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ORIGINAL ARTICLE

Cost and utilization of COPD and asthma among insured adults in the US*

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ABSTRACT

Objectives: This study evaluates the burden of concomitant chronic obstructive pulmonary disease (COPD) + asthma, two highly prevalent and costly conditions.

Patients and methods: The authors identified commercial enrollees from a large health plan database who were aged ≥40 years with medical and pharmacy benefits and medical claims with diagnosis codes for COPD or asthma between January 1, 2004 and December 31, 2004. We assigned patients to COPD or COPD + asthma cohorts, excluding all others. A patient index date was the first evidence date of COPD or COPD + asthma. We excluded those with one outpatient COPD or asthma claim or who were not continuously enrolled during the 12 months before and after index date. After controlling for differences, postindex respiratory-related emergency department (ED) visits and/or hospitalizations and costs were compared between cohorts.

Results: We identified 24,935 patients, 17,394 (70%) in the COPD cohort and 7,541 (30%) in the COPD + asthma cohort. COPD + asthma patients were younger (58 versus 60 years; $p < 0.0001$) and more were females (62% vs 45%; $p < 0.0001$). COPD + asthma patients were 1.6 times more likely to have respiratory-related EDs and/or hospitalizations than COPD patients (95% CI 1.5, 1.8), and had \$1987 (SE = \$174, $p < 0.0001$) more respiratory-related healthcare costs. Mean adjusted respiratory-related healthcare costs were \$3803 for COPD and \$5790 for COPD + asthma. Limitations include a potential for misclassification due to misdiagnosis or coding errors as well as traditional biases of observational studies including the potential for omitted variable bias.

Conclusion: COPD + asthma patients are more costly and use more services than those with COPD, and may be more unstable and require more intensive treatment.

Introduction

Chronic obstructive pulmonary disease (COPD) refers to a group of lung diseases, of which chronic bronchitis and emphysema are its most common forms[1]. More than 11.4 million adults in the United States have been diagnosed with COPD and it is the fourth leading cause of death[1]. In 2004, the estimated annual cost of

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COPD was $37.2 billion, with direct care costs accounting for $20.9 billion[1]. While therapies that improve lung function have been shown to reduce healthcare spending, managing patients with COPD has become a major challenge for healthcare professionals, public and private healthcare payers, and policy makers[2–5]. Adding to this challenge is the presence of other chronic obstructive lung diseases. In 2004, more than 30.2 million Americans reported they had been told by healthcare professionals that they had asthma[6]. In 2004, the estimated annual cost of asthma was $16.1 billion, with direct care costs accounting for $11.5 billion[6]. There is increasing awareness that in some patients asthma and COPD coexist. According to a 20 year study, patients with active asthma are 12 times more likely to develop COPD during their lifetimes than patients without asthma[7]. While the pathogeneses and prognoses of asthma and COPD differ, both are characterized by bronchial obstruction and airway inflammation. Patients with frequent exacerbations of either condition incur significant medical costs, which include expenditures for outpatient physician and emergency department (ED) visits and inpatient hospitalizations. Studies have estimated that among patients with obstructive lung disease, 17–20% have COPD and asthma, yet little is known about the economic impact of this subgroup[8,9]. The authors conducted a study to evaluate the burden of concomitant COPD and asthma among commercial health plan enrollees within the United States.

Methods

Data source

The data was obtained from Integrated Healthcare Information Services (IHCIS) Inc. The IHCIS National Managed Care Benchmark Database is Health Insurance Portability and Accountability Act[10] (HIPAA)-compliant and contains patient-level and service-level managed care claims and membership information from more than 30 distinct health plans and for seven census regions. During the calendar year of 2004, 943,118 individuals within the IHCIS dataset were enrolled in a commercial health plan. No patient identification information was obtained or used, therefore this study met the criteria of exempt from review by an Institutional Review Board (IRB).

Study design

This was a retrospective prevalent cohort study. Eligible patients had medical claims with International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM)[11] diagnosis codes (in any diagnosis field) for asthma and/or COPD during the identification period, January 1 through December 31, 2004. A 12 month period before the index date (defined below) was used to identify preindex characteristics and a 12 month period after the index date was used to identify healthcare utilization and cost outcomes. Continuous enrollment was defined as enrollment in the health plan during the 12 months before the index date (preindex period) through the 12 months after the index date (postindex period). The patient observation period was defined as the time from the beginning of the preindex to the end of the postindex period.

Eligible patients had to be continuously enrolled in commercial health plans for the entire 24 month observation period.

COPD cohort

Each patient (age 40 and older) had to have at least one medical claim with an ICD-9-CM code for COPD (491.x, 492.x, 496.x) during the identification period. The index date was defined as the date of the first medical claim. To confirm diagnosis, each patient was required to have another medical claim with an ICD-9-CM code for COPD during the observation period. To confirm that the health plan included a pharmacy benefit, each patient was required to have at least one pharmacy claim for any medication during the observation period. Any patient who had a medical claim with an ICD-9-CM code for asthma was excluded from this cohort.

COPD + asthma cohort

Each patient aged 40 and older had to have at least one medical claim with an ICD-9-CM code for COPD and at least one for asthma (493.0x, 493.1x, 493.8x, 493.9x) during the identification period. The first medical claim for each diagnosis during the identification period was identified and the earlier of the two dates was selected as the index date. If a medical claim with an ICD-9-CM code that represents COPD and asthma (493.2) was used, the criterion for each disease was met, and the date of that claim was selected as the index date. To confirm diagnoses, patients were required to have another medical claim for each condition (COPD and asthma) or another medical claim with the ICD-9 code that represents COPD and asthma (493.2) anytime during the observation period. To confirm that the health plan included a pharmacy benefit, each patient was required to have at least one pharmacy claim for any medication during the observation period.

Outcome variables

The primary outcomes of interest were respiratory-related total healthcare costs and evidence of a respiratory-related ED encounter and/or hospitalization with a length of stay (LOS) of at least 1 day. Location codes were used within the database to identify ED encounters and hospitalizations, and required an LOS of at least 1 day to exclude patients who were admitted to the hospital for procedures or diagnostic testing. Pharmacy, medical, and total healthcare costs were reported as 'respiratory-related,' 'all other,' and 'overall.' The IHCIS data includes standardized costs that reflect allowable payments. Pharmacy claims for all respiratory medications were considered respiratory-related. Medical claims with respiratory diagnoses listed as primary diagnoses were considered respiratory-related (ICD-9-CM diagnosis codes 460.xx – 519.xx). Healthcare utilization claims for outpatient physician encounters, all other outpatient encounters, ED encounters, hospitalizations with an LOS of at least 1 day, average LOS, and EDs and/or hospitalizations with an LOS of at least 1 day were reported as respiratory-related, all other, and overall, by cohort. If a patient had an ED encounter that advanced to a hospitalization, it was considered a hospitalization. If a patient had an ED encounter and it did not advance to a hospitalization, it was considered an ED encounter.

The number of patients who needed outpatient treatment for acute exacerbations of COPD were reported. The authors defined outpatients as those who had medical claims for outpatient physician encounters with ICD-9-CM codes for COPD as the primary diagnosis and a pharmacy claim with a National Drug Code (NDC)[12] for a 14 day (or fewer) course of an oral corticosteroid or antibiotic, either of which were filled 1–2 days after the outpatient physician visit[13]. If the concomitant ICD-9-CM code for COPD and asthma was used, it was considered a COPD diagnosis for this metric. Other preindex variables included age, sex, geographic region and Charlson comorbidity index (CCI), the individual CCI components, and select other comorbid conditions[14].

The CCI contains 19 categories of comorbidities, defined using ICD-9-CM diagnosis codes. Each category has an associated weight based on adjusted risk of 1 year mortality. The overall score, which can range from 0–31, reflects the cumulative increased likelihood of 1 year mortality. A higher score reflects a more severe comorbidity burden. For this analysis, the authors used an adapted version of the clinical index developed by Charlson and her colleagues, which is based on medical record review and contains 17 categories of comorbidities[15]. The adapted version groups COPD and asthma into a single disease category, thus the COPD + asthma cohort was not assigned an additional respiratory burden based on having both conditions. It was possible that some patients were newly diagnosed on their index dates; therefore, these conditions are not reported as preindex conditions.

Statistical analysis

All data transformations and statistical analyses were performed using SAS© version 9.1 (SAS Institute, Cary, NC, USA)[16]. To compare preindex characteristics between two cohorts, the chi-square test was used for categorical variables and *t* test was used for continuous variables.

The two key outcomes of interest were respiratory-related healthcare costs (pharmacy + medical) and ED encounters and/or acute hospitalizations with an LOS of at least 1 day. To compare these outcomes between cohorts, multivariate analysis was used to adjust for age, sex, census region, and CCI. Ordinary least squares regression was used for respiratory-related total healthcare costs and logistic regression was used for ED/hospitalizations with an LOS of at least 1 day. All two-way interactions were considered, and only those with significant results were included in the models. Age by region was the only significant interaction included in all models. All reported p values are two-sided with a significance level of 0.05.

Results

The authors identified 24,935 patients who met study criteria, 17,394 (69.8%) were stratified to the COPD cohort and 7541 (30.2%) to the COPD + asthma cohort. The COPD + asthma cohort patients were slightly younger ($p < 0.0001$) and more were female than the COPD cohort ($p < 0.0001$). Geographic representation also differed between cohorts ($p < 0.0001$) (Table 1).

With respect to comorbid conditions, the COPD + asthma cohort had a higher mean ± SD CCI (2.0 ± 1.9) than the COPD cohort (1.7 ± 2.1) ($p < 0.0001$). Myocardial infarction, peripheral vascular disease, cerebrovascular disease, renal disease and cancer were more prevalent in the COPD cohort ($p < 0.0001$) and rheumatologic disease, mild-to-moderate diabetes, acute upper respiratory infections and pneumonia were more prevalent in the COPD + asthma cohort ($p < 0.0001$).

Unadjusted healthcare utilization and costs

Unadjusted healthcare utilization measures are in Table 2. Respiratory-related resource utilization rates

Table 1. Preindex characteristics

	COPD $n = 17,394$	COPD + Asthma $n = 7541$	
	Mean (Standard Deviation)		p value[a]
Age	60.1 (9.2)	57.6 (9.1)	<0.0001
Charlson Comorbidity Index	1.7 (2.1)	2.0 (1.9)	<0.0001
	No. of patients (%)		p value[b]
Age Group (in years)			<0.0001
40–54	4617 (26.5)	2777 (36.8)	
55–64	8125 (46.7)	3337 (44.3)	
65–74	2940 (16.9)	1004 (13.3)	
75+	1712 (9.8)	423 (5.6)	
Sex			<0.0001
Female	7808 (44.9)	4689 (62.2)	
Region			<0.0001
Midwest	1412 (8.1%)	462 (6.1)	
Northeast	10,190 (58.6)	4536 (60.2)	
South	1775 (10.2)	540 (7.2)	
West	383 (2.2)	152 (2.2)	
Not specified	3634 (20.9)	1851 (24.5)	

[a]Student's *t*-test
[b]Pearson chi-square test

in the COPD + asthma cohort were higher than the COPD cohort in all utilization measures. More patients in the COPD cohort received outpatient treatment for COPD exacerbations than the COPD + asthma cohort (12.6% vs 10.1%, $p < 0.0001$).

Unadjusted healthcare costs including pharmacy, medical, and total (pharmacy + medical) stratified as respiratory-related, all other, and overall are in Table 3. The overall unadjusted respiratory-related costs (pharmacy, medical, and total) were higher for the COPD + asthma than the COPD cohort.

Adjusted healthcare utilization and costs

After adjusting for age, sex, region, and CCI, the COPD + asthma cohort was 1.6 times more likely to have a respiratory-related ED and/or hospitalization than the COPD cohort (95% CI 1.5, 1.8; Table 4). Adjusted respiratory-related total healthcare costs are in Table 5. The COPD + asthma cohort ($5790; 95% CI $5507, $6073) had $1987 (SE = 174, $p < 0.0001$) higher adjusted respiratory-related total healthcare costs than the COPD cohort ($3803; 95% CI $3619, $3988) ($p < 0.0001$).

Discussion

The findings of this study revealed that those patients with evidence of both COPD and asthma are much more costly and use more healthcare resources than those patients with evidence of COPD alone. Findings also revealed that the cohorts' clinical characteristics differed significantly. The COPD + asthma cohort was younger and comprised more females. This corroborated previous reports that asthma rates decrease with age and that females have higher asthma prevalence than males[6]. The COPD + asthma cohort had a greater burden of comorbidity, evidenced by higher CCI and prevalence of select chronic conditions. The CCI groups asthma and COPD into a single disease category, chronic pulmonary disease, and even though the COPD + asthma cohort was younger, this cohort had a greater burden of comorbidity. Specifically, the COPD + asthma cohort had higher rates of rheumatoid arthritis, diabetes, upper respiratory infections, and pneumonia. This greater burden of comorbidity resulted in greater use of services and higher healthcare costs. We showed that among COPD patients, an additional diagnosis of asthma resulted in a 52.2% increase in respiratory-related total healthcare costs. This demonstrates the substantial economic burden posed by the treatment and management of concomitant COPD + asthma.

While there were distinct differences between the COPD + asthma cohort and the COPD cohort, a post-hoc analysis comparing the COPD + asthma cohort to plan members with asthma only was conducted to ensure significant difference from an

Table 2. *Unadjusted healthcare utilization*

	Respiratory-related			All Other			Overall		
	COPD $n=17,394$	COPD + Asthma $n=7541$	p value	COPD $n=17,394$	COPD + Asthma $n=7541$	p value	COPD $n=17,394$	COPD + Asthma $n=7541$	p value
Outpatient physician visit[a]	2.3 (2.8)	5.1 (6.2)	<0.0001[b]	11.8 (12.1)	13.7 (14.0)	<0.0001[b]	14.1 (12.6)	18.8 (15.8)	<0.0001[b]
All other outpatient visits[a]	1.0 (3.7)	1.6 (3.8)	<0.0001[b]	6.6 (13.0)	7.1 (14.0)	0.0095[b]	7.6 (13.9)	8.7 (15.3)	<0.0001[b]
Patients with ED visits	1864 (10.7)	1537 (20.4)	<0.0001[c]	5716 (32.9)	2810 (37.3)	<0.0001[c]	6366 (36.6)	3347 (44.4)	<0.0001[c]
Patients with hospitalizations whose LOS ≥1 day	2492 (14.3)	1309 (17.4)	<0.0001[c]	3808 (21.9)	1775 (23.5)	0.0042[c]	5400 (31.0)	2559 (33.9)	<0.0001[c]
Average LOS*of those with acute hospitalizations[a]	6.7 (9.4)	7.2 (10.2)	0.1312[b]	11.3 (20.4)	10.0 (16.9)	0.0115[b]	11.0 (19.8)	10.6 (18.4)	0.3239[b]
Patients with ED visits and/or hospitalizations with LOS ≥1 day	3745 (21.5)	2289 (30.4)	<0.0001[c]	6956 (40.0)	3363 (44.6)	<0.0001[c]	7974 (45.8)	3932 (52.1)	<0.0001[c]

[a]Mean (Standard Deviation)
[b]Student's *t*-test
[c]Pearson chi-square test
*Length of stay (LOS)

Table 3. *Unadjusted healthcare costs*[a]

	Respiratory-related Costs			All Other Costs			Overall Costs		
	COPD $n=17,394$	COPD + Asthma $n=7541$	p value[b]	COPD $n=17,394$	COPD + Asthma $n=7,541$	p value[b]	COPD $n=17,394$	COPD + Asthma $n=7541$	p value[b]
Pharmacy Costs	$465 ($918)	$1401 ($1943)	<0.0001	$2716 ($4261)	$3240 ($4879)	<0.0001	$3182 ($4406)	$4641 ($5428)	<0.0001
Medical Costs	$3352 ($12,921)	$4372 ($10,882)	<0.0001	$14,078 ($30,949)	$13,554 ($31,729)	0.2270	$17,430 ($35,672)	$17,926 ($35,870)	0.3144
Total Costs	$3818 ($13,035)	$5773 ($11,238)	<0.0001	$16,794 ($32,209)	$16,793 ($33,059)	0.9983	$20,612 ($36,923)	$22,567 ($37,296)	<0.0001

[a]Mean (Standard Deviation)
[b]Student's *t*-test

Table 4. *Logistic regression predicting occurrence of respiratory-related hospitalization/ED visit*

	Parameter Estimate	Standard Error	*p*-value
Parameter			
Intercept	−1.24	0.20	<0.0001
Age	0.01	0.00	0.0211
Sex F vs. M	0.05	0.03	0.1271
Midwest Region	−1.37	0.39	0.0005
Northeast Region	−2.10	0.24	<0.0001
South Region	−0.90	0.39	0.0202
West Region	−1.28	0.75	0.0884
Age × Midwest Region	0.02	0.01	0.0128
Age × Northeast Region	0.02	0.00	<0.0001
Age × South Region	0.00	0.01	0.4981
Age × West Region	0.01	0.01	0.5555
CCI	0.04	0.01	<0.0001
Asthma + COPD	0.50	0.03	<0.0001
	Lower 95% CI for Odds Ratio	Adjusted Odds Ratio Estimate	Upper 95% CI for Odds Ratio
Asthma + COPD	1.5	1.6	1.8

Note: Referent group = male, unspecified region, COPD
CI = Confidence Interval

Table 5. *Ordinary least squares regression of respiratory-related costs*

	Parameter Estimate	Standard Error	*p*-value
Parameter			
Intercept	5719.26	1196.17	<.0001
Age	22.27	20.00	0.2655
Sex F vs. M	−162.26	158.02	0.3045
Midwest Region	−11,037.44	2179.23	<0.0001
Northeast Region	−9454.63	1344.99	<0.0001
South Region	−5264.60	2074.66	0.0112
West Region	−5420.88	3719.28	0.1450
Age × Midwest Region	126.12	35.67	0.0004
Age × Northeast Region	77.27	22.52	0.0006
Age × South Region	22.95	34.31	0.5035
Age × West Region	17.59	60.35	0.7707
CCI	243.55	40.66	<0.0001
Asthma + COPD	1986.60	174.04	<0.0001
	Lower 95% CI for Adjusted Mean	Adjusted Mean	Upper 95% CI for Adjusted Mean
Asthma + COPD Cohort	$5507	$5790	$6073
COPD Cohort	$3619	$3803	$3988

Note: Referent group = male, unspecified region, COPD
CI = Confidence Interval

asthma only population. Of 39,742 asthma members meeting the same criteria as those in the COPD + asthma cohort (with the exception of the COPD claim) with an average age of 51.7 years (SD 7.8) and 67.9% male, demonstrated a mean Charlson Comorbidity Index of 1.1 (SD 1.3) compared to the COPD + Asthma cohort with 2.0 (SD 1.9) ($p < 0.0001$). Those patients with only asthma were

much less costly than the COPD + asthma cohort; including annual mean respiratory-related total costs for the asthmatics were $1702 (SD $3074) compared to $5773 (SD $11,238) for the COPD + asthma cohort ($p < 0.0001$), similarly annual mean respiratory-related medical costs were $933 (SD $2770) compared to $4372 (SD $10,881) ($p < 0.0001$), and annual mean respiratory-related pharmacy costs were $769 (SD $1152) compared to $1401 (SD $1943) ($p < 0.0001$). Even when combining the per-patient costs of COPD and asthma independently, the comorbidity suggests more than additive effect [annual mean respiratory-related total costs COPD + asthma comorbidity: $5773 vs COPD + asthma independent $5520 ($1702 + $3818) or a $253 difference].

Limitations

The study had some limitations. The authors relied on diagnosis codes from medical claims to stratify patients to the COPD or COPD + asthma cohorts; therefore, the results could have been affected by misdiagnosis or underdiagnosis[7–9,17,18]. Due to challenges in differentiating COPD from asthma, it is possible that some patients may have been misdiagnosed and cohort assignment could have been affected[7]. To overcome this, it was required that patients have at least two medical claims for each condition, yet if patients were misdiagnosed and treated according to that diagnosis, outcomes still may have been affected. While misdiagnosis may provide more confusion about the underlying overlap in disease, it is still an accurate depiction of the use and cost of healthcare and as such, the measurement of asthma + COPD may also reflect the cost of misdiagnosing COPD patients as asthmatics. Studies have reported underdiagnosis of COPD and asthma[9,18]; however, it would be difficult to detect using administrative claims data, so patients who had not been formally diagnosed would have been excluded from the study. The association between disease severity and healthcare utilizations and costs could not be explored using administrative claims data. Likewise, the authors used a prevalent cohort of patients with evidence of disease rather than an incident cohort, so duration of disease is not identified. Finally, the results of the study reflect resource utilization and costs from a commercially insured population primarily from the Northeast and the findings may not be representative of other populations. Even with these limitations, the authors believe this to be the first study to evaluate the economic impact of concomitant COPD and asthma among commercial health plan enrollees.

Conclusion

This study found substantial economic impact of concomitant COPD and asthma. Select respiratory treatments have been shown to reduce bronchial obstruction and airway inflammation, thus reducing ED visits and hospitalizations[3,5]. Targeting patients with COPD and asthma with pharmacologic and non-pharmacologic interventions that focus on improving respiratory status may result in fewer ED encounters and hospitalizations.

Transparency

Declaration of funding
GlaxoSmithKline provided funding for this project.

Declaration of financial/other relationships
C.M.B. and M.A. have disclosed that they were employees of GlaxoSmithKline at the time this research was conducted and A.A.D. has disclosed that he continues to be an employee of GlaxoSmithKline. C.M.B. has disclosed that he has received grants from GlaxoSmithKline and AstraZeneca and serves as a consultant to Sepracor, GlaxoSmithKline, AstraZeneca and NovoNordisk. M.B., C.O., E.C. and M.A. have disclosed they have no relevant financial relationships.

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