

Relationship of validated psychometric tools to subsequent medical utilization for asthma

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Background: Risk stratification is used to identify patients with asthma at increased risk of experiencing morbidity and resource utilization. Validated psychometric tools are infrequently studied sources of data for this purpose.

Purpose: To evaluate 4 types of validated psychometric tools as predictors for subsequent asthma utilization and determine their clinical usefulness.

Methods: Eleven hundred patients with active asthma from a Health Maintenance Organization completed surveys that included demographic information and validated psychometric tools measuring generic quality of life (physical and mental components), asthma-specific quality of life, asthma control, and asthma symptom severity. Survey records were linked to administrative data that captured emergency department and hospital care, short-acting β -agonist, and oral corticosteroid utilization for the year of and the year following the survey. Relationships of survey variables with subsequent utilization were assessed, adjusting for both baseline demographic and asthma utilization factors.

Results: Scores of each psychometric tool were significantly related to subsequent utilization in univariate analyses and after adjusting for baseline utilization and demographic risk factors. Patients with higher scale-defined morbidity were as much as 4 times more likely to have subsequent utilization (sensitivity as high as 58%; specificity as high as 78%). Addition of an asthma-specific tool to either demographic or utilization prediction models added sensitivity (as much as 15%) but did not substantially improve the prediction properties of models containing both demographic and utilization predictors.

Conclusion: Validated psychometric tools appear useful for asthma risk stratification in individuals and in populations in which both utilization and demographic predictors are not available. (J Allergy Clin Immunol 2005;115:564-70.)

Key words: Quality of life, psychometric tools, asthma control, asthma severity, hospitalization, emergency care, antiasthmatic drugs

Recent estimates suggest that 10% of Americans have asthma or have had asthma in their lifetime.¹ In addition to high prevalence, asthma is a cause of substantial morbidity, including hospitalizations, unscheduled physician and emergency department (ED) visits, and absences from school and work.² Moreover, chronic asthma is associated with very large direct and indirect costs.³

Asthma severity may vary in populations of patients, and risk stratification is thus used as part of asthma population management. The purpose of such risk stratification is to identify patients with asthma who are most likely to have morbidity and resource utilization and for whom targeted intervention would be expected to reduce these risks. Studies have shown that such interventions can reduce ED and hospital utilization in high-risk patients with asthma.⁴⁻⁸

Many studies have used clinical information⁹⁻¹² or computerized administrative data¹³⁻¹⁶ to define risk factors for subsequent asthma utilization. Validated psychometric tools demonstrate reliability and validity across multiple domains and represent another source of potentially useful predictors of subsequent asthma resource utilization. Several types of psychometric tools have been studied in patients with asthma, including those measuring generic quality of life,^{17,18} asthma-specific quality of life,¹⁹⁻²¹ asthma control,²²⁻²⁴ and asthma symptom severity.²⁵⁻²⁷ One study demonstrated an independent association between generic quality of life and subsequent hospitalizations or ED visits in elderly patients with asthma,²⁸ but 2 other studies could not show that generic quality of life was independently associated with asthma hospital utilization.^{25,29} Four studies have associated asthma-specific quality of life with asthma hospital utilization,²⁹⁻³² 2 of which were controlled for other risk factors.^{29,32} Three studies have demonstrated an

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Abbreviations used

AOMS: Asthma Outcomes Monitoring System
AQLQ: Asthma Quality of Life Questionnaire
ATAQ: Asthma Therapy Assessment Questionnaire
ED: Emergency department
MCS: Mental Component Scale
NPV: Negative predictive value
OR: Odds ratio
PCS: Physical Component Scale
PPV: Positive predictive value
SF-12: Short Form 12

independent relationship between asthma control and subsequent utilization,³³⁻³⁵ although only one of these used a control scale that had been formally validated.³³ Two studies have related asthma severity scales (which included symptom severity and other measures) to subsequent ED and hospital utilization,^{25,36} although only one of these used a validated tool and adjusted for other predictors.²⁵ Although statistically significant relationships between these tools and subsequent asthma utilization were demonstrated in these studies, their clinical significance has not been established.

The purpose of this study was to evaluate 4 types of validated psychometric tools as predictors for several types of subsequent asthma utilization. In addition, we sought to identify the relationships of these tools to each other and the clinical usefulness of these tools in predicting subsequent ED, hospital, and rescue medication utilization for asthma.

METHODS

Patients

Surveys were sent by the Kaiser-Permanente Care Management Institute in August 2000 to a random sample of Kaiser-Permanente Medical Care Program adult members age 18 to 56 years from the Northern California (n = 3072) and Northwest (n = 543) regions who were diagnosed as having active asthma on the basis of the presence of 1 or more of the following administrative database criteria during 1999: (1) 4 or more asthma medication dispensings, (2) 1 or more ED visits or hospitalizations with a diagnosis of asthma, or (3) 4 or more asthma outpatient visits with 2 or more asthma medication dispensings. Completed surveys were returned between August and October 2000 from 2219 members (61%). Of these, 1998 (90%) answered yes to the question, "Have you ever been told by a doctor that you have asthma?" Of these, electronic utilization information was available for 1100, the participants of this study. Electronic utilization information was not available for subjects who did not meet these criteria for active asthma in 2000. The study was approved by the Northern California Region and the Northwest Region Kaiser-Permanente Institutional Review Boards.

Survey information

The survey included information regarding age, sex, race/ethnicity, educational attainment, household income, and smoking history. The validated tools included (1) the generic quality of life Short Form

12 (SF-12),¹³ analyzed as the Mental Component Scale (MCS) and the Physical Component Scale (PCS); (2) the Mini Asthma Quality of Life Questionnaire (AQLQ) overall score¹⁴; (3) the Asthma Therapy Assessment Questionnaire (ATAQ),¹⁷ an asthma control tool; and (4) the Asthma Outcomes Monitoring System (AOMS) Asthma Severity Staging Survey,²¹ a symptom severity scale.

Utilization information

Survey records were matched by using a unique record number to year 2000 and 2001 administrative data. These electronic data included asthma hospitalizations, ED visits, canisters of short-acting β -agonists dispensed, and number of dispensings of oral corticosteroids. For the purpose of these analyses, the outcomes of hospitalizations and ED visits were combined into a single variable to increase power: presence of 1 or more asthma hospitalizations or ED visits (emergency hospital care) versus nonutilization. Use of short-acting β -agonists >14 canisters per year and any oral corticosteroid dispensings were evaluated, because these have been shown to be independent predictors of subsequent asthma hospital or ED utilization in this population,³⁷ and β -agonist overuse and oral steroid use are also risk factors for asthma mortality.^{38,39} Outcome variables included the adverse asthma utilizations during year 2001 of emergency hospital care, dispensing of >14 β -agonist canisters, and oral corticosteroids. Year 2000 emergency hospital care, dispensing of >14 β -agonist canisters, and oral corticosteroid dispensings were used as baseline severity adjusters in the multivariable analyses.

Data analyses

Demographic and utilization characteristics of the population were evaluated by means of descriptive analyses. Hypothesis testing for univariate analyses of categorical variables was by means of χ^2 tests. Odds ratios (ORs) and 95% CIs were also calculated for analyses of 2-level variables. Two-level survey variables were defined on the basis of distribution, such that the lower quartile (25%) was in the high morbidity group for each scale. Because of limited scale scores, this was not possible for the ATAQ or AOMS. High morbidity groups for the ATAQ could be defined only as the lowest 33% (ATAQ ≥ 2) or the lowest 16% (ATAQ ≥ 3). High morbidity status for the AOMS included 38.6% of subjects who reported the highest score of 4.

Multivariable analyses were performed by using logistic regression methodology. Outcomes were year 2001 utilization variables (emergency hospital care, dispensing of >14 β -agonist canisters per year, and dispensing of oral corticosteroids). The main predictors were the survey scales described as continuous variables. Analyses were adjusted for the demographic factors and year 2000 utilization variables described. Because of potential collinearity, when more than 1 survey variable was included in a model, stepwise forward selection algorithms (with Wald χ^2 P for entrance < .05) were used. The purpose of these analyses was to assess the independence of the survey variables in predicting utilization. The discrimination properties of the overall models (ability of the models to separate subjects in different outcomes states) were measured by the c statistic, which is the area under the receiver operating characteristic curve for each model. A value of 1.0 reflects perfect discrimination, whereas a value of 0.5 reflects no better discrimination than by chance alone.

To determine the clinical significance of the findings, predictive properties were evaluated. *Sensitivity* was defined as the proportion of subjects with subsequent utilization who were in the high morbidity group. *Specificity* was defined as the proportion of participants without subsequent utilization who were not in the high morbidity stratum. *Positive predictive value* (PPV) was defined as the proportion of patients in the high morbidity group with subsequent utilization. *Negative predictive value* (NPV) was defined as the

TABLE I. Demographic characteristics of the study population

Characteristic	Results
Cohort size (n)	1100
Age, y (mean $\pm$ SD)	43.1 $\pm$ 9.3
Female (%)	68.2
Race (%)	
White	66.5
Black	8.5
Hispanic	8.1
Other	11.6
Unknown	5.2
Education (%)	
1. 8th grade or less	0.5
2. Some high school or technical school	4.1
3. High school or technical school graduate	16.2
4. Some college	32.7
5. College graduate	20.2
6. Postgraduate	14.4
Unknown	12.0
Income (%)	
1. <\$10,000	2.5
2. \$10,000 to \$14,999	1.9
3. \$15,000 to \$19,999	2.2
4. \$20,000 to \$24,999	3.6
5. \$25,000 to \$34,999	7.3
6. \$35,000 to \$49,999	15.7
7. >\$50,000	47.7
Unknown	19.1
Smoking/d (%)	
Never smoked	58.0
Past smoker	29.5
½ Pack or less	5.7
½ to 1 Pack	3.3
1-2 Packs	1.5
>2 Packs	0.0
Unknown	2.0

proportion of participants not in the high morbidity stratum who did not have subsequent utilization.

Nominal statistical significance for all analyses was set at $P < .05$. All analyses were performed by using SAS statistical software (SAS Version 8.2 for Windows; SAS Institute Inc, Cary, NC).

RESULTS

The demographic characteristics of the study population are shown in Table I. The majority of the patients were white, female, well educated (at least some college), nonpoor (annual income $>$ \$35,000), and nonsmokers. In 2001, 11.4% of the study patients had emergency hospital utilization for asthma; 15.3% used more than 14 canisters of short-acting β -agonists; and 33.0% required oral steroids.

Relationship of psychometric scales and previous year utilization with future utilization

All psychometric scales demonstrated significant relationships with subsequent hospital/ED, β -agonist, and

oral steroid utilization for asthma (Table II). Patients in the highest morbidity group for each scale (see Methods) were as much as 4 times more likely than other patients to have asthma utilization (Table II).

Each scale except SF-12 MCS was significantly related to subsequent ED or hospital utilization ($P < .002$) and oral steroid dispensing ($P < .02$), above and beyond the effects of demographic and previous utilization predictors (see Tables E1 and E2 in the Journal's Online Repository at www.mosby.com/jaci). All scales including SF-12 MCS were independently related to β -agonist use ($P < .05$; see Table E2 in the Online Repository at www.mosby.com/jaci).

To assess the independent relationships of the various scales with the utilization outcomes, models were constructed for each outcome by forward stepwise selection, using all demographic factors, year 2000 utilization variables, and scales as candidate predictors (Table III). In addition to demographic and utilization predictors, AQLQ was independently related to subsequent emergency hospital care, AOMS to subsequent β -agonist use, and ATAQ to subsequent oral steroid use. Only 1 asthma-specific tool entered each model, suggesting that they were not independent of each other in predicting subsequent utilization. However, the SF-12 PCS was related to subsequent use of oral steroids, above and beyond the effect of the ATAQ, and the SF-12 MCS was related to subsequent β -agonist overuse, above and beyond the effect of the AOMS. These final models provided high discrimination ($c = 0.75$ - 0.90).

Clinical relationships in individual patients

To determine the clinical significance of these findings in individual patients, we determined the predictive properties of being in the high morbidity stratum for each scale (as defined in Table II) in regard to subsequent ED or hospital care (Table IV). The AQLQ and the ATAQ provided higher sensitivities and somewhat higher PPVs than the generic scales. At approximately equal levels of sensitivity, the AQLQ provided more specificity and a higher PPV than the ATAQ (cut at a score of 2). In contrast, the ATAQ provided the highest specificity of all of the scales (cut at a score of 3). The AOMS provided the highest sensitivity, but at the expense of lower specificity and PPV.

Clinical relationships for population management

To determine the clinical significance of these findings for population management, predicted probabilities of requiring emergency hospital care were calculated from the utilization and demographic regression equations with and without AQLQ. Because 11% of patients required emergency hospital care in 2000, the average probability for this occurrence in the population was 11%. To define high risk, several probability cutoffs were used (greater than average probability, ie, $>11\%$; greater than 1.5 times the average probability, ie, $>16.5\%$; and greater than twice the average probability, ie, $>22\%$) that favor varying

TABLE II. Univariate relationships between year 2001 utilization and the validated psychometric scales

Scale	Level*	N (%)†	Hospital or ED‡	>14 β -Agonists§	Oral steroids
SF-12 PCS¶	<38.5	248 (25.1)	20.6%	21.0%	49.2%
	$\geq$ 38.5	740 (74.9)	8.2%	13.7%	26.9%
	P value	—	<.0001	.006	<.0001
	OR (95% CI)	—	2.9 (1.9-4.3)	1.7 (1.2-2.4)	2.6 (2.0-3.5)
SF-12 MCS¶	<42.7	247 (25.0)	17.4%	23.5%	38.5%
	$\geq$ 42.7	741 (75.0)	9.3%	12.8%	30.5%
	P value	—	.0005	<.0001	.021
	OR (95% CI)	—	2.1 (1.4-3.1)	2.1 (1.4-3.0)	1.4 (1.1-1.9)
AQLQ¶	<3.9	253 (25.1)	23.7%	22.9%	46.6%
	$\geq$ 3.9	753 (74.9)	7.2%	12.2%	26.4%
	P value	—	<.0001	<.0001	<.0001
	OR (95% CI)	—	4.0 (2.7-6.0)	2.1 (1.5-3.1)	2.4 (1.8-3.3)
ATAQ#	<2	703 (66.8)	7.7%	10.4%	26.2%
	$\geq$ 2	350 (33.2)	19.7%	24.0%	44.3%
	P value	—	<.0001	<.0001	<.0001
	OR (95% CI)	—	3.0 (2.0-4.3)	2.7 (1.9-3.8)	2.2 (1.7-2.9)
ATAQ#	<3	883 (83.9)	9.0%	12.3%	28.2%
	$\geq$ 3	170 (16.1)	25.9%	28.2%	52.9%
	P value	—	<.0001	<.0001	<.0001
	OR (95% CI)	—	3.6 (2.3-5.4)	2.8 (1.9-4.1)	2.9 (2.0-4.0)
AOMS#	<4	665 (61.4)	7.8%	10.4%	28.3%
	$\geq$ 4	418 (38.6)	17.2%	23.2%	40.2%
	P value	—	<.0001	<.0001	<.0001
	OR (95% CI)	—	2.5 (1.7-3.6)	2.6 (1.9-3.7)	1.7 (1.3-2.2)

*Levels based on distribution described in Methods section.

†Distribution in total population; totals <1100 indicate missing data.

‡Any asthma hospitalization or ED visit.

§Greater than 14 canisters of short-acting β -agonist.

||Any oral corticosteroid dispensing.

¶Higher values indicate better quality of life.

#Higher values indicate more control problems or symptoms.

degrees of sensitivity and specificity. By using these various high-risk cutoffs, the prediction properties of the models with and without AQLQ results were then calculated (Table V). For models with demographics alone, the addition of the AQLQ increased sensitivity by as much as 17.2% and PPV by as much as 6.6%, with a decrease in specificity of as much as 3.2%. For models including only utilization parameters, the addition of the AQLQ increased sensitivity by as much as 10.4%, specificity by as much as 8.6%, and PPV by as much as 5.1%. However, addition of the AQLQ to models including both demographic and utilization predictors added 2.7% to one measure and 1.6% or less to all other measures.

DISCUSSION

The identification of patients with an increased risk for subsequent asthma emergency hospital utilization and rescue therapy use has important implications for both individual and population asthma management. This study found that validated tools measuring generic quality of life (SF-12), asthma-specific quality of life (AQLQ), asthma control (ATAQ), and asthma symptom severity (AOMS) are associated with subsequent utilization, even after adjusting for robust demographic and

previous utilization risk factors (see Table E2 in the Online Repository at www.mosby.com/jaci). In addition, this study found that the asthma-specific tools are not independent of each other in predicting subsequent utilization after adjusting for other risk factors (Table III).

The findings that the ATAQ and an asthma-specific quality of life tool independently predict subsequent asthma emergency hospital utilization confirm the results of 2 previous studies in similar populations^{29,33} and 1 additional study.³² The current study extends those findings to show that these tools are also independently predictive of subsequent rescue therapy requirements (see Table E2 in the Online Repository at www.mosby.com/jaci). This study is the first to report several findings, including a relationship between utilization and SF-12 MCS (independent for β -agonists) and SF-12 PCS (independent for all outcomes), and an independent relationship between an asthma symptom severity tool (AOMS) and subsequent asthma emergency hospital utilization and rescue therapy use (see Table E2 in the Online Repository at www.mosby.com/jaci). The relationship of the SF-12 MCS scale to β -agonist overuse but not to other outcomes, and its independent association with β -agonist overuse above and beyond the effect of other risk factors (Table III), suggest that overuse of β -agonists may be influenced

TABLE III. Independent relationships of demographic, year 2000 utilization, and survey predictors to subsequent year 2001 asthma hospitalizations or ED visits, dispensing of >14 canisters of β -agonist, and dispensing of oral steroids, using forward stepwise selection*

Predictor	Outcomes: OR (P value)		
	Hospital or ED†	>14 β -Agonists‡	Oral steroids§
Female			1.92 (.001)
White	0.54 (.031)		
Year 2000 hospital or ED†	3.66 (<.0001)		1.84 (.027)
Year 2000 >14 β -agonists‡	3.29 (<.0001)	39.7 (<.0001)	2.64 (.0007)
Year 2000 oral steroids§	2.31 (.005)		3.41 (<.0001)
SF-12 MCS¶		0.77 (.041)	
SF-12 PCS¶			0.74 (.0009)
AQLQ#	0.65 (<.0001)		
ATAQ**			1.23 (.015)
AOMS††		1.40 (.022)	
c Statistic‡‡	0.80	0.90	0.75

*All utilization, demographic, and survey scale predictors were candidates for the models for each outcome. ORs are shown only for variables that enter the model ($P < .05$). Age, income, education, and smoking did not enter any of the models ($P > .05$).

†Any asthma hospitalization or ED visit.

‡Greater than 14 canisters of short-acting β -agonist.

§Any oral corticosteroid dispensing.

¶OR per 10-point increase on a scale of 1 to 100.

#OR per 1-point increase on a scale of 1 to 7.

**OR per 1-point increase on a scale of 1 to 5.

††OR per 1-point increase on a scale of 1 to 4.

‡‡Area under the receiver operating characteristic curve for the model.

TABLE IV. Predictive properties of higher morbidity status in the validated psychometric scales for subsequent asthma hospitalizations or ED visits

Scale	Size of group (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
SF-12 PCS	25.1	45.5	77.5	20.6	91.8
SF-12 MCS	25.0	38.4	76.7	17.4	90.7
AQLQ	25.1	52.6	78.4	23.7	92.8
ATAQ (≥ 2)	33.2	56.1	69.8	19.7	92.3
ATAQ (≥ 3)	16.1	35.8	86.5	25.9	91.0
AOMS	38.6	58.1	63.9	17.2	92.2

by mental as well as physical determinants. This warrants further investigation.

In addition, this study is the first to show that the asthma-specific tools are not independent of each other in predicting utilization (Table III), so that only one of them may be necessary to assess the asthma symptom severity/control/quality of life dimension of subsequent utilization risk. Previous studies have demonstrated significant correlations between scales measuring asthma control and those measuring asthma-specific quality of life^{22,23} and between asthma specific quality of life and an asthma severity score.^{20,40}

The utility of these validated scales for predicting outcomes in individual patients is probably best reflected by the PPV and NPV, although these values are dependent on the incidences of the outcomes in the specific population. Although the PPVs of high morbidity levels in the ATAQ and AQLQ were modest (~25 %) for both

emergency hospital care and β -agonist overuse, they were 44% to 52% for future episodes requiring oral corticosteroids (Table IV). Furthermore, patients in the high morbidity level for the ATAQ and AQLQ were 3 to 4 times more likely to require emergency hospital care and more than twice as likely to overuse β -agonists or need oral corticosteroids as other patients (Table II). In addition, the NPV results show that more than 90% of patients who were not in the high morbidity groups for these tools did not require emergency hospital care in the following year. One reason for the modest PPV of the survey tools may be the inherent variability of asthma, such that the relatively short windows assessed by the survey (4 weeks) may not accurately reflect the patient's status over the period of the next 15 months. Repeated measurements of these scales over time would be expected to assess better the patient's overall status and risk.

Although the survey scales were independently predictive of outcomes in multivariable analyses in this and previous studies, this does not define their clinical utility. To determine this, their potential use in clinical population management was simulated by calculating predicted probabilities using models with and without AQLQ and defining high-risk groups on the basis of several probability cutoffs (Table V). AQLQ was chosen for these analyses because it was independently related to emergency hospital care in the final stepwise regression model (Table III). The increase in sensitivity (by as much as 17%) and modest increase in specificity or PPV (by 5% to 9%) observed when AQLQ results were added to either demographic or utilization information could be clinically

TABLE V. Predictive properties of models with and without AQLQ using various predicted probabilities of an event to define high risk

Model	High risk %	PPV (%)	Sensitivity (%)	Specificity (%)	NPV (%)
High risk probability >11%*					
Demographics	32.0	19.3	60.0	71.2	94.0
Demographics/AQLQ	32.2	21.8	67.5	72.0	95.0
Utilization	36.3	21.8	69.6	68.0	94.6
Utilization/AQLQ	28.4	26.9	67.5	76.6	94.9
Utilization/demographics	25.6	25.0	62.3	78.6	94.8
Utilization/demographics + AQLQ	26.3	25.6	65.0	78.2	95.1
High risk probability >16.5%†					
Demographics	14.7	20.5	29.4	87.0	91.5
Demographics/AQLQ	17.5	24.4	41.3	85.3	92.6
Utilization	13.8	36.2	44.0	90.1	92.6
Utilization/AQLQ	18.4	33.5	54.4	86.2	93.7
Utilization/demographics	16.7	31.9	51.8	87.4	94.1
Utilization/demographics + AQLQ	18.0	30.2	52.5	86.0	94.0
High risk probability >22.0%‡					
Demographics	6.2	23.5	14.1	94.8	90.6
Demographics/AQLQ	10.8	30.1	31.3	91.6	92.0
Utilization	13.8	36.2	44.0	90.1	92.6
Utilization/AQLQ	13.1	40.2	46.5	91.1	93.0
Utilization/demographics	11.7	39.2	44.7	92.1	93.6
Utilization/demographics + AQLQ	12.4	38.5	46.3	91.5	93.6

*Greater than the average risk in the population.

†Greater than 1.5 times the average risk in the population.

‡Greater than twice the average risk in the population.

meaningful, especially in large populations. However, AQLQ added little or nothing to models containing both types of information, suggesting that these tools may not be useful for populations in which the robust demographic and utilization information included in this study is available.

This study does have some potential limitations that could affect its internal validity. Selection bias may be introduced because not all potential participants completed questionnaires, although a >60% response rate is not unreasonable for this type of mail-in questionnaire study. A comparison of year 2001 outcomes for the study population versus the general Kaiser-Permanente population of patients with asthma in the 2 regions (G. Tom, unpublished data, January 2003) for β -agonist >14 canisters (15% vs 13%) and for emergency hospital care (11% vs 9%) suggests that the participants who completed the surveys had somewhat more severe or uncontrolled asthma than nonresponders. Further selection bias could have been introduced by the unavailability of utilization data for all subjects. Because patients without utilization data would not have qualified as having active asthma in 2000, this also biases the study sample to those with more severe asthma. This study used Kaiser-Permanente hospital, ED, and pharmacy records to identify utilization, so that uncaptured outside utilization could lead to misclassification bias. However, attempts are made in these administrative data to capture outside hospital and ED visits, and >90% of Kaiser-Permanente subjects with asthma have Kaiser-Permanente prescription benefits (R. Nakahiro,

unpublished data, January 2004), so such misclassification bias should be minimal.

The generalizability of the current results warrants comment. Using data from 2 separate geographical areas should increase generalizability, although both sites were on the West Coast. Because the results were adjusted for demographic factors, they may be expected to apply to populations with different demographic characteristics. Indeed, the demographic data from this study (see Table E1 in the Online Repository at www.mosby.com/jaci) were consistent with the results of many other studies in showing less adverse outcomes in whites and those with higher socioeconomic status.¹⁶ However, the current study population was a very well educated one (almost 75% attending at least some college). Because the validated scales used in this study depend on literacy, the current results may not apply to populations with lower literacy levels.

The findings from this study have several practical implications. These validated questionnaires could be used in the clinical setting for individual patients to assess the likelihood of subsequent utilization and thus to identify patients for whom management intensity should be increased. The cutoffs used in this study could be applied in such individual patient risk assessment pending further validation of these cutoffs in additional populations. Because these tools are patient-completed questionnaires, they would also be suitable for telephone or mail outreach efforts. On the basis of the PPV and specificity, the AQLQ or the ATAQ (cut at 3) would appear to be most

valuable for this purpose. The current findings also suggest that the validated questionnaires used in this study could be valuable as part of risk stratification efforts in populations of patients with asthma in which both robust demographic and previous utilization predictors are not available. From this study, we would suggest that the use of these survey tools for individual patient or population asthma management would improve asthma outcomes by identifying patients in need of more intensive asthma management.

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