pii: jc-17-00500 http://dx.doi.org/10.5664/jcsm.7260

JCSM
Journal of Clinical Sleep Medicine

SCIENTIFIC INVESTIGATIONS

Untreated Sleep Apnea: An Analysis of Administrative Data to Identify Risk Factors for Early Nonadherence

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Study Objectives: Discontinuation of positive airway pressure (PAP) treatment for obstructive sleep apnea (OSA) is widely reported, but research has not adequately addressed nonadherence with diagnostic testing for sleep disorders and initiation of PAP. This study sought to identify drivers of nonadherence with diagnostic sleep testing and PAP treatment initiation among patients preauthorized for these services.

Methods: This observational cohort study used preauthorization records from a sleep management program and administrative medical claims from a large commercial health insurer. Participants included adults preauthorized for sleep testing and a subset in whom OSA was diagnosed and who were preauthorized for PAP treatment. Outcome measures were nonadherence with diagnostic sleep testing and PAP treatment initiation, identified as lack of a claim for a preauthorized service within 3 months of preauthorization of that service. Risk factors for nonadherence included patient demographics, prescribing factors, signs and symptoms of OSA, comorbidities, and prior health service utilization.

Results: Of 51,749 patients preauthorized for diagnostic testing, 23.5% did not undergo testing. Among 19,968 patients preauthorized for PAP treatment, 11.1% did not initiate treatment. Testing and treatment ordered by primary care providers, residence outside the Midwest region, and two or fewer office visits within 6 months before preauthorization were strong predictors of nonadherence. Apnea-hypopnea index score < 30 events/h was also a strong predictor of nonadherence with treatment initiation.

Conclusions: This study adds to existing knowledge about risk factors for nonadherence with sleep testing and treatment initiation following preauthorization. Health plans and providers should develop strategies to better engage patients with higher risk of nonadherence.

Keywords: claims analysis, health care utilization, health outcomes, obstructive sleep apnea, PAP

Citation: Gordon A, Wu S, Munns N, DeVries A, Power T. Untreated sleep apnea: an analysis of administrative data to identify risk factors for early nonadherence. *J Clin Sleep Med.* 2018;14(8):1303–1313.

BRIEF SUMMARY

Current Knowledge/Study Rationale: Widespread nonadherence complicates the treatment of obstructive sleep apnea (OSA), resulting in suboptimal outcomes. A sleep management program requiring preauthorization for sleep testing and treatment presented a unique data environment to study patient nonadherence, and this study is original in examining barriers to initiating OSA testing and therapy even after preauthorization.

Study Impact: Prescribing provider specialty, residential region, baseline utilization patterns, and OSA severity were identified as the top risk factors of patient nonadherence. Patient education and support focused on those most at risk and delivered by those most capable will likely result in a reduction in untreated OSA through more confirmed diagnoses of OSA and improved adherence with both treatment initiation and persistence.

INTRODUCTION

Approximately 18 to 22 million adults in the United States have obstructive sleep apnea (OSA),[1,2] and the prevalence is steadily rising as a result of an increasingly obese population.[3,4] OSA is marked by repeated episodes of upper airway obstruction during sleep, resulting in snoring, choking, gasping, or apnea during sleep, leading to daytime sleepiness, morning headaches, decreased libido or concentration, memory loss, fatigue, and insomnia.[1,2,5–7] Direct medical costs exceed $3.4 billion in the United States,[8] and the burden of illness is substantial, considering OSA has been associated with a number of other conditions including cardiovascular disease,[5,9] stroke,[9] hypertension,[4] diabetes and metabolic disorders,[10,11] depression,[12] surgical complications,[13] epilepsy,[14] cognitive disorders,[15] and overall increased mortality.[13]

Risk factors for OSA include body mass index greater than 35 kg/m^2 and increased neck circumference (more than 16 inches for women and more than 17 inches for men).[6,16,17] The condition is most prevalent in men and in the 40- to 60-year age range.[1] Although signs and symptoms may lead to suspicion of OSA, definitive diagnosis requires a sleep test by in-laboratory polysomnography or unsupervised out-of-sleep-center testing.[6] When a diagnosis is confirmed, the primary treatment is positive airway pressure (PAP) therapy, which acts as a pneumatic splint to maintain an open airway,[6] which is effective in modifying or reversing OSA symptoms and improving clinical outcomes.[4,6,18–20]

One of the leading challenges in the treatment of OSA is the widespread nonadherence to PAP treatment. Among those in whom OSA has been diagnosed, 46% to 55% either refuse PAP therapy outright or do not adhere to treatment.[21,22] In late 2013,

an internal report within a large commercial health insurer revealed a substantial gap between the number of preauthorizations for sleep services (sleep apnea testing and PAP treatment initiation) and the actual number of services for which a billing claim was submitted. That is, patients did not undergo diagnostic testing or initiate treatment even though the service had been prescribed by a physician and approved by the insurer as clinically appropriate. There are many reasons why an approved medical service may never be rendered (including, but not limited to, a change in the patient's medical situation, alternative treatments, poor instructions, lack of shared decision making, family/social factors, and unique patient situations). We assume, however, that prior to seeking preauthorization for a service, the ordering provider has evaluated the patient and informed him/her of the intention to prescribe the service. We also assume that the patient has not voiced the opinion that he/she will refuse to undergo the service if authorized.

Prior research exploring reasons for patient nonadherence to PAP therapy has largely focused on barriers to persistence with long-term therapy among patients who initiated treatment but subsequently discontinued. These prior studies assessed patient-equipment interaction barriers, behavior-related issues,[21–24] and many other factors affecting continuation of long-term therapy. However, the mismatch between approved and performed diagnostic testing and the noninitiation of approved PAP therapy have not been addressed in the literature.

The purpose of this study was to explore the factors associated with nonadherence to (ie, lack of pursuing) diagnostic testing and initiation of PAP therapy for OSA. We address the influence of patient demographics, prescribing factors, signs and symptoms of OSA, comorbidities, and prior health care utilization. This real-world observational study analyzed a large, geographically diverse, commercially insured cohort and is, to our knowledge, the first study to evaluate these issues.

METHODS

Design Overview

This study was a retrospective analysis of a large insurer's administrative data from 2012 through 2014, integrated from two data sources: preauthorization records collected from a sleep management program administered by a large specialty benefit management organization; and administrative medical claims and membership data from the national insurer's health plans across the United States. The sleep management program requires providers to submit preauthorization requests containing member clinical data for diagnostic testing (both laboratory-based and out-of-center) and PAP therapy. Medical claims were linked to the preauthorization dataset to capture patient characteristics, type of health plan, preexisting medical conditions, prior health care utilization, and whether or not patients proceeded with diagnostic testing and PAP treatment.

The measurements of nonadherence were (1) the proportion of patients who did not undergo diagnostic testing following the preauthorization of testing, and (2) the proportion of patients who did not initiate PAP treatment following the preauthorization of treatment.

Setting and Participants

The analysis identified a cohort of 51,749 patients aged 18 years or older who had been preauthorized for sleep testing for suspected OSA or unspecified sleep apnea, and a subset cohort of 19,968 patients in whom OSA was diagnosed and who were preauthorized for initial PAP treatment. All patients were identified from preauthorization transactions occurring between January 2013 and September 2014. Medical claims of these patients were extracted from 6 months before preauthorization to capture patient demographics, preexisting medical conditions, and health care utilization history. Patients were excluded if they did not have medical eligibility with the insurer for 6 months before and 3 months after the preauthorization date. For the cohort of patients with preauthorization for initial PAP treatment, patients were also excluded if they had any claims for PAP treatment or supplies prior to the treatment preauthorization to ensure first-time treatment initiation (**Figure 1**). If patients had multiple preauthorizations for the same service during the study period, only the latest preauthorization was considered in the analysis in order not to "double count" instances of preauthorization/claim mismatch or overestimate nonadherence.

Outcome and Risk Factor Measures

Because preauthorizations are valid for 3 months, medical claims were examined for 3 months following preauthorization to determine testing and treatment nonadherence. Patients were considered nonadherent for sleep testing if they did not undergo sleep testing (based on an absence of claims with Current Procedural Terminology [CPT] codes 95782-3, 95800-1, 95805-8, 95810-1, G0398-9, and G0400) within 3 months after preauthorization for testing, and nonadherent for initiating PAP treatment if they did not initiate PAP treatment (based on an absence of claims CPT codes A4604, A7027-39, A7045-6, E0470-1, E0561-2, E0601, and E1399) within 3 months after preauthorization for initial PAP treatment.

Factors associated with OSA testing/treatment nonadherence were evaluated in the areas of (1) patient demographics (from health plan administrative data), such as age, sex, insurance type, region of residence; (2) prescribing factors (from preauthorizations), such as provider specialty, test location, prescribing season; (3) signs and symptoms of OSA (from preauthorizations), including apnea-hypopnea index (AHI)/respiratory disturbance index (RDI) (applied only to treatment initiation), sleepiness, insomnia, and snoring/gasping/choking; (4) comorbidities (from either preauthorizations or claims), such as obesity, cognitive impairment, diabetes, hyperlipidemia, cardiac arrhythmias, Elixhauser comorbidity index[25]; and (5) prior health care utilization (from claims), including inpatient services, doctor's office visits, and emergency department (ED) visits.

While clinical factors extracted from the preauthorization data (including symptoms/severity of OSA and some of the comorbidities) were assessed by the provider who submitted the preauthorization to the sleep program, the claim-derived risk factors (including health care utilization and some comorbidities) were evaluated from claims history within 6 months prior to the preauthorization date. The socioeconomic factors, including rural/urban residence and patients' income and education level, were derived from patients' residential ZIP codes.

The rural/urban residence indicator was determined based on Rural-Urban Commuting Area Codes standards,[26] and income and education levels were assigned at the ZIP code level from the United States Health Resources and Services Administration's area health resources files.[27]

Testing nonadherence and treatment nonadherence were analyzed separately. The initial treatment analysis included more attributes than the diagnostic testing analysis, including AHI/RDI and prescribed PAP modality (continuous/automatic PAP [CPAP/APAP] or bilevel PAP [BPAP]), which were determined after a sleep test. Additionally, insomnia, pulmonary hypertension, and mood disorders were included in the initial treatment analysis but not in the diagnostic testing analysis, as they were required fields in the preauthorization for PAP treatment and were therefore only available for patients who were preauthorized for PAP treatment following testing. A total of 35 distinct variables were evaluated for testing nonadherence, and 5 additional variables were evaluated for treatment nonadherence (refer to **Table 1** and **Table 2** for a full list of risk factors evaluated in study; **Table S1** and **Figure S1** in the supplemental material contain the definitions of the risk factors derived from claims and preauthorizations, respectively).

Statistical Analysis

The analyses comprised multivariate logistic models to identify the leading factors contributing to patients' nonadherence, which adjusted for effects of other contributing covariates. Stepwise selection was used to determine which variables contributed to adherence rate. This approach was used to reduce the number of covariates in the final models, because the original list of potential risk factors was large. The order of appearance in the stepwise model was used to rank the strength of the association between the risk factors and nonadherence.

For ease of interpretability, all risk factors were modeled as categorical variables, which were classified by common standards (such as Northeast, Midwest, South, and West) or classifications that resulted in greater differences in nonadherence (such as "0–2," "3–5," "6+" office visits). Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for each predictor related to a reference category, and represent the odds of nonadherence compared to a reference group. An OR > 1 means higher nonadherence and an OR < 1 means lower nonadherence than the reference group.

A significance of alpha < .05 (2-sided) was considered for all analyses. Analyses were performed using SAS, version 9.4 (SAS Institute, Cary, North Carolina, United States).

RESULTS

Among 51,749 patients preauthorized for diagnostic testing, 12,148 (23.5%) did not undergo testing. Among 19,968 patients in the cohort preauthorized for PAP treatment, 2,219 (11.1%) did not initiate treatment.

Patient Population

More than half of the total study population (ie, the diagnostic testing cohort) was aged 45 to 64 years, and 60% was male (**Table 1**). The patients came from a geographically diverse national sample, with more than one-third coming from the Midwestern region of the United States, and three-fourths of the patients were from urban centers. More than one-third of the preauthorization requests for diagnostic testing were submitted by primary care providers (PCPs), and 45% were for home testing. Most patients (> 80%) had symptoms of sleepiness and snoring, gasping, or choking (**Table 2**). Obesity was the most common comorbidity (more than half of the patients), and approximately three-fourths of the population had an Elixhauser Comorbidity Index score of at least 1.

Characteristics of patients preauthorized for PAP treatment initiation were similar to those who were preauthorized for diagnostic testing (**Table 1** and **Table 2**).

Risk Factors for Testing Nonadherence

Of the 35 variables entered into the multivariate model, 19 were associated with testing nonadherence ($P < .05$) (**Figure 2**).

The multivariate model showed that prescriber specialty had the strongest association with nonadherence (ie, it was the first variable to enter into the stepwise model) (**Figure 2**). Patients whose diagnostic tests were ordered by pulmonologists (OR 0.72; 95% CI 0.68–0.76) or sleep specialists (OR 0.74; 95% CI 0.68–0.81) were less likely to be nonadherent compared to those whose tests were ordered by PCPs.

Region of residence was another strong predictor of nonadherence, entering second into the model. Patients were more likely to be nonadherent with prescribed testing in the Northeast (OR 1.10; 95% CI 1.03–1.18), South (OR 1.14; 95% CI 1.07–1.21), or West (OR 1.28; 95% CI 1.20–1.37) compared with patients living in the Midwest.

Two or fewer office visits during the 6-month baseline period (for any diagnosis) was another important risk factor; patients who had 3 to 5 visits (OR 0.85; 95% CI 0.81–0.89) and 6 or more visits (OR 0.80; 95% CI 0.76–0.85) had better adherence than those with 2 or fewer visits.

Patients with signs and symptoms, including sleepiness (OR 0.86; 95% CI 0.82–0.91) and snoring/gasping/choking (OR 0.87; 95% CI 0.82–0.92) were less likely to be nonadherent with sleep testing than those without the symptoms. Cognitive impairment (OR 0.74; 95% CI 0.67–0.82) and obesity (OR 0.89; 95% CI 0.85–0.93) were also predictive of lower nonadherence. Patients with ED visits during the 6-month baseline period were more likely to be nonadherent with testing than those without ED visits (OR 1.15; 95% CI 1.08–1.22).

Patient demographics were also predictive of nonadherence, albeit less so than the aforementioned factors. Older age (45 to 64 years OR 0.91, 95% CI 0.87–0.96; 65 years and older OR 0.87, 95% CI 0.80–0.94) (compared to 18 to 44 years) and medium-high education level in patients' residential area (medium: OR 0.88, 95% CI 0.83–0.93; high: OR 0.83, 95% CI 0.78–0.89) (compared to low) were associated with lower nonadherence, whereas female sex (OR 1.09; 95% CI 1.04–1.14), and higher income (> $60,000 in patients' residential region: OR 1.14, 95% CI 1.05–1.25) were associated with higher nonadherence.

Table 1—Patient demographic characteristics and prescribing factors.

	Diagnostic Testing			Initial Treatment		
	Tested (n = 39,601)	Not Tested (n = 12,148)	*P* [a,b]	Treated (n = 17,749)	Not Treated (n = 2,219)	*P* [a,b]
Patient Demographics						
Age (A)			< .001			< .001
18–44 years	12,300 (31.1)	4,121 (33.9)		4,862 (27.4)	741 (33.4)	
45–64 years	23,222 (58.6)	6,930 (57.0)		11,008 (62.0)	1,304 (58.8)	
≥ 65 years	4,079 (10.3)	1,097 (9.0)		1,879 (10.6)	174 (7.8)	
Female (A)	15,676 (39.6)	4,901 (40.3)	.135	6,277 (35.4)	796 (35.9)	.638
Region[c] (A)			< .001			< .001
Midwest	15,230 (38.5)	4,061 (33.4)		7,557 (42.6)	677 (30.5)	
Northeast	7,675 (19.4)	2,242 (18.5)		3,302 (18.6)	485 (21.9)	
South	10,040 (25.4)	3,168 (26.1)		4,835 (27.2)	705 (31.8)	
West	6,365 (16.1)	2,549 (21.0)		1,937 (10.9)	327 (14.7)	
Urban-Rural[c] (A)			.004			.040
Urban center	30,002 (76.5)	9,371 (77.9)		13,181 (75.0)	1,716 (78.0)	
Large town	4,828 (12.3)	1,327 (11.0)		2,263 (12.9)	251 (11.4)	
Small town	2,598 (6.6)	777 (6.5)		1,230 (7.0)	133 (6.0)	
Isolated rural area	1,799 (4.6)	534 (4.6)		911 (5.2)	99 (45)	
Income[c] (A)			< .001			< .001
Low (< $40,000)	7,230 (18.5)	2,209 (18.5)		3,422 (19.5)	386 (17.6)	
Medium ($40,000–60,000)	24,318 (62.3)	7,193 (60.1)		11,014 (62.9)	1,337 (61.0)	
High (> $60,000)	7,497 (19.2)	2,564 (21.4)		3,077 (17.6)	468 (21.4)	
Education (% w/o HS degree)[c] (A)			< .001			< .001
Low (> 16%)	11,184 (28.6)	3,979 (33.3)		4,602 (26.3)	691 (31.5)	
Medium (12–16%)	14,297 (36.6)	4,071 (34.0)		6,640 (37.9)	724 (33.0)	
High (< 12%)	13,565 (34.7)	3,916 (32.7)		6,271 (35.8)	776 (35.4)	
Insurance type (A)			.105			< .001
HMO	9,488 (24.0)	2,992 (24.6)		4,513 (25.4)	647 (29.2)	
PPO	25,199 (63.6)	7,722 (63.6)		10,913 (61.5)	1,274 (57.4)	
CDHP	4,914 (12.4)	1,434 (11.8)		2,323 (13.1)	298 (13.4)	
Prescribing Factors						
Season (P)			.001			.004
Jan-Mar	9,522 (24.0)	2,887 (23.8)		3,410 (19.2)	400 (18.0)	
Apr-Jun	10,706 (27.0)	3,368 (27.7)		4,937 (27.8)	605 (27.3)	
Jul-Sep	13,770 (34.8)	4,336 (35.7)		6,617 (37.3)	908 (40.9)	
Oct-Dec	5,603 (14.1)	1,557 (12.8)		2,785 (15.7)	306 (13.8)	
Specialty (P)			< .001			< .001
PCP	14,321 (36.2)	5,076 (41.8)		4,919 (27.7)	790 (35.6)	
Pulmonologist	10,587 (26.7)	2,476 (20.4)		6,336 (35.7)	577 (26.0)	
Neurologist	3,070 (7.8)	975 (8.0)		1,745 (9.8)	213 (9.6)	
Sleep specialist	3,477 (8.8)	835 (6.9)		2,020 (11.4)	218 (9.8)	
Other	8,146 (20.6)	2,786 (22.9)		2,729 (15.4)	421 (19.0)	
Test location (P): Home	17,722 (44.8)	5,533 (45.5)	.123	7,925 (44.7)	1,115 (50.2)	< .001
Machine type[d] (P)						.006
CPAP/APAP				17,094 (96.3)	2,159 (97.3)	
BPAP with backup				113 (0.6)	18 (0.8)	
BPAP without backup				542 (3.1)	42 (1.9)	

Values are presented as n (%). Letters in parenthesis indicate: (A) = administrative data from health plan, (P) = preauthorization data. Superscript letters indicate: a = *P* values based on χ^2 test, b = *P* values of categorical variables represent the whole category, c = numbers do not add to total population due to missing data, d = only measured for initial treatment. APAP = automatic positive airway pressure, BPAP = bilevel positive airway pressure, CDHP = consumer-driven health plan, CPAP = continuous positive airway pressure, HMO = health maintenance organization, HS = high school, PCP = primary care provider, PPO = preferred provider organization.

Risk Factors for Treatment Nonadherence

Nineteen of 40 risk factors entered the multivariate model and were associated with treatment nonadherence ($P < .05$) (**Figure 3**).

Having fewer office visits within 6 months prior to the preauthorization was the strongest predictor of treatment nonadherence (it entered first into the stepwise model). Patients who had 6 or more visits (OR 0.51, 95% CI 0.45–0.58) or 3 to 5 visits

Table 2—OSA signs and symptoms, comorbidities, and utilization history.

	Diagnostic Testing			Initial Treatment		
	Tested (n = 39,601)	Not Tested (n = 12,148)	*P* [a,b]	Treated (n = 17,749)	Not Treated (n = 2,219)	*P* [a,b]
OSA Signs and Symptoms						
AHI/RDI[c] (P)						< .001
Low severity (5–14 events/h)				4,657 (26.2)	701 (31.6)	
Medium severity (15–30 events/h)				5,751 (32.4)	813 (36.6)	
High severity (≥ 31 events/h)				7,341 (41.4)	705 (31.8)	
Insomnia[c] (P)				2,195 (12.4)	312 (14.1)	.023
Sleepiness (P)	32,725 (82.6)	9,757 (80.3)	< .001	13,307 (75.0)	1,674 (75.4)	.632
Snoring/gasping/choking (P)	34,049 (86.0)	10,191 (83.9)	< .001	15,419 (86.9)	1,891 (85.2)	.031
Comorbidities						
Arthritis (C)	6,285 (15.9)	1,861 (15.3)	.144	3,038 (17.1)	331 (14.9)	.009
Cardiac arrhythmias (P)	339 (0.9)	84 (0.7)	.078	144 (0.8)	22 (1.0)	.393
Cognitive impairment (P)	2,250 (5.7)	498 (4.1)	< .001	798 (4.5)	126 (5.7)	.012
Congestive heart failure (P)	871 (2.2)	218 (1.8)	.007	383 (2.2)	43 (1.9)	.499
COPD (P)	2,996 (7.6)	819 (6.7)	.002	1,335 (7.5)	146 (6.6)	.110
Coronary artery disease (P)	2,727 (6.9)	840 (6.9)	.914	1,310 (7.5)	136 (6.2)	.027
Craniofacial/upper airway disease (P)	2,187 (5.5)	666 (5.5)	.865	1,037 (5.8)	134 (6.0)	.711
Dementia (C)	171 (0.4)	43 (0.4)	.242	73 (0.4)	10 (0.5)	.786
Depression (C)	5,768 (14.6)	1,677 (13.8)	.037	2,654 (15.0)	311 (14.0)	.242
Diabetes (C)	5,398 (13.6)	1,571 (12.9)	.048	2,781 (15.7)	310 (14.0)	.037
Elixhauser Comorbidity Index (C)			< .001			< .001
0	9,545 (24.1)	3,261 (26.8)		3,403 (19.2)	581 (26.2)	
1–4	27,632 (69.8)	8,213 (67.6)		13,128 (74.0)	1,529 (68.9)	
≥ 5	2,424 (6.1)	674 (5.5)		1,218 (6.9)	109 (4.9)	
Gastroesophageal reflux disease (C)	6,053 (15.3)	1,682 (13.8)	< .001	2,975 (16.8)	327 (14.7)	.015
Hyperlipidemia (C)	9,736 (24.6)	2,709 (22.3)	< .001	4,886 (27.5)	523 (23.6)	< .001
Hypertension (P)	9,774 (24.7)	2,768 (22.8)	< .001	4,518 (25.5)	584 (26.3)	.379
Malignancy (C)	3,634 (9.2)	1,000 (8.2)	.001	1,632 (9.2)	165 (7.4)	.006
Mood disorder[c] (P)				1,712 (9.6)	252 (11.4)	.011
Obesity (P)	21,895 (55.3)	6,309 (51.9)	< .001	10,652 (60.0)	1,343 (60.5)	.645
Oxygen dependent (P)	1,074 (2.7)	273 (2.2)	.005	458 (2.6)	33 (1.5)	.002
Pulmonary hypertension[c] (P)				369 (2.1)	40 (1.8)	.386
Renal disease (C)	2,005 (5.1)	592 (4.9)	.402	932 (5.3)	91 (4.1)	.021
Stroke (P)	255 (0.6)	66 (0.5)	.217	152 (0.9)	18 (0.8)	.827
Transient ischemic attack (P)	441 (1.1)	132 (1.1)	.803	197 (1.1)	15 (0.7)	.060
Utilization History						
Inpatient stay, 6 months (≥ 1) (C)	3,846 (9.7)	1,140 (9.4)	.284	1,802 (10.2)	146 (6.6)	< .001
ED visit, 6 months (≥ 1) (C)	5,617 (14.2)	1,822 (15.0)	.025	2,394 (13.5)	318 (14.3)	.275
Office visits, 6 months (C)			< .001			< .001
0–2	11,598 (29.3)	4,130 (34.0)		3,529 (19.9)	683 (30.8)	
3–5	15,039 (38.0)	4,397 (36.2)		7,124 (40.1)	851 (38.4)	
≥ 6	12,964 (32.7)	3,621 (29.8)		7,096 (40.0)	685 (30.9)	

Values are presented as n (%). Letters in parenthesis indicate: (C) = claims data, (P) = preauthorization data. Superscript letters indicate: a = *P* values based on χ^2 test, b = *P* values of categorical variables represent the whole category, c = only measured for initial treatment. AHI = apnea-hypopnea index, COPD = chronic obstructive pulmonary disease, ED = emergency department, RDI = respiratory disturbance index.

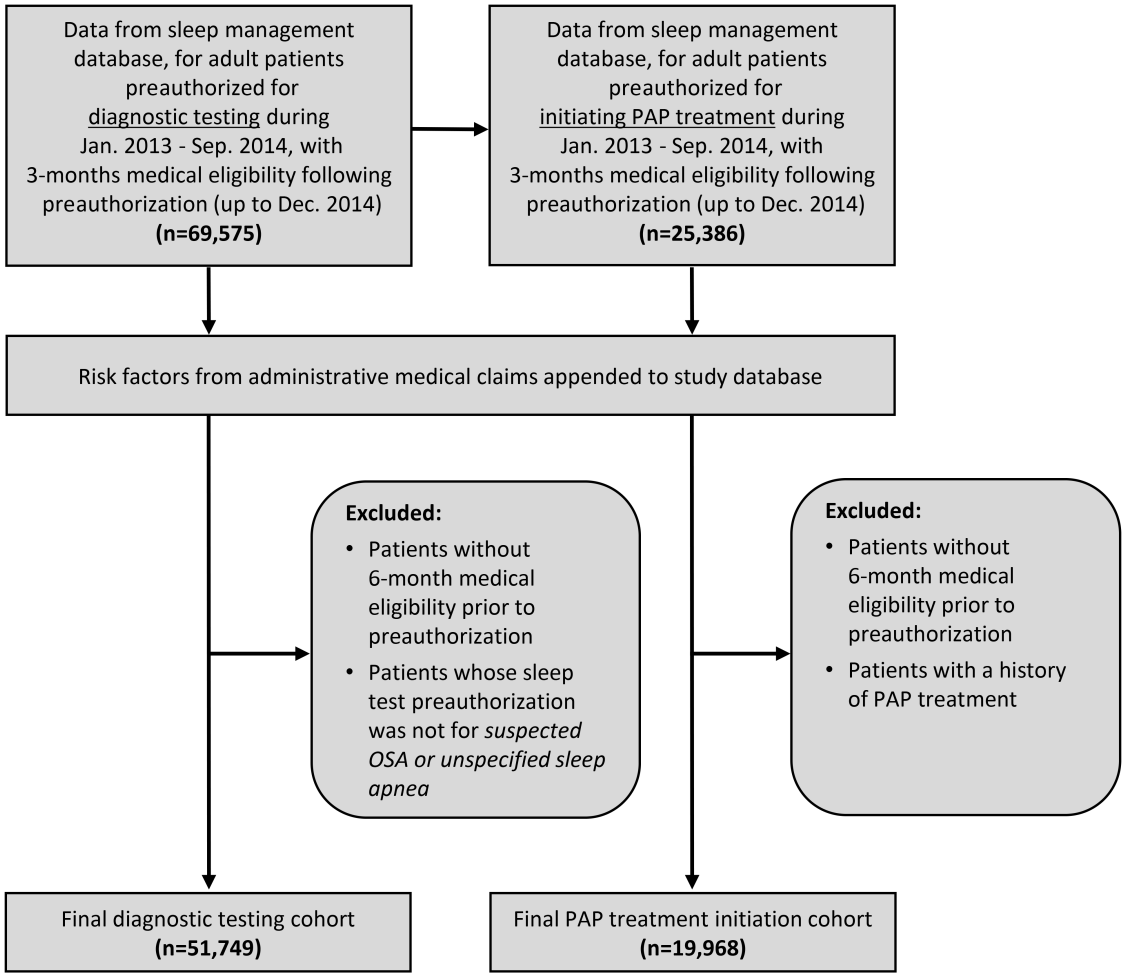
(OR 0.64; 95% CI 0.57–0.72) were less likely to be nonadherent than patients with 2 or fewer visits.

As with diagnostic testing, region of residence was another important predictor (second to enter the model): patients living in the Northeast (OR 1.66; 95% CI 1.45–1.89), South (OR 1.60; 95% CI 1.42–1.82), or West (OR 1.50; 95% CI 1.27–1.76) were more likely to be nonadherent than those living in the Midwest.

Low or medium OSA severity, measured as AHI/RDI 5 to 14 or 15 to 30 events/h, respectively, was an important risk factor of treatment nonadherence. Nonadherence was lower for patients with high OSA severity (AHI/RDI greater than 30 events/h) (OR 0.62; 95% CI 0.55–0.69) compared to low OSA severity.

Having a PCP prescriber was also among the leading determinants of nonadherence; patients seen by a pulmonologist

Figure 1—Data sources and patient inclusion criteria.



(OR 0.64; 95% CI 0.57–0.72), neurologist (OR 0.83; 95% CI 0.70–0.98), or sleep specialist (OR 0.75; 95% CI 0.63–0.88) were more likely to initiate OSA treatment than those seen by PCPs.

Patients with ED visits (OR 1.30; 95% CI 1.14–1.49) and comorbidities including cardiac arrhythmias (OR 1.58; 95% CI 1.17–2.14) and cognitive impairment (OR 1.31; 95% CI 1.07–1.59) were more likely to be nonadherent with initial treatment.

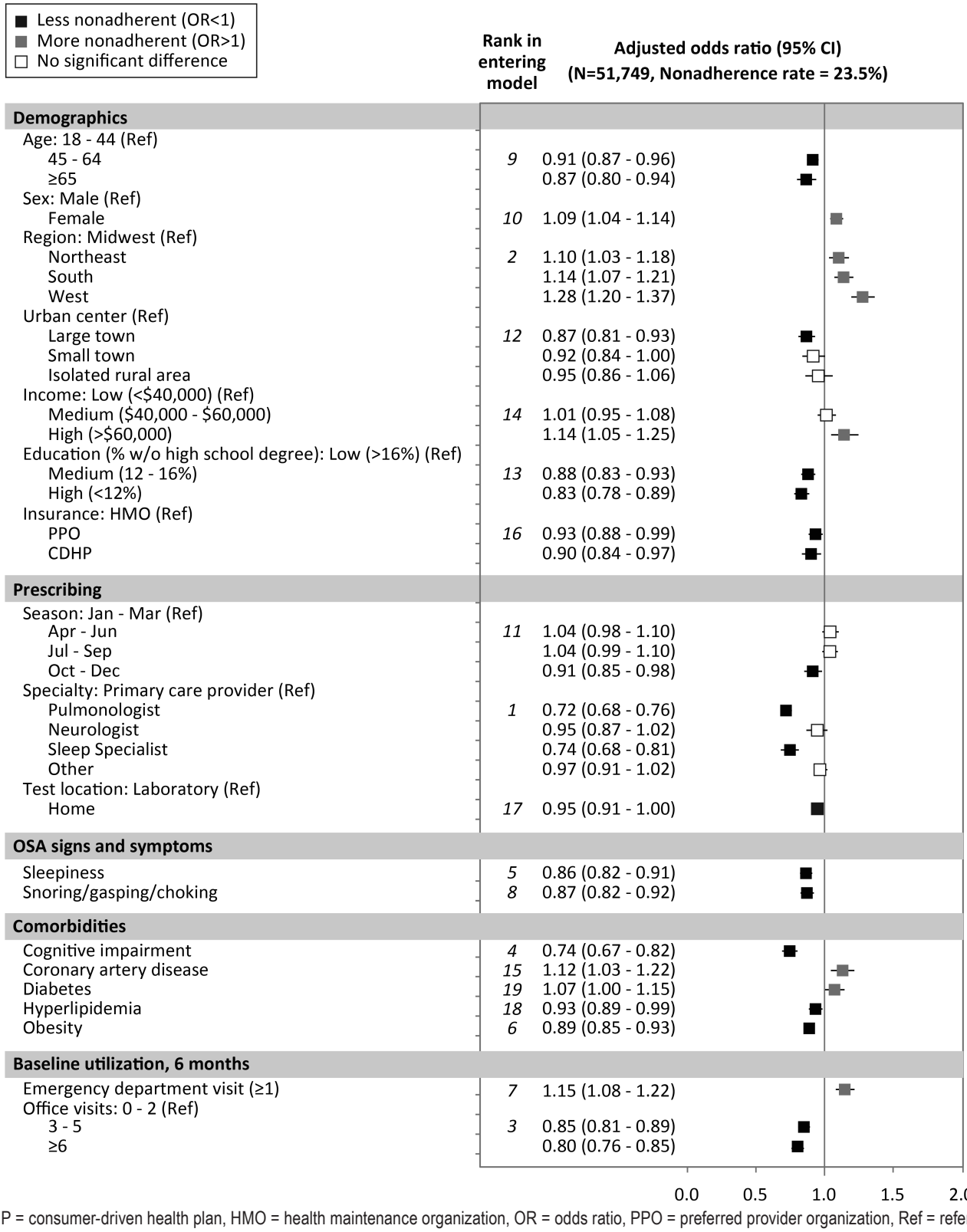
Similar to diagnostic testing, patient demographics were significantly predictive of treatment initiation, although less important than other risk factors. Younger patients (age 45 years or younger) were more nonadherent (45 to 64 years: OR 0.85, 95% CI 0.77–0.94, 65 years or older: OR 0.81, 95% CI 0.67–0.98 compared with 18–44). Patients residing in medium education level (OR 0.77, 95% CI 0.68–0.88) or high education level (OR 0.77, 95% CI 0.66–0.89) areas were more likely to initiate PAP treatment than patients residing in low education level areas. Residing in medium income ($40,000 to $60,000, OR 1.28, 95% CI 1.10–1.48) or high income (above $60,000, OR 1.49, 95% CI 1.22–1.80) areas was associated with higher treatment nonadherence compared to low income areas after adjusting for other factors.

DISCUSSION

The administrative data from the sleep management program contained information about preauthorization for testing and treatment, presenting a unique data environment to study patient adherence that is not often available for other patient care scenarios. In this real-world analysis of patients with suspected OSA, one in every four patients preauthorized for diagnostic testing did not undergo the test. One in every nine patients with established OSA and preauthorized for PAP treatment did not initiate treatment. Several factors—having a lower frequency of office visits, residence outside of Midwest region, and PCP as prescribing provider—were identified as the leading determinants of nonadherence with both diagnostic testing and treatment initiation recommendations.

Geographical differences emerged as a strong predictor of nonadherence with preauthorized sleep services. Similar geographic variability in adherence with care has been reported for a variety of conditions and treatments. For example, a study of adherence to antidiabetic, antihypertensive, and antilipidemic medications showed that patients in the Northeastern and Midwestern regions—and New England in particular—were more adherent than

Figure 2—Factors associated with noncompliance with diagnostic testing.

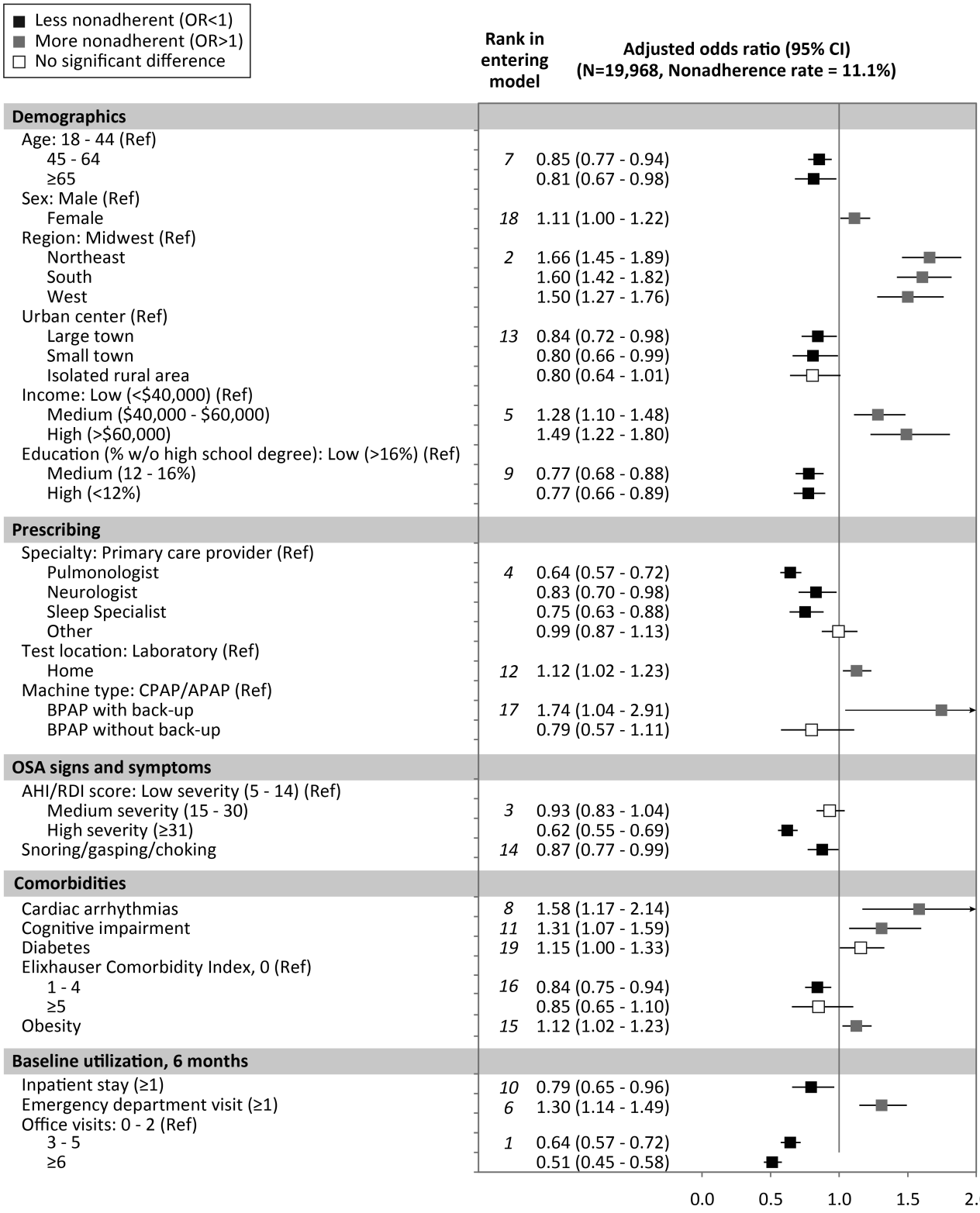


CDHP = consumer-driven health plan, HMO = health maintenance organization, OR = odds ratio, PPO = preferred provider organization, Ref = reference group.

patients living in the Western and Southern regions, with the South having the lowest adherence in both commercial and Medicare populations.[28]

OSA symptoms of snoring, gasping, choking, and sleepiness and higher AHI/RDI score were highly predictive of adherence with PAP treatment initiation. These findings are

Figure 3—Factors associated with noncompliance with treatment initiation.



APAP = automatic positive airway pressure, BPAP = bilevel positive airway pressure, CPAP = continuous positive airway pressure, OR = odds ratio, Ref = reference group.\

consistent with previous studies that described the association between symptoms and severity of OSA and hours of PAP use per night.[1,2,24,29]

Intriguingly, this study found that although patients with poor cognitive function were more likely to proceed with diagnostic testing, they were less likely to start treatment. Prior

studies have also found an association between cognitive impairment and nonadherence with medications for other chronic conditions.[30,31]

Having more office visits prior to preauthorization emerged as top predictor of patient adherence, suggesting better adherence among patients who actively sought care or established care relationships with providers prior to seeking sleep treatment. An interesting finding was the opposing influences of office and ED visits, with ED visits acting as a predictor of nonadherence. Patients who maintain regular office visits may tend to be more adherent with medical care in general, in contrast to patients who do not have a regular health care provider and seek care based on urgency.[32,33]

It is unclear why prescribing provider specialty caused a disparity in adherence after adjusting for other factors. Although patients who seek care from sleep specialists may have more severe symptoms and therefore may be more motivated to pursue testing or treatment, the multivariate model controlled for AHI/RDI score (in the treatment model), as well as signs and symptoms of sleep apnea.

One factor not accounted for in the multivariate analysis was self-referral. Our data show that 23% to 34% (varying by specialty) of patients undergoing specialist-referred diagnostic testing were tested in sleep laboratories located in the same facilities as the referring specialists, whereas this was true of only 8% of patients undergoing diagnostic testing referred by PCPs. It is common for sleep specialists, pulmonologists, and neurologists to have ties to the sleep laboratories to which they refer. These laboratories, which are often adjacent to the physician's office, offer services to patients at a convenient and familiar location and are associated with a high degree of coordination of care. Whether improved adherence related to specialist (rather than generalist) referral is a function of provider expertise, patient convenience/comfort, coherent workflow, or the financial effect of self-referral is uncertain and is most likely multifactorial.

Home sleep apnea tests (testing kits delivered to patients) have recently gained popularity in place of testing in the laboratory due to its convenience and cost-efficiency. Our data showed patients preauthorized for home testing were slightly more likely to proceed with testing than patients preauthorized for laboratory testing. Because home testing is more convenient and more comfortable than laboratory testing, a higher adherence with that arrangement is not surprising. However, patients were slightly less likely to initiate treatment if they were tested at home. Patients who undergo home testing are often approved for initiation of PAP therapy at home using APAP. One potential reason for the lower rates of treatment initiation for home-tested patients is that these patients do not have the opportunity to talk with health care professionals about the importance of PAP treatment and to address their concerns regarding treatment initiation. On the contrary, split-night diagnosis-titration, where OSA is diagnosed and PAP treatment initiated in the same laboratory session, provides a level of support for the patient that cannot be achieved with home testing.[34] This finding illuminates not only the importance of appropriate PAP instruction, but also an opportunity for durable medical equipment suppliers to provide adequate instruction and information regarding the implications of untreated OSA in the shipment of testing kits to patients, to improve patient awareness and treatment adherence.

The improved adherence among patients who had more baseline office visits, who saw pulmonologists or sleep specialists, and who were tested in the laboratory (for treatment adherence) indicate that increased patient education and support—during several steps prior to the initiation of treatment—improves adherence. Patients who had more opportunities to discuss their condition and the importance of treatment (more office visits), had discussions with physicians specifically trained in managing OSA (sleep specialists), and could learn from professionals during the process of first trying a PAP machine (laboratory test) had more exposure, and likely more education, about OSA, which could improve their acceptance of testing and therapy initiation. This is consistent with prior studies that have shown that pretreatment education[35] and education during the early treatment period improve long-term adherence with PAP.[36–38]

Several of the predictors of nonadherence with testing and treatment initiation have also been shown to be predictors of nonadherence with long-term PAP treatment. For example, several studies have shown that patients with less severe OSA (lower AHI/RDI score) use their PAP machines less over time than patients who have more severe OSA or more symptoms.[39–41] Additionally, prior studies suggest that care with sleep specialists or at sleep centers improves long-term adherence with PAP treatment.[42,43] Other factors that we found to be strong predictors of nonadherence with testing and treatment initiation, including geographic region of residence and prior utilization patterns (hospitalization, ED, and office visit history), have not been well studied with respect to their association with long-term adherence. Although we found that younger adults and females were less adherent with testing and treatment initiation, the literature is mixed regarding association between sex and adherence to long-term treatment,[23] and studies have not shown age to be an important factor in predicting long-term adherence.[23,39,44] Most prior studies did not find a difference in long-term adherence between patients who had their test in a laboratory and patients who had their test at home.[23]

This study benefited from a large commercial dataset, but several limitations should be considered when interpreting these results. First, this study is limited by the use of administrative data (ie, claims and preauthorizations); therefore, patient perceptions and preferences, provider-patient communication, unique patient situations, and other potentially relevant factors were not evaluated. For example, some patients may be apprehensive about starting PAP therapy if they believe that using the equipment will be difficult or uncomfortable. Prior studies have shown that perceived benefit of therapy,[20,45,46] perceived self-efficacy,[20,47] patient education,[48] and structure in the home[46] are important predictors of discontinuation of PAP therapy. Another limitation is that the nonadherence rate measured in this study is limited to patients whose provider prescribed and submitted sleep preauthorization; the patients whose providers did not order a test or therapy knowing that the patient would not use PAP[20,22] were not included, so missed

opportunities for OSA treatment benefit may have been underestimated. An additional limitation is that the study assumes that testing and treatment are appropriate after it is prescribed by the practitioner and preauthorized by the sleep management program; it does not take into account shared decision-making processes (or lack thereof) with the patient, particularly in more mild cases of OSA, or other valid reasons for patients not to proceed with testing and treatment. Last, this study analyzed members of commercial health plans, and therefore, the results may not be generalizable to other types of health insurance such as Medicare or Medicaid.

CONCLUSIONS

Our results demonstrated that one in four patients preauthorized for diagnostic testing did not undergo testing, and one in nine patients preauthorized for PAP treatment never initiated the treatment. Although prior research has explored barriers to long-term persistence, information is notably lacking for barriers to initiating patient care even after approvals from preauthorization. This real-world observational analysis of a large commercially insured cohort is among the first to explore this gap in knowledge using administrative data. This study identified testing and treatment ordered by PCPs, residence outside the Midwest region, and having fewer baseline office visits as the strongest predictors of early nonadherence, among all factors evaluated in the categories of patient demographics, prescribing factors, signs and symptoms of OSA, comorbidities, and prior health care utilization. Presence of lower OSA severity score (AHI/RDI) was also among the strongest predictors of nonadherence with PAP treatment initiation. Further research is warranted to better understand the one in four patients who do not proceed with testing and therefore do not obtain test results that would not only help to make a decision regarding pursuit of therapy at that time, but also to establish a baseline measure of AHI/RDI that could inform future diagnostic testing and treatment planning. Given the negative effect of untreated OSA on both clinical outcomes and cost of care, it behooves all stakeholders (patients, providers, and payers) to work collaboratively toward improving adherence with diagnostic testing, PAP initiation, and PAP persistence. Patient education and support focused on those most at risk and delivered by those with most expertise will likely result in more diagnoses of OSA and improved adherence with both treatment initiation and persistence.

ABBREVIATIONS

AHI, apnea-hypopnea index
APAP, automatic positive airway pressure
BPAP, bilevel positive airway pressure
CI, confidence interval
CPAP, continuous positive airway pressure
CPT, Current Procedural Terminology
ED, emergency department
OR, odds ratio
OSA, obstructive sleep apnea
PAP, positive airway pressure
PCP, primary care provider
RDI, respiratory disturbance index
SAS, Statistical Analysis System

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ACKNOWLEDGMENTS

The authors gratefully acknowledge the contributions of Larry Epstein for feedback on the Discussion, Ayushi Kawatra and Diana Rodenberger for data support, Dianna Hayden for programming support, and Cheryl Jones for editorial support.

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication September 25, 2017
Submitted in final revised form March 2, 2018
Accepted for publication March 29, 2018
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DISCLOSURE STATEMENT

Work for this study was performed at HealthCore, Inc., Wilmington, DE. Funding for this study was provided by Anthem, Inc. A Gordon, S Wu, and A DeVries are employees of HealthCore, Inc., a wholly owned subsidiary of Anthem, Inc. T. Power is an employee of AIM Specialty Health, a wholly owned subsidiary of Anthem, Inc. N Munns was an employee of AIM Specialty Health at the time the study was conducted. All authors have seen and approved this manuscript for submission.