Adherence to Positive Airway Pressure Therapy in Hospitalized Patients with Decompensated Heart Failure and Sleep-Disordered Breathing

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Study Objectives: Sleep-disordered breathing (SDB) has been implicated as a risk factor for the development of several adverse cardiovascular outcomes, but can be mitigated with positive airway pressure therapy (PAP). The nonadherence of patients with SDB on PAP in the outpatient setting ranges from 29% to 84%. However, adherence of PAP in patients with congestive heart failure (CHF) admitted for decompensated CHF and in whom SDB has been diagnosed in the hospital setting is not known. We hypothesized that despite a diagnosis in the hospital, the compliance of these patients with PAP therapy would not be different from the well-established adherence in patients with a diagnosis and treatment in the outpatient setting.

Methods: The study was a retrospective analysis of patients admitted to an academic tertiary care hospital between March 2013 and February 2014. Patients presenting with decompensated CHF were screened and high-risk patients were started on PAP empirically and advised to undergo a postdischarge polysomnogram. Compliance of the patients with PAP was tracked for over 12 mo. Data from a similar outpatient group who underwent polysomnography during the study period were also reviewed.

Results: Ninety-one patients underwent polysomnography postdischarge. Of the 91 patients, 81 patients agreed to PAP therapy. One patient was excluded as data were missing. The adherence at 3, 6, and 12 mo was 52%, 37%, and 27%, which was not significantly different than an outpatient control group. There was a trend for those with CHF plus SDB and compliant with PAP to have a higher probability of survival compared to those who were noncompliant (p = 0.07).

Conclusions: Adherence of patients to PAP therapy in whom a SDB diagnosis is made during acute hospitalization for heart failure is comparable to patients in the ambulatory setting. Adherence in first 3 mo is a predictive marker for improved survival trend.

Keywords: sleep-disordered breathing, congestive heart failure, hospitalized patients, adherence to therapy, outcome


BRIEF SUMMARY

Current Knowledge/Study Rationale: There is a growing body of data showing high incidence of undetected sleep-disordered breathing (SDB) in hospitalized patients. Early diagnosis and intervention of SDB in this cohort has been shown to reduce readmissions. However, there is a paucity of data on adherence to positive airway pressure therapy in patients diagnosed through in-hospital screening programs.

Study Impact: The study provided insight into the adherence and outcome of patients diagnosed with SDB in patients hospitalized with acute congestive heart failure and can help develop strategies to improve outcomes.

INTRODUCTION

Sleep-disordered breathing (SDB) is a common condition with a prevalence reported to be as high as 24%.1 It has been implicated as a risk factor for the development of several adverse cardiovascular outcomes.2–5 Despite this association and recent data on sudden deaths,6 the practice of sleep medicine remains largely confined to the outpatient setting. Patients admitted to the hospital are rarely screened for SDB despite significant co-morbid conditions. Our recent data on obese hospitalized patients showed a high prevalence of undetected SDB in patients hospitalized on the medical service.7

Furthermore, a low-cost screening protocol was effectively able to detect underlying SDB.8 We showed that the oxygen desaturation index (ODI) as determined by high-resolution photoplethysmography can reliably detect SDB; there was a high concordance with the outpatient apnea-hypopnea index (AHI) as determined by polysomnography.8 Recent data also suggest that early detection and initiation of therapy for SDB in hospitalized patients may reduce readmissions in patients with congestive heart failure (CHF).9,10 The nonadherence of patients with SDB on positive airway pressure therapy (PAP) in the outpatient setting ranges from 29% to 84%.11,12 However, adherence of PAP in patients with CHF in whom the diagnosis was made in the hospital is not known. We hypothesized that despite a hospital diagnosis, the compliance of these patients with PAP therapy would not be different from the well-established adherence in patients with a diagnosis and treatment in the outpatient setting.
METHODS

This was a retrospective analysis of patients admitted to an academic tertiary care hospital from March 2013 to February 2014. The Thomas Jefferson University Institutional Review Board approved the study. As part of the university’s inpatient sleep program, patients presenting with decompensated CHF were screened with the STOP-BANG (snoring, tiredness during daytime, observed apnea, high blood pressure, body mass index (BMI) ≥ 30 kg/m², age > 50 y, increased neck circumference, male sex) questionnaire by a respiratory therapist. The STOP-BANG questionnaire was chosen because of its brevity, ease of use, and patient acceptance. This made it an ideal tool that would not increase the burden of the respiratory therapist or the patient. Patients admitted during the weekend were not included. The admitting team was notified if the STOP-BANG questionnaire was positive (answering yes to three or more items) who then contacted a board-certified pulmonary sleep medicine physician to determine whether a formal consultation was necessary. A consultation consisted of a comprehensive sleep history and physical examination, and nocturnal high-resolution pulse oximetry, unless the latter was contraindicated (e.g., oxygen requirement > 30%, severe pain, insomnia, altered mental status, anticipated disruption during sleep [imaging/tests or surgeries]). However, none of our patients were on oxygen at the time of the nocturnal high-resolution pulse oximetry. If clinical suspicion of SDB was high (defined according to the Adult Obstructive Sleep Apnea Task Force of the American Academy of Sleep Medicine [AASM]), patients were advised to undergo a postdischarge confirmatory polysomnogram (PSG). Additionally, all patients found to have oxygen desaturation (defined as cumulative oxygen saturations of < 88% for 5 min or more and an elevated oxygen desaturation index ODI (> 15), on overnight high-resolution pulse oximetry, were offered empiric PAP therapy during the hospital stay. A 1-h daytime acclimatization trial was given to the patients. Auto-titrating continuous positive airway pressure (auto-CPAP) was used in most cases with a minimum pressure of 5 cm H₂O to a maximum of 10 cm H₂O on the first day. Subsequently, continuous positive airway pressure (CPAP) was used based on the pressures obtained from the auto-CPAP and adjusted according to patient tolerance. Pressures were rarely increased beyond 10 cm H₂O pressure due to concerns of affecting cardiac output in patients with underlying CHF. CPAP therapy was discontinued if the residual ODI was higher than baseline, as that was interpreted as a sign of central apnea, or if the patient did not tolerate PAP therapy. The patients were not discharged on PAP therapy but were advised and scheduled to have a PSG’s within 2 w of discharge. PSG evaluations were conducted at the Jefferson Sleep Disorder Center, an AASM accredited facility, and included an electrocardiogram, electroencephalogram, electrooculogram, continuous oronasal airflow recording (with a thermistor and a pressure [transducer], recording of chest wall and abdomen movement (using respiratory inductive plethysmography belts), pulse oximetry, and chin electromyogram (Comet AS 40 PSG, Grass Technologies; Warwick, RI, USA). Sleep was staged manually according to AASM scoring guidelines by a registered PSG technologist. The AHI was calculated as the number of apneas plus hypopneas per hour of total sleep time, with hypopneas defined using a desaturation criterion of 4%. A single, board-certified physician interpreted the PSGs. Patients who were confirmed with SDB and titrated with PAP therapy in a split-night protocol were initiated on therapy within 2 w of discharge from the hospital. Compliance of the patients with PAP was tracked objectively for over 12 mo by using data downloaded from the compliance card of the PAP device. Patients were considered compliant if the patients demonstrated 4 h or more usage for 70% or more of nights used. During the same period of time (March 2013 to April 2014) controls were selected from our outpatient clinic to compare the adherence. A total of 466 patients underwent PSG during this time period as outpatients and consecutive patients were reviewed for selection. Patients were first matched for age range (39–87 y). Next, these patients were further selected to include only a BMI range of 25–66 kg/m² and finally matched for severity of SDB with an AHI range between 8.8–136.7 events/h. The process was intended to approximate a propensity model to create a control group that reduces selection bias.

Statistical Approach

Descriptive statistics were calculated for baseline characteristics and polysomnographic findings, and the compliant and noncompliant groups were compared using a chi-square test for categorical parameters and a t-test for continuous variables. A patient was placed in the compliant group if they were compliant at the 3-mo follow-up visit. The percentage of patients compliant after 3, 6, and 12 mo of follow-up was assessed for all patients.

For this analysis, patients who did not follow up and failed to communicate with their durable medical equipment company were considered noncompliant. Comparisons were also made to the control group using a chi-square test comparing adherence proportions at each visit separately. The probability of survival was calculated using Kaplan-Meier methods and compared between groups using the log-rank test. Values of p < 0.05 were considered statistically significant. As appropriate, data are presented as mean ± standard deviation. Statistical analyses were generated using SAS software, version 9.3.

RESULTS

As shown in Figure 1, during the study period, there were 282 patients with decompensated CHF. Of those, 180 patients were screened with STOP-BANG questionnaire, 156 patients screened positive, as defined by STOP-BANG score ≥ 4. There were 127 and 98 subjects with a STOP-BANG score ≥ 4 and ≥ 5, respectively. All 156 patients underwent nocturnal pulse oximetry and formal inpatient sleep consult. Among these 156 patients 132 were identified as high risk of SDB, given a trial of CPAP and advised to schedule an outpatient sleep study. Ninety-one patients eventually had an outpatient sleep study. Among these 91 patients, 85 patients had a positive study for SDB. Of these, 81 patients agreed to restart PAP therapy, 74 had obstructive sleep apnea and 7 had central sleep apnea (CSA, defined as a PSG revealing ≥ 5 central
apneas and/or central hypopneas per hour of sleep, the number of central apneas and/or central hypopneas is > 50% of the total number of apneas and hypopneas). Fifty-three patients started on CPAP, 21 on bilevel PAP, and 7 patients on adaptive servo ventilation. One patient was not included in the statistical summaries due to missing data. For the compliant group, the mean duration of follow-up was 475 days (SD = 232 days) and median = 524 days. For the noncompliant group, the mean duration of follow-up was 493 days (SD = 246 days) and median = 535 days. Complete data were available on 80 patients for final analysis.

After 3 mo, 42 patients were classified as compliant and 38 were noncompliant with PAP (Table 1). The mean age in the compliant group was higher at 64 ± 13 y compared to 58 ± 11 y in the noncompliant group. There was no difference in sex and BMI between the two groups; however, the noncompliant group had a significantly higher percentage of Blacks (59% versus 32%).

The control group was 48% males with a mean age of 63 ± 9 y, mean AHI of 35 ± 26 events/h and mean BMI of 38 ± 9.4 kg/m², which was similar to the hospital cohort. As expected, the severity of the disease was comparable in both groups in terms of both AHI (37 ± 30 versus 31 ± 26 events/h) and oxygen desaturation time below 88% (73 ± 90 versus 49 ± 67 min) (Table 2).

There were no significant polysomnographic differences between the compliant and noncompliant groups except for a higher % N2 sleep noted in the noncompliant group (67 ± 16 versus 59 ± 15) (Table 2). As expected, the severity of the disease was comparable in both groups in terms of both AHI (37 ± 30 versus 31 ± 26 events/h) (Table 2) and oxygen desaturation time below 88% (73 ± 90 versus 49 ± 67 min).
adherence in the first 3, 6, and 12 mo in the hospital group was 52%, 37%, and 27% with average hourly use of 6 h 29 min, 5 h 24 min, and 5 h 52 min, respectively, in the compliant group (Table 3). The average usage hours in the noncompliant group was limited due to a significant proportion of patients who were ‘no shows’ and did not submit compliance data to the
Those with CHF plus SDB and adherent had a higher probability of survival compared to those who were noncompliant, although the difference was not statistically significant ($p = 0.07$).

**Table 4**—Baseline characteristics of patients who died versus those alive.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Dead (n = 15)</th>
<th>Alive (n = 65)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>61 ± 12, 63</td>
<td>61 ± 12, 60</td>
<td>0.99</td>
</tr>
<tr>
<td>Body mass index</td>
<td>34 ± 10, 34</td>
<td>39 ± 9, 38</td>
<td>0.05</td>
</tr>
<tr>
<td>Male</td>
<td>8 (53)</td>
<td>37 (57)</td>
<td>0.80</td>
</tr>
<tr>
<td>Black</td>
<td>6 (40)</td>
<td>30 (46)</td>
<td>0.67</td>
</tr>
<tr>
<td>Hypertension</td>
<td>14 (93)</td>
<td>53 (82)</td>
<td>0.44</td>
</tr>
<tr>
<td>Diabetes mellitus type 2</td>
<td>5 (33)</td>
<td>39 (60)</td>
<td>0.06</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease/asthma</td>
<td>2 (13)</td>
<td>19 (29)</td>
<td>0.33</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>8 (53)</td>
<td>22 (34)</td>
<td>0.16</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>9 (60)</td>
<td>31 (48)</td>
<td>0.39</td>
</tr>
<tr>
<td>Beta blockers</td>
<td>14 (93)</td>
<td>51 (78)</td>
<td>0.28</td>
</tr>
<tr>
<td>Angiotension-converting enzyme inhibitor</td>
<td>5 (33)</td>
<td>32 (49)</td>
<td>0.27</td>
</tr>
<tr>
<td>Calcium channel blocker</td>
<td>5 (33)</td>
<td>21 (32)</td>
<td>1.00</td>
</tr>
<tr>
<td>Loop diuretics</td>
<td>12 (80)</td>
<td>49 (75)</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Values presented as mean ± standard deviation, median or n (%).

Survival curves for those with CHF/SDB and adherent with therapy versus the CHF/SDB who were nonadherent were compared. There was a trend for those with CHF plus SDB and compliant with PAP to have a higher probability of survival compared to those who were noncompliant ($p = 0.07$) (Figure 2).

Baseline characteristics of patients who died during the observational period were compared with those alive and no significant differences were noted (Table 4). Potential confounding variables were considered and a logistic regression model was generated using baseline characteristics found to be significantly different between compliant and noncompliant.
Although the data on the effect of age are less clear, patients are rarely admitted for SDB and most patients with CHF do not have overt symptoms of SDB. Consequently during hospitalization, a lower adherence would be predicted in this group. We believe that the better-than-expected adherence is due to active education, realization of a possible role of SDB in the underlying disease, and the acclimatization trial patients underwent during their hospital stay.

Our findings suggest that patients in whom SDB was diagnosed in the hospital can have PAP adherence comparable to those with overt symptoms in whom the diagnosis was made in an ambulatory setting. In contrast, a previous study evaluating CPAP adherence among patients with obstructive sleep apnea with a new diagnosis prior to elective surgery found poor CPAP adherence, especially among Blacks. We suspect that our favorable long-term adherence rates in hospital-diagnosed patients with CHF may be dependent on early education, acclimatization, and a positive effect of PAP on their underlying condition in the hospital. Our study is also consistent with prior data showing lower adherence in Black patients. Although the data on the effect of age are less clear, previous studies have shown better compliance with age, similar to our results.

Our study also shows that survival of those with CHF plus SDB and adherent on PAP therapy had a nonstatistically higher trend toward greater survival than those who were nonadherent. Although the study was not powered to detect mortality differences, this finding is consistent with prior studies showing increased morbidity and mortality in untreated patients with CHF and SDB. Our findings also are consistent with a recent large prospective study, which showed that newly diagnosed SDB in patients admitted with CHF is associated with increased mortality and treatment mitigated the risk. The study also showed adherence similar to our study. Targeting hospitalized patients with heart failure patients is important for several reasons. First, despite a high prevalence of SDB in patients with CHF the diagnosis is made and treatment is carried out in a minority of patients. Second, treatment of SDB in patients with CHF has been shown to improve ejection fraction. Last, recent data from our group show that early diagnosis and intervention in hospitalized SDB patients is associated with reduced 6-month hospital readmissions. With the Patient Protection Affordable Care Act of 2010 now mandating a penalty for readmissions, early treatment of SDB in patients with CHF may be an important factor in maintaining fiscal stability for hospitals.

There are some limitations of our study. First, this is a retrospective evaluation of an inpatient sleep program limited to patients with CHF and does not reflect compliance or outcomes in other cohorts. Second, patients who ultimately returned to the sleep laboratory to have a follow-up PSG may have represented a cohort generally more adherent to all medical therapy. If differentially greater in those who were adherent to PAP therapy, this would have favored a bias toward the null when comparing adherence rates between the hospital and laboratory cohorts. It also would have contributed to the greater survival noted for those compliant with PAP therapy. Third, other significant factors that have been shown to affect adherence such as insomnia, nasal resistance, or nasal cross-sectional area were not examined or recorded. Fourth, the proportion of central sleep apnea in our study is lower than what has been recorded in prior studies. However, the final diagnosis and therefore choice of PAP therapy was based on predominance of apneas, as defined by > 50% events being obstructive or central in nature. Despite these limitations, our study had notable strengths including the use of laboratory polysomnography to confirm the diagnosis of SDB, the length of follow-up of the cohort, and the use of a standardized protocol for evaluation.

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