

Nasal Cannula Dislodgement During Sleep in Veterans Receiving Long-term Oxygen Therapy for Hypoxemic Chronic Respiratory Failure

Zane Elfessi, PharmD, BCPS, BCCCP^{a,b}; Ahmed Mahgoub, MD^a; Emily Tran, PharmD^{a,b}; Grace McGee^b; Israel Rubinstein, MD^{a,b}

Background: Chronic obstructive pulmonary disease (COPD) is highly prevalent in male veterans. Long-term oxygen therapy (LTOT) can effectively reduce all-cause mortality in these patients, but the effects of nasal cannula dislodgement (NCD) during sleep have not been well studied.

Methods: This study sought to determine whether veterans receiving LTOT for hypoxemic chronic respiratory failure (CRF) due to COPD reported NCD while they slept and, if so, its impact on hospitalizations for COPD exacerbations. Electronic health records were reviewed of veterans with hypoxemic CRF due to COPD who received LTOT and were followed in the pulmonary clinic at the Jesse Brown Veterans Affairs Medical Center between February 1, 2022, and December 31, 2022. Overall hospital cost was calculated for each hospitalized veteran with diagnosed COPD exacerbation. Veterans reported whether they experienced

NCD during sleep and, if so, its frequency.

Results: Interviews were conducted with 66 veterans with a mean age of 71 years. Twenty-two veterans (33%) reported NCD ≥ 1 weekly (median, 4). There were no statistically significant differences in demographics, supplemental oxygen flow rate, duration of LTOT, and pulmonary function tests between patients with and without NCD. Ten patients (45%) with NCD and 9 patients (20%) without NCD were hospitalized for ≥ 1 COPD exacerbation ($P = .045$). Three patients (14%) with NCD were admitted to the medical intensive care unit. Overall hospital costs were 25% higher in the NCD group compared with the no NCD group.

Conclusions: Veterans receiving LTOT for hypoxemic CRF due to COPD who report frequent NCD during sleep have higher hospitalization rates for COPD exacerbation and higher hospital costs.

The prevalence of chronic obstructive pulmonary disease (COPD) among male US veterans is higher than in the general population.¹ Veterans with COPD have higher rates of comorbidities and increased respiratory-related and all-cause health care use, including the use of long-term oxygen therapy (LTOT).²⁻⁵ It has been well established that LTOT reduces all-cause mortality in patients with COPD and resting hypoxemic chronic respiratory failure (CRF) when used for ≥ 15 hours per day.⁶⁻⁸

Delivery of domiciliary LTOT entails placing a nasal cannula into both nostrils and loosely securing it around both ears throughout the wake-sleep cycle. Several veterans with hypoxemic CRF due to COPD at the Jesse Brown Veterans Affairs Medical Center (JBVAMC) in Chicago, Illinois, who were receiving LTOT reported nasal cannula dislodgement (NCD) while they slept. However, the clinical significance and impact of these repeated episodes on respiratory-related health care utilization, such as

frequent COPD exacerbations with hospitalization, were not recognized. Moreover, we found no published reports or clinical practice guidelines alluding to similar events reported by patients with hypoxemic CRF due to COPD receiving LTOT either at home or in an acute care setting.^{8,9} Nonetheless, frequent COPD exacerbations are associated with increased hospital admissions and account for a large portion of health care costs attributed to COPD.¹⁰⁻¹³

The purpose of this study was to determine whether veterans with hypoxemic CRF due to COPD and receiving 24-hour LTOT at JBVAMC were experiencing NCD during sleep and, if so, its impact on their hospitalizations for COPD exacerbations.

METHODS

We reviewed electronic health records (EHRs) of veterans with hypoxemic CRF from COPD who received 24-hour LTOT administered through nasal cannula and were followed in the JBVAMC pulmonary outpatient clinic between February 1, 2022, and December 31, 2022. In each case,

Author affiliations can be found at the end of this article.

Correspondence: Israel Rubinstein (irubinst@uic.edu)

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TABLE 1 Patient Baseline Demographics

Characteristics	Nasal cannula dislodgement		P value
	Yes (n = 22)	No (n = 44)	
Age, mean (SD), y	70.8 (7.5)	71.7 (7.4)	.65
Male sex, No. (%)	22 (100)	44 (100)	.99
Race, No. (%)			
Black	14 (64)	21 (48)	.22
White	7 (32)	22 (50)	.16
Other	1 (4)	1 (2)	.61
Body mass index, mean (SD)	29.1 (7.5)	30.9 (9.9)	.46
Long-term oxygen therapy duration, mean (SD), wk	61 (85)	66 (54)	.77
Supplemental O ₂ flow rate, mean (SD), L/min	2.8 (1)	2.5 (0.8)	.2
Obstructive sleep apnea, No. (%)	6 (27)	11 (25)	.84
Dislodgements per wk, median	4	–	

LTOT was prescribed by a board-certified pulmonologist based on Veterans Health Administration clinical practice guidelines.¹⁴ A licensed durable medical equipment company contracted by the JBVAMC delivered and established home oxygen equipment at each veteran's residence.

Pertinent patient demographics, clinical and physiologic variables, and hospitalizations with length of JBVAMC stay for each physician-diagnosed COPD exacerbation in the preceding year from the date last seen in the clinic were abstracted from EHRs. Overall hospital cost, defined as a veteran overnight stay in either the medical intensive care unit (MICU) or a general acute medicine bed in a US Department of Veterans Affairs (VA) facility, was calculated for each hospitalization for physician-diagnosed COPD exacerbation using VA Managerial Cost Accounting System National Cost Extracts for inpatient encounters.¹⁵ We then contacted each veteran by telephone and asked whether they had experienced NCD and, if so, its weekly frequency ranging from once to nightly.

Data Analysis

Data were reported as mean (SD) where appropriate. The *t* test and Fisher exact test were used as indicated. *P* < .05 was considered statistically significant. The

study protocol was determined to be exempt by the JBVAMC Institutional Review Board (Protocol #1725748).

RESULTS

During the study period, 75 patients with hypoxemic CRF from COPD received LTOT and were followed at the JBVAMC. No patients were hospitalized outside the JBVAMC for COPD exacerbation during this time frame. We also found no documentation in the EHRs indicating that the clinicians managing these patients at the JBVAMC inquired about NCD during sleep.

Of the 75 patients, 66 (88%) responded to the telephone survey and 22 patients (33%) reported weekly episodes of NCD while they slept (median, 4 dislodgments per week). (Table 1). Eight patients (36%) reported nightly NCDs (Figure). All 66 respondents were male and 14 of 22 in the NCD group as well as 21 of 44 in the no NCD group were Black veterans. The mean age was similar in both groups: 71 years in the NCD group and 72 years in the no NCD group. There were no statistically significant differences in demographics, including prevalence of obstructive sleep apnea (OSA), supplemental oxygen flow rate, and duration of LTOT, or in pulmonary function test results between patients

who did and did not experience NCD while sleeping (Table 2).

Ten of 22 patients (45%) with NCD and 9 of 44 patients (20%) without NCD were hospitalized at the JBVAMC for ≥ 1 COPD exacerbation in the preceding year that was diagnosed by a physician ($P = .045$). Three of 22 patients (14%) with NCD and no patients in the no NCD group were admitted to the MICU. No patients required intubation and mechanical ventilation during hospitalization, and no patients died. Overall hospital costs were 25% (\$64,342) higher in NCD group compared with the no NCD group and were attributed to the MICU admissions in the NCD group (Table 3). Nine veterans did not respond to repeated telephone calls. One physician-diagnosed COPD exacerbation requiring hospitalization was documented in the nonresponder group; the patient was hospitalized for 2 days. One veteran died before being contacted.

DISCUSSION

There are 3 new findings in this study. First, health care practitioners at JBVAMC did not document the presence of NCD during sleep in patients with hypoxemic CRF due to COPD and receiving LTOT. Second, one-third of these patients reported frequent NCD during sleep when interviewed. Third, the nocturnal events were associated with a higher hospitalization rate for physician-diagnosed COPD exacerbation and higher overall hospital costs. These findings are unlikely to be explained by differences in COPD severity and/or known triggers that lead to COPD exacerbation and require hospitalization because baseline physiologic and LTOT parameters were similar in both groups. Conceivably, patients with untreated OSA could be restless while asleep, leading to NCD. However, this explanation seems unlikely because the frequency of OSA was similar in both groups.

Nocturnal arterial oxygen desaturation in patients with COPD without evidence of OSA may contribute to the frequency of exacerbations.¹⁶ Although the mechanism(s) underlying this phenomenon is uncertain, we posit that prolonged nocturnal airway wall hypoxia could amplify underlying

TABLE 2 Pulmonary Function Tests

Tests	Nasal cannula dislodgement, mean (SD)		P value
	Yes (n = 22)	No (n = 44)	
FVC, L	3.0 (0.7)	2.9 (0.9)	.70
FEV ₁ , L	1.65 (0.6)	1.7 (0.7)	.63
FEV ₁ , % predicted	53 (18)	53 (23)	.81
FEV ₁ /FVC	56 (19)	59 (15)	.55
DL _{CO} , mL/min/mm Hg	11.4 (3.7)	13.4 (5.4)	.17
DL _{CO} , % predicted	42.9 (14)	46.4 (14.6)	.38

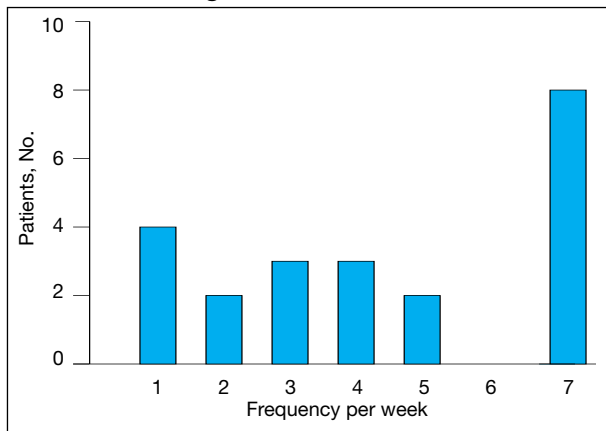
Abbreviations: DL_{CO}, diffusing capacity of the lungs for carbon monoxide; FEV₁, forced expiratory volume in 1 second; FVC, forced vital capacity.

TABLE 3 Outcomes Related to Chronic Obstructive Pulmonary Disease

Outcomes	Nasal cannula dislodgement		P value
	Yes (n = 22)	No (n = 44)	
Exacerbations			
Patients, No. (%)	10 (45)	9 (20)	.045
Hospitalizations, No.	21	22	–
MICU admission, No. (%)	3 (14)	0	.23
Length of stay, mean (SD), d	4.2 (2.2)	3.9 (1.5)	.61
Overall hospital costs, \$	321,217	256,874	–

Abbreviations: MICU, medical intensive care unit.

chronic inflammation through local generation of reactive oxygen species, thereby predisposing patients to exacerbations. Frequent COPD exacerbations promote disease progression and health status decline and are associated with increased mortality.^{11,13} Moreover, hospitalization of patients with COPD is the largest contributor to the annual direct cost of COPD per patient.^{10,12} The higher hospitalization rate observed in the NCD group in our study suggests that interruption of supplemental oxygen delivery while asleep may be a risk factor for COPD exacerbation. Alternatively, an independent factor or factors may have contributed to both NCD during sleep and COPD exacerbation in these patients or an impending exacerbation resulted in sleep disturbances that led to NCD. Additional research is warranted on veterans with hypoxemic CRF from COPD who are receiving LTOT

FIGURE Frequency of Weekly Nocturnal Nasal Cannula Dislodgements

and report frequent NCD during sleep that may support or refute these hypotheses.

To the best of our knowledge, NCD during sleep has not been previously reported in patients with hypoxemic CRF due to COPD who are receiving LTOT at home or in an acute care setting.¹⁷⁻²⁰ Several layperson proposals to secure nasal cannulas to the face while sleeping are posted online. These include wearing a commercially available headband with 2 Velcro loops that fix the cannula tube, using fabric medical tape on both cheeks, and wearing a sleep mask. Conceivably, the efficacy and safety of these inexpensive interventions to mitigate NCD during sleep in patients receiving LTOT with hypoxemic CRF from COPD could be tested in clinical trials.

Limitations

This was a small, single-site study, comprised entirely of male patients who are predominantly Black veterans. The telephone interviews with veterans self-reporting NCD during their sleep are prone to recall bias. In addition, the validity and reproducibility of NCD during sleep were not addressed in this study. Missing data from 9 nonresponders may have introduced a non-response bias in data analysis and interpretation. The overall hospital cost for a COPD exacerbation at JBVAMC was derived from VA data; US Centers for Medicare & Medicaid Services or commercial carrier data may be different.^{15,21} Lastly, access to LTOT for veterans with hypoxemic CRF from COPD

is regulated and supervised at VA medical facilities.¹⁴ This process may be different for patients outside the VA. Taken together, it is difficult to generalize our initial observations to non-VA patients with hypoxemic CRF from COPD who are receiving LTOT. We suggest a large, prospective study of veterans be conducted to determine the prevalence of NCD during sleep and its relationship with COPD exacerbations in veterans receiving LTOT with hypoxemic CRF due to COPD.

CONCLUSIONS

Clinicians at the JBVAMC did not document the presence of NCD during sleep in patients with hypoxemic CRF from COPD who received LTOT. However, self-reported, weekly nocturnal NCD episodes were associated with a higher hospitalization rate for COPD exacerbation and higher hospital costs. Accordingly, user-friendly devices to mitigate NCD during sleep should be developed.

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Author affiliations

^aJesse Brown Veterans Affairs Medical Center, Chicago, Illinois
^bUniversity of Illinois Chicago College of Pharmacy

Author roles

All authors were involved in the conception, study design, data acquisition, analysis, writing, and editing of the manuscript.

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Disclaimer

The opinions expressed herein are those of the authors and do not necessarily reflect those of *Federal Practitioner*, Frontline Medical Communications Inc., the US Government, or any of its agencies.

Ethics and consent

The study protocol was determined to be exempt by Jesse Brown Veterans Affairs Medical Center Institutional Review Board (Protocol #1725748).

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