Articles

Pulmonary and Allergy Subspecialty Care in Adults With Asthma

Treatment, Use of Services, and Health Outcomes

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To study the relationship between physician subspecialty practice type and health measures in patients with adult asthma, we prospectively studied 601 adults with asthma. The subjects were recruited from a random sample of board-certified pulmonary or allergy internal medicine subspecialists practicing in northern California; 539 patients (90%) were restudied after 18 months. Structured telephone interviews were used to elicit demographics, clinical variables, and measures of asthma severity, asthma-specific quality of life, and physical function status. At baseline and follow-up, 283 subjects (53%) reported their principal asthma care provider type as a pulmonary specialist throughout and 150 (28%) as an allergy specialist throughout, 53 (10%) switched provider type during follow-up, and 53 (10%) reported that their principal asthma care physician was from neither subspecialist group. Taking into account illness severity and other demographic and clinical covariates, the group whose principal asthma care came from an allergy subspecialist was more likely than the pulmonary specialist-care group to report possessing a peak expiratory flow rate meter (odds ratio [OR], 2.8; 95% confidence interval [CI], 1.8 to 4.6) and less likely to be receiving high-dose inhaled steroids (OR, 0.3; 95% CI, 0.1 to 0.6). Taking into account demographic and clinical covariates, allergists' care was related to worse subject-reported asthma-specific quality of life (*P* = 0.02), but not to statistically increased risk of hospitalization, decreased physical function, or an increased number of reported health-related restricted-activity days. We observed subject-reported specialist variation in management and health outcomes among adults with asthma not accounted for by differing disease severity or other clinical and demographic variables.

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Asthma among adults is common and costly and appears to be rising in incidence and prevalence.[1–6] Of all ambulatory care visits in the United States, 1% have been estimated to involve asthma as the primary medical diagnosis, whereas among internal medicine specialists, asthma accounts for an even higher proportion of such visits, making it the 13th most common diagnosis in ambulatory care visits for that group.[1,7]

Although characteristics of physicians and their practice style have been recognized as important possible factors affecting health outcomes generally,[8,9] information on practice variation in asthma and its possible effect is scant. A recent national survey found wide-ranging differences in asthma management by practice specialty.[10] For example, although 76% of allergy subspecialists instructed their patients on monitoring peak expiratory flow rates (PEFR), this proportion fell to 56% among pulmonary subspecialists, even though this is a key component of current National Heart, Lung and Blood Institute guidelines aimed at better asthma control.[11,12] A limited number of other studies have examined differences in outcomes following allergy subspecialist care of asthma compared with that of generalists.[13–18] Despite practice differences between pulmonary and allergy specialists noted previously,[10] however, none of the outcome studies have included pulmonary specialists.

We examined a variety of practice and outcome measures for adults with asthma who were cared for by pul-

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ABBREVIATIONS USED IN TEXT

CES-D = Centers for Epidemiological Studies Depression [scale]
CI = confidence interval
HMO = health maintenance organization
OR = odds ratio
PEFR = peak expiratory flow rate
SF-36 = Medical Outcomes Study Short-Form General Health Survey

monary or allergy subspecialists. We hypothesized that, even after taking illness severity and other covariates into account, both clinical practice and health outcomes would differ by subspecialist-treatment group. We addressed this question by analyzing data from an ongoing panel study of adults with asthma initially identified through a random sample of medical specialists.[19]

Subjects and Methods

Overview

The persons with asthma we studied are part of an ongoing panel derived from a random sample of northern California internists board-certified in the subspecialties pulmonary or allergy immunology. Participating physicians maintained a registry of all patients seen with asthma in the outpatient setting over one to two months, depending on their patient volume. A trained survey worker administered a structured, closed-ended, computer-assisted, telephone interview lasting 45 minutes to each person with asthma who agreed to participate in the study when contacted first by mail and then by telephone. At baseline, we also obtained spirometry data, if available, from the recruiting physicians. We carried out follow-up interviews 18 months after the baseline survey. The follow-up interview was similar to the baseline survey and was administered by the same person.

Subject Recruitment for Baseline Interview

The details of the initial subject recruitment have been reported previously.[19] In brief, we obtained a list for northern California of all internal medicine specialists who were also board-certified pulmonary (n = 252) or allergy immunology subspecialists (n = 40). Of 145 randomly selected pulmonary subspecialists, 92 were eligible (had at least one full day of outpatient practice per week in northern California). Of these, 68 agreed to participate. Of 20 allergists selected, 19 were eligible and 17 participated. Overall, 8 recorded no patients, and 3 others listed a few names of which none entered the study. The final number of participating subspecialists from whom subjects were successfully enrolled and studied was 74, of whom 57 were pulmonary and 17 allergy subspecialists.

Patient enrollment criteria were as follows: age 18 through 50 years, asthma clinically consistent with American Thoracic Society and American College of Chest Physicians definitions, and no concomitant chronic bronchitis or emphysema. Other factors such as age of asthma onset, severity, atopy, or smoking history were not eligibility or exclusion criteria.

We attempted to recruit each potential subject registered. Of 698 eligible subjects registered, 84 (12%) declined to participate and 13 (2%) were not successfully contacted, for an overall study participation of 601 (86%) at the time of the baseline interview. Of these, 384 (64%) were recruited from pulmonary and 217 (36%) from allergy subspecialty practices. Study participation rates did not differ significantly by specialty recruitment type (87% versus 84%, $P > 0.5$). The number of participants recruited per practice site, however, was greater from allergy (median, 9) than from pulmonary (median, 5) specialists ($P < 0.05$).

Subject Follow-up

We reinterviewed 539 (90%) of 601 adults with asthma previously studied at baseline. The mean number of months elapsed to reinterview was 18.6 ± 1.0 standard deviation (median, 18.4 months). Of the 62 subjects not reinterviewed, 5 had died in the interim (3 deaths were attributed to asthma). Of the remaining subjects not restudied, 47 returned survey postcards offering the option to decline an interview, as required by the University of California, San Francisco, Committee on Human Research, and 10 subjects were lost to follow-up.

Of those reinterviewed, 343 (64%) were originally recruited from pulmonary practices; 41 (66%) of those not reinterviewed were recruited from pulmonary practices ($P > 0.8$). Those not studied at follow-up were younger (36.0 ± 9.2 versus 39.4 ± 8.1 years; $P = 0.003$) and were more frequently male (28 [45%] versus 160 [30%]; $P = 0.02$), but the ethnic-racial mix did not differ statistically (white, non-Hispanic, 26 [58%] versus 364 [68%]; $P = 0.18$). There was no statistical difference in disease severity between subjects who were retained (severity score, 11.3 ± 5.9) and those not reinterviewed (score, 10.5 ± 6.9; $P > 0.2$).

Definition of Principal Asthma Care Physician

A total of 283 subjects (53%) identified their principal asthma care physician as a pulmonary subspecialist both at baseline and at the follow-up interview. Of these, 17 (6%) reported physician visits with an allergy subspecialist at least once during the preceding 18 months. Of 539 subjects, 150 (28%) identified an allergy subspecialist as their principal asthma care physician at both interviews. Of these, 6 (4%) reported at least one physician visit with a pulmonary subspecialist in the preceding 18 months. Over the course of follow-up, 53 (10%) changed the subspecialist they identified as their principal asthma care physician, either from pulmonary to allergy (n = 42) or from allergy to pulmonary (n = 11).

Finally, 53 other subjects did not identify either a pulmonary or allergy subspecialist as their principal asthma care physician at the time of both baseline and follow-up interviews. Because of subject recruitment, all subjects in this group had been evaluated or treated by a physician from one of these two subspecialist groups before the baseline interview: 38 (72%) were initially recruited from pulmonary and 15 (28%) from allergy subspecialty practices. None, however, reported being cared for by a subspecialist as their principal asthma care physician throughout the 18-month follow-up. At follow-up, 18 (34%) of these 53 subjects reported no regular asthma care health professional of any kind since baseline; 18 (34%) reported some follow-up since baseline with either a pulmonary or allergy subspecialist; and 17 (33%) reported other, nonsubspecialist asthma medical follow-up only.

Interviews and Survey Instruments

The baseline and follow-up interviews included questions covering asthma history, symptoms, and treatment; general health and functional status; and demographic and psychosocial variables. We quantified asthma severity using a validated scoring system derived from the questionnaire responses.[19,20] The severity-of-asthma score is a composite of the following variables: frequency of current asthma symptoms, past asthma hospital admissions and mechanical ventilatory support for asthma, past and current use of oral and parenteral corticosteroids, and the use of asthma medications other than oral and parenteral steroids. A maximum score of 28 reflects the greatest asthma severity.

The survey also included a validated, asthma-specific quality-of-life instrument (Marks and Woolcock) based on a 20-item Likert-type scale. This instrument analyzes four areas: breathlessness, mood, social functioning, and health concerns.[21] A maximum summary score of 80 reflects the greatest adverse effects of asthma on the quality of life.

We also included in the interview the 36-question battery (SF-36) derived from the Medical Outcomes Study Short-Form General Health Survey.[22,23] The SF-36 includes subscales in several domains, of which the subscales for self-perceived general health status (based on responses to 6 questionnaire items) and physical function (based on responses to 10 questionnaire items) were of particular interest. A maximum of 100 points reflects better general health or physical function. Although the SF-36 includes a mental health subscale based on 5 questions, we also included in our follow-up interviews the 20-item Center for Epidemiological Studies Depression (CES-D) scale as an alternative measure of this domain.[24] A maximum score of 60 on this scale reflects the greatest degree of depressive symptoms.

We defined other variables on the basis of structured interview responses. The atopic history was based on reported incidents of allergic rhinitis or atopic dermatitis. Family income was ascertained as a series of increments: <\$5,000, \$5,001 to \$10,000, \$10,000 increments through \$50,000, 50,001 to \$75,000, and >\$75,000. To convert to specific income levels, the midincrement value was applied, except for the highest category, where a value of \$87,500 was applied. For insurance status, respondents were first asked if they had any health insurance and then to specify the type and provider. We specifically asked if coverage was provided by the Kaiser Permanente Health Plan, the largest staff-model health maintenance organization (HMO) in the region, by one of a series of other prominent HMOs in the region, or by several large third-party insurers. The interviewer prompted each by name.

Data Management and Statistical Analysis

Computer-assisted interview software was used. Interview data were exported into a PC-SAS (SAS Institute, Cary, NC) compatible format. We tested the differences between those reinterviewed and those not studied at follow-up by either the χ^2 or t test. We tested the differences between four groups defined by principal asthma provider type using either the χ^2 (categorical variables) or analysis of variance (continuous variables) or, for nonparametric analyses of continuous variables, the Kruskal-Wallis equivalent of the Wilcoxon rank-sum test. Pairwise comparisons of severity-of-asthma score used Tukey's modified t test.

To control for differences in asthma severity and other covariates, we reexamined these differences using multiple-regression analyses. We used multiple-logistic-regression analysis to estimate associations between principal asthma care physician type and those medical treatments (pneumococcal vaccination, PEFR meter provision, allergy desensitization immunotherapy, and high-dose inhaled steroids) that differed significantly by physician type in an initial bivariate analysis.

We also used multiple-logistic-regression analysis to estimate the association between subspecialty care and acute care services use for asthma: ≥2 urgent physician office visits; ≥2 emergency department visits; and ≥1 hospital admission over follow-up. Finally, we used multiple linear regression to estimate the association between principal asthma care physician type and the following outcome measures: asthma-specific quality-of-life score (the overall quality-of-life score and each of its 4 component domains), SF-36 physical function score, health-related activity-restricted days over the past 30 days, and the depression score measured by the CES-D battery.

In each model, we included the following possible confounding variables: age, sex, years of education, baseline income, change in income over follow-up, cigarette smoking status (>100 lifetime cigarettes), history of atopy, childhood asthma onset, severity-of-asthma score, general health status (SF-36), and health insurance status (HMO coverage at baseline and follow-up; non-HMO health insurance at baseline and follow-up; change between HMO and non-HMO during follow-up; uninsured for health care at baseline, at follow-up, or at both interviews). Finally, we reanalyzed the quality-of-life model, adding to it the four practice measures differing by principal asthma care physician: pneumonia vaccination, PEFR meter provision, high-

TABLE 1.—*Baseline Demographics by Principal Asthma Care Subspecialty Group*

Demographic Variable	Principal Asthma Care Provider Type: Pulmonary (n = 283)	Allergy (n = 150)	Both (n = 53)	Neither (n = 53)	P Value*
White, non-Hispanic, no. (%)	194 (69)	97 (65)	37 (70)	36 (68)	>0.8
Female sex, no. (%)	199 (70)	97 (65)	39 (74)	44 (83)	0.08
Age, yr, mean ± SD	40 ± 8	40 ± 8	38 ± 8	37 ± 10	0.07
Education, yr, mean ± SD (median)	14 ± 3 (14)	15 ± 2 (14)	14 ± 2 (14)	14 ± 3 (13)	0.04
Married/partnered, no. (%)	186 (53)	99 (66)	37 (70)	29 (55)	>0.30
Persons in household					>0.50
1, no. (%)	28 (10)	14 (9)	6 (11)	6 (11)	
2, no. (%)	87 (31)	59 (39)	16 (30)	19 (36)	
3, no. (%)	70 (25)	34 (23)	8 (15)	9 (17)	
≥4, no. (%)	98 (35)	43 (29)	23 (43)	19 (36)	

SD = standard deviation.

*Differences were tested by χ^2 or Kruskal-Wallis (education).

dose inhaled-steroid use, and immunotherapy injections. We also tested the effect of recruitment group size.

Results

Demographics and Clinical Variables

Table 1 compares subject demographics by type of principal asthma care provider: pulmonary, allergy, both (subjects who switched between a pulmonary and allergy subspecialist over follow-up), and neither (neither subspecialist type was the principal asthma care physician throughout follow-up). Years of education varied statistically by asthma care physician type (Kruskal-Wallis, $P < 0.05$) and was highest in the allergist-treated group. Differences in sex and age were of borderline statistical significance ($0.05 \leq P < 0.10$); other demographic characteristics did not differ statistically.

Table 2 compares clinical variables by the principal asthma care physician. Asthma severity, measured on a 28-point scale, varied significantly by subspecialist type ($P = 0.01$). Severity was greatest among the pulmonary specialist-treated group; the mean pairwise difference in scores between the pulmonary and allergy subspecialist groups was 1.6 points ($P < 0.05$, Tukey's modified *t* test). Significantly more subjects with an atopic history were in the allergy specialist-treated group. The proportion of subjects who had ever smoked cigarettes regularly (>100 lifetime) also varied significantly, with the greatest proportion (43%) being cared for by pulmonary specialists. Current smokers (not shown in Table 2) numbered only 37 (7%) of the entire group and did not differ statistically by physician type ($P > 0.3$).

Table 3 shows that income and health insurance status varied significantly by principal asthma care physician. Income was highest at baseline in the allergy care

TABLE 2.—*Baseline Clinical Variables by Principal Asthma Care Provider Type**

Clinical Variable	Principal Asthma Care Provider Type: Pulmonary (n = 283)	Allergy (n = 150)	Both (n = 53)	Neither (n = 53)	P Value
Childhood asthma, no. (%)	120 (42)	79 (53)	23 (43)	22 (42)	0.20
Ever smoked, no. (%)	123 (43)	48 (32)	16 (30)	17 (32)	0.045
Atopic history, no. (%)	206 (73)	129 (86)	42 (79)	43 (81)	0.02
Severity score, mean ± SD†	12.1 ± 6.2	10.5 ± 5.0	10.0 ± 5.9	10.9 ± 6.2	0.01
General health, mean ± SD‡	53.5 ± 26	56.5 ± 24	62.2 ± 26	54.2 ± 24	0.11
FEV_1, % predicted, mean ± SD§	79 ± 23% (n = 179)	81 ± 21% (n = 110)	83 ± 25% (n = 39)	85 ± 21% (n = 34)	>0.30

SD = standard deviation

*Differences were tested by χ^2 or analysis of variance. All interview variables were taken at baseline.
†The severity score is based on past asthma history, medication use, and symptoms; a higher score reflects greater illness severity (maximum, 28).
‡General health refers to the general health status domain of the Medical Outcomes Study Short-Form 36-item survey instrument; a higher score (maximum, 100) reflects better respondent-perceived health status.
§The percentage of forced expiratory volume in 1 second (FEV_1%) was available for 362 subjects only.

TABLE 3.—*Income and Insurance Status at Baseline and at 18-Month Follow-up*

*Income and Insurance**	*Pulmonary (n = 283)*	*Allergy (n = 150)*	*Both (n = 53)*	*Neither (n = 53)*	*P Value†*
	Principal Asthma Care Provider Type				
Annual income, thousands of dollars‡					
Baseline, median	25.0	31.3	22.5	22.5	0.01
At follow-up, median	25.0	31.3	31.3	17.5	<0.001
Income change, mean ± SD	0.7 ± 14	3.7 ± 13	3.4 ± 13	−2.3 ± 12	0.03
Health insurance status, no. (%)					
Baseline					<0.001
None	11 (4)	4 (3)	0 (0)	6 (11)	
HMO	166 (59)	112 (75)	29 (55)	22 (42)	
Other insurance	106 (37)	34 (23)	24 (45)	25 (47)	
At follow-up, no. (%)					<0.001
None	19 (7)	3 (2)	3 (6)	16 (30)	
HMO	157 (55)	106 (71)	27 (51)	19 (36)	
Other insurance	107 (38)	41 (27)	23 (43)	18 (34)	
Insurance changes, no. (%)					<0.001
Not covered	24 (8)	5 (3)	3 (6)	19(36)	
HMO throughout	126 (45)	100 (67)	24 (45)	11 (21)	
Other throughout	69 (24)	28 (19)	20 (37)	12 (22)	
Mixed coverage	64 (23)	17 (11)	6(11)	11 (21)	

HMO = health maintenance organization.

*Of those not covered by health insurance either at baseline or at follow-up (n = 51), 11 were without coverage at both interviews, 30 lost their coverage, and 10 gained coverage over follow-up.
†Differences tested by χ^2 or Kruskal-Wallis test.
‡Income refers to per-adult household income.

group and increased to the greatest degree over follow-up. Income fell among those not being seen by a subspecialist; this group also had the greatest proportion (36%) without health insurance coverage at baseline, follow-up, or the time of both interviews.

Clinical Practice and Treatment

Four asthma-related clinical practices differed significantly by principal asthma care physician group (Table 4). The proportion reporting pneumococcal vaccination

TABLE 4.—*Asthma-Related Treatments by Principal Asthma Care Subspecialty Group*

Asthma Measures at Follow-up	*Pulmonary (n = 283), No. (%)*	*Allergy (n = 150), No. (%)*	*Both (n = 53), No. (%)*	*Neither (n = 53), No. (%)*	*P Value**
	Principal Asthma Care Physician Type				
Control strategies adopted					
Vaccinations					
Influenza, previous year	162 (57)	84 (56)	31 (58)	34 (64)	>0.7
Pneumococcal, ever	86 (30)	26 (17)	10 (19)	11 (21)	0.01
PEFR meter available	143 (51)	104 (69)	38 (53)	32 (60)	0.002
Ongoing immunotherapy	10 (4)	38 (25)	12 (23)	1 (2)	<0.001
Medication regimens†					
Inhaled steroid	176 (62)	103 (69)	35 (66)	29 (55)	>0.2
High-dose inhaled steroid	27 (10)	3 (2)	4 (8)	0 (0)	0.004
Regular inhaled β-agonist	186 (66)	101 (67)	33 (62)	34 (64)	>0.9
Without inhaled steroid	50 (18)	25 (17)	9 (17)	11 (21)	>0.9
Oral β-agonist/theophylline	127 (38)	64 (43)	17 (32)	20 (38)	>0.3
Without inhaled steroid	39 (14)	17 (11)	2 (4)	7 (13)	>0.2
Frequent oral steroids	53 (19)	23 (15)	9 (17)	7 (13)	>0.6

*Differences tested by χ^2 test.
†Inhaled steroids and β-agonist and oral β-agonist/theophylline refer to reported use for 2 wk before the follow-up interview. Regular inhaled β-agonist use is defined as ≥2 puffs/day on average. High-dose inhaled steroid is defined as ≥20 puffs/day. Frequent parenteral steroids is defined as used at least every other day for ≥3 months over the 18 mo before the interview.

TABLE 5.—*Subspecialty Follow-up and Treatment Strategies: Multiple-Logistic-Regression Analysis**

	Treatment Strategies Potentially Related to Adult Asthma			
Predictor Variable	*Pneumococcal Vaccination, OR (95% CI)*	*PEFR Meter, OR (95% CI)†*	*Immunotherapy, OR (95% CI)‡*	*≥20 Puffs Steroid, OR (95% CI)*
Principal asthma provider				
Pulmonary (referent)	1.0	1.0	1.0	1.0
Allergy	0.5 (0.3–0.9)	2.8 (1.8–4.6)	9.0 (4.1–19.6)	0.3 (0.1–0.6)
Both	0.6 (0.3–1.4)	1.6 (0.8–3.1)	8.5 (3.3–22.2)	0.4 (0.1–1.3)
Neither	0.9 (0.4–1.9)	2.1 (1.1–4.3)	0.7 (0.1–5.6)	1.0 (0.3–3.6)
Health insurance status				
Not covered (referent)	1.0	1.0	1.0	1.0
HMO over follow-up	2.6 (1.05–6.5)	1.6 (0.7–3.4)	3.2 (0.4–28.4)	4.1 (1.03–16.0)
Other over follow-up	2.4 (0.9–6.1)	0.8 (0.4–1.7)	4.1 (0.4–36.9)	1.2 (0.3–5.1)
Mixed HMO and other coverage	1.0 (0.4–2.6)	0.8 (0.4–1.8)	4.6 (0.5–43.1)	1.1 (0.3–5.1)
Baseline asthma severity	3.0 (2.0–4.6)	4.4 (2.9–6.6)	1.3 (0.7–2.4)	5.8 (3.0–11.4)

CI = confidence interval, HMO = health maintenance organization, OR = odds ratio

*The odds ratio for severity score and age is expressed per 10-unit change. The logistic regression model also includes baseline age, sex, SF-36 general health status (see text and Table 2 for description), education, atopic history, childhood asthma onset, history of ever smoking cigarettes, baseline per-adult family income, and change in income at follow-up from baseline.
†This treatment strategy involves the use of a PEFR meter.
‡The patient receives ongoing allergy desensitization.

was greatest (30%) among the pulmonary specialist-treated group and lowest (17%) among the allergy specialist-treated group. In contrast, the greatest proportion with PEFR meters (69%) was among the allergist-treated group and the lowest (51%) among those being treated by pulmonary specialists. The two other practices that varied statistically by provider subspecialty type were ongoing immunotherapy (allergy desensitization shots), which was most frequent among the allergist-treated group, and the use of high-dose inhaled steroids (≥20 puffs per day), which was most frequent among the pulmonary specialist–treated group. Other patterns of medication use did not differ statistically by physician type.

Table 5 presents a further analysis of these four treatment strategies in relation to principal asthma care physician, taking into account the possible confounding effects of health insurance status, asthma severity, and several other additional covariates. In this multiple-logistic-regression analysis, subjects in the allergist-treated group were statistically more likely than those in the pulmonary specialist–treated group to have a PEFR meter or to be receiving ongoing immunotherapy and were less likely to have ever received a pneumococcal vaccination or to be using high-dose inhaled steroids.

In the same models (Table 5), greater asthma severity assessed at baseline was a potent predictor of PEFR meter possession, pneumococcal vaccination, and the use of high-dose inhaled steroids at follow-up but was not a predictor of ongoing immunotherapy. Insurance coverage through an HMO reported at baseline and at follow-up was strongly associated with high-dose inhaled-steroid use and pneumococcal vaccination.

Health Care Use

As shown in Table 6, we observed only modest variation by principal asthma care physician type in each of three measures of acute asthma care use that we studied: urgent office visits, emergency department visits, and hospital admissions (although the last was of borderline statistical significance). Moreover, when we took into account multiple covariates of interest by multiple-logistic-regression analysis (Table 7), we found that the principal asthma care physician type was not a significant predictor of any of the usage variables we studied ($P > 0.05$).

TABLE 6.—*Asthma-Related Health Care Use by Principal Asthma Care Physician Type*

	Principal Asthma Care Physician Type				
Asthma Measures	*Pulmonary (n = 283), No. (%)*	*Allergy (n = 150), No. (%)*	*Both (n = 53), No. (%)*	*Neither (n = 53), No. (%)*	*P Value**
Services used past 18 mo					
≥2 emergency department asthma visits	39 (14)	14 (9)	7 (13)	4 (8)	>0.3
≥2 Urgent MD office visits	47 (17)	29 (19)	12 (23)	5 (9)	>0.2
≥1 Hospital admission for asthma	36 (13)	8 (5)	6 (11)	3 (6)	0.06

*Differences tested by χ^2 test.

TABLE 7.—*Predictors of Asthma-Related Health Care Use: Multiple-Logistic-Regression Analysis**

	Measures of Acute Health Care Use for Asthma, Reported Frequency Over 18 Mo†		
Associated Factors	*≥2 Urgent MD Office Visits, OR (95% CI)*	*≥2 Emergency Department Visits, OR (95% CI)*	*≥1 Hospital Admission, OR (95% CI)*
Subspecialist follow-up			
Pulmonary (referent)	1.0	1.0	1.0
Allergy	1.6 (0.9–2.9)	1.0 (0.5–2.0)	0.7 (0.4–1.6)
Both	2.1 (0.96–4.7)	1.4 (0.5–3.7)	1.4 (0.5–4.2)
Neither	0.6 (0.2–1.8)	0.6 (0.2–2.0)	0.5 (0.1–2.0)
Health insurance status			
Not covered (referent)	1.0	1.0	1.0
HMO throughout	2.6 (0.9–7.2)	4.3 (1.2–15.4)	4.0 (1.01–16.3)
Other throughout	1.5 (0.5–4.4)	2.0 (0.6–7.1)	3.6 (0.9–14.2)
Mixed coverage	1.4 (0.5–4.4)	2.4 (0.6–8.8)	2.7 (0.6–11.2)
Baseline severity of asthma score	3.2 (2.0–5.1)	4.8 (2.7–8.7)	7.8 (3.4–15.2)
Baseline income‡	0.8 (0.8–1.1)	0.6 (0.5–0.8)	0.7 (0.6–0.96)

HMO = health maintenance organization.

*The logistic regression model also includes baseline age, sex, baseline SF-36 general health status (see text and Table 2 for description), education, atopic history, childhood asthma onset, history of ever-smoking cigarettes, and change in income at follow-up.
†The odds ratio (OR) for the severity score is expressed per 10-unit change.
‡The OR for income is expressed per $10,000 of per-adult family income.

In contrast, greater baseline asthma severity was a strong and consistent predictor of increased health services use. Lower baseline income and HMO insurance coverage throughout the follow-up (relative to lack of health insurance coverage) were associated with a statistically increased probability of emergency department visits and hospital admission.

Health Outcomes

The association between principal asthma care physician type and each of four measures of health and well-being outcome without adjustment for covariates is presented in Table 8. We further studied the predictors of asthma-specific quality of life, the SF-36 physical function score, the number of activity-restricted days, and the CES-D depression score using multiple-linear-regression analysis (Table 9). The overall explanatory power (R^2) of the models ranged from 0.19 for the CES-D score to 0.32 for the quality-of-life score.

When illness severity, income status, health insurance coverage, and demographic and clinical covariates were looked at, the group receiving their principal care from an allergy subspecialist reported poorer asthma-specific quality of life ($P = 0.02$) at follow-up than the group receiving their principal care from a pulmonary subspecialist. Adding to the model the baseline asthma-specific quality of life assessed at the initial interview did not appreciably change the parameter estimate for allergists' care ($\beta = 2.7$; $P = 0.03$).

Adding to the predictive model pneumococcal vaccination, PEFR-meter provision, high-dose inhaled-steroid use, and immunotherapy did not account for the

TABLE 8.—*Asthma-Related Health Care Outcomes by Principal Asthma Care Physician Type*

	Principal Asthma Care Physician Type				
Outcome Measures	*Pulmonary (n = 283)*	*Allergy (n = 150)*	*Both (n = 53)*	*Neither (n = 53)*	*P Value**
Quality-of-life score†‡	20 ± 15	20 ± 14	20 ± 15	23 ± 15	>0.6
Physical function†§	71 ± 28	75 ± 23	68 ± 30	61 ± 30	0.01
CES-D depression score‖¶	5 (2–15)	4.5 (1–12)	6 (0–13)	10 (4–16)	0.03
Activity-restriction days‖#	0 (0–8)	0 (0–5)	1 (0–12)	2 (0–10)	>0.5

*Differences are tested by analysis of variance or the Kruskal-Wallis test.
†The scores are expressed as the mean ± standard deviation.
‡For the asthma-specific quality-of-life score, a higher score denotes poorer quality of life.
§For the physical function domain (see text and Table 2 for description), a higher score denotes better function.
‖The scores are expressed as the median (25% to 75%).
¶For the Center for Epidemiological Studies Depression (CES-D) score, a higher score denotes greater severity of depression.
#Denotes days of activity restricted because of health over past 30 days.

TABLE 9.—*Principal Asthma Care Physician Type and Asthma Outcomes: Multiple-Linear-Regression Analysis**

	Health Outcome Measure at 18-Mo Follow-up Interview							
	Asthma QOL Score† (Model R^2 = 0.30)		Physical Function‡ (Model R^2 = 0.32)		Restricted Days§ (Model R^2 = 0.21)		Depression Score‖ (Model R^2 = 0.19)	
Predictors of Outcome	β (SEM)	P	β (SEM)	P	β (SEM)	P	β (SEM)	P
Principal asthma care type								
Pulmonary (referent)	—		—		—		—	
Allergy	3.0 (1.3)	0.02	-1.5 (2.4)	0.5	-0.2 (0.9)	0.8	-0.4 (1.0)	0.7
Both	3.9 (1.9)	0.04	-9.1 (3.5)	0.01	3.0 (1.4)	0.03	0.4 (1.4)	0.8
Neither	2.7 (2.0)	0.2	-8.7 (3.6)	0.02	0.5 (1.4)	0.7	1.5 (1.5)	0.3
Baseline asthma severity	0.7 (0.1)	<0.001	-0.9 (0.2)	<0.001	0.3 (0.07)	<0.001	0.2 (0.08)	0.01
Baseline income¶	-0.6 (0.4)	0.14	2.9 (0.8)	<0.001	-0.7 (0.3)	0.04	-0.5 (0.3)	0.13
Follow-up income change¶	-1.2 (0.4)	0.005	2.8 (0.8)	<0.001	-0.9 (0.3)	0.002	-1.1 (0.3)	<0.001

SEM = standard error of the mean

*The multiple-linear-regression models also include age, sex, education, atopic history, childhood asthma onset, history of ever smoking cigarettes, and insurance status.
†For the asthma-specific quality-of-life (QOL) score, a higher score denotes poorer QOL.
‡The physical function domain (see text and Table 2 for description), a higher score denotes better function.
§The restricted days refers to the number of days of health-restricted activity over past 30 days.
‖The depression score refers to the Centers for Epidemiological Studies Depression scale; a higher score denotes a more severe depression.
¶The β coefficient for income variables is expressed per $10,000 of per-person adult family income.

association between allergy subspecialty follow-up and the overall quality-of-life score ($\beta = 2.6$; $P < 0.01$). Adjusting for the number of subjects initially recruited from the practice site also did not reduce the strength of this association. As shown in Table 9, allergists' care was not statistically associated with physical function, the number of restricted-activity days, or depression.

To further delineate the possible relationship between allergy subspecialist follow-up and subject-reported quality of life, we analyzed this relationship for each of the quality-of-life measures component subscores: breathlessness, mood disturbance, social functioning, and health concerns. When we took the same covariates listed in Table 9 into account, we found that allergy subspecialty follow-up was a significant predictor of poorer social functioning ($P = 0.03$) and greater health concerns ($P = 0.02$), but was less strongly associated with breathlessness ($P = 0.11$) or mood disturbance ($P > 0.2$).

Subjects who had changed their subspecialist type during follow-up reported worse quality of life, worse physical function, and more restricted-activity days than the group receiving care from a pulmonary subspecialist, taking into account the effects of all the other covariates included in the analysis (Table 9). The baseline asthma severity was a consistent predictor of poorer status assessed by each outcome measure. Greater baseline income and, more potently, increased income since baseline were associated with better health and well-being. None of the health insurance covariates (included in the model but not shown in Table 9) were statistically associated with any of the four outcome measures we studied.

Discussion

We identified several salient differences in practice and outcomes associated with the type of asthma care subspecialist. These differences, however, should be viewed in the context of the more consistent and powerful effects of underlying disease severity, insurance status, and income on health care use and asthma outcomes.

A notable practice difference related to the subspecialist group was in the dispensing of PEFR meters. The use of PEFR meters has been strongly promoted in guidelines for asthma management promulgated by the National Heart, Lung and Blood Institute, although its most recent expert panel report acknowledges that for mild disease, a symptom-based "action plan" may substitute for PEFR monitoring.[11,12] Subjects cared for by allergy specialists as their principal asthma care physician had nearly three times greater odds of having a PEFR meter than those subjects cared for by pulmonary subspecialists.

In contrast, the group receiving their principal care from an allergy specialist was a third as likely as the group being treated by a pulmonary specialist at follow-up to report using high-dose inhaled steroids (defined as ≥20 puffs per day), taking the baseline severity and a number of other covariates into account. This may reflect different subspecialty-related approaches to stepwise anti-inflammatory therapy in the pharmacologic management of asthma. Similarly, the pulmonary specialist-treated group was more likely to receive pneumococcal vaccination, taking into account the asthma-specific severity, including steroid use. Recent recommendations of the Advisory Committee on Immunization Practices of the Centers for Disease Control and Prevention do not include nonsteroid-dependent asthma without concomitant chronic obstructive pulmonary disease or chronic bronchitis as a risk factor for pneumococcal pneumonia.[25] Although we excluded these comorbid diagnoses, limited the age of participants to 50 years and younger in our recruitment, and included age and smoking history as covariates in our predictor modeling, we cannot exclude the possibility that the association between pulmonary practice and pneumococcal vaccination was confounded by such comorbidity.

The most salient outcome difference was in the quality-of-life measures. The group receiving their principal care from an allergy specialist reported poorer asthma-specific quality of life, even after a number of possibly confounding factors were adjusted for. The two subscale domains of quality of life accounting for most of this difference were those of social disruption and concerns of health. This should be put in context with the other health use and outcomes with which allergy-specific principal care was not significantly associated, including hospital admission, number of restricted-activity days, and impaired physical functioning. Nonetheless, National Heart, Lung and Blood Institute guidelines do emphasize that quality of life is one of the six principal domains of asthma health.

This is an observational study. We did not randomly assign patients to be treated by different subspecialists, nor did we control their access to other consultants. For this reason, it is all the more important that the associations we observed took into account many possibly confounding variables that could affect subspecialty choice, including asthma severity, health insurance, income, and demographic factors. We cannot exclude the possibility that other confounders that we did not study may have been responsible for some of the associations observed. For example, an underlying deterioration from baseline may have resulted in both changes in follow-up care between pulmonary and allergy subspecialists and in worse outcomes.

Although our study design provides a powerful, prospective comparison between pulmonary and allergy subspecialists, it cannot address the comparison between subspecialty and generalist care. All of our subjects, at a minimum, received a subspecialist consultation before study entry by the very nature of the subject recruitment design. Over the follow-up period, most received care by medical subspecialists who the subjects identified as their principal asthma care physicians.

We defined a group of 53 subjects who were not followed up closely by subspecialists, but this was a heterogeneous group, including those with ongoing consultation, nonsubspecialty care only, and no regular medical follow-up. Although we took this variable into account in our analyses, we nonetheless had little statistical power to directly examine the question of generalist relative to subspecialist care in this study. We are currently recruiting a supplemental panel of patients from outpatient family practice settings that may help better address the important question of generalist compared with subspecialist care. A recent cross-sectional study comparing allergist- with generalist-treated adults with asthma from a single staff-model HMO observed poorer functional status among the generalists' patients.[16] Pulmonary specialist-treated patients, however, were specifically excluded from that study. Other published reports have also found differences in outcomes between adults with asthma treated by allergy subspecialists and those treated by generalists, but none have compared allergists' care with that of pulmonary subspecialists.[13–15,17,18]

Our subspecialty principal asthma care groups were not "pure." We did classify separately the 53 subjects who switched the identity of their principal asthma care physician between allergy and pulmonary subspecialists, but even so, 5% of subjects in the allergy or pulmonary specialist-treated groups reported at least some cross-consultation. This explains why some patients even in the pulmonary specialist-treated group could report ongoing immunotherapy. Moreover, other subjects likely received differing subspecialty consultation or treatment before the study period. For example, altogether 101 (36%) of the pulmonary follow-up group reported ever having received immunotherapy injections at some time, even though few were being so treated currently. We view such "cross-contamination" as a strength of the study because it reflects the realities generalizable to standard practice. To the extent that it leads to a misclassification by the treatment group, it would tend to minimize rather than exaggerate observed differences, making the associations that we found more conservative estimates.

Our survey design is highly dependent on subject-elicited responses. These may be affected by recall bias or in other ways. This study limitation must be kept in mind when interpreting these findings. We did not independently verify reported income, health care services use, or actual possession of a PEFR meter. We did employ, however, validated survey research instruments such as the SF-36, the asthma-specific quality-of-life battery, and our asthma-severity scoring system. The last demonstrated its strong association with a wide variety of asthma treatment, health care use, and health outcome variables. Overall, the loss to follow-up was minimal, although some selection bias may have been introduced by preferential losses of younger men. The initial recruitment numbers varied by practice site, and that may have influenced the findings, although we took this into account in the key analysis of quality of life. Also, sex, age, and smoking did vary by asthma-care group. We included these covariates in the multivariate models we analyzed.

The differences in management, health care use, and outcomes we observed have a number of implications. The use of PEFR monitoring is particularly relevant to the implementation of asthma management guidelines. Health insurance and income status in relation to outcomes are central to health care policy. The quality of life in asthma, precisely because it is subjective, is becoming increasingly important as an outcome measure in this condition.[26] With the accrual of additional subject follow-up time, we intend to better delineate the relationships among these variables for adults with asthma to address these critical issues.

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