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Electronic health record reported symptomology analysis in patients with chronic obstructive pulmonary disease, asthma, and asthma and COPD overlap syndrome

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Introduction

COPD is a preventable lung disease that is characterized by obstruction of airflow, hyperinflation, dyspnea and limitation of activity.[1] The prevalence of COPD is approximately 8% in the general population and 10% in individuals above 40 years old[2] and is a leading cause of death in the U.S.[3]

In contrast, asthma is the most prevalent chronic lung disease in individuals less than 18 years old in the U.S.[4] It is characterized by chronic reversible attacks of chest tightness, wheezing and cough[5], and over 8% of the general U.S. population is affected by asthma. The burden of asthma is large, resulting in about 14 million private physician visits annually.[6]

Asthma and COPD overlap syndrome (ACOS) shares a similar etiology to both COPD and asthma, making it difficult for researchers and physicians to differentiate between the diseases. Currently experts utilize differing criteria to identify patients with ACOS. Despite the variation in how ACOS has been identified in the literature, a recent review found that patients with ACOS typically exhibit the following characteristics: (1) younger than COPD patients but older than asthma patients; (2) more likely African American; (3) have less smoking history than patients with COPD; (4) experience wheezing, atopy, allergic rhinitis, and hay fever (similar to asthma patients); and (5) typically have a history of asthma.[7]

Differentiating ACOS from asthma and COPD is necessary because ACOS patients need extra help with disease management. A recent study found that individuals with ACOS were more likely to be hospitalized after experiencing a severe exacerbation, took more respiratory medications, and experienced more gas trapping than those with COPD alone.[7]

For this study we aimed to find clinical clues within the electronic health record (EHR) database that might help providers and health systems differentiate patients with asthma and COPD, and identify patients with ACOS. To do so we examined patient demographics, comorbidities, and signs, diseases and symptoms (SDS) terms captured from provider notes by mutually exclusive asthma, COPD, and ACOS cohorts.

Methods

We searched the Optum EHR database for patients with at least two non-diagnostic medical encounters with ICD-10-CM diagnosis codes for COPD (Table 1) or asthma (Table 2) on two separate dates of service between January 1, 2016 and December 31, 2016 (study period). Patients were classified into three mutually exclusive cohorts: Asthma, COPD and ACOS. Patients with only asthma diagnoses were assigned to the asthma cohort, those with only COPD diagnoses were assigned to the COPD cohort, and individuals with at least one diagnosis of asthma and one diagnosis of COPD were assigned to the ACOS cohort. As there were over two million patients found in the EHR database with COPD, asthma, or ACOS, we randomly sampled 25% of eligible patients for our analysis. Patients were excluded if they had no EHR records or were missing demographic information. We hypothesized that children and younger adults with asthma would likely have different comorbidities and symptom presentation than older adults, therefore, we restricted the analysis to patients age 40 and older to minimize reporting differences due to age rather than condition. A full patient attrition table is presented in Table 4.

Using the patient information within the EHR database, we captured patient demographics such as age, gender, race and ethnicity, by diagnosis. We also identified the presence of comorbid conditions, including acute sinusitis, allergic rhinitis, and anxiety, using ICD-10 diagnosis codes from health care encounters during the study period. Finally, we searched the EHR database for SDS terms with clinical relevance (e.g., cough, dyspnea, and wheeze). All SDS terms were reviewed by a clinician who selected the most clinically relevant terms for our analysis. Our clinical reviewer also looked for negation terms such as 'negative', 'resolved' and 'null' to rule out SDS terms that were captured in the EHR database but may not have applied to the patient's condition.

Analysis

Patient demographics, comorbid conditions and SDS terms are summarized by cohort. This analysis was intended to be descriptive and hypothesis generating, therefore statistical testing was not conducted. All analyses were performed by Optum using SAS v9.x (SAS Institute, Cary, NC).

The data used for this analysis are fully de-identified per expert determination as described in §164.514(b)(1) of the Health Insurance Portability and Accountability Act (HIPAA) privacy rule, therefore Institutional Review Board approval and waiver of authorization was not required. All data were accessed and used in compliance with HIPAA rules to protect patient privacy and no identifiable protected health information was extracted or accessed during the course of the analysis.

Results

Demographics

Individuals with asthma, COPD, or ACOS made up 39.5% (N = 99,718), 46.9% (N = 118,403) and 13.6% (N = 34,175) of our sample, respectively (total N = 252,296; Table 4). Males accounted for 30.0% (N = 29,883), 49.1% (N = 58,098) and 34.3% (N = 11,725) of the asthma, COPD, and ACOS populations, respectively. The majority of individuals were non-Hispanic, Caucasian, but African Americans made up a greater proportion of the ACOS and asthma cohort than the COPD cohort. Furthermore, asthma patients were slightly younger than COPD and ACOS patients.

Comorbidities

Metabolic syndrome (61.6%), hypertension (56.2%), and peptic ulcer/gastroesophageal reflux disease (33.1%) were the top three most common comorbidities of the asthma cohort. Hypertension (72.8%), metabolic syndrome (65.0%), and dyspnea (38.5%) were the top three most common comorbidities of the COPD cohort. Similarly, hypertension (75.0%), metabolic syndrome (70.3%) and dyspnea (48.2%) were also the top three most common comorbidities of the ACOS cohort.

Our results suggest that COPD and ACOS patients experience similar rates of hypertension, diabetes and renal disease. Alternately, asthma and ACOS patients experience similar rates of sinusitis and rhinitis, while ACOS patients experience higher rates of anxiety, depression, gastroesophageal reflux disease and sleep apnea than COPD or asthma patients. The distribution of comorbidities experienced by each cohort is summarized in Figure 1.

SDS

We found that many SDS terms overlapped between the three diseases of interest (Figure 1). Dyspnea, cough, wheeze and fatigue were the top four most commonly mentioned SDS among all three cohorts. Although many SDS terms overlapped, we found differences in how frequent an SDS term was mentioned. We display these differences in a rank order list of SDS terms by diagnosis (Table 6).

Discussion

In this descriptive study we hypothesized that asthma, COPD and ACOS would be differentiated by comorbid conditions and symptomology. We searched the encounter records and provider notes in the Optum EHR database for this evidence. Differentiating ACOS from asthma and COPD is important because existing knowledge on ACOS is limited and varies. Better characterization of ACOS patients could ensure timely and appropriate treatment, and subsequently improve outcomes.

We mentioned that previous research found patients with ACOS were usually younger than COPD patients but older than asthma patients.[7] Though we limited our analysis to individuals 40 years and older, we did find a similar distribution in age among our population. In general, asthma patients were younger than COPD and ACOS patients, while COPD patients were older than asthma and ACOS patients. Previous research also identified that African Americans were more likely to have ACOS.[7] Though we did not conduct statistical testing, our descriptive results showed that slightly more African Americans had ACOS than COPD or asthma. Also, previous research identified allergic rhinitis and wheezing as common symptoms experienced by ACOS patients.[7] Our study reflects past research; we found that allergic rhinitis was more common in the ACOS cohort than the COPD or asthma cohorts. Furthermore, wheezing was among the top five most commonly reported SDS in the ACOS cohort. Lastly, research suggests that ACOS individuals may require more specialized care.[7] We found higher rates of anxiety, depression, gastroesophageal reflux disease and sleep apnea in the ACOS cohort. These comorbid conditions may be contributing to poorer health outcomes among ACOS patients.

Limitations

Our study has several limitations. First, this is a descriptive, cross sectional. Our results should not be used to infer causality. Second, because we did not adjust for large differences in observed age or other characteristics between asthma and ACOS/COPD cohorts, our comorbidity and SDS findings may be subject to bias, in particular, confounding due to age. Finally, because ACOS does not have its own diagnosis code, patients were identified using both asthma and COPD diagnoses codes. However, the presence of both asthma and COPD is not definitive proof that a patient has ACOS. The patient may have been misdiagnosed with one of the conditions, or the diagnosis code may be incorrectly coded or included as rule-out rather than actual disease. Our identification methods would have grouped such patients into the ACOS cohort. Future studies could improve on our identification methods. We believe the impact is minimal in our study but could have improved in our identification of eligible patients by including a confirmatory prescription fill for an inhaler for asthma or COPD treatment. Future studies could consider adding these options.

Conclusion

When we began this study we expected to see different comorbidity and SDS profiles in patients with COPD, asthma and ACOS. We found that though many SDS overlapped between the three diseases of interest, the relative frequency of the SDS terms did differ between cohorts. When we compared the characteristics of our ACOS cohort to what has been reported in the literature, we found similar results. Our results also showed that comorbid conditions relating to mental health, peptic ulcer/GERD and sleep apnea occurred more often in patients with ACOS, highlighting the need for close management of patients with this condition. Our findings suggest that ACOS is a unique disease, with unique characteristics that require specialized care and attention.

Tables and Figures

Table 1. ICD-10 Codes for Chronic Obstructive Pulmonary Disease

Code Type	Code	Description
ICD-10 Dx	J41	Simple and mucopurulent chronic bronchitis
ICD-10 Dx	J41.0	Simple chronic bronchitis
ICD-10 Dx	J41.1	Mucopurulent chronic bronchitis
ICD-10 Dx	J41.8	Mixed simple and mucopurulent chronic bronchitis
ICD-10 Dx	J42	Unspecified chronic bronchitis
ICD-10 Dx	J43	Emphysema
ICD-10 Dx	J43.0	Unilateral pulmonary emphysema [MacLeod's syndrome]
ICD-10 Dx	J43.1	Panlobular emphysema
ICD-10 Dx	J43.2	Centrilobular emphysema
ICD-10 Dx	J43.8	Other emphysema
ICD-10 Dx	J43.9	Emphysema, unspecified
ICD-10 Dx	J44	Other chronic obstructive pulmonary disease
ICD-10 Dx	J44.0	Chronic obstructive pulmonary disease with acute lower respiratory infection
ICD-10 Dx	J44.1	Chronic obstructive pulmonary disease with (acute) exacerbation
ICD-10 Dx	J44.9	Chronic obstructive pulmonary disease, unspecified

Table 2. ICD-10 Codes for Asthma

Code Type	Code	Description
ICD-10 Dx	J45	Asthma
ICD-10 Dx	J45.2	Mild intermittent asthma
ICD-10 Dx	J45.20	Mild intermittent asthma, uncomplicated
ICD-10 Dx	J45.21	Mild intermittent asthma with (acute) exacerbation
ICD-10 Dx	J45.22	Mild intermittent asthma with status asthmaticus
ICD-10 Dx	J45.3	Mild persistent asthma
ICD-10 Dx	J45.30	Mild persistent asthma, uncomplicated
ICD-10 Dx	J45.31	Mild persistent asthma with (acute) exacerbation
ICD-10 Dx	J45.32	Mild persistent asthma with status asthmaticus
ICD-10 Dx	J45.4	Moderate persistent asthma
ICD-10 Dx	J45.40	Moderate persistent asthma, uncomplicated
ICD-10 Dx	J45.41	Moderate persistent asthma with (acute) exacerbation
ICD-10 Dx	J45.42	Moderate persistent asthma with status asthmaticus
ICD-10 Dx	J45.5	Severe persistent asthma
ICD-10 Dx	J45.50	Severe persistent asthma, uncomplicated
ICD-10 Dx	J45.51	Severe persistent asthma with (acute) exacerbation
ICD-10 Dx	J45.52	Severe persistent asthma with status asthmaticus
ICD-10 Dx	J45.9	Other and unspecified asthma
ICD-10 Dx	J45.90	Unspecified asthma
ICD-10 Dx	J45.901	Unspecified asthma with (acute) exacerbation
ICD-10 Dx	J45.902	Unspecified asthma with status asthmaticus
ICD-10 Dx	J45.909	Unspecified asthma, uncomplicated
ICD-10 Dx	J45.99	Other asthma
ICD-10 Dx	J45.990	Exercise induced bronchospasm
ICD-10 Dx	J45.991	Cough variant asthma
ICD-10 Dx	J45.998	Other asthma

Table 3. Study Attrition

Criteria	Subjects Remaining n	Subjects Remaining %	Subjects Excluded n	Subjects Excluded %
Inclusion criteria				
Commercial health plan members with ≥ 2 medical encounters for COPD or asthma on two separate dates of service between 01/01/2016 and 12/31/2016 (initial sample)	2,386,773	100	0	0
25% Random Sample	474,583	25.0	1,912,190	75.0
≥ 1 EHR record available to accurately assess clinical factors	414,566	87.4	60,017	12.6
Exclusion criteria				
Missing demographic information	350,352	84.5	64,214	15.5
Age < 40 years	252,296	72.0	98,056	28.0
Final study population				
COPD	118,403	46.9	0	0
Asthma	99,718	39.5	0	0
ACOS	34,175	13.5	0	0

Abbreviations: COPD, chronic obstructive pulmonary disease; EHR, electronic health records; ACOS, asthma-COPD overlap syndrome.

Table 5. Demographics, N(%)

Demographics	Asthma N = 99,718	COPD N = 118,403	ACOS N = 34,175	Total N = 252,296
Gender				
Male	29,883 (30.0)	58,098 (49.1)	11,725 (34.3)	99,706 (39.5)
Ethnicity				
Non-Hispanic	96,281 (96.6)	116,836 (98.7)	33,455 (97.9)	246,572 (97.7)
Race				
Caucasian	83,453 (83.7)	107,874 (91.1)	28,834 (84.4)	220,161 (87.3)
African American	14,403 (14.4)	9,701 (8.2)	4,974 (14.6)	29,078 (11.6)
Asian	1,862 (1.9)	828 (0.7)	367 (1.1)	3,057 (1.2)
Region				
Midwest	48,296 (48.4)	57,616 (48.7)	17,617 (51.6)	123,529 (49.0)
Northeast	15,476 (15.5)	12,317 (10.4)	3,928 (11.5)	31,721 (12.6)
South	26,045 (26.1)	37,868 (32.0)	9,722 (28.5)	73,635 (29.1)
West	9,901 (9.9)	10,602 (9.0)	2,908 (8.5)	23,411 (9.3)
Age (years)				
40 – 49	25,478 (25.6)	3,865 (3.3)	2,925 (8.6)	32,268 (12.8)
50 – 59	27,964 (28.0)	17,561(14.8)	7,458 (21.8)	52,983 (21.0)
60 – 69	25,061 (25.1)	32,287 (27.3)	9,463 (27.7)	66,811 (26.5)
70 – 79	14,237 (14.3)	35,504 (30.0)	8,178 (23.9)	57,919 (23.0)
> 80	6,978 (7.0)	29,186 (24.7)	6,151 (18.0)	42,315 (16.8)

Figure 1. Comorbidity by Asthma, COPD and ACOS

Comorbidity	ACOS	Asthma	COPD
Acute sinusitis	8.5	12.2	5.1
Allergic rhinitis	16.4	23.9	7.8
Anxiety	32.7	22.9	23.2
Atrial fibrillation	16.9	5.7	19.4
Cardiac arrythmias	15.8	7.0	14.9
Chronic rhinitis	2.5	2.5	1.3
Chronic sinusitis	6.6	7.1	3.2
Congestive heart failure	23.8	5.2	23.3
Depression	35.6	24.8	25.5
Diabetes	35.0	22.2	29.9
Dyspnea	48.2	22.9	38.5
Hypertension	75.0	56.2	72.8
Ischemic heart disease	31.5	10.7	35.0
Metabolic syndrome	70.3	61.6	65.0
Osteoporosis	9.9	4.9	8.6
Peptic Ulcer/gastroesophageal reflux disease	44.6	33.1	30.6
Peripheral vascular disease	17.7	6.3	22.3
Pneumonia	20.6	5.9	18.1
Pulmonary fibrosis	4.0	1.4	4.0
Renal disease	31.5	15.5	30.9
Sleep apnea	27.4	16.5	17.6
Stroke	5.8	2.3	6.2

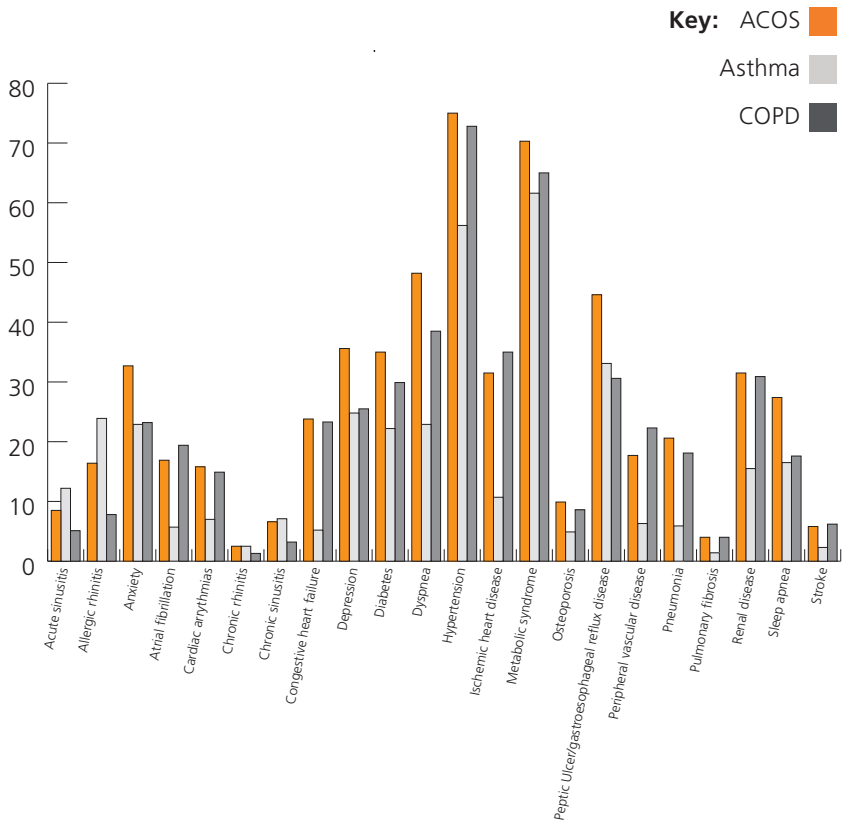

Figure 2. Signs, Disease and Symptoms Word Cloud

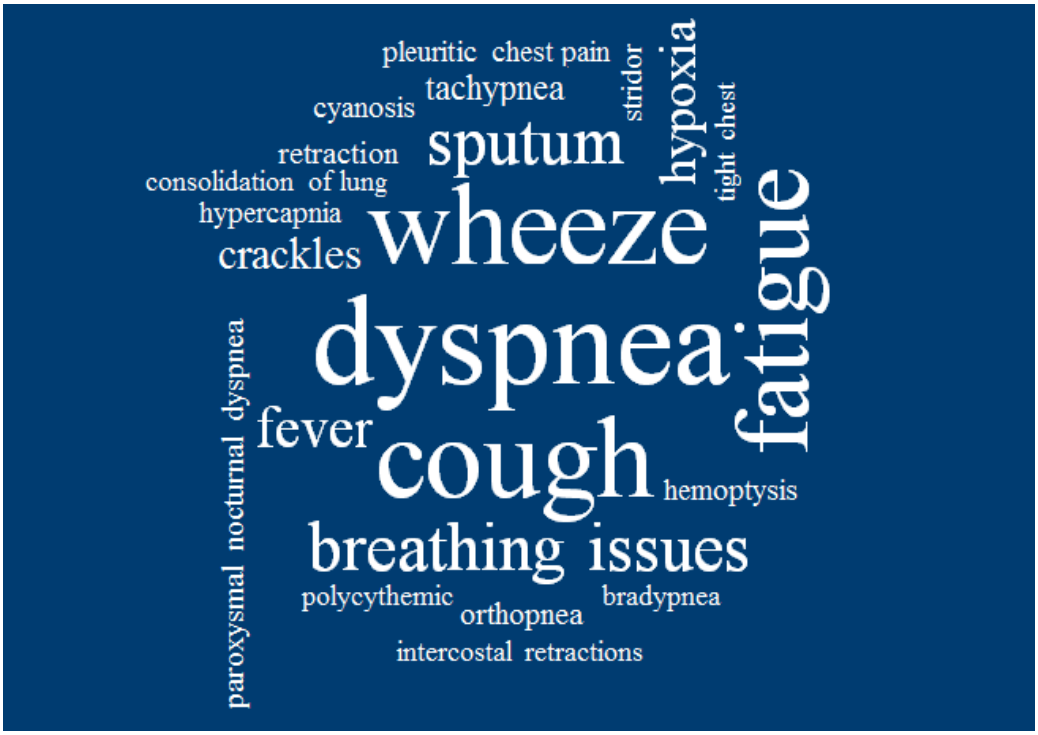

Table 6. Rank Order of Signs, Diseases, and Symptoms by Disease Type

Asthma, COPD, and ACOS	Asthma	COPD	ACOS
dyspnea	cough	dyspnea	dyspnea
cough	dyspnea	cough	wheeze
wheeze	wheeze	wheeze	cough
fatigue	fatigue	fatigue	fatigue
breathing issues	fever	breathing issues	breathing issues
sputum	breathing issues	sputum	sputum
fever	sputum	fever	fever
hypoxia	paroxysmal dyspnea	hypoxia	hypoxia
crackles	crackles	crackles	crackles
tachypnea	retraction	tachypnea	tachypnea
retraction	tachypnea	orthopnea	retraction
paroxysmal nocturnal dyspnea	hypoxia	retraction	orthopnea
orthopnea	orthopnea	hypercapnia	paroxysmal nocturnal dyspnea
hypercapnia	hemoptysis	paroxysmal dyspnea	hypercapnia
hemoptysis	stridor	hemoptysis	stridor
stridor	pleuritic chest pain	stridor	hemoptysis
pleuritic chest pain	cyanosis	pleuritic chest pain	pleuritic chest pain
cyanosis	hypercapnia	cyanosis	cyanosis
intercostal retractions	tight chest	intercostal retractions	intercostal retractions
tight chest	intercostal retractions	tight chest	tight chest
bradypnea	bradypnea	bradypnea	bradypnea
polycythemic	polycythemic	polycythemic	polycythemic
consolidation of lung	consolidation of lung	consolidation of lung	consolidation of lung

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