary

## Background

Asthma is a respiratory disease characterized by variable and recurring symptoms, airflow obstruction, bronchial hyper-responsiveness, and inflammation of the airways. In the U.S., an estimated 24.6 million people (8.2%) currently have asthma.[1] Students with asthma miss more than 14 million school days every year due to illness. In 2005, there were approximately 679,000 emergency room visits in the U.S. due to asthma in children under 15 years of age.[2] Currently, asthma is the third leading cause of hospitalization among children in this age group.[2] Furthermore, certain U.S. population subgroups have higher prevalence rates of asthma in comparison to the national average: children (9.6%), poor children (13.5%), non-Hispanic African American children (17.0%), women (9.7%), and poor adults (10.6%).[1]

A number of asthma guidelines have been published internationally (e.g., the National Asthma Education and Prevention Program *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma* is also known as EPR-3,[3] a guideline based on a systematic review of published evidence and expert opinion). Following asthma guideline treatment recommendations improves clinical outcomes in a variety of pediatric populations, including high-risk populations, such as inner-city, poor, and/or African American populations.[4-6] The available evidence suggests that most people with asthma can be symptom-free if they receive appropriate medical care, use inhaled corticosteroids when prescribed, and modify their environment to reduce or eliminate exposure to allergens and irritants.

Despite the evidence of improved outcomes associated with adherence to guidelines, their long term existence (>20 years) and wide-spread availability, health care providers do not routinely follow asthma guideline recommendations.[7 8] In one study, only 34.2 percent of patients reported receiving a written asthma action plan, while only 68.1 percent had been taught the appropriate response to symptoms of an asthma attack.[8] In the same study, only about one-third of children or adults were using long-term asthma controller medicine such as inhaled corticosteroids. Health care providers do not appropriately assess asthma control in most children,[9-12] resulting in substandard care. Minority children are up to half as likely as Caucasian children to receive inhaled steroids. [13] The significance of these studies is that suboptimal outcomes persist, such as 2-fold higher rates of emergency room visits for African American children compared to their Caucasian counterparts.[14]

With the lack of adherence to guideline recommendations, attention has been focused on why best practices are not followed (i.e., adhered to) by health care providers. In 1999, Cabana et al.[15] proposed a theoretical framework to understand why physicians do not adhere to guidelines, citing lack of awareness, disagreement with the guidelines recommendations, doubts about the effectiveness of the guidelines recommendations, lack of confidence in being able to carry out the best practice, inability to overcome the inertia of previous practice behaviors, and external barriers (e.g., time constraints during a visit, lack of user-friendly guidelines, patient preferences). There is a growing understanding that one of the shortcomings of asthma guidelines is the limited extent to which health care providers are provided with the tools and resources necessary to follow the recommended care.[16] There is a lack of interventions developed specifically to address the barriers outlined by Cabana et al. Awareness of asthma guidelines may have improved over time,[17 18] but certain barriers outlined by Cabana et al. would likely not be overcome as a result of increased exposure to asthma guidelines (e.g., the inability of health care providers to overcome practice inertia and external barriers).[19] Therefore,

learning what strategies are available to overcome these barriers and improve adherence to asthma guidelines would be beneficial.

Most interventions targeting improvement of asthma care and outcomes have been patient-focused,[20-23] but there have also been provider-targeted interventions to improve adherence to guidelines (e.g., educational seminars, prompts, etc.).[24-29] However, there is no consensus on what are the most effective provider-targeted interventions that improve adherence to guidelines.

## Scope and Key Questions

The objective of our systematic review was to assess whether interventions targeting health care providers improve adherence to asthma guideline recommendations for asthma care and if these interventions subsequently improve clinical outcomes for patients. We also sought to determine whether any observed changes in asthma care processes directly improve clinical outcomes. Our specific Key Questions (KQs) are listed below and are displayed graphically in Figure A.

> KQ 1: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact health care process outcomes (e.g., receiving appropriate treatment)?
>
> KQ 2: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact clinical outcomes (e.g., hospitalizations, patient reported outcomes such as symptom control)?
>
> KQ 3: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact health care process outcomes that then affect clinical outcomes?

**Figure A. Analytic framework for Guidelines on the Care of Adults and Children with Asthma**

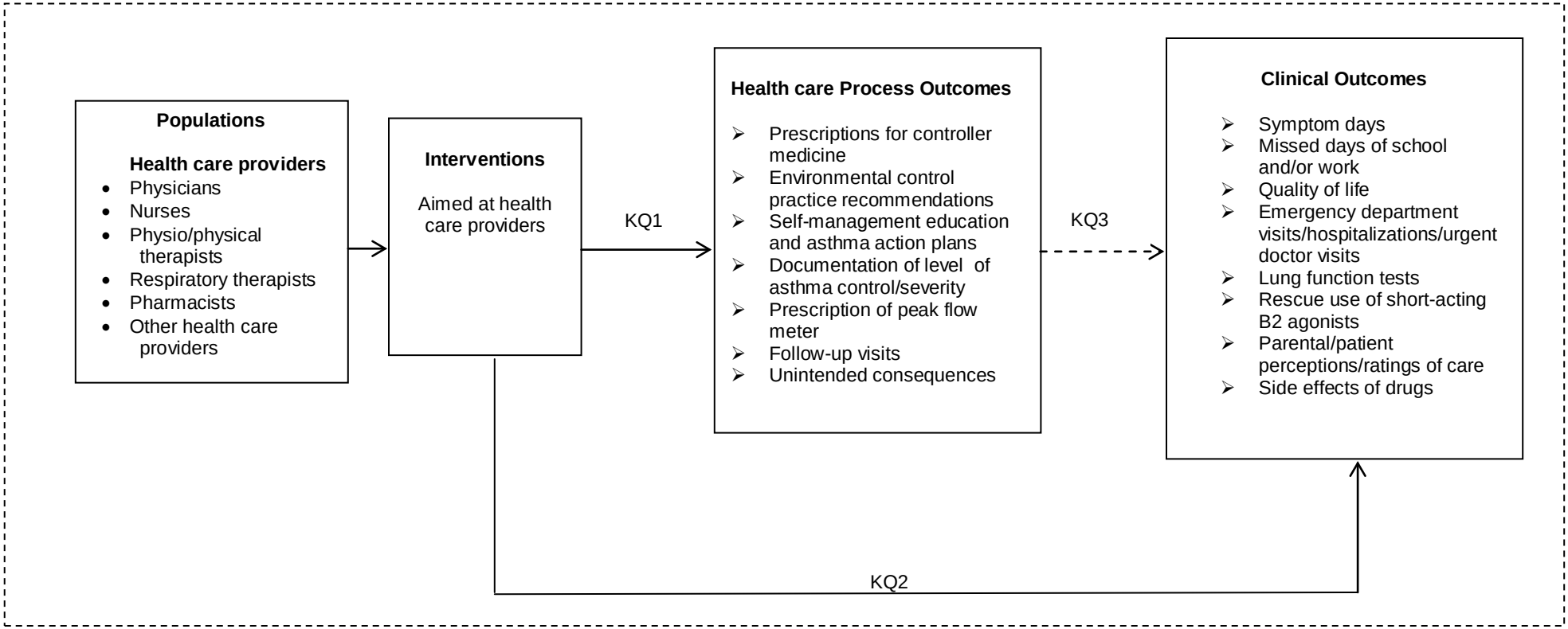


Figure A shows our analytic framework presenting the Key Questions (KQ) in terms of: 1) the populations (physicians, nurses, physio/physical therapists, respiratory therapists, pharmacists, and other healthcare providers); 2) the interventions aimed at our given populations; 3) the healthcare process outcomes (prescriptions for controller medicine, environmental control practice recommendations, self-management education and asthma action plans, documentation of level of asthma control/severity, prescription of peak flow meter, follow-up visits, and unintended consequences); 4)clinical outcomes (symptom days, missed days of school and/or work, quality of life, emergency department visits/hospitalizations/urgent doctor visits, lung function tests, rescue use of short-acting β2 agonists, parental/patient perceptions/ratings of care, side effects of drugs

# Methods

## Literature Search Strategy

We searched the following databases for primary studies: MEDLINE®, EMBASE®, and the Cochrane Central Register of Controlled Trials, Cumulative Index to Nursing and Allied Health Literature (CINAHL®), Educational Resources Information Center (ERIC), PsycInfo, and Research and Development Resource Base in Continuing Medical Education (RDRB/CME) through January 2012. We developed a search strategy for MEDLINE®, accessed via PubMed, based on an analysis of the medical subject headings (MeSH), terms, and text words of eligible articles identified *a priori* (Appendix B). This strategy was translated for use in the other electronic sources. No limits were imposed based on language or date of publication. Searches were conducted in January 2012. Updated searches will be conducted during peer review of the draft report. We also completed backward citation searching using Scopus for each included article.

## Study Selection

Title and abstracts were screened independently by two trained investigators, and were excluded if both investigators agreed that the article met one or more of the exclusion criteria (see inclusion and exclusion criteria listed in Table A and the Abstract Review Form in Appendix C). Differences between investigators regarding abstract eligibility were resolved through consensus.

Citations promoted on the basis of title and abstract screen underwent another independent paired-reviewer screen using the full-text article (Appendix C, Article Review Form). Differences regarding article inclusion were resolved through consensus.

We included randomized and non-randomized studies with a comparison (e.g., participants serving as own controls or a separate comparison group) that addressed interventions such as education, reminders, decision support, clinical pharmacy service, organization changes, etc. to improve the adherence to guidelines in health care providers. We excluded studies that were conducted in the inpatient or emergency department setting only.

## Data Abstraction and Data Management

We used DistillerSR (Evidence Partners, 2010) to manage the screening process. DistillerSR is a Web-based database management program that manages all levels of the review process. We uploaded to the system all citations identified by our search.

We created standardized forms for data extraction. (Appendix C) We pilot tested the forms prior to the beginning the process of data extraction. We used Access (Microsoft, Redmond, WA) for the data abstraction process. Reviewers extracted information on general study characteristics, study participants, eligibility criteria, interventions, and the outcomes. One reviewer completed data abstraction and the second reviewer confirmed the first reviewer's data abstraction for completeness and accuracy. Reviewers completed risk of bias assessment independently. Reviewer pairs included personnel with both clinical and methodological expertise. We resolved differences between investigators regarding data through consensus.

**Table A. Study inclusion and exclusion criteria**

| | Inclusion | Exclusion |
|---|---|---|
| **Populations** | Participants: human subjects.<br>Health care providers: physicians, nurses, physiotherapists/physical therapists, respiratory therapists, pharmacists, and other health care providers treating children or adults with asthma | • Animal models/simulations. |
| **Intervention** | Interventions to improve adherence to guidelines including decision support (health information technology and paper-based), organizational change, feedback and audit, clinical pharmacy support, education only, quality improvement/pay-for-performance, multi-component, information only. | Studies that do not:<br>• Assess an intervention<br>• Address adherence to asthma guidelines<br>• Target health care providers<br>• |
| **Comparisons of interest** | Usual care, as defined in each eligible study, and comparisons between interventions | Studies lacking a comparison |
| **Outcomes** | **Health care process outcomes:**<br>➢ Prescriptions for controller medicine<br>➢ Environmental control practice recommendations<br>➢ Self-management education and asthma action plans<br>➢ Documentation of level of asthma control/severity<br>➢ Prescription of peak flow meter<br>➢ Follow-up visits<br>➢ Unintended consequences<br>**Clinical outcomes:**<br>➢ Symptom days<br>➢ Missed days of school and/or work<br>➢ Quality of life<br>➢ Emergency department visits/hospitalizations/urgent doctor visits<br>➢ Lung function tests<br>➢ Rescue use of short-acting B2 agonists<br>➢ Parental/patient perceptions/ratings of care<br>➢ Side effects of drugs<br>The outcomes were non-directional; that is, all outcomes were considered whether they were beneficial or caused potential harms or unintended consequences | Studies that do not report an outcome of interest (e.g., studies reporting acceptability of intervention only). |
| **Type of Study** | Randomized and quasi-randomized controlled trials and cross-over studies.<br>Non-randomized studies with comparison groups including non-randomized controlled trial or cross-over studies, controlled pre-post studies, historically controlled studies, cohort studies, case-control studies, and cross-sectional studies.<br>Non-randomized studies without a separate comparison group, including interrupted-time-series, non-controlled and pre-post studies. | We excluded meeting abstracts and studies with no original data (e.g., reviews, editorials, comments, and letters) or non-comparative studies. |
| **Timing and Setting** | Studies of any duration follow-up that occurred in an outpatient setting employing healthcare providers were eligible for inclusion. | We excluded studies exclusively addressing inpatient or emergency department settings or guidelines. |

## Risk of Bias Assessment

We used the Cochrane Collaboration's tool for assessing the risk of bias of controlled studies. Two reviewers independently assessed the included studies according to the guidelines in Chapter 8 of the Cochrane Handbook for Systematic Reviews of Interventions[30] using the following criteria: sequence generation and allocation concealment (selection bias), blinding of health care providers, investigators, and outcome assessors (detection bias), incomplete outcome data (attrition bias), selective outcome reporting (reporting bias), and other sources of bias. We report judgments for each criterion as "Low risk of bias," "High risk of bias" or "Unclear risk of bias (information is insufficient to assess)."

For pre-post studies, we added the two relevant criteria from the Cochrane Effective Practice and Organization of Care (EPOC) data collections checklists.[31]

## Data Synthesis

For each KQ, we created a detailed set of evidence tables containing all information abstracted from eligible studies. We grouped the information for each KQ by intervention(s) being assessed:

1) Decision support interventions are health information technology- and/or paper-based-interventions designed to support/facilitate healthcare provider treatment decision-making (e.g., classify asthma severity);
2) Organizational change interventions are designed to change the way in which an organization provides asthma care (e.g., having an asthma "champion");
3) Feedback and audit interventions are based upon providing performance data to health care providers about their quality of asthma care;
4) Clinical pharmacy service support: interventions targeting pharmacists' delivery of asthma care;
5) Education only interventions are focused on educating health care providers about the content of asthma clinical practice guidelines;
6) Quality improvement/pay-for-performance interventions are focused on quality improvement initiatives or pay-for-performance as the primary intervention;
7) Multi-component interventions use more than one type of intervention.
8) Information only interventions are designed only to provide information to health care providers about asthma guideline recommendations (e.g., provide a pocket guide to asthma guidelines)

Based on feedback from key informants and public comment, a variety of health care process and clinical outcomes were selected to evaluate the effectiveness of interventions.

The health care process outcomes included:

- Prescriptions for controller medicine
- Environmental control practice recommendations
- Self-management education and asthma action plans
- Documentation of level of asthma control/severity
- Prescription of peak flow meter
- Follow-up visits
- Unintended consequences

The clinical outcomes, assessed in patients, included:

- Symptom days
- Missed days of school and/or work
- Quality of life
- Emergency department (ED) visits/hospitalizations/urgent doctor visits
- Lung function tests
- Rescue use of short-acting $\beta_2$ agonists
- Parental/patient perceptions/ratings of care
- Side effects of drugs

We conducted narrative synthesis of the evidence for critical outcomes. We identified these outcomes as critical to making a decision.[32] These outcomes were prescription of asthma controller medicines, provision of asthma action plan/self-management education, ED visits/hospitalizations, and missed days of school or work. The critical outcomes were identified as the most commonly used in practice; those relied upon by clinicians to guide decision-making; and those endorsed by the NIH Workshop on Asthma Outcomes.[33] Data abstracted for all outcomes can be found in Appendix E.

## Strength of the Body of Evidence

Two reviewers graded the strength of evidence for each outcome for each of the key questions using the grading scheme recommended by the Methods Guide for Conducting Comparative Effectiveness Reviews.[34] In assigning evidence grades we considered four domains: risk of bias of included studies, directness, consistency and precision. We classified evidence into four basic categories: 1) "high" grade (indicating high confidence that the evidence reflects the true effect, and further research is very unlikely to change our confidence in the estimate of the effect); 2) "moderate" grade (indicating moderate confidence that the evidence reflects the true effect, and further research may change our confidence in the estimate of the effect and may change the estimate); 3) "low" grade (indicating low confidence that the evidence reflects the true effect, and further research is likely to change our confidence in the estimate of the effect and is likely to change the estimate); and 4) "insufficient" grade (evidence is unavailable or does not permit a conclusion). Our judgments were first based on the ability to make a conclusion (if not able to make a conclusion, then "insufficient" was assigned) and then on the confidence in the conclusion (classified as low, moderate or high with increasing certainty). The author of the section first graded the evidence and this was reviewed by the principal investigator. Any disagreements were discussed with the full team.

## Applicability

Applicability was assessed separately for the different outcomes of benefit and harm for the entire body of evidence guided by the PICOS framework as recommended in the Methods Guide for Comparative Effectiveness Reviews of Interventions.[34]We considered factors that may limit applicability of the findings (e.g., a study conducted in a non-U.S. health care setting, providers not common to the U.S. health care system).

# Results

## Results of Literature Searches

We identified 4166 unique citations. We excluded 3846 citations during the abstract screening. During full-text article screening, we excluded an additional 244 articles that did not meet one or more of the inclusion criteria. Seventy-two articles were eligible for inclusion and 70 addressed one of the four critical outcomes (prescription of asthma controller medicines, provision of asthma action plan/self-management education, ED visits/hospitalizations, and missed days of school or work) and are thus included in the narrative of the report.

# Organization of Results

The results are organized according to each KQ, the four critical outcomes and each type of intervention. For each KQ, a description and summary of the key findings from each type of intervention are presented, along with a table summarizing the strength of evidence.

## Results by Key Questions

### KQ 1: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact health care process outcomes (prescription of controller medications; providing asthma education/asthma action plans)?

### Outcome: Prescription of controller medicines

#### Decision Support

Fifteen studies of decision support interventions evaluated the effects on prescription of asthma controller medications: six RCTs [35-40] and nine with pre-post designs.[41-49] The types of decision support interventions varied, including the provision of asthma guidelines in a more accessible format (e.g., "pocket" versions),[38 45 47] use of a specific algorithm, pathway or flow sheet,[38 46-48] a structured template for taking a history,[41 42]or a reminder system to raise awareness of the health care provider about the patient's asthma status. [36 37 43] The decision support interventions were often combined with other strategies, including education, [35 38-40 43 48 50 51] reminders,[36 40-42 45] feedback,[37 45] and/or organizational change.[44] Computer-based interventions served to guide the health care provider through a guideline-consistent assessment and/or treatment approach.[36 39 40 43 45 49 52]

Ten studies reported that a decision support intervention increased the prescription of asthma controller medicines by health care providers, [35 37 40-43 45 46 48 49] while five studies found no significant effect.[36 38 39 44 47] Most of the studies reporting increased prescribing of asthma controller medicines used a pre-post study design, while 3 of the 5 RCTs observed no benefit from decision support interventions.[36 38 39] The increase in prescribing of asthma controller medicines ranged from 2 percent to 34 percent in the pre-post design studies and ranged from 2 percent to17 percent in RCTs. The absolute difference in effect observed between control and interventions arms of the RCT studies was generally less than 10 percent. In summary, moderate

evidence supports the use of decision support interventions in increasing the prescription of asthma controller medications.

## Organizational Change

Two studies[53 54] examined the impact of organizational change on the prescribing of asthma controller medications by health care providers. One study was an RCT,[53] while the other used a pre-post study design.[54] Both studies focused the intervention on pediatric health care providers. Both studies utilized additional personnel to facilitate organizational change, as well as education for the participating health care providers. One study used an asthma nurse educator, [53] while the pre-post study. used a community health worker.[54] The RCT found that neither the peer-led education arm nor the planned care intervention (utilizing an asthma nurse educator) arms resulted in a significantly higher proportion of prescriptions for inhaled steroids or asthma controller medications compared to the control arm of the study.[53] Notably, prescribing increased in all arms of the study, including the control arm, ranging from 4 to16 percent for all asthma controller medicines and 4 to 19 percent for inhaled corticosteroids (no p-value reported). The pre-post study observed a 12 percent increase in prescriptions for inhaled steroids among all asthma patients (no p-value reported). [54] Low strength of evidence supports the effectiveness of organizational change in increasing the prescribing of asthma controller medicines.

## Feedback and Audit

We identified six RCTs[55-60] and six pre-post studies [61-66] evaluating the effect of feedback and audit interventions on the prescription of controller medications. Most feedback and audit interventions were part of a multifaceted intervention combined with provider education,[55 58 60-64 66] prioritized review criteria for audit,[57] benchmarking or comparison with peers or other practices [57 59] or pharmacy monitoring of fill data and feedback[65].

Of the six RCTs,[55-60] four demonstrated positive effects from the intervention.[55 57 58 60] Increased prescribing of asthma controller medicines was reported for audit and feedback interventions using targeted key guideline messages about the inflammatory nature of asthma (such as, "use inhaled corticosteroids promptly") (5% to 12% increase from baseline, p=0.05),[55] prioritized guideline review criteria on single card,[57] medical record prompts for annual review of asthma management with guideline prompts,[58] and individualized feedback on prescribing and decision strategies.[60] The two RCTs reporting no effect on prescribing of asthma controller medications involved feedback of prescribing data [56] and a trial of performance feedback.[59] Of the studies using a pre-post design, three studies reported an increase in prescribing of controller medicines.[62 64 65] The increase reported in these studies ranged from 40 to 50 percent.[62 65] In summary, moderate evidence supports the use of feedback/audit to increase the prescribing of controller medicines.

## Clinical Pharmacy Support

Three studies—one RCT[67] and two prospective cohort studies[68 69]—evaluated the effect of clinical pharmacy support on the prescription of asthma controller medications. In the RCT, pharmacists trained in risk assessment, medication adherence and spirometry reported increase in the dispense of asthma controller medicines (Odds Ratio 3.80, (95% Confidence Interval(CI): 1.40, 10.32; p=0.01).[67] In the two cohort studies, increases in controller medication prescribing of 20 percent [69]and 6 percent[68]were observed (p<0.05 for both studies). The former study used a specialized asthma service by community pharmacies including seeing patients by appointment,

assessing and intervening on patient medication needs and goal-setting with the patient.[69] In the latter study, pharmacists were encouraged to hold meetings with local general practitioners to discuss guidelines for the care of children with asthma.[68] In summary, there is moderate evidence to support the effectiveness of clinical pharmacy support interventions to increase the prescribing of asthma controller medications by health care providers.

## Education (alone)

Ten studies reported on the effect of educational interventions on prescription of asthma controller medication. Six were RCTs [70-75] and four were pre-post designs.[76-79] Most of the studies targeted primary care physicians (GPs, FPs, pediatricians) or nurses. One study recruited pharmacists.[74] The education interventions were varied and included small group asthma education programs, [71] structured training,[79], seminars (including interactive) [73], and grand rounds. [79] Besides aiming to deliver specific asthma content, certain interventions also emphasized more general skills, such as training in communication.[70 73] The findings from all studies were consistently in the positive direction, reporting increases in prescribing of controller medicines by 3.5 percent to 50.3 percent, though statistically significant differences were reported only in 3 of the studies. In summary, moderate evidence does not favor the effectiveness of education as a strategy to increase the prescription of controller medications by health care providers.

## Quality Improvement and Pay-for-Performance

No studies examined the effect of quality improvement strategies on prescription of asthma controller medications. Therefore, there is insufficient evidence to evaluate the effect of quality improvement/pay-for-performance on the prescription of controller medications by health care providers.

## Multi-component

Four studies evaluated the impact of multi-component interventions on prescribing of asthma controller medicines. [80-83] All interventions included a copy of the guidelines and an educational component; additional interventions included from the provision of materials for provider use, onsite staff to aide in reorganization of practice flow; and feedback to individual providers based on chart reviews. Three studies [81-83] were cluster-randomized studies (randomizing primary care practices); and one [80] was a pre-post study. Only the pre-post study[80] and one of the three randomized studies [81] found an impact of the intervention on rates of inhaled corticosteroid prescriptions. Two of the three studies which did not report between group differences in steroid prescribing rates [82 83] did observe secular trends of increased steroid prescribing rates among both intervention and control groups over time. In summary, because of conflicting results among a few studies, there is insufficient evidence to evaluate the effect of multi-component interventions on prescribing of controller medications for asthma.

## Information Only

Two studies [84 85] examined the effect of the provision of information to health care providers (without an accompanying educational intervention) on rates of controller medication prescribing. One study, an RCT in which information on asthma management and treatment guidelines was inserted in patient medical records for provider use, [85] reported no benefit. The second study [84] included providers randomly selected to participate in developing local asthma

guidelines which were then mailed to providers in both intervention and comparison groups. This study reported a negative effect on controller medication prescribing, with providers in the intervention group writing 8 fewer prescriptions per 1000 patients than those in the comparison group ($p<0.01$). This is the only unintended consequence that we identified. In summary, because of conflicting results between two studies, there is insufficient evidence to evaluate the effect of information alone on rates of controller medication prescribing in asthma.

## Outcome: Self- management education and asthma action plans

### Decision Support

Ten studies evaluated the impact of decision support interventions on the provision of patient education/asthma action plans.[39 40 44 45 47 50 86-89] Four of the studies were RCTs, [39 40 87 89] while the remainder employed a pre-post study design. [44 45 47 50 86 88] The interventions included computerized support, [39 40 44 45 89] a flow sheet/algorithm,[86 88] and/or the provision of guidelines.[47]These studies all focused on primary care settings and involved general practitioners,[39] pediatricians, [50 87] or family practitioners. [88]

Seven of these studies reported a positive effect of decision support on the provision of patient education/asthma action plans.[44 45 47 50 86-88] The increase in self-management education/use of asthma action plans ranged from 14 percent to 84 percent (all reported as statistically significant). Of the four RCTs, only one showed a positive impact from decision support intervention.[87] In summary, moderate evidence supports the use of decision support interventions to increase the provision of asthma education/asthma action plans by health care providers.

### Organizational Change

Two studies examined how organizational change influenced the provision of patient self-management education and/or asthma action plans, one using an RCT design [90]and the other a pre-post design.[91] In the pre-post study, the investigators [91] instituted a registry to track asthma patients and an asthma case manager, while in the RCT [90] the investigators restructured the clinical protocol for how asthma patients are cared for during ambulatory care encounters ("3+ visit plan"). Both studies reported a positive effect from organizational change. Investigators in the pre-post study observed a 10 percent increase in documentation of patient education ($p<0.001$) and a 14 percent increase in documentation of home asthma action plan dispensations ($p<0.001$), while in the RCT, there was a 10 percent increase in asthma education ($p=0.01$). In summary, low strength of evidence supports the use of organizational change as a method to increase the provision of self-management education/asthma action plan by health care providers.

### Feedback and Audit

Six studies—three RCTs [57-59] and three pre-post studies [62 63 66]—evaluated the effect of feedback and audit interventions on the provision of self-management education and asthma action plans by health care providers. Statistically significant increases in provision of self-management education/asthma action plans ranging from 4 to 46 percent were reported in five of the six studies.[58 59 62 63 66] In summary, the low strength of evidence supports the use of feedback and audit interventions to increase the provision of self-management education/asthma action plans by health care providers.

## Clinical Pharmacy Support

We identified one RCT [67] and one prospective cohort study [69] evaluating the effect of clinical pharmacy support on self-management education/asthma action plan use by health care providers. Patients receiving care by pharmacists enrolled in Pharmacy Asthma Care Program had increased asthma action plan possession (mean change from baseline: 40.4 percent ((95% CI: 31.9, 48.9), p=0.001), however there is no comparison data for the control group. [67] Asthma action plan ownership was also significantly increased 6 months after implementing a community pharmacy based intervention that provided specialized asthma service (increase in asthma action plan ownership: INT: 45%,: p<0.001).[69] In summary, based on two studies with consistent results, a moderate level of evidence supports the use of clinical pharmacy interventions to increase self-management education/asthma action plan use by health care providers.

## Education (alone)

There were five RCTs [70 72 73 92 93] that examined the impact of health care provider education on the provision of a written asthma action plan. Most targeted general practitioners and one focused on pediatricians. The educational strategies included small group asthma education programs, structured training, and interactive seminars. Two studies showed increased use of asthma action plans of 10 percent (p=0.03)[73] and 15 percent (p=0.046). [70] The other three studies [72 92 93] reported no benefit from their educational intervention on the provision of asthma action plans. In summary, low strength of evidence suggests that educational interventions can increase use of asthma action plans by health care providers.

## Quality Improvement and Pay-for-Performance

Three studies examined the effect of quality improvement strategies on receipt of asthma action plans.[94-96] The design of the studies included an RCT[96], a pre-post study,[94] and a controlled, pre-post study.[95] All three studies involved pediatric health care providers, including nurses, nurse practitioners and pediatricians. Two studies assessed participation in a Breakthrough Series collaborative,[95 96] and one study assessed a combination of continuous quality improvement and the addition of a community health worker.[94]

A beneficial effect was reported in two studies,[94 95] showing a 28 to 32 percent increase in the proportion of patients who had received an asthma action plan, while the third study—an RCT—showed no effect.[96] The two studies that demonstrated a beneficial effect enrolled practices that had already joined a quality improvement initiative[95] or were part of a demonstration project.[94]

In summary, there is moderate evidence that quality improvement increases the provision of self-management education/asthma action plans by health care providers.

## Multi-component

Three studies [80 82 97] examined the impact of multimodal interventions on rates at which providers created asthma action plans for their patients. One study [82] was a cluster-randomized trial of primary care practices, while the remaining two studies [80 97] were pre-post studies with no comparison group. Both pre-post studies reported an increase in provision of asthma action plans by health care providers over time: increases of 20 percent [80] and 44 percent. [97] There was no increase in the completion of asthma action plans in the RCT (-0.07%; p>0.05). In summary, because of low study quality and conflicting results, there is insufficient evidence to evaluate the

effect of multimodal interventions on the provision of self-management education/asthma action plans by health care providers.

### Information Only

No studies examined the impact of information provision alone on self-management education or asthma action plans. Therefore, there is insufficient information to assess the effect of information-only strategies on self-management education/asthma action plan use by health care providers.

## KQ2: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact clinical outcomes (ED visits/hospitalizations; missed days of school/work)?

## Outcome: Emergency department visits/hospitalizations

### Decision Support

Ten studies examined the effect of decision support interventions on patient use of emergency department (ED) visits or hospitalizations for asthma.[37 38 44 45 47 51 52 86 89 98] The decision support interventions included computer systems, [44 45 52 89], checklists, [98] supplemental feedback protocols,[37] and structured pathways/algorithms.[38 51] These interventions were combined with educational interventions, organizational changes and/or reminders. Of the 10 studies evaluating the effect of decision support on ED visits/hospitalizations, four were RCTs, [37 38 89 98] while the remainder were pre-post studies.[44 45 47 51 52 86] The populations in these studies were a mix of adult [44 45 47 86 89 98] and pediatric patients. [37 38 51 52 86]

Nine studies reported a reduction in ED visits or hospitalizations [37 38 44 45 47 51 52 86 98] ranging from 5 percent to 60 percent (all statistically significant) among the studies using a pre-post study design. Among the RCTs reporting a difference, the difference between intervention and control arms ranged from 1 percent to 7 percent.[37 38 98] The one study reporting no difference was an RCT. [89]

In summary, there is moderate evidence that decision support interventions targeting health care provider adherence to guidelines reduce ED visits/hospitalizations.

### Organizational Change

Four studies evaluating organizational change measured the impact on patient ED visits and/or hospitalizations.[53 54 90 91] Two of these were RCTs [53 90], while the other two were pre-post studies.[54 91] Three of the studies were focused on pediatric health care providers.[53 54 90] One of the studies restructured asthma care visits, [90] while the remaining three studies utilized supplemental trained personnel as part of the intervention.[53 54 91] Three of the studies also incorporated an educational component provided to health care providers.[53 54 91]

Two studies reported reductions in ED visits and/or hospitalizations. The first study reported 41 percent reduction in ED visits and 54 percent reduction in hospitalizations (p-value <0.001 for both outcomes).[91] The second study reported a 4 percent reduction in hospitalizations (no p-value reported). [54] The two RCTs did not report statistically significant reductions in ED visits/hospitalizations (1%, p>0.05[53] and 7 %, p=0.06[90]) compared to the control arms in the

study. In summary, the strength of evidence is low that organizational change reduces ED visits/hospitalizations for asthma.

## Feedback and Audit

We identified one RCT [59] and one pre-post study [66] that evaluated the effect of health care provider feedback and audit on ED visits and hospitalizations of patients. The interventions were: 1) a traditional quality circle (TQC) intervention, in which providers were given feedback on their individual performance and the aggregate performance of group providers, compared with a benchmark quality circle (BQC) intervention, in which feedback on providers' individual performance was explicitly compared to a performance benchmark [59], and 2) an intervention comparing individual primary care provider's guideline practice patterns with their peers plus providing asthma education to office staff. [66] Clinicians in both studies were primary care practitioners.

Non-statistically significant decreases, in ED visits were reported in both arms of the RCT (12 months after the intervention (TQC: 19.7% to 6.1%; BQC: 17.6% to 10.9%, p=0.064).[59] No change in ED visits was reported in the pre-post study.[66] Neither study reported any change in hospitalizations. In summary, due to conflicting results among a small number of studies, there is insufficient evidence to determine the effect of feedback and audit interventions on ED visits/hospitalizations.

## Clinical Pharmacy Support

We identified one RCT [99] evaluating the effect of clinical pharmacy support on the number of ED visits and hospitalizations in patients with asthma. In this RCT, patients seen by pharmacists provided with patient specific clinical data, training about asthma management, patient educational materials, resource guides, and pragmatic strategies were more likely to have a reduction in ED visits/hospitalizations at 12 months compared to patients seen by pharmacists who received peak flow meter (PFM) teaching only (Odds Ratio 2.16 (95% CI: 1.76-2.63)), but not compared to patients of the usual care control group (Odds Ratio 1.08 (95% CI:0.93-1.25)).[99] In summary, with only one study, there is insufficient evidence to determine the effect of clinical pharmacy support interventions on ED visits/hospitalizations.

## Education (alone)

There were seven studies, 5 RCTs [72-74 93 100] and two pre-post studies,[77 79] that examined the impact of health care provider education on ED visits and/or hospitalizations. The educational interventions included interactive seminars, structured training and medical grand rounds. The effects reported were inconsistent. One of the studies did not find a statistically significant effect for the intervention group overall, but did report statistically significant findings in a subgroup of low income participants (-1.23 visits per year, p=0.001).[72] For hospitalization, one study reported statistically significant reduction in the annual rate,[72] while the other 5 studies showed no reduction on the rates of hospitalization. Overall, due to conflicting results among a number of studies, the low strength of evidence suggests that education-alone interventions do not reduce asthma ED visits and/or hospitalizations.

## Quality Improvement and Pay-for-Performance

An RCT and a pre-post study examined the effect of quality improvement/pay-for-performance interventions on ED visits and/or hospitalizations. [95 96] Both studies evaluated a

Breakthrough Series collaborative quality improvement strategy. These studies focused on pediatric health care providers working in community health center settings. The patients were primarily African American or Hispanic.

Neither study showed a statistically significant reduction in ED visits/hospitalizations, with two to five percent reductions reported. One study reported the percentage of patients requiring either ED visits or hospitalizations[96] and the second the mean number combined acute visits per patient.[95]

In summary, there is low strength of evidence to suggest that quality improvement does not reduce ED visits/hospitalizations.

### Multi-component

No studies examined the impact of a multimodal intervention on rates of ED visits or hospital admissions. Therefore, the strength of evidence is insufficient to determine the effect of multi-component interventions on ED visits and/or hospitalizations.

### Information Only

One RCT study [85] examined the impact of information provision on rates of ED visits and hospitalizations for asthma. This study randomized patients to have information about asthma guidelines inserted in their medical records for provider use; each provider thus managed patients in both intervention and control arms simultaneously. This study found no differences in rates of either ED visits or hospitalizations between study groups. In summary, based on a single study with a high risk of bias, there is insufficient evidence to determine the effect of information-only interventions on ED visits/hospitalizations.

## Outcome: Missed days of work/school

### Decision Support

There were two studies that examined the impact of decision support interventions on missed work or school. One study used an RCT design [37], while the other used a pre-post design. [86] Both studies involved children, although one study [86] also included adult patients. The RCT study [37] reported no significant reduction in missed school (0.05 school days; $p = 0.4$) in their study of mailing patient-specific asthma morbidity information to their health care provider. The pre-post design study [86] reported a 49 percent reduction ($p<0.001$) in school absenteeism and a 51 percent reduction in the odds of missed work (Odds Ratio 0.49 ( 95% CI: 0.34–0.71)) among the patient populations in a study that utilized a combination of an asthma care map, a treatment flow chart, program standards, management flow chart and action plan.

In summary, based on two studies with inconsistent results, there is insufficient evidence to evaluate the effect of decision support interventions on the number of missed days of school or work.

### Organizational Change

One RCT of organizational change based on restructuring the clinical protocol for asthma patient care during ambulatory care encounters ("3+ visit plan"), evaluated the impact on missed school days.[90] In this study, there was a 7 percent difference in missed school days between patients in the intervention versus control arms of the study ($p = 0.3$). In summary, with only a

single study, there is insufficient evidence to evaluate the effect of organizational change intervention on the number of missed days of school or work.

## Feedback and Audit

We identified one pre-post study[66] that evaluated the impact of feedback and audit on days of missed work/school. This study provided asthma education to office staff and observed an 11 percent reduction in school days missed (no significance test reported). In summary, with only one study, there is insufficient evidence to evaluate the effect of feedback and audit interventions on the number of missed days of school or work.

## Clinical Pharmacy Support

We identified no studies evaluating the effect of clinical pharmacy support on the outcome of missed days of work and school. Therefore, there is insufficient evidence to evaluate the effect of clinical pharmacy support interventions on the number of missed days of school or work.

## Education (alone)

There were 3 RCTs that evaluated the effect of health care provider education on missed school days.[70 72 74] The interventions targeted GPs, pediatricians and pharmacists and included structured training, seminars and workshops. In all 3 trials there was consistent evidence of small non-statistically significant reductions in missed school (0.6 days to 4 days).

Two RCTs[70 92] and one pre-post study[77] examined missed work as an outcome. The interventions included workshops, training in how to perform spirometry and one study compared asthma program development to a nurse educator program or continuing education. The effects observed ranged from 10 percent reduction to a 5 percent increase in missed days of work ($p>0.05$).

In summary, the study results were inconsistent and had imprecise estimates of the effect of these education interventions. Therefore there is insufficient evidence to evaluate the effect of education-only strategies on the number of missed days of work/school from asthma.

## Quality Improvement and Pay-for-Performance

One pre-post study examined the effect of Quality Improvement on missed school and/or work. [95] This study evaluated health care provider participation in a Breakthrough Series collaborative quality improvement strategy. This study reported a reduction of 0.2 school days ($p = 0.4$) and zero parental work days missed due to a child's asthma ($p = 0.7$). In summary, with only one study, there is insufficient evidence to determine the effect of quality improvement interventions on school or work absenteeism.

## Multi-component

No studies examined the impact of information provision alone on missed days of work or school, so there is insufficient evidence to determine the effect of multi-component interventions on school or work absenteeism.

## Information Only

No studies examined the impact of information provision alone on missed days of work or school (insufficient strength of evidence).

## KQ 3: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact health care process outcomes that then affect clinical outcomes?

No studies evaluated how interventions designed to change health care provider adherence to asthma guidelines impacts clinical outcomes.

## Discussion

We identified a number of different strategies designed to improve health care provider adherence to asthma guidelines. The studies we reviewed evaluated these strategies either in terms of their impact on health care processes and/or clinical outcomes. We found a large degree of variability in the frequency with which certain interventions were studied and in the frequency with which certain outcomes were evaluated. More specifically, decision support, feedback/audit and education only interventions were the most common and were tested for each of the critical outcomes we evaluated in this report. Conversely, organizational change, clinical pharmacy support, quality improvement/pay-for-performance, information-only and multi-component strategies were less consistently tested for each of the outcomes.

In terms of the outcomes we evaluated, there was much more evaluation of the health care process outcomes than the clinical outcomes. Most common was the evaluation of prescribing of asthma controller medications, which arguably has been a frequently reported problem in the management of asthma in primary care settings. Least common was evaluations of missed days of work/school (we noted three types of interventions in which no data were available to evaluate the impact on missed days of work/school), which has significant implications for patient quality of life.

We identified few RCTs testing these interventions. Most of the interventions were studied using a pre-post design, which more often reported a beneficial effect than the few RCTs we identified. We found that there was insufficient evidence to comment on the effectiveness of many of the interventions on health care process outcomes or clinical outcomes. The inability to draw conclusions due to inadequate evidence was particularly striking for the outcome of missed school or work days, where there was insufficient evidence to evaluate the effect of any of these interventions.

**Table B. Summary of Strength of Evidence for included studies for KQ1**

| Outcomes | Intervention | No. of studies/ no. health care providers | Strength of evidence | Conclusions |
|---|---|---|---|---|
| Prescriptions for controller medications | Decision support | 15/1,635<br>6 RCTs,9 Pre-post | Moderate | Most of the evidence supporting the use of decision support Interventions comes from a number of non-randomized studies consistently showing that decision support interventions can increase health care provider prescriptions for asthma controller medications. |
| | Organizational change | 2/228<br>1RCT, 1 pre-post | Low | Although far fewer studies performed using organizational change (in comparison with Decision Support or Feedback/Audit), the findings consistently showed that organizational change can increase health care provider prescriptions for controller medicines, but the effect on prescriptions by health care providers is smaller. |
| | Feedback and audit | 12/ 1,831<br>6 RCTs, 6 pre-post | Moderate | These studies consistently showed that feedback/audit interventions effectively increase prescriptions for controller medicines by health care providers. In a couple of studies, the increase was quite large (>40%). |
| | Clinical Pharmacy Support | 3/ 91<br>1 RCT, 2 cohort | Moderate | The three studies were consistent in showing that clinical pharmacy support interventions increase asthma controller medication prescribing |
| | Education | 10/ 451<br>6RCTs, 4 pre-post | Moderate | The evidence suggests that interventions based only on education of clinicians do not improve prescription of asthma controller medications. |
| | Quality Improvement and Pay-for-Performance | 0 study | Insufficient | Studies are needed to determine if quality improvement/pay-for-performance interventions are an effective means to increase prescriptions for controller medicines by health care providers. |
| | Multi-component interventions | 4/ 842<br>3 Cluster randomized, 1 pre-post | Insufficient | There is insufficient strength of evidence to determine that effect of multi-component interventions on prescribing of asthma controller medications for asthma. |
| | Information Only | 2/107<br>1 RCT, 1 quasi-experimental | Insufficient | Inconsistent and limited studies have resulted in the assessment that the evidence is insufficient to determine the effect of information alone on prescribing of asthma controller medication. |
| Patient education/asthma action plans | Decision support | 10/122-124<br>4RCTs, 6 pre-post | Moderate | A majority of non-randomized studies consistently favor the use of decision support interventions to improve the provision of self-management education/asthma action plans by health care providers. |
| | Organizational change | 2/24<br>1RCT, 1 pre-post | Low | Both studies favor the use of organizational change to increase patient education/asthma action plan use by health care providers. However, more studies are needed to increase the strength of evidence. |
| | Feedback and | 6/336 | Low | Despite a number of studies examining |

| Outcomes | Intervention | No. of studies/ no. health care providers | Strength of evidence | Conclusions |
|---|---|---|---|---|
| | audit | 3 RCTs, 3 pre-post | | feedback/audit, inconsistent results lead to a low strength of evidence for the use of feedback/audit to improve self-management education/ asthma action plan use. |
| | Clinical Pharmacy Support | 2/ 82<br>1 RCT, 1 cohort | Moderate | The two studies are consistent in favoring the use of Clinical Pharmacy Support to improve self-management education/asthma action plan use by health care providers |
| | Education | 5/470<br>5 RCTs | Low | Small increases in asthma self-management education were observed in a minority of studies, resulting in an overall low strength of evidence regarding this outcome. |
| | Quality Improvement and Pay-for-Performance | 3/ 2213<br>1 RCT, 2 pre-post | Moderate | Two of the three studies report that quality improvement increases self-management education/ asthma action plans. |
| | Multi-component interventions | 3/76<br>1 RCT, 2pre-post | Insufficient | There are few studies with conflicting results, rendering insufficient the evidence to evaluate the effect of multi-component interventions on the provision of self-management/asthma action plans |
| | Information Only | 0 | Insufficient | Studies are needed to determine if information alone is effective in improving rates of self-management education and the provision of asthma action plans by health care providers. |

Note: If the number of healthcare provider participants was not reported for a particular study, the "NR" value was treated as zero for that particular intervention and outcome category.

## KQ2: In the care of pediatric or adult patients with asthma, what is the evidence that Interventions designed to improve health care provider adherence to guidelines impact clinical outcomes (e.g., hospitalizations, patient reported outcomes such as symptom control)?

The key findings are summarized below, in Table C.

**Table C. Summary of Strength of Evidence for included studies for KQ2**

| Outcomes | Intervention | No. of studies/ no. health care providers | Strength of evidence | Conclusions |
|---|---|---|---|---|
| ED Visits/Hospitalizations | Decision support | 10/820<br>5 RCTs, 5 Pre-post | Moderate | 9 of 10 studies reported that decision support interventions reduce ED visits/hospitalizations. |
| | Organizational change | 4/252<br>2RCTs, 2 pre-post | Low | Inconsistent results account for the low strength of evidence for organizational change to reduce ED visits/hospitalizations. |
| | Feedback and audit | 2/125<br>1 RCT, 1 pre-post | Insufficient | Inconsistent results from a limited number of studies has resulted in an insufficient grade of evidence to evaluate the impact of feedback and audit interventions on ED visits and hospitalizations |
| | Clinical Pharmacy Support | 1/36<br>1 RCT | Insufficient | There is insufficient evidence available to determine the effect of clinical pharmacy support interventions on ED visits/hospitalizations. |
| | Education | 7/343<br>5RCTs, 2pre-post | Low | Overall, due to conflicting results among a number of studies, the low strength of evidence suggests that education-alone interventions do not reduce asthma ED visits and/or hospitalizations. |
| | Quality Improvement and Pay-for-performance | 2/1142<br>1 RCT, 1 pre-post | Low | Two studies show that quality improvement does not reduce ED visits and hospitalizations. More studies are needed. |
| | Multi-component | 0 | Insufficient | There is no published evidence to evaluate the impact of multimodal interventions on ED visits or hospitalizations. |
| | Information only | 1/ 13<br>1 RCT | Insufficient | Based on a single study with a high risk of bias, there is insufficient evidence to determine the effect of information-only interventions on ED visits/hospitalizations. |
| Missed days of work/school | Decision support | 2/435<br>1RCT, 1 pre-post | Insufficient | There is insufficient evidence to evaluate the effect of decision support interventions on the number of missed days of work/school. |
| | Organizational change | 1/24<br>1RCT | Insufficient | There is insufficient evidence to evaluate the effect of organizational change on missed days of work or school. |
| | Feedback and audit | 1/29<br>1 pre-post | Insufficient | There is insufficient evidence to evaluate the effect of feedback and audit interventions on the number of missed days of work and school from asthma. |
| | Clinical Pharmacy Support | 0 | Insufficient | There is insufficient evidence to evaluate the effect of clinical pharmacy support interventions on the number of missed days |

| Outcomes | Intervention | No. of studies/ no. health care providers | Strength of evidence | Conclusions |
|---|---|---|---|---|
| | | | | of work and school from asthma. |
| | Education | 5/1767<br>4 RCTs, 1 pre-post | Insufficient | There is insufficient evidence to evaluate the effect of education-only strategies on the number of missed days of work/school from asthma. |
| | Quality Improvement and Pay-for-performance | 1/511<br>1 pre-post | Insufficient | There is insufficient evidence to evaluate the effect of quality improvement/pay-for-performance interventions on the number of missed days of work/school from asthma. |
| | Multi-component | 0 | Insufficient | There is insufficient evidence to evaluate the effect of multi-component interventions on the number of missed days of work/school from asthma. |
| | Information only | 0 | Insufficient | There is insufficient evidence to evaluate the effect of multi-component interventions on the number of missed days of work/school from asthma. |

Note: If the number of healthcare provider participants was not reported for a particular study, the "NR" value was treated as zero for that particular intervention and outcome category

## Future Research

In addition to further research to assess interventions for which we found insufficient evidence, there are a variety of study design elements that may be considered to strengthen future research of health care provider-targeted interventions. Such considerations include: standardization of outcome measures and presentation of data; more comprehensive measurement of health care process and clinical outcomes within a given study; more information about the intensity (dose and frequency of the intervention); improved description of the comparator and the intervention; and more use of RCT study designs to isolate the effectiveness of each intervention.

## Conclusion

In summary, we found more information about the effectiveness of interventions on improving health care process outcomes than for clinical outcomes. There is a need for further evaluations of how these interventions may improve clinical outcomes for patients with asthma. There is low to moderate evidence to support the use of decision support tools, feedback and audit, and clinical pharmacy support to improve the adherence of health care providers to asthma guidelines, as measured through health care process outcomes, and to improve clinical outcomes. There is a need to further evaluate health care provider-targeted interventions with a focus on standardized measures of outcomes and more rigorous study designs.

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# EVIDENCE REPORT

# Introduction

## Background

### Burden of Asthma

Asthma is a respiratory disease characterized by variable and recurring symptoms, airflow obstruction, bronchial hyper-responsiveness, and inflammation of the airways. In the U.S., an estimated 24.6 million people (8.2%) currently have asthma.[1] Students with asthma miss more than 14 million school days every year due to illness. Furthermore, certain U.S. population subgroups have higher prevalence rates of asthma in comparison to the national average: children (9.6%), poor children (13.5%), non-Hispanic black children (17.0%), women (9.7%), and poor adults (10.6%).[1]

### Treatment of Asthma and Clinical Practice Guidelines

The current approach to asthma management includes monitoring symptoms and lung function, encouraging the use of medications that control and prevent symptoms, controlling the triggers of asthma, educating the patient, and maintaining a collaborative patient-provider relationship that includes the use of written action plans.[2] The main goals of therapy are to minimize current impairment and future risk.

A number of different organizations and countries have published clinical practice guidelines to guide health care providers in the diagnosis and management of asthma. For example, the National Asthma Education and Prevention Program (NAEPP) of the National Heart, Lung, and Blood Institute (NHLBI) has published comprehensive guidelines for diagnosing and managing asthma. The most recent guidance was published in 2007 (previous versions were published in 1991, 1997, and 2002): *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma* is also known as EPR-3.[2] This guideline provides treatment recommendations with the strength of the evidence base for children 0 to 4, 5 to11, and over 12 years of age and adults. EPR-3 is based on a systematic review and expert opinion.

Clinical trials have shown that treatment in alignment with asthma guideline recommendations improves clinical patient outcomes in a variety of populations, including among high-risk populations, such as inner-city, poor, and/or African American populations.[3-5] The available evidence suggests that most people with asthma can be symptom-free if they receive appropriate medical care, use inhaled corticosteroids when prescribed, and modify their environment to reduce or eliminate exposure to allergens and irritants.

### Current Asthma Management Practices

Despite the evidence of efficacy in improving outcomes, their long-standing presence (>20 years) and their wide availability, there is extensive evidence that guideline recommendations are not routinely followed by health care providers.[6 7] In one study, only 34.2 percent of patients reported being given a written asthma action plan, while only 68.1 percent had been taught the appropriate response to symptoms of an asthma attack.[7] In the same study, only about one-third of children or adults were using long-term control medicine such as inhaled corticosteroids. Health care providers do not appropriately assess asthma control in most children, [8-11] resulting in substandard care. Minority children are up to half as likely as Caucasian children to receive inhaled steroids. [12] The significance of these studies is that suboptimal outcomes persist, such as 2-fold higher rates of emergency room visits for African American children compared to their

Caucasian counterparts.[13]In 2005, there were approximately 679,000 emergency room visits in the U.S. due to asthma in children under 15 years of age.[14] Currently, asthma is the third leading cause of hospitalization among children in this age group.[14]

With the growing evidence that health care providers are poorly adherent to the asthma management recommendations in published clinical practice guidelines (CPGs), there has been more focused attention on the lack of adherence to best practices. In 1999, Cabana et al.[15] proposed a theoretical framework to understand why health care providers do not adhere to CPGs: lack of awareness of CPGs, disagreement with the CPG recommendations (e.g., use of inhaled corticosteroids), doubts about the effectiveness of the CPG recommendations (e.g., efficacy of inhaled steroids to reduce the likelihood of asthma attacks), lack of confidence in being able to carry out the best practice (e.g., confidence in ability to provide smoking cessation counseling(e.g., inability to overcome the inertia of previous practice behaviors (e.g., changing from prescribing orally administered Albuterol to prescribing inhaled Albuterol), and external barriers (e.g., time constraints during a visit, the CPGs are not user-friendly, patient preferences). There is a growing understanding that the shortcomings in health care providers' adherence to asthma CPGs may also relate to the content of asthma CPGs, which do not provide health care providers with the with the tools and strategies necessary to follow the recommended care.[16] It is possible that with the publication of additional asthma CPGs over the past 20 years, more physicians have been exposed to the asthma CPGs, resulting in greater awareness of the CPGs, fewer disagreements with CPG recommendations, and greater confidence in carrying out recommended asthma care.[17 18] However, there are some barriers outlined by Cabana et al. that would not be solved by increased exposure to asthma CPGs, including the inability of health care providers to overcome practice inertia and external barriers (e.g., time constraints during a visit, CPGs that are not user-friendly, patient preferences).[19] These types of unaddressed barriers to the adherence by health care providers to asthma CPGs highlight the need to evaluate strategies that may improve adherence to asthma CPGs.

## Knowledge Gaps

Although most interventions targeted at improving asthma care and outcomes have been patient-focused,[20-23] there have been provider-targeted interventions to improve adherence to guidelines (e.g., educational seminars, prompts).[24-29] However, there is no consensus on the most effective health care provider-targeted interventions to improve adherence to guidelines.

## Potential Impact of a Comparative Effectiveness Review

Good-quality guidelines are currently available for the care of children or adults with asthma. Systematic reviews have been published on patient-targeted interventions,[30 31] but little attention has been directed toward the effectiveness of clinician-focused strategies designed to enhance the implementation of guidelines in clinical practice. In 2007, the Stanford University–University of California San Francisco Evidence-based Practice Center published a report on asthma care, entitled *Closing the Quality Gap: A Critical Analysis of Quality Improvement Strategies: Volume 5—Asthma Care*.[32] This report showed that, despite the availability of evidence-based guidelines for the management of pediatric and adult asthma, a significant gap remains between accepted best practices for asthma care and the actual care delivered to patients with asthma in the U.S... The report authors examined the published literature through May 2006 on quality improvement strategies to improve the processes and outcomes of outpatient care for children and adults with asthma. The interventions included in their analyses had been tested between 1976 and 2004, so

studies published after 2004 would not have been included. Furthermore, the interventions used in those studies were directed at patient adherence to provider-prescribed care, rather than at provider adherence to asthma guidelines.

## Key Questions

Our Key Questions (KQs) are listed below, with the PICO elements listed in Table 1 and the questions displayed in Figure 1.

KQ 1: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact health care process outcomes (e.g., receiving appropriate treatment)?

KQ 2: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact clinical outcomes (e.g., hospitalizations, patient reported outcomes such as symptom control)?

KQ 3: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact health care process outcomes that then affect clinical outcomes?

**Table 1. Characteristics of the target studies according to the PICOTS framework**

| | |
|---|---|
| **Population(s)** | Physicians, nurses, physiotherapists/physical therapists, respiratory therapists, pharmacists and other health care providers treating children (0 to 18 years of age) or adults (over 18 years of age) with asthma |
| **Interventions** | Interventions to improve adherence to guidelines. Includes: decision support (health information technology and paper-based), organizational change, feedback and audit, clinical pharmacy support, education only, quality improvement/pay-for-performance, multi-component, information only |
| **Comparators** | Usual care, as defined by eligible study, and comparisons between interventions |
| **Outcomes** | Health care process outcomes (including: prescriptions for controller medicine, environmental control practice recommendations, self-management education, asthma action plans, documentation of level of asthma severity, prescription of peak flow meter, and follow-up visits,)<br>Clinical outcomes (including: symptom days, missed days of school and/or work, quality o life, emergency department visits/hospitalizations/urgent doctor visits, lung function tests, rescue use of short-acting β2 agonists, parental/patient perceptions/ratings of care, and side effects of drugs)<br>The outcomes are non-directional. That is, outcomes deemed good, as well as those deemed to be potential harms or unintended consequences, were considered. |
| **Timing** | Studies with all duration of follow-up were considered for the review. |
| **Setting** | Outpatient settings in which health care providers work, but not emergency room or in-patient settings. |

**Figure 1. Analytic framework for Guidelines on the Care of Adults and Children with Asthma**

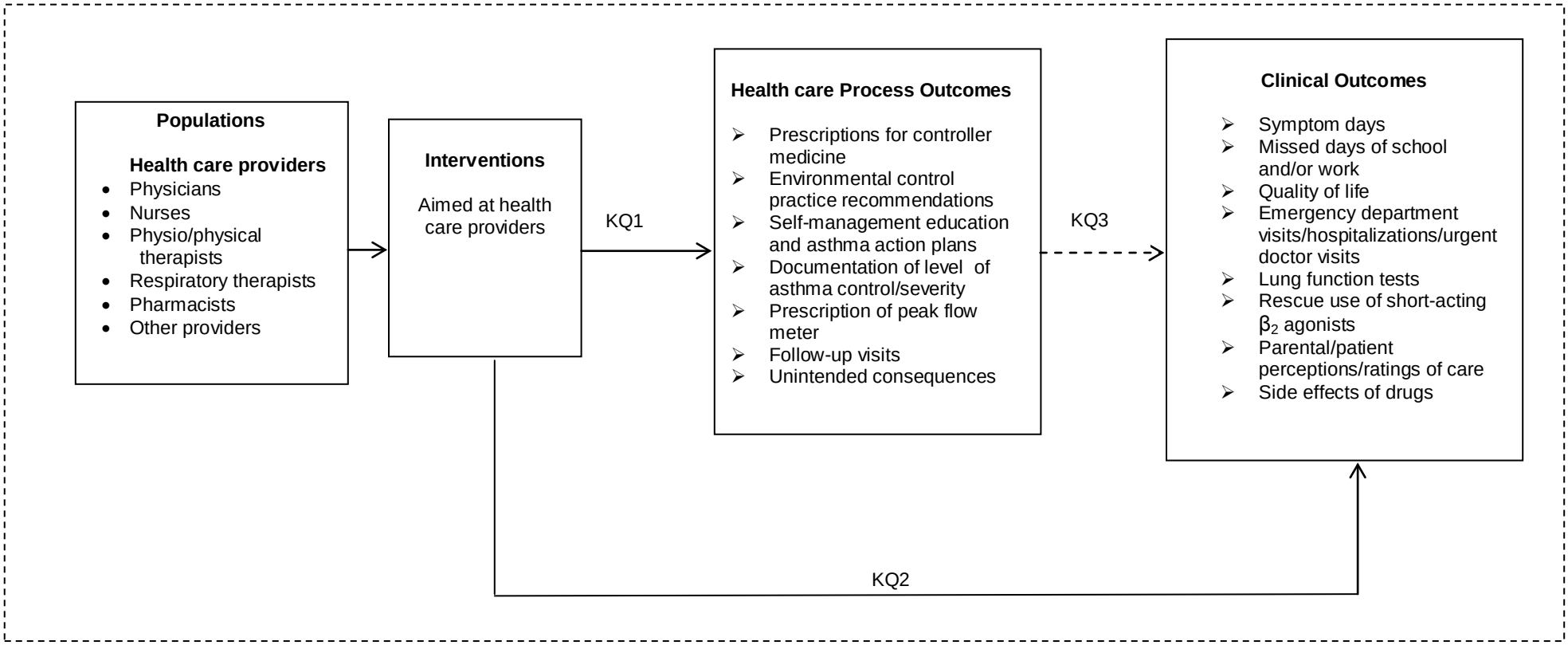



Figure 1 shows our analytic framework presenting the Key Questions (KQ) in terms of: 1) the populations (physicians, nurses, physio/physical therapists, respiratory therapists, pharmacists, and other healthcare providers); 2) the interventions aimed at our given populations; 3) the healthcare process outcomes (prescriptions for controller medicine, environmental control practice recommendations, self-management education and asthma action plans, documentation of level of asthma control/severity, prescription of peak flow meter, follow-up visits, and unintended consequences); 4)clinical outcomes (symptom days, missed days of school and/or work, quality of life, emergency department visits/hospitalizations/urgent doctor visits, lung function tests, rescue use of short-acting β2 agonists, parental/patient perceptions/ratings of care, side effects of drugs

# Methods

The methods for this systematic review follow the AHRQ Methods Guide for Effectiveness and Comparative effectiveness Reviews (available at: http://www.effectivehealthcare.ahrq.gov/methods guide.cfm)

## Topic Development and Review Protocol

The topic for this report was nominated in a public process by a staff member of the Ohio Department of Health. We recruited six key informants to provide input on the selection and refinement of the questions for the systematic review. To develop the key questions, we reviewed existing systematic reviews, developed an analytic framework and solicited input from our key informants through email and conference calls. Our draft key questions were posted on Effective Health Care Program Web site for public comment on October 14th, 2011. The key questions were revised, as necessary, based on comments.

We drafted a protocol and recruited a panel of technical experts, including guidelines and methods experts, pediatricians and asthma specialists. We finalized the protocol with input from the technical expert panel and representatives from AHRQ. The protocol was posted on the Effective Health Care Program Web site on March 2nd, 2012.

## Search Strategy

We searched the following databases for primary studies: MEDLINE®, EMBASE®, and the Cochrane Central Register of Controlled Trials®, Cumulative Index to Nursing and Allied Health Literature (CINAHL®), Educational Resources Information Center (ERIC), PsycInfo, and Research and Development Resource Base in Continuing Medical Education (RDRB/CME) through January 2012. We developed a search strategy for MEDLINE®, accessed via PubMed, based on an analysis of the medical subject headings (MeSH), terms, and text words of eligible articles identified *a priori* (Appendix B). This strategy was translated for use in the other electronic sources. No limits were imposed based on language or date of publication. Searches were conducted in January 2012. Updated searches will be conducted during peer review of the draft report. We also completed backward citation searching using Scopus for each included article.

## Study Selection

Title and abstracts were screened independently by two trained investigators, and were excluded if both investigators agreed that the article met one or more of the exclusion criteria (see inclusion and exclusion criteria listed in Table 2 and the Abstract Review Form in Appendix C). Differences between investigators regarding abstract eligibility were resolved through consensus.

Citations promoted on the basis of title and abstract screen underwent another independent paired-reviewer screen using the full-text article (Appendix C, Article Review Form). Differences regarding article inclusion were resolved through consensus. During full-text screen we identified articles not in English for which we could not determine eligibility. This will allow for reconsidering those articles in the future, should further time and resources be available.

We included randomized and non-randomized studies that included a comparison and that addressed interventions such as education, reminders, decision support, clinical pharmacy

support, organization changes, etc. to improve adherence to guidelines in health care providers. We excluded studies that were conducted in inpatient or emergency department settings only.

**Table 2. Study inclusion and exclusion criteria**

| | Inclusion | Exclusion |
|---|---|---|
| **Populations** | Participants: human subjects.<br>Health care providers: physicians, nurses, nurse practitioners, physiotherapists/physical therapists, respiratory therapists, pharmacists, and other health care providers treating children or adults with asthma | • Animal models/simulations. |
| **Intervention** | Interventions to improve adherence to guidelines including decision support (health information technology and paper-based), organizational change, feedback and audit, clinical pharmacy support, education only, quality improvement/pay-for-performance, multi-component, information only. | • Intervention does not address adherence to asthma guidelines.<br>• Intervention does not target health care providers. |
| **Comparisons of interest** | Usual care, as defined in each eligible study, and comparisons between interventions | Studies lacking a comparison |
| **Outcomes** | **Health care process outcomes:**<br>➢ Prescriptions for controller medicine<br>➢ Environmental control practice recommendations<br>➢ Self-management education and asthma action plans<br>➢ Documentation of level of asthma control/severity<br>➢ Prescription of peak flow meter<br>➢ Follow-up visits<br>➢ Unintended consequences<br><br>**Clinical outcomes:**<br>➢ Symptom days<br>➢ Missed days of school and/or work<br>➢ Quality of life<br>➢ Emergency department visits/hospitalizations/urgent doctor visits<br>➢ Lung function tests<br>➢ Rescue use of short-acting B2 agonists<br>➢ Parental/patient perceptions/ratings of care<br>➢ Side effects of drugs<br>The outcomes were non-directional; that is, all outcomes were considered whether they were beneficial or caused potential harms or unintended consequences | Studies that do not report an outcome of interest (e.g., studies reporting acceptability of intervention only). |
| **Type of Study** | Randomized and quasi-randomized controlled trials and cross-over studies.<br>Non-randomized studies with comparison groups including non-randomized controlled trial or cross-over studies, controlled pre-post studies, historically controlled studies, cohort studies, case-control studies, and cross-sectional studies.<br>Non-randomized studies without a separate comparison group, including interrupted-time-series, non-controlled and pre-post studies. | We excluded meeting abstracts and studies with no original data (e.g., reviews, editorials, comments, and letters) or non-comparative studies. |
| **Timing and Setting** | Studies of any duration follow-up that occurred in an outpatient setting employing healthcare providers were eligible for inclusion. | We excluded studies exclusively addressing inpatient or emergency department settings or guidelines. |

## Data Abstraction and Data Management

We used DistillerSR (Evidence Partners, 2010) to manage the screening process. DistillerSR is a Web-based database management program that manages all levels of the review process. We uploaded to the system all citations identified by the search strategies.

We created standardized forms for data extraction. (Appendix C) We pilot tested the forms prior to the beginning the process of data extraction. We used Access (Microsoft, Redmond, WA) for the data abstraction process. Reviewers extracted information on general study characteristics, study participants, eligibility criteria, interventions, and the outcomes. One reviewer completed data abstraction and the second reviewer confirmed the first reviewer's data abstraction for completeness and accuracy. Reviewers completed risk of bias assessment independently. Reviewer pairs included personnel with both clinical and methodological expertise. We resolved differences between investigators regarding data through consensus.

## Risk of Bias Assessment

We used the Cochrane Collaboration's tool for assessing the risk of bias of controlled studies. Two trained reviewers independently assessed the included studies according to the guidelines in Chapter 8 of the Cochrane Handbook for Systematic Reviews of Interventions[33] using the following criteria: sequence generation and allocation concealment (selection bias), blinding of health care providers, investigators, and outcome assessors (detection bias), incomplete outcome data (attrition bias), selective outcome reporting (reporting bias), and other sources of bias. We reported judgments for each criterion as "Low risk of bias," "High risk of bias" or "Unclear risk of bias (information is insufficient to assess)" per criteria provided by tool. Disagreements were resolved through team discussion.

For pre-post studies, we added the two relevant criteria from the Cochrane Effective Practice and Organization of Care (EPOC) data collections checklists.[34] Specifically, the questions asked if the intervention was likely to affect data collection, and if the intervention was independent of other changes.

## Data Synthesis

For each KQ, we created a detailed set of evidence tables containing all information abstracted from eligible studies. We categorized the interventions being assessed in the studies, and synthesized information by KQ based on these categories:

1) Decision support interventions are health information technology- and/or paper-based-interventions designed to support/facilitate health care provider treatment decision-making (e.g., classify asthma severity);
2) Organizational change interventions are designed to change the way in which an organization provides asthma care (e.g., having an asthma "champion");
3) Feedback and audit interventions are based upon providing performance data to health care providers about their quality of asthma care;
4) Clinical pharmacy support: interventions targeting pharmacists' delivery of asthma care;
5) Education only interventions are focused on educating health care providers about the content of asthma clinical practice guidelines;
6) Quality improvement/pay-for-performance interventions are focused on quality improvement initiatives or pay-for-performance as the primary intervention;

7) Multi-component interventions use more than one type of intervention;
8) Information only interventions provide only information to health care providers about asthma guideline recommendations (e.g., provide a pocket guide to asthma guidelines)

Based on feedback from key informants and public comment, a variety of health care process and clinical outcomes were selected to evaluate the effectiveness of interventions.

The health care process outcomes included:

- Prescriptions for controller medicine
- Environmental control practice recommendations
- Self-management education and asthma action plans
- Documentation of level of asthma control/severity
- Prescription of peak flow meter
- Follow-up visits
- Unintended consequences

The clinical outcomes, assessed in patients, included:

- Symptom days
- Missed days of school and/or work
- Quality of life
- Emergency department visits/hospitalizations/urgent doctor visits
- Lung function tests
- Rescue use of short-acting $\beta_2$ agonists
- Parental/patient perceptions/ratings of care
- Side effects of drugs

We identified outcomes we considered critical to making a decision on which to focus our synthesis. [35] These outcomes were prescription of asthma controller medicines, provision of asthma action plan/self-management education, ED visits/hospitalizations, and missed days of school or work. The critical outcomes were identified as the most commonly used in practice; those relied upon by clinicians to guide decision-making; and those endorsed by the NIH Workshop on Asthma Outcomes.[36] Data abstracted for all outcomes can be found in Appendix E.

We conducted narrative synthesis of the evidence. Our team felt that the heterogeneity in the studies, including in the measures of outcomes, population included, and specifics of the interventions, precluded quantitative synthesis.

Magnitude of effect for studies addressing each outcome was considered as: small (less than 10% change or difference), moderate (10-30% change or difference) and large (over 30% change or difference). These judgments were made by one reviewer, checked by another, with disagreements discussed with the full team

## Strength of the Body of Evidence

We graded the strength of evidence for each outcome for each of the key questions using the grading scheme recommended by the Methods Guide for Conducting Comparative Effectiveness Reviews.[37] In assigning evidence grades we considered the four required domains including risk of bias of included studies, directness, consistency and precision. We classified evidence into four basic categories: 1) "high" grade (indicating high confidence that the evidence reflects the true effect, and further research is very unlikely to change our confidence in the estimate of the effect); 2) "moderate" grade (indicating moderate confidence that the evidence reflects the true effect, and further research may change our confidence in the estimate of the effect and may change the estimate); 3) "low" grade (indicating low confidence that the evidence reflects the true effect, and further research is likely to change our confidence in the estimate of the effect and is likely to change the estimate); and 4) "insufficient" grade (evidence is unavailable or does not permit a conclusion). Our judgments were first based on the ability to make a conclusion (if not able to make a conclusion, then "insufficient" was assigned) and then on the confidence in the conclusion (classified as low, moderate or high with increasing certainty). The author of the section first graded the evidence and this was reviewed by the principal investigator. Any disagreements were discussed with the full team.

## Applicability

Applicability was assessed separately for the different outcomes for the entire body of evidence guided by the PICOS framework as recommended in the Methods Guide for Comparative Effectiveness Reviews of Interventions.[37]We considered factors that may limit applicability of the findings (e.g., a study conducted in a non-U.S. health care setting, providers not common to the U.S. health care system).

## Peer Review and Public Comment

We invited experts in guidelines, methods, policy, pediatricians and asthma specialists, clinical care delivery, healthcare payer fields and individuals representing stakeholder and user communities were invited to provide external peer review of this CER; AHRQ representatives and an associate editor also provided comments. AHRQ will post the draft report on its website for 4 weeks to elicit public comment. We will address all reviewer comments, revising the text as appropriate, and documenting everything in a disposition of comments report that we will be made available 3 months after AHRQ posts the final review on its website.

# Results

## Results of the Search

Figure 2 summarizes the results of our search. We identified 4166 unique citations. We excluded 3846 citations during the abstract screening. During full-text article screening, we excluded an additional 244 articles that did not meet one or more of the inclusion criteria. (Listing of excluded studies is included in Appendix D.) Seventy-two articles were eligible for inclusion and 70 addressed one of the critical outcomes and are thus included in the narrative of the report. We identified four outcomes as critical to making a decision on which to focus our synthesis: [35] prescription of asthma controller medicines, provision of asthma action plan/self-management education, ED visits/hospitalizations, and missed days of school or work. Data abstracted for all outcomes can be found in Appendix E.

## Description of Types of Studies

Of the 72 studies identified, 37 (51.4%) were based in the U.S. and 35 (48.6%) were international. Studies were classified by intervention assessed as Decision Support (n=25), Feedback and audit (n=16), Education (n=16), Multimodal (n=5), Information only (n=2), Quality Improvement (n=4), Organizational Change (n=3), or Detailing and Support (n=0) (Table 3). Half of the studies were randomized trials (n=37), 22 were pre-post, and the remainder were controlled pre-post (n=6), non-randomized (n=4), and cohort (n=3) (Table 4). Most interventions targeted general practitioners (n=24). The most frequently reported health care process outcome was prescription of controller medication (n=44), followed by provision of an asthma action plan (n=17), prescription of a peak flow meter (n=17), and self-management education (n=11) (Table 5). Common clinical outcomes included emergency department visits (n=29) and hospitalizations (n=26), followed by use of short-acting β2 agonists (n=8), missed school days (n=7), lung function tests (n=6), symptom days (n=6), quality of life (n=5) and urgent doctor visits (n=5) (Table 6).

**Table 3. Studies stratified by intervention**

| Intervention Type | Number of Studies (%) |
|---|---|
| Feedback and Audit | 16 (21.6) |
| Decision Support | 25(36.5) |
| Detailing and Support | 0 (0) |
| Education | 16 (23.0) |
| Information Only | 2 (2.7) |
| Multimodal | 5 (6.8) |
| Organizational Change | 3 (4.1) |
| Quality Improvement | 4 (5.4) |

**Table 4. Studies stratified by study design**

| Study Design | Number of Studies, n |
|---|---|
| Controlled Pre-post | 6 |
| Cross-sectional | 0 |
| Non-randomized | 4 |
| Cohort | 3 |
| Pre-post | 22 |
| Randomized | 37 |

**Table 5. Studies stratified by health care process outcome**

| Health care Process Outcome | Number of Studies (n) |
|---|---|
| Asthma action plan | 17 |
| Documentation of asthma control/severity | 9 |
| Environmental control practice recommendations | 6 |
| Follow-up visits | 8 |
| Prescription of peak flow meter | 17 |
| Prescriptions for controller medicine | 44 |
| Proportion of patients on inhaled corticosteroids | 1 |
| Self-management education | 11 |
| Non-urgent care asthma visit | 1 |

**Table 6. Studies stratified by clinical outcome**

| Health care Clinical Outcome | Number of Studies (n) |
|---|---|
| Emergency department visits | 29 |
| Hospitalizations | 26 |
| Lung function tests | 6 |
| Missed days of school | 7 |
| Missed days of work | 3 |
| Parental/patient perceptions | 2 |
| Quality of life | 5 |
| Use of short-acting β-2 agonists | 8 |
| Symptom days | 6 |
| Symptom score | 3 |
| Urgent doctor visits | 5 |

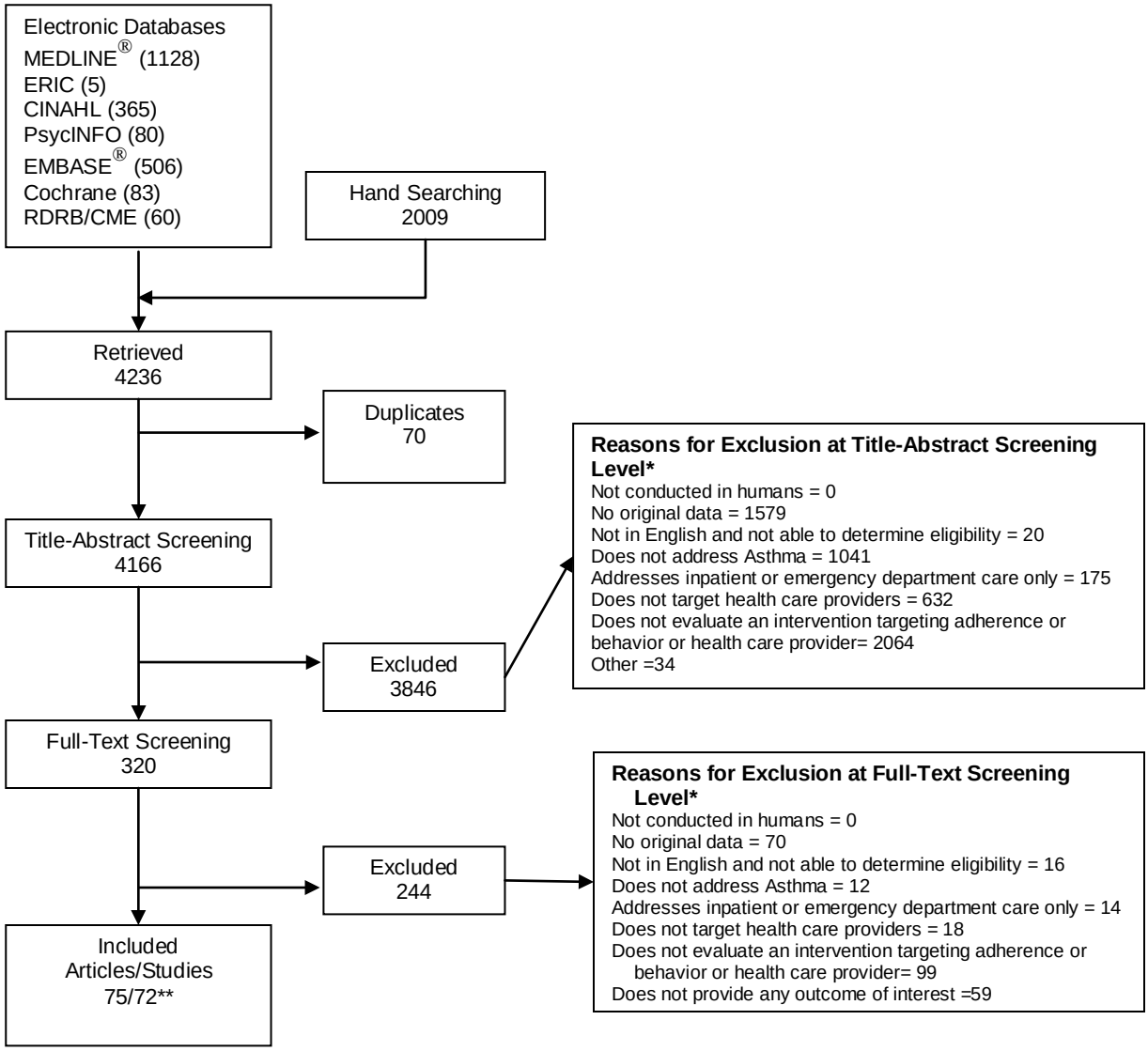
**Table 7. Studies stratified by setting**

| International vs. Domestic | Number of Studies, n (%) |
|---|---|
| U.S. | 37 (51.4) |
| International | 35 (48.6) |

# Organization of Results

The results are organized according to each KQ, the four critical outcomes (prescription of asthma controller medicines, provision of asthma action plan/self-management education, ED visits/hospitalizations, and missed days of school or work) and each type of intervention. For each KQ, a description and summary of the key findings from each type of intervention are presented, along with a table summarizing the strength of evidence.

**Figure 2. Summary of search (number of articles)**




* Total exceeds the # in the exclusion box, as reviewers did not need to agree on reason for exclusion
**Three distinct pairs of articles described a single intervention or cohort. For the purposes of this review, each pair was counted as a single study, yielding 72 studies reported in 75 articles.

# KQ1: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact health care process outcomes (e.g., receiving appropriate treatment)?

## Outcome: Prescription of controller medicines

### Key Points and Evidence Grades

- There is moderate evidence for the effectiveness of decision support interventions to increase prescribing of asthma controller medicines by health care providers. Most of the evidence supporting the use of decision support interventions comes from non-randomized studies.
- Low strength of evidence supports the effectiveness of organizational change to increase the prescribing of asthma controller medicines by health care providers.
- Most feedback and audit interventions were multifaceted, limiting our ability to discern whether the specific feedback and audit component was effective in increasing controller medication prescribing by practitioners. There was moderate evidence to support feedback/audit interventions as an effective means to increase prescribing of asthma controller medications.
- There was moderate evidence that clinical pharmacy support interventions increased prescribing of asthma controller medications.
- Moderate evidence suggests that education interventions do not increase prescription of asthma controller medications by clinicians (mostly primary care).
- No studies examined the effect of quality improvement strategies on prescription of asthma controller medications.
- There is insufficient evidence to determine the effect of multi-component interventions on prescribing rates of asthma controller medications.
- There is insufficient evidence to determine if information alone is effective in improving rates of asthma controller medication prescribing in asthma.

### Decision support

Fifteen studies of decision support interventions evaluated prescription of asthma controller medications as an outcome. These studies included six RCTs[38-43] and nine with pre-post designs.[44-52] The control condition for the RCTs was usual care [38 40 41 43] or the provision of decision support for non-asthma conditions.[39 42]The health care provider participants all worked in primary care settings (i.e., no allergists, pulmonologists or other sub-specialists). Most studies did not focus the intervention on one type of health care provider, but involved a combination of physicians, nurse practitioners/physician assistants and other non-physician employees. [45 47 49 51] A minority of studies involved pediatric health care providers. [40 44 49] With few exceptions, there was little description of the patient populations by race/ethnicity, [40 43 49]gender, [40 45 49 52] or disease severity/control.[44 52] The reported racial/ethnic make-up in those studies providing such data reported that a majority of patients cared for as African American, Latino and/or requiring public health insurance.[40 43 44 49 51-53]

The types of decision support interventions varied, and included the provision of asthma guidelines in a more accessible format (e.g., "pocket" versions),[41 48 50] use of a specific algorithm, pathway or flow sheet,[41 49-51] a structured template for taking a history,[44 45] or a reminder system to raise awareness of the health care provider about the patient's asthma status.[39 40 46] The decision support interventions were often combined with other strategies, including education, [38 41-43 46 51 53 54] reminders,[39 43-45 48] feedback, [40 48] and/or organizational change [47]. Some interventions were computer-based, which often served to guide the health care provider through a guideline-consistent assessment and/or treatment approach.[39 42 43 46 48 52 55]

Ten studies found that a decision support intervention increased the prescription of asthma controller medicines by health care providers, [38 40 43-46 48 49 51 52] while five studies found no statistically significant effect. [39 41 42 47 50] Most of the studies in which a positive effect on prescribing was observed used a pre-post study design, while 3 of the 5 RCTs observed no benefit from decision support interventions. [39 41 42] The increase in prescribing of controller medicines reported in the interventions ranged from 2 percent to 34 percent in the studies using the pre-post design, while the difference between intervention and control conditions in the RCT studies ranged from 2 percent to17 percent. The absolute difference in increased prescribing observed in the RCT studies was generally less than 10 percent. The impact of these decision support interventions to increase the prescribing of controller medicines by health care providers was modest and was observed primarily in pre-post study designs and not as consistently in RCT studies. In summary, moderate evidence supports the use of decision support interventions in increasing the prescription of asthma controller medications.

## Organizational Change

Two studies [56 57] examined the impact of organizational change on the prescribing of asthma controller medications by health care providers. One study was an RCT, [56] while the other was a pre-post study. [57] Both studies included pediatric health care providers. Both studies utilized the addition of personnel to facilitate organizational change. The former study used an asthma nurse educator, [56] while the latter study used a community health worker.[57] Both studies also incorporated provider education as part of the organizational change intervention. The two studies reported beneficial effects on the prescribing practices of health care providers. The former study [56] found that neither the peer-led education arm nor the planned care intervention (utilizing an asthma nurse educator) arms resulted in a statistically significantly higher proportion of prescriptions for inhaled steroids or asthma controller medications compared to the control arm of the study. Notably, prescribing improved in all arms of the study, including the control arm. The improvement in prescribing controller medications ranged from 8 to16 percent among all patients with asthma patients and 4 to 11 percent among asthma patients with persistent asthma. For inhaled steroids, the ranges of improved prescribing of controller medications were 4 to 9 percent and 13 to 19 percent, respectively. In the latter study, the investigators[57] observed a 12 percent increase (an absolute change from 44% to 56%) in prescriptions for inhaled steroids among all asthma patients. The effect of organizational change on increasing prescribing asthma controller medications ranges from small to modest in the two eligible studies reviewed. In summary, a low strength of evidence supports the effectiveness of organizational change in increasing the prescribing of asthma controller medicines.

## Feedback and Audit

We identified six RCTs[58-63] and six pre-post studies[64-69] evaluating the effect of feedback and audit on the prescription of controller medications. Most feedback and audit studies were conducted in Europe [58-64 68] or the U.S. [65-67 69]. Clinicians included primarily general practitioners [58-64] along with primary care physicians [62 65 69] unidentified prescribers, [66]physicians and nurses, [65]pharmacists, [68] and pharmacist and physicians [67]. No studies addressed specialty care such as allergy, pediatrics or pulmonary medicine. There was little description of the clinician populations by race/ethnicity, gender, or years of experience.

Most feedback and audit interventions were combined with another intervention; 8 included provider education, [58 61 63-67 69] one included prioritized review criteria for audit,[60] two included benchmarking or comparison with peers or other practices [60 62] and one included pharmacy monitoring of fill data and feedback to providers as part of a therapeutic outcomes monitoring (TOM) intervention, in which pharmacists also provided counseling and medication monitoring to patients.[68] For each of these studies, however the feedback and audit component was the predominant provider intervention. Comparison groups included feedback unrelated to asthma, control groups located in another community/country, or pre-post comparisons. Implementation many of the interventions appeared complex and may potentially influence the effectiveness of the interventions.

Of the six RCTs[58-63]four demonstrated positive effects of the intervention[58 60 61 63]. Increased prescribing of asthma controller medicines was reported for audit and feedback interventions using targeted key guideline messages about the inflammatory nature of asthma (such as, "use inhaled corticosteroids promptly, treat severe exacerbations with oral corticosteroids") (5% to 12% increase from baseline, p=0.05),[58] prioritized guideline review criteria on single card,[60] medical record prompts for annual review of asthma management with guideline prompts,[61] and individualized feedback on prescribing and decision strategies.[63] The two RCTs reporting no effect on prescribing of asthma controller medications involved feedback of prescribing data [59] and a trial of performance feedback.[62] Of the studies using a pre-post design, three studies reported an increase in prescribing of controller medicines.[65 67 68] The increase reported in these studies ranged from 40 to 50 percent.[65 68] No effect or a small effect was noted in a RCT of unsolicited mailed prescriber feedback of individual patient pharmacy count data (Incidence Rate 0.13 (95% CI: 0.01, 0.017)) vs. group practice aggregate prescribing data (Incidence Rate 0.014 (95% CI: 0.01, 0.018)) as compared to controls who received feedback regarding another disease (Incidence Rate 0.018 (95% CI: 0.015,0.021)).[59] No effect was also noted in an RCT comparing a traditional quality circle (TQC) intervention, in which providers were given feedback on their individual performance and the aggregate performance of group providers, with a benchmark quality circle (BQC) intervention, in which feedback on providers' individual performance was explicitly compared to a performance benchmark (the highest-performing 10% of providers in the benchmark arm).[62]

In a pre-post study, use of a feedback tool that applied an algorithm based on guidelines and patient asthma information (Asthma Apgar tool) demonstrated a strong positive effect in prescribing controller medication (Pre 24%, Post 73%, p<0.001), [65] as did a physician education and mailed asthma management fact sheet + patient pharmacy profile for patients with short-acting bronchodilator over use or no anti-inflammatory medication use (Mean difference in number of long-acting controllers over 9 months: Intermittent asthma: 0.37 (95% CI: 0.25,0.47, p<0.001; Persistent asthma: -0.29 (95% CI: -0.47, -0.12, p=0.009).[67] Yet, a mailed educational

and feedback of specific patient pharmacy profile with copy of guidelines showed no effect on inhaled corticoid steroid fills post intervention, despite targeting patients with poorly controlled asthma, i.e. high short acting beta agonist users. [66] In summary, a number of feedback/audit studies show a small to moderate increase in prescribing of controller medicines by health care providers, suggesting that this is an effective intervention strategy. Although, most feedback/audit interventions were multifaceted, limiting our ability to discern if the specific feedback/audit component was effective in increasing controller medication prescribing by health care providers. In summary, moderate evidence supports the use of feedback/audit to increase the prescribing of controller medicines.

## Clinical Pharmacy Support

We identified one RCT [70] and two prospective cohort studies [71 72] evaluating the effect of clinical pharmacy support on the prescription of asthma controller medications. The one RCT implemented a pharmacy care program training pharmacists in risk assessment, medication adherence and spirometry use and compared to a control group of usual care.[70] Among the non-randomized studies, only one intervention of a specialized asthma service by community pharmacies including seeing patients by appointment, assessing and intervening on patient medication needs and goal setting was compared with two groups of control patients was strong.[72] The other non-randomized study tested a minimal intervention that encouraged pharmacists to hold meetings with local general practitioners to discuss guideline care for children with asthma.[71] All interventions included a pharmacist education component. All were conducted at international sites including Australia[70 72] and Netherlands.[71]
Clinicians in all studies were pharmacists.[70-72] Only one study included clinician characteristics such as gender (control: female 56%t, intervention: female 44%) and most pharmacists 35 years of age or older.[70]
The one RCT implemented a pharmacy care program training pharmacists in risk assessment, medication adherence and spirometry use. This RCT reported a statistically significant increase in the dispense of preventer and reliever medication versus reliever only in the intervention group when compared to controls (Odds Ratio 3.80 (95% CI: 1.40,10.32), p=0.01).[70] Increased asthma controller medication use at 6 months follow-up was also reported in an intervention of a specialized asthma service by community pharmacies including seeing patients by appointment, assessing and intervening on patient medication needs and goal setting with the patient as compared to control patients in two control groups (Preventive medication use: control 1: 90.9 %, control 2: 78.6%, intervention: 97.4%; p=0.04), however an analysis was not reported for comparison of control 1 vs. intervention groups.[72] One minimal intervention encouraged pharmacists to hold meetings with local general practitioners to discuss guideline care for children with asthma reporting an increase in controlled medications using a prospective cohort design (2.7% children with no use of an inhaled corticosteroid medication at 12 months, $p<0.05$).[71] In summary, there is moderate evidence to support the effectiveness of clinical pharmacy support interventions to increase the prescribing of asthma controller medications by health care providers.

## Education (alone)

Ten studies of education examined prescription of asthma controller medication as an outcome, including six RCTs [73-78] and four with pre-post designs [79-82]. Nearly all of the studies targeted primary care physicians (GPs, FPs, pediatricians) or nurses and one recruited

pharmacists.[77] The education interventions were varied and included small group asthma education programs,[74] structured training[82] seminars (including interactive), [76]and grand rounds.[82] Besides aiming to deliver specific asthma content, certain interventions also emphasized more general skills, such as training in communication.[73 76] The studies examined prescription of asthma controller medications, including "anti-inflammatory" medications generally, as well as specific classes such as inhaled corticosteroid, leukotriene modifiers and cromolyn. The findings from all studies were consistently in the positive direction, reporting increases in prescribing of controller medicines by 3.5 percent to 50.3 percent, though statistically significant differences were reported only in 3 of the studies. Most studies were at high risk of bias and the strength of the evidence was low overall. Thus, the evidence is not sufficient to conclude that the education of health care providers (mostly primary care) would lead to improvements in prescription of controller medications. A majority of provider education intervention studies showed no significant increase in prescribing of asthma controller medicines. In summary, moderate evidence does not support the effectiveness of education as a strategy to increase the prescription of controller medications by health care providers.

## Quality Improvement and Pay-for-Performance

No studies examined the effect of quality improvement strategies on prescription of asthma controller medications. Therefore, there is insufficient evidence for this outcome.

## Multi-component

Four studies evaluated the impact of multi-component interventions. [83-86] All interventions included a copy of the guidelines and an educational component; additional interventions included from the provision of materials for provider use, onsite staff to aide in reorganization of practice flow; and feedback to individual providers based on chart reviews. Three [84-86] were cluster-randomized controlled trials (randomizing primary care practices) and one[83] was pre-post study with no comparison group. Only the pre-post study[83] and one of the three RCTs [84] found an impact of the intervention on rates of inhaled corticosteroid prescriptions. Although the magnitude of effect in the pre-post study was large (25% increase in patients prescribed inhaled steroids per participating provider), this outcome was measured via self-report and the study did not have a comparison group. Collectively, because of inconsistent results, there is insufficient evidence to evaluate the effect of multi-component interventions on the prescribing of controller medications for asthma.

## Information Only

Two studies[87 88] involved provision of information to providers as the only intervention. One[88] was a randomized trial in which patients were randomized to have information about asthma management and treatment guidelines inserted in their medical records for provider use. Individual providers thus cared for patients in both arms simultaneously. This study found no difference in rates of inhaled corticosteroid prescribing between study groups. The other [87] randomized providers to be involved in guideline development or not, prior to the distribution of the guidelines to all study providers. This study reported a decrease, rather than in increase, in inhaled corticosteroid prescribing rates that was statistically significantly larger in the intervention group than the comparison group (9 fewer prescriptions per 1000 patients in the intervention group vs. 1 fewer prescription per 1000 patients in the control group, $p<0.01$). This was the only unintended consequence we identified from the included studies. In summary,

because of conflicting results between two studies, there is insufficient evidence to determine if information alone is effective in improving rates of controller medication prescribing in asthma.

**Table 8. Prescriptions for controller medications - Strength of Evidence for KQ1**

| Intervention | No. of studies/ no. health care providers | Risk of bias | Consistency | Directness | Precision | Strength of evidence & Magnitude of effect |
|---|---|---|---|---|---|---|
| Decision support | 15/1,635<br>6 RCTs,9 Pre-post | Medium | Consistent | Direct | Precise | SOE: Moderate<br>MOE: Large |
| Organizational change | 2/228<br>1RCT, 1 pre-post | Medium | Consistent | Direct | Precise | SOE: Low<br>MOE: Small |
| Feedback and audit | 12/ 1,831<br>6 RCTs, 6 pre-post | Medium | Consistent | Direct | Imprecise | SOE: Moderate<br>MOE: Large |
| Clinical Pharmacy Support | 3/ 91<br>1 RCT, 2 cohort | Medium | Consistent | Direct | Precise | SOE: Moderate<br>MOE: Large |
| Education | 10/ 451<br>6RCTs, 4 pre-post | Medium | Consistent | Direct | Imprecise | SOE: Moderate<br>MOE: None |
| Quality improvement and Pay-for-performance | 0 | | | | | SOE: Insufficient |
| Multi-component interventions | 4/ 842<br>3 Cluster randomized, 1 pre-post | High | Inconsistent | Direct | Imprecise | SOE:Insufficient<br>MOE: Large |
| Information Only | 2/107<br>1 RCT, 1 quasi-experimental | High | Inconsistent | Direct | Imprecise | SOE: Insufficient |

SOE= strength of evidence; MOE = magnitude of effect; RCT= Randomized controlled trial

# Outcome: Self-management education and asthma action plans

## Key Points and Evidence Grades

- There is moderate strength of evidence supporting the effectiveness of decision support interventions to improve the provision of self-management education/asthma action plans by health care providers. Most of the evidence supporting the use of decision support interventions comes from non-randomized studies.
- Low strength of evidence suggests that organizational change is effective in increasing the provision of self-management education/asthma action plans by health care providers.
- Low strength of evidence supports the use of feedback and audit interventions to increase the use of self-management education/asthma action plans by health care providers.
- We found moderate evidence that clinical pharmacy support interventions increase the provision of self-management education and asthma action plans.
- There is low strength of evidence that educational interventions directed at general practitioners and pediatricians increase the use of asthma action plans.
- There is moderate evidence to support the effectiveness of quality improvement on the prescription of asthma action plans/self-management education by healthcare providers.
- There is insufficient evidence to evaluate the effect of multi-component interventions on self-management education/asthma action plan use by health care providers.
- There is insufficient evidence to determine if information alone is effective in improving rates of provision of self-management education and asthma action plans by health care providers.

## Decision support

Ten studies evaluated the impact of decision support interventions on the provision of patient education/asthma action plans.[42 43 47 48 50 54 89-92] Four of the studies were RCTs, [42 43 90 92] while the remainder used a pre-post study design. [47 48 50 54 89 91] The interventions included computerized support, [42 43 47 48 92] a flowsheet/algorithm,[89 91] and/or the provision of guidelines.[50]These studies all focused on primary care settings and all studies involved a mix of primary care providers, such as general practitioners, [42]pediatricians, [54 90] or family practitioners.[91] Of the two studies that reported patient sociodemographic data,[43 90] the majority of patient subjects were African American.

Seven of these studies reported a positive effect of decision support on the provision of patient education/asthma action plans.[47 48 50 54 89-91]The increase in self-management education/use of asthma action plans across these studies ranged from 14 percent to 84 percent. Of the four RCTs, only one showed a positive impact.[90] The impact of these decision support interventions on the provision of asthma education/asthma action plans by health care providers was beneficial, but was observed primarily in pre-post studies. In summary, moderate evidence supports the use of decision support interventions to increase the provision of asthma education/asthma action plans by health care providers.

## Organizational Change

Two studies examined how organizational change influenced the provision of patient self-management education and/or asthma action plans, one using an RCT design[93] while the other used a pre-post design.[94] Investigators in the pre-post study[94] instituted a registry to track asthma patients and an asthma case manager, while investigators in the RCT[93] restructured the clinical protocol for how asthma patients are cared for during ambulatory care encounters ("3+ visit plan"). Both studies reported a positive effect from organizational change. In the pre-post study, there was a 10 percent increase in documentation of patient education ($p<0.001$) and a 14 percent increase in documentation of home asthma action plan ($p<0.001$), while in the RCT, the investigators observed a 10 percent increase in asthma education ($p=0.01$).

In general, the effect of organizational changes to increase self-management education/asthma action plan use by health care providers was small. In summary, low strength of evidence supports the use of organizational change as a method to increase the provision of self-management education/asthma action plan by health care providers.

## Feedback and Audit

We identified three RCTs[60-62] and three pre-post studies [65 66 69] evaluating the effect of feedback and audit interventions on the self-management education and use of asthma action plans. Results of feedback and audit interventions for increasing use of self-management education and asthma action plans are positive. Statistically significant positive effects for recording inhaler technique were noted with RCT of a medical record annual asthma and guideline audit with prompt intervention when compared to diabetes control group[61] A significantly higher proportion of recording inhaler technique was reported in the audit and prompting intervention group (proportion difference between intervention and diabetes control group: 12.9 (95% CI: 1.9, 23.9)), yet no difference was reported between the two groups for peak flow meter recording.[61] Asthma action plan use was significantly increased in patients exposed to a benchmarking feedback intervention or benchmarking quality circle (BCQ), i.e. comparing own prescribing performance with performance of GP who performed best in the quality circles (benchmarking), as compared to Traditional Quality circles (TQC) intervention without benchmarking and compared over time between baseline (T1) and 12 months after implementing the intervention (T2) (T1-T2: Benchmark Quality Circle: 6.7 to14.3%, Traditional Quality Circle: 6.1 to10.6%, $p=0.008$).[62] An increase in patient asthma education was reported in use of a feedback tool that applied an algorithm based on guidelines and patient asthma information (Asthma Apgar tool) intervention (asthma education: Pre: 8 %, Post:54 %; $p<0.0001$),[65] and in a feedback intervention comparing individual primary care providers with peers and asthma education for their office staff (asthma education: baseline:30%, 6 months:70%.,[69] but not in a benchmarking feedback intervention.[62] Spacer use was increased in patients enrolled an intervention that involved a letter based prescriber and pharmacist educational plus prescribing feedback intervention pre and post intervention (Feedback and pharmacy education intervention: increased 6 percent to 7 percent, with comparator of control group that received no feedback or pharmacy education with a decreased of 8 to 2 percent in spacer use at post intervention $p=0.007$).[66] No effect in self-management or asthma action plans was demonstrated in a RCT of a prioritized guideline criteria and feedback intervention.[60] Feedback/audit interventions increase asthma self-management education/asthma action plan use, although the amount of increase ranges is variable. In summary, the low strength of evidence supports the use of

feedback and audit interventions to increase the provision of self-management education/asthma action plans by health care providers.

## Clinical Pharmacy Support

We identified one RCT [70] and one prospective cohort study [72] evaluating the effect of clinical pharmacy support on the self-management education and asthma action plans. Patients receiving care by pharmacists enrolled in Pharmacy Asthma Care Program had increased asthma action plan noted as percent change from baseline to 6 months (asthma action plan provision mean change from baseline: 40.4% (95% CI: 31.9, 48.9), p=0.001, however there is no comparison data for the control group.[70] Asthma action plan ownership was also significantly increased at 6 months after implementing a community pharmacy based intervention that provided specialized asthma service, (6 months asthma action plan ownership: INT: 57%, comparison between 3 groups: p<0.001).[72]

In summary, based on two studies with consistent results, moderate evidence supports the use of clinical pharmacy interventions to increase self-management education/asthma action plan use by health care providers.

## Education (alone)

There were five RCTs[73 75 76 95 96] that examined provision of a written asthma action plan as an outcome. Most targeted general practitioners and one focused on pediatricians, with a variety of education only strategies. The education interventions were varied and included small group asthma education programs, structured training, and interactive seminars. Two studies reported statistically significant increases in receipt of an asthma action plan, with increases of 10 percent (p=0.03)[76] and 15 percent (p=0.046)[73]while the other 3 [75 95 96] had no or small effects, which were not statistically significant. One study examined not only whether patients were more likely to receive an asthma action plan[96] but also whether the physicians in the intervention arm were more likely to report using a asthma action plan. A non-statistically significant increase in physician report of asthma action plan was reported. In summary, there is low evidence that educational interventions directed at general practitioners and pediatricians can improve use of asthma action plans. These studies evaluating the use of health care provider education had mixed results in improving patient education/asthma action plan use by health care providers. In summary, low strength of evidence suggests that educational interventions can increase use of asthma action plans by health care providers.

## Quality Improvement and Pay-for-Performance

Three studies examined the effect of quality improvement strategies on receipt of asthma action plans.[97-99] The design of the studies included an RCT[99]
a pre-post study,[97] a controlled, pre-post study. [98] All three studies involved pediatric health care providers, including nurses, nurse practitioners and pediatricians. Two studies assessed participation in a Breakthrough Series collaborative,[98 99] and one study assessed a combination of continuous quality improvement and the addition of a community health worker.[97]

Overall, the results are inconsistent; two of the three studies[97 98] showed a 28 to 32 percent absolute improvement in the proportion of patients who had received an asthma action plan, while the third showed no effect.[99] The two studies that demonstrated an effect were both in selected practices: practices that had already joined a quality improvement initiative[98] or were

part of a demonstration project.[97] In addition, there was some evidence of poor uptake of the quality improvement intervention in the randomized controlled trial.[99]

One study examined the effect of a Breakthrough Series collaborative quality improvement initiative on asthma self-management education in addition to asthma action plans.[98] In this study, documented self-management education in children in the intervention group increased by an absolute 21 percent over children in the control group, although there was no definition of what constituted self-management education and how it was documented.

In summary, there is moderate evidence to support the effectiveness of quality improvement on the prescription of self-management education/asthma action plan use by health care providers.

## Multi-component

Three studies[83 85 100] examined the impact of multimodal interventions on rates at which providers created asthma action plans for their patients. One study [85] was cluster-randomized trial of primary care practices, while the remaining two studies [83 100] were pre-post studies. Although both observational studies reported a positive impact on asthma action plans over time, they could not account for secular trends, and neither experimental study found a statistically significant difference between control and intervention groups. Collectively, there is insufficient evidence to evaluate the effectiveness of multimodal interventions on the provision of patient education/asthma action plans. In summary, because of low study quality and conflicting results, there is insufficient evidence to support the effectiveness of multimodal interventions to increase the provision of self-management/asthma action plans.

## Information Only

No studies examined the impact of information provision alone on self-management education or asthma action plans. Therefore, there is insufficient information to assess the effect of information-only strategies on self-management education/asthma action plan use by health care providers.

**Table 9. Self- management education and asthma action plans outcome - Strength of Evidence for KQ1**

| Intervention | No. of studies/ no. health care providers | Risk of bias | Consistency | Directness | Precision | Strength of evidence & Magnitude of effect |
|---|---|---|---|---|---|---|
| **Decision support** | 10/122-124<br>4RCTs, 6 pre-post | Medium | Consistent | Direct | Precise | SOE :Moderate<br>MOE: Large |
| **Organizational change** | 2/24<br>1RCT, 1 pre-post | Medium | Consistent | Direct | Precise | SOE:Low<br>MOE: Moderate |
| **Feedback and audit** | 6/336<br>3 RCTs, 3 pre-post | Medium | Inconsistent | Direct | Imprecise | SOE: Low<br>MOE: Large |
| **Clinical Pharmacy Support** | 2/ 82<br>1 RCT, 1 cohort | Low | Consistent | Direct | Imprecise | SOE: Moderate<br>MOE: Large |
| **Education** | 5/470<br>5 RCTs | High | Inconsistent | Direct | Imprecise | SOE: Low<br>MOE: Small – moderate |
| **Quality improvement and Pay-for-performance** | 3/ 2213<br>1 RCT, 2 pre-post | High | Consistent | Direct | Precise | SOE: Moderate<br>MOE: Large |
| **Multi-component interventions** | 3/76<br>1RCT, 2 pre-post | High | Inconsistent | Direct | Imprecise | SOE: Insufficient<br>MOE: None |
| **Information only** | 0 | | | | | SOE: Insufficient |

SOE= strength of evidence; MOE = magnitude of effect; RCT= Randomized controlled trial

# KQ2: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact clinical outcomes (e.g., hospitalizations, patient reported outcomes such as symptom control)?

## Outcome: Emergency Department Visits/Hospitalization

### Key Points and Evidence Grades

- There is moderate strength of evidence supporting the effectiveness of decision support interventions to reduce ED visits/hospitalizations. Most of the evidence supporting the use of decision support interventions comes from non-randomized studies.
- There is low strength of evidence favoring the effectiveness of organizational change to reduce ED visits and hospitalizations for asthma.
- There is insufficient evidence to evaluate the effectiveness of feedback ad audit interventions to reduce ED visits and hospitalizations.
- There was insufficient evidence about the effectiveness of clinical pharmacy support interventions to reduce ED visits and hospitalizations for asthma.
- Based on a low strength of evidence, of the evidence suggests that clinician education does not reduce hospitalization/ED visits for asthma.
- There is low strength of evidence to suggest that quality improvement does not decrease ED visits and hospitalizations.
- No studies examined the impact of multi-component interventions on rates of ED visits or hospital admissions (insufficient strength of evidence).
- There is insufficient evidence to evaluate the effect of information-only strategies on ED visits/ or hospitalizations for asthma.

### Decision Support

Of the ten studies evaluating the effect of decision support on ED visits/hospitalizations, four were RCTs, [40 41 92 101] while the remainders were pre-post studies. [47 48 50 53 55 89] The decision support interventions included computer systems, [47 48 55 92]checklists, [101] supplemental feedback protocols,[40] and structured pathways/algorithms.[41 53] These interventions were combined with educational interventions, organizational changes and/or reminders.

The populations in these studies were a mix of adult [47 48 50 89 92 101] and pediatric patients. [40 41 53 55 89] Nine studies reported a reduction in ED visits or hospitalizations,[40 41 47 48 50 53 55 89 101] ranging in impact from 5 percent to 60 percent (all statistically significant) among the studies using a pre-post study design. Among the RCTs, the difference between intervention and control arms ranged from 1 percent to 7 percent. One RCT reported no reduction in ED visits/hospitalizations. [92]

In summary, there is moderate evidence that decision support interventions targeting health care provider adherence to guidelines reduce ED visits/hospitalizations.

## Organizational Change

Four studies evaluating organizational change measured the impact on patient ED visits and/or hospitalizations.[56 57 93 94] Two of these were RCTs,[56 93]while the other two were pre-post studies.[57 94] Three of the studies were focused on pediatric health care providers.[56 57 93] Little specific sociodemographic information is provided about the patient populations. One of the studies restructured asthma care visits[93], while the remaining three studies utilized supplemental trained personnel as part of the intervention. [56 57 94] Three of the studies also incorporated an educational component provided to health care providers.[56 57 94]

Reductions in ED visits and/or hospitalizations were reported by two of the pre-post studies (41% and 54%, respectively, p-value <0.001 for both outcomes[94] and 4% reduction in hospitalizations—no p-value reported[57]), while two of the RCTs (1%, p>0.05[56] and 7%, p=0.06[93]) did not report statistically significant reductions in ED/hospitalization rates compared to the control arms in the study. In summary, the strength of evidence is low that organizational change reduces ED visits/hospitalizations for asthma.

## Feedback and Audit

We identified one RCT[62] and one pre-post design[69] that evaluated the effect of feedback and audit on ED visits and hospitalizations. Clinicians in both studies were primary care practitioners with one study providing asthma education to unspecified office staff.[69] No studies addressed specialty care such as allergy, pediatrics or pulmonary medicine. There was little description of the clinicians by race/ethnicity, gender or number of years of experience.

In the RCT [62], a traditional quality circle (TQC) intervention, in which providers were given feedback on their individual performance and the aggregate performance of group providers, was compared to a benchmark quality circle (BQC) intervention in which feedback on providers' individual performance was explicitly compared to a performance benchmark (the highest-performing 10% of providers in the benchmark arm). The pre-post study [69] evaluated an intervention comparing individual primary care provider's guideline practice patterns with their peers plus providing asthma education to office staff. [69] The studies were conducted in Europe[62] and the U.S.[69]

There was a decrease in ED visits in the RCT comparing a traditional quality circle (TQC) intervention, in which providers were given feedback on their individual performance and the aggregate performance of group providers, with a benchmark quality circle (BQC) intervention, in which feedback on providers' individual performance was explicitly compared to a performance benchmark (the highest-performing 10% of providers in the benchmark arm). [62] Patients whose providers participated in a benchmark quality circle (BQC) had a decrease in ED visits (from 17.6% at baseline to 10.9% twelve months post intervention), but this decrease was smaller than that seen among patients whose provider participated in a traditional quality circle (TQC) (19.7% at baseline to 6.1% twelve months post intervention (p=0.064)).[62] No effect in ED visits were reported in a feedback intervention comparing individual primary care provider's guideline practice patterns with their peers plus providing asthma education to office staff.[69] The RCT did not report a change in hospitalizations[62] nor did the pre-post study comparing individual provider practice patterns with peers.[69] Limited studies show no effect of these interventions on reducing hospitalizations for asthma.

In summary, due to conflicting results among a small number of studies, there is insufficient evidence to determine the effect of feedback and audit interventions on EDvisits/hospitalizations.

## Clinical Pharmacy Support

We identified one RCT[102] evaluating the effect of clinical pharmacy support on the number of ED visits and hospitalizations in patients with asthma. In this RCT of a pharmaceutical care intervention providing patient specific clinical data, training about asthma management, patient educational materials, resource guides, and pragmatic strategies demonstrated a statistically significant decrease in the percent of ED visit or hospitalization at 12 months in the intervention subjects versus the peak flow meter (PFM) teaching control group was reported (Pharmacy Care Program vs. PFM: Odds Ratio 2.16 (95% CI: 1.76,2.63), p= < 0.05 but was not statistically significantly different from the usual care control group (PCP vs. Usual Care: Odds Ratio 1.08; (95% CI:0.93,1.25),p<0.05).[102] In summary, with only one study, there is insufficient evidence to determine the effect of clinical pharmacy support interventions on ED visits/hospitalizations.

## Education (alone)

There were seven studies, 5 RCTs[75-77 96 103] and 2 pre-post studies,[80 82] that examined the impact of education on ED visits and hospitalizations. One only considered ED visits.[96] A variety of educational approaches were used to influence general practitioners, pediatricians and pharmacists, including interactive seminars, structured training and medical grand rounds. The findings for both ED visits and hospitalizations were mixed. For ED visits, the findings included both reduction and increase in visits. One of the studies did not find a statistically significant effect for the intervention group overall, but did show statistically significant findings in a subgroup of low income participants (-1.23 visits per year, p=.001)[75]. For hospitalization, one study showed significant reduction in the annual rate[75] while the other 5 studies showed no reduction on rates of hospitalization. In summary, due to conflicting results among a number of studies, the low strength of evidence suggests that education-alone intervention do not reduce asthma ED visits and/or hospitalizations.

## Quality Improvement and Pay-for-Performance

Two studies examined the effect of Breakthrough Series collaborative quality improvement strategies on ED visits and hospitalizations.[98 99] The two studies were focused on pediatric health care providers working in community health center settings. The patients were primarily African American or Hispanic.

Neither of the two studies showed a reduction in these measures, with one study reporting the percentage of patients requiring either ED visits or hospitalizations[99] and the second the mean number combined acute visits per patient.[98]

In summary, there is low strength of evidence to suggest that quality improvement does not reduce ED visits/hospitalizations., based on the small number of studies, some evidence of poor uptake of the intervention in one study[99], and imprecision in the measurement of outcomes.[99]

## Multi-component

No studies examined the impact of a multimodal intervention on rates of ED visits or hospital admissions. Therefore, the strength of evidence is insufficient to determine the effect of multi-component interventions on ED visits and/or hospitalizations.

## Information Only

One RCT study examined the impact of information provision alone.[88] The study was done in Australia and measured outcomes only in children ages 1-15.[88] Information was inserted into

the charts of patients randomized to the intervention group. However, each provider managed patients in both intervention and control arms simultaneously. This study found no differences in rates of either ED visits or hospitalizations between study groups. In summary, based on a single study with a high risk of bias, there is insufficient evidence to evaluate the effect of information only interventions on ED visits/hospitalizations.

**Table 10. Emergency Department Visits/Hospitalization – Strength of Evidence for KQ2**

| Intervention | No. of studies/ no. health care providers | Risk of bias | Consistency | Directness | Precision | Strength of evidence & Magnitude of effect |
|---|---|---|---|---|---|---|
| **Decision support** | 10/820<br>5 RCTs, 5 Pre-post | Medium | Consistent | Direct | Imprecise | SOE :Moderate<br>MOE: Large |
| **Organizational change** | 4/252<br>2RCTs, 2 pre-post | Medium | Inconsistent | Direct | Imprecise | SOE: Low<br>MOE: Large |
| **Feedback and Audit** | 2/125<br>1 RCT, 1 pre-post | Medium | Inconsistent | Direct | Precise | SOE:Insufficient<br>MOE: Small |
| **Clinical Pharmacy Support** | 1/36<br>1 RCT | Low | Unknown | Direct | Imprecise | SOE:Insufficient<br>MOE: Large |
| **Education** | 7/ 343<br>5RCTs, 2 pre-post | High | Inconsistent | Direct | Imprecise | SOE:Low<br>MOE:None |
| **Quality improvement and Pay-for-performance** | 2/1142<br>1 RCT, 1 pre-post | Medium | Consistent | Direct | Imprecise | SOE:Low<br>MOE: None |
| **Mutli-component** | 0 | | | | | SOE: Insufficient |
| **Information only** | 1/ 13<br>1 RCT | High | Unknown | Direct | Imprecise | SOE:Insufficient<br>MOE: None |

SOE= strength of evidence; MOE = magnitude of effect; RCT= Randomized controlled trial

# Outcome: Missed Days of Work/School

## Key Points and Evidence Grades

- There is insufficient strength of evidence determine the effect of decision support on the number of missed days of work/school from asthma.
- There is insufficient evidence to determine the effect of organizational change interventions on the number of missed days of work/school from asthma.
- The strength of evidence is insufficient to determine effect of feedback and audit interventions on the number of work or school days missed.
- No clinical pharmacy support interventions addressed the outcomes of missed days of work/school from asthma. (Insufficient strength of evidence)
- There is insufficient evidence to evaluate the effect of education alone strategies on missed days of work/school from asthma.
- There is insufficient evidence to evaluate the effect of quality improvement interventions on missed days of work/school from asthma.
- No studies examined the impact of multi-component interventions on missed days of work/school from asthma. (insufficient strength of evidence)
- No studies are available to evaluate the effectiveness of the provision of information to health care providers on the number of missed days of work/school from asthma (insufficient).

## Decision Support

The two studies examining the impact of decision support interventions on missed work or school had differing results. One study used an RCT design[40] while the other used a pre-post design.[89] Both involved children, although the pre-post study.[89] also included adult patients. The RCT[40] reported no reduction in missed school in their study of providing supplemental morbidity information to health care providers. The pre-post study[89] reported a 49 percent reduction ($p<0.001$) in school absenteeism and a 51 percent reduction in the odds of missed work (Odds Ratio 0.49 (95% CI: 0.34,0.71)) among the patient populations in a study that utilized a combination of an asthma care map, a treatment flow chart, program standards, management flow chart and action plan.

In summary, based on two studies with inconsistent results there is insufficient evidence to evaluate the effect of decision support interventions on the number of missed days of school or work.

## Organizational Change

One study of organizational change, based on restructuring the clinical protocol for how asthma patients are cared for during ambulatory care encounters ("3+ visit plan"), evaluated the impact on missed school days and observed no significant effect.[93]

In summary, with only one study, there is insufficient evidence to evaluate the effect of organizational change intervention on the number of missed days of school or work.

## Feedback and Audit

We identified one pre-post study[69] that evaluated the effect of feedback and audit on work and school days missed. Use of a feedback intervention comparing individual primary care provider's guideline practice patterns with their peers plus providing asthma education to office staff had no effect on work or school days missed.[69] In summary, in the one study eligible to evaluate feedback/audit did not reduce the number of missed days of work/school. In summary, with only one study, there is insufficient evidence to evaluate the effect of feedback and audit interventions on the number of missed days of school or work.

## Clinical Pharmacy Support

We identified no studies evaluating the effect of clinical pharmacy support on the outcome of missed days of work and school. Therefore, there is insufficient evidence to evaluate the effect of clinical pharmacy support interventions on the number of missed days of school or work.

## Education (alone)

There were 3 RCTs[73 75 77] that included children missing school as an outcome. The interventions targeted general practitioners, pediatricians and pharmacists and included structured training, seminars and workshops. In all 3 trials there was consistent evidence of small positive effects that did not reach statistical significance. Thus, there is insufficient evidence that education alone strategies aimed at various types of care providers can reduce school absenteeism from asthma.

Two RCTs[73 95] and one pre-post study[80] examined missed work as an outcome, including one study that had a compound outcome of missing either work or school. The interventions included workshops, training in how to perform spirometry and one study had compared asthma program development to a nurse educator program or continuing education. Results were mixed and in each study were not statistically significant. In summary,

In summary, the study results were inconsistent and had imprecise estimates of the effect of these education interventions. Therefore there is insufficient evidence to evaluate the effect of education-only strategies on the number of missed days of work/school from asthma.

## Quality Improvement and Pay-for-Performance

One pre-post study examined the effect of participation in a Breakthrough Series collaborative quality improvement strategy on missed days of school in children and missed days of work in their parents.[98] This study showed no effect on the mean number of school days or parental work days missed due to a child's asthma. In summary, with only a single study with imprecise outcome estimates, there is insufficient evidence to determine the effect of quality improvement interventions on school or work absenteeism.

## Multi-component

No studies examined the impact of multi-component on missed days of work or school.

## Information Only

No studies examined the impact of information provision alone on missed days of work or school.

**Table 11. Missed Days of Work/School– Strength of Evidence for KQ2**

| Intervention | No. of studies/ no. health care providers | Risk of bias | Consistency | Directness | Precision | Strength of evidence & Magnitude of effect |
|---|---|---|---|---|---|---|
| **Decision support** | 2/435<br>1RCT, 1 pre-post | Medium | Inconsistent | Direct | Precise | SOE: Insufficient<br>MOE: small-large |
| **Organizational change** | 1/24<br>1RCT | Low | Unknown | Direct | Imprecise | SOE: Insufficient<br>MOE: Small |
| **Feedback and Audit** | 1/29<br>1 pre-post | High | Unknown | Indirect | Imprecise | SOE: Insufficient<br>MOE: Small |
| **Clinical Pharmacy Support** | 0 | | | | | SOE: Insufficient |
| **Education** | 5/1767<br>4 RCTs, 1 pre-post | High | Inconsistent | Direct | Imprecise | SOE :Insufficient<br>MOE: Small |
| **Quality improvement and Pay-for-performance Information only** | 1/511<br>1 pre-post | High | Unknown | Direct | Precise | SOE: Insufficient<br>MOE: Small |
| **Multi-component** | 0 | | | | | SOE: Insufficient |
| **Information only** | 0 | | | | | SOE: Insufficient |

**SOE= strength of evidence; MOE = magnitude of effect; RCT= Randomized controlled trial**

## KQ3: In the care of pediatric or adult patients with asthma, what is the evidence that interventions designed to improve health care provider adherence to guidelines impact health care process outcomes that then affect clinical outcomes?

We identified no studies providing evidence on the link between changes in health care provider behavior (health care process outcomes) to changes in clinical outcomes.

# Discussion

## Key Findings

The key findings from this report are summarized below, according to Key Question and by type of intervention.

### KQ1: In the care of pediatric or adult patients with asthma, what is the evidence that Interventions designed to improve health care provider adherence to guidelines impact health care process outcomes (e.g., receiving appropriate treatment)?

The key findings are summarized in Table 12.

**Table 12. Summary of Strength of Evidence for included studies for KQ1**

| Outcomes | Intervention | No. of studies/ no. health care providers | Strength of evidence | Conclusions |
|---|---|---|---|---|
| Prescriptions for controller medications | Decision support | 15/1,635<br>6 RCTs,9 Pre-post | Moderate | Most of the evidence supporting the use of decision support Interventions comes from a number of non-randomized studies consistently showing that decision support interventions can increase health care provider prescriptions for asthma controller medications. |
| | Organizational change | 2/228<br>1RCT, 1 pre-post | Low | Although far fewer studies performed using organizational change (in comparison with Decision Support or Feedback/Audit), the findings consistently showed that organizational change can increase health care provider prescriptions for controller medicines, but the effect on prescriptions by health care providers is smaller. |
| | Feedback and audit | 12/ 1,831<br>6 RCTs, 6 pre-post | Moderate | These studies consistently showed that feedback/audit interventions effectively increase prescriptions for controller medicines by health care providers. In a couple of studies, the increase was quite large (>40%). |
| | Clinical Pharmacy Support | 3/ 91<br>1 RCT, 2 cohort | Moderate | The three studies were consistent in showing that clinical pharmacy support interventions increase asthma controller medication prescribing |
| | Education | 10/ 451<br>6RCTs, 4 pre-post | Moderate | The evidence suggests that interventions based only on education of clinicians do not improve prescription of asthma controller medications. |
| | Quality Improvement and Pay-for-Performance | 0 study | Insufficient | Studies are needed to determine if quality improvement/pay-for-performance interventions are an effective means to increase prescriptions for controller medicines by health care providers. |
| | Multi-component interventions | 4/ 842<br>3 Cluster randomized, 1 | Insufficient | There is insufficient strength of evidence to determine that effect of multi-component interventions on prescribing of asthma |

| Outcomes | Intervention | No. of studies/ no. health care providers | Strength of evidence | Conclusions |
|---|---|---|---|---|
| | | pre-post | | controller medications for asthma. |
| | Information Only | 2/107<br>1 RCT, 1 quasi-experimental | Insufficient | Inconsistent and limited studies have resulted in the assessment that the evidence is insufficient to determine the effect of information alone on prescribing of asthma controller medication. |
| Patient education/asthma action plans | Decision support | 10/122-124<br>4RCTs, 6 pre-post | Moderate | A majority of non-randomized studies consistently favor the use of decision support interventions to improve the provision of self-management education/asthma action plans by health care providers. |
| | Organizational change | 2/24<br>1RCT, 1 pre-post | Low | Both studies favor the use of organizational change to increase patient education/asthma action plan use by health care providers. However, more studies are needed to increase the strength of evidence. |
| | Feedback and audit | 6/336<br>3 RCTs, 3 pre-post | Low | Despite a number of studies examining feedback/audit, inconsistent results lead to a low strength of evidence for the use of feedback/audit to improve self-management education/ asthma action plan use. |
| | Clinical Pharmacy Support | 2/ 82<br>1 RCT, 1 cohort | Moderate | The two studies are consistent in favoring the use of Clinical Pharmacy Support to improve self-management education/asthma action plan use by health care providers |
| | Education | 5/470<br>5 RCTs | Low | Small increases in asthma self-management education were observed in a minority of studies, resulting in an overall low strength of evidence regarding this outcome. |
| | Quality Improvement and Pay-for-Performance | 3/ 2213<br>1 RCT, 2 pre-post | Moderate | Two of the three studies report that quality improvement increases self-management education/ asthma action plans. |
| | Multi-component interventions | 3 /76<br>1 RCT, 2 pre-post | Insufficient | Conflicting results among a few studies indicates there is insufficient evidence to evaluate the effect of multi-component interventions on self-management education/asthma action plan use by health care providers. |
| | Information Only | 0 | Insufficient | Studies are needed to determine if information alone is effective in improving rates of self-management education and the provision of asthma action plans by health care providers. |

## KQ2: In the care of pediatric or adult patients with asthma, what is the evidence that Interventions designed to improve health care provider adherence to guidelines impact clinical outcomes (e.g., hospitalizations, patient reported outcomes such as symptom control)?

The key findings are summarized by outcome in Table 13.

**Table 13 . Summary of Strength of Evidence for included studies for KQ2**

| Outcomes | Intervention | No. of studies/ no. health care providers | Strength of evidence | Conclusions |
|---|---|---|---|---|
| ED Visits/Hospitalizations | Decision support | 10/820<br>5 RCTs, 5 Pre-post | Moderate | 9 of 10 studies reported that decision support interventions reduce ED visits/hospitalizations. |
| | Organizational change | 4/252<br>2RCTs, 2 pre-post | Low | Inconsistent results account for the low strength of evidence for organizational change to reduce ED visits/hospitalizations. |
| | Feedback and audit | 2/125<br>1 RCT, 1 pre-post | Insufficient | Inconsistent results from a limited number of studies has resulted in an insufficient grade of evidence to evaluate the impact of feedback and audit interventions on ED visits and hospitalizations |
| | Clinical Pharmacy Support | 1/36<br>1 RCT | Insufficient | There is insufficient evidence available to determine the effect of clinical pharmacy support interventions on ED visits/hospitalizations. |
| | Education | 7/343<br>5 RCTs, 2 pre-post | Low | Overall, due to conflicting results among a number of studies, the low strength of evidence suggests that education-alone interventions do not reduce asthma ED visits and/or hospitalizations. |
| | Quality Improvement and Pay-for-performance | 2/1142<br>1 RCT, 1 pre-post | Low | Two studies show that quality improvement does not reduce ED visits and hospitalizations. More studies are needed. |
| | Multi-component | 0 | Insufficient | There is no published evidence to evaluate the impact of multimodal interventions on ED visits or hospitalizations. |
| | Information only | 1/ 13<br>1 RCT | Insufficient | Based on a single study with a high risk of bias, there is insufficient evidence to determine the effect of information-only interventions on ED visits/hospitalizations. |
| Missed days of work/school | Decision support | 2/435<br>1RCT, 1 pre-post | Insufficient | There is insufficient evidence to evaluate the effect of decision support interventions on the number of missed days of work/school. |
| | Organizational change | 1/24<br>1RCT | Insufficient | There is insufficient evidence to evaluate the effect of organizational change on missed days of work or school. |
| | Feedback and audit | 1/29<br>1 pre-post | Insufficient | There is insufficient evidence to evaluate the effect of feedback and audit interventions on the number of missed days of work and school from asthma. |
| | Clinical Pharmacy Support | 0 | Insufficient | There is insufficient evidence to evaluate the effect of clinical pharmacy support interventions on the number of missed days of work and school from asthma. |

| Outcomes | Intervention | No. of studies/ no. health care providers | Strength of evidence | Conclusions |
|---|---|---|---|---|
| | Education | 5/1767<br>4 RCTs, 1 pre-post | Insufficient | There is insufficient evidence to evaluate the effect of education-only strategies on the number of missed days of work/school from asthma. |
| | Quality Improvement and Pay-for-performance | 1/511<br>1 pre-post | Insufficient | There is insufficient evidence to evaluate the effect of quality improvement/pay-for-performance interventions on the number of missed days of work/school from asthma. |
| | Multi-component | 0 | Insufficient | There is insufficient evidence to evaluate the effect of multi-component interventions on the number of missed days of work/school from asthma. |
| | Information only | 0 | Insufficient | There is insufficient evidence to evaluate the effect of multi-component interventions on the number of missed days of work/school from asthma. |

## Applicability

We assessed applicability of these studies to the relevant potential users of this review using the PICOS framework. We have detailed our assessment more specifically below, according to each PICOS element:

**Table 14. Applicability**

| Domain | Description of applicability of evidence |
|---|---|
| **Population - Provider** | From a health care provider perspective, primary care providers were essentially the only targeted population of the studies we reviewed. The types of primary care providers were varied, but primarily focused on physicians, although some studies did include nurses, nurse practitioners and pharmacists. No studies targeted respiratory therapists and only one study included an asthma specialist (pulmonologist or allergist). |
| **Population - Patients** | A minority of studies described the patient population in detail—these often were U.S.-based studies that were conducted in settings with a high proportion of African American, Latino and/or poor patients. Therefore, we believe that at least some of the interventions reviewed could be implemented in settings that care for such patient populations. |
| **Intervention** | In terms of the interventions themselves, general descriptions of the content and administration were provided, but often without an explanation of dose or intensity needed—this would be important for: 1) those deciding what intervention to replicate for their own setting; 2) estimating the likelihood of successful implementation and long-term sustainability of a given intervention; 3) determining how likely health care providers are to buy-in and adhere to using these interventions in their routine clinical practice. In addition, three intervention types were most frequently studied: decision support, feedback/audit, and education accounted for 80% of the interventions we reviewed. There were relatively few studies of organizational change, quality improvement, information-only strategies or even using a combination of interventions. |
| **Comparators** | We often were not able to discern with any specificity what the comparative condition was in these studies, since the comparator was often described as “usual care”. This limitation was true even among the RCTs we reviewed. |
| **Outcomes** | There were a number of different health care process and clinical outcomes evaluated in these studies, although these were heavily skewed to 2 – 3 outcomes: prescribing of asthma controller medicines; self-management education; asthma action plans; and emergency department visits/hospitalizations accounted for the vast majority of outcomes studied. Therefore, those seeking to impact these outcomes have data available to base an intervention choice upon, while those seeking to reduce missed days of school or other infrequently studied outcomes will not have sufficient evidence upon which to base this decision. |
| **Setting** | We observed a nearly equal distribution of studies conducted in the U.S. vs. outside of the U.S. The non-U.S. study locations were quite varied and included Africa, Asia, Australia, Canada and Europe. There was relatively little detail about the specific settings in which the studies were conducted, so applicability to a specific clinical type is limited. |

## Limitations of Review

There are a number of limitations of our review that should be acknowledged. First, we did not consider or search for reports of potentially relevant studies in the grey literature. This means that our evidence base could be open to publication bias. We did not complete formal assessment of publication bias as this is challenging, at best. It has been suggested that funnel plots be used to check for publication bias, however, these are difficult to interpret and considered unhelpful for comparisons and outcomes with less than 10 studies.[104]

We identified potentially eligible studies that were published in a language other than English (i.e., no restrictions by language in search) but were unable, due to resource limitations,

to consider these articles for inclusion in the review. While this raises the possibility of introducing publication bias, we do not feel that the exclusion of the non-English reports of studies influenced our conclusions or ability to draw conclusions. In addition, there were only 20 of 3, 846 abstracts and 16 of 244 articles excluded because they were not in English and we could not determine eligibility. Therefore, these represent a minority of the studies excluded. Furthermore, it is unclear if these studies would be relevant to the U.S. health care setting or U.S. health care provider.

We determined that the heterogeneity in the studies, including in how outcomes were measured, study populations and specific details of interventions, precluded the conduct meta-analyses. A narrative synthesis is thus more appropriate, but does not always give the bottom-line answer that decision-makers would like.

To maintain a reasonable scope for both the conduct of our review and readers of the report, we limited our narrative synthesis to four critical outcomes. Although these outcomes were chosen as those most important for making decisions, limiting our synthesis to these outcomes meant that we could not comment on the effectiveness of these interventions in improving other elements of asthma care (e.g., environmental control practices) or asthma outcomes (e.g., symptom-free days).

We did not include studies in which interventions were specifically targeted at both health care providers and patients for which we could not distinguish whether changes in outcomes were due to changes amongst the providers or patients. We did not evaluate patient adherence to health care provider prescribed treatment, which might moderate the clinical outcomes measured in our review. We suggest this review be considered along with the existing EPC report on patient adherence.[105]

## Limitations of Evidence Base

There was relatively little published data available to evaluate the impact of interventions on most clinical outcomes (except for ED visits/hospitalizations), highlighting the need for more evidence for those seeking to implement evidence-based interventions targeting health care providers. Specific limitations in the evidence we identified is detailed using the PICOTS framework in the Future Research section.

## Findings in Relationship to What Is Already Known

We conducted a search for relevant Cochrane reviews and excluded 63 of 86 at the title-search screening level for lack of relevance. Of the remaining 23 reviews, we identified 10 reviews as relevant, five of which had some asthma-related outcomes relevant to and included in this review.[42 61 78 92 103] Of the reviews addressing relevant interventions (but not asthma per se), we had similar findings of primarily modest effects observed in low quality studies of education[106-110]; Pay-for-performance[111-113]; Reminder systems[114 115];and Feedback/Audit.[116 117] These findings suggest that additional evidence is needed to fully evaluate the effectiveness of these interventions in improving health care provider adherence to guidelines and, ultimately, clinical outcomes.

# Future Research

**Table 15. Future Research**

| | Observation | Recommendation for Future Research |
|---|---|---|
| **Population** | Inadequate clinical and socio-demographic descriptions of the patient population. | Measure asthma control/severity, race/ethnicity, gender, socioeconomic status, etc. in patient populations to more effectively compare effectiveness between studies of interventions. |
| | | Test efficacy of multifaceted individualized interventions *targeting* a specific group of subjects (i.e., young or older age groups, high asthma severity, and high health care utilizers). |
| **Intervention** | Few studies utilized a randomized, controlled intervention approach. | Augment number of studies with RCT design, especially as reviewed RCTs tended to yield more equivocal results. |
| | The reported impact on healthcare provider behaviors (even when illustrating a beneficial effect) was modest, suggesting that certain barriers to provider adherence to asthma guidelines remained unaddressed. | Develop/incorporate new strategies or combinations of strategies to increase provider adherence to guidelines. |
| | Relatively few computer-based interventions. | Computerized systems offer an opportunity to increase efficiency in the health care process, thereby potentially improving provider adherence to guidelines. If time constraints pose a barrier to adherence, electronic/ computer-based interventions may meaningfully improve delivery of asthma care. |
| | Strategies were generally "passive" (i.e., suggesting care to the provider; discussing asthma management generally, but not for specific patients). | Interventions should take a more *active* role in asthma care process (e.g., provide asthma action plans, patient education, environmental control practices), particularly processes associated with a low risk of harm and those inhibited by specific barriers such as time constraints, poor self-efficiency, lack of awareness. Focus on health care processes impeded by logistical barriers, rather than those barred by provider discord regarding recommendations or lack of outcome expectancy.[1] |
| | Interventions were often narrow in scope and failed to address the comprehensive and complex tasks health care providers must execute in order to be adherent to asthma guideline recommendations (as well as "competing" guidelines including well child care, chronic comorbidities). | Test interventions that address all of the elements of the asthma health care process (or as many as is feasible). For example, an intervention that would facilitate/expedite the following elements of care in a single visit might be beneficial: (1) Rx for controller medicine, (2) environmental control practice recommendations, (3) self-management education and asthma action plans, (4) documentation of asthma control/severity, (5) Rx of peak flow meter, (6) schedule of automatic follow-up visits within 3 months of visit.[1] |
| | | Specify *multifaceted interventions* to include provider education + feedback + decision support (or other combinations that seem most potent mixtures of interventions).<br>• Test similar multifaceted models.<br>• Multifaceted interventions are feasible because they are more translatable than interventions limited to one modality.<br>• Caveat: multifaceted interventions are more costly.[2] |

| | | |
|---|---|---|
| | Inadequate description or measure of dose. | Measure or address intervention "dose." For example, if only 50 percent of provider participate in intervention, dose is important. |
| **Comparisons** | Pre/post designs common. Uncontrolled studies used. | Move beyond pre-post studies; use cluster RCTs; conduct studies with appropriate control groups. |
| **Outcome** | Heterogeneity in presentation of the outcome measures. | Develop minimum standards for presentation of outcomes (e.g., percent change in prescriptions for inhaled steroids). Other outcomes could be presented, but at minimum, one standard would facilitate comparisons between studies. |
| | Studies failed to link changes in health care process to clinical outcomes. | Develop studies that illustrate how specific changes in provision of care manifest improvements in patient outcomes. |
| | Subjectivity/variability in clinical outcome measures including:<br>1. Hospitalizations, ED visits | Objective/reliable outcome measures:<br>1. Administrative health care utilization data for verification of ED visits, hospitalizations; standardization of cut-points. |
| | Subjectivity/variability in health care process outcomes measures including:<br>1. Lack of determination of appropriateness of controller medication prescriptions<br>2. Lack of assessment of patient medication adherence as an outcome and/or a modifier of outcomes | Utilize pharmacy data or electronic monitoring of medication use to objectively measure controller medication adherence by patients as a clinical outcome.<br>**Consider additional metrics as indicators of appropriate care, e.g.,**<br>Use of controller meds: >6 fills per 12 months.<br>Controller-to-total asthma medication ratio: # controller fills in past 12 months/# controller fills + all other asthma med fills. (Cut-point: >0.5). |
| | Lack of use of significance tests | Develop standards for inclusion of significance testing of data presented (e.g., chi-squared for proportions) |
| **Timeframes** | | No new recommendations |
| **Settings of care** | | No new recommendations |

# Implications for Clinical and Policy Decision Making

For decisionmakers and health care providers alike, there are proven strategies that can be implemented to improve the adherence of health care providers to asthma guideline recommendations. In particular, decision support, feedback/audit and clinical pharmacy support strategies more often were associated with improving provider adherence to guidelines than other interventions (e.g., education). With the exception of education interventions, these strategies were more often studied and more often improved provider adherence to guidelines. It is not clear from our review of the literature why some intervention types have been more studied than others. Education –based interventions were most likely to show no benefit, so may not be worth pursuing as an isolated strategy. Most studies tested a single strategy, although there were a few studies that utilized multiple strategies (Table 16)—too few to draw any definitive conclusions whether such "multi-modal" interventions are more successful than single-intervention studies. A number of studies were tested in busy primary care settings, suggesting that these interventions should be implementable by busy health care providers. However, few harms were reported in the studies we reviewed (only one study reported an unintended harm). Given that

few studies reported on the frequency and intensity of exposure to the intervention, there is little evidence available to estimate the likelihood of sustainable implementation of these interventions into routine clinical practices. More specifically, issues of time constraints, work flow considerations and limited resources were not addressed in these studies, so we cannot be sure that these interventions can be adapted without significant modification. That being said, there were some promising findings, particularly among interventions that utilized decision support, feedback/audit or clinical pharmacy support strategies to improve health care provider adherence to guidelines. These strategies tended to have higher levels of strength and larger magnitudes of effect in comparison to other intervention strategies (e.g., education or information only). Many studies utilized a variety of health care providers, so generalizability of health care provider types is strength. Although these studies included nurse practitioners and other mid-level/ancillary providers, there were few that were directed specifically at those groups, so there is more to learn about interventions targeting those health care provider populations. Lastly, it is unknown what the impact of different patient populations and behaviors might be on the true effect of implementing these interventions.

**Table 16. Primary and Secondary Interventions Utilized by the Included Studies**

| Author, Year | Decision Support | Organizational Change | Feedback and Audit | Clinical Pharmacy Support | Education | Quality Improvement and Pay-for-Performance | Multi-component | Information Only |
|---|---|---|---|---|---|---|---|---|
| Ables AZ, 2002[118] | | | | | P | | | |
| Armour C., 2007[70] | | | | P | | | | |
| Baker R., 2003[119] | | | | | P | | | |
| Baker R., 2003[60] | | | P | | S | | | |
| Bell L.M., 2010[43] | P | | | | S | | | |
| Bender B. G., 2011[83] | | | | | | | P | |
| Blackstien-Hirsch P., 2000[82] | S | | | | P | | | |
| Brown R, 2004[75] | | | | | P | | | |
| Bryce FP, 1995[88] | | | S | | | | | P |
| Cabana M. D., 2006[103] | | | | | P | | | |
| Cho S. H., 2010[46] | P | | | | S | | | |
| Clark NM, 1998[76] | | | | | P | | | |
| Cloutier M. M., 2002[51] | P | | | | S | | | |
| Cloutier M. M., 2005[49] | P | | | | S | | | |
| Cloutier M.M., 2009[53] | P | | | | S | | | |
| Coleman C. I., 2003[66] | | | P | | | | | |
| Cowie R. L., 2001[80] | | | | | P | | | |
| Daniels E. C., 2005[85] | | | | | | | P | |

| Author, Year | Decision Support | Organizational Change | Feedback and Audit | Clinical Pharmacy Support | Education | Quality Improvement and Pay-for-Performance | Multi-component | Information Only |
|---|---|---|---|---|---|---|---|---|
| Davis AM, 2010[52] | P | | | | | | | |
| Davis R. S., 2004[81] | | | | | P | | | |
| de Vries T. W., 2010[71] | | | S | P | S | | | |
| Eccles M., 2002[42] | P | | | | S | | | |
| Fairall L., 2010[38] | P | | | | S | | | |
| Feder G, 1995[61] | | | P | | S | | | |
| Finkelstein J. A., 2005[56] | | P | S | | | | | |
| Foster J. M., 2007[120] | | | P | | S | | | |
| Fox P., 2007[97] | | | | | | P | | |
| Frankowski B. L., 2006[100] | | S | S | | | | P | |
| Glasgow N. J., 2003[93] | | P | | | | | | |
| Gorton T. A., 1995[121] | S | | | | P | | | |
| Hagmolen, W., 2008[84] | | | | | | | P | |
| Halterman J. S., 2005[122] | P | | | | | | | |
| Halterman J.S., 2006[90] | P | | | | | | | |
| Herborg H., 2001[68] & [123] | | | P | S | | | | |
| Holton C., 2011[95] | | | | | P | | | |
| Homer CJ, 2005[99] | | | | | | P | | |
| Horswell R., 2008[48] | P | | S | | | | | |
| Hoskins G., 1997[64] | | | P | | S | | | |

| Author, Year | Decision Support | Organizational Change | Feedback and Audit | Clinical Pharmacy Support | Education | Quality Improvement and Pay-for-Performance | Multi-component | Information Only |
|---|---|---|---|---|---|---|---|---|
| Kattan M., 2006[40] | P | | S | | | | | |
| Lesho E. P., 2005[50] | P | | | | S | | | |
| Liaw S. T., 2008[124] | | | | | P | | | |
| Lozano P., 2004[125] | S | | | | P | | | |
| Lundborg C. S., 1999[86] | | | P | | | | S | |
| Mahi-Taright S., 2004[79] | | | | | P | | | |
| Mangione-Smith R., 2005[98] | | S | | | | P | | |
| Martens J. D., 2006[87] | P | | | | | | | |
| Martens J. D., 2007[39] | P | | | | | | | |
| Massie J, D., 2004[126] | | | | | | | P | |
| McCowan C, 2001[92] | P | | | | | | | |
| Mitchell E. A., 2005[41] | P | | | | S | | | |
| Newton W. P., 2010[47] | P | S | | | | | | |
| O'Laughlen MC, 2008[127] | P | | | | S | | | |
| Patel P. H., 2004[94] | | P | | | | | | |
| Premaratne U. N., 1999[78] | | | | | P | | | |
| Ragazzi H., 2011[54] | P | S | | | S | | | |
| Rance K., 2011[44] | P | | | | | | | |
| Renzi P. M., 2006[101] | P | | | | | | | |

| Author, Year | Decision Support | Organizational Change | Feedback and Audit | Clinical Pharmacy Support | Education | Quality Improvement and Pay-for-Performance | Multi-component | Information Only |
|---|---|---|---|---|---|---|---|---|
| Richman M. J, 2000[69] | | | P | | S | | | |
| Ruoff G., 2002[91] | P | | | | | | | |
| Saini B, 2004[72] | | | S | P | | | | |
| Schneider A., 2008[62] | | | P | | | | | |
| Shah S., 2011[73] | | | | | P | | | |
| Shapiro A., 2011[45] | P | | | | | | | |
| Shiffman R. N., 2000[55] | P | | | | | | | |
| Smeele I. J., 1999[74] | | | | | P | | | |
| Sondergaard J., 2002[59] | | | P | | | | | |
| Stergachis A, 2002[77] | | | | | P | | | |
| Suh D. C., 2001[67] | | | P | | S | | | |
| Sulaiman N. D., 2010[96] | | | | | P | | | |
| Thyne S.M., 2007[57] | | P | S | | P | | | |
| To T., 2008[89] | P | | | | S | | | |
| Veninga CCM, 1999[58] | | | P | | | S | | |
| Veninga CCM, 2000[63] | | | P | | S | | | |
| Weinberger M, 2002[102] | | | S | P | | S | | |
| Yawn BP, 2008[65] | S | | P | | S | | | |

**P = Primary intervention; S = secondary intervention(s)**

## Conclusions

In conclusion, there is some evidence to support the use of decision support tools, feedback and audit, and clinical pharmacy support interventions to improve the adherence of health care providers to prescribing asthma controller medicines and to reduce ED visits/hospitalizations. However, we commonly observed an insufficient level of evidence to evaluate the effectiveness of a number of interventions. Therefore, there is a significant need to further evaluate other types of health care provider-targeted interventions (e.g., multi-modal) and other health care process or clinical outcomes (e.g., missed days of work/school).

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