The Direct Medical Costs of Undiagnosed Chronic Obstructive Pulmonary Disease

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ABSTRACT

Objective: To estimate the costs of undiagnosed chronic obstructive pulmonary disease (COPD) by describing inpatient, outpatient, and pharmacy utilization in the years before and after the diagnosis.

Methods: A total of 6864 patients who were enrolled in the Lovelace Health Plan for at least 12 months during the study period (January 1, 1999 through December 31, 2004) were identified. The first date that utilization was attributed to COPD was considered the first date of diagnosis. Each COPD case was matched to up to three age- and sex-matched controls. All utilization and direct medical costs during the study period were compiled monthly and compared based on the time before and after the initial diagnosis.

Results: Total costs were higher by an average of $1182 per patient in the 2 years before the initial COPD diagnosis, and $2489 in the 12 months just before the initial diagnosis, compared to matched controls. Most of the higher cost for undiagnosed COPD was attributable to hospitalizations. Inpatient costs did not increase after the diagnosis was made, but approximately one-third of admissions after the diagnosis were attributed to respiratory disease. Outpatient and pharmacy costs did not differ substantially between cases and matched controls until just a few months before the initial diagnosis, but remained 50% to 100% higher than for controls in the 2 years after diagnosis.

Conclusions: Undiagnosed COPD has a substantial impact on health-care costs and utilization in this integrated managed care system, particularly for hospitalizations.

Keywords: burden of illness, COPD, epidemiology, health-care costs, health-care utilization.

Introduction

Chronic obstructive pulmonary disease (COPD) is the fourth leading cause of death in the United States, and its prevalence is growing, especially among women [1]. It is also a leading cause of chronic disability worldwide [2]. Nevertheless, even with COPD's high prevalence and devastating impact, undiagnosed COPD is still a very common problem. Estimates based on billing information and telephone surveys have suggested that for every COPD patient who has been diagnosed, there may be two or more undiagnosed cases [1]. Surveys such as the Third National Health and Nutrition Study (NHANES III) that have conducted lung function testing among representative samples from the general population have shown that the majority of patients with airflow obstruction proven by spirometry have not been diagnosed with lung disease, even though undiagnosed COPD is proven to have a negative impact on functional status and quality of life [3,4].

Health systems have been slow to respond to the growing COPD epidemic. One reason may be that there are few studies describing what impact undiagnosed COPD has on health-care costs and utilization. One might assume that undiagnosed COPD is not costing the health-care system anything because there has been no utilization attributed to it. Nevertheless, we and others have shown that among COPD patients utilization and costs for nonrespiratory ailments are at least as great as those directly attributable to respiratory illness [5]. In fact, we have developed algorithms that use particular aspects of this increased utilization to identify patients at risk for undiagnosed COPD [6]. Decision-makers at managed care organizations and other health-care leaders need information on undiagnosed COPD's true impact so that they might better understand the importance of early identification and management.

The overall goal of this study is to describe the costs of undiagnosed COPD among patients enrolled in a managed care system. To do this, we examined the natural history of health-care utilization and costs for COPD patients starting from the very first day that a patient is given the diagnosis. The costs of undiagnosed COPD are then examined by comparing the

health-care utilization that COPD patients incurred in the years before formally being diagnosed to that of persons with similar demographic and utilization characteristics who have never been diagnosed with COPD.

Methods

Study Site, Data Abstraction, and Chart Review

All patients for this study were enrolled in the Lovelace Health Plan (LHP), which is a staff and network model managed care provider based in Albuquerque, New Mexico. The LHP had approximately 240,000 members in 2001, which includes participants in their Medicare, Medicaid, and commercial HMO programs. The LHP is the insurance component of the Lovelace Health System, which includes four hospital facilities and 20 outpatient centers in Northern New Mexico. This project was reviewed and approved by the Lovelace's Office of Research Administration and Human Research Review Committee.

The data for this study were derived primarily from the claims data routinely collected by the LHP. All services performed for LHP members are electronically coded with the date of service, specific type of service according to CPT or internal service codes, and all associated diagnoses using ICD-9 codes. The administrative data also include demographic information such as age and sex, but abstraction of these files was limited to only the minimum required to characterize the patient population to comply with privacy regulations.

The LHP administrative records do not capture pulmonary function test data or information about smoking or other exposures. In order to characterize the study population in terms of the severity of airflow obstruction and tobacco use, we conducted a limited medical record review of 200 COPD patients randomly selected from this cohort. Our senior abstractor, who is also a registered nurse and has participated in previous COPD projects, assisted with the development of an abstraction instrument and associated protocol, abstracted all of the records, and provided a brief synopsis of each case.

COPD Patients and Matched Controls

The COPD patients were identified using case identification methods validated in our previous studies [7,8]. We required that patients have one inpatient or two outpatient visits on two separate days that were associated with a primary or secondary diagnosis of COPD (ICD-9 codes 491.xx [emphysema], 492.x [chronic bronchitis], or 496 [COPD-unspecified]), at any time during the study period (January 1, 1999 through December 31, 2004). In a project that included a comprehensive chart review of more than 2000 COPD patients, we found that more than 95% of the patients identified by this system had two or more types of documented clinical evidence (spirometry, chest x-rays, smoking history, or chronic respiratory symptoms) supporting the diagnosis of COPD [8]. The first date that one of these codes appeared in each patient's claims data was considered to be the very first date of diagnosis, which was validated in 196 of the 200 cases that were randomly selected for our chart review.

Identical exclusion criteria were applied to COPD patients and controls (Fig. 1). Patients who had only one COPD code, or who had a lung disease that is not typically included within the context of COPD, were excluded from being either a case or a control. Only adults who were between the ages of 40 and 90 years at the beginning of the study period were eligible for this study, and they had to have at least 12 months of continuous enrollment (6 months before the very first COPD diagnosis, and 6 months after) in the LHP. These criteria exclude any person who died with less than 6 months of follow-up after their initial diagnosis of COPD.

Each COPD patient was matched to up to three controls by sex and age (± 2 years) at the time of the initial COPD diagnosis. Control subjects were required to have at least the minimal amount of utilization required to be a COPD case (at least one hospitalization or two outpatient visits during the study period), and controls who were matched to COPD patients who had a hospitalization during the study period were also required to have a hospitalization. Controls also needed to have at least 6 months of enrollment on either side of their COPD patient's index date. Complete 3:1 matches were found for 98.3% of our COPD cohort.

Utilization, Cost, and Comorbidity Capture

All health-care utilization and cost data for each COPD case and control patient during the study period were captured. Lovelace Health System generates charges for all services administered to LHP members, and charges are also submitted for services administered by other network providers. To convert charges to cost, we applied the Medicare cost-to-charge ratios for 2003 [9]. The costs and utilization were stratified into inpatient, outpatient, and outpatient pharmacy categories, with emergency department visits not associated with an admission included in the outpatient category. Charges were compiled by calendar month, with the month including the patient's date of initial diagnosis described as the index month.

To identify prognostically significant comorbidities, we used a modified version of the Charlson-Deyo index that was based on outpatient utilization in the year before the initial COPD diagnosis [10]. COPD was not included in the calculation of this index.
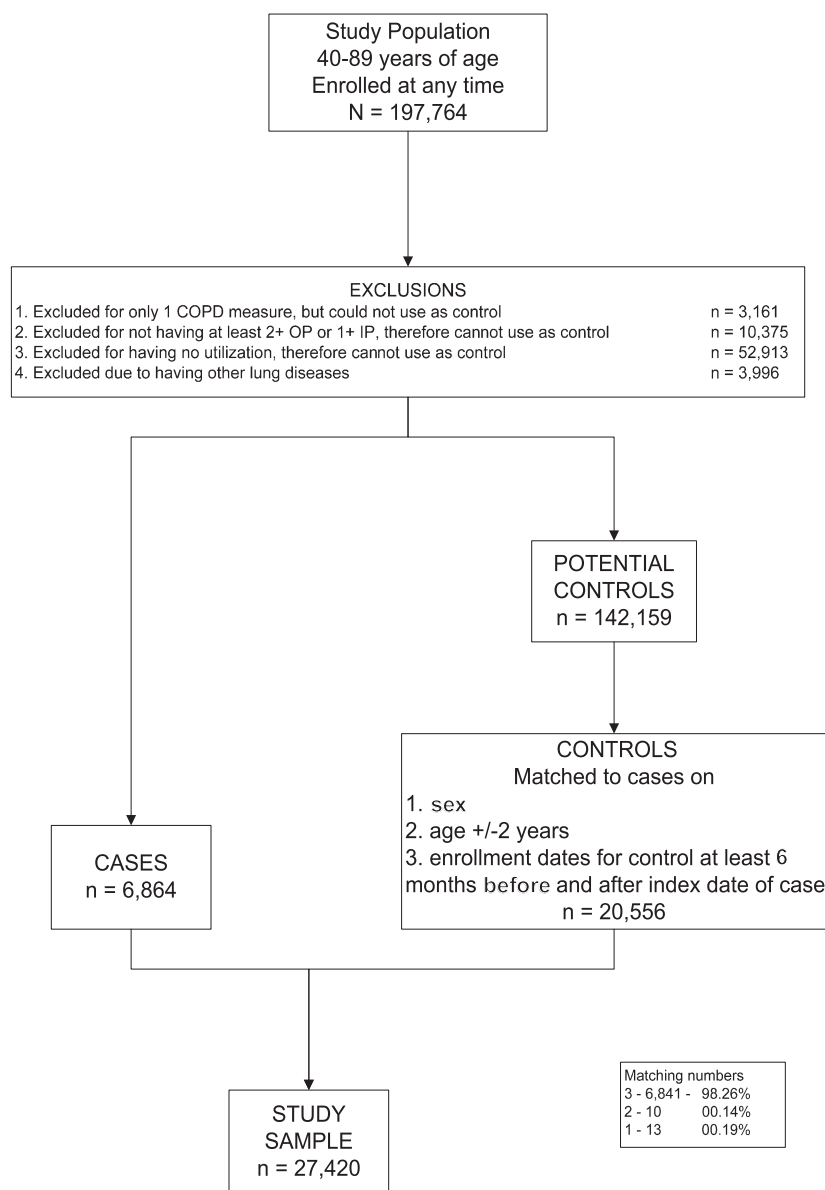
Figure 1 Flow diagram illustrating application of chronic obstructive pulmonary disease (COPD) case and control inclusion and exclusion criteria. IP, inpatient; OP, outpatient.

Statistical Analysis

All data were analyzed using SAS for Windows version 8.3 (SAS Institute Inc., Cary, NC, USA). Proportional differences between groups were compared using the Mantel-Haenszel test. Differences in utilization and cost were tested using the Mann–Whitney rank-sum test.

Results

The mean age of the COPD cohort at the time of initial diagnosis (67.6 ± 4.8 years) was not significantly different from that of controls (66.2 ± 3.6 years), and 57.1% of the cohort were female. The mean Charlson Index in the COPD cohort was 0.67 versus 0.45 for the controls ($P < 0.001$), indicating that the COPD group had significantly more prognostically important comorbidities other than lung disease. Most of this difference was attributable to cardiovascular complications (arrhythmias, coronary artery disease, or congestive heart failure), which affected 38.9% of the COPD cohort versus 22.1% of the controls. The chart review of 200 randomly selected COPD patients found that 56.5% (n = 113) had pulmonary function testing at least one time in the 2 years after diagnosis, with a mean percentage of predicted FEV_1 of 57.3%. Approximately 85% of those selected for the review had a documented history of tobacco use, with a mean cigarette exposure of 41.3 pack-years, and 45% were noted to be still using cigarettes in the year before diagnosis.

Total direct health-care costs were higher among COPD patients in the 24 months proceeding the index
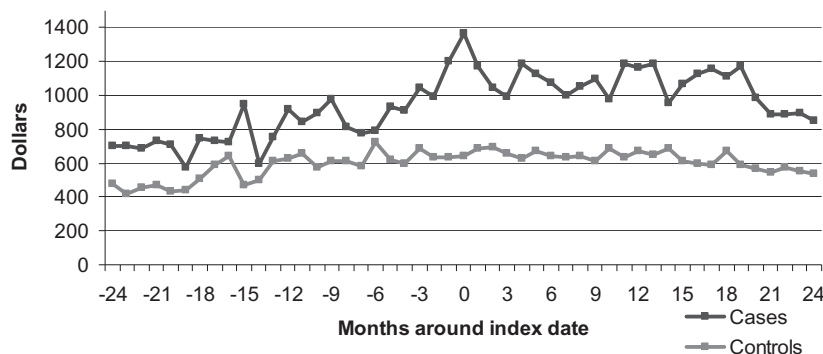
Figure 2 Mean total direct health-care costs by month in the 24 months before and after the month of initial chronic obstructive pulmonary disease diagnosis.

month (Fig. 2 and Table 1). The highest costs during the study period were seen in the month of the index date, which is largely attributable to the fact that most COPD patients were diagnosed during an acute respiratory event. In fact, COPD was first diagnosed during a hospitalization in 17.8% of the cohort. After the initial COPD diagnosis, total health-care costs among COPD patients continued at a higher monthly rate than that seen before the diagnosis (Fig. 2). COPD patients' mean annual health-care costs were 24% to 36% greater than those of control patients in the 2 years before diagnosis, and 69% to 73% greater in the 2 years after diagnosis (Table 1).

Most of the higher costs observed among COPD patients in the 2 years before and after diagnosis are attributable to inpatient utilization (Fig. 3 and Table 1). Of the 6864 COPD patients identified for this study, 41.6% were hospitalized for COPD at least one time during the study interval, and for 1222 patients their first COPD diagnosis was made during a hospi-

talization. The absolute and relative differences in inpatient costs between COPD patients and their controls do not change substantially after the diagnosis of COPD is made; however, the primary reasons for hospital admission do change (Table 2). Respiratory symptom complaints including COPD, chronic bronchitis, and pneumonia become much more common in the years after the COPD is diagnosed, accounting for more than a third of the admissions.

Unexpectedly, renal failure was found to be the leading cause for admission in the COPD case group in the 2 years before initial diagnosis, and was much higher among COPD patients than controls (Table 2). To see whether costs related to renal failure were the cause of most of the differences between the groups, we ran an additional analysis after excluding all patients with renal failure. Total cost differences between cases and controls did decrease (24–13 months before index month: $860; 12–1 months before index month: $1703; at index month: $571; 1–12 months after index

Table 1 Summary of costs in the 2 years before and after the initial month of diagnosis ($)

Time period	Visit type	Case (95% CI)	Control (95% CI)	Absolute difference	Case is X greater than control
24–13 months before index month	IP	1,700 (1,184–2,216)	449 (358–539)	1,251	3.8
	OP	3,670 (2,522–4,819)	3,720 (3,046–4,394)	50	1.0
	RX	656 (612–700)	676 (651–701)	20	1.0
	Total	6,026 (4,757–7,297)	4,844 (4,158–5,531)	1,182	1.2
12–1 months before index month	IP	1,956 (1,420–2,492)	598 (484–711)	1,358	3.3
	OP	5,900 (4,484–7,317)	5,100 (4,264–5,936)	800	1.2
	RX	1,461 (1,399–1,522)	1,131 (1,102–1,159)	330	1.3
	Total	9,317 (7,785–10,849)	6,828 (5,978–7,679)	2,489	1.4
Index month	IP	226 (139–313)	73 (20–95)	153	3.1
	OP	872 (463–1,281)	447 (339–555)	425	2.0
	RX	276 (266–286)	108 (105–111)	168	2.6
	Total	1,374 (953–1,795)	598 (487–708)	776	2.3
1–12 months after index month	IP	1,621 (1,282–1,960)	719 (597–841)	902	2.3
	OP	8,224 (6,030–10,419)	5,297 (4,444–6,150)	2,927	1.6
	RX	2,191 (2,111–2,270)	1,099 (1,072–1,126)	1,092	2.0
	Total	12,036 (9,800–14,271)	7,115 (6,248–7,981)	4,921	1.7
13–24 months after index month	IP	1,907 (1,491–2,324)	632 (515–749)	1,275	3.0
	OP	7,159 (4,859–9,458)	4,695 (3,916–5,475)	2,464	1.5
	RX	1,293 (1,221–1,389)	655 (633–678)	638	2.0
	Total	10,359 (7,994–12,725)	5,983 (5,189–6,777)	4,376	1.7

Costs are expressed as the mean in US dollars per person for the time period listed.
P-values for all differences were < 0.001 except for OP and RX in the 24–13 months before Index Month.
CI, confidence interval; IP, inpatient; OP, outpatient; RX, outpatient pharmacy.
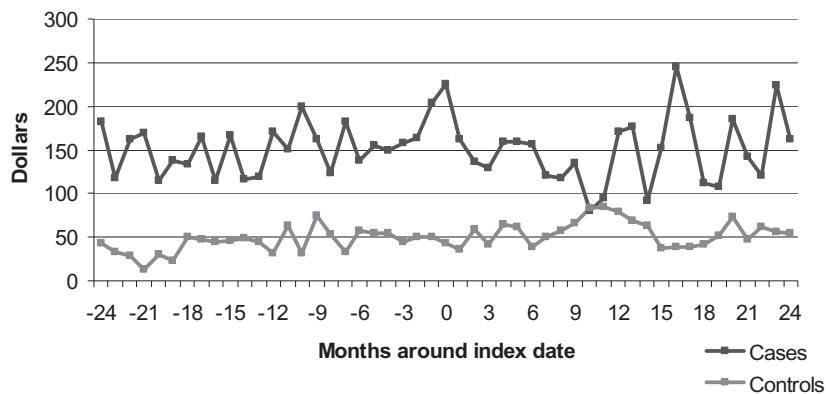
Figure 3 Mean inpatient costs by month in the 24 months before and after the month of initial chronic obstructive pulmonary disease diagnosis.

month: $4311; 13–24 months after index month: $4074), but remained highly significant (*P* < 0.001 for all differences).

Outpatient costs do not differ substantially between case and control patients until just a few months before the index month (Fig. 4 and Table 1). Nevertheless, a steady increase in outpatient costs is seen among the COPD patients from thereafter, excepting a large spiked increase in costs during the month of diagnosis. A total of 4010 COPD patients (58.4%) were only treated as outpatients during the study interval. In the years after the initial COPD diagnosis, office visits for COPD and respiratory symptom complaints account for 18% of overall outpatient utilization.

As with the outpatient health-care costs, there are no substantial differences in pharmacy costs between COPD cases and matched controls until just before the initial diagnosis of COPD (Fig. 5 and Table 1). The spiked increase in pharmacy costs at the time of diagnosis is more pronounced than that seen for either inpatient or outpatient utilization. Outpatient pharmacy costs for COPD patients are then approximately double those of the control group in the 2 years after the initial diagnosis, but only approximately 8% of prescription fills for COPD patients during this period are attributable to respiratory drugs (Table 3).

Discussion

Our study demonstrates that COPD patients have substantially higher direct medical costs in the 2 years before their first COPD diagnosis. Most of the increased costs are attributable to hospitalizations. Interestingly, the hospitalization rate does not change after the initial diagnosis of COPD, but the reasons for admission do change, with more than one-third of the admissions after the diagnosis attributed to lung diseases. The reasons for this change are not certain, but this could represent either progression of the disease or a heightened awareness among COPD patients and their physicians about the contribution that lung

disease is making to their declining health. A remarkably high 17.8% of the cohort did not have a diagnosis of COPD until they were hospitalized for it. Mean pharmacy and outpatient visit costs did not increase substantially until just 3 to 4 months before the index date, but remained substantially higher thereafter. The marginal cost increase among this limited cohort of 6864 COPD patients was more than $17 million in the year before the initial diagnosis, and more than $25 million for the 2 years prior. This study confirms that undiagnosed COPD has a substantial impact on this managed care system, and that there are several opportunities for improvement in both diagnosis and treatment.

In our random chart review of 200 COPD patients, we did find evidence suggesting that the lung disease component of the clinical presentation was often either completely ignored or misdiagnosed. We found that the average patient had very obvious risk factors, such as an average 41-pack-year cigarette smoking history, and 56.5% were documented to have at least one chronic respiratory symptom. Implementation of screening spirometry for all adults over the age of 45 years who have a smoking history and/or who have chronic respiratory symptoms, as recommended by the National Lung Health Education Project, could have identified many of these COPD patients several years earlier [11,12]. Spirometry also needs to be used more consistently to confirm the diagnosis. In terms of treatment, the use of bronchodilators was very inconsistent, and the use of respiratory medications after the initial diagnosis declined rapidly. Earlier diagnosis of COPD could lead to more timely interventions, including smoking cessation and appropriate pharmacotherapy, and may result in improved patient care and quality of life [13].

There are several limitations to this study that must be considered. The main limitation is the difficulty of estimating the impact of a disease that has not been diagnosed. Our main goal was to estimate the economic impact of undiagnosed COPD, but for this analysis we were limited to using only those persons

Table 2 Primary hospital admission diagnoses by 12-month intervals before and after the index date in COPD cases and age- and sex-matched controls

	Case			Control		
	ICD-9 (diagnosis)	No. admits	% of admits	ICD-9 (diagnosis)	No. admits	% of admits
24–13 months before index month						
1	585 Chronic renal failure	162	21.3	786.5 Chest pain NOS	262	16.7
2	786.5 Chest pain NOS	93	12.3	427.9 Arrhythmia NOS	203	13.0
3	427.9 Arrhythmia NOS	83	10.9	794.31 Abnormal ECG	105	6.7
4	794.31 Abnormal ECG	54	7.1	789 Abdominal pain NOS	68	4.3
5	486 Pneumonia	38	5.0	786.59 Chest pressure	67	4.3
6	428 Heart failure	33	4.3	427.31 Atrial fibrillation	57	3.6
7	401.9 Hypertension	32	4.2	486 Pneumonia	57	3.6
8	714 Rheumatoid arthritis	26	3.4	780.79 Malaise or fatigue	55	3.5
9	427.31 Atrial fibrillation	24	3.2	401.9 Hypertension	51	3.3
10	250 Diabetes mellitus	24	3.2	585 Chronic renal failure	51	3.3
12–1 months before index month						
1	585 Chronic renal failure	263	15.2	786.5 Chest pain NOS	374	13.7
2	786.5 Chest pain NOS	227	13.1	427.9 Arrhythmia NOS	358	13.1
3	427.9 Arrhythmia NOS	214	12.4	789 Abdominal pain NOS	148	5.4
4	428 Heart failure	164	9.5	794.31 Abnormal ECG	143	5.2
5	486 Pneumonia	126	7.3	585 Chronic renal failure	124	4.5
6	794.31 Abnormal ECG	115	6.6	428 Heart failure	118	4.3
7	789 Abdominal pain NOS	77	4.4	427.31 Atrial fibrillation	113	4.1
8	436 Cerebrovascular disease	69	4.0	436 Cerebrovascular disease	102	3.7
9	729.5 Pain in limb	68	3.9	414.01 Coronary artery disease	99	3.6
10	799 Ill-defined causes	68	3.9	786.59 Chest pressure	98	3.6
Index month						
1	496 COPD	392	10.1	427.9 Arrhythmia NOS	43	14.2
2	786.5 Chest pain NOS	348	9.0	786.5 Chest pain NOS	33	10.0
3	486 Pneumonia	286	7.4	427.31 Atrial fibrillation	18	5.9
4	427.9 Arrhythmia NOS	283	7.3	428 Heart failure	16	5.3
5	428 Heart failure	192	4.9	794.31 Abnormal ECG	14	4.6
6	491.21 Chronic bronchitis	175	4.5	789 Abdominal pain NOS	13	4.3
7	786.09 Respiratory symptoms	167	4.3	585 Chronic renal failure	13	4.3
8	786.05 Respiratory symptoms	145	3.7	436 Cerebrovascular disease	13	4.3
9	794.31 Abnormal ECG	123	3.2	414.01 Coronary artery disease	12	4.0
10	799 Ill-defined causes	118	3.0	250 Diabetes mellitus	11	3.6
1–12 months after index month						
1	496 COPD	666	17.1	427.9 Arrhythmia NOS	529	14.3
2	786.5 Chest pain NOS	539	13.9	786.5 Chest pain NOS	489	13.2
3	427.9 Arrhythmia NOS	509	13.1	794.31 Abnormal ECG	259	7.0
4	428 Heart failure	436	11.2	436 Cerebrovascular disease	188	5.1
5	486 Pneumonia	418	10.9	427.31 Atrial fibrillation	185	5.0
6	585 Chronic renal failure	393	10.1	428 Heart failure	184	5.0
7	786.09 Respiratory symptoms	260	6.7	789 Abdominal pain NOS	171	4.6
8	794.31 Abnormal ECG	226	5.8	585 Chronic renal failure	161	4.4
9	786.05 Respiratory symptoms	196	5.0	486 Pneumonia	147	4.0
10	491.21 Chronic bronchitis	189	4.9	780.79 Malaise or fatigue	140	3.8
13–24 months after index month						
1	496 COPD	582	24.6	427.9 Arrhythmia NOS	474	12.6
2	427.9 Arrhythmia NOS	403	17.1	786.5 Chest pain NOS	444	11.6
3	786.5 Chest pain NOS	391	16.5	794.31 Abnormal ECG	213	5.6
4	428 Heart failure	259	11.0	436 Cerebrovascular disease	152	4.1
5	486 Pneumonia	241	10.2	789 Abdominal pain NOS	142	3.7
6	585 Chronic renal failure	225	9.5	585 Chronic renal failure	137	3.6
7	794.31 Abnormal ECG	212	9.0	427.31 Atrial fibrillation	131	3.5
8	786.09 Respiratory symptoms	175	7.4	428 Heart failure	115	3.1
9	491.21 Chronic bronchitis	142	6.0	599 Urinary tract infection	115	3.1
10	786.05 Respiratory symptoms	114	4.8	486 Pneumonia	115	3.1

COPD, chronic obstructive pulmonary disease; ECG, electrocardiogram; NOS, not otherwise specified.

who have had a diagnosis of COPD at some point during the study period. Undoubtedly, there are a large number of persons with COPD in the LHP who simply were never diagnosed, or who were only given the diagnosis of COPD one time as an outpatient, and it is impossible to know how much this misclassification error contributed to the observed differences between the cases and controls. Another limitation is that patients for our study were captured from one managed care organization from one part of the country. Although population-based studies such as ours help to establish the validity of the findings, their generalizability to other populations may be limited. The differences between cases and controls may also be
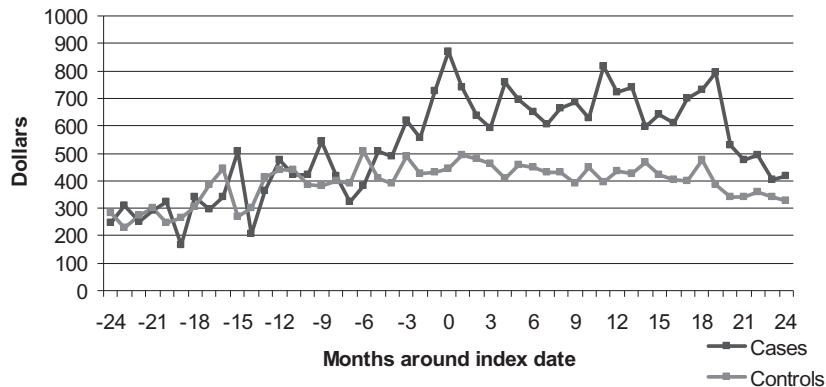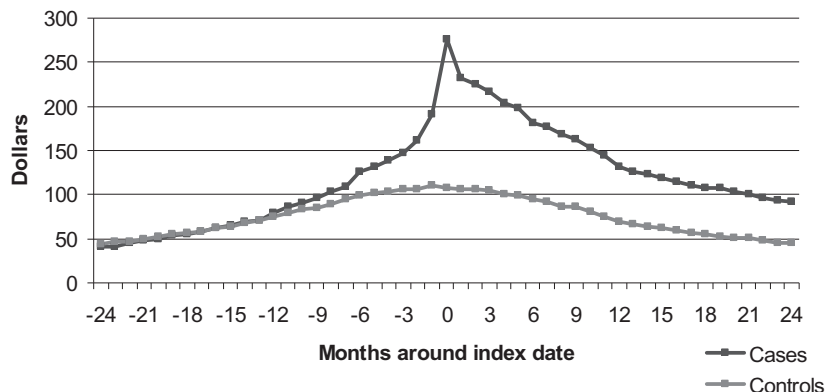
Figure 4 Mean outpatient costs by month in the 24 months before and after the month of initial chronic obstructive pulmonary disease diagnosis.

confounded by the higher prevalence of comorbid conditions such as heart disease among the COPD patients. We used the Charlson Index to describe the burden of prognostically significant comorbidities in our COPD and control populations, but the Charlson Index only covers the major comorbidities as it was originally developed to predict mortality. Other study populations may have different prevalence of serious comorbidities that will affect their overall utilization rates. They also may have different mixes of disease severity, which has been shown to have a significant impact on total direct costs in COPD [14].

To our knowledge, this is the first study that examines the natural history of utilization among COPD patients before and after the initial diagnosis of the disease. Several recently published articles have examined COPD from a variety of perspectives. Some have focused on national cost estimates, such as the study by the National Heart, Lung, and Blood Institute (NHLBI) which estimated that direct and indirect costs totaled $37.2 billion in the United States in 2004, with 56% of this total attributable to direct costs [15]. Two other studies using national data also estimated annual direct costs to be in the range of $20 to $26 billion per year, after adjustment for inflation [16,17]. The NHLBI report found that 55% of direct costs were for hospital and nursing home care, 24% were for pre-

scription drugs, and 18% were for outpatient physician services [15]. This suggests a much higher proportion of cost for prescription drugs, and lower cost for outpatient services, than what we have found in our database, which we believe is due to limitations in how prescription drug and outpatient utilization is captured at the national level. Dividing the NHLBI's estimate of $20.8 billion in direct costs attributable to COPD by the approximately 11 million diagnosed COPD patients in the United States in 2004 yields an average total cost of $1894 per patient, which is obviously far below our marginal COPD cost estimate of $4921 in the first year and $4376 in the second year after initial diagnosis.

Our previous analysis of excess costs in COPD, which captured patients in 1996 and then analyzed their 1997 cost, found that COPD patients had total direct costs that were approximately twice those of controls, with the biggest proportional difference found in costs for hospitalization [5]. An important difference between this and our previous study is that the controls selected in the first study were not required to have similar rates of utilization (i.e., at least one hospitalization or two outpatient visits), so the absolute differences between the cases and controls were much greater. The total direct annual cost difference in 1997 was $5036, which would be the equiva-

Figure 5 Mean pharmacy costs by month in the 24 months before and after the month of initial chronic obstructive pulmonary disease diagnosis.

Table 3 Summary of pharmacy utilization in the 2 years before and after the initial month of diagnosis of COPD

	Case			Control	
	Drug category	No. RX fills (%)		Drug category	No. RX fills (%)
24–13 months before index month					
1	All other prescriptions	22,820 (42.2)		All other prescriptions	75,687 (46.2)
2	Analgesics/psychotherapeutics	12,995 (24.0)		Analgesics/psychotherapeutics	42,213 (25.8)
3	Cardiovascular	11,928 (22.1)		Cardiovascular	29,787 (18.2)
4	Antibiotics	4,116 (7.6)		Antibiotics	13,129 (8.0)
5	Respiratory	2,229 (4.1)		Respiratory	2,967 (1.8)
12–1 months before index month					
1	All other prescriptions	47,528 (41.9)		All other prescriptions	118,213 (45.4)
2	Analgesics/Psychotherapeutics	26,584 (23.4)		Analgesics/psychotherapeutics	68,153 (26.2)
3	Cardiovascular	23,238 (20.5)		Cardiovascular	48,920 (18.8)
4	Antibiotics	9,034 (8.0)		Antibiotics	20,670 (7.9)
5	Respiratory	7,128 (6.3)		Respiratory	4,569 (1.8)
Index month					
1	All other prescriptions	9,221 (40.0)		All other prescriptions	11,595 (44.8)
2	Analgesics/psychotherapeutics	4,534 (19.7)		Cardiovascular	6,928 (26.8)
3	Cardiovascular	4,013 (17.4)		Analgesics/psychotherapeutics	4,843 (18.7)
4	Respiratory	2,680 (11.6)		Antibiotics	2,070 (8.0)
5	Antibiotics	2,583 (11.2)		Respiratory	425 (1.6)
1–12 months after index month					
1	All other prescriptions	81,585 (42.3)		All other prescriptions	129,354 (44.9)
2	Analgesics/psychotherapeutics	40,011 (20.8)		Cardiovascular	78,196 (27.2)
3	Cardiovascular	39,340 (20.4)		Analgesics/psychotherapeutics	54,196 (18.8)
4	Respiratory	16,892 (8.8)		Antibiotics	21,725 (7.5)
5	Antibiotics	14,902 (7.7)		Respiratory	4,464 (1.6)
13–24 months after index month					
1	All other prescriptions	49,727 (42.8)		All other prescriptions	80,584 (45.1)
2	Cardiovascular	24,097 (20.8)		Cardiovascular	50,882 (28.4)
3	Analgesics/psychotherapeutics	23,572 (20.3)		Analgesics/psychotherapeutics	32,488 (18.2)
4	Respiratory	9,758 (8.4)		Antibiotics	12,592 (9.0)
5	Antibiotics	8,904 (7.7)		Respiratory	2,320 (1.3)

COPD, chronic obstructive pulmonary disease; RX, outpatient pharmacy.

lent of approximately $8000 today after adjustment for health-care inflation. Approximately half of the excess costs in our previous study were attributable to comorbidities. Similar studies of Medicaid populations, which tend to be younger and have less comorbidities, have found annual direct costs in the $6000 range, with about a third of these attributable to comorbidities [18]. The excess cost estimate derived from the 2000 Medical Expenditure Panel Survey (MEPS) data by Miller et al. also estimated marginal cost differences in the $6000 range [19].

Attributable cost estimates for COPD are invariably lower than marginal cost estimates, mostly because of the fact that they do not capture the associated smoking-related comorbidities. The methods used to collect data in the attributable cost studies are also highly variable; for example, some are population-based studies of entire groups of Medicaid patients [18], while others rely on surveys of relatively small groups [20]. In the study of Medicaid patients, which used both marginal and attributable cost approaches, Marton et al. found attributable costs in the range of $2500 to $2800 after adjustment for inflation [18]. In Miller et al.'s study using the MEPS data, they estimated the direct attributable cost of COPD to be a little more than $3000 per patient, after adjustment for demographic factors, smoking, and inflation [19]. In a survey of 462 patients who participated in the 1999 and 2000 US Medicare Current Beneficiary Survey, Stuart et al. estimated attributable costs of only slightly more than $1000 after adjustment for inflation [20].

Conclusions

We have demonstrated that undiagnosed COPD has a substantial impact on health-care utilization and costs, especially for hospitalizations. As therapy changes from the palliative approach of years past to aggressive interventions aimed at reducing exacerbations and improving survival and quality of life, it will become more important to reduce the number of undiagnosed cases and identify patients at earlier stages of the disease [13].

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