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Original Research

COPD

Spirometry Use in Clinical Practice Following Diagnosis of COPD*

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Background: **Little is known about current use of pulmonary function testing in clinical practice. This study evaluated spirometry use in persons with COPD receiving care from the Veterans Health Administration health-care system.**

Methods: **Administrative data were used to identify a cohort of patients who were ≥ 40 years of age with recently diagnosed COPD. Spirometry was identified using administrative data. Spirometry use was characterized over a 12-month period, and the use of spirometry around acute exacerbations and surgical procedures was examined.**

Results: **A total of 197,878 patients met the inclusion criteria in 1999. The average age was 67.5 years (SD, 10.0), and 98.2% of patients were male. A total of 66,744 patients (33.7%) underwent spirometry. The use of spirometry for newly diagnosed COPD patients decreased with age and was 3.3 times higher for those visiting pulmonologists.**

Conclusions: **This study suggests that spirometry is inconsistently used in the diagnosis of COPD or the care of patients with COPD. This inconsistent pattern of use is seen even with the endorsement of spirometry use for patients with COPD by two national guidelines; however, the data predate the most recent version of the guidelines. It is unclear whether it is lack of physician knowledge of, attitudes about, or belief in the utility of spirometry that underlie the current patterns of physician use of this clinical tool.** ***(CHEST 2006; 129:1509–1515)***

Key words: COPD; pulmonary epidemiology; spirometry

Abbreviations: ATS = American Thoracic Society; CI = confidence interval; ED = emergency department; ERS = European Respiratory Society; ICD-9 = *International Classification of Diseases*, ninth revision; OR = odds ratio; VHA = Veterans Health Administration

A joint document sponsored by two international pulmonary medicine organizations, both the American Thoracic Society (ATS) and the European Respiratory Society (ERS),[1,2] as well as the Global Initiative for Chronic Obstructive Lung Disease[3,4] guidelines indicate that spirometry is necessary for the diagnosis of COPD. The ATS/ERS standards[1] advocate performing spirometry in all persons with a history of exposure to cigarette smoke and/or environmental pollutants, a family history of COPD, or the presence of a chronic cough, sputum production, or shortness of breath. Additionally, the National Committee for Quality Assurance has recently adopted spirometry as a performance measure for the Health Plan Employer Data and Information Set in patients with a new diagnosis of COPD.[5]

The classification of disease severity relies heavily on spirometry measures and is an important measure as it has been associated with other outcomes in patients with COPD. Outcomes associated with severity based on lung function include health status, health-care utilization, and exacerbations, with worsening severity related to worsened health status and increased health-care utilization and exacerbations.[6–10] Severity is also an important component when predicting mortality in patients with COPD.[11] However, the role of spirometry in the routine care

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of individuals is not clear, and a comparison of other markers of disease severity, like symptoms or exacerbations, that could serve as useful predictors for subsequent events has not been made with spirometry. Questions remain as to the validity of spirometry findings obtained in the general practice setting and the value of spirometry in the management of patients with known COPD.[12–17]

In order to understand the value of spirometry or what changes may be necessary in the current use of spirometry, one must first understand current spirometry practice patterns. The US Veterans Health Administration (VHA) provides a good place to examine spirometry use in patients with COPD. Because the current demographics of the VHA include a significant number of older men with a history of smoking, COPD is a prevalent condition within the VHA health-care system. The VHA provides annual care to between 250,000 and 300,000 patients with a diagnosis of COPD. The objective of this analysis was to characterize spirometry use in the VHA for patients with newly diagnosed COPD and to examine spirometry use around the following two clinical scenarios: acute COPD exacerbations; and surgical procedures.

Materials and Methods

This project was approved by the institutional review board of the Hines Veterans Affairs Hospital. Using a retrospective cohort design, VHA administrative data were used to identify patients with a diagnosis of COPD. Patients with at least two visits with diagnoses of COPD (*International Classification of Diseases*, ninth revision [ICD-9] codes 491.x, 492.x, and 496) between October 1, 1998, and September 30, 1999, were eligible to be included in the analysis. To be included, patients must have been ≥ 40 years of age at their initial visit have received a COPD diagnosis. Patients were required to have made at least one non-COPD health-care visit between October 1, 1997, and September 30, 1998. To create a cohort of patients with newly diagnosed COPD (or possibly very mild illness), persons with any COPD-related visits between October 1, 1997, and September 30, 1998, were excluded from the analysis. Thus, patients who had made visits for COPD between October 1, 1998, and September 30, 1999, and had received care in the VHA health-care system in the prior 12-month period but did not have any COPD-related visits were identified for inclusion. For this analysis, patients who died prior to the end of the study period (*ie*, September 30, 1999) were excluded from the study. It is important to note that the timeframe used for this study predates the most recent version of the COPD treatment guidelines; however, both the ATS and ERS had guidelines available prior to the beginning of this analysis.[1,2]

Spirometry examinations performed during the 12-month period between October 1, 1998, and September 30, 1999, were identified. Spirometry was identified through Current Procedural Terminology codes (94010, 94014, 94015, 94016, 94060, 94070, and 94620), ICD-9 procedure codes (89.37 and 89.38), and clinic stop codes. Clinic stops in the VHA system identify the specific location of an encounter during a visit. There is a clinic stop code that is specific to pulmonary function testing in the VHA system (clinic stop 104). For each patient included in the analysis, we searched patient records for any of these codes during the 12-month period from October 1, 1998, to September 30, 1999. Patients were categorized as having received spirometry if any of the codes were present in their records during the analysis period.

Exacerbations

Acute exacerbations of COPD that occurred between January 1, 1999, and June 30, 1999, were identified. This 6-month time window was selected in order to have at least 3 months before and 3 months after the event to identify spirometry during the study period. Acute exacerbations were defined using a combination of inpatient, outpatient, and pharmacy data. A visit was identified as a part of an acute exacerbation of COPD if it had an ICD-9 code for COPD and was a hospitalization, an emergency department (ED) visit, or an outpatient visit with a prescription for an oral steroid or antibiotic dispensed within 5 days of the visit. Outpatient visits with a diagnosis for infections other than respiratory infections (*eg*, cellulitis) were not included as an exacerbation. Exacerbations were assumed to last 30 days, and after 30 days a new acute exacerbation could be identified.[18,19] Because identifying exacerbations utilizes the identification of medications dispensed, only patients who had actively filled at least one prescription were included in the exacerbation analysis.

Surgeries

All of the inpatient surgical procedures performed between October 1, 1998, and September 30, 1999, in which a general anesthetic was used were extracted for this analysis. For patients who had undergone surgical procedures on multiple days, only their first procedure was used in the analysis. Procedures were stratified into surgeries involving the cardiovascular or respiratory systems and those that did not.

Statistical Analysis

To characterize care, patients included in the analysis were stratified by the use of spirometry in the year of diagnosis. Health-care utilization over the study period was summarized as hospitalizations, ED visits, outpatient visits, and pulmonary medication use. Patient characteristics (*eg*, age and comorbidities), health system characteristics (*eg*, geographic location of the facility), and type of physician (*eg*, primary care and pulmonary) were used to examine the variation in spirometry use.

Comparisons between the groups with and without spirometry were made with χ^2 tests for categoric variables and t tests for continuous variables. The association between having spirometry performed and patient characteristics was evaluated in unadjusted models. Logistic regression was used to estimate the odds of receiving spirometry for region of the country, age, health-care utilization, comorbidities, and use of respiratory medications. Adjusted models included all of the patient characteristics.

The proportion of acute exacerbations for which spirometry was performed within 3 months following the onset of the exacerbation was determined. The cumulative proportion of patients having undergone spirometry following an exacerbation was calculated at fixed time points of 14, 30, 60, and 90 days. For surgical procedures, the proportion of patients who had undergone spirometry within 14 days and within 30 days prior to the procedure was determined.

Sensitivity Analysis

Since veterans are not limited to the VHA health-care system for their care, it is important to consider the non-VHA use of

spirometry. To understand the potential impact of this use, a sensitivity analysis was conducted examining spirometry in a random sample of 6,000 patients who were ≥ 65 years of age using Medicare data. From this analysis, the proportion of patients that would be misclassified as not having received spirometry was estimated.

Results

A total of 197,878 patients with newly diagnosed COPD were included in the analysis. Of these patients, 98% were male, and 66,744 (33.7%) had undergone at least one spirometry session during the 12-month period (Table 1). Those patients in the spirometry group were slightly younger (mean age, 66.6 years) than those who had not undergone spirometry (mean age, 68.0 years; $p < 0.001$).

In the adjusted analysis, as expected, a pulmonary clinic visit was the factor that had the highest association with having undergone spirometry (Table 2). Patients who had a pulmonary clinic visit were 3.29 times more likely (95% confidence interval [CI], 3.21 to 3.37) to have undergone spirometry compared to those with no pulmonary clinic visit. Younger age was also significantly associated with the likelihood of having spirometry performed. Compared to patients who were < 50 years old, the

Table 1—*Patient Characteristics Stratified by Whether or Not a Spirometry Was Performed During the Analysis Year

Patient Characteristics	Spirometry		No Spirometry		p Value
	No.	%	No.	%	
Total	66,744		131,134		
Male	65,422	98.1	128,915	98.3	< 0.001
Age, yr					
40–49	4,009	6.0	7,087	5.4	< 0.001
50–59	11,704	17.5	19,175	14.6	
60–69	21,904	32.8	39,252	29.9	
70–79	24,803	37.2	53,019	40.4	
80+	4,324	6.5	12,601	9.6	
Average age (SD)	66.6	(9.8)	68.0	(10.0)	< 0.001
Geographic region					
Northeast	10,499	15.7	20,200	15.4	< 0.001
South	26,785	40.1	56,271	42.9	
Midwest	16,308	24.4	33,684	25.7	
West	12,757	19.1	19,928	15.2	
Other	395	0.6	1,051	0.8	
Comorbidities					
Hypertension	37,368	56.0	73,236	55.9	0.556
Diabetes	13,187	19.8	26,580	20.3	0.007
Heart disease	24,090	36.1	47,398	36.1	0.821
Cancer†	18,265	27.4	30,511	23.3	< 0.001
Mental health‡	3,592	5.4	8,421	6.4	< 0.001
Substance abuse	1,185	1.8	2,516	1.9	0.026
Depression	4,094	6.1	6,718	5.1	< 0.001
Arthritis	15,528	23.3	31,303	23.8	0.003
CHF	12,461	18.7	23,990	18.3	0.042
Alcoholism	5,235	7.8	11,003	8.4	< 0.001
Health-care utilization					
Hospitalization	16,583	24.9	32,303	24.6	0.301
ED visit	9,615	14.4	17,135	13.1	< 0.001
Outpatient visit	66,703	99.9	125,595	95.8	< 0.001
Pulmonary clinic visit	23,149	34.7	16,638	12.7	< 0.001
Medication use					
None	7,772	11.6	25,203	19.2	< 0.001
Short-acting β-agonist	51,254	76.8	90,690	69.2	< 0.001
Ipratropium	47,201	70.7	77,850	59.4	< 0.001
Inhaled corticosteroid	31,635	47.4	48,717	37.2	< 0.001
Long-acting β-agonist	7,762	11.6	9,118	7.0	< 0.001
Theophylline	14,687	22.0	26,082	20.0	< 0.001

*CHF = chronic heart failure.

†Nonmelanoma cancers.

‡Nondepression mental health diagnoses.

Table 2—*Association Between Spirometry and Patient Characteristics

Characteristics	Unadjusted OR	95% CI	Adjusted OR†	95% CI
Region				
Northeast	1		1	
South	0.92	0.89–0.94	0.97	0.94–1.00
Midwest	0.93	0.90–0.96	0.96	0.93–0.99
West	1.23	1.19–1.27	1.21	1.17–1.25
Other	0.72	0.64–0.81	0.58	0.51–0.65
Age, yr				
40–49	1		1	
50–59	1.08	1.03–1.13	0.97	0.92–1.02
60–69	0.99	0.95–1.03	0.82	0.78–0.86
70–79	0.83	0.79–0.86	0.68	0.65–0.71
80+	0.61	0.58–0.64	0.52	0.49–0.55
Health-care utilization				
Hospitalization	1.01	0.99–1.03	0.90	0.88–0.93
ED visit	1.12	1.09–1.15	1.04	1.01–1.07
Pulmonary clinic	3.65	3.57–3.74	3.29	3.21–3.37
Comorbidities				
Hypertension	1.01	0.99–1.02	1.05	1.03–1.07
Diabetes	0.97	0.95–0.99	0.96	0.93–0.98
Heart disease	1.00	0.98–1.02	1.04	1.01–1.06
Cancer	1.24	1.22–1.27	1.20	1.17–1.23
Mental health	0.83	0.80–0.86	0.86	0.83–0.90
Substance abuse	0.92	0.86–0.99	0.89	0.82–0.96
Depression	1.21	1.16–1.26	1.12	1.07–1.17
Arthritis	0.97	0.95–0.99	1.04	1.02–1.07
CHF	1.03	1.00–1.05	1.01	0.99–1.04
Alcoholism	0.93	0.90–0.96	0.94	0.90–0.97
Medications				
None	1		1	
Short-acting β-agonist	1.48	1.44–1.51	1.14	1.11–1.17
Ipratropium	1.65	1.62–1.69	1.28	1.25–1.31
Inhaled corticosteroid	1.52	1.50–1.55	1.16	1.13–1.18
Long-acting β-agonist	1.76	1.71–1.82	1.10	1.06–1.14
Theophylline	1.14	1.11–1.16	0.90	0.88–0.93

*See Table 1 for abbreviation not used in the text.
†All variables listed were included in the adjusted model.

likelihood of undergoing spirometry was 18% lower in those patients who were 60 to 69 years of age, 32% lower in those who were 70 to 79 years old, and 48% lower in those who were ≥ 80 years old.

Generally, respiratory medication use was associated with the increasing probability of having spirometry performed. Theophyilline was the exception to this, as a dispensing of theophylline was associated with a 10% decrease in the odds of undergoing spirometry (adjusted odds ratio [OR], 0.90; 95% CI, 0.88 to 0.93). Mental health and substance abuse diagnoses were also associated with a lower likelihood of having spirometry performed.

Exacerbations

A total of 44,980 acute exacerbations of COPD were identified in this cohort. Of those, there was a lung function test identified for 15,568 of the exacerbations (34.6%) at some point during the 12-month period. Postexacerbation spirometry was performed 21.4% of the time (Table 3). Of the spirometry sessions occurring after the exacerbation, 32.6% occurred within 14 days of the beginning of the exacerbation and 60.4% occurred within 60 days.

Presurgical Use of Spirometry

There were 9,802 patients with surgical procedures included in the analysis, of which 3,793 procedures (38.7%) were cardiac or respiratory. For 78.6% of patients, spirometry was performed between 0 and 14 days before the surgery, and for 85.5% of which were performed between 0 to 30 days prior to patients undergoing surgery (Table 4). The rates of the presurgical use of spirometry were similar for the two surgery categories used in the analysis.

Non-VHA (Medicare) Use of Spirometry Services

A small proportion of patients ≥ 65 years of age underwent spirometry outside the VHA health-care

Table 3—*Spirometry Use Following Acute Exacerbations of COPD*

Time Spirometry Performed After Exacerbation	Spirometry Procedures, No.	All Exacerbations, %	Exacerbations With Spirometry Postexacerbation, %	Exacerbations With Spirometry by 90 d, %
≤ 14 d after	3,136	7.0	32.6	44.9
≤ 30 d after	4,202	9.3	43.7	60.2
≤ 60 d after	5,800	12.9	60.4	83.1
≤ 90 d after	6,983	15.5	72.7	100.0
Ever	9,609	21.4	100.0	

system. Of the random sample of 6,000 patients, 344 (5.7%) had spirometry identified in the Medicare data. Of these 344 patients, there were 260 who did not have any spirometry performed in the VHA system during the analysis period. An estimated total of 4.3% of patients ≥ 65 years of age were misclassified as not having spirometry based on VHA data alone. The proportion did not vary by age.

Discussion

The objective of this study was to examine spirometry use in routine clinical practice in patients with a new diagnosis of COPD. Overall, the presence of spirometry in patients with a new diagnosis of COPD was low, with only 33.7% of patients having spirometry performed during the analysis period. The patients who were more likely to undergo spirometry were those who had been to a pulmonary clinic and those in younger age groups. The use of spirometry to assess lung function after an acute exacerbation was low, with only 15.5% of acute exacerbations undergoing spirometry within 90 days of the onset of the exacerbation. Spirometry was used most frequently around surgical procedures that required general anesthesia, with 85.5% of patients undergoing spirometry ≤ 30 days before their procedure.

There are advocates for the use of spirometry by providers in general medicine clinics for the diagnosis of COPD.[20–22] However, some research[23–26] suggests that the quality of spirometry in this setting may be suboptimal. Within the VHA health-care system, spirometry is almost always performed in pulmonary function laboratories and not in general medicine clinics, a situation that may differ from that in many health-care systems. Regardless, for patients with a new diagnosis of COPD in the VHA system during a 1-year period, a minority had spirometry performed that same year. Low rates of spirometry were also reported by Anthonisen et al[27] in patients in whom COPD had been diagnosed relative to those with asthma in a Canadian population. This raises questions about how COPD is being diagnosed in patients who are treated in general medicine clinics and whether patients who are identified with only a diagnostic code actually have the disease. COPD is frequently identified as an underdiagnosed and undertreated disease,[1,28] but it would be difficult to be certain whether patients have the disease without measuring their lung function. Not surprisingly, those patients who were seen in pulmonary clinics had a higher likelihood of having spirometry performed, but these patients are also probably more likely to have more severe COPD if they require referral and treatment in pulmonary clinics.

There were several factors related to the lower rates of spirometry. Increasing age had the most pronounced impact on decreasing the likelihood of undergoing spirometry. However, there do not appear to be any studies in the literature suggesting that age alone should exclude patients with a new diagnosis of COPD from undergoing spirometry. For example, Pezzoli et al[29] have shown that age is not a risk factor for 'bad' spirometry independent of other factors. Alternatively, the finding that nondepressive mental health diagnoses were associated with a lower

Table 4—*Spirometry Use Prior to Surgical Procedures*

Time Spirometry Performed Before Surgery	All Procedures		Noncardiovascular and/or Respiratory Procedures		Cardiovascular and/or Respiratory Procedures	
	No.	%	No.	%	No.	%
≤ 14 d	7,704	78.6	4,683	77.9	3,021	79.7
≤ 30 d	8,378	85.5	5,093	84.8	3,285	86.6
Ever	9,182	93.7	5,604	93.3	3,578	94.3

likelihood of spirometry use may be explained by physicians anticipating difficulties with certain patients during a procedure that requires a high degree of patient cooperation. Also, the use of theophylline was associated with decreased rates of spirometry, and may be an indicator of the lack of awareness of contemporary treatment guidelines and diagnostic criteria in caring for patients with COPD.

The Global Initiative for Chronic Obstructive Lung Disease guidelines[3,4] recommend that spirometry be performed in a follow-up assessment 4 to 6 weeks after an exacerbation. These recommendations seem to be based on clinical experience as there is no evidence concerning the role of spirometry following an acute exacerbation. In this study, follow-up spirometry was performed in only 13% of patients who had experienced exacerbations by 8 weeks following the onset of the event. This raises questions about the perception by physicians of the utility of spirometry following exacerbations, as spirometry is not being used in routine clinical practice in the VHA health-care system. Whether the lack of use is a result of physician knowledge, attitudes, or beliefs is an important question. The setting in which spirometry was consistently used in this analysis was around surgical procedures. Prior to surgical procedures, physicians are interested in knowing about patient lung function, presumably in order to decide whether the COPD patient is capable of tolerating general anesthesia and the surgical procedure, and whether extra precautions with the patient may be necessary. In this study, there was equal use of spirometry prior to surgery regardless of the type of surgery, suggesting that patients with COPD are routinely screened prior to surgery regardless of the type of procedure.

There are limitations to this study. First, the patients in this analysis may not have had truly incident cases of COPD as a period of only a single year was used in which they were defined as being disease free. The use of a longer lead-in period would have likely reduced the size of the cohort and may have increased the rates of spirometry in the newly diagnosed patients. However, because the rates in this cohort were around 30%, it is unlikely that the majority of patients underwent spirometry. The addition of non-VHA utilization indicated that about 4% of the patients may have been misclassified as not having undergone spirometry. This low rate of misclassification would likely not have a notable impact on the overall low rate of spirometry in these newly diagnosed patients. Finally, the use of the clinic stop code to identify spirometry may have resulted in the misclassification of patients undergoing spirometry when they only performed a 6-min walk test or had arterial blood gas measurements made. If this were the case, the number of patients with spirometry performed would be even lower.

This study suggests that much of the current COPD diagnosis and management is based solely on symptoms, rather than a combination of symptoms and objective lung function assessment. Spirometry also does not appear to be used routinely to assess the impact of acute exacerbations on lung function. However, spirometry was used routinely in patients undergoing surgical procedures. Thus, the role of spirometry in routine clinical practice remains unclear, and providers may benefit from better guidance on the use of spirometry in patients with COPD.

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