Quality Improvement Strategies for Children With Asthma

A Systematic Review

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Objective: To evaluate the evidence that quality improvement (QI) strategies can improve the processes and outcomes of outpatient pediatric asthma care.

Data Sources: Cochrane Effective Practice and Organisation of Care Group database (January 1966 to April 2006), MEDLINE (January 1966 to April 2006), Cochrane Consumers and Communication Group database (January 1966 to May 2006), and bibliographies of retrieved articles.

Study Selection: Randomized controlled trials, controlled before-after trials, or interrupted time series trials of English-language QI evaluations.

Interventions: Must have included 1 or more QI strategies for the outpatient management of children with asthma.

Main Outcome Measures: Clinical status (eg, spirometric measures); functional status (eg, days lost from school); and health services use (eg, hospital admissions).

Results: Seventy-nine studies met inclusion criteria: 69 included at least some component of patient education, self-monitoring, or self-management; 13 included some component of organizational change; and 7 included provider education. Self-management interventions increased symptom-free days by approximately 10 days/y (P=.02) and reduced school absenteeism by about 0.1 day/mo (P=.03). Interventions of provider education and those that incorporated organizational changes were likely to report improvements in medication use. Quality improvement interventions that provided multiple educational sessions, had longer durations, and used combinations of instructional modalities were more likely to result in improvements for patients than interventions lacking these characteristics.

Conclusions: A variety of QI interventions improve the outcomes and processes of care for children with asthma. Use of similar outcome measures and thorough descriptions of interventions would advance the study of QI for pediatric asthma care.


Asthma is the most common chronic childhood medical condition in the United States, with serious economic and public health consequences. It affects 4.2 million children in the United States and results in an estimated 14.7 million missed school days, 727,000 emergency department visits, and 196,000 hospitalizations annually. Among children with chronic medical conditions, asthma is the most common reason for hospitalization and school absence. An estimated $10.7 billion was spent in the United States in 1994 on asthma-related costs—a cost that is expected to rise to $18 billion by 2020.

Despite the availability of evidence-based guidelines for the management of pediatric asthma, a significant gap remains between accepted best practices for pediatric asthma care and actual care delivered to asthmatic patients in the United States. For example, although the National Committee for Quality Assurance has found that more patients with asthma have been prescribed appropriate asthma medications in recent years (71% in 2003 vs 63% in 2000), many children with asthma and their caregivers do not use preventive medications or know how to prevent or treat asthma attacks. Diette and colleagues evaluated the rate of adherence of asthma care with the National Asthma Education and Prevention Program guidelines for 318 pediatric patients. They found that only 55% of eligible patients used preventive medications daily, 49% had written instructions for handling asthma attacks, and 44% had instructions for adjustment of medication before exposures.
Given the enormous public health impact of childhood asthma, the Institute of Medicine has designated quality improvement (QI) in asthma care (especially for children with mild/moderate persistent asthma) as a priority area. The objective of this study was to evaluate the evidence that QI strategies can improve the processes and outcomes of outpatient pediatric asthma care. Specifically, we sought to evaluate the effects of a variety of types of QI strategies, used singly and in combination, in a variety of outpatient settings to describe the strategies consistently associated with the greatest improvements for children with asthma.

METHODS

We sought articles describing evaluations of QI strategies for pediatric asthma care. We developed a taxonomy of 9 QI strategies, described in detail elsewhere, based on several well-established classification systems. The 9 strategies are patient education, provider education, organizational change, audit and feedback, provider reminders, patient reminders, facilitated relay of clinical data to providers, financial or legislative incentives, and the promotion of self-monitoring or self-management. We classified interventions as being principally self-management if the goal of the intervention was to improve the ability of children with asthma or their caregivers to self-monitor and take actions that could reduce the impact of asthma on their lives. In contrast, we classified interventions as being principally patient education if the purpose was to increase asthma knowledge or improve inhaler technique without emphasizing patient decision making or behavior change.

LITERATURE SEARCH AND DATA SOURCES

In collaboration with professional librarians, we developed search strategies using search terms such as asthma, patient education, caregiver education, self-management, provider education, and reminders (complete search strategies available elsewhere). We searched 3 databases: the Cochrane Effective Practice and Organisation of Care Group database (January 1966 to April 2006), the Cochrane Consumers and Communication Group database (January 1966 to May 2006), and MEDLINE (January 1966 to April 2006). We also manually searched the bibliographies of all retrieved articles.

STUDY SELECTION

We included studies that evaluated QI interventions in the outpatient setting for pediatric asthma. We excluded studies that enrolled only adults (age ≥18 years). For studies that enrolled both children and adults, we excluded studies that did not provide separate data for participating children.

We included studies with 1 of 3 designs: randomized controlled trials (RCTs), controlled before-after trials that included contemporaneous observation periods for control and intervention groups, and interrupted time series trials that reported data at 3 or more points both before and after intervention to facilitate time trend analysis. Included studies had to report at least 1 of the 4 primary outcome measures: clinical status (eg, symptoms or symptom-free days, spirometric measures, number of asthma attacks); functional status (eg, days lost from work or school); health services use (eg, hospital admissions, emergency department visits); or adherence to guidelines (eg, number of patients given prescriptions for inhaled corticosteroids).

STUDY QUALITY

For each included study, we assessed the following predefined quality criteria: whether the investigators clearly described the QI intervention; whether the investigators cited previous literature or a theoretical (conceptual) framework to describe the evidence base for their proposed intervention; whether the patient, caregiver, and/or assessors were blinded to the intervention; whether inclusion/exclusion criteria were explained; whether the unit of analysis was explained; whether intervention assignments were adequately concealed; whether the comparison populations and sites were comparable; and whether informed consent and institutional review board approval were obtained.

DATA ABSTRACTION

Two investigators independently reviewed the title and abstract of each article identified in our search to determine if the article met inclusion criteria. We resolved all disagreements by repeated review and discussion. Full-text review was performed by a single investigator who abstracted data from included studies about the study design, participants, detailed descriptions of the QI intervention, and the reported primary outcomes. In addition to the primary outcomes, we also abstracted data concerning the following secondary outcomes: cost of the QI strategy implementation and asthma-related health care costs; patient or provider satisfaction; quality of life outcomes; and reduction in tobacco exposure and environmental allergens. A second investigator verified all abstracted data. Multiple articles describing the same population were included only once in our analyses.

DATA SYNTHESIS AND STATISTICAL ANALYSIS

There have been numerous previous systematic reviews of asthma self-monitoring, self-management, or patient education. To avoid duplicating the work done in prior reviews, we did not evaluate the comparative effectiveness of symptom-based vs peak flow–based self-monitoring or self-management interventions. Instead, we evaluated specific intervention characteristics (eg, setting, teaching strategy, intensity of the intervention) and population characteristics (eg, adolescents, country of residence) associated with improvements in outcomes of care for children with asthma.

We used exploratory univariate analyses to identify the patient, study design characteristics, and interventions associated with the 4 primary outcomes of interest. Because we made multiple comparisons, we applied a Bonferroni correction and rejected the null hypothesis for 2-tailed P values ≤0.0125 (0.05/4=0.0125).

For each study reporting the same specific outcome (eg, percentage of predicted peak flow), we quantitatively summarized the results of the studies using a random-effects model. Often, the included studies did not report means or standard deviations for the outcomes of interest in a common manner. Thus, for several of the outcomes, such as symptom-free days, we calculated the rate of the outcome per month (denoted p) for the treatment and control groups. We calculated the variance of this rate as 1–p and n=sample size at the end of the trial. We also calculated the difference in p (preintervention–postintervention) between the intervention and control groups.

To minimize heterogeneity, we only synthesized those studies describing similar interventions in similar populations. We performed formal assessments of heterogeneity by the χ² and I² statistics. We performed least squares regression (weighted...
RESULTS

DESCRIPTION OF STUDIES OF QI FOR CHILDREN WITH ASTHMA

We identified 3843 potentially relevant articles \( (\text{Figure 1}) \), of which 91 articles describing 79 studies of QI strategies for children with asthma met our inclusion criteria (eTable, http://www.archpediatrics.com). Interventions were performed between 1974 and 2004 and ranged in length from 4 weeks to 5 years. Most were performed in the United States (46), Australia (7), the United Kingdom (6), the Netherlands (4), or Canada (4). The median sample size was 97 (interquartile range, 47-194). Interventions occurred in various settings, including outpatient clinics (38%), home (14%), and school (18%). In 10% (8 of 79) of studies, providers (ie, physicians, nurses, or pharmacists) were the target of the intervention.

Of the 79 included studies, 63 (80%) were RCTs, 5 (6%) were quasi-RCTs, and 11 (14%) were controlled before-after trials. Eleven RCTs compared 2 or more QI interventions but lacked a control group that did not also receive a QI intervention (ie, in general, they compared more and less intense QI interventions).\(^{36-46}\) Not surprisingly, these studies generally found improvements in both groups over baseline. Because they lacked a true control group, these 11 studies were excluded from our analyses. The 54 remaining RCTs were less likely to report statistically significant improvements in the processes and outcomes of care for children with asthma than were studies of other designs (63% vs 93%; \( P \) value = .04).

Articles often did not report detailed information about the interventions, making quality assessment difficult. For example, only 43 studies (54%) described a theoretical framework for their intervention. In general, studies reporting a theoretical framework were no more likely to observe improvements in outcomes for patients with asthma. However, studies reporting decreases in health services use tended to have described a theoretical basis for their intervention (\( P = .048 \)).

Table 1 presents baseline and final data for studies reporting outcomes in a sufficiently similar manner to be combined and represents data from all types of QI strategies. The data on guideline adherence were highly heterogeneous and often not readily interpretable (eg, often studies would report the number of patients taking inhaled corticosteroids but would not report whether this was because disease severity had increased or because of increased adherence to guidelines); thus, we do not present these results. There was no statistically significant difference in measured outcomes between the intervention and control groups for the 3 other types of outcome measures.

Only 8% (6 of 79) of studies exclusively enrolled adolescents.\(^{49-54}\) None of the 6 interventions directed exclu-
Twenty-six studies evaluated self-management interventions for children with asthma or their caregivers; 83% of these reported at least 1 statistically significant outcome in the intervention group compared with the control group. Self-management intervention studies (n=7) had a 2.8% improvement in the rate of symptom-free days per month (95% confidence interval [CI], 0.6%-5%; \( P = .02 \)); equivalent to approximately 0.8 day per month), whereas interventions that did not include self-management showed no such improvement (Figure 2). Similarly, self-management intervention studies (n=16) demonstrated a 0.4% reduction in the rate of monthly school absenteeism (95% CI, 0%-0.7%; \( P = .03 \)); equivalent to approximately 0.1 day per month), whereas interventions that did not include self-management had no significant reduction in school absenteeism (Figure 3). We sought study design and intervention characteristics associated with the greatest reductions in school absenteeism. Using the standardized mean difference in school absenteeism as the dependent variable in weighted least squares regression, we found that the longer the study, the greater the expected reduction in asthma-related school absenteeism (\( P < .001 \)) (Table 2).

### Table 1. Distribution of Included Studies by Reported Outcome

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No. of Studies</th>
<th>Intervention Mean (SD)</th>
<th>Control Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health services use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED visits, baseline</td>
<td>15</td>
<td>0.28 (0.36)</td>
<td>0.31 (0.41)</td>
</tr>
<tr>
<td>ED visits, final</td>
<td>28</td>
<td>0.09 (0.13)</td>
<td>0.12 (0.16)</td>
</tr>
<tr>
<td>Hospitalizations, baseline</td>
<td>9</td>
<td>0.09 (0.10)</td>
<td>0.08 (0.09)</td>
</tr>
<tr>
<td>Hospitalizations, final</td>
<td>17</td>
<td>0.04 (0.08)</td>
<td>0.04 (0.06)</td>
</tr>
<tr>
<td>Clinical status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptom-free days, baseline</td>
<td>13</td>
<td>16.74 (7.05)</td>
<td>17.15 (7.36)</td>
</tr>
<tr>
<td>Symptom-free days, final</td>
<td>14</td>
<td>21.35 (7.35)</td>
<td>21.17 (6.94)</td>
</tr>
<tr>
<td>Functional status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School days lost, baseline</td>
<td>17</td>
<td>2.22 (2.94)</td>
<td>1.98 (2.68)</td>
</tr>
<tr>
<td>School days lost, final</td>
<td>27</td>
<td>0.53 (0.54)</td>
<td>0.63 (0.54)</td>
</tr>
</tbody>
</table>

Abbreviation: ED, emergency department.

a There was no statistically significant difference in measured outcomes between the intervention and control groups.

### Patient/Caregiver Education

Forty-seven studies evaluated interventions designed primarily to educate children or parents/caregivers of children with asthma. Most (86%) demonstrated at least 1 statistically significant improvement. Among all studies of pediatric asthma evaluating self-management or patient education interventions, those directed at parents/caregivers (especially for the youngest children) were most likely to be associated with statistically significant improvement in clinical outcomes (\( P = .02 \)) (Table 3). Among the interventions targeting parents/caregivers, the summary reduction in asthma hospitalization rates for asthma was 1.2% per year (95% CI, 0.1%-2.4% per year; \( P = .03 \)) (Figure 4).

### Provider Education

Seven interventions were designed to provide training for clinicians caring for children with asthma.53,57,70,71,84,85,94-98
Commented the care provided in pediatric clinics by adding interventions fell broadly into 2 categories: those that augmented the care provided in pediatric clinics by adding self-management education intervention characteristics most likely associated with improvements in clinical outcomes for patients. These interventions differed dramatically in terms of intensity and scope of training (ranging from a single one-on-one training session to a year-long multistaff, multisession program). All but 1 study found statistically significant improvements in use of medications (most often increases in the use of inhaled controller medications). Several found improvements in asthma symptoms and reductions in emergency department use. Given the small number and heterogeneity of these studies, we cannot evaluate the specific provider education intervention characteristics most likely associated with improved asthma control.

**Organizational Change**

Thirteen studies evaluated organizational change strategies designed to alter the structure or delivery of care to improve the efficiency or breadth and depth of clinical care provided to children with asthma. These interventions fell broadly into 2 categories: those that augmented the care provided in pediatric clinics by adding specially trained personnel (nurses, pharmacist, or psychologist) and those that provided an increased level of asthma care in schools (through directly observed asthma therapy). These relatively heterogeneous studies tended to report improvements in the number of asthmatic patients receiving inhaled controller medications. Five studies of organization change reported school absenteeism and found a 0.4% decline in absenteeism per month in the intervention group at the end of the trial compared with control participants (95% CI, 0.1%-0.8%; P = .004; equivalent to about 0.1 day per month).

**Interventions With Multiple QI Strategies**

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

**OTHER REPORTED OUTCOMES**

Thirty-four studies reported emergency department/urgent care visits (including 15 with self-management

Table 3. School absenteeism per month is decreased in the self-management studies. The upper panel presents the difference in the postintervention rate of school days missed per month in the intervention and control groups from the studies that used quality improvement strategies other than self-management. The lower panel presents the difference in the postintervention rate of school days missed per month in the intervention and control groups in the studies that evaluated self-management strategies. The studies to the left of 0 indicate more days missed in the control group than in the intervention group.

<table>
<thead>
<tr>
<th>Source (year)</th>
<th>Rate difference</th>
<th>Lower limit</th>
<th>Upper limit</th>
<th>P value</th>
<th>Favor control</th>
<th>Favor intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilson et al (1996)</td>
<td>-0.020</td>
<td>-0.038</td>
<td>-0.002</td>
<td>.03</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Halterman et al (2004 and 2005)</td>
<td>-0.008</td>
<td>-0.013</td>
<td>-0.003</td>
<td>.003</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Mangione-Smith et al (2005)</td>
<td>-0.006</td>
<td>-0.010</td>
<td>-0.002</td>
<td>.002</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Deaves (1993)</td>
<td>-0.004</td>
<td>-0.014</td>
<td>0.006</td>
<td>.42</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Stengachis et al (2002)</td>
<td>-0.002</td>
<td>-0.003</td>
<td>-0.001</td>
<td>&lt;.001</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Christiansen et al (1997)</td>
<td>-0.001</td>
<td>-0.012</td>
<td>0.010</td>
<td>.86</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Hughes et al (1991)</td>
<td>0.000</td>
<td>-0.006</td>
<td>0.006</td>
<td>&gt;.99</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Kamps et al (2003 and 2004)</td>
<td>0.000</td>
<td>-0.009</td>
<td>0.009</td>
<td>&gt;.99</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Perrin et al (1992)</td>
<td>0.001</td>
<td>-0.008</td>
<td>0.010</td>
<td>.92</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Covi et al (2002)</td>
<td>0.002</td>
<td>-0.006</td>
<td>0.010</td>
<td>.63</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Hill et al (1991)</td>
<td>0.002</td>
<td>-0.000</td>
<td>0.004</td>
<td>.07</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Summary, other strategies</td>
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<td>-0.005</td>
<td>0.000</td>
<td>.09</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Velos-Friedrich et al (2004)</td>
<td>-0.015</td>
<td>-0.027</td>
<td>-0.003</td>
<td>.01</td>
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<td>Favors intervention</td>
</tr>
<tr>
<td>Fireman et al (1981)</td>
<td>-0.012</td>
<td>-0.030</td>
<td>0.006</td>
<td>.19</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Agrawal et al (2005)</td>
<td>-0.011</td>
<td>-0.025</td>
<td>0.003</td>
<td>.13</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Krishna et al (2003)</td>
<td>-0.011</td>
<td>-0.017</td>
<td>-0.005</td>
<td>.001</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Morgan et al (2004)</td>
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<td>-0.012</td>
<td>-0.010</td>
<td>&lt;.001</td>
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<td>Favors intervention</td>
</tr>
<tr>
<td>Persaud et al (1996)</td>
<td>-0.008</td>
<td>-0.041</td>
<td>0.025</td>
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<td>Favors intervention</td>
</tr>
<tr>
<td>Chariton et al (1994)</td>
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<td>-0.014</td>
<td>0.000</td>
<td>.051</td>
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<td>Favors intervention</td>
</tr>
<tr>
<td>Ciocutto et al (2002)</td>
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<td>-0.006</td>
<td>-0.002</td>
<td>&lt;.001</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Guimdelma et al (2002)</td>
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<td>-0.005</td>
<td>0.001</td>
<td>.17</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Evans et al (1997, 1987, and 1999)</td>
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<td>-0.003</td>
<td>0.001</td>
<td>.36</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Toelle et al (2002, 2004, and 1993)</td>
<td>-0.001</td>
<td>-0.010</td>
<td>0.008</td>
<td>.82</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Runge et al (2006)</td>
<td>0.000</td>
<td>-0.005</td>
<td>0.005</td>
<td>&gt;.99</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
<tr>
<td>Wensley and Silverman (2004)</td>
<td>0.000</td>
<td>-0.007</td>
<td>0.007</td>
<td>&gt;.99</td>
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<td>Favors intervention</td>
</tr>
<tr>
<td>Runge et al (2006)</td>
<td>0.002</td>
<td>-0.002</td>
<td>0.006</td>
<td>.33</td>
<td>Favors control</td>
<td>Favors intervention</td>
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<tr>
<td>Collard et al (2004)</td>
<td>0.003</td>
<td>-0.021</td>
<td>0.027</td>
<td>.81</td>
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<td>Favors intervention</td>
</tr>
<tr>
<td>Maslenikova et al (2003)</td>
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<td>0.005</td>
<td>0.033</td>
<td>.008</td>
<td>Favors control</td>
<td>Favors intervention</td>
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<td>Summary, self-management</td>
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<td>-0.007</td>
<td>-0.000</td>
<td>.03</td>
<td>Favors control</td>
<td>Favors intervention</td>
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<tr>
<td>Summary, school days absent</td>
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<td>-0.005</td>
<td>-0.001</td>
<td>.009</td>
<td>Favors control</td>
<td>Favors intervention</td>
</tr>
</tbody>
</table>
Table 2. Association of Pediatric Self-management, Self-monitoring, and/or Patient Education Intervention Characteristics and Reductions in School Absenteeism*  

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Regression Coefficient (SE)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model constant</td>
<td>20.974 (95.357)</td>
<td>.83</td>
</tr>
<tr>
<td>Intervention duration in months, continuous variable</td>
<td>−0.159 (0.035)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Year of publication, continuous variable</td>
<td>−0.01 (0.048)</td>
<td>.8</td>
</tr>
<tr>
<td>Studies that specified a theoretical/conceptual framework vs those that did not</td>
<td>−1.073 (0.596)</td>
<td>.09</td>
</tr>
<tr>
<td>No. of educational meetings with the students, continuous variable</td>
<td>0.450 (0.387)</td>
<td>.3</td>
</tr>
</tbody>
</table>

*Model details: weighted least squares regression (weighted by the sample size). Dependent variable: standardized mean difference effect size for school absenteeism (R²=0.68). Twenty-two studies were included in this analysis (because they reported data for each of the variables included in this regression).

Table 3. Association of Pediatric Self-management and/or Patient Education Intervention Characteristics and Finding Significant Clinical Outcomes*  

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Regression Coefficient (SE)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention duration in months, continuous variable</td>
<td>0.03 (0.08)</td>
<td>.7</td>
</tr>
<tr>
<td>Interventions that targeted parents/caregivers vs children</td>
<td>−2.70 (1.16)</td>
<td>.02</td>
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<tr>
<td>Studies that specified a theoretical/conceptual framework vs those that did not</td>
<td>−0.06 (0.76)</td>
<td>.9</td>
</tr>
<tr>
<td>Year of publication, continuous variable</td>
<td>−0.05 (0.06)</td>
<td>.4</td>
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<tr>
<td>No. of educational meetings with the subjects, continuous variable</td>
<td>−0.28 (0.62)</td>
<td>.7</td>
</tr>
<tr>
<td>Model constant</td>
<td>99.68 (114.42)</td>
<td>.4</td>
</tr>
</tbody>
</table>

*Model details: Method: logistic regression. Dependent variable: any statistically significant clinical outcome (R²=0.3). The predictor variables that were entered as continuous variables are so noted in the Table. The 3B studies of self-management and/or patient education interventions reporting data for each of the variables in this regression were included in this analysis. This analysis was not weighted by sample size.

Figure 4. Mean hospitalizations per year are decreased in the caregiver education studies. The upper panel presents the difference in the postintervention rate of hospital days per year in the intervention and control groups from the studies that used quality improvement strategies other than caregiver education. The lower panel presents the difference in the postintervention hospital days per year in the control group. The studies to the left of 0 indicate fewer hospital days per year in the intervention group than in the control group.

components, 7 with parent/caregiver education components, 18 with patient education components, 6 with organizational change components, and 5 with provider education components). None of the specific QI strategies resulted in a significant difference between intervention and control participants in emergency department/urgent care visits at the end of the study.

Of the 7 studies reporting asthma-related health care cost data, 5 reported reduced costs among the intervention groups. Most studies only included the costs...
and benefits accrued during the first year after an intervention.

Fourteen studies reported quality of life results.† Of these, only 4 found significantly better quality of life in the intervention group compared with the control group. Notably, most of the studies that failed to report improvements in quality of life used individualized, or “one-on-one,” educational sessions.

SENSITIVITY ANALYSES

We found no evidence of publication bias. Stepwise single-study elimination did not significantly affect the outcomes for which we present summary effect sizes. For some QI strategies, we found a significant association between the year that the intervention was performed and the reporting of statistically significant improvements in patient outcomes. However, we did not determine why more recent interventions might produce incrementally better outcomes for intervention subjects relative to controls.

COMMENT

Our review of 79 QI interventions for asthma in children found that many different interventions improve process and outcomes of care. Given that effective care for children with asthma includes the complex interplay of multiple factors, including the recognition and reduction of key triggers, identification of symptoms, knowledge of and timely access to asthma medications, and ability to effectively use medications, it is not surprising that some of the most effective QI interventions involved multiple QI strategies—a characteristic shared by effective QI interventions for adults.13 Among children with asthma, the education of parents/caregivers to reduce environmental triggers, recognize symptoms in their children, and help administer medication is critical. Especially among low-income populations, this may require considerable effort, including attempts to reduce household tobacco use and the provision of vacuum cleaners or air filters for reduction of dust mites in addition to providing education regarding the fundamentals of asthma treatment and prevention. Additionally, the involvement of pharmacists and/or nurse specialists to help ensure that patients have and know how to use appropriate medications has been repeatedly demonstrated to be an effective component of successful QI interventions. The QI strategies with the greatest body of evidence of effectiveness include the self-management and patient education interventions. Other strategies worked well in specific circumstances. Overall, the included studies suggest that QI interventions can improve asthma care, although the magnitude of the improvement was modest for many interventions. There is not sufficient evidence to determine definitively which strategy or combinations of strategies work best for a given situation.

Our key findings were that self-management interventions increased symptom-free days by approximately 10 per year, a difference that is likely to be clinically important. The effect of self-management interventions on school absenteeism was much more modest—a reduction of just more than a day per year. Children, particularly the very young, are less likely to have either adequate asthma knowledge or the capacity to take disease-modifying actions without considerable assistance from their caregivers; we advocate for the inclusion of caregivers in asthma self-management strategies for this population.

Among the other QI strategies, provider education and organizational change strategies were likely to be associated with improvements in medication use. Of concern was the finding that none of the 34 studies that reported use of emergency department or urgent care visits found a difference in number of visits across a variety of QI interventions.

Because most of the included QI interventions were designed to change behavior on the part of patients with asthma, their caregivers, or providers, we hypothesized that interventions specifically designed based on the principles of effective behavior change would be most likely to produce improved outcomes for patients. For example, it has been previously demonstrated that a key component of successful interventions is understanding the barriers to providing high-quality care.105 The included studies rarely described even basic information about underlying gaps in care that their interventions were trying to address. Even among the included studies that described a theoretical foundation for the design of their intervention (54%), many provided scant information about the rationale for the specific design characteristics of the intervention. We did find a trend for those studies that described a theoretical framework to be more likely to report significant improvements in health services use. Given the robust literature on intervention characteristics associated with durable behavior change, future QI interventions for asthma care should strive to incorporate those characteristics with a history of effectiveness in similar situations.

Our results suggest that QI interventions that specifically target adolescents require additional evaluations. None of the 6 studies of educational interventions that exclusively enrolled adolescents with asthma resulted in significant durable improvements in key asthma outcomes. Clearly, identification of targeted QI interventions that result in effective behavior change for this vulnerable population requires further investigation.

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

This review has several limitations. The included articles were highly heterogeneous with respect to the rigor
of the QI strategies implemented, the quality of their study designs, and the details provided about each. We had hoped to identify specific intervention characteristics associated with the greatest improvements for patients with asthma. Unfortunately, we were limited by the lack of detailed information about the interventions or baseline data for the outcomes of interest. Absence of specific information about the intervention’s design limits reproducibility and understanding of the extent to which interventions may be relevant for use in other populations or other settings. Because too few studies reported the same specific outcomes (eg, medication use), we used a composite outcome for some of our analysis (namely, any statistically significant result reported for ≥1 of the outcomes of interest: clinical status, functional status, health services use, or guideline adherence). The use of this composite outcome limited our ability to delineate which QI strategies were more likely to be associated with improvements in each of the specific outcomes.

Despite these limitations, the literature suggests that QI strategies can begin to bridge the gap between best practices for asthma care and actual care delivered to children with asthma. Use of similar outcome measures and thorough descriptions of interventions would advance the study of QI for asthma care. The key targets for future study are identifying those strategies that can effectively reduce emergency department and urgent care visits, reduce overall costs for patients with asthma, and increase their quality of life.

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Study concept and design: Bravata, Holty, McDonald, and Owens. Acquisition of data: Bravata, Gienger, Holty, Sundaram, and Owens. Analysis and interpretation of data: Bravata, Gienger, Holty, Khazen, Wise, McDonald, and Owens. Drafting of the manuscript: Bravata, Holty, Khazen, and Owens. Critical revision of the manuscript for important intellectual content: Bravata, Gienger, Holty, Sundaram, Wise, McDonald, and Owens. Statistical analysis: Bravata and Wise. Obtained funding: Bravata, McDonald, and Owens. Administrative, technical, and material support: Gienger, Holty, Sundaram, and McDonald. Study supervision: Bravata and Owens.

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Saying, “When I was a kid, we weren’t allowed to do that” is not sufficient for your teenager to feel you have thoughtfully considered how to decide on his request.