CLINICAL RESEARCH STUDY

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A Clinical Study of COPD Severity Assessment by Primary Care Physicians and Their Patients Compared with Spirometry

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ABSTRACT

PURPOSE: Primary care physicians often do not use spirometry to confirm the diagnosis of chronic obstructive pulmonary disease. This project was designed to see how well physicians' impressions about their patients' chronic obstructive pulmonary disease severity correlate with the severity of airflow obstruction measured by spirometry and to assess whether spirometry results subsequently changed the physicians' opinions about chronic obstructive pulmonary disease severity and treatment.

METHODS: We performed a multicenter, cross-sectional, observational study conducted in 83 primary care clinics from across the United States. A total of 899 patients with a clinical diagnosis of chronic obstructive pulmonary disease completed a questionnaire and spirometry testing. Physicians completed a questionnaire and case report forms. Concordance among physician ratings, patient ratings, and spirometry results was evaluated.

RESULTS: Physicians' chronic obstructive pulmonary disease severity ratings before spirometry were accurate for only 30% of patients with evaluable spirometry results, and disease severity in 41% of patients was underestimated. Physicians also underestimated severity compared with patients' self-assessment among 42% of those with evaluable results. After spirometry, physicians changed their opinions on the severity for 30% of patients and recommended treatment changes for 37%. Only 75% of patients performed at least 1 high-quality spirometry test; however, the physicians' opinions and treatment decisions were similar regardless of suboptimal test results.

CONCLUSIONS: Without performing spirometry, physicians are likely to underestimate their patients' chronic obstructive pulmonary disease severity or inadequately characterize their patients' lung disease. Spirometry changed the physicians' clinical impressions and treatments for approximately one third of these patients; thus, spirometry is a valuable tool for chronic obstructive pulmonary disease management in primary care.

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Spirometry is recommended by current guidelines as an essential test for persons with suspected chronic obstructive pulmonary disease to confirm the diagnosis, measure the severity of airflow obstruction, and assess the progression of disease.[1-4] Unfortunately, studies from countries worldwide have found that the use of spirometry among patients with

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chronic obstructive pulmonary disease who are treated in primary care clinics is inconsistent, with the percentage who have ever had a spirometry test ranging from 6% to 68%.[5-12] Furthermore, in cross-sectional studies of patients with a clinical diagnosis of chronic obstructive pulmonary disease who subsequently undergo spirometry, 32% to 42% do not have airflow obstruction.[8,11,13-15]

Many reasons for the underuse of spirometry in primary care have been identified. Some are institutional barriers, such as limited access to spirometry equipment,[16-18] lack of staff training in how to obtain adequate tests,[19,20] and limited physician training in interpreting the results.[20,21] Others are practical limitations, such as insufficient time in overburdened primary care clinics,[17,19,20,22-24] the need for constant recalibration of the spirometer, and other quality assurance concerns.[19,20,24-29] Surveys and focus groups of primary care physicians also have found that many simply prefer to base the diagnosis of chronic obstructive pulmonary disease on signs and symptoms, which may reflect a lack of understanding of the importance of confirming the diagnosis objectively or a sense of nihilism about chronic obstructive pulmonary disease.[16,17,20,30,31]

Recent guidelines, expert opinions, and clinical studies may create confusion or skepticism about the role of spirometry in primary care. The US Preventative Services Task Force conducted a comprehensive review of the role of spirometry in screening for chronic obstructive pulmonary disease and concluded that screening asymptomatic adults would mostly identify persons with mild to moderate airflow obstruction "who would not experience additional health benefits if labelled as having COPD". The Task Force recommended "Do not screen adults for COPD using spirometry."[32-34] The Task Force's recommendations were based on population-based screening of asymptomatic persons, but the nuances of using spirometry for screening versus diagnostic testing are easily confused. Studies examining the validity and effectiveness of spirometry in primary care have reported variable results. Some programs were generally successful[26,27,35,36] while others were disappointing,[19,20,29,37-39] even when equipment and training were provided for free. Advocacy groups, such as the National Lung Health Education Program, continue to promote the use of spirometry in primary care,[40,41] but some experts suggest that it is more practical to refer patients to outside laboratories for spirometry tests.[42,43] Recent chronic obstructive pulmonary disease guidelines, including those of the Global Initiative for Chronic Obstructive Lung Disease (GOLD) Committee, recommend spirometry for all patients with suspected chronic obstructive pulmonary disease, but they acknowledge the weak correlation between the degree of airflow obstruction and the clinical outcomes.[1,3,4]

Few studies have examined how spirometry affects primary care physicians' impressions about the severity of chronic obstructive pulmonary disease in their patients or whether spirometry results improved their decisions about chronic obstructive pulmonary disease treatment.[35,44] Understanding how spirometry affects providers' opinions of their patients and changes chronic obstructive pulmonary disease treatment could provide new insight into the value of spirometry in primary care and how best to support physicians in improving chronic obstructive pulmonary disease diagnosis and management.

The primary aim of this study was to examine how primary care physicians' subjective opinions about the severity of chronic obstructive pulmonary disease in their patients compares with the severity of airflow obstruction measured by spirometry. Additional aims were to assess whether spirometry results would change the physicians' opinions about their patients' chronic obstructive pulmonary disease severity and affect their treatment, to compare how closely patients' self-assessments of chronic obstructive pulmonary disease severity agree with their physicians' assessment, and describe clinical characteristics that are associated with physician over- or underestimation of chronic obstructive pulmonary disease severity compared with spirometry.

CLINICAL SIGNIFICANCE

- Physicians underestimated the chronic obstructive pulmonary disease severity of approximately half of their patients compared with objective assessment by spirometry.
- Physicians' estimates of chronic obstructive pulmonary disease severity were less severe than their patients' self-assessments, indicating that primary care physicians tend to underestimate the impact that chronic obstructive pulmonary disease has on their patients' lives.
- After reviewing the spirometry, the results changed physicians' opinions about disease severity in approximately half of this cohort and changed treatment in approximately one third of this cohort.

MATERIAL AND METHODS

Participants and Recruitment Strategy

This is a cross-sectional clinical study of patients with chronic obstructive pulmonary disease who were treated in primary care practices in the United States. A total of 95 primary care physicians with clinical research experience were recruited to participate, and 83 study investigators enrolled at least 1 patient. Investigators identified potential subjects in electronic records using a stratified random sampling approach (ie, selection of each n^{th} patient) to ensure unbiased selection. Patients were recruited by investigators using a scripted telephone call or mailed letter. Patients who were aged 40 years or more with English language ability—and diagnosed and treated for chronic

obstructive pulmonary disease for at least 1 year at the physician's clinic—were included in the study. Patients were excluded if they had conditions that contraindicated the forced expiratory maneuver or had participated in a clinical trial within the previous 12 months.

Data Collection

Data were collected by investigators during a scheduled office visit. During the visit, physicians recorded the patients' clinical history, spirometry results obtained during the visit, severity assessments, and healthcare resource use in a web-based case report form. Patients completed a paper questionnaire to collect demographic and clinical characteristics, healthcare resource use, and chronic obstructive pulmonary disease-specific measures. The Clinical COPD Questionnaire (CCQ), a 10-item chronic obstructive pulmonary disease health status measure, and The Duke Health Profile, a 17-item general health status profile measure designed for use in primary care settings, were collected to determine patient-reported physical, mental, and social health.[45-47] Each investigator also completed a 1-time web survey to collect demographic and practice characteristics, use of spirometry, and knowledge of GOLD guidelines before initiation of patient enrollment at the site. Data were collected between February 2012 and November 2012. This study was approved and overseen by the Sterling Institutional Review Board (Atlanta, Ga), study #3872. Informed consent was obtained from all participants.

Spirometry Procedure

Each site was provided with an electronic MicroLoop portable spirometer and the associated Spirometry PC software (CareFusion Corporation, San Diego, CA) for study use. The spirometer provided an assessment of the adequacy of the blows (ie, whether a test was good), indicated whether a patient's overall results met American Thoracic Society (ATS) guidelines, and saved all test results by patient. Following ATS guidelines, relaxed spirometry testing was first used to capture 3 slow vital capacity results, and then forced spirometry testing was used to capture 3 technically acceptable results for forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1). Up to 8 efforts were required from each patient to obtain up to 3 acceptable tests according to ATS guidelines. Predicted values and the percentage of predicted FEV1 were calculated using National Health and Nutrition Examination Survey III reference values.

Before patient enrollment, investigators and study personnel completed a real-time, study-specific training on the study procedures, including standard ATS spirometry procedures and how to use the MicroLoop spirometer, via an online meeting platform. After enrollment of the first 3 patients at each study site, spirometry results were sent to an independent respiratory therapist experienced and certified in pulmonary function testing for quality-control review.

CHRONIC OBSTRUCTIVE PULMONARY DISEASE SEVERITY

Before testing each patient, the investigator recorded a global assessment of the patient's chronic obstructive pulmonary disease severity at the time of the study visit on a 5-point scale, ranging from 1 (no clinical symptoms or disease impact) to 5 (very severe). Patients' general assessment of their severity at the time of the study visit was collected on the patient questionnaire using a 5-point scale, ranging from 1 (very mild) to 5 (very severe).

By using the spirometry test results, patients were classified into chronic obstructive pulmonary disease severity levels based on the GOLD guidelines, adding a "stage 0" for patients who were at risk for chronic obstructive pulmonary disease but had normal spirometry or did not have an FEV1/FVC ratio less than 0.70. According to GOLD terminology, the chronic obstructive pulmonary disease severity for those with an FEV1/FVC ratio less than 0.70 was described using the percent of predicted FEV1 stratified as follows:

- Mild COPD: FEV1 80% predicted
- Moderate COPD: FEV1 from 50% up to 80% predicted
- Severe COPD: FEV1 from 30% up to 50% predicted
- Very Severe COPD: FEV1 <30% predicted

Statistical Approach

Statistical comparisons of continuous variables were made using *t* tests and analysis of variance, as appropriate. Counts and percentages were compared using chi-square analyses. To compare agreement between the perceived severity measures and the spirometry-based severity results, a Cohen's kappa coefficient was used. This approach evaluates disagreement between levels of severity and provides a summary result ranging from 0 (no agreement) to 1 (perfect agreement). All analyses used a 2-sided *P* value of .05 for significance and were performed using SAS 9.2 (SAS Institute Inc, Cary, NC).

RESULTS

Most participating physicians (63%) described their specialty as Family Practice, and the rest described their specialty as General Internal Medicine (**Table 1**). The average participating physician had more than 2 decades of practice experience, was in a solo or small group single-specialty practice, and was managing a large number of patients with chronic obstructive pulmonary disease in their clinic. Spirometry was routinely used by the majority of these physicians (38% for all or approximately all, and 22% for most patients with chronic obstructive pulmonary disease), largely for the purpose of initial diagnosis, and all but 4 had some formal training in spirometry use and interpretation. Only 11% were not familiar with current GOLD chronic obstructive pulmonary disease guidelines (data not shown).

The average study participant was aged 65.4 years, 54% were women, 78% were non-Hispanic white, 84% had

Table 1 Investigator and Practice Characteristics and Spirometry Experience

	Total (N = 83)	
Physician Characteristics	Mean	SD
Years in practice	22.0	9.1
Patients with COPD currently treated by investigator	161.5	180.7
	n	Col %
Investigator specialty		
Family Practice	52	63
General Internal Medicine	31	37
Investigator gender		
Male	73	88
Female	10	12
Practice size		
Solo practice	32	39
Group practice, ≤5 physicians	41	49
Group practice, 6-15 physicians	9	11
Group practice, 16-30 physicians	1	1
Practice setting		
Single specialty	66	80
Multispecialty group	17	20
Spirometer available in office	69	83
Use of office spirometry for COPD by investigator*		
All or almost all	26	38
Most	15	22
Approximately half	9	13
Some	16	23
Very few or none	3	4
Investigator's spirometry training		
No training	4	5
Training during professional education	56	68
Training on specific device	48	58
General training during professional meetings	41	49
Project-specific training for other research studies	29	35
Other	1	1

COPD = chronic obstructive pulmonary disease; SD = standard deviation.

*Of investigators with spirometer available in office.

accomplished at least a high school educational level or the equivalent, and 73% had household annual incomes less than $50,000 US dollars per year (Table 2). Most patients were obese (43%) or overweight (29%), and only 4% were underweight. Only 9% were never-smokers, and the mean smoking history among former and ex-smokers was 50.1 pack-years. A history of asthma was reported by 42% of patients but only 31% of their doctors, and among patients who reported also having asthma, the diagnosis occurred an average of 23 years before the study visit, versus 10 years for their chronic obstructive pulmonary disease diagnosis.

Even with study-specific training for all spirometry technicians and use of state-of-the-art spirometers, 223 patients (25%) were unable to perform at least 1 spirometry that met the ATS standards for an acceptable effort and were designated the Incomplete Spirometry group. The only statistically significant demographic differences between these groups were race/ethnicity (non-Hispanic white 69% in the Incomplete Spirometry group vs 81% among the rest). Patients in the Incomplete Spirometry group also had significantly poorer heath status compared with the rest of patients, as indicated by higher CCQ scores (Total and Functional State) and the Duke Health Profile (lower physical, mental, and general health scores and greater anxiety, depression, pain, and disability scores) (results not shown).

Among the 668 patients with spirometry that could be rated for severity, the agreement between the physician's assessment of chronic obstructive pulmonary disease severity and the severity as measured by spirometry was poor, with physicians underestimating their patients' airflow obstruction in 41% of this group (Figure 1). The agreement between patient self-assessment and spirometry severity was only slightly better. The agreement between the doctor's impression of chronic obstructive pulmonary disease severity and their patient's self-assessment was also poor ($\kappa = 0.18$). Among patients with at least 1 ATS quality test, 68% rated their chronic obstructive pulmonary disease severity as moderate or worse, whereas before spirometry their doctors rated 48% of this group with moderate or worse severity (Table 3).

After reviewing each patient's spirometry, the physicians were asked to again rate their patients' chronic obstructive pulmonary disease severity (Table 3). There were substantial changes in the ratings, more in alignment with their patient's self-assessment, particularly among those with confirmed airflow obstruction. Spirometry changed the physician's rating of chronic obstructive pulmonary disease severity for 368 of the 668 patients (55%) who completed at least 1 ATS quality spirometry, with 45% finding that their patient's disease was more severe than expected. Although 213 patients (32%) were found to have GOLD 0 (normal or restrictive spirometry) or mild chronic obstructive pulmonary disease (Table 2), physicians reclassified disease severity as less severe in only 66 patients (10%) (Table 3).

Physicians were then asked directly whether the spirometry results changed their prior assessment of the patient's chronic obstructive pulmonary disease severity, and among 219 of the 668 patients (33%) the physicians indicated that they considered their patients' disease severity as more severe (24%) or less severe (9%), whereas 64% said that the spirometry results were consistent with what they expected (Table 4). Although the spirometry quality for the 223 patients in the Incomplete Spirometry group did not meet ATS standards, the impact on physicians' impressions of chronic obstructive pulmonary disease severity was still changed for 22% of this group, with disease severity rated as more severe in 37 patients (17%) and less severe in 12 patients (5%).

Physicians were then asked if their patients' spirometry results would cause them to change their chronic obstructive

Table 2 Patient Demographics and Clinical Characteristics

	Total (N = 891)		ATS Spirometry (N = 668)		Incomplete Spirometry (N = 223)	
	Mean	SD	Mean	SD	Mean	SD
Patient age	65.4	10.5	65.8	10.1	64.2	11.5
Years seeing Primary Care Physician (investigator-reported)	10.2	8.2	10.2	7.9	10.3	9.0
Patient age at COPD diagnosis (patient reported)*	55.4	14.2	55.8	14.3	54.2	13.7
Best spirometry result from site visit						
FEV1 (liters)	—	—	1.66	0.76	—	—
FVC (liters)	—	—	2.71	0.92	—	—
%FEV1 predicted	—	—	60.3	23.0	—	—
%FVC predicted	—	—	73.5	20.3	—	—
	n	Col %	n	Col %	n	Col %
Age group						
40-49 y	60	7	36	5	24	11
50-59 y	214	24	157	24	57	26
60-64 y	139	16	109	16	30	14
65-69 y	159	18	122	18	37	17
70-74 y	130	15	102	15	28	13
75-79 y	104	12	78	12	26	12
80+ y	85	10	64	10	21	9
Gender*						
Male	411	46	316	47	95	43
Female	478	54	350	53	128	57
Highest education level*						
Less than high school	47	5	34	5	13	6
Some high school	97	11	71	11	26	12
High school or equivalent	320	36	231	35	89	40
Some college but no degree	219	25	176	26	43	19
2-year degree	90	10	62	9	28	13
College graduate	65	7	54	8	11	5
Graduate school	50	6	37	6	13	6
Race/ethnicity*						
Non-Hispanic white	694	78	540	81	154	69
Hispanic	46	5	29	4	17	8
Black or African American	103	12	68	10	35	16
Other	45	5	28	4	17	8
Household income*						
<$25,000	375	44	272	43	103	48
$25,000-$49,999	251	29	181	28	70	33
$50,000-$74,999	136	16	115	18	21	10
$75,000-$99,999	42	5	31	5	11	5
>$100,000	49	6	40	6	9	4
Smoking status*						
Current smoker	348	39	250	38	98	44
Former smoker	453	51	356	54	97	44
Never smoked	79	9	53	8	26	12
BMI						
Underweight (<18.5)	36	4	28	4	8	4
Normal weight (18.5-24.9)	207	23	159	24	48	22
Overweight (25-29.9)	262	29	200	30	62	28
Obese (BMI ≥30)	386	43	281	42	105	47
Prior spirometry experience (patient-reported)*						
Have not had prior spirometry test	122	14	83	12	39	18
Unknown history	43	5	24	4	19	9
Have had a prior spirometry test	723	81	559	84	164	74

ATS = American Thoracic Society; BMI = body mass index; COPD = chronic obstructive pulmonary disease; FEV1 = forced expiratory volume in 1 second; FVC = forced vital capacity; SD = standard deviation.

*Items do not total 891 responses when some patients did not answer that item.

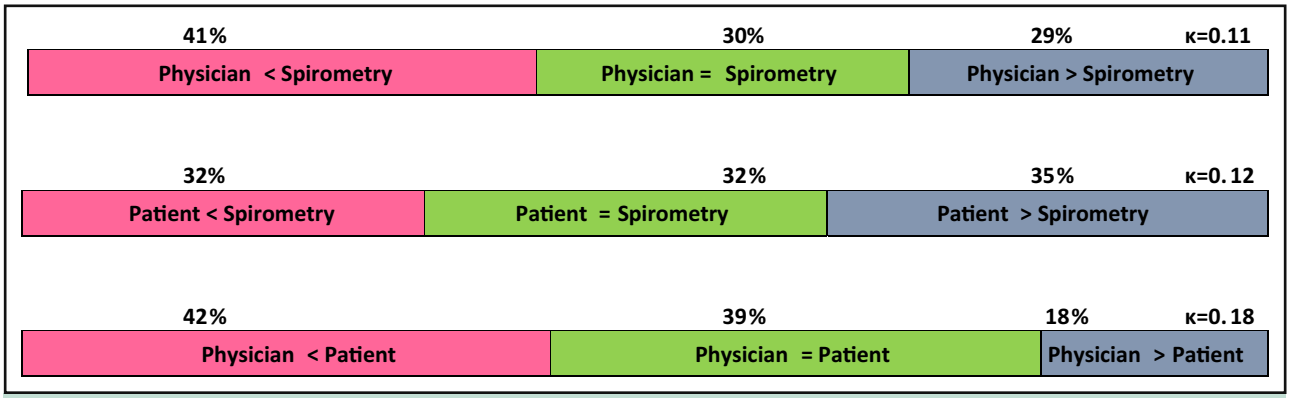

Figure 1 COPD severity estimate by physicians (pre-test) versus spirometry. Patients* versus spirometry and physicians (pre-test) versus patients. *A total of 668 patients with spirometry results that could be rated for severity.

pulmonary disease treatment. In the overall study cohort of 891 patients, 315 (35%) would have chronic obstructive pulmonary disease medications added or increased, and only 20 (2%) would have their chronic obstructive pulmonary disease medications reduced or discontinued. Again, the fact that the spirometry quality did not meet ATS standards appeared to have little effect on physicians' opinions, with the distribution of treatment changes among patients with Incomplete Spirometry group being similar to those who had 1 good quality effort.

We examined clinical factors associated with physician over- or underestimation of chronic obstructive pulmonary disease severity compared with ATS quality spirometry to discern whether any might be clinically useful predictors (Table 5). Disease severity was underestimated in approximately half (48%) of men, but equally under- and overestimated in women. Disease severity tended to be overestimated (40%) in obese persons and underestimated (49%-57%) in all other weight categories. Persons in whom disease severity was underestimated also tended to be older, non-Hispanic white, and in the middle-income range, and to have more comorbid conditions. However, there were no factors that were associated so strongly with under- or overestimation of severity that they would obviate the need for spirometry.

DISCUSSION

We found that primary care physicians' subjective opinions about their patients' chronic obstructive pulmonary disease severity were correlated poorly with the stage of airflow obstruction measured by spirometry, with approximately half underestimating chronic obstructive pulmonary disease severity. The physicians' estimates of chronic obstructive pulmonary disease severity were less severe than their patients' self-assessments, indicating that physicians may be underestimating the impact that chronic obstructive pulmonary disease has on their patients' lives. After reviewing the spirometry, the results did change the physicians' opinions about disease severity in a substantial proportion of patients, even if the test did not meet ATS standards for quality. Physicians also confirmed that the spirometry results would change the chronic obstructive pulmonary disease management of approximately one third of the total study cohort. These results demonstrate that spirometry has a substantial impact on physicians' assessment and treatment of chronic obstructive pulmonary disease, and that without performing spirometry, they are likely to misdiagnose chronic obstructive pulmonary disease or grossly underestimate its severity.

We also found 2 important barriers that may affect the widespread uptake of spirometry in primary care. First, only

Table 3 Patient- and Investigator-Reported Chronic Obstructive Pulmonary Disease Severity Compared with Spirometry

Severity Rating	Spirometry Severity (N = 666)	Physician Estimate of Severity Before Spirometry (N = 668)	Patient Estimate of Severity (N = 654)	Physician Estimate of Severity After Spirometry (N = 668)
GOLD 0 or very mild	213 (32%)*	136 (20%)	65 (10%)	54 (8%)
Mild	44 (7%)	212 (32%)	142 (22%)	150 (22%)
Moderate	203 (30%)	199 (30%)	291 (45%)	245 (37%)
Severe	148 (22%)	107 (16%)	134 (20%)	179 (27%)
Very severe	58 (9%)	14 (2%)	22 (3%)	40 (6%)

n (Column %).
GOLD = Global Initiative for Chronic Obstructive Lung Disease.
*Includes persons with no airflow obstruction (FEV1/FVC ratio ≥0.70).

Table 4 Spirometry: Impact on Physician Severity Assessment and Treatment Decisions

	Total (N = 891)		ATS Spirometry (N = 668)		Incomplete Spirometry (N = 223)	
	n	Col %	n	Col %	n	Col %
Did study spirometry results alter investigator's prior assessment of severity?						
No, the subject's COPD severity is what was expected	573	64	427	64	146	66
No, the spirometry results were invalid/unreliable*	33	4	9	1	24	11
No, spirometry is a minor part of investigator's assessment of COPD severity	17	2	13	2	4	2
Yes, the investigator considers the subject's COPD to be more severe*	194	22	157	24	37	17
Yes, the investigator considers the subject's COPD to be less severe	74	8	62	9	12	5
Treatment changes considered on the basis of spirometry results						
Initiating or adding COPD medications	240	27	188	28	52	23
Discontinuing current COPD medication(s)	15	2	14	2	1	0
Increasing dose or dose frequency of current COPD medications(s)	75	8	60	9	15	7
Decreasing dose or dose frequency of current COPD medication(s)	5	1	2	0	3	1
Adding or changing other nonpharmacologic therapy	78	9	59	9	19	9
No changes (consider the subject's current therapy appropriate)	528	59	393	59	135	61
Don't know/not sure*	33	4	20	3	13	6

ATS = American Thoracic Society; COPD = chronic obstructive pulmonary disease.
*Difference between ATS and incomplete spirometry groups significant at $P < .05$.

75% of participating patients could provide at least 1 spirometry effort that met ATS quality standards, and only 56% could provide 3 efforts that met the reproducibility standards. This is disappointing, especially given that 84% of the patients had prior experience with spirometry and that the great majority of clinics routinely performed in-office spirometry. This suggests that although some primary care clinics are adept at obtaining good-quality tests, most will find it technically challenging, and a large proportion of patients tested will still need to be referred for complete pulmonary function testing. Second, among patients who did complete at least 1 ATS quality test, 32% had restrictive or normal spirometry, suggesting that the physicians may not be interpreting spirometry data correctly. Although it is still possible that these patients had chronic obstructive pulmonary disease, additional testing is necessary to confirm the diagnosis, such as complete pulmonary function testing including lung volume and diffusion capacity measurement. Our findings seem to support the opinions of those who suggest that although spirometry is undoubtedly important, it might be more practical for most primary care physicians to refer patients to pulmonary function laboratories, especially if the results of their office testing are not clearly interpretable.[42,43,48]

Few studies have measured the impact of spirometry among patients with chronic obstructive pulmonary disease who are treated in primary care clinics, but those that have report similar findings. Yawn et al[35] conducted a study designed to assess the technical quality, accuracy of interpretation, and impact of office spirometry on treatment and management decisions for patients with asthma and chronic obstructive pulmonary disease in primary care. A total of 368 patients (100 diagnosed with chronic obstructive pulmonary disease) were recruited from 12 family medicine practices across the United States. Similar to our study, only 71% of the tests were deemed technically adequate for interpretation. Compared with lung specialist interpretation, 30% of the physicians' spirometry interpretations for patients with chronic obstructive pulmonary disease were not correct, with a report of obstruction when no obstruction was present being the major discordance. Changes in management were reported for 48% of all participants in this study. The percentage of patients with chronic obstructive pulmonary disease with changes in management compared to those with asthma was not provided. Other studies have demonstrated poor agreement between physician opinions of severity and other objective measures.[13,47]

Study Limitations

First, we recruited primary care physicians who had an active interest in chronic obstructive pulmonary disease and relatively large numbers of well-established patients with chronic obstructive pulmonary disease in their practices. We suspect that our results would be different if physicians with other experience and practice populations had been selected. Another difficulty is that the terminology for the severity of chronic obstructive pulmonary disease is subjective, so when asked about their global impression of chronic obstructive pulmonary disease severity, physicians' responses were made on the basis of only their personal definitions. This ambiguity in language introduces a degree of random variability, but should not affect the fact that

Table 5 Clinical Factors Associated with Doctors' Overestimation or Underestimation of Chronic Obstructive Pulmonary Disease Stage Compared with Spirometry

	Concordant (N = 202)		Overestimated Severity (N = 194)		Underestimated Severity (N = 270)	
Clinical Factors	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)
Age	202	65.6 (9.9)	194	64.5 (10.7)	270	66.9 (9.7)
Years seeing physician (investigator-reported)	202	9.7 (8.1)	194	9.7 (7.3)	270	10.9 (8.1)
Age at COPD diagnosis (patient-reported)	195	54.2 (15.5)	190	56.1 (13.7)	266	56.7 (13.9)
	n	Row %	n	Row %	n	Row %
Gender						
Male	86	27	78	25	152	48
Female	116	33	116	33	118	34
Race/ethnicity*						
Non-Hispanic white	163	30	143	27	233	43
Other	38	30	50	40	37	30
Household income*						
<$25,000	72	27	94	35	106	39
$25,000-$49,999	55	31	41	23	84	47
$50,000+	63	34	53	29	70	38
BMI						
Underweight (<18.5)	8	29	4	14	16	57
Normal (18.5-24.9)	48	30	31	20	79	50
Overweight (25-29.9)	56	28	47	24	97	49
Obese (BMI 30)	90	32	112	40	78	28
Comorbid conditions						
Asthma diagnosis	62	29	70	33	79	37
Other respiratory	56	29	76	40	59	31
Hypertension	139	33	126	30	162	38
Gastrointestinal	63	27	87	37	88	37
Cardiovascular	101	32	105	33	111	35
Mental health	71	28	90	36	91	36
Muscle/bone	97	31	107	34	112	35
Smoking status*						
Current smoker	74	30	71	28	105	42
Former smoker	109	31	98	28	149	42

BMI = body mass index; COPD = chronic obstructive pulmonary disease; SD = standard deviation.
*Items do not total 891 responses when some patients did not answer that item.

spirometry did convince many physicians that their patients' lung function was worse than expected.

CONCLUSIONS

This study confirms that spirometry can have a large impact on how primary care physicians perceive and treat their patients with chronic obstructive pulmonary disease. We found that even in patients with chronic obstructive pulmonary disease who have had relationships with their physicians for an average of 10 years, spirometry was still useful. Conversely, without spirometry, patients with chronic obstructive pulmonary disease have a high probability of being underestimated or misdiagnosed. The impact of spirometry on chronic obstructive pulmonary disease management in this project demonstrates that it is more than just a test needed for diagnostic completeness; it is a measure that provides objective information that is essential for proper evaluation and management in primary care.

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