Utilization of Healthcare Resources in Obstructive Sleep Apnea Syndrome: a 5-Year Follow-Up Study in Men Using CPAP

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Study Objectives: Patients with untreated obstructive sleep apnea syndrome (OSAS) have higher healthcare utilization than matched controls. However, the long-term impact of continuous positive airway pressure (CPAP) use on healthcare utilization is unknown.

Design: Retrospective observational cohort study.

Subjects: There were 342 eligible men with OSAS and matched controls on whom there were utilization data for 5 years prior to initial OSAS diagnosis and for the 5 years on CPAP treatment of the cases.

Interventions: Patients were treated with CPAP.

Results: Patients with OSAS were typical cases (mean±SD): age, 48.2±0.6 years; body mass index, 35.6±0.4 kg/m2; Epworth Sleepiness Scale score, 14±0.3; apnea-hypopnea index, 47.1±1.8 events per hour. The number of physician visits were higher by 3.46±0.2 (95% confidence interval [CI]:2.57 to 4.36) in cases in the year before diagnosis, compared with the fifth year before diagnosis, then decreased over the next 5 years by 1.03±0.49 (95% CI: -1.99 to -0.07)(P<.0001). Physician fees, in Canadian dollars, were higher by $148.65±$27.27(95% CI: 95.12 to 202.10) in cases in the year before diagnosis, compared with the fifth year before diagnosis, and then decreased over the next 5 years by $13.92±$27.94(95%CI: -68.68 to 40.83)(P=.0009). Preexisting ischemic heart disease at the time of OSAS diagnosis predicted about a 5-fold increase in healthcare utilization between the second and fifth year of treatment.

Conclusions: Treatment of OSAS reversed the trend of increasing healthcare utilization seen prior to diagnosis. Preexisting ischemic heart disease results in a negative impact on healthcare utilization. CPAP results in a long-term health benefit, as measured by the use of healthcare services.

Keywords: Sleep, apnea, medical economics, epidemiology, healthcare utilization, CPAP compliance

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INTRODUCTION

OBSURCTIVE SLEEP APNEA SYNDROME (OSAS) IS CHARACTERIZED BY PERIODIC COMPLETE OR PARTIAL UPPER AIRWAY OBSTRUCTION DURING SLEEP, causing intermittent cessation of breathing (apneas) or reductions in airflow (hypopneas). These episodes of apnea and hypopnea cause sleep fragmentation and repetitive hypoxemia, which leads to excessive daytime sleepiness, neurocognitive impairment, increased risk for motor vehicle and occupational accidents.1-3 OSAS has also been associated with adverse cardiovascular consequences such as hypertension and congestive heart failure.4,5 Although OSAS is a common disorder with a 2% to 4% prevalence in the middle-aged adult population, most cases (75%–80%) remain undiagnosed and untreated, which makes this disorder a burden on the healthcare system and on society.10,12

Patients with OSAS and obesity hypoventilation syndrome have higher healthcare utilization (HCU) (physician visits, hospitalization, and medical investigations) than matched controls during the 5 to 10 years prior to OSAS diagnosis.15-16 We previously reported a decrease in HCU for patients who are compliant with continuous positive airway pressure (CPAP) over the following 2 years.17 However, HCU 5 years following diagnosis and treatment has not been documented. We hypothesized that OSAS patients using CPAP will have a decrease in HCU over 5 years of treatment.

METHODS

This study was done in the Canadian province of Manitoba with a population of 1,100,000 people, where all residents have equal and free access to government-funded healthcare, including physician visits, medical tests, and hospitalization. Standardized data for all residents, based on every physician and hospital contact, are submitted to Manitoba Health, the provincial agency responsible for funding. The submitted data include patient identification, physician’s claims, diagnoses and their respective International Classification of Disease (ICD-9) code, cost (in Canadian dollars), hospitalization, and institutionalization data. The data are maintained and controlled in the Manitoba Health database that has been described elsewhere.18

With these data, we compared the HCU of patients before and after the diagnosis and treatment of OSAS. We also compared each patient with OSAS to 4 matched controls from general population based on age (± years), sex, family physician, and postal code (for the socioeconomic status and access to physicians and hospitals). Patients obtaining services outside the province, some physician’s salaries (ie, those paid to provide specific services, such as intensive care unit coverage, or trainees), medications, or home-care cost were not included.

The human ethics committee of the University of Manitoba and the Access and Confidentiality Committee of Manitoba Health approved the study.

Disclosure Statement
This was not an industry supported study. Drs. Banno, Albarrak, Sabbagh, Delaive, Walid, Manfreda, and Kryger have indicated no financial conflicts of interest.

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Patients

First we selected all male patients who were diagnosed with OSAS at the St. Boniface General Hospital, Sleep Disorders Centre, from 1990 to 1998. The diagnosis of OSAS required a visit to the Sleep Disorders Centre and evaluation by a sleep specialist, with diagnosis confirmed by an overnight sleep study (see below). Patients who were included in the study were residents of Manitoba on whom 10 years of consecutive data were available—5 years before diagnosis and 5 years after. Second, 117 patients who refused to use CPAP or returned CPAP (see below) were excluded. Then, only patients who were prescribed CPAP and had been continuing to use CPAP for 5 years after a definitive OSAS diagnosis were selected. There remained 342 eligible male cases for the analysis. The percentage of cases using CPAP out of the total 459 cases was 74.5%

Polysomnography

All patients with OSAS had comprehensive overnight polysomnography, a multichannel monitoring of electroencephalogram, chin electromyogram, electrooculogram, anterior tibialis electromyogram, and Spo₂ (by ear oximeter). The airflow was monitored by nasal pressure and oronasal co₂. Two plethysmograph belts were used to assess thoracic and abdominal movements. Apnea was defined as a complete cessation of airflow, and hypopnea as a visual reduction by 50% in airflow and associated with a decrease of 3% or more in the arterial oxygen saturation of hemoglobin or with arousal. The apnea-hypopnea index (AHI), the number of episodes of apnea and hypopnea per hour, was used as an indicator of sleep apnea severity. The time of Spo₂ below 90% was measured as indicator of severity of oxygen desaturation. Patients were started on continuous positive airway pressure (CPAP) or bilevel positive airway pressure based on the severity of their symptoms and the result of the sleep study. The criteria for use of CPAP were as follows: the AHI was greater than or equal to 15 events per hour or the AHI was greater than 5 with documented symptoms of excessive daytime sleepiness, impaired cognition, mood disorders, or insomnia or a history of hypertension, ischemic heart disease, or stroke.

Postevaluation and Follow-Up

Patients with OSAS confirmed by polysomnography and prescribed CPAP were referred to the government program that provides ventilatory assistance devices for all Manitoba residents. All patients had free access to CPAP machines and disposables. Once patients received the CPAP machine, they were contacted by telephone after 1 and 3 months and then every 6 months to assess patients’ symptoms, weight changes, and use of CPAP. Patients who refused to use CPAP or used it fewer than 5 nights per week were required to return the equipment. Thus, the OSAS group we are reporting was made up of patients who used CPAP or bilevel positive airway pressure for 5 nights or more per week in the 5 years following diagnosis.

Control Subjects

For each patient, a computer program randomly chose 4 control subjects from the general population pool selected from the Manitoba health database. They were matched to their controls based on age, sex, family physician, and postal code to correct for socioeconomic variables and geographic proximity to healthcare services, including the treating physician and hospitals. Thus, we had 10 years of data for all the patients and controls. The average of the 4 control subjects was used to generate each patient’s control. The average of the controls for each patient was used in the final analysis as a single virtual control.

Exclusion Criteria

Patients and controls were excluded from analysis if they were not a resident of the Province of Manitoba for 10 consecutive years and if their healthcare was covered by other sources. Patients in the latter category would include military personnel and aboriginal people whose healthcare was covered by the Canadian federal government. We also excluded patients who averaged more than seven days in hospital per year over a 10-year period (70 days over 10 years), patients on hemodialysis or those who were in a chronic care institution. This was done to avoid skewing the data.

Data Analysis

The study period analyzed in this report was 10 years spanning the period from 5 years prior the diagnosis labeled as (-5) and the fifth year following the diagnosis and treatment labeled as (+5). Because patients were matched controls for analysis in the study, we applied the same labeled year for the control group when we referred to a specific period with respect to HCU. Physician fees and visits were used as surrogates of HCU. Physician fees and visits related to OSAS diagnosis, treatment, or follow-up were also included for analysis. Because HCU may progressively peak proximate to the time an intervention occurs, costs or visits related to diagnosis and intervention were placed into the year (+1) to avoid this bias. The distribution of the variables for analysis was symmetrical and unimodal. Continuous variables were expressed as mean ± SEM.

First, we examined the long-term trends between the fifth year before diagnosis and the year before diagnosis and then by analyzing the change between the fifth year after diagnosis and the year before diagnosis. This allowed for the examination of the trend of physician visits and fees over 10 years with the diagnosis having been made in the middle of the span of time.

We then compared the average number of physician fees and visits on yearly basis from (-1) to (+5) year between patients and their matched controls. We used paired t tests for this analysis. χ² Tests were used when compliance status were analyzed with different body mass index classification. The change in physician visits and fees from the year (-1) to (+2) and (+5) for each group was analyzed by paired t tests. A P value less than .05 was considered to be statistically significant.

A linear regression was performed to determine predictors of increased HCU after CPAP prescription. This was done using the fees and physician visits as dependent variables. The independent variables included age, clinical parameters of sleep, and past medical history of different diseases. All statistical analyses were performed with the use of SAS Version 8.2 software (SAS Institute, Cary, NC, USA).

All analyses were done in such a way as to protect individual confidentiality, by using an encrypted health insurance number for patients and controls and using the encrypted number as the only unique identifier.
RESULTS

During the period of 1990 to 1998, there were 342 male patients (Table 1) diagnosed with OSAS who met the inclusion criteria and were prescribed CPAP and were still using CPAP after 5 years.

Physician Visits

The number of physician visits increased in the 5 years leading up to diagnosis and then decreased over the next 5 years on treatment. The number of physician visits in the year prior to diagnosis was 3.46 ± 0.2 (95% confidence interval [CI]: 2.57 to 4.36) greater than the number of visits in the fifth year before diagnosis. On the other hand, during the fifth year after diagnosis, the number of visits to the doctor had decreased by 1.03 ± 0.49 (95% CI: -1.99 to -0.07). This change was significant (P<.0001). In the controls, the number of doctor visits in the year (-1) was 0.39 ± 0.49 (95% CI: 0.10 to 0.67) greater than the number of visits in the year (-5). The number of visits to the doctor increased by 0.82 ± 0.16 (95% CI: 0.51 to 1.13) from the year (-1) to (+5). This change was not significant (P=.08).

Over the 6-year period spanning the year before diagnosis to the fifth year after diagnosis, OSAS patients had more physician visits than controls (Table 2). In the year prior to diagnosis, the mean difference was 5.18 ± 0.45 (95% CI: 4.28 to 6.07) (P<.0001). In the fifth year after the diagnosis (+5), the mean difference was now 3.33 ± 0.44 (95% CI: 2.46 to 4.20) (P<.0001). The difference in physician visits between the 2 groups in the year (-1) and (+5) was significantly reduced to 1.85 ± 0.52 (95% CI: 0.82 to 2.88) (P=.0005).

Table 1—Demographics and Characteristics of 342 Patients With OSAS at Time of Diagnosis

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>48.2</td>
<td>48.0</td>
<td>10.7</td>
<td>0.6</td>
</tr>
<tr>
<td>Height, cm</td>
<td>178.0</td>
<td>177.8</td>
<td>7.7</td>
<td>0.4</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>112.7</td>
<td>109.1</td>
<td>24.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Body mass index, kg/m2</td>
<td>35.6</td>
<td>34.8</td>
<td>7.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Epworth Sleepiness Scale</td>
<td>14.2</td>
<td>14.0</td>
<td>5.3</td>
<td>0.3</td>
</tr>
<tr>
<td>CPAP pressure, cm H2O</td>
<td>10.3</td>
<td>10.0</td>
<td>3.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Apnea hypopnea index, no./h</td>
<td>47.1</td>
<td>41.1</td>
<td>32.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Sleep time with SpO2 below 90%, %</td>
<td>24.6</td>
<td>16.0</td>
<td>24.0</td>
<td>1.3</td>
</tr>
</tbody>
</table>

CPAP refers to continuous positive airway pressure.

Table 2—Physician Visits and Fees for Patients With OSAS on CPAP and Their Control at Year Prior To Diagnosis and 2 and 5 Years After Diagnosis (+2) And (+5) Year and the Difference Between the Control and Each Group From Year Prior (+1).

<table>
<thead>
<tr>
<th></th>
<th>Year Prior</th>
<th>Year +2</th>
<th>Year +5</th>
<th>Difference Between Year Prior and Year 2</th>
<th>Difference Between Year Prior and Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visits, no./y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cases</td>
<td>9.21 ± 0.44 (7.0)</td>
<td>7.27 ± 0.37 (5.0)</td>
<td>8.18 ± 0.41 (6.0)</td>
<td>1.95 ± 0.42*</td>
<td>1.03 ± 0.49*</td>
</tr>
<tr>
<td>Controls</td>
<td>4.04 ± 0.16 (2.0)</td>
<td>4.51 ± 0.17 (3.0)</td>
<td>4.86 ± 0.19 (3.0)</td>
<td>-0.48 ± 0.13*</td>
<td>-0.82 ± 0.16*</td>
</tr>
<tr>
<td>Difference between cases and control</td>
<td>5.18 ± 0.45*</td>
<td>2.76 ± 0.39*</td>
<td>3.33 ± 0.44*</td>
<td>2.42 ± 0.45*</td>
<td>1.85 ± 0.52*</td>
</tr>
<tr>
<td>Fees, $/y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cases</td>
<td>372.1 ± 24.15 (272.72)</td>
<td>281.29 ± 18.60 (174.71)</td>
<td>358.18 ± 22.91 (224.90)</td>
<td>90.81 ± 23.32*</td>
<td>13.92 ± 27.98</td>
</tr>
<tr>
<td>Controls</td>
<td>152.69 ± 8.09 (71.39)</td>
<td>168.27 ± 8.62 (85.90)</td>
<td>200.21 ± 9.87 (105.12)</td>
<td>-15.58 ± 6.20*</td>
<td>-47.52 ± 8.07*</td>
</tr>
<tr>
<td>Difference between cases and control</td>
<td>219.42 ± 25.15*</td>
<td>113.02 ± 19.7*</td>
<td>157.97 ± 24.27*</td>
<td>106.40 ± 24.1*</td>
<td>61.44 ± 29.51*</td>
</tr>
</tbody>
</table>

Data are presented as mean ± SEM (median) *P<.05. OSAS refers to obstructive sleep apnea syndrome; CPAP, continuous positive airway pressure.

Definition of abbreviations: CI, confidence interval; OSAS, obstructive sleep apnea syndrome; CPAP, continuous positive airway pressure.

Fees

Fees are generated from contacts with the healthcare system and include physician fees and other health-services fees such as investigations requested during the visit. We were able to calculate the fees related to specific ICD 9 diagnoses.

Total physician fees increased in the 5 years leading up to diagnosis and then decreased over the next 5 years (Figure 1). Mean total fees in the year prior to diagnosis was $148.65 ± 27.27 (95% CI: 95.12 to 202.10) greater than the total fees in the fifth year before diagnosis. During the fifth year after diagnosis total fees were $13.92 ± $27.94 (95% CI: -68.68 to 40.83) less than the year before diagnosis. This change was significant (P=.0009).

In the controls, the physician fees in the year (-1) was $19.62 ± 7.64 (95% CI: 4.64 to 34.59) greater than the fees in the (-5). The physician fees increased by $47.52 ± 8.07 (95% CI: 31.69 to 63.34) from the year (-1) to the year (+5). This change was...
significant (P=.03).

The total yearly fees for the OSAS cases were higher than their matched controls over the 6-year period spanning the period from the year before diagnosis (-1) to the fifth year (+5) on treatment. Fees were highest in the year prior to diagnosis and lowest in the second year (+2) on treatment (Figure 2).

The total yearly fees in patients with OSAS in the year prior to diagnosis (-1) was $372.10 ± $24.15 versus $152.69 ± $8.09 for the matched controls, with a significant mean difference of $219.42 ± $25.19 (95% CI: 169.87 to 268.96) (P<.0001). In the fifth year on treatment (+5), the total yearly fees decreased to $358.18 ± $22.91 in the cases versus an increase to $200.21 ± $9.87 for the controls, with a significant mean difference of $157.97 ± $24.27 (95% CI: 110.24 to 205.72) (P<.0001). When we compared the difference in fees between the 2 groups in the year (-1) to (+5), there was a significant reduction in the difference between cases and controls of $61.44 ± $29.51 (95% CI: 3.39 to 119.49) (P=.04). Similar to the reduction in physician visits, the drop in fees was significant at the year (+2) for the cases (Figure 3).

Over the 5 years on treatment, while, overall, there was no significant change, there were significant changes in fees related to specific organ systems (eg, the circulatory and respiratory systems) (Figure 4). During this period, there were significant increases in fees related to endocrine, digestive, and musculoskeletal diseases by $14.81 (95% CI: 6.70 to 22.92) (P=.05), $8.97 (95% CI: 0.36 to 17.59) (P<.05), and $18.45 (95% CI: 8.12 to 28.77) (P<.05), respectively, and a significant decrease in fees related to respiratory diseases by $13.37 (95% CI: -21.87 to -4.87) (P<.05).

The largest drop in fees and physician visits occurred during the second year of treatment, after which fees started to increase over the following 3 years. From the year (+2) to the year (+5), there was an average fee increase of $76.89 (95% CI: 33.28 to 120.50)

DISCUSSION

Whereas in the 5 years before the diagnosis of OSAS, there is a progressive increase in healthcare expenditure in patients with OSAS, after 5 years on CPAP treatment, this trend in utilization is arrested or reversed. In general, there is leveling off or reduction in the cost for patients, while controls have an increase. Thus, there is a narrowing of the difference between patients and controls over the 5 years following diagnosis of OSAS. This suggests that evaluation and treatment have a positive impact on patients’ health.

Prior to diagnosis and treatment, patients with OSAS are a financial burden because of the direct and indirect costs of their...
We and others have previously reported that there is a progressive increase in expenditure in the 10 years before diagnosis. We did not, however, explicitly evaluate the influence of obesity, which may have contributed to these findings.

Our data suggest that obesity-related diseases increase healthcare use in these patients between 2 and 5 years on CPAP. Thus, clinicians should not assume that CPAP “cures” these patients. CPAP treats only one aspect of the obesity-related diseases. Control of weight should remain the goal in order to prevent other obesity-related comorbidities.

CONCLUSIONS
Evaluation and treatment of OSAS reverses or aborts the progressive increase in healthcare costs seen in the 5 years before diagnosis. Our data suggest that obesity-related diseases increase healthcare use in these patients between 2 and 5 years on CPAP. Thus, clinicians should not expect CPAP to entirely reverse 5 to 10 years of abnormal physiology. This suggests that OSAS should be diagnosed and patients treated much earlier.

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