Effect of Early Intervention With Positive Airway Pressure Therapy for Sleep Disordered Breathing on Six-Month Readmission Rates in Hospitalized Patients With Heart Failure

Sunil Sharma, MD[a,*], Paul Mather, MD[b], Ankit Gupta, MD[a], Gordon Reeves, MD[b], Sharon Rubin, MD[b], Raphael Bonita, MD[b], Anindita Chowdhury, MD[a], Raymond Malloy, BS[a], Leslee Willes, MS[c], and David Whellan, MD[b]

Rehospitalization for congestive heart failure (CHF) is high within 6 months of discharge. Sleep disordered breathing (SDB) is common and underdiagnosed condition in patients with CHF. We hypothesized that early recognition and treatment of SDB in hospitalized patients with CHF will reduce hospital readmissions and emergency room visits. Patients admitted for CHF underwent overnight polysomnography within 4 weeks of discharge. Patients diagnosed with SDB were provided therapy with positive airway pressure therapy. Patients were identified as having good compliance if the device use was for a minimum of 4 hours 70% of the time for a minimum of 4 weeks during the first 3 months of therapy. Hospital admissions for 6 months before therapy were compared with readmission within 6 months after therapy in patients with good and poor compliance. A total of 70 patients were diagnosed with SDB after discharge. Of the 70 patients, 37 (53%) were compliant with positive airway pressure therapy. Compliant patients were more likely to be older (64 ± 12 vs 58 ± 11 years) and women (54% vs 33%) and less likely to be patient with diabetes (40% vs 67%) versus noncompliant patients. Although both groups experienced a decrease in total readmissions, compliant patients had a significant reduction (mean ± SE: −1.5 ± 0.2 clinical events vs −0.2 ± 0.3; p <0.0001). In this single-center analysis, identification and treatment of SDB in admitted patients with CHF with SDB is associated with reduced readmissions over 6 months after discharge. Adherence to the treatment was associated with a greater reduction in clinical events. **(Am J Cardiol 2016;117:940−945)**

Congestive heart failure (CHF) is a major public health issue and is the leading cause of hospital admissions in Unites States.[1,2] More health care dollars are spent on CHF care than on any other diagnosis.[2] and the single largest source of costs are attributable to hospitalizations. In particular, admission rates after heart failure hospitalization remain high, with >50% patients readmitted to hospital within 6 months of discharge.[3−5] Several factors have been identified as predictors of readmissions for patients with CHF, including undiagnosed sleep disordered breathing (SDB).[6] An estimated 40% to 60% of patients with CHF have SDB which remains mostly underrecognized[7−9] Reasons for this underrecognition includes poor awareness and a lack of tools to evaluate hospitalized patients for SDB.[10] Studies on CHF and SDB have shown that therapy improved ejection fraction, blood pressure, and sleepiness.[11−13] Abnormal heart rhythms associated with untreated SDB may also contribute to readmissions in this cohort of patients.[14] We hypothesized that early identification and successful therapy of SDB in patients hospitalized with CHF reduces clinical events (hospital readmissions and emergency room [ER] visits) over a 6-month period.

Methods

Consecutive patients admitted to Thomas Jefferson University Hospital from April 2013 to July 2014 for decompensated CHF and not previously diagnosed or treated for SDB were screened as part of a clinical care pathway. Initial screening for SDB was performed with an 8-item test that measures the incidence of loud Snoring, Tiredness, Observed apnea, high blood Pressure and takes into account body mass index, age, neck circumference, and gender[15] Patients with a positive screen were offered consultation with the inpatient sleep medicine service led by a board certified sleep physician. If after a comprehensive evaluation, patients were found to be high risk for SDB and they had no contraindications, they underwent a formal outpatient polysomnography (PSG). All PSG were performed within 2 weeks of discharge. Total clinical events (TCEs) refer to the combined admissions experience including both hospital and ER admissions. Patients

[a]Division of Pulmonary and Critical Care, Department of Internal Medicine, Jefferson Sleep Disorders Center and [b]Division of Cardiology, Department of Internal Medicine, Advanced Heart Failure and Cardiac Transplant Center, Jefferson Medical College of Thomas Jefferson University, Philadelphia, Pennsylvania; and [c]Independent Biostatician, Willes Consulting Group, Inc., Encinitas, California. Manuscript received October 8, 2015; revised manuscript received and accepted December 18, 2015.

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*Corresponding author: Tel: (+1) 215-955-8285; fax: (+1) 215-955-9783.

E-mail address: Sunil.Sharma@jefferson.edu (S. Sharma).

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diagnosed with SDB were initiated on the continuous positive airway pressures (CPAPs) device within 48 hours of a diagnostic PSG. The study was approved by the Thomas Jefferson University Institutional Review Board committee.

Compliance data were obtained objectively by the compliance card on the PAP device or modem attached to the device; patients were deemed compliant if the compliance data revealed a minimum of 4 hours of use 70% of the time for 4 weeks consecutively or more during the first 3 months of therapy. Patients who had less than this amount of usage, returned their devices because of nontolerance (2 patients) or could not be contacted either by the clinic or their durable medical equipment provider (1 patient) were deemed noncompliant.

Hospital admissions and ER visits were collected from an electronic medical records system, and reasonable efforts were made to review outpatient records to look for evidence of admissions/ER visits in other hospitals. Medications, pacemaker placements, left ventricular assist device or heart transplant were monitored.

Baseline characteristics were compared between groups using the Student *t* test or Wilcoxon rank-sum test for continuous variables and chi-square test for categorical variables. TCEs were calculated as the sum of hospital admissions and ER admissions over a 6-month period before intervention and for 6 months after intervention. For study end points, the change in TCE, between 6 months before and after intervention was calculated for each subject, and the mean change was compared between the groups using a Student *t* test. The mean change in hospital admissions and ER admissions was also separately compared between groups.

Because this is an observational study in which subjects effectively choose their treatment groups (compliant vs noncompliant), there is the potential for bias in comparing groups. There are a number of attributes that could also affect the outcome variable because of differences between groups. Two methods were used to correct for potential bias: (1) direct multivariate regression (DMR) adjustment and (2) inverse probability weighting using propensity scores.[16] Propensity score methods match patients with similar baseline and clinical variables and then compare the outcome variable within the pairs. Because matching on all relevant covariates may not be possible with a limited sample size, Rosenbaum et al[17] suggest the use of propensity scores, which are functions of the relevant covariates. Specifically, the propensity score is the probability that a patient with certain characteristics will be compliant.

The DMR investigated all baseline characteristics with significant differences between the groups (using a significance level of 0.10) in a regression model of change in TCE that included the potential confounders, the dichotomous compliance variable and an interaction term as predictors. The propensity score model was chosen with a stepwise logistic regression using a p value threshold of 0.15. Data not available were considered missing. p Values of <0.05 were considered significant for paired comparison.

Results

A total of 347 hospitalizations with CHF occurred during the study period. Of these, 282 were screened for SDB, with 171 patients evaluated by a board certified sleep specialist for acute and chronic management of sleep disorders. Seventy-five of these patients underwent PSG at the Jefferson sleep disorders center within 2 weeks of discharge. Reasons for patients not undergoing PSG are noted in Figure 1. Of the 75 patients, 70 (94%) had SDB with apnea hypopnea index (AHI) >5 and had objective data on compliance to review, with 37 patients (53%) identified as compliant with PAP therapy based on the criteria defined in the method.

Table 1 provides information on baseline patient characteristics. Specifically, there was no significant difference between the mean ($\pm$ SD) AHI in the 2 groups, 36 ± 31 (compliant) versus 31 ± 26 (noncompliant; $p = 0.56$). There were also no significant differences in baseline characteristics or co-morbid conditions in the 2 groups except that the compliant patients were older on average ($p = 0.05$) and less likely to have type-2 diabetes ($p = 0.03$; Table 1). Of 70 patients, 13 (18.5%) had central sleep apnea (CSA) and another 15 patients (21.4%) demonstrated central events although they were fewer than 50% of the total events. All PSG were split-night protocols, and most patients were placed on fixed continuous PAPs (CPAPs). Of the 13 patients with CSA, 5 patients were placed on adaptive servo ventilation (ASV) because of worsening of central apneas on CPAP (complex sleep apnea).

For both the compliant and noncompliant groups, we compared the number of hospital admissions and ER admissions for the 6 months before the number of admissions and ER readmissions for the 6 months after therapy was started. The compliant group with PAP therapy experienced a mean reduction of 1.5 in TCEs compared to a mean reduction of 0.2 events in the noncompliant group ($p < 0.0001$; Figures 2 and 3. The group that was compliant with PAP therapy had a mean decrease in hospital readmissions of 1.1 compared to a 0.6 decrease for the noncompliant group ($p = 0.01$). The mean change in the number of ER readmissions between the 2 groups was also statistically significant ($p = 0.0002$), with the compliant group having a mean decrease in ER visits of 0.4 compared to a 0.4 increase in ER visits for the noncompliant group (Table 2).

With the exception of age, gender, calcium channel blockers (CCB) use, and type 2 diabetes, baseline characteristics were similar in both groups (p value >0.10). Two statistical methods were used to adjust for imbalance in these groups. First, a DMR model was used with the change in TCEs as the dependent variable and age, compliance, gender, CCB use, and type-2 diabetes as independent variables. The potential confounding effects of these four variables were assessed with a regression model of change in TCEs. Only CCB had a significant effect on the change in TCEs (patients who did not use CCB decreased their mean number of visits by 1.0 visit more than patients that used CCB); noting that the interaction of CCB and compliance was not statistically significant (p value >0.10). As presented in Table 3, the estimated effect of compliance in the regression model with CCB and compliance as main effects (compliant patients decreased their mean number of visits by 1.0 visit more than noncompliant patients) was statistically significant (p value = 0.002) and similar to that in the regression model without CCB (compliant patients decreased their mean number of visits by 1.3 visits more than noncompliant patients). Second,