

COMMENTARY

CPAP Adherence and Readmission: Marker of Health or Cost-Effective Tool?

Comment on Truong et al. Nonadherence to CPAP associated with increased 30-day hospital readmissions. *J Clin Sleep Med*. 2018;14(2):183–189.

Lucas M. Donovan, MD; Martha E. Billings, MD, MSc

Division of Pulmonary, Critical Care and Sleep Medicine, Department of Medicine, University of Washington, Seattle, Washington

Obstructive sleep apnea (OSA) is a frequent comorbidity in hospitalized patients.^{1,2} OSA is implicated in the pathogenesis of many serious diseases that result in hospitalizations, including heart failure, coronary artery disease, arrhythmias, diabetes, and stroke.³ Mounting evidence also links OSA to poor outcomes following surgery⁴ and adverse events among those with respiratory conditions such as chronic obstructive pulmonary disease and pneumonia, which frequently prompt hospitalization.^{1,5} Treating OSA with continuous positive airway pressure (CPAP) may be a cost-effective way to improve hospital outcomes. For instance, in-hospital use of CPAP in those at high risk of OSA has been shown to reduce rapid response rates.⁶ Furthermore, observational studies suggest initiating CPAP therapy in patients with congestive heart failure and chronic obstructive pulmonary disease with comorbid OSA can reduce readmissions.^{2,7} Because hospitals are financially penalized for readmissions after less than 30 days, CPAP therapy for OSA has the potential to reduce health care costs and utilization as well as improve outcomes.⁸

In this issue of *Journal of Clinical Sleep Medicine*, Truong and colleagues detail an association of adherence to CPAP and reduced hospital readmission rates in patients with OSA.⁹ The study utilized administrative data from a single VA center over an 8-year period looking at rates of hospital readmission less than 30 days. The cohort included veterans with established OSA on CPAP therapy with available download data and an index admission. The authors found greater all-cause 30-day readmission rates in subjects who were nonadherent to CPAP compared to those who were adherent (adherence was defined as using CPAP more than 4 hours per day on 70% of days in a 30-day period). The authors obtained objective medication adherence data and adjusted for comorbidities to reduce confounding. Patients with OSA who were nonadherent had two times greater odds of cardiovascular readmission in adjusted analyses. The authors note a novel finding of reduced psychiatric, urologic, and infectious admissions among those more adherent, postulating this may be due to the mood, hormonal, and immunologic effects of CPAP. Thus CPAP, by improving overall well-being, may reduce unnecessary hospitalizations.

Although Truong and colleagues find a convincing association between CPAP adherence and lower readmission rates for multiple diseases, further work must be done before we can

assert with confidence that the provision of CPAP and encouragement of CPAP adherence will prevent readmissions. The current state of the literature regarding OSA therapy and readmissions brings to mind our evolving understanding of OSA treatment and cardiovascular disease. Large cohort studies demonstrating robust associations between OSA and cardiovascular events^{10–12} and a reduction in cardiovascular morbidity and mortality with CPAP^{13–15} convinced many, including the authors of this editorial, of the promise of treating OSA. However, recent well-conducted randomized trials have failed to support a cardiovascular benefit of CPAP.^{16–18} This disconnect in part is hypothesized to occur due to the “healthy user effect” where individuals who are adherent to CPAP may be healthier, more adherent to lifestyle and treatment recommendations, and without competing psychosocial stressors.¹⁹ Thus, the improved health outcomes may reflect this marker of healthy behaviors and potential for recovery seen among those adhering to CPAP rather than true physiological benefits of CPAP. Truong and colleagues account for the “healthy user effect” in part by incorporating medication adherence into their modeling strategy. Nevertheless, this limitation intrinsic to observational studies likely persists despite their best attempts to include confounders.

In order to truly verify the efficacy of CPAP reducing hospital readmission, a randomized trial is necessary. Such a trial aimed at those at high risk for readmissions would include a focus on optimizing CPAP adherence in the intervention group. Adherence has been the major limitation of the large trials, with *post hoc* analyses suggesting possible cardiovascular benefits among those adherent, but this sample is of course no longer random.¹⁸ Sample inclusion criteria in any future trial will need to be carefully considered to ensure generalizable results. Randomized trials of CPAP have typically excluded very sleepy patients and those with severe desaturation, thus potentially excluding those more likely to benefit. Given the costs associated with OSA management and therapy, estimated to be more than \$2,000 annually per patient,²⁰ the cost-effectiveness of such an intervention would need to be carefully assessed.

If effective OSA therapy indeed does reduce readmissions, the field of sleep medicine will need to adapt from the slower-paced ambulatory environment to delivering care in the acute setting. As a field currently best equipped for outpatient

identification and management of sleep disorders, new models of care will need to be implemented to improve our reach to the inpatient population and implement positive airway pressure therapy in a timely fashion. Such demands will tax an already overextended sleep workforce²¹; therefore, care models that show promise in ambulatory management—such as the training and utilization of primary care providers, nurses, and telehealth strategies—could be adapted for this purpose.^{22–25}

Truong and colleagues present intriguing evidence regarding CPAP use and readmissions, and assessing the effect, costs, and implementation of OSA management among hospitalized patients should be a priority of future research.

CITATION

Donovan LM, Billings ME. CPAP adherence and readmission: marker of health or cost-effective tool? *J Clin Sleep Med*. 2018;14(2):161–162.

REFERENCES

- Lindenauer PK, Stefan MS, Johnson KG, Priya A, Pekow PS, Rothberg MB. Prevalence, treatment, and outcomes associated with OSA among patients hospitalized with pneumonia. *Chest*. 2014;145(5):1032–1038.
- Sharma S, Mather P, Gupta A, et al. Effect of early intervention with positive airway pressure therapy for sleep disordered breathing on six-month readmission rates in hospitalized patients with heart failure. *Am J Cardiol*. 2016;117(6):940–945.
- Bradley TD, Floras JS. Obstructive sleep apnoea and its cardiovascular consequences. *Lancet*. 2009;373(9657):82–93.
- Hai F, Porhomayon J, Vermont L, Frydrych L, Jaoude P, El-Solh AA. Postoperative complications in patients with obstructive sleep apnea: a meta-analysis. *J Clin Anesth*. 2014;26(8):591–600.
- Marin JM, Soriano JB, Carrizo SJ, Boldova A, Celli BR. Outcomes in patients with chronic obstructive pulmonary disease and obstructive sleep apnea: the overlap syndrome. *Am J Respir Crit Care Med*. 2010;182(3):325–331.
- Sharma S, Chowdhury A, Tang L, Willes L, Glynn B, Quan SF. Hospitalized patients at high risk for obstructive sleep apnea have more rapid response system events and intervention is associated with reduced events. *PLoS One*. 2016;11:e0153790.
- Coughlin S, Liang WE, Parthasarathy S. Retrospective assessment of home ventilation to reduce rehospitalization in chronic obstructive pulmonary disease. *J Clin Sleep Med*. 2015;11(6):663–670.
- Chen M, Grabowski DC. Hospital readmissions reduction program: intended and unintended effects. *Med Care Res Rev*. 2017;1077558717744611.
- Truong KK, De Jardin R, Massoudi N, Hashemzadeh M, Jafari B. Nonadherence to CPAP associated with increased 30-day hospital readmissions. *J Clin Sleep Med*. 2018;14(2):183–189.
- Gottlieb DJ, Yenokyan G, Newman AB, et al. Prospective study of obstructive sleep apnea and incident coronary heart disease and heart failure: the Sleep Heart Health Study. *Circulation*. 2010;122(4):352–360.
- Redline S, Yenokyan G, Gottlieb DJ, et al. Obstructive sleep apnea-hypopnea and incident stroke: the Sleep Heart Health Study. *Am J Respir Crit Care Med*. 2010;182(2):269–277.
- Marin JM, Carrizo SJ, Vicente E, Agusti AG. Long-term cardiovascular outcomes in men with obstructive sleep apnoea-hypopnoea with or without treatment with continuous positive airway pressure: an observational study. *Lancet*. 2005;365(9464):1046–1053.

- Martinez-Garcia MA, Soler-Cataluna JJ, Ejarque-Martinez L, et al. Continuous positive airway pressure treatment reduces mortality in patients with ischemic stroke and obstructive sleep apnea: a 5-year follow-up study. *Am J Respir Crit Care Med*. 2009;180(1):36–41.
- Kanagala R, Murali NS, Friedman PA, et al. Obstructive sleep apnea and the recurrence of atrial fibrillation. *Circulation*. 2003;107(20):2589–2594.
- Barbe F, Duran-Cantolla J, Capote F, et al. Long-term effect of continuous positive airway pressure in hypertensive patients with sleep apnea. *Am J Respir Crit Care Med*. 2010;181(7):718–726.
- Craig S, Kylintireas I, Kohler M, et al. Effect of CPAP on cardiac function in minimally symptomatic patients with OSA: results from a subset of the MOSAIC randomized trial. *J Clin Sleep Med*. 2015;11(9):967–973.
- Peker Y, Glantz H, Eulenburg C, Wegscheider K, Herlitz J, Thunstrom E. Effect of positive airway pressure on cardiovascular outcomes in coronary artery disease patients with nonsleepy obstructive sleep apnea. The RICCADSA randomized controlled trial. *Am J Respir Crit Care Med*. 2016;194(5):613–620.
- McEvoy RD, Antic NA, Heeley E, et al. CPAP for prevention of cardiovascular events in obstructive sleep apnea. *N Engl J Med*. 2016;375(10):919–931.
- Platt AB, Kuna ST, Field SH, et al. Adherence to sleep apnea therapy and use of lipid-lowering drugs: a study of the healthy-user effect. *Chest*. 2010;137(1):102–108.
- Frost & Sullivan; American Academy of Sleep Medicine. Hidden health crisis costing America billions: underdiagnosing and undertreating obstructive sleep apnea draining health care system. <https://aasm.org/advocacy/initiatives/economic-impact-obstructive-sleep-apnea>. Published August 8, 2016. Accessed December 29, 2017.
- Watson NF, Rosen IM, Chervin RD, Board of Directors of the American Academy of Sleep Medicine. The past is prologue: the future of sleep medicine. *J Clin Sleep Med*. 2017;13(1):127–135.
- Fields BG, Behari PP, McCloskey S, et al. Remote ambulatory management of veterans with obstructive sleep apnea. *Sleep*. 2016;39(3):501–509.
- Antic NA, Buchan C, Esterman A, et al. A randomized controlled trial of nurse-led care for symptomatic moderate-severe obstructive sleep apnea. *Am J Respir Crit Care Med*. 2009;179(6):501–508.
- Chai-Coetzer CL, Antic NA, Rowland LS, et al. Primary care vs specialist sleep center management of obstructive sleep apnea and daytime sleepiness and quality of life: a randomized trial. *JAMA*. 2013;309(10):997–1004.
- Parsons EC, Mattox EA, Beste LA, et al. Development of a sleep telementorship program for rural department of veterans affairs primary care providers: sleep veterans affairs extension for community healthcare outcomes. *Ann Am Thorac Soc*. 2017;14(2):267–274.

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication December 29, 2017

Submitted in final revised form December 29, 2017

Accepted for publication December 29, 2017

Address correspondence to: Martha E. Billings, MD, MSc, UW Medicine Sleep Center, Harborview Medical Center, Box 359803, 325 Ninth Avenue, Seattle, WA 98104; Email: mebillin@uw.edu

DISCLOSURE STATEMENT

Dr. Donovan reports grant support from the NIH/NHLBI T32HL007287-38 during the conduct of this work. This work was performed at the University of Washington in Seattle, WA. All authors have seen and approve of the manuscript. The authors report no conflicts of interest.