Quality of Care for Childhood Asthma: Estimating Impact and Implications

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ABSTRACT

We conducted a review of 164 relevant publications to consolidate the evidence on gaps in the quality of asthma care, the impact of those gaps, and the costs and benefits of closing those gaps. Researchers used a wide variety of definitions for measures of quality asthma care, clinical and utilization end points, and disease severity. Gaps in care were most evident for pharmacologic treatment, particularly the underuse of inhaled corticosteroids, with median usage rates of 40%; however, in studies with large proportions of black subjects, the inhaled corticosteroid usage rate was only 32%, compared with 51% for nonminority populations. Studies on outcomes focused on emergency department visits, hospital admissions, and missed school days. Because only 6 studies included information on the costs of improving asthma care, no consensus estimates of the cost/benefit ratio for better asthma care could be derived. There was insufficient evidence in the literature for assessment of the impact of gaps in care and the costs of closing those gaps. More economic evaluations of the impact of gaps in asthma care and of interventions to improve asthma control are needed. Future research on gaps in asthma care and their impact must use standardized definitions for key variables such as disease severity and care utilization to allow comparisons across studies and building of an evidence base that is convincing for policy makers and purchasers of care. *Pediatrics* 2009; 123:S199–S204

I N 2002, >30 million US individuals reported having been diagnosed as having asthma, including 122 per 1000 children (which made asthma the most common chronic disease among children) and 106 per 1000 adults. The prevalence of the disease remains at historically high levels.[1] In 2004, the total estimated annual costs of treating asthma were approximately $16.1 billion, of which $11.5 billion were direct costs.[2] Prescription drugs accounted for the largest single component of these direct costs ($5 billion), and hospital care represented one third of the $11.5 billion.[2]

Although recent advances in pharmacotherapy have made asthma a highly treatable disease, research suggests that treatment often falls short of recommended care; according to a 2001 study,[3] 74% of children with moderate/severe asthma in a national sample did not receive adequate treatment. Despite their higher prevalence of disease, minority children are less likely than nonminority children to receive adequate treatment.[4] Two Rand studies showed that only 43% of adult patients and only 44% of children who used a rescue inhaler ≥3 times per day were given maintenance treatment.[5,6] Recognition by policy makers, providers, and the public of the discrepancies between recommended care and care that is actually received has led to initiatives to improve the quality of asthma care, such as the Healthy People 2010 initiative.[7]

Although the quality of asthma care, treatment options, and the effects of the disease have been addressed extensively by the research community, there have been no consolidated robust estimates of the relative costs of medications and medical care and the benefits of quality asthma care (eg, hospitalizations and emergency department [ED] visits avoided, reductions in lost school or work days, and improved workplace productivity). Such information is crucial to enable policy makers and purchasers of care to make prudent decisions about the allocation of resources and the organization of care delivery.

This article attempts to bridge this information gap by synthesizing existing published data to address the following questions: (1) What are the gaps in the quality of asthma care for children and adults? (2) What are the implications of those gaps (eg, excess morbidity and deaths, avoidable hospitalizations, or lost school or work days)? (3) What would it cost to close the gaps in the quality of asthma care? and (4) What would be the cost/benefit ratio of better asthma care?

METHODS

Review and Selection of Publications

To identify relevant publications, a comprehensive review was performed of the English-language literature dating from 1995 to 2006, using the key words asthma, quality of care, treatment, care, therapy, disparities, inadequate,

variability, differential, inequity, gap, variation, variance, medication, adherence, utilization, guideline adherence, disease management, impact, effect, morbidity, mortality, hospitalization, hospital admission, emergency room, emergency department, loss, absence, work, employment, workdays, school, attendance, absenteeism, and presenteeism. To obtain abstracts of articles published in peer-reviewed journals, the traditional health literature databases (ie, Medline, Embase, CINAHL, PsycINFO, Social Sciences Abstracts, and EconLit) were searched. Reference lists in relevant articles were mined for additional items. In addition, a number of databases for non–peer-reviewed literature and the Web sites of relevant governmental, professional, and advocacy organizations were searched.

Two reviewers (Drs Mattke and Martorell) independently reviewed the titles of identified items, to assess whether the articles were likely to provide information on gaps in asthma care and their impact. The 2 reviewers then independently reviewed the abstracts or, if abstracts were unavailable, the full publications, to determine whether the publications contained information relevant to our study. Differences between reviewers were resolved through consensus. Reports were omitted from further consideration if they did not contain any data relevant to our research questions, were not conducted in the United States, were review or opinion articles, or were duplicative publications of the same data.

Article Abstraction

All selected articles were retrieved and abstracted into a comprehensive database that contained variables for both content (eg, measures of quality of care, utilizations, clinical end points, and costs of care) and study design (eg, population characteristics and comparison strategy). Although the overall body of evidence was quite large (2786 abstracted articles), the heterogeneity of measures and end points across studies allowed for structured review of only 1 quality measure (use of inhaled corticosteroids [ICSs]) and 2 utilization end points (hospitalizations and ED visits). This article focuses on the in-depth analysis of the 3 common indicators; a report with the full details of the review is available elsewhere.[8]

To facilitate cross-study comparisons, the 3 indicators were recalculated by using common metrics. Use of ICSs was defined as the proportion of patients with asthma who had ≥1 filled ICS prescription per year or who reported ICS use. Hospitalization and ED visits were defined as the proportion of patients with asthma who had ≥1 inpatient admission or ED visit per year. Studies that recruited patients in EDs or hospitals were excluded from the analysis of their respective end point. Four categories of explanatory variables were constructed to account for differences in indicators across studies, that is, disease severity, age, race/ethnicity, and data source.

Severity Classification Criteria and Study Populations

For studies that had information on utilization of care, our classification of disease severity was based on the definition of moderate/severe asthma that underlies the National Committee for Quality Assurance Healthcare Effectiveness and Data Information Set (HEDIS) measures, that is, in a single year, the patient had ≥1 of the following[9]: (1) 1 hospital admission; (2) 1 ED visit; (3) 4 prescription drug claims for asthma drugs; or (4) 4 office visits and 2 prescription drug claims.

Study populations were categorized according to disease severity, as follows: (1) mild asthma, that is, studies that used criteria to identify patients with asthma that were less stringent than the National Committee for Quality Assurance HEDIS criteria (eg, studies that identified patients on the basis of only 1 office visit); (2) moderate/severe asthma, that is, studies that explicitly selected patients on the basis of the National Committee for Quality Assurance HEDIS criteria for moderate/severe asthma or selected patients who would have met those criteria; or (3) severe asthma, that is, studies of populations that were at considerably higher risk, such as patients who had multiple ED visits or hospital admissions. It is important to keep in mind that the severity classification refers to the threshold criteria that were used to include patients in a given study; although all patients met the entry criteria, some might have been considerably sicker.

Nine studies assessed disease severity on the basis of symptoms and pulmonary function tests; 7 studies used the National Heart, Lung, and Blood Institute (NHLBI) criteria (sometimes referred to as the National Institutes of Health or National Asthma Education and Prevention Program criteria) and 2 used the American Thoracic Society criteria. Because only 2 studies used the American Thoracic Society criteria, those were dropped from the analysis. Studies based on the NHLBI criteria were included but were not stratified according to severity because of the small number and because only 3 of the 7 studies provided enough information for stratification of patients.

The studies were divided into 4 mutually exclusive groups on the basis of the age structure of their populations: (1) children (0–12 years); (2) nonadults (0–18 years); (3) adults (≥18 years); or (4) all ages. The data sources that each study used were classified into 1 of 4 nonexclusive groups: (1) commercial claims data; (2) Medicaid claims data; (3) medical records/charts; or (4) self-reported information. Finally, characterization of the racial/ethnic composition of each study's sample was attempted; given the heterogeneity of the samples across studies, 4 broad but mutually exclusive categories that would provide a general characterization of the sample composition were created: (1) large proportion of black subjects (>40%); (2) large proportion of Hispanic subjects (>25% Hispanic and <40% black); (3) predominately white subjects (>50%); or (4) no information on race/ethnicity.

RESULTS

Structured Review

Findings on Quality of Asthma Care

Of the 2786 publications identified in the initial searches, 164 contained relevant information and were abstracted. A subset of 68 articles had information on
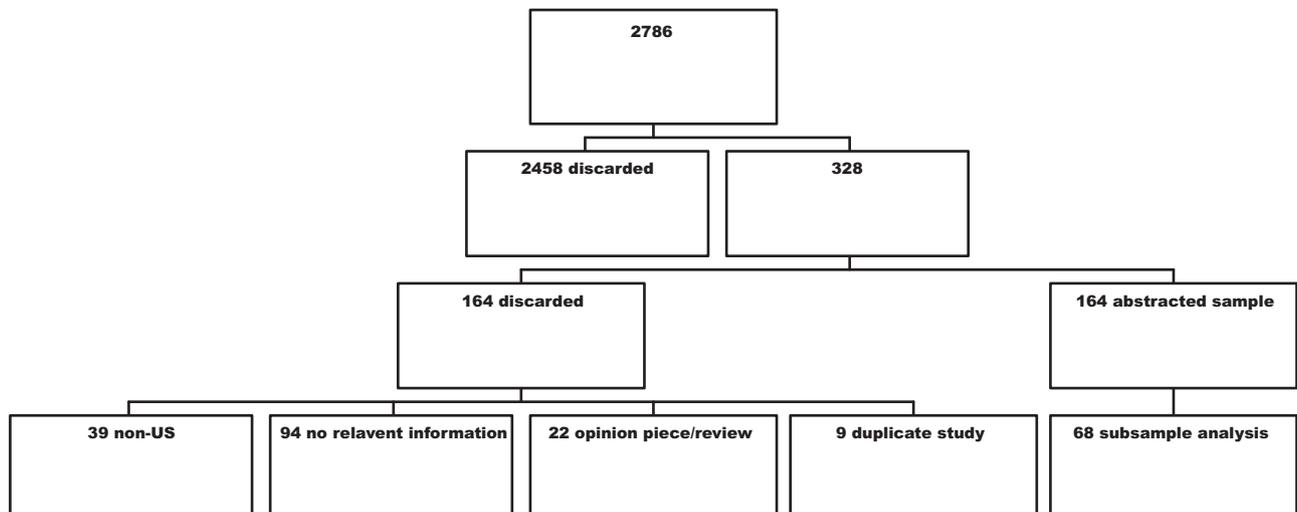
FIGURE 1
Publications evaluated for inclusion in the review.

ICS use, ED visits, and hospital admissions (Fig 1). The most common focus of studies on asthma care quality was pharmacologic treatment. Of the studies in this review, 68 examined use of antiinflammatory maintenance drugs (ICSs and leukotriene inhibitors), 34 examined use of bronchodilators (long-acting β-adrenergic receptor agonists and methylxanthines), and 48 examined use of rescue treatments (short-acting β-adrenergic receptor agonists and systemically active steroids). Seven studies examined nonpharmacologic care such as allergen reduction, smoking, and occupational exposure.

As shown in Table 1, there was considerable variability in the reported usage rates for each category of asthma medications. The rates for antiinflammatory drugs ranged from 0% to 94%, and similar variability existed in estimates of the use of bronchodilators and rescue treatments. Despite this variability, 3 important patterns emerged. Use of antiinflammatory medications was low, with the median treatment rate across studies being 32.5%. However, antiinflammatory medications seemed to be used more widely than bronchodilators, with the median rate of bronchodilator use being only 16.9%. Finally, rescue treatment rates varied substantially but only 14 of the 48 studies expressly examined the adequacy of treatment with rescue inhalers.

Findings on Outcomes of Care
Hospitalization rates were examined in 83 studies, 78 studies examined ED visit rates, and 22 studies measured lost school days. Two studies measured symptom-free days, 5 measured symptom days, and 7 examined complications associated with asthma as the study end point. Other outcomes included morbidity and/or death (17 studies), quality of life (7 studies), pulmonary function (8 studies), and control of symptoms (5 studies). A total of 32 studies attempted to attribute changes in end points directly to gaps in quality of care (for example, by correlating antiinflammatory treatment rates with the risk of hospital admission). Of those studies, 16 were multifaceted intervention studies in which changes in treatment and subsequent effects on outcomes were attributed to the overall intervention. Another 9 studies made no attempt to quantify the impact of changes in quality on changes in end points.

Findings on Costs of Closing Gaps in Care
Forty-five of the studies formally evaluated the efficacy of asthma disease management programs or similar interventions, such as school- or community-based outreach programs. Only 6 of those studies contained any information on the cost of the interventions and the savings they achieved. All 6 studies examined disease management for asthma and found the interventions to be cost-effective but not necessarily cost-saving; in other words, although the interventions did not reduce direct medical costs, they produced better outcomes at an additional cost that seemed reasonable.

TABLE 1   Estimates of Asthma Medication Usage Rates

Drug Class	Usage Rate, %						No. of Studies
	Mean	Minimum	25th Percentile	Median	75th Percentile	Maximum	
Antiinflammatory drugs	34.5	0.0	15.7	32.5	49.6	94.0	68
Bronchodilators	27.5	0.26	9.1	16.9	44.8	98.0	34
Rescue treatment	50.0	0.56	14.1	52.8	84.1	96.0	48

Studies were included if they reported some measure of the proportion of children and adults with asthma who took or were prescribed a drug in 1 of the 3 classes.

TABLE 2 Estimates of ICS Usage Rates According to Sample Characteristics and Data Source

	ICS Usage Rate, %			No. of Studies
	Minimum	Median	Maximum	
Asthma severity				
Mild	10	36	72	14
Moderate/severe	15	32	94	9
Severe	39	69	80	5
NHLBI criteria	19	39	78	4
Race/ethnicity				
No information	17	40	55	9
Large proportion of black patients	17	32	80	7
Large proportion of Hispanic patients	15	26	78	5
Predominately white patients	10	51	94	12
Age				
Children (0–12 y)	26	26	26	1
Nonadults (0–18 y)	10	35	80	15
Adults (≥18 y)	31	52	78	9
All ages	15	42	94	8
Data source				
Commercial claims data	17	40	55	7
Medicaid claims data	10	27	56	9
Medical charts	26	33	80	5
Self-reported data	26	67	78	11
Self-reported/medical charts	94	94	94	1
All studies	10	40	94	33

TABLE 3 Estimates of ED Visits According to Sample Characteristics and Data Source

	ED Visits, No. per 100 Patient-Years			No. of Studies
	Minimum	Median	Maximum	
Asthma severity				
Mild	0.0	3.6	58.3	21
Moderate/severe	0.0	3.7	66.7	12
Severe	2.2	5.0	80.0	4
NHLBI criteria	0.0	9.9	32.0	5
Race/ethnicity				
Large proportion of black patients	0.1	4.5	58.3	16
Large proportion of Hispanic patients	0.0	3.6	80.0	5
Predominately white patients	0.0	0.5	23.4	9
Age[a]				
Nonadults (0–18 y)	0.0	3.3	47.0	16
Adults (≥18 y)	0.1	5.3	80.0	12
All ages	0.0	2.5	61.6	14
Data source				
Commercial claims data	0.1	5.3	66.7	16
Medicaid claims data	0.0	0.2	58.3	13
Medical charts	3.6	6.7	9.9	2
Self-reported data	0.6	6.4	80.0	7
Self-reported/claims	9.8	9.8	9.8	1
Self-reported/medical charts	23.4	42.5	61.6	2
All studies	0.0	3.6	80.0	41

[a] No studies reported on children's ED visits.

Analysis of Selected Indicators

ICS Usage Rates

A total of 33 studies had sufficient information to enable us to estimate ICS usage rates. Table 2 illustrates how ICS usage rates were related to disease severity, age, race, ethnicity, and the data sources used in the studies.

ICS usage rates were positively correlated with disease severity; the median usage rate in studies of patients with severe asthma was 69%, compared with 32% for studies that included populations with moderate/severe asthma. ICS usage was lower in studies in which the sample included large proportions of racial and ethnic minorities. The median estimate of ICS usage in studies with large proportions of black subjects was 32%, compared with 51% in studies with predominately white subjects. ICS usage rates also were higher in studies of adults (median: 52%) than in studies of children or nonadults (median: 26% and 35%, respectively). Finally, estimates of ICS usage differed systematically according to data source; studies based on self-reported data tended to find higher usage rates than did those based on claims data or medical charts.

Although asthma severity, race/ethnicity, age, and data source were all found to correlate with ICS usage rates, there was considerable variability within the categories. In the 5 studies on populations with severe asthma, the estimates of ICS usage ranged from 39% to 80%; in the 14 studies on populations with mild asthma, the estimates ranged from 10% to 72%. In studies with predominately white samples, the estimates of ICS usage ranged from 10% to 94%; in studies with large proportions of black subjects, the estimates ranged from 17% to 80%. Although studies based on claims data generally reported lower ICS usage rates than did studies based on self-reports or medical charts, there was a relatively broad range of estimates (10%–56%) among the 9 studies that used Medicaid claims data (Table 2).

ED Visits

A total of 41 studies had sufficient information for estimation of ED visit rates. Table 3 illustrates how ED visit rates in those studies were related to disease severity, age, race, ethnicity, and the data sources used in the studies.

Studies of the more severely affected asthma populations generally reported higher estimates of ED visit rates. The median number of ED visits was 3.6 visits per 100 patient-years in studies of populations with mild asthma, compared with 5.0 visits per 100 patient-years in the 4 studies of populations with moderate/severe or severe asthma. Overall, the highest ED utilization rates were found in studies with large proportions of black subjects (ie, 80 visits per 100 patient-years). Estimates tended to be higher in studies of adults and in studies that used self-reported data. As with ICS usage rates, the most striking finding was the wide range of estimates. The median ED visit rate for all 41 studies analyzed was 3.6 visits per 100 patient-years, but a number of studies had much higher rates, with the highest being 80 visits per 100 patient-years.

TABLE 4 Estimates of Hospital Admissions According to Sample Characteristics and Data Source

	Hospital Admissions, No. per 100 Patient-Years			No. of Studies
	Minimum	Median	Maximum	
Asthma severity				
Mild	0.0	1.7	13.0	20
Moderate/severe	0.0	3.9	33.3	14
Severe	0.7	2.9	53.3	3
NHLBI criteria	0.0	2.0	9.9	4
Race/ethnicity				
Large proportion of black patients	0.0	2.0	11.0	16
Large proportion of Hispanic patients	0.0	9.0	53.3	6
Predominately white patients	0.0	0.1	10.0	9
Age				
Children (0–12 y)	17.3	22.2	27.0	2
Nonadults (0–18 y)	0.0	2.6	13.0	16
Adults (≥18 y)	0.0	3.3	53.3	12
All ages	0.0	0.6	19.6	12
Data source				
Commercial claims data	0.0	2.5	33.3	15
Medicaid claims data	0.0	0.1	13.0	13
Medical charts	0.7	2.4	4.0	2
Self-reported data	0.0	9.2	53.3	8
Self-reported/claims	3.8	3.8	3.8	1
Self-reported/medical charts	9.9	14.7	19.6	2
All studies	0.0	2.3	53.3	41

Hospital Admissions

A total of 41 studies had sufficient information for estimation of hospital admission rates. Table 4 illustrates how admission rates were related to disease severity, age, race, ethnicity, and the data sources used in the studies.

The results for hospitalization rates largely mirrored those for ED visits. Hospitalization rates varied widely, even within the categories based on the explanatory variables. Despite this variability, some patterns can be seen. Hospitalization rates increased with asthma severity, although it should be noted that only 3 studies on populations with severe asthma remained after studies that recruited patients in hospitals had been excluded. The highest estimates of hospitalization rates came from studies based on self-reported data. For the 8 studies that used only self-reported data, the median estimate was 9.2 hospital admissions per 100 patient-years and the highest estimate was 53.3 admissions per 100 patient-years. Hospital admission rates were highest in studies with large proportions of black patients.

DISCUSSION

A structured review of the literature on the costs and benefits of improving quality of care for asthma was performed. The results showed that, although this is an area of active research, as evidenced by the almost 2800 publications that were identified, the current state of the evidence does not allow our research questions to be fully answered.

Evidence was found for less-than-optimal treatment with antiinflammatory drugs, which is consistent with previously published reports. For example, a study by Warman et al[10] that measured antiinflammatory drug use among inner-city children with persistent asthma found that only 39% were receiving daily antiinflammatory treatment. A similar study by Diaz et al[11] found that 39% of children with severe asthma were using antiinflammatory medications. However, it was difficult to derive a reasonably bounded estimate for ICS usage rates because of the heterogeneity of the studies. Overall, antiinflammatory medications seem to be used more widely than bronchodilators, which reflects current guideline recommendations.

Although there was insufficient clinical information to determine what the appropriate ICS treatment rate should have been for each study, the fact that studies commonly recruited patients with frequent or costly encounters with the health care system suggests that treatment rates were far lower than optimal. ICS usage rates in almost all studies was well below 100%, even when the subjects were selected on the basis of having at least moderate/severe asthma and thus had a clear treatment indication. In addition, because our definition of ICS treatment was based on the number of prescriptions filled, not daily ICS use, actual adherence to guideline-recommended care was likely overestimated. Insufficient quality of care seems to affect disadvantaged populations disproportionately, because ICS usage rates were lower in studies with large proportions of black or Hispanic subjects and in studies of Medicaid populations.

Overall, 32 intervention studies attempted to relate the impact of insufficient ICS treatment on clinical or utilization end points; however, because 16 of those studies involved multifaceted interventions, it was impossible to isolate the relative contribution of ICS treatment from that of other changes, such as improvements in air quality and reductions in allergen exposures. In an additional 9 studies, the authors did not attempt to quantify the effect of better ICS treatment on clinical or utilization end points, which left us with an insufficient number of studies to provide a consensus estimate for the effects of ICS treatment on utilization and clinical outcomes.

In addition, one of the difficulties in detecting patterns across the studies was that researchers used many different metrics for hospital admission and ED visits; some studies reported events per 10 000 patients, whereas others reported the proportions of patients with any events in various time periods. The 20 studies that measured lost school days consistently reported relationships between asthma and absenteeism, but the lack of uniformity in metrics made it difficult to compare the results across studies; 11 studies defined absenteeism as ever missing a day of school in various time periods, whereas the other 9 studies used the average number of days missed.

Given the heterogeneity of the study designs, the insufficient clinical information, and the lack of uniformity in metrics, it was not possible to derive reasonable estimates for the impact of insufficient ICS use or other gaps in treatment on excess spending (eg, avoidable

hospital admissions or ED visits). Three additional limitations made it impossible to estimate the cost/benefit ratio for improving asthma care. First, there is an overall dearth of economic evaluations of interventions aimed at improving asthma care. Second, most publications focused on only one aspect of the question (eg, estimating ICS treatment rates or hospital admission rates). The studies that did relate variations in clinical and utilization end points to gaps in care typically reported on multifaceted interventions that combined efforts to improve pharmacologic treatment with changes in education or environment; therefore, the relative contributions of individual components to outcomes could not be determined. Third, and more importantly, researchers used a large variety of criteria to recruit their study patients and to define their treatment variables and study end points. Similarly, as the key determinant of both treatment intensity and patient outcomes, disease severity was often insufficiently defined (ie, not defined according to well-established criteria), which makes comparisons across studies or formal meta-analyses almost impossible. This finding is surprising, considering the availability of well-established patient identification and risk stratification criteria that can be applied to utilization data (HEDIS criteria) or clinical data (NHLBI and American Thoracic Society criteria). Although particular study objectives or available data do not always allow the use of such standard definitions, a greater degree of standardization is clearly feasible.

A formal meta-analysis of the results reported in the reviewed articles could not be performed because of the heterogeneous nature of the studies, and there are limitations to making qualitative statements without being able to test for statistical significance. Some of the outer bounds of the reported ranges for ICS usage and hospital and ED visit rates clearly came from unusual samples for which our classification system did not account. Exclusion of those studies would have narrowed the ranges but also further reduced the sample.

Our findings strongly suggest that research on gaps in asthma care and their impact must use standardized definitions for key variables such as disease severity and care utilization. Without such standardization, it will remain difficult to compare studies, to aggregate data, and to build an evidence base that can convince policy makers and purchasers of care. A similar recommendation was made in 1996.[12] Public and private funding agencies should use their influence to move the asthma research community toward standardization of definitions, although arriving at such definitions is no easy feat, because it requires consensus and acceptance from multiple stakeholders.

Another important finding was that both ICS usage and ED and hospital utilization rates were typically higher in studies that relied on self-reported data than in studies that used health insurance claims or medical charts as their sources. This implies that study outcome findings that have been derived from different types of data sources should not simply be pooled; instead, the data source must be taken into account when results are being interpreted.

Finally, an important conclusion of this review is that gaps in quality of care clearly exist, and they affect minority populations more severely. However, given the enormous variability of results, overly confident statements about the magnitude of those gaps or their impact should be avoided, because any estimates would depend on their context. More economic evaluations of the impact of gaps in asthma care and of interventions to improve asthma control are needed; meanwhile, policy makers and other stakeholders should review carefully the sources and methods used to generate existing data when they use those data as the basis for critical decisions.

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